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Comparison of complication profiles for femoral neck, intertrochanteric, and subtrochanteric geriatric hip fractures

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Abstract

Introduction Most geriatric hip fractures occur in the femoral neck (FN) and intertrochanteric (IT) regions of the femur, while a minority occur in the subtrochanteric (ST) region. Relative outcomes based on the anatomical subtype of fracture are not well studied. This study characterizes postoperative complications and outcomes of hip fractures distinguished by anatomic region.

Materials and methods The targeted hip fracture series of the American College of Surgeons National Surgical Quality Improvement Program database was queried to identify geriatric (≥ 65 years) patients who sustained operative FN, IT, and ST hip fractures. Primary patient demographic and perioperative data were collected and correlated with 30-day postoperative complications and outcomes. Multivariate regression was used to calculate relative risks of adverse events (AEs) between groups.

Results In total, 8220 geriatric hip fracture patients were identified. Risk-adjusted 30-day mortality was not significantly different between patients with ST (5.8%, $p = 0.735$) and IT (7.3%, $p = 0.169$) femur fractures relative to those with FN fractures (6.6%). The overall risk-adjusted rate of minor and major medical AEs within 30 days and risk-adjusted rate of wound complications was not significantly different between FN, IT, and ST fractures. Patients with IT [34.4%, OR 2.35 (2.35–3.08), $p < 0.001$] and ST fractures [49.8%, OR 5.94 (4.58–7.70), $p < 0.00$] had higher risk-adjusted incidence of postoperative blood transfusion relative to FN fractures (18.5%). Furthermore, patients with IT fractures had a slightly lower risk-adjusted incidence of unplanned reoperation [2.1 vs. 2.7%, OR 0.69 (0.47–0.99), $p = 0.046$] and hospital readmission (7.8 vs. 9.2%, OR 0.76 [0.63–0.91], $p = 0.003$) than patients with FN fractures.

Conclusions With respect to anatomic region, geriatric hip fractures have similar short-term mortality and medical AE profiles with differences in transfusion, reoperation, and readmission rates. Knowledge of these short-term outcomes may guide surgeons in counseling hip fracture patients peri-operatively.

Keywords Subtrochanteric · Intertrochanteric · Femoral neck · Complications · Outcomes · Hip fracture · Fracture · Geriatric

Introduction

More than 3,00,000 patients are hospitalized and surgically treated for fragility hip fractures in the United States each year. Hip fractures are associated with a high mortality rate that approaches 30% within one year of surgery [1, 2]. Furthermore, geriatric hip fractures represent a significant burden on the US healthcare system with costs estimated to be $17 billion per year as a whole, and approximately $40,000 dollars per-patient in the first year [2]. In addition to high perioperative mortality, most also experience some functional loss to their quality of life, with more than half discharged to skilled nursing facilities and showing long-term deterioration in activities of daily living (ADLs) [2, 3].

Anatomically, most hip fractures occur in the femoral neck (FN) or in the intertrochanteric (IT) region of the femur, while a minority occur in the subtrochanteric region (ST) of the femur [4]. Prior small case series have identified greater mortality among patients with IT fractures relative to those with FN fractures at up to one year [1, 5]. At hospital

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discharge, Haentjens et al. found that elderly female patients with intertrochanteric fractures were also found to have more functional impairment as well as mortality as compared to elderly female patients with femoral neck fractures [5, 6]. However, these prior retrospective studies are limited in sample size and are primarily derived from single institutions. As each subtype of hip fracture is treated differently based on relative risk of fracture nonunion and collapse, differences in outcomes may be expected and hip fractures may not be easily lumped into one category. More detailed knowledge of this outcome profile can provide surgeons guidance on counseling families and patients on their specific short-term prognosis.

The purpose of the study was to characterize postoperative complications and outcomes of hip fractures distinguished by anatomic fracture patterns. We used the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database to identify geriatric patients (≥65 years) who underwent operative fixation of FN, IT, and ST hip fractures in 2016. Our initial hypothesis was that ST fractures would be associated with higher risk of perioperative medical morbidity and mortality, surgical complications, hospital readmissions, and longer hospital length of stay as a result of the complexity of fracture management.

