Unipolar Versus Bipolar Hemiarthroplasty for Displaced Femoral Neck Fractures in Elderly Patients

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ABSTRACT

Hip replacement using hemiarthroplasty (HA) is a common surgical procedure in elderly patients with femoral neck fractures. However, questions remain regarding the choice of unipolar or bipolar HA. A meta-analysis of randomized, controlled trials (RCTs) was performed to determine whether bipolar HA was associated with lower rates of dislocation, reoperation, acetabular erosion, mortality, and general complications, as well as lower Harris Hip Scores, compared with unipolar HA. The authors searched PubMed and the Cochrane Register of Controlled Trials database, and 8 RCTs (including a total of 1100 patients) were selected for meta-analysis. Risk ratios (RRs) and weighted mean differences (WMDs) from each trial were pooled using random-effects or fixed-effects models depending on the heterogeneity of the included studies. There were...
Hip fractures in older patients are associated with impaired mobility, high rates of morbidity and mortality, and loss of independence. Thus, hip fractures remain a public health concern, especially with the aging population and the high incidence of osteoporosis. Displaced femoral neck fractures are one of the most common hip fractures, and they generally need surgical intervention. The goals of surgical treatment are immediate pain relief, rapid mobilization, accelerated rehabilitation, and a low risk of surgical complications or subsequent revision.

Optimal treatment of femoral neck fractures has been controversial for years. One debate is unipolar (fixed-head) vs bipolar (universal) endoprosthesis for the treatment of displaced (Garden types III through IV) femoral neck fractures in elderly patients. The bipolar prosthesis has a theoretical advantage because it was designed to move at its inner bearing in addition to articulating at the prosthesis-acetabulum interface. This should decrease the amount of acetabular erosion and reduce pain. However, several studies have shown that the inner bearing loses mobility with time and becomes stiff, thereby minimizing the advantage of the bipolar prosthesis. Furthermore, the increased cost of the bipolar prosthesis compared with the unipolar prosthesis raises the question of whether the difference in cost translates to better functional outcomes and quality of life.

Many randomized, controlled trials (RCTs) have evaluated the benefits of bipolar hemiarthroplasty (HA) vs unipolar HA, but there is inconsistency across the studies regarding outcomes. The aim of the current study was to evaluate the clinical outcomes of bipolar vs unipolar HA, including the rates of dislocation, reoperation, acetabular erosion, mortality, and general complications, as well as the Harris Hip Score.

**MATERIALS AND METHODS**

**Inclusion Criteria**

All RCTs comparing bipolar HA with unipolar HA for the treatment of femoral neck fractures were considered for this review. Quasirandomized trials, cohort studies, retrospective studies, and other nonrandomized, comparative studies were excluded. All patients were adults and were randomized into 2 groups: bipolar HA and unipolar HA. All patient parameters, including number, age, and body mass index (BMI), were comparable between groups.

**Exclusion Criteria**

The following criteria were used to exclude studies from the analysis: (1) studies in which the surgical technique (whether bipolar or unipolar HA) could not be defined; and (2) studies in which the outcome of comparison of both techniques was not reported or it was not possible to calculate this from the published results.

**Treatments of Interest**

Bipolar HA and unipolar HA were compared by way of the following factors: dislocation rate, reoperation rate, acetabular erosion rate, mortality rate, general complication rate, and Harris Hip Score. General complications included pneumonia, pressure ulcer, myocardial infarction, pulmonary embolism, and deep venous thrombosis.

**Search Technique and Data Extraction**

An Internet-based search was undertaken using PubMed and the Cochrane Register of Controlled Trials database using the keywords hemiarthroplasty and neck of femur fracture to identify relevant studies published in English between 1966 and April 2014. Articles that had relevant titles were retrieved and assessed for inclusion. Eight articles fulfilled the criteria and were selected. Data were collected by 2 independent researchers (F.Y., X.Z.) who screened titles, abstracts, and keywords; differences were resolved by discussion. The studies were assessed in terms of blinding, allocation concealment, follow-up coverage, and quality level (according to whether allocation concealment was adequate [A], unclear [B], inadequate [C], or not used to assess the study quality [D]).

