The Predictors of Surgical Procedure and the Effects on Functional Recovery in Elderly With Subcapital Fractures

Yuchi Young,1 Pearl German,2 Larry Brant,3 John Kenzora,1 and Jay Magaziner1

1University of Maryland School of Medicine.
2The Johns Hopkins University School of Hygiene and Public Health.
3National Institute on Aging at Baltimore.

Background. It has been demonstrated that the majority of hip fracture patients do not regain their prefracture level of functioning and usually decline in function following fracture. Little is known about the effectiveness of surgical procedure performed (hemiarthroplasty vs internal fixation) on functional recovery of subcapital fracture patients. This study examines the factors related to the type of the surgical procedure chosen and the effect of this selection on physical activities of daily living (PADL) and instrumental activities of daily living (IADL).

Methods. The sample consists of 312 patients with subcapital fractures age 65 and older admitted from the community to one of seven Baltimore area hospitals between 1984 and 1986. Baseline information was obtained during hospitalization through structured interviews with both patients and their significant others (proxy). The follow-up interviews were administered to proxies at two months, six months, and one year after discharge from hospital. Information on disease diagnoses, fracture severity, and surgical procedures performed was obtained from medical charts.

Results. Patients with a displaced fracture were seven times more likely to receive a hemiarthroplasty (OR = 7.0, 95% CI 3.7–13.1). During the short-term recovery (2 months after surgery), patients who received hemiarthroplasty were doing better in transferring, meal preparation, and shopping than those who received internal fixation. For the long-term functional recovery (one year), the overall PADL and IADL functions were not statistically significantly different between the two surgical procedures performed.

Conclusions. The severity of fracture was found to be the most important determinant of surgical procedure. Patients with a subcapital fracture who received hemiarthroplasty tended to have a better functional recovery in the short term. Further study of other benefits of using a hemiarthroplasty is needed.
proxy at 2, 6, and 12 months after discharge from hospital to
determine the patient's disposition, level of functioning,
physical health, medical care utilization, mental status, and
level of social support. In addition to the three follow-ups,
physical (PADL) function was evaluated prior to hospital
discharge through interview with nursing staff. The reliability
of proxy responses has been demonstrated previously (10).

Of the 858 subjects identified on entry into a study
hospital, 760 (88.6%) consented to participate in the pro-
spective follow-up. The main reasons for nonparticipation
were mental confusion, medical illness, and death prior to
being approached for an interview. To examine the potential
bias introduced by the nonparticipants, selected characteris-
tics of participants and nonparticipants were compared by
using chi-square tests for homogeneity. Nonparticipants
were not significantly different ($p < .05$) from participants in
age, gender, race, fracture type, fracture side, diagnosed
dementia, or hospital length of stay. Of the 760 participants,
312 had a subcapital fracture and were treated with either
internal fixation or hemiarthroplasty; they are the focus of
this study.

Comparison of the study population to hip fracture patients
discharged from other Baltimore area hospitals in 1979 as
recorded by the Maryland Health Services Cost Review
Commission, revealed that the study population was similar
to patients discharged from other Baltimore area hospitals not
included in the study with regard to age, gender, mean length
of hospital stay, percent having surgery, and percent dis-
charged to nursing home. The study population also was
compared to the 1990-1991 Medicare data; it was found that
fracture types were similar across groups, but internal fixation
was utilized less frequently in the 1990-1991 cohort.

Measurement of Outcomes

Two major outcome variables were examined in two
separate analyses. The first outcome variable examined was
choice of surgical procedure (internal fixation vs hemiar-
throplasty); the second, the effect of surgical procedure on
PADL and IADL functions. The functional status of hip
fracture patients was assessed using 14 items from the
Multidimensional Functional Assessment Questionnaire
(MFAQ) of the Older American Resources and Services
(OARS) instrument (11). The first seven questions which
corrinate to PADL include eating, dressing, grooming, walk-
ing, transferring, bathing, and using the toilet. The remain-
ing seven questions relate to IADLs and include taking
medication, using the telephone, mobility, shopping, pre-
paring meals, doing housework, and handling money. The
response options of the PADL and IADL questions are:
without help, with some help, and completely unable to
carry out. Two summary scales were constructed by sum-
mimg scores on each item of PADLs and IADLs. The score
range for each scale is from 0 to 14, with 0 indicating
completely independent, and 14 completely unable to per-
form all seven activities independently. The OARS instru-
ment has been found to be reliable and valid for use with
community elderly (12-15) and has been used in more than
150 research and practice settings (16).

