Comparison of Complication Rates Between Hemiarthroplasty and Total Hip Arthroplasty for Intracapsular Hip Fractures

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abstract

Hip fractures are common and have come to represent an increasing burden of disease. As a result, it is critical that cost-effective and evidence-based treatments be used to treat hip fractures. However, with regard to hemiarthroplasty vs total hip arthroplasty (THA), the optimal treatment of displaced femoral neck fractures in elderly patients remains controversial. The purpose of this study was to compare complication rates after hemiarthroplasty and THA for intracapsular hip fractures.

Data on hospitalizations from 1995 through 2005 were obtained from California’s Office of Statewide Health Planning and Development. Regression analyses were used to compare rates of short-term complications and mid-term revision surgeries following hemiarthroplasty and THA. The data identified 2437 patients undergoing THA and 38,328 undergoing hemiarthroplasty. At 90 days postoperatively, patients undergoing THA had no statistically significant increase in short-term complication risk compared with patients undergoing hemiarthroplasty (odds ratio, 0.89; P=.06). Cox regression analysis demonstrated no statistically significant difference in risk of revision surgery during the 11-year observation period.

This study demonstrates similar short-term complication and mid-term revision risks following hemiarthroplasty and THA. This suggests that both procedures are safe alternatives, but further study is needed to clarify differences in functional outcomes and long-term revision rates for patients undergoing these procedures following a hip fracture.

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Hip fractures are the most common type of fragility fracture and have come to represent an ever-increasing burden of disease. According to the American Academy of Orthopaedic Surgeons (AAOS), hip fractures account for 350,000 hospital admissions and 60,000 nursing home admissions each year; by 2050, an estimated 650,000 hip fractures will occur annually in the United States. The associated costs of osteoporotic fractures are anticipated to increase to $25.3 billion in 2025, with hip fractures being the key driver of these costs. This burden of cost and disease can only be expected to increase in the United States given the slowly increasing longevity of the population, changing demographic trends, and the increasing incidence of osteoporosis.

In light of the increasing costs of health care, cost-effective and evidence-based treatments need to be used to treat hip fractures. Currently, 4 accepted surgical treatment options exist to manage displaced femoral neck fractures: internal fixation, unipolar hemiarthroplasty, bipolar hemiarthroplasty, and total hip arthroplasty (THA). The efficacy of these surgical strategies has been evaluated in randomized trials and meta-analyses. The general consensus of the studies is that, for active patients between the ages of 70 and 90 years, THA is associated with better function and fewer complications than internal fixation. Two recent randomized trials compared the outcomes of THA vs unipolar and bipolar hemiarthroplasty in healthy, mobile patients with displaced femoral neck fractures. Baker et al noted overall better function in the THA group. A higher dislocation rate (6% vs 0%) and a lower overall revision rate (2.5% vs 14%; P = .058) were found in the THA group. Blomfeldt et al noted no differences in health related to quality of life outcomes and no difference in mortality between patients undergoing THA and those undergoing bipolar hemiarthroplasty. The authors noted higher Harris Hip Scores at 4 months and 12 months in patients undergoing THA.

Although these randomized trials suggest that better outcomes can be obtained with THA vs hemiarthroplasty, the conclusions are not definitive. Both studies were relatively small (81 and 120 patients, respectively), and the follow-up was 1 year. Therefore, the current authors evaluated the results of the management of displaced femoral neck fractures with THA or hemiarthroplasty using population-based data. This type of analysis allowed access to a larger sample size than is typically assessed in other studies. The purpose of this study was to use hospitalization data obtained from California’s Office of Statewide Health Planning and Development (OSHPD) to compare complication rates of displaced femoral neck fractures managed with hemiarthroplasty or THA. This will further shed light on the controversy of the best surgical treatment for displaced femoral neck fractures.

**MATERIALS AND METHODS**

**Data Source**

Data on all hospitalizations in California from 1995 through 2005 were obtained from California’s OSHPD. The OSHPD database is compiled annually and includes discharge abstracts from all licensed nonfederal hospitals in California. Each discharge abstract reports demographic information, including age, sex, ZIP Code of residence, and the race or ethnicity of the patient. In addition, International Classification of Diseases, 9th Revision (ICD-9) codes are entered into the record for each patient; the number of codes entered is not prespecified, and the maximum allowed is 20 inpatient procedures and 24 diagnoses per hospitalization. Hospital characteristics are also reported, including the teaching status and whether a hospital is classified as rural in location. The OSHPD inpatient database was initiated as a component of the Healthcare Cost and Utilization Project (HCUP) and is collected through mandatory reporting by all nonfederal hospitals in the state of California. Institutional review board approval was obtained for this study.

