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Original Research Article

LONG-TERM FUNCTIONAL AND BIOMECHANICAL OUTCOMES OF BIPOLAR HEMIARTHROPLASTY FOR INTRACAPSULAR FEMORAL NECK FRACTURES: A RETROSPECTIVE ANALYSIS

Krishna Kunkumalla[1], Ajay Kumar Ambati[2], Sravankumar Kamarapu[3]

[1]Assistant Professor, Department of Orthopaedics, Government Medical College and Hospital, Kumuram Bheem Asifabad, Telangana, India
[2]Assistant Professor, Department of Orthopaedics, Father Colombo Institute of Medical Sciences, Hunter Road, Warangal, Telangana, India
[3]Assistant Professor, Department of Orthopaedics, Chalmeda Anandrao Institute of Medical Sciences, Karimnagar, Telangana, India.

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Corresponding Author:
Dr. Krishna Kunkumalla,
Assistant Professor, Department of Orthopaedics, Government Medical College and Hospital, Kumuram Bheem Asifabad, Telangana, India.
Email: krishnakunkumalla@gmail.com

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ABSTRACT

Background: Bipolar hemiarthroplasty is a widely used surgical intervention for intracapsular femoral neck fractures, particularly in elderly patients. The procedure aims to provide pain-free mobility, reduced acetabular erosion, and improved functional outcomes. This study evaluates the range of motion, functional outcomes, and implant stability in patients who underwent bipolar hemiarthroplasty.

Materials and Methods: A retrospective study was conducted on 56 patients who underwent bipolar hemiarthroplasty between 2006 and 2012. The Harris Hip Score (HHS) was used for functional assessment, while the range of motion at the inner and outer bearing was evaluated. The incidence of acetabular erosion, implant dissociation, and perioperative mortality was also recorded.

Results: Sex Distribution: 33% male (18) and 67% female (38). Age Distribution: Mean 66.03 years (range: 52–88 years). Range of Motion: Total abduction 24–31° (average 27.5°); Outer bearing: 15–24° (average 19.5°); Inner bearing: 4–9° (average 6.5°). Functional Outcomes: HHS > 90 in 28% of patients, mean HHS 83.77. Complications: No acetabular erosion, implant dissociation, or perioperative mortality.

Conclusion: Bipolar hemiarthroplasty provides long-term functional stability with minimal complications, maintaining inner bearing motion even after six years. The procedure offers significant pain relief, improved mobility, and low implant failure rates, making it a preferred choice for elderly patients with displaced femoral neck fractures.

Keywords: Bipolar hemiarthroplasty, intracapsular femoral neck fracture, Harris Hip Score, acetabular erosion, range of motion.

INTRODUCTION

Intracapsular femoral neck fractures are a common orthopedic condition, particularly in elderly patients, and often result in significant morbidity and loss of mobility.[1] These fractures are associated with osteoporosis and an increased risk of complications due to limited healing capacity in the femoral head. Surgical intervention is typically required to restore function and prevent long-term disability.[2]

Bipolar hemiarthroplasty is a widely adopted treatment for displaced femoral neck fractures, offering advantages over unipolar hemiarthroplasty and total hip arthroplasty in elderly patients.[3] The bipolar prosthesis consists of two articulating components—an inner bearing between the femoral head and the polyethylene liner and an outer bearing between the polyethylene liner and the acetabulum. This design aims to reduce acetabular erosion, decrease wear, and improve range of motion,

ultimately enhancing functional outcomes and implant longevity.[4,5]

Despite the widespread use of bipolar hemiarthroplasty, concerns remain regarding long-term implant stability, range of motion, and functional performance6. Previous studies have reported variations in inner and outer bearing motion, which may influence the overall success of the procedure.[6,7] Additionally, factors such as patient age, sex, and bone quality can impact postoperative recovery and implant behavior.

This study aims to evaluate the clinical and biomechanical outcomes of bipolar hemiarthroplasty in patients with intracapsular femoral neck fractures. Specifically, we assess postoperative range of motion, functional recovery using the Harris Hip Score (HHS), and implant stability over an extended follow-up period. By analyzing the distribution of movement between the inner and outer bearings and documenting complication rates, this study provides valuable insights into the efficacy and durability of bipolar hemiarthroplasty in elderly patients.

