High-energy Femur Fractures Increase Morbidity but not Mortality in Elderly Patients

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Abstract

Background Trauma centers are projected to have an increase in the number of elderly patients with high-energy femur fractures. Greater morbidity and mortality have been observed in these patients. Further clarification regarding the impact of high-energy femur fractures is necessary in this population.

Questions/purposes Our purpose was to assess the influence of high-energy femur fractures on mortality and morbidity in patients 60 years and older. Specifically, we asked (1) if the presence of a high-energy femur fracture increases in-hospital, 6-month, and 1-year mortality in patients 60 years and older, and (2) if there is a difference in morbidity (number of complications, intensive care unit [ICU] and total hospital length of stay, discharge disposition, accompanying fractures, and surgical intervention) between patients 60 years and older with and without high-energy femur fractures.

Methods A retrospective review of 242 patients was performed. Patients with traumatic brain injury or spine injury with a neurologic deficit were excluded. A control group, including patients admitted secondary to high-energy trauma without femur fractures, was matched by gender and Injury Severity Score (ISS). In-hospital mortality, 6-month and 1-year mortality, complications, ICU and total hospital length of stay, discharge disposition, accompanying fractures, surgical intervention, and covariates were recorded. Statistical analyses using Fisher's exact test, ANOVA, Kaplan-Meier estimates, and Cox regression models were performed to show differences in mortality (in-hospital, 6-month, 1-year), complications, length of ICU and total hospital stay, discharge disposition, surgical intervention, and accompanying fractures between elderly patients with and without femur fractures. The average ages of the patients were 72.8 years (± 9 years) in the femur fracture group and 71.8 years (± 9 years) in the control group. Sex, age, ISS, and comorbidities were homogenous between groups.

Results In-hospital ($p = 0.45$), 6-month ($p = 0.79$), and 1-year mortality ($p = 0.55$) did not differ in patients with and without high-energy femur fractures. Elderly patients with high-energy femur fractures had an increased number of complications ($p = 0.029$), longer total hospital length of stay ($p = 0.039$), were discharged more commonly to rehabilitation centers ($p < 0.005$), had more accompanying long bone fractures ($p = 0.002$), and were more likely to have surgery ($p < 0.001$). Average ICU length of stay was similar between the two groups ($p = 0.17$).

Conclusions High-energy femur fractures increased morbidity in patients 60 years and older; however, no increase in mortality was observed in our patients. Concomitant injuries may play a more critical role in this population. Additional studies are necessary to clarify the

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Each author certifies that his or her institution approved the reporting of this manuscript, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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role of high-energy femur fracture mortality in this age group.

Level of Evidence Level III, therapeutic study. See the Instructions for Authors for a complete description of levels of evidence.

Introduction

The elderly population, defined as age 60 years and older by the United Nations, is projected to double by 2030 in the United States [8, 25]. With increasing life expectancy [5, 8] and active lifestyle of the elderly [4, 5, 8, 9], trauma centers are seeing an increase in the number of elderly patients with trauma secondary to higher-energy injuries [10, 11, 13, 19, 22, 24]. Projected to be nearly 40% of total hospital trauma admissions by 2050 [10], elderly patients with trauma not only use 25% of hospital resources [28], but also are at increased risk for serious injuries [13]. Advanced age [4, 12], Injury Severity Score (ISS) [4, 6, 14], male gender [12], preexisting conditions [2, 10–12], and in-hospital complications [6, 20, 21] have been associated with increased mortality rates in these patients. When compared with a younger population with trauma, elderly patients with trauma have higher mortality rates [10, 11, 16, 18, 26]. Furthermore, mortality in elderly patients with trauma occurs later during the course of treatment [26] and has been attributed to diminished physiologic reserves [8, 12, 15].

Relatively high mortality rates from a low-energy (fall from standing) femur fracture involving the proximal (20% to 30% at 1 year) [4, 19, 22], distal (23% at 1 year) [23], and midshaft (21% at 1 year) [3] regions have been seen in the elderly population. However, limited studies [3, 17] have examined the influence of high-energy (eg, motor vehicle collision and auto versus pedestrian) femur fracture mortality and morbidity in elderly patients. Studies have examined the mortality of femur fractures in patients with trauma [7, 17], but to our knowledge, none has focused only on patients 60 years and older. With the increasing incidence of trauma in elderly patients, clarification concerning the influence of high-energy femur fractures is necessary.

