Mortality in Centenarians With Hip Fractures

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abstract

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The proximal femur is one of the primary areas of weakness in the skeleton due to osteoporosis. With more than 50,000 Americans aged at least 100 years, an increasing number of these extremely elderly patients will present with hip fractures. A paucity of literature exists on functional outcomes and mortality rates in the centenarian population who sustain hip fractures. This study evaluated the mortality rate in centenarians who sustained hip fractures to determine whether operative intervention is safe and appropriate.

The authors retrospectively reviewed 23 patients (22 women and 1 man) aged at least 100 years with hip fractures treated at their institution between 2003 and 2010. Twenty-one patients were treated operatively and 2 were treated nonoperatively. Mean Charlson comorbidity index was 2 (range, 0 to 5). The patients’ medical charts or the Social Security Death Index was used to determine their dates of death. Average patient age was 101.9 years at injury and 102.8 years at death. Cumulative in-hospital, 30- and 90-day, 6- and 12-month, and 2-, 3-, and 6-year mortality rates for operatively treated patients were 15%, 20%, 30%, 45%, 60%, 70%, 90%, and 95%, respectively. Both patients treated nonoperatively died within 90 days. One patient is still alive 6 years postoperatively. Postoperative complications occurred in 9 (43%) patients.

Although this patient population is a relatively small subset of the elderly population, the number of these patients is rapidly increasing. Operating on patients older than 100 years carries an acceptable mortality rate. Age alone should not preclude centenarians from undergoing operative treatment for hip fractures.
Due to osteoporosis, hip fractures occur often in the elderly population, typically from a low-energy mechanism. It is estimated that approximately 1.6 million older adults worldwide sustain hip fractures annually, with approximately 320,000 of these in the United States.1,2 This number is expected to increase as the population ages and has been estimated to exceed 500,000 by the year 2040.1 The majority of all hip fractures, approximately three-quarters, occur in women.3-5 Hip fracture risk increases as people age; adults aged 85 years and older are more than 10 times more likely to sustain hip fractures than are those aged between 65 and 69 years.5 Osteoporosis and falls are major risk factors for hip fractures in elderly patients.4 Risk factors for falls in the elderly population, such as impaired balance, polypharmacy, use of assistive devices, and cognitive impairment, also increase the risk of hip fractures.6

Much has been written in the literature regarding the optimal treatment strategies and natural history of hip fractures.2,7-9 The morbidity and mortality associated with operative and nonoperative management of hip fractures have been reviewed.10,11 Some authors have investigated very elderly patients (octogenarians and nonagenarians) who sustain hip fractures.12,13 Few studies have explored the mortality rates of hip fractures in centenarians in Europe14 and Israel15; however, even fewer have investigated these rates in North America.

Census data from 2008 noted that an estimated 105,000 individuals in the United States will live past 100 years of age in the year 2015.16 In a recent investigation from Scotland, the authors extrapolated their findings to the United States population, suggesting that approximately 9500 fractures per year occur in the centenarian population.12

A paucity of literature exists on functional outcomes and mortality rates in the centenarian population sustaining hip fractures. This is likely due to the small sample size of patients who live to this advanced age. The purpose of this descriptive study was to report the mortality rate of centenarians who sustained hip fractures to determine whether operative intervention is safe and appropriate. The authors also reviewed the fracture patterns, operative management, and comorbidities of these patients and sought to expand on the limited data available for surgeons who may encounter this small yet challenging patient population.

**Materials and Methods**

Two institutional databases were queried to obtain a list of individuals older than 100 years who presented with hip fractures between 2003 and 2010. After institutional review board approval, the authors performed a thorough retrospective review of patient medical records. Patients’ Social Security numbers were cross-referenced with the records held in the Social Security Death Index to identify patients who were deceased. At the conclusion of the review in May 2012, patients who were still alive or not registered in the Social Security Death Index were contacted by telephone to confirm their status. One patient’s living status was unable to be confirmed at the end of the investigation. The index procedure for this individual was a hemiarthroplasty performed in 2010. A Social Security Death Index search yielded no record of this individual, and all contact phone numbers were exhausted without confirmation of the patient’s status.

