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EVALUATION OF UNIPOLAR AND BIPOLAR HEMIARTHROPLASTY IN ELDERLY PATIENTS WITH DISPLACED FEMORAL NECK FRACTURES: A RANDOMISED CONTROLLED TRIAL

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ABSTRACT

Background: Hemiarthroplasty is widely accepted as the preferred treatment for displaced femoral neck fractures in elderly patients, the comparative efficacy of unipolar versus bipolar prostheses continues to be debated.

Objective: To compare how unipolar versus bipolar hemiarthroplasty affects patients hip function and health-related quality of life (HRQoL) with participants randomly assigned to one of these two treatments, and to explore how the severity of acetabular wear relates to their postoperative outcomes.

Materials and Methods: One hundred patients with a mean age of 75 years and an acute displaced fracture of the femoral neck were randomly allocated to treatment by either unipolar or bipolar Hemiarthroplasty. The Outcomes assessed in the study comprised hip function (Harris Hip Score, HHS), Health-related Quality of life (EQ-5D) and the presence of acetabular erosion. Follow-up evaluations were conducted at four and twelve months postoperatively.

Results: The groups showed notable differences in complication rates. At both follow-up assessments, the Harris Hip Score was superior for the bipolar group. There was a tendency for the bipolar hemiarthroplasty group to report superior Health-related Quality of Life, EQ-5D index score 0.62 vs 0.54(p=0.06) by the end of fourth month. 30 percent of the patients in unipolar hemiarthroplasty group displayed acetabular erosion at the 12-month follow up compared to 10 percent follow up in the bipolar hemiarthroplasty group(p=0.03), and a tendency towards worse hip function and Health-related Quality of Life was observed among patients with acetabular erosion compared to those without: mean HHS scores 76 versus 82.8, respectively (p=0.09), and EQ-5D index scores 0.56 versus 0.64, respectively (p=0.13).

Conclusion: At the one-year mark, bipolar hemiarthroplasty achieved superior clinical outcomes compared to unipolar hemiarthroplasty, unipolar implants demonstrated a significantly higher rate of acetabular erosion, suggesting bipolar hemiarthroplasty as the preferred surgical option.

Keywords: Hemiarthroplasty, Unipolar, Bipolar, Acetabular erosion, intracapsular femoral neck fractures.

INTRODUCTION

Femoral neck fractures (FNFs) are a major public health concern, with worldwide incidence projected to reach 6.3 million cases annually by 2050 due to population ageing and increased life expectancy.[1]

In 1990, approximately 1.66 million hip fractures occurred globally, and this number has more than doubled in recent decades.[2] Such fractures are associated with a 20–30% one-year mortality rate and significant morbidity including impaired mobility and inherent loss of independence and marked long-term functional decline, especially among the

elderly.[3] Given their high incidence and associated detrimental effects on patient lives, hip fractures are considered a global health and economic burden, with a cost of 13 billion US dollars per year.[4] Surgery in these patients is undertaken to provide timely pain relief, rapid mobilization, and accelerated rehabilitation, while minimizing perioperative surgical and medical complications.[5] Surgical options for displaced Femoral Neck Fractures include internal fixation (IF), total hip arthroplasty (THA), and hemiarthroplasty (HA).[6] Management should be tailored to suit individual patient's needs. Multiple randomized controlled trials have demonstrated that Internal Fixation is inferior to arthroplasty in terms of mobility, functional outcome, reoperation risk, and risk of non-union for displaced Femoral Neck Fractures.[7] In contrast, Hemiarthroplasty provides reliable pain relief, allows immediate weight-bearing, and is technically less demanding, making it the preferred treatment for elderly patients with low functional demands, less active lifestyle and intact acetabular cartilage.[8,9]