We therefore sought to determine the impact of high-energy femur fractures on mortality and morbidity in patients 60 years and older. Specifically, we asked (1) if the presence of a high-energy femur fracture increases in-hospital, 6-month, and 1-year mortality in patients 60 years and older, and (2) if there is a difference in morbidity (number of complications, intensive care unit (ICU) and total hospital length of stay, discharge disposition, accompanying long bone fractures and surgical intervention) between patients 60 years and older with and without high-energy femur fractures.

Patients and Methods

Institutional review board approval was obtained before the start of the study. All patients were treated at an American College of Surgeons verified Level I trauma center. Using our institution's trauma registry, and examining the years 2004 to 2010, we reviewed the medical records of patients 60 years and older who had proximal, midshaft, and distal femur fractures (International Classification of Diseases, 9th Revision codes 820–821) associated with the following mechanisms of injury: motor vehicle collisions, motorcycle collision, automobile versus pedestrian, and other (animal-related injury, fall from height, or farm accident). An animal-related injury involved injury from being struck or pinned by a bull or horse, and a farm accident involved injury from motorized farm vehicles. Exclusion criteria were: specific mechanisms of injury (fall from standing, assault, and penetrating injury); traumatic brain injury; and spinal injury resulting in neurologic deficit. Seventy-six patients met the inclusion and exclusion criteria. All charts were examined to ensure that the femur fracture was secondary to direct high energy. After chart review, 11 additional patients were excluded. For matching purposes, the femur fracture group was divided by gender and ISS. ISS was stratified into minor (ISS < 16), moderate (ISS 16–24), and severe (ISS > 24). The control group was obtained in the following manner. A list of all patients 60 years and older with trauma who met the inclusion criteria above without International Classification of Diseases, 9th Revision codes for proximal, midshaft, and distal femur fractures (820–821) was obtained. The same inclusion and exclusion criteria were applied to the control group. Therefore the control group consisted of elderly patients who had high-energy injuries without a femur fracture. A total of 608 patients were included in this list. Patients in the control group then were matched by gender and ISS [1] to the cohort of patients with high-energy femur fractures. Thus, six groups were obtained for matching based on gender and ISS stratification: male-minor, male-moderate, male-severe, female-minor, female-moderate, and female-severe.

Primary outcomes measured were in-hospital, 6-month, and 1-year mortality. Medical records were reviewed for date of death or date of most recent clinical visit to identify postadmission mortality. A patient was assumed to be alive at 6-months and 1-year with a medical record dated greater than 6-months and 1-year after the accident, respectively. As some patients were completely lost to followup, we performed Kaplan-Meier estimates of survival to account for this loss. Secondary outcomes were occurrence of in-hospital complications (acute respiratory distress syndrome, pneumonia, myocardial infarction, sepsis, deep vein thrombosis and pulmonary embolism, acute kidney

injury, development of decubitus ulcer, and tracheobronchitis), ICU and total hospital length of stay, discharge disposition, distribution of accompanying fractures, and type of surgical intervention. Discharge disposition categories were home, rehabilitation center, skilled nursing or nursing facility, long-term acute care facility, hospice, and dead. Accompanying fracture was further stratified into long bone fracture (defined as any fracture of the humerus, ulna, radius, or tibia in the proximal to distal metadiaphysis segment), nonlong bone fracture (any other fracture excluding the spine, face, and ribs), and no fracture. The variable of surgical intervention was delineated as only orthopaedic surgery, orthopaedic plus general surgery, only general surgery, or none. Age, gender, ISS, and comorbidities (coronary artery disease, hypertension, diabetes mellitus, chronic renal disease, peripheral vascular disease, respiratory disease including chronic obstructive pulmonary disorder, emphysema, pulmonary fibrosis, pulmonary hypertension, and dementia) were collected (Table 1).

