

Comparative Clinico-Radiological Outcomes of Total Hip Arthroplasty and Bipolar Hemiarthroplasty for Femoral Neck Fractures: An Ambispective Cohort Study

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ABSTRACT

Background: Displaced femoral neck fractures in older adults are commonly managed by either bipolar hemiarthroplasty (BHA) or total hip arthroplasty (THA). Although THA may offer better functional recovery and restoration of hip biomechanics, it is generally associated with longer operative time, greater blood loss, and concerns regarding instability. Evidence from Indian tertiary-care settings that simultaneously evaluates functional and radiological outcomes remains limited. **Methods:** This hospital-based ambispective comparative cohort study was conducted in the Department of Orthopaedics, Dr Rajendra Gode Medical College and Hospital, Amravati, among patients aged 50–80 years with femoral neck fractures treated with either THA or BHA. The calculated sample size was 25 patients per group (total n=50). Patients were assessed for perioperative variables, Harris Hip Score (HHS) at 3, 6, and 12 months, postoperative complications, mortality, femoral offset restoration, limb-length discrepancy, ambulation status, and patient satisfaction. Continuous variables were compared using the independent-samples t test and categorical variables using the chi-square test; $p < 0.05$ was considered statistically significant. **Results:** The groups were comparable with respect to age, sex, fracture side, and comorbidity profile. THA required significantly longer operative time than BHA (93.69 ± 7.65 vs 72.99 ± 6.48 minutes; $p < 0.0001$) and was associated with greater blood loss (506.37 ± 59.22 vs 296.47 ± 37.76 mL; $p < 0.0001$) and longer hospital stay (9.26 ± 1.89 vs 7.64 ± 1.04 days; $p = 0.0005$). However, HHS was significantly higher after THA at 3 months (78.5 ± 10.3 vs 66.9 ± 8.1), 6 months (83.3 ± 7.7 vs 72.2 ± 9.4), and 12 months (90.4 ± 9.7 vs 76.0 ± 10.5), with all comparisons statistically significant. Restoration of femoral offset was achieved in 92% of THA patients and 72% of BHA patients; minimal limb-length discrepancy (< 1 cm) was present in 88% and 64%, respectively. Independent ambulation at 3 months was more frequent after THA (72% vs 44%; $p = 0.028$). Six-month satisfaction was also higher following THA (8.8 ± 1.2 vs 7.1 ± 1.6 ; $p = 0.002$). One-year mortality and overall complication rates were comparable. **Conclusion:** In independently ambulatory adults with femoral neck fractures, THA produced superior functional recovery, radiological restoration, early ambulation, and patient satisfaction compared with BHA, at the cost of greater operative time, blood loss, and hospital stay. BHA remains a reasonable option when reduced surgical burden is prioritized. Procedure selection should therefore be individualized according to physiological reserve, baseline mobility, functional demand, life expectancy, and surgical risk.

Keywords: femoral neck fracture; total hip arthroplasty; bipolar hemiarthroplasty; Harris Hip Score; femoral offset; limb-length discrepancy

INTRODUCTION

Femoral neck fractures are among the most consequential fragility injuries encountered in orthopaedic practice. They are associated with substantial mortality, prolonged disability, loss of independence, and considerable health-care expenditure. The burden is expected to increase as populations age, particularly in low- and middle-income countries where the absolute number of older adults is rising rapidly and access to organized fracture prevention and rehabilitation is variable.[1,2] Hip fractures are especially important because the clinical event is not limited to a local skeletal injury; it frequently precipitates immobility, thromboembolism, pulmonary complications, pressure injuries, delirium, and deterioration in pre-existing medical illness. Early surgery, medical optimization, and mobilization remain central to contemporary management.[3]

Displaced intracapsular fractures of the femoral neck have a high risk of non-union and avascular necrosis because the injury can compromise the retinacular blood supply to the femoral head. In older adults, arthroplasty therefore commonly replaces internal fixation when the fracture is displaced and the probability of biological failure is high.[3,4] The two principal arthroplasty strategies are hemiarthroplasty, in which the femoral head is replaced while the native acetabulum is retained, and total hip arthroplasty (THA), in which both the femoral and acetabular sides of the articulation are reconstructed. Bipolar hemiarthroplasty (BHA) remains widely used because it is technically less demanding, generally requires less operative time and blood loss, and can provide reliable pain relief and early mobilization in lower-demand patients.

