

Concomitant Upper Extremity Fracture Worsens Outcomes in Elderly Patients With Hip Fracture

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Abstract

Background: Elderly patients with low-energy hip fractures have high rates of morbidity and mortality, but it is not well known how often concurrent upper extremity fractures occur and how this impacts outcomes. We used the National Trauma Databank (NTDB), the largest aggregation of US trauma registry data available, to determine whether patients with concurrent upper extremity and hip fractures have worse outcomes than patients with hip fractures alone. **Methods:** We accessed the NTDB to identify patients aged 65 to 100 who sustained a hip fracture. The cohort was then narrowed to include only patients who sustained their injury in a fall and had an injury severity score indicating hip fracture as the most severe injury. We then analyzed this group to assess the impact of a simultaneous upper extremity fracture on length of stay, in-hospital mortality, and discharge disposition. **Results:** From 2007 to 2014, a total of 231,299 patients aged 65 to 100 were identified as having a hip fracture. The narrowed cohort with fall as the mechanism and hip fracture as the most severe injury included 193,862 patients. Of these, 12,618 patients sustained a concomitant upper extremity fracture (6.5%). Compared to isolated hip fractures, patients with a concomitant upper extremity fracture had higher odds of death in the hospital (odds ratio [OR] = 1.3; 95% confidence interval = 1.2-1.4), were less likely to be discharged to home as compared to a skilled facility (OR = 0.73; 95% confidence interval = 0.68-0.78), and had a significantly longer average length of stay (7.1 vs 6.4 days, $P < .001$). **Conclusions:** We found a 6.5% prevalence of concomitant upper extremity fractures in patients aged 65 to 100 with a hip fracture sustained after a fall where the hip fracture was the most severe injury. These patients had a higher risk of in-hospital mortality, were less likely to be discharged to home, and had longer average length of stay.

Keywords

geriatric trauma, geriatric medicine, fragility fractures, hip fracture, upper extremity fracture, trauma surgery

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Introduction

The elderly patient provides unique challenges in management and recovery after trauma. Even low-energy mechanisms of injury including ground-level falls can place elderly patients at risk for injuries such as distal radius, proximal humerus, spine, and hip fractures.^{1,2} It is well recognized that elderly patients with hip fractures have high rates of morbidity and mortality, that these injuries have a significant economic impact, and that the public health burden of these fractures is on the rise.³⁻⁶ Similarly, fragility fractures of the upper extremity have been shown to occur at high frequency and with significant impact to the individual and society.⁶⁻⁸ Mobilization of patients with hip fractures can be difficult for multiple reasons including pain, balance, and gait issues. Early fracture

fixation has become the standard of care to facilitate early mobilization in an effort to decrease morbidity and mortality. Most hip fracture patients require assistive devices for

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ambulation following their injury. The presence of concomitant upper extremity fractures adds significant challenges in mobilization for patients.

It is not well known how often concurrent hip and upper extremity fractures occur and how this impacts outcomes. Previous small cohort studies estimate the prevalence from 3.7% to 4.7%.^{9,10} We used the National Trauma Databank (NTDB), the largest aggregation of US trauma registry data available, to assess the prevalence of concomitant upper extremity fractures in patients aged 65 to 100 with hip fracture admitted to a participating trauma hospital. We sought to assess the prevalence of simultaneous hip and upper extremity fractures in this population as well as to determine whether patients with concomitant injuries have worse outcomes than patients with hip fracture alone.

Materials and Methods

Data Collection

The NTDB is compiled and maintained by the American College of Surgeons. Trauma centers throughout the United States enroll in the NTDB, and the data from patients' charts are uploaded to NTDB annually.¹¹ Using the NTDB from 2007 to 2014, we identified patients aged 65 or older at the time of hospital admission who were admitted to an emergency department at a participating hospital with a hip fracture. To create a more homogenous subgroup of patients, we subsequently narrowed our cohort to include only patients injured in a fall in which the injury severity score (ISS) indicated hip fracture was the most severe injury. All available data were then collected on this subset of patients including average age, race, fracture types, treatment types, and in-hospital outcomes. This study did not require approval from the institutional review board as the NTDB is a deidentified public use data set and does not meet the federal regulatory definition of human subjects research.