MATERIALS AND METHODS

Study Design: This retrospective study was conducted to assess the functional and biomechanical outcomes of bipolar hemiarthroplasty in patients with intracapsular femoral neck fractures. The study was carried out at Durgabai Deshmukh Hospital and Research Centre and included patients who underwent surgery between 2006 and 2012.

Patient Selection

A total of 96 patients underwent bipolar hemiarthroplasty during this period, and they were invited for follow-up in 2012. Out of these, 56 patients returned for evaluation. The average postoperative follow-up period was 3 years.

Inclusion Criteria

Patients meeting the following criteria were included in the study:

Age above 50 years

Acute intracapsular fracture of the femoral neck

Non-union intracapsular fracture of the femoral neck

Exclusion Criteria

Patients were excluded if they had:

Avascular necrosis (AVN) and underwent bipolar hemiarthroplasty

Bipolar hemiarthroplasty with cement fixation

Trochanteric fractures treated with bipolar hemiarthroplasty

Pre-existing conditions like hemiplegia, affecting hip function

Implant Details

The Talwalkar's bipolar hip prosthesis (INOR India) was used in all patients. The implant specifications were:

Stem: Stainless steel, 160 mm length, 8 mm thickness

Neck: 35 mm length, 125° neck-shaft angle, 19 mm diameter

Inner head: 28 mm diameter, articulating with an UHMWPE (ultra-high molecular weight polyethylene) liner

Outer cup: Stainless steel, with acetabular cup sizes ranging from 39 mm to 51 mm

Surgical Procedure

All surgeries were performed under standard aseptic precautions in an elective operation theatre.

Preoperative Management

Skin traction (3–5 kg) was applied preoperatively to relieve pain and prevent limb shortening.

NSAIDs were administered for pain relief.

Preoperative medical optimization was done for comorbid conditions like diabetes, hypertension, ischemic heart disease (IHD), COPD, and bronchial asthma, with consultations from relevant specialists.

Blood transfusion was provided when needed for anemia correction.

Preoperative exercises (deep breathing, static quadriceps exercises, and ankle movements) were taught to patients to facilitate postoperative rehabilitation.

A pre-anesthetic examination was conducted one day before surgery. Prophylactic antibiotics were administered one hour before anesthesia induction.

Surgical Approach

The posterolateral (Moore's) approach was utilized for the procedure. The patient was positioned in lateral decubitus, lying on the unaffected side. A skin incision was made, extending 5–7 cm distal to the posterior superior iliac spine, along the gluteus maximus to the posterior margin of the greater trochanter. The sciatic nerve was carefully preserved, while the obturator internus, gemelli, and piriformis were detached and tagged for reattachment. The femoral neck was prepared, ensuring that at least 1.75 cm (one finger breadth) of the calcar was preserved. The femoral canal was rasped and prepared for prosthesis insertion. The bipolar prosthesis was then inserted at 20° anteversion and gently impacted into the femoral shaft. After confirming implant stability, the capsule was closed, and the external rotators were reattached. The wound was closed in layers, and a suction drain was placed, which was removed after 48 hours. Blood transfusion was administered as necessary.

Postoperative Care

Mobilization was initiated on postoperative day 3, allowing weight-bearing as tolerated. Cross-legged sitting and squatting were restricted for 3–4 months to prevent strain on the implant. Parenteral antibiotics were administered for 5 days postoperatively to prevent infections. Sutures were removed on the 14th postoperative day, ensuring proper wound healing and reducing the risk of complications.