Surgical procedure was defined as a dichotomous vari-
able; the patient received either internal fixation or hemi-
arthroplasty. Patients receiving total hip replacement and
other procedures, less prevalent in this study population
(5%), were excluded from this study.

Measurement of Predictor Variables

The selection of variables that might predict the choice of
surgical procedure was guided by results of other studies.

Fracture severity. — Severity of fracture is an extremely
important factor for determining both treatment and prog-
nosis among hip fracture patients. The simplest and most
appropriate classification system to use in the elderly popu-
lation is to divide all femoral neck fracture into nondis-
placed fractures (Garden I and II) and displaced fractures
(Garden III and IV) (17-19). This classification places
fractures with similar treatment alternatives and similar
prognoses in the same category. In this study, severity of
fracture is a dichotomous variable with the fracture being
displaced or nondisplaced.

Health status. — Baseline presence of dementia and
chronic medical conditions was determined from medical
chart review of physician-diagnosed conditions. Dementia
was categorized as a dichotomous variable depending on
whether the patient had been diagnosed with or without
dementia. The baseline prevalence of 10 chronic conditions
(heart disease, arthritis, cancer, osteoporosis, diabetes, em-
physema, circulatory disorder, stroke, Parkinson’s disease,
and Alzheimer’s disease) was analyzed individually and also
dichotomized to either having any one or having none of
these selected chronic conditions.

Health care utilization. — Respondents were asked
where they typically went for medical care: private physi-
cian, free clinic, hospital OPD/clinic, hospital emergency
room, military or federal hospital, or whether no usual
source of care existed. In this study, nearly 87% of the
elderly had a private physician, so that their usual source of
medical care was grouped into having private physician or
another provider source.

Sociodemographic characteristics. — Variation in surgi-
cal procedure selection by age, gender, and marital status
also was examined. Age was grouped into three categories of
65-74, 75-84, and 85 and over.

Data Analysis

The predictors of surgical procedure were identified using
simple logistic regression and followed by multivariate lo-
gistic regression. Potential interaction effects of surgical
procedure with severity on functional outcomes were tested.
Paired $t$-tests were performed to examine the mean differ-
ence of functional recovery in PADL and IADL between
baseline and the subsequent follow-up times. Repeated anal-
ysis of variance (ANOVA) was used to examine functional
recovery over time and the role in the recovery of the two
specific surgical procedures performed. The Greenhouse-
Geisser $F$-test was used to determine the significance of
differences over time and by surgical procedures.
RESULTS

Description of Population
Table 1 summarizes the demographic and medical characteristics of the study population. The average age of the population was 79 years with a range of 65-98. The majority of these patients were White (93%) and female (83%). More than three-quarters (76%) were currently unmarried, most of whom were widowed; 44% were living alone. Eight percent were diagnosed with dementia, 65% had a displaced fracture, and 68% received a hemiarthroplasty surgery. Of the chronic conditions measured, heart disease was the most prevalent (49%), followed by arthritis (33%), while cancer and osteoporosis had an equal frequency of 17% each.

Eighty-seven percent of the patients had a private physician. Comparison of length of stay of patients with the two surgical procedures showed that those with hemiarthroplasty had, on average, longer hospital stays of approximately 3 days than those treated by internal fixation. At one-year follow-up, 49 (16.7%) patients had died. A comparison of selected characteristics of survivors with deceased patients showed that survivors were not statistically significantly different from deceased patients with regard to age, gender, number of chronic conditions, and type of surgical procedure performed. Those who died after hip fracture surgery were more disabled in prefracture PADL function than those who survived (p < .003).