THA offers potential advantages in patients who were independently mobile before injury and who are expected to remain active after recovery. Replacement of the acetabular surface avoids progressive acetabular erosion and permits greater control over joint biomechanics. Randomized trials and systematic reviews have generally shown modestly superior hip function and quality-of-life measures after THA, although these benefits must be weighed against increased operative complexity and a higher risk of instability in some populations.[5-9] The large multicentre HEALTH trial found no significant reduction in secondary hip procedures with THA compared with hemiarthroplasty over 24 months, while functional outcomes modestly favoured THA and instability was more frequent after THA.[5] These findings highlight that the choice of arthroplasty cannot be based on functional scores alone.

An additional determinant of postoperative function is restoration of native hip biomechanics. Femoral offset the perpendicular distance from the centre of the femoral

head to the long axis of the femoral shaft affects abductor muscle tension, joint reaction force, gait, range of motion, and stability.[10,11] Failure to restore offset may result in abductor weakness, Trendelenburg gait, reduced walking efficiency, or instability. Similarly, limb-length discrepancy can adversely affect gait and patient satisfaction. Modular THA systems provide multiple options for femoral neck length, head size, stem offset, and acetabular positioning and may therefore allow more precise restoration of anatomy. Modern bipolar systems also permit adjustment, but the retained acetabulum can limit the surgeon's ability to optimize the reconstructed centre of rotation.

In clinical practice, the apparent advantage of THA in function must be balanced against perioperative burden, particularly in older patients with diabetes, hypertension, cardiovascular disease, pulmonary disease, poor bone quality, or limited physiological reserve. BHA may be preferable in patients in whom minimizing anaesthetic time, blood loss, and surgical stress is more important than maximizing long-term hip performance. Current guidelines therefore emphasize patient selection, premorbid mobility, cognitive status, comorbidity, and expected life span rather than a universal preference for one implant.[3]

Indian data are important because patient characteristics, referral delays, implant affordability, rehabilitation resources, and expectations after surgery may differ from those in large Western trials. Furthermore, many comparative studies focus primarily on functional scores and complications, while radiological restoration of femoral offset and limb length is less frequently integrated with ambulation and patient satisfaction. A combined clinico-radiological assessment can provide a more complete evaluation of whether anatomical reconstruction translates into meaningful recovery.

The present study compared THA and BHA for femoral neck fractures in a tertiary teaching hospital in Amravati. The primary objective was to compare postoperative clinical and functional improvement between the two procedures. Secondary objectives were to compare restoration of femoral offset, limb-length discrepancy, patient satisfaction, ambulation, perioperative characteristics, postoperative complications, and one-year mortality. We hypothesized that THA would provide superior functional and radiological outcomes but would require greater operative time and blood loss than BHA.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based ambispective comparative cohort study was conducted in the Department of Orthopaedics, Dr Rajendra Gode Medical College and Hospital,

Amravati, Maharashtra, India. The source study described both prospective enrolment/follow-up and retrospective analysis of previously available medical records; accordingly, the manuscript reports the design as ambispective. The study duration was 12 months. Patients were managed according to routine institutional orthopaedic and perioperative protocols.

Study Population

Patients aged 50–80 years with femoral neck fractures who underwent either THA or BHA were eligible. Only patients who had been independently ambulatory before injury and had no contraindication to anaesthesia were included. The study cohort comprised patients with adequate immediate postoperative documentation and follow-up required for outcome assessment.

Inclusion and Exclusion Criteria

Inclusion criteria were age 50–80 years, femoral neck fracture, independent ambulation before injury, suitability for anaesthesia, and availability for the planned postoperative follow-up. Patients were excluded if arthroplasty had been performed for an indication other than femoral neck fracture, if the fracture was pathological, if pre-existing osteoarthritis or rheumatoid arthritis affected the fractured hip, if the patient had been non-ambulatory before injury, if relevant medical records were incomplete, or if the patient was lost to follow-up.

Sample-size Estimation

Sample size was estimated for comparison of mean Harris Hip Score (HHS) between two independent groups. Using an assumed standard deviation of 10.4, a minimum clinically relevant between-group difference of 8.8 points, a two-sided alpha of 0.05 ($Z_{\alpha/2}=1.96$), and 80% power ($Z_{\beta}=0.84$), the estimated requirement was approximately 22 participants per group. After allowing approximately 10% for attrition or incomplete follow-up, the final target was 25 participants in each group, yielding a total sample of 50 patients. The analysed cohort therefore consisted of 25 THA and 25 BHA patients.