**Patient Sample**

The data identified 45,299 patients undergoing hemiarthroplasty or THA using ICD-9 diagnosis codes for intracapsular hip fractures (820.00) and procedure codes for hemiarthroplasty (81.52) and primary THA (81.51). A coding algorithm was used to exclude 3844 patients with infection, pathologic fracture, or undergoing revision arthroplasty. Also excluded were 690 patients with a non-California ZIP Code to decrease the probability of the patients having prior admissions meeting exclusion criteria or experiencing a subsequent complication treated outside of the state. The unit of analysis was hospital discharge for each patient. All patients had basic demographic data as mandated by the state reporting requirements, so no patients were excluded for missing data. Baseline patient characteristics were recorded in the database and analyzed.

**Outcomes Studied (Dependent Variables)**

The outcomes analyzed as the dependent variables were the aggregate rate of short-term complications and the separately analyzed rates of individual complications, including mortality or readmission for the specific complications of infection, dislocation, revision surgery, and thromboembolic disease within 90 days postoperatively. The second main category of outcome analyzed was midterm survivorship of the prosthesis, with failure defined as revision of the implant during the observation period. A coding algorithm was adapted to detect codes consistent with a complication. The coding algorithms use ICD-9 nomenclature to identify patients undergoing THA using the 81.51 procedure code. Additional associated diagnoses, exclusion criteria, and complications were defined based on ICD-9 procedure and diagnosis codes judged by the authors to be consistent.
with the diagnoses or complications of interest. These algorithms were modified to correct for coding changes made during the study period.\textsuperscript{5,9} Mortality was identified by the linkage of the California State Death Master Statistical File (DMSF) to the OSHPD database. This allowed the authors to identify hospital deaths occurring after discharge and the time elapsed before death in patients undergoing treatment. The DMSF is a database of death certificates for all individuals who die in California and of California residents who die outside of California’s borders but within the United States.\textsuperscript{10}

\textbf{Predictors (Independent Variables)}

The authors selected the primary patient-based predictors: procedure performed (hemiarthroplasty or THA), Charlson comorbidity index, age, race, sex, and income using the ZIP Code as a proxy, as reported in the OSHPD database, cross-referenced to US Census data.\textsuperscript{11,12} The Charlson comorbidity index assesses 19 comorbid conditions and has been validated for use in administrative database studies.\textsuperscript{11,12} The current study used the approach of Deyo et al.,\textsuperscript{11} who adapted the Charlson index by defining the 19 comorbid conditions using ICD-9-CM coding and subsequently determining whether the relevant codes are included in a patient record.\textsuperscript{12}

Hospital characteristics included surgical volume of hip fracture cases in the sample, rural location, and teaching status. Teaching status and rural location were self-reported by the participating hospitals. Surgical volume was defined as the average number of hemiarthroplasty and THA cases performed for hip fracture yearly during the study period. Hospitals were classified by their annual average volume as high-, intermediate-, or low-volume hospitals. Hospitals were categorized as low volume if they were in the lowest 40th percentile by annual volume among hospitals where cases were performed. Intermediate-volume hospitals were defined as those within the 40th to 80th percentile; high-volume hospitals were defined as those within the highest 20th percentile.

\textbf{Statistical Analyses}

All statistical analyses were performed using Stata/SE version 8.0 software (StataCorp, College Station, Texas). The patient sample is described with descriptive statistics. Results reported using descriptive statistics include patient demographics and annual rates of hemiarthroplasty and THA for patients with hip fractures. Raw rates of complications are also reported separately for the hemiarthroplasty and THA groups.

The short-term outcomes were analyzed using multivariate logistic regression. The short-term outcomes analyzed as dependent variables included mortality, infection, dislocation, revision surgery, and thromboembolic disease, as well as the aggregate rate of these complications. Multiple variable logistic models were used to examine the relationship of each patient and provider variable and each of these outcomes. Separate regression models were used for each dependent variable, and each model evaluated the role of the choice of primary procedure (hemiarthroplasty) while correcting for patient demographics (ie, age, sex, race/ethnicity, and proxy income), comorbidities (Charlson comorbidity index), and provider characteristics (ie, hospital volume, teaching status, and rural location). The strength of association between the risk of short-term complications and the selection of hemiarthroplasty or primary THA are expressed as odds ratios (ORs) for a complication in a patient undergoing THA with respect to the reference group of hemiarthroplasty patients. Ninety-five percent confidence intervals (CIs) and \( P \) values are reported.