The theoretical advantage of the bipolar design is that this configuration results in decreased acetabular erosion, a lower dislocation rate, and improved range of motion.[11] The selection between a unipolar and a bipolar prosthesis remains a matter of ongoing debate, despite numerous studies and several meta-analyses attempting to compare their clinical outcomes.[12] Some evidence suggests bipolar hemiarthroplasty may reduce acetabular erosion and improve short-term function,[13] while other studies have found no significant differences in reoperation rates, complication profiles, or long-term results compared to unipolar hemiarthroplasty.[14,15] The primary purpose of this study was to evaluate hip function and health-related quality of life (HRQoL) in the elderly lucid patients with displaced femoral neck fractures randomized to receive either unipolar or bipolar hemiarthroplasty. A

secondary objective was to assess the extent of acetabular erosion and its impact on clinical outcomes.

MATERIALS AND METHODS

A study was conducted with a hundred patients in Maheshwara Medical College & Hospital (https://www.maheshwaramedical.com) having acute post traumatic displaced femoral neck fractures of grade III and IV following the given criteria.[19]

The Inclusion criteria included being of age between 60-90 years, absence of any significant cognitive dysfunction based on the Short Portable Mental Status Questionnaire (SPMSQ).[20] Presence of independent living status (i.e. not institutionalized) and independent walking status with or without walking aid prior to trauma.

The Exclusion criteria included Patients having Rheumatoid arthritis, Pathological fractures, post traumatic fractures >48 hours, or patients with osteoarthritis.

Randomization of groups was then conducted by opaque sealed envelope technique. After clearance by an anaesthetist, patients were assigned to groups for a cemented unipolar Hemiarthroplasty or cemented Bipolar Hemiarthroplasty.

Surgical intervention

All procedures were performed under spinal anaesthesia by experienced orthopaedic surgeons (n=12). The procedures were performed using a posterior approach, a southern (Moore) approach in the lateral decubitus position was uniformly employed. A cemented Exeter femoral stem was used in all cases. Patients received either a unipolar or bipolar head (figure 1), with identical cementing techniques applied across both groups.

Figure 1: bipolar hemiarthroplasty

Head sizes ranged from 41–56 mm for unipolar heads and 44–72 mm for bipolar heads, with increments of 1.5 mm and 1.0 mm, respectively. The internal head diameter of the bipolar components was consistently 28 mm.

Prophylactic antibiotics consisted of three doses of 1 g ceftriaxone IV (one dose preoperatively, two within 24 hours postoperatively). Low-molecular-weight heparin (LsMWH) was administered starting preoperatively and continued for 14 days postoperatively for thromboprophylaxis.

Both groups were mobilized postoperatively with full weight-bearing as tolerated and were instructed in appropriate mobilization techniques; no activity restrictions were maintained beyond 6–8 weeks.

Primary assessment and follow up

Informed consent was obtained preoperatively by a research nurse. Baseline assessment included cognitive evaluation based on the Short Portable Mental Status Questionnaire (SPMSQ) and general health status, graded according to the American Society of Anaesthesiologistso5(ASA) classification.[21]

Patient-reported data on pre-fracture living conditions, mobility, ambulation, hip function, and health-related quality of life (HRQoL) were collected using the EuroQol-5D (EQ-5D) instrument.[22]

Perioperative metrics such as intraoperative blood loss, transfusion requirements, and operative time

were recorded. Postoperative data included general and hip-specific complications, activities of daily living (ADL) status, functional outcomes, living arrangements and HRQoL.

The patients were summoned at four (mean 4.3, SD 0.6) and 12 months (mean 12.4, SD 1.2) for a clinical and radiographic examination.

All clinical assessments including Harris hip score (HHS), EQ-5d index, general complications, hip complications, ADL status, except for hip range of motion, were performed by independent observers blinded to the treatment groups.

Methods

General physical health of patients is graded using the ASA classification by the attending anesthesiologist.

The patients' Cognitive function is evaluated using the Short Portable Mental Status Questionnaire (SPMSQ), only patients with normal or mildly impairment—defined as scoring more than three correct answers on the ten-item test were included.