Detailed analysis of the complete medical records of all patients in the study cohort was performed. Data regarding demographics, comorbidities, fracture pattern, operative procedure, and time from injury to death were extracted. Demographic endpoints evaluated included age at injury, sex, race, body mass index, fracture pattern, and Charlson comorbidity index. Operative data included time elapsed from injury to surgery, length of hospital stay, operative procedure, American Society of Anesthesia (ASA) score, type of anesthesia, hemoglobin levels, blood product transfusion requirements, and postoperative anticoagulation. The mortality of this cohort was analyzed using the parameters of time from injury to death, time from surgery to death, and age at death.

Cumulative mortality rates were calculated for patients who underwent surgery after excluding 2 patients managed nonoperatively and 1 patient lost to follow-up. Cox proportional hazards model was used to determine the proportional change in the probability of the event happening at any time due to multivariate factors. Age, Charlson comorbidity index, body mass index, and length of hospital stay were the variables included in the model. The authors began with full models, then used backward stepwise regression.

**Results**

**Demographics**

Twenty-three patients (22 women and 1 man) with hip fractures who were aged at least 100 years (mean, 101 years 9 months; range, 100 years 2 months to 104 years 7 months) were identified. Twenty-one patients were Caucasian and 2 were African American. Average body mass index was 21.0 kg/m² (range, 13.7 to 27.9 kg/m²). Prior to injury, only 1 patient was an unassisted community ambulator. The remaining patients required a cane (n=3; 17.6%), a walker device (n=16; 94.1%), or a wheelchair (n=3; 17.6%). Eleven fractures were intertrochanteric fractures, 11 were femoral neck fractures, and 1 was a stable greater trochanteric periprosthetic fracture. Twenty-one patients were treated operatively and 2 were treated nonoperatively. Demographics and medical comorbidities are outlined in the Table. The majority of patients had a diagnosis of hypertension, and the other most common comorbidities were dementia, arrhythmia, and anemia. Mean Charlson comorbidity index was 2 (range, 0 to 5).

**Operative and Postoperative Course**

Mean time from injury to surgery was 0.9 days (range, 0 to 2 days). Patients who underwent surgery had a mean ASA score
of 3.2. Preoperatively, average hemoglobin was 12.0 g/dL (range, 8.1 to 14.6 g/dL), and 9 patients received a preoperative transfusion of packed red blood cells. On discharge from the hospital, mean hemoglobin was 10.4 g/dL (range, 7.9 to 14.2 g/dL).

Mean intraoperative blood loss was 120 mL (range, 50 to 250 mL). Of the 21 patients who underwent operative management, 19 (90.5%) underwent general endotracheal intubation and 2 (9.5%) patients were managed with regional spinal anesthesia. Operative procedures included the use of cephalomedullary nails in 8 (38.1%) patients, sliding hip screws in 6 (28.6%), hemiarthroplasty in 6 (28.6%), and 3 parallel screws in 1 (4.8%).

Patients who underwent surgery had a mean hospital stay of 6.3 days (range, 2 to 20 days). The majority (12 [57%]) of these patients were prescribed aspirin for postoperative deep venous thrombosis (DVT) prophylaxis. The remaining patients were prescribed warfarin (n=6; 29%), heparin (n=2; 10%), and enoxaparin (n=1; 4%) for DVT prophylaxis.

**Time of Death**

Average patient age was 101 years 9 months at injury and 102 years 8 months at death. Cumulative in-hospital, 30- and 90-day, 6- and 12-month, and 2-, 3-, and 6-year mortality rates for operatively treated patients were 15%, 20%, 30%, 45%, 60%, 70%, 90%, and 95%, respectively. Both patients treated nonoperatively died within 90 days of injury. One operatively treated patient was confirmed alive 6 years after the index procedure. She was 102.9 years old when she sustained an intertrochanteric fracture. The patient was confirmed living in a nursing facility at 109.2 years old at the conclusion of this study.

### Table

<table>
<thead>
<tr>
<th>Patient No./Sex/ Age at Injury</th>
<th>BMI, kg/m²</th>
<th>Fracture Type</th>
<th>Treatment</th>
<th>ASA Score</th>
<th>Charlson Index</th>
<th>Length of Hospital Stay, d</th>
<th>Time From Injury to Death, d</th>
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<tr>
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<td>11</td>
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<td>TFN</td>
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<td>3</td>
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<td>DHS</td>
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<td>3</td>
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<td>TFN</td>
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<td>5</td>
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<td>Hemi</td>
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<td>1</td>
<td>10</td>
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<td>Hemi</td>
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</table>

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; DHS, dynamic hip screw; Hemi, hemiarthroplasty; NR, not recorded; PP, periprosthetic; TFN, trochanteric fixation nail.
(265 days) vs patients treated nonoperatively (53 days) (P = .0943) approached but did not reach statistical significance in this small sample size. Postoperative complications occurred in 9 (43%) patients, including 2 cases of acute renal failure, 1 pulmonary embolism, 1 cerebrovascular accident, 1 case of postoperative pneumonia, 1 case of acute oxygen desaturation, 1 urinary tract infection, 1 case of dehydration, and 1 case of respiratory distress.

