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Original Research Article

Long-term Functional Outcomes of Modular Bipolar vs Conventional Bipolar Hemiarthroplasty in Elderly Patients: An 8-Year Retrospective Cohort Study from A Tertiary Care Hospital in Assam

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Abstract:

Background and Objective: Displaced femoral neck fractures in the elderly represent a major cause of morbidity and loss of independence. Hemiarthroplasty remains the most common surgical treatment, but the choice between modular bipolar and conventional bipolar prostheses continues to be debated. Modular designs offer intraoperative flexibility and potentially better biomechanics, while conventional implants remain popular due to lower cost and simplicity. The purpose of study was to examine the long-term functional outcomes, complications, and survival between modular and conventional bipolar prostheses in elderly patients.

Methods: From December 2014 to December 2022, a retrospective cohort study was carried out at Fakhruddin Ali Ahmed Medical College & Hospital in Barpeta, Assam. There were 122 patients with displaced femoral neck fractures who were at least 60 years old. Of these, 64 had modular bipolar hemiarthroplasty and 58 had traditional bipolar implants. The Visual Analog Scale (VAS) for pain and the Harris Hip Score (HHS) were used to evaluate functional outcomes. Mortality, reoperations, and complications were noted. The significance level was established at $p<0.05$, and the data were examined using the proper statistical tests.

Results: At a mean follow-up of 5.8 years, the modular group demonstrated higher HHS (84.6 ± 9.1 vs. 80.2 ± 10.3, $p=0.012$) and lower VAS pain scores (1.9 ± 0.8 vs. 2.4 ± 1.0, $p=0.04$). Rates of acetabular erosion (7.8% vs. 17.2%) and reoperation (6.3% vs. 12.1%) were lower in modular prostheses, though not statistically significant. Mortality rates were comparable (18% vs. 21%).

Conclusion: Modular bipolar prostheses provided superior long-term functional outcomes and fewer complications without affecting survival. They may be preferred for active elderly patients, while conventional implants remain suitable for frail or resource-limited individuals.

Introduction

Fractures of the femoral neck are among the most frequent and disabling injuries in older adults. With the steady rise in life expectancy, their occurrence has become a growing public health concern worldwide. These fractures are often referred to as a "life-changing event" because they are strongly associated with reduced mobility, dependency, and increased mortality. The treatment strategy for elderly patients must prioritize rapid pain relief and early return to ambulation in order to minimize complications of prolonged immobility. Hemiarthroplasty has emerged as a preferred surgical approach in this population, largely because it reduces the risks of nonunion and avascular necrosis, which are commonly seen when osteoporotic bone is treated with internal fixation.

Within hemiarthroplasty, the bipolar prosthesis offers clear advantages over unipolar designs by attempting to protect acetabular cartilage and improving the arc of motion. Traditionally, the monoblock or conventional bipolar prosthesis has been widely used in many hospitals due to its straightforward technique and lower cost. Yet, this design lacks flexibility in adjusting head size or offset, which can limit the restoration of normal biomechanics. Over time, this has been linked to problems such as groin pain, accelerated acetabular wear, and the need for revision procedures. In response, modular bipolar prostheses were introduced, giving surgeons the ability to select stem size, head diameter, and offset separately. This adaptability provides a more individualized fit, which is expected to enhance joint mechanics,

reduce discomfort, and potentially improve long-term function.

The debate between modular and conventional prostheses, however, is far from settled. Several clinical studies have reported better functional outcomes and reduced complications with modular implants, while others have found little or no significant difference between the two. The lack of consensus may be due to differences in study design, duration of follow-up, patient profiles, and health system characteristics. Importantly, most available evidence originates from Western countries, where healthcare delivery, rehabilitation resources, and socioeconomic circumstances differ considerably from those in India. The scarcity of long-term data from Indian hospitals, especially those serving rural populations, makes it difficult to generalize international findings to local practice.

In the northeastern state of Assam, where healthcare access is often delayed and resources are constrained, the choice of implant carries both clinical and economic implications. Fakhruddin Ali Ahmed Medical College & Hospital in Barpeta caters to a predominantly rural population and frequently manages elderly patients with hip fractures. Against this background, the current study was undertaken to evaluate and compare the long-term outcomes of modular and conventional bipolar hemiarthroplasty. Over an eight-year period, functional scores, pain levels, complication rates, and implant survival were systematically assessed. The intention was to generate locally relevant evidence that can guide surgeons in selecting the most appropriate prosthesis for elderly patients, while also contributing meaningful data to the global discussion on bipolar hemiarthroplasty.