Functional status was assessed with the Katz Activities of Daily Living (ADL) index, which examines independence in six domains: bathing, dressing, toileting, transferring, continence and feeding. An ADL index of A denotes independence in all six domains; B denotes independence in all but one; and C–G denote dependence in bathing plus at least one additional domain.[23]

Categorization of patients is based on living conditions into independent or institutionalized.

Hip-Specific Complications such as dislocations, deep infections, periprosthetic fractures, and acetabular erosion were recorded.

Deep wound infection was defined as an infection located beneath the fascial layer that necessitated surgical debridement or revision.

Acetabular erosion was graded based on analysis of radiographs by radiologists blinded to clinical outcome, according to criteria by Baker et al,[24] as

Grade 0(no erosion),

Grade 1(narrowing of articular cartilage),

Grade2(Acetabular bone erosion),

Grade 3 (protrusio acetabuli).

Post operative general complications or new fractures were noted during follow-up.

During follow-up, we recorded postoperative general complications including pressure sores and cardiac, pulmonary, thromboembolic, or cerebrovascular events as well as any new fractures of the lower limb.

Hip function was evaluated using the Harris Hip Score (HHS), with subcategories for pain (0-44), function (0-47), absence of deformity (0-4), and Range of motion (0-5) with a maximum score of 100,[25] and HRQoL was rated according to EQ-5D.[22] An EQ-5D index score of 0 indicated the worst possible health status and a value of 1 indicated best possible health status.

Statistical Methods

A prior power analysis determined that a sample size of 100 would yield a statistical power of 90% with a significance level of 5%. Mann–Whitney U-tests were used for ordinal and scale variables. Chi-square or Fisher's exact tests were employed for categorical variables. The Wilcoxon signed-ranks test was used to compare the EQ 5D before fracture and at follow-ups. All tests were two-sided, with significance set at $p<0.05$ and trends defined as $0.05 < p < 0.2$. All statistical analyses were conducted using SPSS version 30.0 (IBM Corp., Armonk, NY).

RESULTS

The following flowchart in Figure.2 displays patients who participated in the study with number patients lost to follow-up.

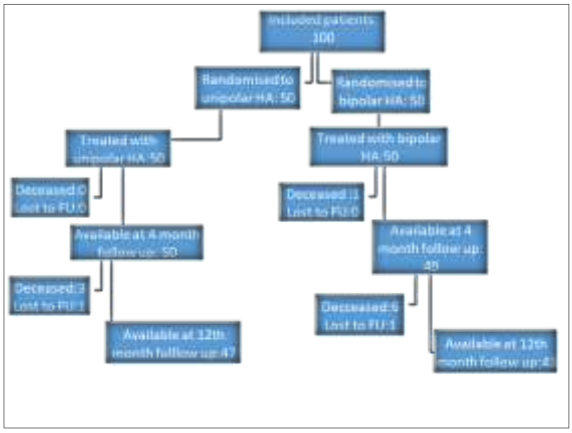

Figure 2: Follow-up of all patients with the number of patients lost to each follow up (n=100)

The mean patient age was 75 years (range: 60–90), with 76% of the cohort being female. The proportion of males was higher in the bipolar group (30%) than in the unipolar group (18%). Most patients (97%) were independent in ADLs, and 95% were classified as ASA grade 2 or 3.

Perioperative data and Surgical outcome

Duration of surgery, intra-operative blood loss and need for blood transfusions were similar and showed no differences when comparing randomization groups with each other. [Table 1]

Table 1: Perioperative data for all patients are included using the Mann–Whitney U-test (n=100)

Measurement	Unipolar HA (n=50)	Bipolar HA (n=50)	P
Mean intraoperative blood loss in ml(range)	280(50-1200)	220(50-600)	0.31
Mean transfused blood volume in ml(range)	260(0-1600)	250(0-1800)	0.42
Mean duration of surgery in minor(range)	74(35-107)	69(40-125)	0.11

Within unipolar randomization group there were 6 (10%) hip related complications: two dislocations, one deep infection, two periprosthetic fractures (figure 3) and one secondary arthritis.