The rate of a mid-term complication was analyzed using Cox proportional hazard regression models. The mid-term outcome analyzed as the dependent variable was the rate of a revision procedure. Cox proportional hazard models were used to examine the relationship of each patient and provider variable and this outcome. A regression model was used for the dependent variable and evaluated the role of the choice of primary procedure while correcting for patient demographics, comorbidities, and provider characteristics. The strength of association between the risk of a mid-term revision and the selection of hemiarthroplasty or primary THA is expressed as the hazard ratio for a revision in a patient undergoing hemiarthroplasty with respect to the reference group of THA patients. Ninety-five percent CIs and \( P \) values are reported.

\textbf{RESULTS}

\textbf{Patient Sample}

A total of 2437 patients underwent THA and 38,328 patients underwent hemiarthroplasty during the 11-year study period. Table 1 shows the annual incidence of each procedure. Table 2 lists the

\begin{table}[!h]
\centering
\begin{tabular}{|c|c|c|}
\hline
\textbf{Year} & \textbf{Hemiarthroplasty} & \textbf{THA} \\
\hline
1995 & 3133 & 273 \\
1996 & 2964 & 228 \\
1997 & 3121 & 247 \\
1998 & 3271 & 244 \\
1999 & 3422 & 228 \\
2000 & 3439 & 201 \\
2001 & 3721 & 184 \\
2002 & 3655 & 184 \\
2003 & 3770 & 197 \\
2004 & 3884 & 232 \\
2005 & 3948 & 219 \\
Total & 38,328 & 2437 \\
\hline
\end{tabular}
\caption{Incidence of THA and Hemiarthroplasty for Intracapsular Hip Fractures in California From 1995 Through 2005}
\end{table}

Abbreviation: THA, total hip arthroplasty.
demographic information of patients undergoing each procedure. Mean patient age was 78 years in the THA group and 81 years in the hemiarthroplasty group. The proportion of patients with a Charlson co-morbidity score greater than 1 was similar in the hemiarthroplasty (36.8%) and THA (35.3%) groups. Similar percentages of White patients existed in both groups, and median income was similar in the 2 groups. Rheumatoid arthritis was more common in the THA group (5.7%) compared with the hemiarthroplasty group (2.9%), and the rate of uncomplicated and complicated diabetes mellitus were similar between the groups.

### Short-term Complications

The raw incidence of short-term complications is shown in Table 3. The ORs of short-term complications in the THA group relative to the hemiarthroplasty group are shown in Table 4. At 90 days postoperatively, patients undergoing THA had no statistically significant increase in the rate of complication (14.4% compared with 17.4% for patients undergoing hemiarthroplasty) (OR, 0.89; 95% CI, 0.79-1.02; P = .06).

The regression analysis included patient and provider characteristics. Increased Charlson co-morbidity scores (OR, 2.11; P < .001), age older than 75 years (OR, 1.89; P < .001), and low hospital volume (OR, 1.20; P = .003) were statistically significant predictors of an increased risk of short-term complications. Patients of Hispanic (OR, 0.82; P < .001) and Asian (OR, 0.72; P < .001) ethnicity were at a decreased risk of readmission for a complication within 90 days of the index procedure.

### Mid-term Complications

The incidence of revision surgery within 1 year associated with THA and hemiarthroplasty is shown in Table 3. The hazard ratios shown in Table 4 reflect the risk of complications in patients undergoing THA relative to the reference group of patients undergoing hemiarthroplasty. The raw rate of major revision surgery at 1 year postoperatively was 1.0% in the hemiarthroplasty group and 1.5% in the THA group.

Correcting for patient and provider factors, Cox regression analysis did not demonstrate a statistically significant difference in the risk of a revision surgery for patients undergoing THA relative to those undergoing hemiarthroplasty (hazard ratio, 1.06; 95% CI, 0.92-1.20; P = .65) (Table 4). Increased Charlson comorbidity was an independent predictor of revision during the observation period (hazard ratio, 1.30; P < .002).

### Discussion

The results of this study demonstrate similar mortality rates and complication rates when comparing the outcomes of THA and hemiarthroplasty for the management of patients with intracapsular hip fractures. The number of major revision procedures required in the mid-term were also similar after adjusting for patient characteristics. These results suggest that,
with appropriate patient selection, THA is a safe alternative to hemiarthroplasty following acute intracapsular hip fractures.