Predictors of Surgical Procedure
Factors examined that might affect the choice of surgical procedure in the simple logistic regression include age, gender, marital status, dementia, chronic conditions, private physician, fracture severity, and prefracture PADL function. A bivariate analysis shows that 84% of displaced fracture received hemiarthroplasty treatment, where only 42% of nondisplaced fracture received the same treatment. An age-stratified analysis indicated that age is not a confounder of surgical procedure with regard to severity of fracture, chronic conditions, and having a private physician.

Table 2 presents the results of univariate and multivariate logistic regression analysis of predictors of surgical procedure. The univariate regression results show that severity of fracture (p < .0001) and having a private physician (p < .03) were significantly associated with surgical procedure. These two variables were included in the subsequent multivariate models. Age, chronic conditions, and prefracture PADL function were not statistically significant, but because of the clinical and conceptual importance of these variables, they too were included in the multivariate model. The final multivariate regression model for choice of procedure indicates that severity of fracture is highly significantly associated with surgical procedure (p < .001), while adjusting for...
age, private physician, chronic conditions, and prefracture physical function. The resulting odds suggest that patients with displaced fractures are seven times more likely to receive a hemiarthroplasty than patients with a nondisplaced fracture (OR = 7.0, 95% CI 3.7–13.1). Having a private physician was marginally significant in the multivariate model (OR = 2.3, 95% CI 0.9–5.6). The odds ratio of receiving a hemiarthroplasty among patients having a private physician is 2.3 times greater than among patients without a private physician. The other three potential indicators for surgical procedure, i.e., age, chronic conditions, and prefracture PADL function, were not significant predictors of surgical procedure in this study population.

Effectiveness of Surgery on PADL Function

Figure 1 shows the PADL and IADL function before and after the fracture occurred. In general, this study population was very independent in their PADL function prior to hip fracture. Nearly two-thirds (64.5%) reported no PADL functional limitations prior to the hip fracture with a mean score of 1.24. As expected, the PADL function was most impaired during the hospitalization, where almost every patient (99.6%) had several impaired functions in PADL tasks at discharge (M = 5.25). The percentage of patients with no impairment drops dramatically from prefracture (64.5%) to two months after hospital discharge (17.7%). Four months later, at six months post discharge, only 41.2% of the patients demonstrate no impairment (M = 2.70); the percentage with no impairment remained essentially unchanged from six months to one year.

Paired t-tests were used to compare the PADL and IADL functional change between baseline and the subsequent follow-ups. The results on PADLs indicated that the mean score of each follow-up was significantly different from that of baseline: the mean score difference between hospitalization and baseline was 4.04 (p < .0001), and similarly at two months (M = 2.17, p < .0001), six months (M = 1.63, p < .0001), and one year (M = 1.54, p < .0001). These results suggest that recovery in physical function was taking place over time in these hip fracture patients. However, at one year post discharge, the PADL function was still significantly different from prefracture function, meaning that, overall, patients did not recover to their prefracture PADL function level at one year after surgery. A test of the PADL scores at two months against hospitalization scores yielded a significantly different PADL function, indicative of improvement (M = 1.78, p < .0001). Similarly, there was evidence of recovery at six months (M = 2.26, p < .0001) and one year (M = 2.40, p < .0001). These findings were further substantiated by the repeated ANOVA. The overall effect of time on PADL between hospitalization and the three follow-ups was significant (p < .0001).

To explore whether PADL functional recovery was different between the two surgical procedures, a repeated measures ANOVA was carried out. Results in Table 3 indicate a functional recovery over time (p < .0001), but there was no significant effect of surgical procedure on overall PADL functional recovery (p > .70). In terms of short-term recovery at two months after hospitalization, results indicate that there is a marginally significant difference between the two surgical procedures (p < .06). This result prompted a further examination of the four individual items of the seven PADLs which measure lower extremity function and are most affected by hip fracture: walking, transferring, bathing, and toileting. The results indicate that the hemiarthroplasty group was doing better in transferring (p < .02) at two months after surgery (Figure 2A). However, walking, bathing, and toileting functions were not statistically significantly different between the two surgical procedures.