Statistical Analyses

Patient demographics and injury characteristics were described by whether or not the patient had a concurrent hip and upper extremity fracture. We explored the distribution of ISS calculated using *International Classification of Diseases (ICD) Programs for Injury Categorization*¹² by mechanism of injury comparing patients with simultaneous upper extremity fracture using box and whisker plots; we then tested differences in ISS within mechanism using the Wilcoxon rank sum test. Differences in average length of stay and discharge disposition were tested using χ^2 test and Wilcoxon rank sum test, as appropriate. Finally, we assessed the odds of death using a logistic regression and odds of discharge to home, hospice, inpatient units, or other location compared to odds of discharge to a skilled nursing facility using a multinomial logistic regression. To identify the most parsimonious set of confounders necessary for complete adjustment, we used a directed acyclic graph (DAG)

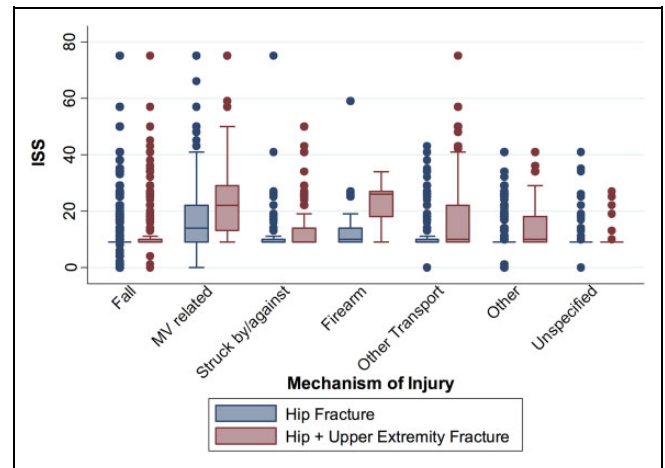


Figure 1. Mechanism of injury and injury severity score (ISS) among total hip fracture population for patients with and without concomitant upper extremity fracture. For all mechanisms of injury, patients with concomitant upper extremity injury had higher ISS as indicated by the box and whisker plot. All were statistically significant except for injuries resulting from firearms.

to identify the minimum set of confounders. The DAG was constructed based on prior literature and a priori knowledge, and it identified age as the minimum set necessary for complete adjustment. To assess the robustness of our findings, we additionally used the empirically identified minimum set of confounders for the NTDB for our fully adjusted models as described by Haider et al. These included age, hypotension, pulse, total Glasgow Coma Scale, ISS score, and need for ventilator use.¹³ All models clustered on facility and all analyses were conducted using Stata 14 (StataCorp LLC, College Station, Texas, USA 2015).

Results

Total Cohort Prior to Restriction

A total of 231,299 patients aged 65 or older were identified as having a hip fracture from 2007 to 2014 in the NTDB. Of these patients, 18,443 (8%) sustained a simultaneous upper extremity fracture. The most common mechanism of injury was fall in both groups (95% in hip fractures alone, 84% in hip and upper extremity fractures). The next most common mechanism in both groups was motor vehicle-related trauma (13% in hip and upper extremity fracture group compared to 2.5% in hip fractures alone) followed by trauma related to nonmotor vehicle transportation (bicycle, motorcycle, scooter) at 2% for upper extremity and hip fracture and 1.3% for hip fracture alone. Firearms, unspecified, and other uncategorized mechanisms each made up less than 1% of the mechanisms of injury. For each injury mechanism group, patients with a simultaneous upper extremity fracture had a higher distribution of ISS scores. The difference between groups was significant for all injury mechanism groups, except for injuries resulting from firearms (Figure 1).

Hip Fractures Resulting From a Fall

After restricting our cohort to patients whose mechanism of injury was fall and whose hip fracture was the most severe injury sustained, there were 193,862 patients available for our full analysis. In this low-energy mechanism population, 12,618 (6.5%) patients sustained both hip and upper extremity fracture. While the median ISS was 9 in both groups, patients with both hip and upper extremity fracture had a significantly higher distribution as calculated by Wilcoxon rank sum ($P < .001$).