**Statistical Analysis**

The relative risk (RR) was calculated in each study for dichotomous outcomes, and the weighted mean difference (WMD) was calculated for continuous outcomes using Review Manager version 5.0 statistical software (Cochrane, Oxford, United Kingdom). The RR and WMD adopted a 95% confidence interval (CI). Heterogeneity was tested using the chi-square test and the F test. A significance level of P<.10 for the chi-square test was interpreted as evidence of heterogeneity. The F test was used to estimate the total variation among the studies. When no statistical evidence of heterogeneity existed, a fixed-effects model was adopted. Otherwise, a random-effects model was chosen. The authors did not include the possibility of publishing bias due to the small number of studies included.

**RESULTS**

Using the inclusion and exclusion criteria, 8 studies comparing unipolar HA with bipolar HA were identified. The number of fractures in each study ranged from 48 to 261. A total of 1100 fractures occurred; 548 fractures were treated with unipolar HA, and 552 were treated with bipolar HA. Most studies evaluated the rates of dislocation, reoperation, acetabu-
lar erosion, mortality, and general complications, as well as the postoperative Harris Hip Score.

Four studies\textsuperscript{7,8,10,12} were level A quality, and 4 studies\textsuperscript{4,6,9,11} were level B quality because the randomization or allocation concealment was unclear according to the evaluation criteria (Tables 1-2).

**Dislocation**

Dislocation occurred in 9 of 521 fractures managed with unipolar HA and 8 of 528 fractures managed with the bipolar HA. Heterogeneity tests indicated no statistical evidence of heterogeneity (chi-square=1.01; \( P=0.99; I^2=0\%\)). The data were pooled using a fixed-effects model and indicated that there was no difference in dislocation rate between unipolar HA and bipolar HA (RR=1.02; 95% CI, 0.47 to 3.07; \( P=0.71\)) (Figure 1).

Sensitivity analysis for dislocation rate did not identify significant differences in the relative risk of heterogeneity using random- and fixed-effects models (Figure 2).

**Reoperation**

Reoperation occurred in 13 of 374 fractures managed with unipolar HA and 20 of 377 fractures managed with bipolar HA. Heterogeneity tests indicated no statistical evidence of heterogeneity (chi-square=3.20; \( P=0.53; I^2=0\%\)). The data were pooled using a fixed-effects model and indicated that there was no difference in reoperation rate between unipolar HA and bipolar HA (RR=0.64; 95% CI, 0.33 to 1.26; \( P=0.19\)) (Figure 3).

**Acetabular Erosion**

Acetabular erosion occurred in 12 of 284 fractures managed with unipolar HA and 4 of 268 fractures managed with bipolar HA. Heterogeneity tests indicated no statistical evidence of heterogeneity (chi-square=1.27; \( P=0.74; I^2=0\%\)). The data were pooled using a fixed-effects model and indicated that there was no difference in acetabular erosion rate between unipolar HA and bipolar HA (RR=2.29; 95% CI, 0.85 to 6.12; \( P=0.10\)) (Figure 4).

### Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>Age, Mean±SD (Range), y, Unipolar/Bipolar</th>
<th>Men</th>
<th>No. of Fractures, Unipolar/Bipolar</th>
<th>Country</th>
<th>Follow-up, mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inngul et al\textsuperscript{4}</td>
<td>87.4 (80-100)/85.5 (80-96)</td>
<td>24.1%</td>
<td>60/60</td>
<td>Sweden</td>
<td>48</td>
</tr>
<tr>
<td>Calder et al\textsuperscript{6}</td>
<td>85 (82-88)/85 (82-88)</td>
<td>14%</td>
<td>132/118</td>
<td>UK</td>
<td>24</td>
</tr>
<tr>
<td>Cornell et al\textsuperscript{7}</td>
<td>77.6±10/78.0±8</td>
<td>25%</td>
<td>15/33</td>
<td>US</td>
<td>6</td>
</tr>
<tr>
<td>Davison et al\textsuperscript{8}</td>
<td>76 (72-77)/75 (71-78)</td>
<td>23.5%</td>
<td>90/97</td>
<td>UK</td>
<td>60</td>
</tr>
<tr>
<td>Malhotra et al\textsuperscript{9}</td>
<td>68/65</td>
<td>55.6%</td>
<td>36/32</td>
<td>India</td>
<td>26</td>
</tr>
<tr>
<td>Raia et al\textsuperscript{10}</td>
<td>81.8 (65-101)/82.4 (65-95)</td>
<td>27.8%</td>
<td>60/55</td>
<td>US</td>
<td>24</td>
</tr>
<tr>
<td>Stoffel et al\textsuperscript{11}</td>
<td>81.9±8.8/82.9±9.7</td>
<td>28%</td>
<td>128/133</td>
<td>Australia</td>
<td>12</td>
</tr>
<tr>
<td>Jeffcote et al\textsuperscript{12}</td>
<td>81.4±80.1</td>
<td>23.5%</td>
<td>27/24</td>
<td>Australia</td>
<td>24</td>
</tr>
</tbody>
</table>

**Abbreviations:** UK, United Kingdom; US, United States.
Mortality

Four articles comprising 603 patients provided mortality data within 24 months. Among the 309 patients managed using unipolar HA, 65 deaths occurred, and among the 294 patients managed using bipolar HA, 71 deaths occurred. Heterogeneity tests indicated no statistical evidence of heterogeneity (chi-square=0.72; \(P=0.87\); \(I^2=0\%\)). The data were pooled using a fixed-effects model and indicated that there was no difference in mortality rate between unipolar HA and bipolar HA (RR=0.85; 95% CI, 0.63 to 1.13; \(P=0.26\)) (Figure 5).

General Complication

General complications occurred in 41 of 248 fractures managed with unipolar HA and 39 of 248 fractures managed with bipolar HA. Heterogeneity tests indicated no statistical evidence of heterogeneity (chi-square=1.89; \(P=0.39\); \(I^2=0\%\)). The data were pooled using a fixed-effects model and indicated that there was no difference in general complication rate between unipolar HA and bipolar HA (RR=1.05; 95% CI, 0.70 to 1.56; \(P=0.10\)) (Figure 6).

Harris Hip Score

No difference was found in postoperative Harris Hip Scores between patients undergoing unipolar HA and bipolar HA (WMD=−1.32; 95% CI, −3.29 to 0.65; \(P=0.19\)). Heterogeneity tests indicated no statistical evidence of heterogeneity (chi-square=0.99; \(P=0.61\); \(I^2=0\%\)). Data were pooled using a fixed-effects model (Figure 7).

Discussion

The geriatric population is increasing worldwide, and femoral neck fractures have become a major public health concern. Contemporary evidence from RCTs is compelling and indicates that the treatment of choice for a displaced fracture of the femoral neck in an elderly patient is arthroplasty. In the majority of elderly and frail patients, a cemented HA is the choice for most surgeons. Hemiarthroplasty is a procedure in which the head and neck of the femur are replaced with a prosthesis but the acetabulum is not modified. When using an HA, there are 2 types of articulations of the prosthesis and the patient’s acetabulum: unipolar or bipolar. Whereas the unipolar head has a single articulation between the prosthesis and the acetabulum, the bipolar head offers a second articulation between an inner smaller head and the polyethylene liner of the larger outer head. The choice of prosthesis in HA is controversial. The theoretical advantage of the bipolar prosthesis is the motion at its inner bearing in addition...
to the prosthesis-acetabulum interface.\textsuperscript{14} This should decrease the amount of acetabular erosion evidenced radiologically and reduce pain clinically. Nevertheless, studies have shown that the inner bearing loses mobility over time and that the bipolar prosthesis behaves similarly to the unipolar prosthesis.\textsuperscript{15,16}