Outcome Measures and Evaluation

Range of Motion (ROM) Analysis

Radiographic Assessment:

Anteroposterior (AP) X-rays were taken with the patient in a neutral position.
The operated limb was abducted to the maximum possible extent while maintaining a neutral rotation.
The following angles were measured:
Angle A: Formed between the ischial reference line and the inferior acetabular margin.
Angle B: Formed between the ischial reference line and the femoral neck axis.
The difference between B1 (neutral position) and B2 (maximum abduction) represented the total hip abduction.
The difference between A1 (neutral) and A2 (maximum abduction) represented outer bearing motion.
Inner bearing motion was calculated as the difference between the two.
Implant Stability and Complications
X-rays were evaluated for acetabular erosion and femoral stem loosening.
Clinical follow-ups checked for implant dislocation, dissociation, or failure.
Functional Assessment – Harris Hip Score (HHS)
Functional outcomes were evaluated using the Harris Hip Score (HHS), categorizing patients as:
Excellent (>90 points), Good (81–90 points), Fair (70–80 points), Poor (<70 points), HHS Components Evaluated:, Pain level (scale: 0–44), Limp severity (0–11), Walking ability (0–11), Support required for walking (0–11), Stair climbing ability (0–4), Sitting comfort (0–5), Ability to wear shoes and socks (0–4), Range of motion (measured and scored)

Statistical Analysis

Descriptive statistics were used to analyze patient demographics, functional scores, and ROM. Comparative analysis was performed to assess ROM differences across age groups. Trend analysis evaluated changes in inner vs. outer bearing motion over time.

RESULTS

This study analyzed the functional and biomechanical outcomes of bipolar hemiarthroplasty in 56 patients with intracapsular fracture of the femoral neck, focusing on demographic distribution, range of motion, functional assessment, and implant stability.

Sex Distribution

The study population included 18 male (33%) and 38 female (67%) patients (Table 1). The higher prevalence of fractures in females aligns with the known increased risk of osteoporosis in postmenopausal women.

Age Distribution

Patients' ages ranged from 52 to 88 years, with a mean age of 66.03 years. The majority of patients (43%) were between 60 and 69 years, followed by 25% in the 50–59 years group (Table 2). This highlights that intracapsular femoral neck fractures are most prevalent in elderly patients.

Range of Movements

The total range of abduction varied from 24° to 31°, with an average of 27.5° (Table 3). The movement at the outer bearing ranged from 15° to 24°, averaging 19.5°, while the movement at the inner bearing ranged from 4° to 9°, with an average of 6.5°. The percentage of movement at the outer bearing was 77% to 85%, with an average of 75%. The percentage of movement at the inner bearing was 15% to 37%, with an average of 25%. Over time, the ratio of movement at the outer face decreased, while the ratio at the inner face increased, suggesting a gradual shift in mobility between the two bearing surfaces.

Range of Movements Across Age Groups

Patients aged 50-59 years and 60-69 years demonstrated similar outer-to-inner movement ratios (75% and 76%, respectively) (Table 4). However, older age groups (70-79 years and >80 years) exhibited higher movement at the inner bearing (up to 33%) and lower movement at the outer bearing, suggesting increased wear and reduced stability in advanced age.

Functional Outcomes – Harris Hip Score (HHS)

Functional evaluation using the Harris Hip Score revealed that: 28% of patients (16 cases) had excellent outcomes (HHS > 90). 42% (23 cases) had good outcomes (HHS 81–90). 13% (7 cases) had fair outcomes (HHS 70–80). 17% (10 cases) had poor outcomes (HHS < 70) (Table 5).
The mean Harris Hip Score was 83.77, indicating a generally favorable functional recovery following bipolar hemiarthroplasty. The highest recorded HHS was 96, while the lowest was 64.

6. Implant Stability and Complications

There were no cases of acetabular erosion in the study. No incidents of dislocation or dissociation of the prosthesis were observed. No perioperative mortality was reported. These findings suggest that bipolar hemiarthroplasty provides long-term functional stability with minimal complications.

