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RESEARCH ARTICLE

MODULAR VERSUS FIXED BIPOLAR HEMIARTHROPLASTY IN FEMORAL NECK FRACTURES: A NARRATIVE REVIEW OF CLINICAL, FUNCTIONAL, AND RADIOLOGICAL OUTCOMES

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ABSTRACT

Femoral neck fractures are a major cause of morbidity and mortality in the elderly population. Hemiarthroplasty remains the preferred treatment for displaced intracapsular femoral neck fractures in elderly patients with limited functional demands. Bipolar hemiarthroplasty prostheses are broadly classified into modular and fixed bipolar designs, each with distinct biomechanical and clinical implications. Despite widespread use, consensus regarding the superiority of one design over the other remains unclear. This review critically evaluates existing evidence comparing modular and fixed bipolar hemiarthroplasty with respect to clinical outcomes, functional recovery, radiological findings, complications, and implant longevity. The review highlights the advantages of modular bipolar prostheses in terms of improved functional outcomes, limb length restoration, and implant stability, while acknowledging concerns related to cost and implant complexity.

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INTRODUCTION

Hip fractures, particularly intracapsular femoral neck fractures, represent a major global health burden, with an annual incidence exceeding 1.6 million cases worldwide and a steadily increasing trend due to population aging (1). These fractures predominantly affect the elderly and are associated with high one-year mortality rates ranging from 14% to 36%, along with significant functional decline among survivors (2). Hemiarthroplasty has become the gold-standard surgical treatment for displaced femoral neck fractures (Garden III and IV) in elderly patients, offering better pain relief, early mobilization, and reduced reoperation rates compared to internal fixation (3). Early weight-bearing following hemiarthroplasty plays a crucial role in preventing postoperative complications such as pneumonia, deep vein thrombosis, and pressure sores (4).

Evolution of Bipolar Hemiarthroplasty: Bipolar hemiarthroplasty was developed to overcome the limitations of unipolar prostheses by reducing acetabular cartilage wear and improving joint biomechanics (5). The bipolar design allows movement at two interfaces, thereby theoretically distributing stresses more evenly across the hip joint (6). Fluoroscopic and radiographic studies have demonstrated that bipolar prostheses exhibit dual articulation, although motion at the inner bearing decreases over time as the outer articulation becomes dominant (6,7).

Modular versus Fixed Bipolar Prostheses: Modular bipolar hemiarthroplasty systems consist of separate components that allow intraoperative customization of stem size, neck length, femoral offset, and head diameter. This flexibility improves restoration of hip biomechanics and limb length equality, potentially leading to superior functional outcomes (8).

In contrast, fixed bipolar prostheses are single-piece constructs with limited adjustability. While they offer surgical simplicity and reduced operative time, they may lead to increased acetabular stress and earlier cartilage erosion (6,10). Biomechanical studies suggest that modular bipolar designs reduce acetabular contact pressures by approximately 30–40% when compared to fixed bipolar implants (7).

Clinical and Functional Outcomes: Several studies have evaluated postoperative pain, mobility, and functional recovery following bipolar hemiarthroplasty. Modular bipolar prostheses have been associated with reduced postoperative pain and improved walking ability compared to fixed bipolar designs (8,9). Functional outcome assessments using the Harris Hip Score have shown marginally better scores in modular prosthesis groups, particularly during mid-term follow-up, although some studies report no statistically significant differences (11,12). Improved range of motion, especially abduction and flexion, has been reported more consistently with modular implants (8).

Radiological Outcomes: Radiological assessment focuses on implant positioning, limb length discrepancy, acetabular erosion, and prosthetic migration. Modular bipolar prostheses demonstrate superior limb length restoration and better femoral offset reconstruction compared to fixed bipolar implants (8,14). Although short-term studies report minimal differences in acetabular erosion between the two designs, fixed bipolar prostheses tend to show earlier radiographic evidence of acetabular wear during longer follow-up periods (10).

Complications: Common complications following hemiarthroplasty include infection, dislocation, limb length discrepancy, and implant loosening. Modular bipolar prostheses are associated with fewer gait abnormalities and reduced thigh pain due to improved biomechanical restoration (8,9). However, modular systems are more expensive and have been associated with rare complications such as intraprosthetic dissociation (9). Cemented bipolar hemiarthroplasty has been shown to provide reliable fixation and good outcomes in elderly patients with osteoporotic bone (13).

Comparison with Total Hip Arthroplasty: Long-term comparative studies have shown that bipolar hemiarthroplasty provides outcomes comparable to total hip arthroplasty in elderly, low-demand patients, with lower dislocation rates and shorter operative times (10).

CONCLUSION

Based on the available evidence, modular bipolar hemiarthroplasty offers superior biomechanical restoration, improved functional outcomes, and reduced complication rates when compared to fixed bipolar designs (8,9,14). Despite higher costs and increased surgical complexity, the long-term clinical benefits of modular prostheses justify their preferential use in elderly patients with displaced femoral neck fractures. Further large-scale, long-term randomized studies are required to establish definitive implant selection guidelines.

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