The results of the current study demonstrated no differences regarding hip complications, such as dislocation (RR=1.02; 95\% CI, 0.47 to 3.07; \textit{P}= .71) and acetabular erosion (RR=2.29; 95\% CI, 0.85 to 6.12; \textit{P}= .10), in elderly patients with a displaced fracture of the femoral neck randomized to either a unipolar HA or a bipolar HA. A study by Dalldorf et al\textsuperscript{17} comparing the histologic features of acetabular specimens of patients undergoing revision HA against age-matched subjects suggested that acetabular wear correlated directly with the amount of time the implant remained in the hip rather than the type of implant used. It has also been suggested in the literature that acetabular wear is more of an issue in younger, more active patients.\textsuperscript{18} Tsukamoto et al\textsuperscript{19} conducted cadaver motion studies of bipolar implants and found that in stems loaded with less than 10 kg, motion occurred at both bearings. If greater than 20 kg was applied, the outer bearing was the primary site of articulation. Only when the acetabular cartilage was removed did motion occur at the inner bearing. Leonardsson et al\textsuperscript{20} found the most common reasons for HA reoperation and revision were implant dislocation and infection, accounting for three-quarters of patients, and there was no difference (RR=0.64; 95\% CI, 0.33 to 1.26; \textit{P}= .19) in the rate of reoperation between the 2 groups.

The current meta-analysis failed to demonstrate any differences in the rates of mortality and general complications between the 2 groups. The literature shows that increased age,\textsuperscript{21} high American Society of Anesthesiologists score,\textsuperscript{22} and delayed surgery\textsuperscript{23} are correlated with increased mortality and complications.

In theory, the bipolar prosthesis design with an additional inner articulation can entail a better range of motion and better functional outcome. However, the current study found no functional differences (Harris Hip Score) between unipolar and bipolar HA (WMD=-1.32; 95\% CI, -3.29 to 0.65; \textit{P}= .19). de los Santos et al\textsuperscript{24} reported no significant differences in function between patients with unipolar vs bipolar prostheses, but patients in the latter group presented lower pain scores, more quickly regained the ability to walk, and used fewer external supports. Perhaps the fact that patients receiving a bipolar HA were younger and presented a better functional status before fracture was also responsible for this difference.

Meta-analysis of RCTs is generally considered to provide the strongest evi-
dence of clinical interventions and has more advantages than observational studies and single randomized trials. Nevertheless, some possible limitations to this study should be acknowledged. First, although every effort was made to ensure the results were accurate, not all related randomized trials were included because of publication bias, which may have excluded obvious outcome differences of the 2 treatment methods, and selection bias, which may have excluded selective studies that preferred some kind of treatment. Strict searches in the library and of included bibliographies were conducted to reduce bias. Second, the problem is study heterogeneity, both in the nature of the studies themselves and in the statistical heterogeneity of individual relative risks. Concerning the latter, there was no apparent heterogeneity. There were differences in the protocols of the studies identified. For example, although all studies included elderly patients, there were differences in age ranges (Table 1) in the studies included. It is possible that there may be effect modification by age, but the authors could not determine this from the data available. Third, the clinical outcomes of cemented and uncemented unipolar HA or bipolar HA differed, and a previous Cochrane review suggested there was good evidence that cementing the prostheses in place would reduce postoperative pain and lead to better mobility; however, the authors did not perform subgroup analyses according to cemented or uncemented status owing to the limited studies reported in the original reports.

CONCLUSION

The authors found that both unipolar and bipolar HA have satisfying results for displaced femoral neck fractures. The theoretical advantages of bipolar HA have not been supported by clinical studies, and the equivalent functional outcomes with the lower initial cost of unipolar HA should be considered.

REFERENCES