Table 1: Sex Distribution

Gender	Number of Patients	Percentage (%)
Male	18	33%
Female	38	67%

Table 2: Age Distribution

Age Group (Years)	Number of Patients
50-59	14
60-69	24
70-79	10
>80	8

Table 3: Range of Movements (Post-Surgery)

No. of Years After Surgery	No. of Patients	Avg. Outer Movement (°)	Avg. Inner Movement (°)	Total Implant Movement (°)	Outer Face Ratio (%)	Inner Face Ratio (%)
0-1 Years	6	23	4	27	85%	15%
1-2 Years	8	19	6	25	76%	24%
2-3 Years	20	19	7	26	73%	27%
3-4 Years	8	15	9	24	63%	37%
4-5 Years	4	24	7	31	77%	23%
5-6 Years	10	21	6	27	77%	23%

Table 4: Range of Movements with Respect to Age Groups

Age Group (Years)	No. of Patients	% Outer Cup Movement	% Inner Cup Movement
50-59	14	75%	25%
60-69	24	76%	24%
70-79	10	67%	33%
>80	8	81%	19%

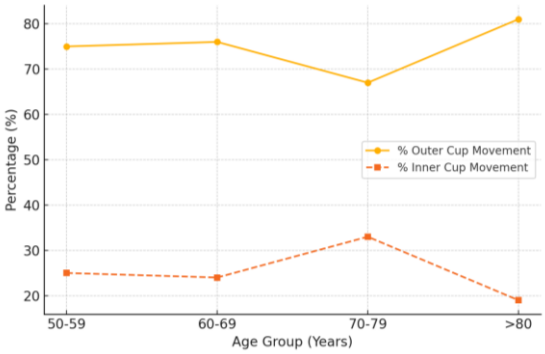

Figure No:1. Range of Movements with Respect to Age Groups

Table 5: Functional Outcomes (Harris Hip Score)

Harris Hip Score	Outcome	Number of Patients
90-100	Excellent	16
81-90	Good	23
71-80	Fair	7
61-70	Poor	10

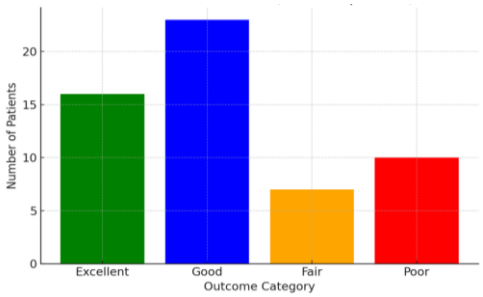

Figure No:2. Functional Outcomes (Harris Hip Score)

Figure No:3. Post Operative X-rays(Adduction)

Figure No:4. Post Operative X-rays(Abduction)

Figure No:5. Full Weight Bearing with Walker on 4 th Post –OPerative Day

DISCUSSIONS

Intracapsular femoral neck fractures are predominantly seen in the elderly population, particularly postmenopausal women, due to age-related bone fragility and falls. In this study, 56 patients who underwent bipolar hemiarthroplasty were analyzed, with a higher prevalence in females (67%) compared to males (33%). This finding aligns with previous studies indicating that osteoporosis significantly increases fracture risk in postmenopausal women (Rajak et al[10]., 2013). The mean age of patients was 66.03 years (range: 52–88 years), reinforcing that femoral neck fractures commonly affect elderly individuals, as also reported in studies by Fahad et al[11]. (2019).

Postoperative range of motion (ROM) was assessed to evaluate implant mobility and functional recovery. The total abduction ranged from 24° to 31° (mean: 27.5°), with movement primarily occurring at the outer bearing (mean: 19.5°) and a smaller component at the inner bearing (mean: 6.5°). The percentage of movement at the outer bearing was 77%–85% (mean: 75%), while inner bearing movement ranged from 15% to 37% (mean: 25%). Over time, the movement ratio shifted, with increased motion at the inner bearing and decreased motion at the outer bearing, particularly in older age groups. This suggests a gradual reduction in acetabular mobility, likely due to polyethylene wear, adaptive remodeling, and patient-specific activity levels. Similar findings were reported by Rathod et al[12]. (2024), who observed progressive changes in bearing motion with aging, which may influence long-term implant function and stability.

Functional assessment using the Harris Hip Score (HHS) revealed favorable postoperative outcomes. In this study, 28% of patients (16 cases) achieved excellent scores (HHS > 90), 42% (23 cases) had good outcomes (HHS 81–90), 13% (7 cases) had fair outcomes (HHS 70–80), and 17% (10 cases) had poor outcomes (HHS < 70). The mean HHS was 83.77, reflecting good functional recovery in most patients. The highest recorded score was 96, while the lowest was 64. These findings are consistent with those of Grabmann et al[9]. (2024), who reported early postoperative weight-bearing ability and functional recovery following bipolar hemiarthroplasty.