Comorbidities

The group of patients sustaining a hip fracture from a fall with hip fracture as the most severe injury was evaluated for comorbidities. Diabetes, heart failure, and active smoking were evaluated in detail. The overall percentage of patients with each of these comorbidities was similar between patients with hip fracture alone and hip and concomitant upper extremity fracture. For patients sustaining a fall with hip fracture alone, 1.8% had diabetes, 1.3% had heart failure, and 0.6% were current active smokers. Similarly, in patients with hip and upper extremity fracture, 1.6% had diabetes, 1.3% had heart failure, and 0.6% were smokers.

Demographic Data

The average age of patients in both groups was 80 years. A majority of the patients were female, including 69.6% of patients with hip fracture alone and 78.0% of patients with hip and upper extremity fracture. A large majority of patients were also Caucasian (89.5% of hip fracture patients, 91.7% hip and upper extremity fractures).

Injury and Treatment Profiles

The most common type of hip fracture sustained was a femoral neck fracture (50.8% in hip fracture alone, 47.6% in hip and upper extremity fracture; Figure 2). The most common concomitant upper extremity fractures were proximal humerus (32.7%) and distal radius/ulna fractures (37%). Other fractures sustained included other forearm (10.6%), humeral shaft (2.2%), distal humerus (3.7%), carpal (2.1%), and other hand fractures (4.4%; Figure 3).

Surgical treatment profiles for the hip fractures were similar in both groups. For patients with isolated hip fracture, 28% received open reduction and internal fixation, while 19% had intramedullary fixation, 26% had a hemiarthroplasty, and 3.5% underwent a total hip arthroplasty. For patients with hip and upper extremity fractures, 29% received open reduction and internal fixation, 20% had intramedullary fixation, 22% had a hemiarthroplasty, and 3.4% underwent total hip arthroplasty.

In-Hospital Outcomes

For patients after a fall with an isolated hip fracture recorded as the most severe injury, 4689 (2.6%) patients of 181,244 died in

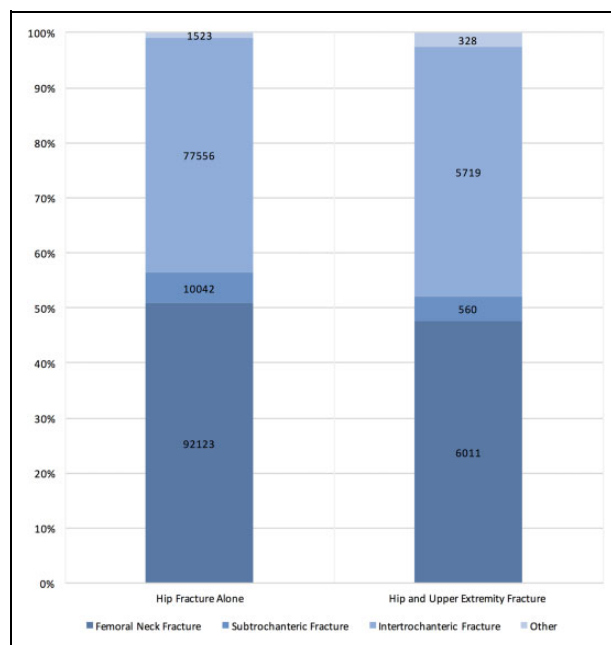


Figure 2. Types of hip fracture sustained as evaluated by ICD-9 code recorded in the National Trauma Databank from 2007 to 2014.

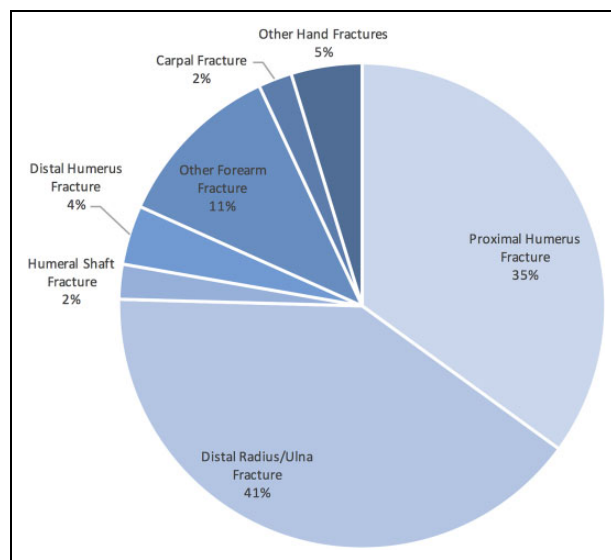


Figure 3. Types of upper extremity fractures sustained in patients with hip fractures as evaluated by ICD-9 code recorded in the national trauma databank from 2007 to 2014.