Treatment Groups and Operative Technique

The decision to perform THA or BHA was made by the treating orthopaedic team according to the patient's clinical profile, premorbid activity, fracture characteristics, comorbidities, expected functional demand, and surgical suitability. Procedures were performed by trained orthopaedic consultants. Both cemented and uncemented femoral stems were represented in the cohort. Because implant fixation was not the primary exposure under study, outcomes were

analysed according to procedure type (THA versus BHA).

Clinical and Radiological Assessment

Demographic characteristics, clinical history, physical examination findings, fracture side, comorbidities, perioperative variables, and postoperative outcomes were recorded using a standardized case-record proforma. Operative time and estimated intraoperative blood loss were recorded. Duration of hospital stay and postoperative complications were documented.

Functional outcome was assessed using the Harris Hip Score, a 100-point clinician-based instrument that incorporates pain, function, deformity, and range of motion.[12] Higher scores indicate better hip function. HHS was recorded at 3, 6, and 12 months. The study also classified overall functional outcome as good or poor according to the criteria used in the source dataset.

Radiographic assessment was performed using anteroposterior pelvic radiographs obtained with attention to standardized patient positioning and avoidance of pelvic tilt. A calibration marker was used to improve measurement consistency. Femoral offset was defined as the perpendicular distance from the centre of the femoral head to the long axis of the femoral shaft. Preoperative native offset was assessed for planning, and postoperative offset was measured using the prosthetic femoral head centre and femoral shaft axis. Restoration was considered satisfactory when postoperative reconstruction approximated the planned/native offset according to the study protocol.

Limb-length discrepancy (LLD) was assessed clinically and radiographically. True limb length was measured from the anterior superior iliac spine to the medial malleolus, and postoperative discrepancy was recorded. For comparative reporting, minimal LLD was defined as <1 cm.

Additional Patient Centered Outcomes

Ambulation status at 3 months was classified as independent without an aid, walker/cane-assisted, or bedridden/minimally mobile. Patient satisfaction was assessed at 6 months on a 0–10 scale, with higher values indicating greater satisfaction. Postoperative complications included superficial infection, deep infection, dislocation, periprosthetic fracture, and groin pain. Mortality within one year of surgery was recorded.

Outcome Measures

The principal clinical outcome was postoperative functional recovery measured by serial HHS. Secondary outcomes included femoral offset restoration, minimal LLD, ambulation status at 3 months, satisfaction at 6 months, operative time, intraoperative blood loss,

duration of hospitalization, postoperative complications, and one-year mortality.

Statistical Analysis

Data were coded and analysed using SPSS version 22. Continuous variables were summarized as mean±standard deviation and categorical variables as frequency and percentage. The independent-samples t test was used for comparison of continuous variables between THA and BHA groups. Categorical variables were compared using the chi-square test as described in the source analysis. A two-sided p value <0.05 was considered statistically significant. The analysis was primarily unadjusted because of the modest sample size and the broadly comparable baseline characteristics of the two groups.

Ethical Considerations

The study was undertaken after Institutional Ethics Committee approval, and confidentiality of patient information was maintained through anonymized study records. Written informed consent was obtained for prospectively enrolled participants. The IEC approval number and exact approval date should be inserted in the final journal submission from the institutional record.

RESULTS

A total of 50 patients were analysed, with 25 patients in the THA group and 25 in the BHA group. Baseline demographic and clinical characteristics were comparable between the groups. The largest age stratum was 66–70 years (32% in THA and 28% in BHA). Men constituted 60% of the THA group and 56% of the BHA group. Right-sided fractures were present in 52% of THA and 40% of BHA patients. Hypertension and diabetes were the most frequent comorbidities, while 48% of THA patients and 44% of BHA patients had no recorded comorbidity. None of these baseline differences reached statistical significance (Table 1).