Effectiveness of Surgery on IADL Function

The percentage of independence in IADL function was lower than that of PADL function in this study population (Figure 1). Almost one-third (31%) of the study population reported no IADL functional impairment prior to hip fracture with a mean score of 3.71. The percentage with no impairment dropped to 3.2% at two months after surgery (M = 7.12). At six months, 11.5% of the patients returned to their prefracture level (M = 5.92), and at one year, 15.6% had returned to their prefracture level (M = 5.73).

Paired t-tests show that overall IADL functions were significantly different in mean scores at baseline and two months (M = 3.56, p < .0001), six months (M = 2.64, p < .0001), and one year (M = 2.57, p < .0001). Although this result indicates some recovery of function over time, there was not a return to prefracture IADL functional level at one year. In comparing the overall recovery in IADL function by surgical procedure, repeated ANOVA shows there was no statistically significant difference between the two procedures performed at the one-year follow-up (Table 3). This indicates that IADL function was partially recovered over time (p < .0001), but there is no significant effect of surgical procedure on IADL functional recovery (p > .96). In terms
Figure 2. Comparison of the effectiveness of surgical procedures performed on functional recovery (● = hemiarthroplasty, □ = internal fixation). The abscissa indicates the time of function recovery, and the ordinate represents the function score. In both surgical groups, a significant difference in short-term function recovery was observed \( p < .05 \). A: functional recovery (transferring) between hospitalization and 2 months post surgery. B and C: IADL recovery (shopping and meals preparation) between prefracture and 2 months post surgery.

Table 3. Recovery in Physical and Instrumental Functioning by Surgical Procedure in Subcapital Fracture Patients Admitted to Seven Baltimore Hospitals

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>PADL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical procedure</td>
<td>1</td>
<td>4.93</td>
<td>0.15</td>
</tr>
<tr>
<td>Time</td>
<td>4</td>
<td>110.38</td>
<td>34.97***</td>
</tr>
<tr>
<td>Time × Surgical procedure</td>
<td>4</td>
<td>3.40</td>
<td>1.08</td>
</tr>
<tr>
<td>IADL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical procedure</td>
<td>1</td>
<td>0.15</td>
<td>0.00</td>
</tr>
<tr>
<td>Time</td>
<td>3</td>
<td>205.71</td>
<td>47.80***</td>
</tr>
<tr>
<td>Time × Surgical procedure</td>
<td>3</td>
<td>8.62</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Note: Repeated ANOVA analysis. ***\( p < .0001 \).

of short-term IADL functional recovery (two months) there was a significant difference between the two surgical procedures \( p < .04 \). This result invited further investigation of individual IADL functions related to lower extremities: mobility, shopping, meals preparation, and doing housework. The repeated ANOVA indicated that the hemiarthroplasty group was doing better in meal preparation \( p < .05 \) and shopping \( p < .02 \) at two months following discharge (Figure 2B and 2C).

**DISCUSSION**

As expected, there was a significant association between the severity of fracture and choice of surgical procedure. Severity of fracture was extremely important for both treatment and prognosis among hip fracture patients. Displacement increases the difficulty in fracture reduction and the risks of non-union and avascular osteonecrosis if treated with an internal fixation procedure (19). In order to reduce the risks of avascular osteonecrosis and nonunion, the orthopedic surgeon usually recommends a hip arthroplasty, which also permits early mobilization. Early mobilization of the patients reduces morbidity and mortality (20). In addition, having a private physician also is associated with the choice of surgical procedure, although this finding was only marginally significant \( p < .07 \). Hemiarthroplasty is a more expensive procedure than internal fixation primarily due to the higher costs of prostheses over internal fixation devices. Having a private physician may imply more resources, better access to care, and better information furnished to orthopedists before a surgical procedure decision is made.