the hospital, compared to 496 (4.0%) patients of 12,618 in the hip and upper extremity fracture group. There were higher odds of death in the hospital for patients with both hip and upper extremity fracture in our fully adjusted model (odds ratio [OR] = 1.3; 95% confidence interval [CI] = 1.2-1.4). In addition, the patients with concomitant upper extremity fractures had a significantly longer average length of stay in days (and standard deviation) at 7.1 (4.6) days versus 6.4 (5.0) days in hip

Table 1. Regression Analysis of In-Hospital Outcomes for Hip Fracture Patients With and Without Upper Extremity Fracture.

	Number of Patients (%) With Hip Fracture	Number of Patients (%) With Hip + Upper Extremity Fracture	Unadjusted OR	Minimally Adjusted OR ^a	Fully Adjusted OR ^b
Death	4,689 (2.6)	496 (3.9)	1.5 (1.4-1.7)	1.6 (1.4-1.7)	1.3 (1.2-1.4)
Discharge disposition					
Skilled facility	137,318 (79)	9,751 (81)	1.0 (ref)	1.0 (ref)	1.0 (ref)
Home	22,409 (13)	1,179 (9.8)	0.74 (0.69-0.79)	0.73 (0.67-0.78)	0.73 (0.68-0.78)
Hospice	1,803 (1.0)	143 (1.2)	1.1 (0.94-1.3)	1.1 (0.95-1.4)	1.0 (0.86-1.2)
Inpatient	8,411 (4.8)	621 (5.2)	1.0 (0.94-1.2)	1.0 (0.93-1.1)	1.0 (0.91-1.1)
Other	4,487 (2.6)	303 (2.5)	0.95 (0.80-1.1)	0.95 (0.78-1.1)	0.92 (0.77-1.1)

Abbreviation: OR, odds ratio.

^aAdjusting for age and clustering by facility.

^bAdjusting for age, hypotension, pulse, total Glasgow Coma Scale (GCS) score, injury severity score (ISS) score, and need for ventilator use and clustering by facility.

fractures alone ($P < .001$). There was a significant difference in the distribution of discharge location based on whether patients had an upper extremity fracture (13% discharged home with hip fracture alone versus 9.8% with an upper extremity fracture; $P < .001$), with patients with simultaneous upper extremity fractures having lower odds of being discharged home as compared to a skilled facility (OR = 0.73; 95% CI = 0.68-0.78) in our fully adjusted model (Table 1).

Discussion

Hip fractures are a common injury in the elderly, but it is less common for these patients to sustain concomitant upper extremity fracture. We utilized the NTDB, the largest aggregation of US trauma registry data available, to assess the prevalence of concomitant upper extremity fractures in patients 65 and older with hip fracture among patients admitted to a participating NTDB hospital.

We found that 6.5% of patients aged 65 to 100 with a low-energy hip fracture sustained a simultaneous upper extremity injury (8% when considering both high and low mechanisms of injury). This higher rate of simultaneous injury may be attributed to the much larger data set investigated as a result of the NTDB. Patients with both hip and upper extremity fractures had a higher risk of in-hospital mortality, were less likely to be discharged to home, and had longer average length of stay. The multiply injured group, with an average age of about 80 years, had a higher percentage of females than hip fractures alone.

In comparison to prior studies, we had a much larger patient population due to our use of the NTDB, and we found a higher prevalence of concomitant hip and upper extremity fractures compared to previously reported case series. To our knowledge, this study represents the largest cohort of elderly patients with concomitant hip and upper extremity fractures currently in the literature. Additionally, we found a greater proportion of the hip fracture patient population to have an additional upper extremity fracture than that has previously been published. Robinson et al found 4.1% patients with hip fracture had an additional fracture, with 90% of these (73/81 or 3.7% of total)

occurring in the upper extremity. However, their patient population was much smaller than ours and may have unintentionally selected a patient population with less severe injuries, leading to an underestimate of coinjury. They found, similar to our study, that distal radius and proximal humerus were the most common concomitant upper extremity fractures.⁹ Mulhall et al in 2002 found 36 patients with simultaneous upper extremity fractures out of 760 total patients admitted over a 4-year period with hip fractures (4.7%).¹⁰ They also noted distal radius as the most common upper extremity fracture type.