Perioperative outcomes differed substantially between procedures. Mean operative time was 93.69±7.65

minutes for THA and 72.99±6.48 minutes for BHA ($p<0.0001$). Estimated intraoperative blood loss was also significantly greater with THA (506.37±59.22 mL) than with BHA (296.47±37.76 mL; $p<0.0001$). Mean hospital stay was 9.26±1.89 days after THA and 7.64±1.04 days after BHA ($p=0.0005$) (Table 2).

Functional recovery consistently favoured THA. At 3 months, mean HHS was 78.5±10.3 in the THA group compared with 66.9±8.1 in the BHA group ($p=0.0001$). At 6 months, mean HHS was 83.3±7.7 versus 72.2±9.4 ($p<0.0001$), and at 12 months it was 90.4±9.7 versus 76.0±10.5 ($p<0.0001$). Thus, the between-group difference persisted and increased during follow-up. Using the study's categorical definition of functional outcome, all 25 THA patients were classified as having a good outcome, compared with 16 (64%) BHA patients; 9 (36%) BHA patients were classified as having a poor outcome ($p=0.0032$) (Table 3).

THA was also associated with more favourable radiological and patient-centred outcomes. Femoral offset was satisfactorily restored in 92% of THA patients compared with 72% of BHA patients. Minimal postoperative LLD (<1 cm) was present in 88% and 64%, respectively. At 3 months, 18 (72%) THA patients were independently ambulatory without an aid, 6 (24%) required a walker or cane, and 1 (4%) had minimal mobility. In the BHA group, 11 (44%) were independently ambulatory, 10 (40%) required an aid, and 4 (16%) were minimally mobile or bedridden ($p=0.028$). Mean satisfaction score at 6 months was 8.8±1.2 after THA and 7.1±1.6 after BHA ($p=0.002$) (Table 4).

Complication rates were low in both groups. One superficial infection occurred in each group. The BHA group additionally had one deep infection, one periprosthetic fracture, and one case of groin pain. No dislocation occurred in either group during the reported follow-up. One-year mortality was 8% (2/25) after THA and 12% (3/25) after BHA; this difference was not statistically significant ($p=0.98$) (Table 5).

Table 1. Baseline demographic and clinical characteristics

Characteristic	THA (n=25)	BHA (n=25)	p value
Age 51–60 years	2 (8%)	3 (12%)	0.9493*
Age 61–65 years	7 (28%)	4 (16%)	
Age 66–70 years	8 (32%)	7 (28%)	
Age 71–75 years	5 (20%)	7 (28%)	
Age 76–80 years	3 (12%)	4 (16%)	
Male sex	15 (60%)	14 (56%)	0.96
Right-sided fracture	13 (52%)	10 (40%)	0.5704
Hypertension	6 (24%)	5 (20%)	0.6467*
Diabetes mellitus	4 (16%)	6 (24%)	
Coronary artery disease	2 (8%)	3 (12%)	
COPD	1 (4%)	0	
No recorded comorbidity	12 (48%)	11 (44%)	

*Overall p value for the relevant categorical distribution.

Table 2. Perioperative outcomes

Outcome	THA	BHA	p value
Operative time (min), mean±SD	93.69±7.65	72.99±6.48	<0.0001
Intraoperative blood loss (mL), mean±SD	506.37±59.22	296.47±37.76	<0.0001
Hospital stay (days), mean±SD	9.26±1.89	7.64±1.04	0.0005

Table 3. Functional outcomes

Outcome	THA	BHA	p value
HHS at 3 months, mean±SD	78.5±10.3	66.9±8.1	0.0001
HHS at 6 months, mean±SD	83.3±7.7	72.2±9.4	<0.0001
HHS at 12 months, mean±SD	90.4±9.7	76.0±10.5	<0.0001
Good functional outcome	25 (100%)	16 (64%)	0.0032
Poor functional outcome	0	9 (36%)	

Table 4. Radiological, ambulation, and satisfaction outcomes

Outcome	THA	BHA	p value
Femoral offset restored	23 (92%)	18 (72%)	Not reported
Minimal LLD (<1 cm)	22 (88%)	16 (64%)	Not reported
Independent ambulation at 3 months	18 (72%)	11 (44%)	0.028*
Walker/cane-assisted at 3 months	6 (24%)	10 (40%)	
Bedridden/minimal mobility at 3 months	1 (4%)	4 (16%)	
Satisfaction at 6 months (0–10), mean±SD	8.8±1.2	7.1±1.6	0.002

*Overall p value for ambulation-status distribution. LLD, limb-length discrepancy.