The study was unable to evaluate physical function and pain relief. However, 2 recent single-center randomized trials demonstrated superior results with THA vs hemiarthroplasty after 1-year follow-up.\textsuperscript{3,4} In addition, in a small randomized trial, Macaulay et al\textsuperscript{13} noted that patients randomized to undergo THA had less pain and scored significantly better on the Short Form 36 and the Western Ontario and McMaster Osteoarthritis Index function scores compared with patients undergoing hemiarthroplasty. These 3 randomized trials suggest that THA provides results superior to hemiarthroplasty in active elderly patients with displaced femoral neck fractures. The results of these studies suggest that healthy, mobile patients will obtain greater benefit from a THA than a hemiarthroplasty. These randomized trials had small sample sizes and short-term follow-up. The current study’s results are useful to support these findings because it used a large sample to demonstrate no significant differences in complication rates and revision surgery between THA and hemiarthroplasty. Therefore, it may be preferable to perform THA in active patients because the potential benefits related to function can be gained without incurring a significant increase in risk to patients.

The current study included an analysis of more than 40,000 patients who were followed for up to 11 years. The demographics of the patients in the 2 groups were similar. Both groups comprised mostly women, and mean patient age was 78.0 years in the THA group and 80.7 years in the hemiarthroplasty group. At 90 days postoperatively, patients undergoing THA had no significant increase in the complication rate (14.4% vs 17.4%; \( P = .06 \)). Outcomes were influenced by the scores on the Charlson comorbidity index, with increased comorbidity increasing the risk of complications.

Hospital volume was also a predictor of revision surgery in both groups. Lower-volume hospitals had higher rates of complications and an increased need for revision surgery in both groups. The inverse relationship between volume and outcomes has been previously reported in patients undergoing THA, but volume also influenced outcomes in hemiarthroplasty, which is considered a simpler procedure.\textsuperscript{7,8} The current study demonstrated that Asian and Hispanic patients had a decreased risk for readmission 90 days after the index procedure. The reason for this finding is unclear, but the influence of race and ethnicity and its effect on outcomes requires further study.

The limitations of this study include its retrospective nature and the use of an administrative database that may be subject to inaccuracies in coding and data collection, which could influence the results of the study. In addition, the database did not allow the authors to assess outcomes with respect to pain and function. The strengths of the study were that the authors were able to study a large number of patients and evaluate outcomes not only with respect to type of procedure but also hospital volume. Finally, this study included both short- and mid-term follow-up over an 11-year observation period. Most randomized trials evaluating hip fracture patients are single-center trials that follow patients for 2 or fewer years.

The number of hip fractures will continue to increase as the population ages. The goal of treatment is to maximize the functional outcomes in this patient population. In the past, surgeons often preferred hemiarthroplasty to THA because of concerns about increased risks of complications because THA was a more technically involved procedure. In addition, concerns existed about increased risks for dislocation because of the use of smaller femoral heads. However, the current study’s data showed no significant difference in rates of complications or revision surgery between patients undergoing hemiarthroplasty or THA after adjusting for patient and provider characteristics. No significant difference existed in dislocation rates between the 2 groups, and these cases were performed when the use of larger femoral heads was not as prevalent as it is today. These data support the findings of 3 recent randomized trials that reported that THA is the procedure of choice for patients with a displaced femoral neck.\textsuperscript{3,4,13} Large, multicenter randomized trials are needed to confirm these findings.

**Conclusion**

The results of this study demonstrate similar short-term complication and mid-term revision rates following hemiarthroplasty and THA for intracapsular hip fracture. This suggests that both procedures are

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### Table 4

<table>
<thead>
<tr>
<th>Complication</th>
<th>Ratio (95% CI)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall complication rate within 90 d</td>
<td>OR, 0.89 (0.79–1.02)</td>
<td>.06</td>
</tr>
<tr>
<td>Mid-term</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major revision surgery</td>
<td>Cox hazard ratio, 1.06 (0.92–1.20)</td>
<td>.65</td>
</tr>
</tbody>
</table>

*Abbreviation: CI, confidence interval; OR, odds ratio; THA, total hip arthroplasty.*
safe alternatives, but further study is needed to clarify differences in functional outcomes and long-term revision rates for patients undergoing these procedures following hip fracture.

REFERENCES