Additionally, Mulhall et al found a ratio of 2.4:1 females to males in hip fracture alone versus 8:1 for combined fractures.¹⁰ In our study, there was a higher percentage of females in the hip and upper extremity fracture group than the isolated hip fracture group (67.9% of patients with hip fracture alone and 72.4% of patients with hip and upper extremity fracture). They comment on a "usual mechanism of injury" in both groups of fall onto the side which matches the most common injury of fall in our study. They also found a longer length of stay for the combined injury group (15.6 vs 20.5 days, $P = .010$).

Tow et al in 2009 performed a retrospective review on 33 patients admitted for hip and upper extremity injuries.¹⁴ These patients were matched to patients of similar age with hip fracture alone. They found an average age for hip and upper extremity fracture patients of 79.5 years, very similar to our average age of 79.3. The median length of hospital stay in their study was 23 versus 17 days for isolated hip fracture, much higher than our reported length of stay but consistent with the hypothesis that patients with additional fractures required a longer length of stay.

A few prior studies have looked specifically at distal radius fractures in combination with hip fractures. In our study, approximately one-third of the concomitant injuries were distal radius fractures. Uzoigwe et al in 2013 evaluated 88 patients with hip and distal radius fractures and compared them to 772 patients with isolated hip fractures.¹⁵ They found similar age distribution between groups but a much higher proportion of females in the multiply injured group (female:male of 9:1 versus 4:1, $P < .0001$). They also found a longer length of hospital stay in the multiply injured group (18 vs 13 days, $P < .00001$),

similar to our findings. There was no difference in survivorship between groups.

Shabat et al retrospectively evaluated 46 patients over 65 years for a 10-year period who sustained a distal radius and hip fracture.¹⁶ This included 40 females and 6 males, all victims of low-energy trauma. They found that patients were very commonly discharged to a rehab facility (28/46 or 60.1%) but that those treated in rehab centers almost always returned to their prior level of activities of daily living. They concluded from this that patients with concomitant distal radius and hip fractures have better rehabilitation potential despite their multiple injuries, and they expect this may be because they have a higher activity level at baseline. We noted in our data that patients with hip fracture were less likely to be discharged home with a concomitant upper extremity fracture. We were unable to evaluate, however, whether this portended worse outcomes beyond their hospital stay due to the nature of our database study.

Our study should be considered in light of its limitations. Our cohort was drawn exclusively from a sample of patients from trauma centers participating in the NTDB in the United States, which may introduce some selection bias and may represent a more injured population that is nationally representative. It must also be noted that patients with concomitant injuries diagnosed at different institutions due to transfer, discharge, or referral would not be recognized in this study as multiply injured due to the nature of database collection. Another potential confounder in this study is our grouping of all upper extremity fractures together, as we acknowledge there is wide variability in these fractures and their associated morbidity. However, the large size of the NTDB allows a robust analytical approach that would not be possible with smaller samples present in the literature currently. Due to the nature of the data set and its reliance on administrative records, charting practices and data collection strategies by participating institutions may lead to missing data, possible misclassification, and lack of potentially important covariates including physician impression of the patient. We believe that even with these limitations, our study represents an important contribution that provides support to prior literature using a much larger data set.

In conclusion, simultaneous hip and upper extremity fractures occur relatively infrequently but may result in increased mortality, increased length of hospital stay, and decreased likelihood of discharging home for the geriatric patient. This knowledge may help shape conversations with elderly patients and their families regarding expectations in the hospital after hip and upper extremity fractures as well as guide resource allocation. Given the substantial number of hip fractures annually, our results provide useful data for health systems and third-party payers regarding an independent factor that significantly impacts outcomes. This information may be particularly important in the current health-care environment of increased focus on metrics of performance and value.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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