Materials and Methods

Study design: A retrospective cohort study was conducted.

Study place: Fakhruddin Ali Ahmed Medical College & Hospital, Barpeta, Assam

Study duration: 15th December 2014 – 14th December 2022 (8 years)

Sample size: 122 patients

Inclusion criteria

- Age ≥60 years
- Displaced intracapsular femoral neck fracture treated with bipolar hemiarthroplasty (either modular or conventional)
- Minimum 2 years of follow-up

Exclusion criteria

- Pathological fractures (other than osteoporosis)
- Previous hip surgery on the same side
- Incomplete records

Data collection

Patient details were retrieved from hospital records, operation theatre registers, and follow-up outpatient notes. Functional outcomes were assessed using:

- **Harris Hip Score (HHS)**
- **Visual Analog Scale (VAS) for pain**
- **Mobility status** (independent vs assisted)

Radiographs were reviewed for acetabular erosion and implant-related complications. Mortality and reoperation rates were documented.

Statistical analysis: Continuous variables were compared using Student's t-test and categorical variables using Chi-square test. Survival analysis was performed using Kaplan–Meier estimates. A p-value <0.05 was considered significant.

Results

Patient characteristics: The study comprised 122 elderly adults with displaced femoral neck fractures. Of these, 64 underwent modular bipolar hemiarthroplasty and 58 received conventional bipolar prostheses. The overall mean age was 73.9 ± 6.8 years, and females constituted 58% of the study population. Age, gender distribution, fracture side, comorbidities, and pre-injury ambulatory status did not differ statistically significantly between the two groups.

Table 1: Baseline Characteristics of Patients

Variable	Modular (n=64)	Conventional (n=58)	p-value
Mean Age (years)	74.1 ± 6.6	73.7 ± 7.1	0.72
Female (%)	59.4	56.9	0.81
ASA Grade III–IV (%)	42.2	44.8	0.74
Mean Follow-up (years)	5.9 ± 1.4	5.7 ± 1.6	0.56
Pre-injury Independent Walk	71.9	70.7	0.89

No significant differences in baseline parameters between the two groups.

Functional Outcomes: At the final follow-up (average 5.8 years), the mean HHS was significantly higher in the modular group (84.6 ± 9.1) compared to the conventional group (80.2 ± 10.3, p=0.012). Similarly, pain scores were lower in patients with modular prostheses (VAS: 1.9 ± 0.8) compared to conventional prostheses (VAS: 2.4 ± 1.0, p=0.04). Although a greater proportion of patients in the

modular group regained independent outdoor ambulation (71% vs. 58%), this difference did not reach statistical significance.