Within bipolar group there were 3 (5%) hip related complications: one prosthetic dislocation, two deep infections.
Reoperation was required for all hip complications and necessary data on the nine patients undergoing additional surgery are displayed in Table 3.
There was no significant difference in complication or re-operation rate between two groups (p= 0.3).
The subsequent outcome was uneventful for all patients.

Figure 3: Periprosthetic fracture in Unipolar hemiarthroplasty

Table 2: Data on the nine patients undergoing additional surgery.

Patient number	Gender	Group	Indication for reoperation	Reoperation/ reoperations performed	Number of times reoperations performed	Time[b](months)
11	Male	Unipolar	Deep infection	Wound revision and finally extraction of prosthesis	5	0.8-0.9
20	Male	Unipolar	Periprosthetic fracture	Revision with cables and cemented long Exeter stem	1	0.6
35	Female	Unipolar	Secondary arthritis	Total hip replacement	1	0.8
46	Male	Bipolar	Deep infection	Wound revision	3	0.8-0.9
54	Female	Unipolar	Periprosthetic fracture	Revision with uncemented Lubinus MP II	1	0.4
67	Female	Bipolar	Deep infection	Wound revision	3	0.8-0.9
78	Male	Unipolar	Prosthetic dislocation	Closed reduction	3	0.6-0.8
85	Male	Bipolar	Prosthetic dislocation	Closed reduction	2	0.4-0.5
94	Female	Unipolar	Prosthetic dislocation	Closed reduction	2	0.5-0.6

{ Time[b] -Time elapsed from the primary operation}
General Complications-
The major complications between both randomization groups were comparable to mortality. Complications within unipolar group being pneumonia(n=3), Pressure sores (n= 1), Cardiac complications(n=1) and complications within bipolar group being DVT(n=2), and pulmonary embolism(n=1).
The one-year mortality rate was 10% (10/100): 6% (3/50) in the unipolar HA group and 14% (7/50) in bipolar HA group (p=0.12).
There was a significantly higher mortality in male patients,33.3% (8/24), compared to female patients 11.8% (9/76) (p=0.003).
The higher mortality in bipolar group is not of much significance as the percentage of males in bipolar group (35%) significantly exceeds that of unipolar group (11%).

Functional outcome and HRQoL
Hip function in bipolar group was found to be superior to unipolar group, according to Harris hip score. (Table 4)
Table 4– Mean Harris hip score(range) for all patients available at each follow-up (4months, n=99;12months, n=90) using Mann–Whitney U-test.
HA hemiarthroplasty
P values given for differences between groups. P-value<0.05 indicates significance
The HRQoL according to EQ-5D index showed a better quality of life in bipolar groups at 4 months with a greater difference at 12 months (p=0.06).
In unipolar groups, the HRQol according to ED-5D index was 0.80(SD=0.21) before fracture to 0.54(SD=0.25) in 4 months, and 0.56(SD=0.30) in 12 months.
In bipolar group, the HRQol according to ED-5Dindex was 0.80(SD=0.21) before fracture to

0.62(SD=0.29) in 4 months, and 0.64(SD=0.32) in 12 months.
The difference in ADL or living conditions between randomization groups was significant.

At 4 months,69.5% (32/46) of those unipolar groups and 79% (34/43) of those in Bipolar group (p=0.99) and at 12 months, 78.2% (36/46) from unipolar group and 83.7% (36/43) from bipolar groups (p=0.59) were categorized as index A or B.

Table 3: Mean Harris HIP score (Range) for all patients available at each follow-Up.