Using the Cox proportional hazards model, the authors found that surgery may decrease the risk of mortality (risk ratio, 0.209; 95% confidence interval [CI], 0.039 to 1.11; P = .065), whereas a higher Charlson comorbidity index may indicate an increased risk of mortality (risk ratio, 1.309 per point increase in the Charlson index; 95% CI, 0.977 to 1.752; P = .071). However, these associations were not statistically significant in this small sample.

**Discussion**

Few studies in the literature address the management and mortality rates of hip fractures in the centenarian population. Furthermore, to the authors’ knowledge, the 90-day mortality rate of a centenarian without a hip fracture is unknown as a comparison. As the life expectancy of the world population continues to increase, so too will the unique group of patients who sustain hip fractures after the age of 100 years. Thus, orthopedic surgeons may face the decision of whether to treat these patients nonoperatively or operatively.

This study’s findings in a group of 23 patients with hip fractures suggest that surgery should not be denied based on age alone. This finding is consistent with other reports in the literature. Forster and Calthrope14 were among the first to report on mortality rates in this population. In their review of 13 centenarians with proximal femoral fractures who underwent operative management, the mortality rates at 30 days, 6 months, and 1 year postoperatively were 31%, 50%, and 56%, respectively. The authors reported a statistically significantly higher mortality rate in centenarian compared with noncentenarian hip fracture patients.14 Oliver and Burke17 reported 18 centenarians with hip fractures treated operatively and compared them with a younger control group comprising patients aged between 75 and 83 years. They observed 1- and 4-month mortality rates of 33.3% and 50%, respectively.17 Shabat et al15 reported a series of 23 centenarian patients with hip fractures, 4 of whom did not undergo operative management secondary to their medical status or their desire not to pursue surgery. Three of the 4 patients died within 30 days of injury, and all patients died within 40 days of injury. The operative cohort had a 6-month and 1-year mortality rate of 42%.15

Mortality rates in the current study are similar to these reports at 30 days, 6 months, and 1 year (20%, 45%, and 60%, respectively) for the 20 patients who underwent surgery and for whom living status was confirmed, whereas the 2 nonoperatively treated patients died within 90 days of injury. Although this was not statistically different, the authors may have made a type II error due to the small sample size.

Hip fractures, regardless of patient age at injury, present an urgent challenge given the morbidity and mortality associated with them. Morris and Zuckerman3 reported that approximately 4% of all patients with hip fractures die during their initial hospitalization and 10% to 35% die within 1 year of hip fracture. In a recent report on hip fracture management, Hung et al2 reported that 13.5% of older adults with hip fractures die within 6 months and 24% die within 1 year of injury. Operatively treated patients in the current study lived for a mean of 265 days postoperatively.

Time to surgery may be the patient’s influence length of hospital stay, as well as the morbidity and mortality. In a study reporting the 1-year survival of 651 patients older than 60 years with hip fractures, Yosef et al18 concluded that early (less than 48 hours after injury) operative treatment of hip fractures is associated with improved 1-year survival. The role of delay of surgery has also been investigated in the centenarian population. Verma et al19 reviewed the records of 26 centenarians with hip fractures and compared them with a younger cohort. They found that centenarians had a mean delay of surgery of 3.6 days, whereas the noncentenarian group underwent surgery in a mean of 1.9 days. The difference in time to surgery between the cohorts was due to the need to optimize the physiology of the centenarian group and was not found to be statistically significant.19 Patients in the current study did not experience a significant delay of surgery; mean time from injury to surgery was less than 24 hours (mean, 0.9 days; range, 0 to 2 days). Operatively treated patients were expeditiously evaluated by a multidisciplinary team and medically optimized in a timely fashion before undergoing surgery.