Table 5. Postoperative complications and one-year mortality

Outcome	THA (n=25)	BHA (n=25)
Superficial infection	1 (4%)	1 (4%)
Deep infection	0	1 (4%)
Dislocation	0	0
Periprosthetic fracture	0	1 (4%)
Groin pain	0	1 (4%)
One-year mortality	2 (8%)	3 (12%); p=0.98

DISCUSSION

The present study compared THA and BHA in adults aged 50–80 years with femoral neck fractures and demonstrated a consistent clinical trade-off. THA was associated with superior serial HHS, better restoration of femoral offset and limb length, a greater proportion of independent ambulation at 3 months, and higher patient satisfaction. Conversely, BHA required less operative time, resulted in less blood loss, and was associated with a shorter hospital stay. Mortality and the overall frequency of complications were broadly comparable.

These findings support individualized arthroplasty selection rather than a single procedure for all patients. The most striking difference was in postoperative function. HHS was approximately 12 points higher after THA at 3 months and 14 points higher at 12 months. This pattern is directionally consistent with several randomized trials and meta-analyses showing better hip-specific function after THA in independently mobile or physiologically fit patients.[5-9] Keating et al. demonstrated better functional outcomes after THA than bipolar hemiarthroplasty among healthy older patients

with displaced intracapsular fractures, although THA was more resource intensive.[6] Earlier pooled analyses similarly suggested improvements in function and lower reoperation risk with THA, while acknowledging a higher risk of dislocation.[7,8]

The HEALTH trial substantially refined this interpretation. In 1,495 independently ambulatory patients, THA did not significantly reduce the incidence of secondary hip procedures at 24 months compared with hemiarthroplasty. Although functional and quality-of-life measures modestly favoured THA, the magnitude of average benefit was small and serious adverse events were somewhat more frequent.[5] The present study found a larger HHS separation than HEALTH, which may reflect its smaller sample, non-randomized treatment allocation, different implant choices, local rehabilitation pathways, and patient selection. Because surgeons may preferentially select THA for fitter and more active patients, residual confounding by physiological reserve and baseline function cannot be excluded. Consequently, the observed functional advantage should be interpreted as an association within this cohort rather than proof that procedure type alone caused the entire difference.

Radiological restoration provides a plausible biomechanical explanation for some of the functional findings. Femoral offset influences the lever arm of the hip abductors, joint reaction forces, range of motion, and soft-tissue tension.[10,11] In this study, satisfactory offset restoration was more frequent after THA (92%) than BHA (72%). THA also yielded a higher proportion of patients with postoperative LLD <1 cm. Modular femoral stems and head-neck options, combined with acetabular reconstruction, permit the surgeon to alter the centre of rotation and femoral length more precisely. In BHA, the native acetabulum is preserved and the available options for correcting centre-of-rotation and soft-tissue tension may be more constrained.

Asayama et al. showed that reconstructed femoral offset influences abductor strength after THA, and Sariali et al. emphasized the importance and technical challenge of accurate offset reconstruction.[10,11] These relationships are clinically relevant because inadequate offset may lead to abductor insufficiency, limp, fatigue, or instability, whereas excessive offset can increase soft-tissue tension and joint reaction forces. The present findings suggest that radiographic reconstruction and functional recovery may be linked, but the study was not designed to test a formal correlation between the magnitude of offset error and HHS. A future prospective analysis using continuous offset measurements and multivariable modelling would be useful.

Early ambulation also favoured THA: 72% of THA patients were independently mobile at 3 months compared with 44% after BHA. Early restoration of

mobility is particularly important after hip fracture because prolonged dependence increases the risk of deconditioning, medical complications, institutionalization, and loss of prefracture independence. The difference observed here is consistent with the higher HHS and better biomechanical restoration in the THA group. However, ambulation after hip fracture is multifactorial. Cognitive status, cardiopulmonary reserve, pre-injury walking distance, fear of falling, contralateral limb disease, sarcopenia, family support, and access to physiotherapy can all affect recovery. These variables were not fully adjusted for in the source dataset, so the association should be interpreted cautiously.