MEASUREMENT	Follow up at 4 months	Follow up at 4 months	Follow up at 4 months	Follow up at 12 months	Follow up at 12 months	Follow up at 12 months
	Unipolar HA	Bipolar HA	P	Unipolar HA	Bipolar HA	P
Total score	73.3	78.7	0.15	76	82.8	0.9
1. Pain	39.2	42.3	0.2	38.5	42.5	0.91
2. Function	25.6	27.6	0.36	29.5	31.5	0.9
3. Absence of deformity	4	4	1	4	4	1
4. Range of movements	4.5	4.8	0.04	4	4.8	0.24

Harris hip score shows significant difference in values at 4 months between randomized unipolar and randomized bipolar groups with the values for criteria such as
Pain being 39.2 for unipolar and 42.3 for bipolar(p=0.22),
Function being 25.6 for unipolar and 27.6 for bipolar(p=0.38),
Range of motion showing 4.5 in unipolar and 4.8 in bipolar(p=1.0),
Absence of deformity being 4.0 in both unipolar and bipolar groups. (p=0.05)
Overall p = 0.17
The values of HHS at 12 months for criteria such as
Pain is 38.5 for unipolar and 42.5 for bipolar(p=0.92),
Function being 29.5 for unipolar and 31.5 for bipolar(p=0.91),
Range of motion being 4.0 for unipolar and 4.8 for bipolar(p=1.0) and
Absence of deformity remains at 4.0 in both unipolar and bipolar groups (0.26).
Overall p= 1.0
The percentage of people from randomized groups living independently at 4months are 86.9% (40/46) from unipolar group and 93% (40/43) from bipolar groups, and at 12 months are 93.4% (43/46) from unipolar group and 98% (42/43) from bipolar group, respectively(p=0.25).
Acetabular erosion.
At 12 months follow-up, 85 out of 89 (95%) of present patients were able to produce findings of radiological examination: 92.8% (39/42) in unipolar group and 97.6% (42/43) in bipolar group.
Acetabular erosion was observed in 14 out of 46(30%) patients within the unipolar HA group as compared to 4 out of 43(10%) patients in bipolar HA group(p=0.03).
Upon considering the grade of erosion., Acetabular erosion within unipolar group was grade1 (n=9) and grade 2(n=5) and for bipolar group grade 1 (n=3) and grade 2 (n=1).
Worsening of hip functioning was observed in patients with acetabular erosion(n=18) at 12 months when compared to those without acetabular erosion(n=72). Similar trends were noted with HHS scores of 76 and 82.8 and EQ-5D index of 0.56 and 0.64 respectively (p=0.13).Similar pattern was observed with ADL function: only 50% (9/18) were categorized as index A or B at 12 months when compared to 79%(57/72) of those without erosion (p=0.12).Acetabular erosion showed a trend of occurring more frequently in patients with BMI<24kg/m2(n=50)as compared to those with BMI>24kg/m2(n=40),22%(11/50) and 5%(2/40),respectively(p=0.04).All patients values were accounted for.

DISCUSSION

Our study demonstrated that bipolar hemiarthroplasty (HA) led to significantly better outcomes than unipolar HA in elderly patients with displaced femoral neck fractures, including lower complication rates, improved hip function, and higher HRQoL. Notably, acetabular erosion at one year was significantly more frequent in the unipolar group (30%) compared to the bipolar group (10%, p < 0.05), highlighting the potential protective effect of the bipolar implant's dual-bearing design. These findings support the growing evidence favouring bipolar HA in this patient population.
Furthermore, the presence of acetabular erosion appeared to be associated with poorer functional outcomes and reduced health-related quality of life (HRQoL). Overall, bipolar hemiarthroplasty demonstrated more favourable outcomes than unipolar HA in this elderly and frail patient cohort (mean age 75 years).
Our study identified a higher incidence of acetabular erosion in patients treated with unipolar hemiarthroplasty compared to those who received bipolar implants. Moreover, the trend toward worse hip function and lower HRQoL in patients with acetabular erosion at one year may suggest a risk of further decline over time, particularly in the unipolar hemiarthroplasty group. Direct comparison of these findings with those of the previous RCTs is limited, as most did not include systematic radiological follow-up or standardized assessment of acetabular erosion.[24]
We selected 4-month and 12-month follow-up intervals to capture both early and late postoperative