Age played a critical role in postoperative mobility and function. Patients aged 50–69 years demonstrated higher outer bearing movement (75%–76%), reflecting better acetabular engagement and greater prosthetic stability. However, patients aged 70+ years exhibited increased inner bearing motion (up to 33%), indicating progressive acetabular adaptation and potential polyethylene wear. These findings suggest that bipolar hemiarthroplasty preserves function in the short to mid-term but may exhibit age-dependent biomechanical changes in the long run. Older patients showed increased dependence on inner bearing movement, which may predispose them to long-term wear-related complications, as noted by Mazen et al.[13] (2010).

One of the significant strengths of this study was the low incidence of complications. No cases of acetabular erosion were reported, supporting the notion that bipolar articulation reduces direct acetabular wear, as previously reported by Coleman et al8. (2001). Furthermore, no implant dislocations or dissociations occurred, indicating that the prosthesis remained mechanically stable over time. Additionally, there were no cases of perioperative mortality, reflecting effective perioperative management and surgical technique, a finding consistent with Rajak et al.[10] (2013). These results highlight the durability and safety of bipolar hemiarthroplasty, making it a reliable choice for elderly patients with femoral neck fractures.

Several studies have explored the efficacy of bipolar hemiarthroplasty compared to unipolar hemiarthroplasty and total hip arthroplasty (THA). Bipolar implants have been found to reduce acetabular erosion and maintain better range of motion due to their dual articulation. The findings of this study align with those of Coleman et al8. (2001), as no acetabular erosion was observed, and inner bearing motion was preserved over time. Comparatively, while total hip arthroplasty (THA) generally provides superior functional outcomes, it has higher dislocation rates and longer recovery times (Fahad et al[11]., 2019). Bipolar hemiarthroplasty remains a preferred option in elderly patients due to lower surgical risks, reduced recovery time, and sufficient functional restoration, a conclusion supported by Grabmann et al.[9] (2024). This study reinforces that bipolar hemiarthroplasty offers a balance between mobility preservation and implant stability, making it a viable alternative in elderly patients with intracapsular fractures who may not be ideal candidates for THA.

There are several clinical implications and future considerations based on these findings. Long-term follow-up beyond six years is needed to assess

potential late-stage complications such as polyethylene wear, progressive acetabular erosion, or implant loosening (Rajak et al[10]., 2013). Further studies comparing cemented versus uncemented bipolar prostheses could help refine implant selection criteria (Fahad et al[11]., 2019). Additionally, functional outcomes may vary depending on rehabilitation intensity, suggesting that structured physiotherapy postoperatively could further enhance patient recovery, as highlighted by Rathod et al[12]. (2024).

CONCLUSION

Bipolar hemiarthroplasty is a reliable and effective treatment for displaced intracapsular femoral neck fractures in elderly patients, providing significant pain relief, improved mobility, and long-term functional stability. The study demonstrated favorable outcomes, with a mean Harris Hip Score of 83.77, indicating good postoperative recovery. The preservation of inner bearing motion over time suggests sustained implant function, while the absence of acetabular erosion, implant dissociation, or perioperative mortality highlights its safety. Age-related biomechanical changes were observed, with increased inner bearing movement in older patients. Given its low complication rates and preserved range of motion, bipolar hemiarthroplasty remains a preferred choice for elderly patients, balancing functional restoration with implant longevity while minimizing surgical risks.