Patient satisfaction was significantly higher after THA at six months. Satisfaction reflects more than radiographic success; it incorporates pain relief, perceived stability, walking ability, confidence, independence, and concordance between expectations and achieved function. A mean difference of 1.7 points on a 10-point scale suggests that the superior objective outcomes after THA were also perceived by patients. Nevertheless, satisfaction scoring in this study was a simple numerical scale rather than a formally validated patient-reported outcome measure. Future work should incorporate instruments such as EQ-5D, Oxford Hip Score, WOMAC, or the Forgotten Joint Score to provide standardized patient-reported outcome data.

The functional advantages of THA came at the cost of substantially greater surgical burden. Operative time was about 21 minutes longer and blood loss about 210 mL greater than with BHA. These differences are expected because THA requires acetabular exposure and preparation, cup implantation, additional trial reduction, and a broader set of intraoperative decisions. Similar trends have been reported across comparative studies.[6-9] In frail patients, even modest increases in operative duration and blood loss may be clinically important, especially in the presence of anaemia, cardiovascular disease, renal dysfunction, anticoagulant use, or reduced physiological reserve. Thus, the superior HHS observed with THA should not automatically override perioperative risk.

Hospital stay was also longer after THA by approximately 1.6 days. In a resource-constrained setting, this difference has implications for bed occupancy, cost, and rehabilitation planning. However, length of stay is influenced by institutional practice, discharge criteria, social support, physiotherapy availability, and medical comorbidities. A longer index admission may be acceptable if it produces better long-term independence and reduces later health-care utilization, but this study did not include a formal cost-effectiveness analysis. Economic evaluation would be particularly relevant in Indian public and mixed-payment

health systems, where implant cost and out-of-pocket expenditure may influence treatment choice.

Complication rates were low and did not reveal a clear disadvantage for THA. Notably, no dislocations were recorded in either group. This differs from large trials and meta-analyses in which THA has generally been associated with more instability than hemiarthroplasty.[5,7-9] The absence of dislocation may reflect careful patient selection, surgical technique, implant positioning, postoperative precautions, and the small sample. With only 25 patients in each group, the study had limited power to detect uncommon events. Therefore, the absence of observed dislocation should not be interpreted as evidence that the two procedures have identical instability risk.

The BHA group had isolated cases of deep infection, periprosthetic fracture, and groin pain. Groin pain after hemiarthroplasty may be related to acetabular cartilage loading and progressive erosion, although longer follow-up is usually required to assess the true burden of acetabular wear. One rationale for THA in active patients with longer life expectancy is avoidance of painful acetabular degeneration and later conversion to THA. Conversion surgery can be more complex than primary THA and may be associated with inferior outcomes compared with an appropriately selected primary THA. In lower-demand patients, however, the native acetabulum may remain sufficiently tolerant of a bipolar prosthesis for the remainder of life.

One-year mortality was similar between groups (8% after THA and 12% after BHA). This is consistent with the broader literature, which generally indicates that mortality after hip fracture is driven more by age, frailty, comorbidity, perioperative complications, and prefracture health than by the choice between THA and hemiarthroplasty.[5,7,9] The study was not powered for mortality and the numerical difference of one death should not be overinterpreted.

A clinically useful way to interpret these results is to separate the goals of arthroplasty into two domains: minimizing immediate surgical burden and maximizing long-term hip performance. BHA performed well in the first domain, with shorter surgery, lower blood loss, and shorter hospitalization. THA performed better in the second domain, with higher functional scores, superior radiological reconstruction, greater early independence, and higher satisfaction. This distinction is consistent with guideline-based shared decision-making. A cognitively intact, independently ambulatory patient with good physiological reserve and a reasonable life expectancy may be more likely to benefit from THA. In contrast, a patient with limited activity, major comorbidity, or reduced life expectancy may reasonably be offered BHA to achieve pain relief and mobilization with less operative stress.[3]

The study has particular relevance to Indian tertiary-care practice. Hip fracture treatment often occurs in a context of late presentation, variable osteoporosis treatment, limited access to structured geriatric co-management, and inconsistent availability of prolonged rehabilitation. Implant affordability and family caregiving capacity can also influence choice. A procedure that produces somewhat better long-term hip function may not necessarily be the best option when surgical risk, cost, or rehabilitation constraints dominate. Conversely, selecting BHA solely because it is simpler may disadvantage physiologically fit patients who have high functional expectations and longer anticipated survival.