A total of 242 patients were included in the study. Sixty-five patients (26 women [40%] and 39 men [60%]) comprised the high-energy femur fracture group (Table 1). One hundred seventy-seven patients (71 women [40%] and 106

men [60%]) were included in the control group. The mean ages of patients in the femur fracture group and control group were 72.8 years (± 9 years) and 71.8 years (± 9 years), respectively. The mean ISS in the femur fracture group was 20.1 (± 12) compared with 17.6 (± 13) for the control group. The injury was secondary to a motor vehicle collision in 45 patients (69.2%), motorcycle collision in seven (10.8%), automobile versus pedestrian in three (4.6%), and other in 10 (15.4%). The corresponding distribution in the control group was a motor vehicle collision in 139 patients (78.5%), motorcycle collision in 14 (7.9%), automobile versus pedestrian in 13 (7.3%), and other in 11 (6.2%). Two hundred five of 242 (85%) patients had at least one comorbidity (Table 1). In the femur fracture group, 89% (58/65) had at least one comorbidity compared with 83% (147/177) in the control group. Age, gender, ISS, percent comorbidity, and mechanism of injury did not differ statistically between the two groups. In the control group, a majority of patients were discharged home (45.8% [81/177]), whereas patients with high-energy femur fractures (32.3% [21/65]) were discharged to a rehabilitation facility (Table 2). In the control group, 18.6% (33/177) had an accompanying long bone fracture, 40.11% (71/177) had a nonlong bone fracture, and 41.2% (73/177) did not have any fracture. The corresponding numbers in the femur fracture group were 38.5% (25/65), 24.6% (16/65), and 36.9% (24/65), respectively. The overall in-hospital mortality rate for the entire study population was 9.9% (24/242). Eight (12.3%) patients in the femur fracture group and 16 (9.1%) patients in the control group sustained in-hospital mortality. Forty-six patients (71%) in the high-energy femur fracture group and 43 (66%) in the control group had 6-month followups and 117 (66%) in the high-energy femur fracture group and 111 (63%) in the control group had sufficient 1-year followups.

Table 1. Demographic comparison between the femur fracture and control groups

Demographic	Femur fracture group Number (percentage)	Control group Number (percentage)	p value
Total number of patients	65	177	
Age (years)	72.1	71.8	0.42
Injury Severity Score	20.1	17.6	0.17
Gender			0.99
Male	39 (60%)	106 (60%)	
Female	26 (40%)	71 (40%)	
Mechanism			0.11
Auto versus pedestrian	3 (4.60%)	13 (7.30%)	
Motor vehicle collision	45 (69.20%)	139 (78.50%)	
Motorcycle collision	7 (10.80%)	14 (7.90%)	
Other	10 (15.40%)	11 (6.20%)	
Accompanying long bone fracture	25 (38.50%)	33 (18.60%)	0.002
Comorbidity			
Coronary artery disease	16 (24.60%)	51 (28.80%)	0.52
Hypertension	42 (64.60%)	120 (67.80%)	0.64
Diabetes mellitus	21 (32.30%)	51 (28.80%)	0.6
Renal disease	2 (3.10%)	9 (5.10%)	0.73
Peripheral vascular disease	4 (6.10%)	10 (5.60%)	0.88
Respiratory disease	12 (18.50%)	20 (11.30%)	0.14
Dementia	5 (6.20%)	4 (2.80%)	0.22

Table 2. Comparison of in-hospital mortality and complications between the femur fracture and control groups

Outcomes	Femur fracture group Number (percentage)	Control group Number (percentage)	p value
In-hospital mortality	8 (12.3%)	16 (9%)	0.45
Complications			
Any	25 (38.5%)	43 (24.3%)	0.03
Pneumonia	5 (7.7%)	12 (6.8%)	0.78
Myocardial infarction	11 (16.9%)	5 (2.8%)	< 0.005
Deep vein thrombosis	4 (6.2%)	9 (5.1%)	0.74
Acute kidney Injury	3 (4.6%)	1 (0.6%)	0.028
Ulcers	4 (6.2%)	10 (5.7%)	0.88
Bronchitis	2 (3.1%)	4 (2.3%)	0.72
	5 (7.7%)	6 (3.4%)	0.15

Differences in age, ISS, and gender between patients with and without high-energy femur fractures were shown using t-tests or Fisher's exact tests. Percentage of in-hospital mortality was compared between patients with and without high-energy femur fractures using Fisher's exact tests and a logistic regression model was used to assess the influence of a high-energy femur fracture on mortality, accounting for potential confounding variables. Kaplan-Meier analysis was used for 6-month and 1-year mortality rates. Covariates identified as significant for outcomes were included in Cox regression models to determine the influence of those covariates on 6-month and 1-year mortality. Fisher's exact tests were used to compare discharge disposition and complication rates between the two groups. T-tests were used to analyze difference in length of ICU and total hospital stay between the two groups.