Materials and methods

We performed a retrospective review of the ACS NSQIP database to identify geriatric patients (≥65 years) [15] who underwent operative fixation of FN, IT, and ST fractures in 2016. These cases were identified using the target hip fracture participation utilization file, provided by NSQIP to report on prospectively collected data and outcomes specific to hip fracture patients, and merged with the general data collected in the 2016 NSQIP participant utilization file. The ACS NSQIP is a prospective, multi-institutional program that collects perioperative data on more than 200 patient variables from over 500 NSQIP-participating hospitals in the United States. Reported data are retrieved from medical records, operative notes, and patient interviews by trained clinical reviewers and are compliant with the Health Insurance Portability and Accountability Act. The ACS NSQIP data series is routinely audited and ensures high-quality data with reported inter-rater disagreement of less than 2–3% for all variables [15]**.** Data are collected up to postoperative day (POD) 30 and includes data after hospital discharge within the appropriate time frame.

Hip fracture patients were divided into three cohorts based on the listed hip fracture pattern (1) femoral neck fracture (non-displaced and displaced), (2) intertrochanteric femur fracture, and (3) subtrochanteric femur fracture. Cases were categorized based on the anatomic pattern as defined by the AO/OTA classification system rather than the treatment modality [e.g., arthroplasty, cephalomedullary nailing (CMN), percutaneous pinning] and was reported as part of the target hip fracture series within the ACS NSQIP dataset [16]. Patient data and characteristics collected from the registry included patient age, sex, height, weight, smoking history (within one year), American Society of Anesthesiologists (ASA) class, functional health status, and medical comorbidities including diabetes, delirium, dementia, chronic obstructive pulmonary disorder (COPD), liver disease with ascites, congestive heart failure (CHF), hypertension (HTN), and dialysis-dependent kidney disease. Body mass index (BMI) was calculated for each patient's height and weight. Functional status was defined as the patient's ability to perform ADLs either independently or in a partially or completely dependent manner within the 30 days prior to admission.

Data on postoperative medical complications within 30 days were collected and included death, deep vein thrombosis (DVT), pulmonary embolism (PE), pneumonia, acute renal failure, urinary tract infection (UTI), cardiac arrest, myocardial infarction (MI), cerebrovascular accidents (CVA), and sepsis. Surgical complications data on postoperative superficial and deep surgical site infection (SSI), wound dehiscence, and unplanned reoperations within 30 days were also collected for both cohorts. We then combined non-mortality complications into categorized minor and major adverse events (AEs) as previously described by previous authors using the NSQIP database [7]. Briefly, postoperative UTI, pneumonia, and progressive renal insufficiency were considered minor AEs; while, postoperative DVT, PE, MI, cardiac arrest, CVA, sepsis, unplanned reintubation, deep SSI and wound dehiscence were categorized as major complications. Complications of superficial SSI, deep SSI, and wound dehiscence were also combined into the separate category of wound complications. Hip fracture-specific outcomes data collected included discharge destination (home versus facility), hospital readmission, and total hospital length of stay (LOS).

All postoperative complications and outcomes were compared among the three cohorts. Descriptive statistics and comparison of baseline characteristics between the cohorts were performed using chi-square (χ^2) testing for categorical variables and one-way ANOVA testing for continuous variables. Multivariate logistic regression was used to compare the relative risk of binary medical complications, surgical complications, and hip fracture outcomes wherein femoral neck fractures were used as the comparison cohort for intertrochanteric and subtrochanteric femur fractures separately. In each comparison, baseline patient age, gender, race, BMI, functional status, ASA classification, and comorbidities were used as covariates to compute risk-adjusted odds

ratio (OR) for each variable. Multivariate linear regression was similarly used to assess the risk-adjusted relationships between fracture subtype and hospital LOS and operative time. Standardized OR, 95% confidence intervals (CI), and *p* values were computed. Statistical significance was defined as $p < 0.05$ and all statistical analyses were performed using SPSS 21 software (IBM Corp., Armonk, NY).