The study also illustrates the value of incorporating radiological outcomes into comparative hip-fracture research. HHS alone can identify a functional difference but does not explain why the difference occurs. Femoral offset and limb length provide mechanistic information about reconstruction quality. Future studies should record actual preoperative and postoperative offset values in millimetres, calculate absolute and percentage restoration error, assess acetabular and femoral component position, and correlate these variables with abductor strength, gait analysis, patient-reported outcomes, and dislocation. Such analyses could identify clinically meaningful thresholds for offset restoration rather than relying on a dichotomous satisfactory/unsatisfactory classification.

Several methodological issues deserve attention. First, treatment allocation was not randomized. Surgeons likely used patient fitness and functional demand when choosing THA or BHA, which may have created confounding by indication. Second, the study included both cemented and uncemented stems. Fixation method can influence early pain, periprosthetic fracture risk, operative physiology, and rehabilitation, but subgroup analysis was not feasible. Third, the modest sample limited precision for complications and mortality. Fourth, baseline HHS or a validated prefracture functional score was not available in a manner that permitted adjusted longitudinal modelling. Fifth, the study relied on a single-centre cohort, which improves consistency of practice but may limit generalizability.

Despite these limitations, the internal pattern of findings is coherent. The same procedure that produced better radiological reconstruction also produced higher HHS, faster independent ambulation, and greater satisfaction, while the procedure that was technically simpler produced lower blood loss and shorter operative time. This consistency supports the clinical plausibility of the results. Importantly, the study does not suggest that THA is universally superior; rather, it demonstrates that the choice involves a trade-off between perioperative burden and functional potential.

For clinical decision-making, the results support a structured selection framework. Prefracture independent mobility, cognitive status, life expectancy, comorbidity burden, anaesthetic risk, bone quality, and patient expectations should be assessed before selecting the implant. Where THA is chosen, meticulous restoration of offset, leg length, and component orientation is essential. Where BHA is selected, attention to femoral sizing, neck length, offset, and soft-tissue tension remains important to maximize function and reduce groin pain and instability.

Future research from Indian centres should use prospective multicentre designs with predefined treatment-selection criteria or randomization where feasible. Studies should include validated patient-reported outcome measures, frailty scores, cognitive assessment, ASA grade, time from injury to surgery, transfusion requirement, rehabilitation exposure, cost data, and longer radiographic follow-up for acetabular erosion and revision. Larger sample sizes would also permit adjusted analyses and evaluation of clinically important but uncommon complications. Such data would improve the precision with which THA and BHA can be matched to individual patients.

Strengths and Limitations

This study evaluated functional, perioperative, radiological, mobility, satisfaction, complication, and mortality outcomes within the same cohort, thereby providing a broader assessment than a comparison based only on HHS. Standardized radiographic principles were used for offset and limb-length assessment, and serial HHS measurements allowed evaluation of recovery over 12 months.

The principal limitations were the single-centre ambispective design, small sample size, and non-random treatment allocation. Residual confounding by patient fitness and prefracture activity is possible. The cohort included both cemented and uncemented stems without sufficient numbers for subgroup analysis. The study was underpowered for uncommon complications such as dislocation and periprosthetic fracture. A simple satisfaction score was used instead of a validated patient-reported outcome instrument. Exact continuous femoral-offset differences were not available for correlation analysis, and longer follow-up is needed to evaluate acetabular erosion, revision, and implant survivorship.

CONCLUSION

THA and BHA represent effective but clinically distinct strategies for femoral neck fractures. In this cohort, THA was associated with substantially better HHS at 3, 6, and 12 months, more frequent restoration of femoral offset, less clinically relevant limb-length discrepancy, faster return to independent ambulation, and greater patient

satisfaction. These advantages were accompanied by longer operative time, greater intraoperative blood loss, and longer hospital stay. One-year mortality and overall complication rates were similar.

Accordingly, THA may be preferred for physiologically fit, independently ambulatory patients with meaningful functional demands and sufficient life expectancy to benefit from improved hip performance. BHA remains appropriate when minimizing operative stress is a priority. The final choice should be individualized through careful assessment of baseline mobility, comorbidity, cognitive status, life expectancy, patient expectations, and local surgical resources.

Declarations

Ethics approval and consent to participate:

Institutional Ethics Committee approval was obtained before initiation of the study. Written informed consent was obtained for prospectively enrolled participants.

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