Verma et al19 reported that mean length of hospital stay for their centenarian group was 20.4 days, compared with 15.3 days in their noncentenarian group. Another series from the United Kingdom reported that the mean length of hospital stay for patients older than 95 years was 36 days.12 Mean length of hospital stay in the current study was 6.3 days (range, 2 to 20 days). The patient who was hospitalized for 2 days was 1 of 2 patients who did not undergo surgery and died 90 days after injury. These findings are similar to those of Shabat et al,15 who reported that centenarians were hospitalized for a mean of 11.21 days (range, 4.33 to 18.09 days). The current authors routinely emphasize early mobilization and prompt discharge from the hospital to a rehabilitation facility when medically safe. This may prevent some nosocomial infections and other complications associated with prolonged hospitalization. In addition, the 2 hospitals in which this study was conducted are considered high-volume orthopedic hospitals and have inpatient nursing and physical therapists who are focused on rehabilitating postoperative orthopedic patients.
Patients in this study were just as likely to have sustained an intertrochanteric fracture (n=11; 47.8%) as a femoral neck fracture (n=11; 47.8%). These numbers are similar to a report in the literature of a large series of patients, which found intracapsular fractures (42%) and extracapsular fractures (52%) in 919 patients older than 95 years at the time of hip fracture. In the current study, intertrochanteric fractures were fixed with cephalomedullary nails in 8 (38%) patients, and basicervical neck fractures were fixed with sliding hip screws in 3 (14%). Six (29%) femoral neck fractures were treated with hemiarthroplasty, and 1 (5%) femoral neck fracture was treated with 3 parallel screws. The choice of fixation vs replacement was dictated by the fracture pattern.

Postoperative complications occurred in 9 (43%) patients, including 2 cases of acute renal failure, 1 pulmonary embolism, 1 cerebrovascular accident, and 1 case of postoperative pneumonia. One patient with acute renal failure became septic and died 14 days after having 3 parallel screws placed for a femoral neck fracture. The patient who developed a pulmonary embolism was discharged from the hospital after 7 days and died 3.8 years after receiving a sliding hip screw for an intertrochanteric fracture. The patient who developed postoperative pneumonia was discharged after 5 days and died 153 days after receiving a cephalomedullary nail for an intertrochanteric fracture. The patient who developed a postoperative cerebrovascular accident had a medical history of cardiac arrhythmia and died 6 days after a cephalomedullary nail was placed for an intertrochanteric fracture.

Although postoperative complications arise, some authors have concluded that nonagenarians and centenarians should not be denied operative intervention because of perceived risks associated with their advanced chronological age. Miller et al reported an increase in cardiac complications and mortality in nonagenarians after operative treatment of hip fractures compared with younger cohorts. In a review of 795 patients aged at least 90 years who underwent operative treatment, Hosking et al found the overall serious morbidity rate within 48 hours postoperatively to be 9.4% and the mortality rate to be 1.6%. The authors concluded that morbidity and mortality in this patient population was highly associated with the ASA physical status classification of the individual patient. Patients in the current study had a mean ASA score of 3.2, which denotes a patient with severe systemic disease. Despite this elevated risk, the majority of patients in this study did not develop severe postoperative complications.

This study had some limitations. The retrospective design of the study, with its inherent deficiency in the variability of data recording, is perhaps the most important. Two institutional databases were scrutinized to extract consistent variables; however, not every record yielded the exact number of endpoints. At the conclusion of this study, 1 medical record had been destroyed and it was not possible to reexamine. Another limitation of this investigation is the small sample size of patients who sustained a hip fracture and who were older than 100 years. The results of this study may be generalized to other institutions; however, a larger-scale, multicenter review would allow its conclusions to be confirmed or refuted. Finally, this study reports the mortality rate associated with hip fracture in the centenarian population, the majority of whom underwent operative management. However, the study does not completely capture the functional outcomes associated with operative repair of hip fractures in this unique population. It was not possible to assess the functional outcome of each patient postoperatively given the variability in patient follow-up and the nature of the study design.

This study reports a small operative group of centenarians who sustained hip fractures. Although this patient population is a relatively small subset of the elderly population, the numbers of these patients are rapidly increasing. The decision to operate on a centenarian patient with an acute hip fracture should be based on the patient’s medical and functional status, age, and desire to pursue operative management. Operating on patients older than 100 years carries an acceptable mortality rate, and age alone should not preclude centenarians from undergoing operative treatment for hip fractures.

REFERENCES