Results

The query identified a total of 8220 geriatric patients who had operative fixation of FN, IT, or ST fractures. Of these, 3160 patients (38.4%) had FN fractures, 4544 patients (55.3%) had IT fractures, and 516 patients (6.3%) had ST fractures. The median age of the entire cohort was 86 years (SD 7.3 years). Despite differences in size of groups, population-level statistical analysis was permissible and could be performed given the scope of the study. Of the total cohort, 71.5% were female, 91.2% were white, and 77.0% were independent in their ADLs at baseline. Between the cohorts, baseline age ($p < 0.001$), gender ($p = 0.003$), race ($p = 0.006$), BMI ($p < 0.001$) were different, as was the incidence of dementia ($p < 0.001$), delirium ($p = 0.003$), diabetes ($p = 0.007$), and hypertension ($p = 0.044$) (Table 1). Functional health status, ASA classification, and all other comorbidities were not significantly between the cohorts.

Multivariate logistic regression analysis was performed to assess the relative risk-adjusted incidence of perioperative mortality and complications to correct for baseline differences (Table 2). Risk-adjusted 30-day mortality was not significantly different between patients with subtrochanteric (5.8%, $p = 0.735$) and intertrochanteric (7.3%, $p = 0.169$) femur fractures relative to those with femoral neck fractures (6.6%). The overall risk-adjusted rate of minor and major medical AEs within 30 days was not significantly different between FN, IT, and ST fractures, nor was the risk-adjusted rate of wound complications (Table 2). Patients with IT [34.4%, OR 2.35 (2.35–3.08), $p < 0.001$] and ST fractures [49.8%, OR 5.94 (4.58–7.70), $p < 0.001$] had higher risk-adjusted incidence of postoperative blood transfusion relative to FN fractures (18.5%). However, patients with

Table 1 Comparison of baseline demographics and characteristics of geriatric hip fracture patients among anatomical subtypes of hip fracture

Baseline characteristic	Femoral neck fractures ($n = 3160$) (%)	Intertrochanteric femur fractures ($n = 4544$) (%)	Subtrochanteric femur fractures ($n = 516$) (%)	*p* value
Age (years, mean)[a]	82.2 ± 7.3	83.1 ± 7.3	81.7 ± 7.3	< 0.001
Female (%)	69.4	72.7	74.0	0.003
White (%)	90.9	92.1	87.0	0.006
Body mass index (BMI)[a]	24.8 ± 5.2	24.8 ± 5.7	26.1 ± 6.4	< 0.001
Functional health status				0.343
Independent	76.5	76.8	80.4	
Partially dependent	20.3	20.1	17.4	
Totally dependent	3.3	3.2	2.2	
ASA classification (continuous)[a]	3.1 ± 0.6	3.1 ± 0.6	3.0 ± 0.6	0.162
ASA classification (ordinal)				0.357
1	0.3	0.5	0.4	
2	23.0	14.1	17.1	
3	61.9	62.7	61.3	
4	23.5	22.5	21.2	
5	0.1	0.2	0.0	
Dementia (%)	33.4	31.3	22.0	< 0.001
Preoperative delirium (%)	13.6	12.8	8.2	0.003
Diabetes (%)	15.8	18.5	18.8	0.007
Smoker, current (%)	9.5	8.3	9.1	0.757
COPD (%)	10.1	11.2	11.2	0.300
Ascites (%)	0.2	0.3	0.6	0.340
CHF (%)	4.0	4.2	3.5	0.707
Hypertension (%)	68.3	69.9	64.0	0.044
Dialysis (%)	1.6	1.8	2.1	0.682

All other comparisons performed using chi-square analysis

[a]Statistical comparison performed using one-way ANOVA

Table 2 Perioperative complications and adverse events by subtype of hip fracture using multivariate logistic regression