outcomes. The 4-month mark corresponds to the end of initial rehabilitation, when most patients regain basic mobility and independence in activities of daily living (ADLs), allowing assessment of early functional recovery and HRQoL improvement. The 12-month follow-up, a standard endpoint in orthopaedic outcome research, reflects long-term recovery, with patients typically reaching a plateau in hip function and quality of life, and enables evaluation of late complications such as acetabular erosion, implant loosening, and delayed infection.

Our findings align with those of Papavasiliou et al,[27] who conducted a systematic review and meta-analysis of randomized controlled trials comparing bipolar and unipolar hemiarthroplasty for femoral neck fractures. They reported that patients treated with bipolar hemiarthroplasty had significantly lower rates of acetabular erosion at 6 and 12 months, along with better hip function and less pain, without notable differences in mortality and reoperation rates. These results further support the potential long-term advantage of bipolar prostheses despite higher initial cost.

Interestingly, acetabular erosion was more prevalent in patients with a lower BMI (<24) (21% vs 5%). While greater body weight would intuitively be expected to increase acetabular wear, this finding suggests an alternative underlying mechanism. One plausible explanation is osteoporosis, as lower body weight is associated with reduced bone mineral density. However, as bone density was not assessed using DXA in this cohort, this remains a hypothesis.

The strengths of our study include its randomised controlled design, clearly defined cohort, use of validated outcome measures (predominantly self-reported), high follow up rate, and blinded radiological assessment of acetabular erosion using standardised grading system. A notable limitation is that the clinical assessor, although unbiased, was aware of the type of surgical intervention, which could introduce some observer bias; however, since most outcomes were self-reported, this risk is likely minimal. Another limitation of this study is that our interpretation of quality-of-life data relies on patient's recall of their pre-fracture health status. However, as prospective collection of preinjury HRQoL data in trauma studies is not feasible, such recall or comparison with population data is standard practice. Notably, our patients reported slightly higher pre fracture EQ-5D scores than the Swedish reference population,[30] likely due to the inclusion of relatively healthier elderly individuals and evidence suggests older patients can accurately recall their prior health status for up to six weeks. Therefore, we believe the impact of recall bias is minimal, and our findings remain representative and valid.

CONCLUSION

Our randomized controlled trial demonstrated that bipolar hemiarthroplasty offers significant advantages over unipolar hemiarthroplasty in elderly patients with displaced femoral neck fractures. The bipolar prosthesis was associated with lower rates of acetabular erosion, better functional outcomes, and improved health-related quality of life at one year, without increasing the risks of mortality or major complications. the protective effect of the bipolar implant's dual-bearing design provides a meaningful benefit for those who live longer, supporting its use in this frail yet functionally vulnerable population.

Furthermore, our findings highlight important prognostic differences within this patient cohort. Acetabular erosion was more prevalent in patients with lower BMI, suggesting a potential link with osteoporosis. Mortality was significantly higher among male patients, consistent with large-scale cohort studies, emphasizing sex as an important prognostic factor in hip fracture outcomes and may partly explain our observed mortality differences. While bipolar implants carry higher upfront costs, their potential to reduce long-term complications and maintain functional independence may justify their use in carefully selected patients. Overall, bipolar hemiarthroplasty appears to be a superior option compared to unipolar implants in elderly patients with displaced femoral neck fractures. Future research with longer follow-up and cost-effectiveness analyses will help further clarify the role of bipolar prostheses in optimizing both clinical and economic outcomes in this growing patient population.

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