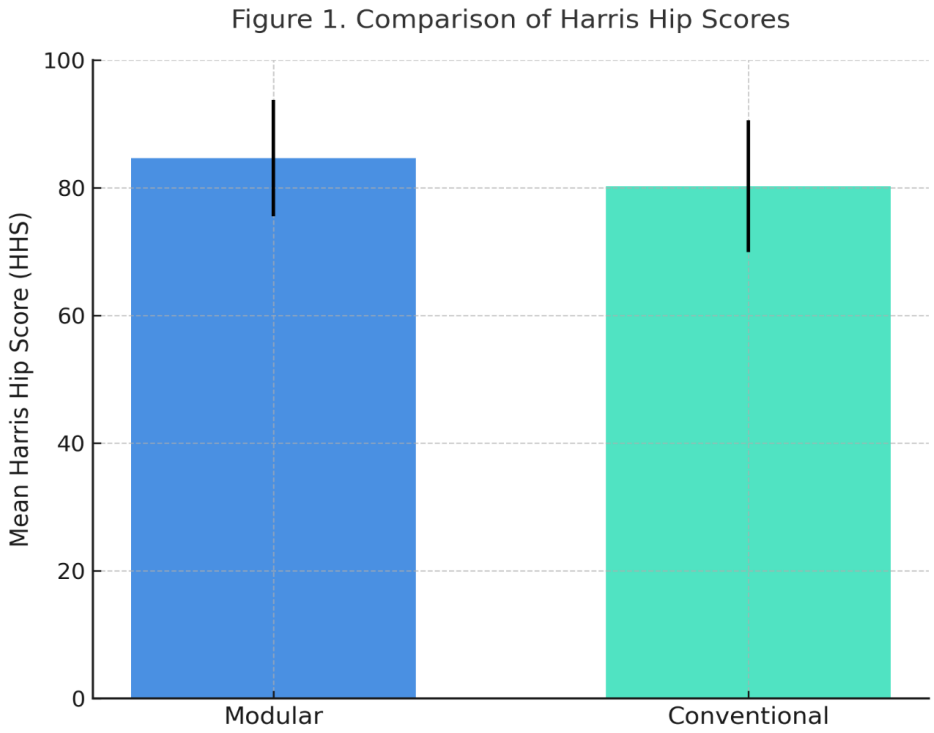

Figure 1: Comparison of HHS between Modular and Conventional Groups

Complications and Prosthesis-related Issues: The overall complication rate was lower in the modular group (18.8%) compared with the conventional group (27.6%), though the difference was not statistically significant (p=0.23). Acetabular erosion was observed in 7.8% of modular cases versus 17.2% in conventional cases. Dislocation occurred in 3.1% (modular) and 6.9% (conventional). Deep infection was rare in both groups. The need for reoperation was more in the conventional group (12.1%) than the modular group (6.3%).

Table 2: Complications and Reoperations

Outcome	Modular (n=64)	Conventional (n=58)	p-value
Any complication (%)	18.8	27.6	0.23
Acetabular erosion (%)	7.8	17.2	0.09
Dislocation (%)	3.1	6.9	0.31
Deep infection (%)	1.6	3.4	0.47
Reoperation (%)	6.3	12.1	0.21

Survival and Mortality Analysis: At 5 years of follow-up, implant survival was higher in the modular group, with fewer revisions observed, though there was no statistically significant difference. The Kaplan–Meier survival analysis demonstrated a trend favoring modular prostheses for implant longevity. At five years, the modular group's mortality rate was 18%, whereas the conventional group's was 21%. This difference was not statistically significant (p=0.72).

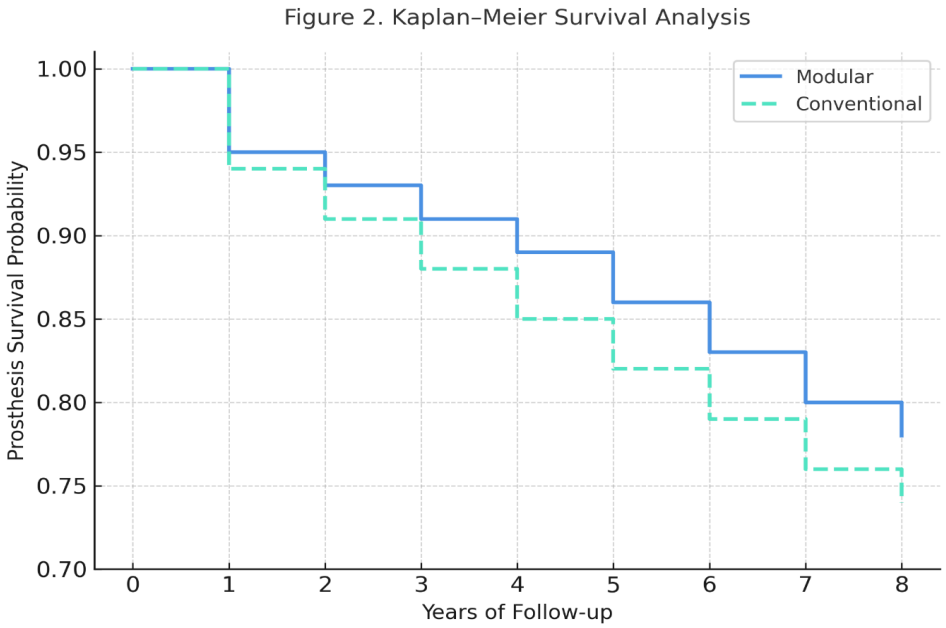

Figure 2: Kaplan–Meier Curve for Prosthesis Survival

Discussion

The present study was undertaken to assess the long-term outcomes of modular bipolar hemiarthroplasty compared with conventional bipolar prostheses in elderly patients with displaced femoral neck fractures. Over an eight-year period, 122 patients were followed, of whom 64 received modular implants and 58 conventional designs. The analysis revealed that modular prostheses were associated with higher functional scores, lower levels of pain, and a tendency toward fewer complications and reoperations. Mortality rates were comparable between the two groups, and implant survival curves indicated a slight advantage in favor of modular designs. These findings contribute to the continuing discussion regarding the optimal choice of prosthesis in elderly patients, particularly in settings where resources and follow-up services are limited.