Complications (within 30 days)	Femoral neck (FN) (%)	Intertrochanteric (IT) (%)	Adjusted OR (for patients with IT vs. FN fractures)	*p* value	Subtrochanteric (ST) (%)	Adjusted OR (for patients with ST vs. FN fractures)	*p* value
Death	6.6	7.3	1.18 (0.93–1.48)	0.169	5.8	1.10 (0.64–1.88)	0.735
Any major medical AE	10.3	9.8	1.05 (0.86–1.27)	0.649	10.1	1.24 (0.83–1.84)	0.288
Any minor medical AE	9.3	9.4	0.98 (0.79–1.21)	0.816	11.4	1.14 (0.72–1.79)	0.585
Wound complications	0.7	0.6	0.58 (0.24–1.45)	0.245	1.4	2.17 (0.58–8.07)	0.248
Blood transfusion	18.5	34.4	2.69 (2.35–3.08)	< 0.001	49.8	5.94 (4.58–7.70)	< 0.001
Unplanned reoperation	2.7	2.1	0.69 (0.47–0.99)	0.046	1.6	0.71 (0.30–1.68)	0.435
Hospital readmission	9.2	7.8	0.76 (0.63–0.91)	0.003	7.0	0.81 (0.52–1.24)	0.324

Adjusted OR computed using multivariate logistic regression with age, gender, BMI, comorbidities, and ASA classification as covariates

IT fractures had a slightly lower risk-adjusted incidence of unplanned reoperation [2.1% vs. 2.7%, OR 0.69 (0.47–0.99), $p = 0.046$] and hospital readmission [7.8% vs. 9.2%, OR 0.76 (0.63–0.91), $p = 0.003$] than patients with FN fractures. Mean operative time was significantly different between hip fracture categories with treatment of ST fractures (mean 84.0 min) taking significantly more OR time than FN (mean 71.1 min) and IT fractures (mean 54.5 min) ($p < 0.001$ for all comparisons). The total hospital LOS was significantly higher for ST fractures (7.5 days) than FN (6.4 days) and IT (6.5 days) fractures ($p < 0.001$).

Discussion

Geriatric hip fractures are a significant burden on healthcare costs and are associated with high mortality and loss of functional status for many patients [8]. Although studies have explored differences in functional outcome and mortality between some subtypes of hip fractures, none focus on more specific short-term complications and outcomes associated with FN, IT, and ST fractures with a large data set [1, 5]. In this study, we found similar complication rates for major and minor medical AEs as well as 30-day mortality across all types of fractures. Patients with ST and IT fractures had a higher incidence of postoperative blood transfusions relative to the FN fractures, and IT fracture patients had a slightly lower reoperation and readmission rate relative to FN fracture patients. In addition, patients treated for ST fractures had higher mean operative times and longer total hospital LOS than those with IT or FN fractures. Knowledge of these outcome patterns will help physicians deliver more accurate prognosis to our patients.

In the geriatric population, most standard FN fractures are treated with arthroplasty in displaced fractures or percutaneous pinning in stable garden I/II fracture patterns. IT fractures are generally surgically fixed with a CMN or sliding hip screw (SHS) construct. Conversely, ST fractures typically necessitate fixation with CMN constructs, often with percutaneous or open reduction in addition to traction given greater deforming forces. Such differences in surgical treatment may affect postoperative outcomes. Our study found similar risk-adjusted 30-day mortality among ST (5.8%), IT (7.3%), and FN (6.6%) fractures. While previous studies found higher one-year mortality for IT fractures as compared to FN fractures, they also noted an overall decrease for IT mortality in the past 30 years, while FN mortality remained relatively stable [5]. Our findings of similar IT and FN mortalities may be a result of the improvement in clinical standard practice in reducing IT mortality over time, especially in the short-term setting with the more routine use of CMN. Our original hypothesis of higher mortality in the ST population was similarly based on the need for open surgery and increased blood loss, but we also found ST mortality to not be significantly different from FN mortality.

We found that the overall risk-adjusted rates of perioperative of minor and major medical AEs, as well as wound complications were similar among all FN, IT, and ST fracture subtypes. Risk factors for medical complications are more likely influenced by patients' pre-fracture medical history and status, and less tied to the specific type of fracture. A previous study by Kastanis et al. shows ASA classification to be of prognostic significance for postoperative medical complications, length of hospital stay and readmission for geriatric hip fractures [9]. There were no significant differences in rates of wound complications between subtypes of fractures. Although the ST and FN fractures result in lengthier open surgeries (Table 3), wound complications were all similarly uncommon (< 1.5% in all categories) and the increased mean OR time was likely not enough to influence the wound complication rate.