Results

Our data showed no difference in in-hospital, 6-month, and 1-year mortality between patients 60 years and older with and without high-energy femur fractures. Twelve percent (eight of 65) in the femur fracture group and 9.1% (16/177) in the control died in the hospital, ($p = 0.45$). For 6-month and 1-year mortality, Kaplan-Meier estimates revealed a total of 21 deaths with no difference in mortality between patients with high-energy femur fractures and without ($p = 0.79$). Estimated survival rates at 6-months and 1-year were 85% (95% CI, 76%–95%) and 85% (95% CI, 76%–95%), respectively, for patients who sustained a high-energy femur fracture. The corresponding estimated survival rates were 86% (95% CI, 81%–92%) and 86% (95% CI, 81%–92%) for the control group. However, the ISS ($p < 0.001$) and age ($p = 0.01$) were associated with in-hospital death for all patients in both groups.

Patients with high-energy femur fractures had more complications, longer total length of hospital stay, were more likely to be discharged to a rehabilitation facility, had more accompanying long bone fractures, and had a higher percentage of surgical interventions; however, the average total ICU length of stay was similar in both groups. Patients with high-energy femur fractures had a greater overall prevalence of complications, 38.5% versus 24.3% ($p = 0.029$). When examining each complication separately, there were more myocardial infarctions (16.9% versus 2.8, $p < 0.005$) and deep vein thromboses (4.6% versus 0.6%, $p = 0.028$) in the high-energy femur fracture group. The average ICU lengths of stay (SD) were 4.5 (SD, 6.78) and 3.21 (SD, 5.82) days in the femur fracture and control groups, respectively ($p = 0.17$). Average total hospital length of stay for the patients with high-energy

femur fractures was 11.2 ± 12 days compared with 7.7 ± 7 days in the control group ($p = 0.039$). Patients with high-energy femur fractures were more likely to be discharged to a rehabilitation center than patients in the control group (32% versus 19.8%, $p < 0.005$); whereas, a majority of the control group was discharged home (45.8% versus 16.9%, $p < 0.005$). In the high-energy femur fracture group, 36.9% had no other fracture, 38.5% had an additional long-bone fracture, and 24.6% had another nonlong-bone fracture; by contrast, in the control group, the corresponding percentages were 41.2%, 18.64%, and 40.1%. This distribution was different between the two groups ($p = 0.004$). Specifically examining the presence of an accompanying long-bone fracture, there was a difference between patients with a high-energy femur fracture and patients without a high-energy femur fracture (38% [25/65] versus 19% [33/17], respectively, $p = 0.002$). Patients with femur fractures were more likely to have had surgery. In the femur fracture group, 75.5% underwent only orthopaedic surgery, 13.9% underwent general and orthopaedic surgery, 1.5% underwent only general surgery, and 9.2% did not have any surgery; by contrast, in the control group, the corresponding percentages were 27.1%, 7.3%, 5.1%, and 60.5% ($p < 0.001$).

Discussion

Trauma centers are expected to treat an increasing number of elderly patients with trauma [3, 9, 11, 19, 23, 24]. With more active lifestyles and improved longevity, the elderly are going to incur more high-energy injuries [10, 11, 13]. Specifically, the impact of a high-energy femur fracture, an injury that potentially may occur more frequently in the future, has yet to be examined in this age group. Our study suggests that high-energy femur fractures do not influence in-hospital, 6-month, and 1-year mortality. However, patients with these fractures have more complications, longer total hospital length of stay, greater discharge to rehabilitation centers, more accompanying long bone fractures, and a greater number of surgical interventions.