The improved Harris Hip Scores in patients treated with modular prostheses can be attributed to the flexibility these implants offer during surgery. By allowing the surgeon to adjust stem size, head size, and offset independently, modular implants permit more accurate restoration of hip biomechanics. This adaptability is crucial in elderly individuals, where variation in bone stock and anatomy can complicate surgery. Our results echo earlier reports from randomized trials and cohort studies, which also demonstrated superior functional outcomes with modular designs. By contrast, conventional monoblock prostheses, although easier to implant and more affordable, provide limited intraoperative adjustment. This limitation may explain the modest but significant differences in hip scores and pain levels observed in our study.

Setting these findings within the larger body of knowledge is crucial. While many investigators have reported advantages with modular implants, others have found little to no difference in function or quality of life between the two groups. Meta-analyses have also produced mixed conclusions, often emphasizing the heterogeneity of available studies in terms of patient populations, follow-up durations, and outcome measures. Our findings add weight to the argument for modular prostheses, particularly because the cohort was relatively homogeneous, the follow-up was longer than in many studies, and the perioperative protocols were consistent across patients. These conditions reduce confounding and strengthen the credibility of the observed differences.

Although the differences were not always statistically significant, the modular group had decreased rates of complications. Acetabular erosion, in particular, was less frequent, supporting the theoretical advantage of modularity in distributing forces more evenly across the joint. Reduced shear stresses may delay cartilage wear and thereby preserve acetabular integrity. Previous studies in India and abroad have described similar patterns, suggesting that the design of modular prostheses offers mechanical benefits over time. Reoperation rates were also lower in the modular cohort, again aligning with the view that improved biomechanics translate into greater implant longevity. However, mortality remained unaffected by implant type, which is consistent with large-scale studies showing that survival after hip fracture depends more on comorbidities, general health, and perioperative care than on the design of the prosthesis.

The context of the study adds further weight to these findings. Conducted in a tertiary hospital in Assam, it reflects the realities of orthopedic care in a largely rural and socioeconomically challenged population. Patients often present late, rehabilitation facilities are scarce, and financial constraints influence both treatment decisions and long-term follow-up. In such an environment, the observation that modular prostheses provide better function and fewer complications has practical significance. Although their higher initial cost cannot be ignored, the potential to reduce reoperations and prolonged disability suggests they may be more cost-effective in the long term, especially for elderly patients who remain relatively active and independent. For less active patients with limited life expectancy, the conventional prosthesis may remain an appropriate option, emphasizing the need for individualized decision-making.

Several limitations must be recognized when interpreting the results. The retrospective design carries the risk of incomplete documentation and missing data, particularly in functional scoring and radiographic assessments. Although baseline characteristics were well balanced between the groups, unmeasured confounders cannot be excluded. The sample size, while adequate for detecting differences in hip scores and pain levels, was not large enough to reliably evaluate rarer complications such as dislocation or deep infection. Another limitation is the absence of a formal cost-effectiveness analysis, which would have been especially relevant in a setting where resource allocation is critical. Finally, the results of this single-center study might not apply to other organizations or demographics, though they do provide much-needed evidence for hospitals facing similar circumstances.

Notwithstanding these drawbacks, the study has a number of advantages. The follow-up period of nearly six years on average is longer than many comparable reports, allowing long-term differences to become evident. The sample size is among the larger cohorts reported from this region of India, and the surgical and perioperative protocols were consistent, reducing variability in care. The results therefore provide a reliable snapshot of outcomes achievable in a tertiary care center catering to a rural population. In conclusion, the study demonstrates that modular bipolar prostheses are associated with superior functional outcomes and fewer complications compared with conventional prostheses, without any increase in mortality. While acknowledging that conventional implants may still be suitable for more fragile or financially strapped people, these findings support the use of modular implants in active senior patients where resources permit. By providing evidence from an Indian setting, this study contributes both locally relevant and globally valuable insights into the ongoing debate over implant choice in hemiarthroplasty.

Conclusion

The present study compared modular and conventional bipolar hemiarthroplasty in elderly patients with displaced femoral neck fractures over an eight-year period. Findings showed that modular prostheses achieved better hip function, with higher Harris Hip Scores and lower pain levels, and were associated with fewer complications such as acetabular erosion and revision surgery. Mortality outcomes remained similar between the two groups, emphasizing that overall survival is influenced more by age, comorbidities, and perioperative care than by prosthesis design.

These results highlight the value of modular prostheses for elderly patients who remain active and are likely to benefit from long-term functional gains, while conventional implants continue to offer a reasonable option for frailer individuals or those with financial limitations. By presenting evidence from a tertiary care hospital in Assam, this study provides practical guidance for clinical decision-making in similar healthcare settings and contributes meaningful data to the global discussion on hemiarthroplasty.

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