In our study, there were significantly higher risk-adjusted postoperative blood transfusion rates for both IT and ST fractures relative to FN fractures (34.4% and 49.8 vs 18.5%, respectively). Increased blood transfusion rates are unsurprising due to expected blood loss associated with reaming

Table 3 Outcome measures, total length of stay in hospital and mean operative time by subtype of hip fracture

Outcome measure[a]	Femoral neck (FN)	Intertrochanteric (IT)	*p* value	Subtrochanteric (ST)	*p* value
Total hospital LOS (days)	6.4 ± 4.3	6.5 ± 4.4	0.169	7.5 ± 5.5	< 0.001
Operative time (minutes)	71.1 ± 37.6	54.5 ± 35.9	< 0.001	84.0 ± 44.7	< 0.001

[a]Independent-samples *t* test

for CMN. Additionally, the metaphyseal and metadiaphyseal location of IT and ST fractures denotes a rich and likely more robust blood supply inducing greater bleeding both during injury and treatment. In concordance, Desai et al. also found that patients with IT and ST fractures needed more postoperative blood transfusions and further confirmed that IT fractures fixed with CMNs resulted in more postoperative blood transfusions as compared IT fractures fixed with a SHS [10].

We found that IT fracture patients had lower reoperation (2.1 vs. 2.7%) and readmission (7.8 vs. 9.2%) rates relative to patients with FN fractures. We hypothesize that higher reoperation and readmission rates for FN fractures are likely due to early arthroplasty complications (e.g., dislocation, periprosthetic fracture) or early failures of percutaneous pinning resulting in conversion to arthroplasty. Since IT fractures are extracapsular with preserved blood supply to the femoral neck, fewer fixation failures are noted. This finding is corroborated by a study by Yli-Kyyny et al. with the Finnish National Database which found that FN fractures were more likely to result in readmission compared to IT and ST fractures, and largely in the groups undergoing arthroplasty [11]. Lin et al. reported in Taiwanese nonagenarians that there are higher reoperation rates in the FN fracture group consistent with our findings, but higher mortality and hospital readmission in the IT group [12]. As a whole, Boockvar et al. reported that hospital readmissions rates following hip fracture cite largely non-surgical causes for readmission in the first 30 days, with only 11% due to surgical complication [13]. Kastanis et al. showed ASA status to be of prognostic value for medical complications and hospital readmission for geriatric hip fractures [9].

Advantages of our study design using the ACS NSQIP database include the large anonymized dataset combined from multiple institutions. However, a major limitation is that our data only track patient outcomes and complications to 30 days postoperatively. As a result, there are no long-term mortality or complications data, especially with failures and revisions occurring more than 30 days postoperatively. In the future, longer follow-up would be highly relevant for further study. The population studied was also largely female and white. While this is the common demographic for hip fractures, it may represent a source of bias. In addition, preoperative baseline characteristics of the patients provided by the dataset are relatively limited, without much predictive value for the type of fractures incurred or likely medical complication outcomes. While we risk-adjusted for many factors including baseline patient age, gender, race, BMI, functional status, ASA classification, and comorbidities, we accept that there may be other non-accounted for risk factors beyond the scope of the dataset of the ACS NSQIP. Finally, the FN fracture cohort did not distinguish between patients who underwent percutaneous pinning as opposed to arthroplasty due to granularity limitations within the database. This is important to consider given that prior studies have demonstrated difference in reoperation rate when comparing arthroplasty versus internal fixation for FN fractures in elderly populations at longer follow-up [14].

Conclusions

In summary, the purpose of the study was to compare postoperative complications and outcomes of hip fractures distinguished by anatomic fracture patterns. FN fractures are associated with higher readmission and reoperation rates, while IT and ST fractures are associated with higher mean operative time, hospital LOS, and need for postoperative blood transfusion. 30-day mortality and rates of medical complications were comparable across all fracture types. Knowledge of these short-term prognoses and risk profiles may help the provider to prepare a better estimate of outcomes for patients recovering from geriatric hip fractures.

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

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