Our study has several limitations. First, the study was retrospective. Inherently, this subjects the study to bias of missing documentation. However, our institution has developed a thorough trauma registry from which a majority of the information was obtained. Furthermore, our study had incomplete followup of mortality at 6-months and 1-year. Therefore we examined this outcome using Kaplan Meier analysis to account for loss to followup. Third, the functional outcomes and influence of these fractures on these outcomes were not reflected in our study. Patients may have survived the femur fracture, but the injury might have significantly affected functional ability.

Survivorship may not be associated with return to preinjury status. Fourth, we did not examine the time from admission to surgery in the high-energy femur fracture group. Similar to hip fractures, a delay in surgery may have an influence on mortality and morbidity; however, with high-energy femur fractures this has not been clarified. Finally, femur fractures were identified as high-energy based on mechanism of injury. No radiographic confirmation examining the fracture pattern was performed; however, each chart was evaluated to confirm a high-energy injury. In the elderly, even a ground-level fall can produce a comminuted fracture and as a result, radiographic evaluation may have not fully clarified the degree of energy. Furthermore, a similar radiographic confirmation would not apply to the control group.

Patients with high-energy femur fractures did not have increased in-hospital, 6-month, and 1-year mortality compared with an age and ISS-matched control group without high-energy femur fractures. The percentages of in-hospital mortality for the femur fracture and control groups were 12% and 9%, respectively. These percentages were less than expected and could be attributed to sample size. Furthermore, the percentage of mortality potentially may be reflective of the specific patient population. The patients in the study had enough functional ability to be involved in a high-energy mechanism of injury. As a result these patients may be more apt to withstand the physiologic insult in contrast to patients with a displaced femoral neck fracture from a ground-level fall. For 6-month and 1-year mortality, the survival rates were 85% and 86% at both times for the femur fracture and control groups, respectively. It may be that patients who survive the early stresses of high-energy trauma have enough physiologic reserve to survive after hospital discharge. The association of mortality with ISS and age was seen in our study and has been confirmed in other studies [4, 6, 12, 27]. The cumulative injuries, that is, the ISS and influence of physiologic reserve may play a greater role in mortality for this group of patients rather than the presence of a high-energy femur fracture.

Our patients with high-energy femur fractures had increased complications, longer average total hospital length of stay, greater discharge to rehabilitation centers, more accompanying long bone fractures, and more surgical interventions. The longer, total hospital stay may be because the orthopaedic intervention for the femur fracture could have been delayed until patient stabilization after surgery or secondary to physical therapy mobilization before hospital discharge. In addition, the greater number of complications could have been attributed to increased total hospital length of stay in the femur fracture group. Complications, specifically myocardial infarction and deep vein thrombosis, were greater in the patients with high-energy femur fractures. The

stresses on the cardiovascular system from a femur fracture may have contributed to a myocardial infarction or could have been attributable to direct chest trauma and/or resuscitation. These patients may benefit from more aggressive fluid management and cardiovascular monitoring. Patients without a high-energy femur fracture more commonly were discharged home, whereas patients with high-energy femur fractures more commonly were discharged to a rehabilitation center. Patients who sustain a femur fracture require physical therapy which probably explains the difference in discharge disposition. In addition, the high-energy femur fracture group had more accompanying long bone fractures further supporting the necessity of therapy. As a result, patients with high-energy femur fractures may require more resources and potentially incur more direct and indirect costs than patients 60 years and older without a high-energy femur fracture. A study specifically examining this difference may provide more insight. As expected, patients with high-energy femur fractures had greater surgical intervention. Approximately 10% of patients in this group did not have orthopaedic surgery secondary to death in an emergency department or death during or after initial general surgery intervention, and one patient who was nonambulatory refused surgery.

Low-energy femur fractures have been studied extensively in the elderly population [3, 4, 22–24, 27]. However, the impact of high-energy femur fractures in elderly patients with trauma has not been reported to our knowledge. With the projected increase in elderly patients with high-energy trauma [10, 11, 24], a more active lifestyle [4, 8], and longer life expectancy [5], attention to this particular group of patients is warranted. The presence of high-energy femur fractures in patients 60 years and older with trauma did not appear to influence in-hospital mortality in our study cohort. However, there seemed to be some influence on morbidity. Higher-powered multicenter studies are necessary to further clarify and either support or refute the current findings.

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