Surprisingly, age was not a significant predictor of surgical procedure selection for this study population after adjusting for fracture severity, private physician, chronic conditions, and prefracture PADL function. Orthopedists who advocate either internal fixation or prostheses agree that, in general, prostheses are preferred for older, frailer, and more debilitated patients. However, when severity of fracture is present among other factors for consideration, severity appears to outweigh other factors including age, chronic conditions, and prefracture functional ability. While prefracture physical functioning, chronic conditions, and dementia status are significant predictors of recovery in physical function (9,21,22), these factors are not significant predictors of surgical procedure selection.
The comparisons of PADL and IADL function between baseline (prefracture status) and the subsequent follow-ups among all hip fracture patients were all statistically significant ($p < .0001$). However, while PADL and IADL are improved at 2, 6, and 12 months compared to baseline, on average they never returned to prefracture functional level. These results are consistent with other studies which found that hip fracture patients do not regain their prefracture function (3,9) and usually evidence decline in function following fracture (3,9,17,23). The findings that PADL and IADL function did not return to prefracture levels over one year may be attributable to increasing age, declining health, and socioenvironmental factors. The inability to perform these activities is not always associated with a specific disease but may be evidence of declining reserve capacities (24) and the inability to handle the insult of the injury and its sequelae.

At one year post fracture, the overall PADL and IADL functional recovery was not statistically significantly different between the two surgical groups. However, the short-term recovery after surgery shows that hemiarthroplasty patients were doing better in transferring, shopping, and meal preparation. These differences between the two procedures are reasonable to expect, because the hemiarthroplasty procedure allows early weight bearing and rehabilitation. The patient with a hemiarthroplasty may start with strengthening and mobilizing exercise emphasizing the antigravity muscles of both the upper and lower limbs, and then proceed to full weight-bearing exercises between parallel bars and gait training. In contrast, the patient with internal fixation has limited nonweight-bearing exercises such as isometric strengthening exercise in bed and light partial weight bearing. Thus, early weight bearing may enable hemiarthroplasty patients to return to optimum function between 1–2 months, while minimum or nonweight bearing may take 3–4 months or longer for patients with internal fixation to gain their optimum function (25,26). This earlier mobilization also may enhance patients’ confidence to return to their daily routine sooner. The possibility exists that short-term (2-month) improvements in transferring, shopping, and meal preparation are due to differences in hip fracture severity. However, controlling for severity is problematic in this study due to the strong relationship between surgical procedure and severity. Stratifying by severity results in a significant reduction in statistical power. Future research in a larger sample would be necessary for answering this question.

Other limitations of the study include the unavailability of information on intensity of rehabilitation, severity of chronic conditions, presurgical risks of anesthesia, financial access, and physicians’ preferences on surgical types. These factors may affect the choice of surgical procedure and functional recovery. Future studies would do well to consider these.

The differences between the two surgical procedures on transferring, shopping, and meal preparation suggest that hemiarthroplasty is a better procedure for subcapital fracture patients at the early stage of recovery. These three functions are essential for self-care and independent living. This finding supports the use of hemiarthroplasty procedure for the subcapital fracture in elderly patients. Hemiarthroplasty, the more costly procedure, demonstrated better short-term functional recovery, which may in turn prevent readmission and reoperation to correct nonunion and avascular necrosis. Further study of other benefits of using a hemiarthroplasty is needed.

ACKNOWLEDGMENTS

This research was supported, in part, by the following grants: HCFA 17-C-98393/3, NIA AG06322, NICHD HD0073, and AHCPR R01 HSO6658.

The authors also acknowledge the cooperation of medical and administrative personnel and the departments of orthopedic surgery at the seven study hospitals: Baltimore County General Hospital; Mercy Medical Center; Sinai Hospital of Baltimore; Saint Joseph Hospital; Saint Agnes Hospital; the Union Memorial Hospital; and University of Maryland Hospital.

Address correspondence to Dr. Yuchi Young, Division of Gerontology, Department of Epidemiology and Preventive Medicine, University of Maryland, 660 W. Redwood Street, No. 142, Baltimore, MD 21201-1549.

REFERENCES

19. Gustke KA. Hemiarthroplasty and total arthroplasty in the treatment of...

Received July 28, 1995
Accepted December 1, 1995