REFERENCES

1. Doring R, Jentzsch T, Scheyerer MJ, Pfäffli W, Werner CM. The value of modular hemiarthroplasty for unstable femoral neck fractures in elderly patients with coxarthrosis. BMC Musculoskelet Disord. 2016 May 23;17:223. doi: 10.1186/s12891-016-1068-x. PMID: 27215472; PMCID: PMC4877940.
2. Robertson GA, Wood AM. Hip hemi-arthroplasty for neck of femur fracture: What is the current evidence? World J Orthop. 2018 Nov 18;9(11):235-244. doi: 10.5312/wjo.v9.i11.235. PMID: 30479970; PMCID: PMC6242732.
3. Hayat Z, Tiwari V, Varacallo MA. Surgical Management of Femoral Neck Fractures. [Updated 2024 May 1]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK538236/
4. Migliorini F, Maffulli N, Trivellas M, Eschweiler J, Hildebrand F, Betsch M. Total hip arthroplasty compared to bipolar and unipolar hemiarthroplasty for displaced hip fractures in the elderly: a Bayesian network meta-analysis. Eur J Trauma Emerg Surg. 2022 Aug;48(4):2655-2666. doi: 10.1007/s00068-022-01905-2. Epub 2022 Feb 19. PMID: 35182161; PMCID: PMC9360085.
5. Onggo J, Nambiar M, McDougall C, Hau R, Babazadeh S. Comparing outcomes of total hip arthroplasty versus hemiarthroplasty in neck of femur fracture patients: an Australian registry study. Eur J Trauma Emerg Surg. 2023 Oct;49(5):2147-2153. doi: 10.1007/s00068-023-02305-w. Epub 2023 Jun 24. PMID: 37355483; PMCID: PMC10520181.
6. Raja BS, Gowda AKS, Singh S, Ansari S, Kalia RB, Paul S. Comparison of functional outcomes and complications of cemented vs uncemented total hip arthroplasty in the elderly neck of femur fracture patients: A systematic review and meta-analysis. J Clin Orthop Trauma. 2022 Apr 22;29:101876. doi: 10.1016/j.jcot.2022.101876. PMID: 35515344; PMCID: PMC9062326.
7. Pauyo T, Drager J, Albers A, Harvey EJ. Management of femoral neck fractures in the young patient: A critical analysis review. World J Orthop. 2014 Jul 18;5(3):204-17. doi: 10.5312/wjo.v5.i3.204. PMID: 25035822; PMCID: PMC4095012.
8. Coleman SH, Bansal M, Cornell CN, Sculco TP. Failure of bipolar hemiarthroplasty: a retrospective review of 31 consecutive bipolar prostheses converted to total hip arthroplasty. Am J Orthop (Belle Mead NJ). 2001 Apr;30(4):313-9. PMID: 11334453.
9. Grabmann C, Hussain I, Zeller A, Kirnaz S, Sullivan V, Sommer F. Early Postoperative Weight-Bearing Ability after Total Hip Arthroplasty versus Bipolar Hemiarthroplasty in Elderly Patients with Femoral Neck Fracture. Journal of Clinical Medicine. 2024; 13(11):3128. https://doi.org/10.3390/jcm13113128
10. Rajak MK, Jha R, Kumar P, Thakur R. Bipolar hemiarthroplasty for intracapsular femoral neck fractures in elderly patients. J Orthop Surg (Hong Kong). 2013 Dec;21(3):313-6. doi: 10.1177/230949901302100310. PMID: 24366791.
11. Fahad S, Nawaz Khan MZ, Aqueel T, Hashmi P. Comparison of bipolar hemiarthroplasty and total hip arthroplasty with dual mobility cup in the treatment of old active patients with displaced neck of femur fracture: A retrospective cohort study. Ann Med Surg (Lond). 2019 Jul 13;45:62-65. doi: 10.1016/j.amsu.2019.07.025. PMID: 31372217; PMCID: PMC6660598.
12. Rathod A, Barick D, Khobragade AS, Patil VE, Waghe S, Vaidya AA. Functional Outcomes of Bipolar Hemiarthroplasty in Unstable Intertrochanteric Femur Fractures in the Elderly: A Prospective Study. Cureus. 2024 Jul 30;16(7):e65731. doi: 10.7759/cureus.65731. PMID: 39211719; PMCID: PMC11359907.
13. Mazen S, Julien G, Riad F. Retrospective evaluation of bipolar hip arthroplasty in fractures of the proximal femur. N Am J Med Sci. 2010 Sep;2(9):409-15. doi: 10.4297/najms.2010.2409. PMID: 22558588; PMCID: PMC3339098.