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Impact of frailty on complications in patients with thoracic and thoracolumbar spinal fracture

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ABSTRACT

Objectives: It is well-documented that geriatric patients are at risk for serious injuries after fracture due to pre-existing medical conditions, physical changes of aging, and medication effects. Frailty has been demonstrated to be a predictor of morbidity and mortality in inpatient head and neck surgery, and for surgical intervention for adult spinal deformity and degenerative spine disease. However, the impact of frailty on complications following thoracolumbar/thoracic fractures are unknown and has not been previously assessed in the literature, particularly in a nationwide setting.

Patients and Methods: This was a retrospective study of the prospectively-collected American College of Surgeons National Surgical Quality Improvement database for the years 2007 through 2012. Patients who underwent spinal decompression (+/− fusion) or an alternative intervention, defined as vertebroplasty or kyphoplasty (VP/KP) for thoracic or thoracolumbar fracture were identified. Frailty status was determined using a modified frailty index from the Canadian Study of Health and Aging Frailty Index, with frailty defined as a score = 0.27. 30-day morbidity and mortality were compared between frail and non-frail patients in each treatment group.

Results: A total of 303 patients were included in this study. Of these, 38% of patients had VP/KP and 62% underwent surgery. Within the VP/KP cohort, 26% were frail. The proportion of these patients who developed at least one complication was 3.3% versus 3.6% for non-frail patients ($p = 1.0$). The 30-day mortality for frail versus not frail patients in this cohort was 0% versus 2.4% ($p = 1.0$). Among the surgical group, 13% were frail. In contrast, the likelihood of complications was 33.3% among frail patients and 4.2% for non-frail patients ($p < 0.001$). Frail patients also had a 16.7% 30-day mortality rate as compared to 0.6% in the non-frail group ($p = 0.001$). When comparing the frail versus non-frail patients overall, frail patients had a complication rate of 16.7%, as opposed to 4.0% in non-frail patients.

Conclusion: Frailty and surgical intervention are correlated with a higher 30-day complication rate in patients with thoracic and thoracolumbar fracture. This finding is an important consideration for surgical decision-making and patient counseling on treatment options.

1. Introduction

In the US, the incidence of spinal column injuries is approximately 12,000 cases every year [1]. Between 15% and 20% of traumatic spinal fractures occur at the thoracolumbar junction (T11–L2), whereas 9%–16% occur in the thoracic spine (T1–T10) [2]. The thoracolumbar spine is the most common location of all spinal injuries [3].

Thoracolumbar spinal fractures, including spinous and transverse process fractures, may occur in 8–15 % of blunt trauma patients cared for at major trauma centers [4]. In addition, vertebral fractures are, together with proximal femoral and wrist fractures, the most common osteoporotic fractures among elderly patients. The majority of these vertebral fractures are located are also situated in the thoracolumbar spine [5].

Although less frequent than cervical-spinal column injuries, thoracolumbar spinal column fractures can result in severe neurological deficits [6]. The 10-year survival rate for spinal fracture with concomitant neurological injury for patients younger than 29 years is 86%.

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This percentage significantly decreases to 50% for patients older than 29 years [7].

It is well-documented that geriatric patients are at risk for serious injuries after fracture due to pre-existing medical conditions, the physical changes of aging, and medication effects [8–11]. Age has historically been the indicator used to evaluate underlying physical wellbeing and resiliency, however patients at any age differ significantly in their physical abilities, mental abilities, and comorbidities [12]. Frailty encompasses a wide variety of physical and mental elements, incorporating muscle and bone strength, delirium risk, changes in daily activities, susceptibility to infection or trauma, loss of body mass index, cognitive decline, hemodynamic instability, and cardiovascular and respiratory pre-existing conditions [13,14]. As such, and given the flaws of using age in predicting complications, frailty markers may more accurately depict physiologic attributes than age [15].

Frailty has been demonstrated to be a predictor of morbidity and mortality in inpatient head and neck surgery, and for surgical intervention for adult spinal deformity and degenerative spine disease [16–18]. However, the impact of frailty on complications following thoracolumbar and thoracic fractures is unknown and has not been previously assessed in the literature, particularly using a national inpatient database. Thus, our study sought to compare perioperative morbidity and mortality in frail versus non-frail patients with thoracolumbar or thoracic fracture using the ACS-NSQIP database.

2. Patient and methods

2.1. Data source

This was a retrospective study that used the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database for the years 2007–2012. ACS-NSQIP is a national database that collects more than 150 variables for each surgical procedure entered, including demographic information, preoperative comorbidities, intraoperative variables, and 30-day postoperative mortality and morbidity data. Procedures are reported using Current Procedural Terminology (CPT) codes. This information is then risk-adjusted to allow for equitable comparison among hospitals nationwide. Patients in the ACS-NSQIP database are representative of all insurance statuses, including those uninsured and those covered by private insurance, Medicare, and Medicaid. Since its inception in 2004, ACS-NSQIP has expanded to include 445 participating hospitals, each with a trained “Surgical Clinical Reviewer” that performs data collection; the current inter-rater disagreement rate is approximately 2% for all assessed program variables (https://www.facs.org/quality-programs/acs-nsqip). ACS-NSQIP database has been extensively applied in the spine surgical literature, and currently has a 30-day follow-up rate of over 95%, with high accuracy and reproducibility [19,20]. This study was deemed exempt from review by our Institutional Review Board (IRB00096323).

2.2. Frailty index

The modified frailty index (mFI) was developed by Saxton and Velanovich and is based on matching 11 variables from the Canadian Study of Health and Aging Frailty Index (CSHA-FI) to those in the NSQIP dataset [21]. This method has been validated to correspond with frailty across all surgical specialties [15,22–24].

These variables are used to ascertain the prevalence of frailty and its association with perioperative complications (Table 1]). To calculate an mFI score, the presence of one variable equals one point. The total number of variables present for each patient is then divided by the total number evaluated (n/11). The range of mFI scores is from 0 to 1.0, and an mFI score of ≥ 0.27 to be considered as frail based on past literature [25].

Table 1
Matched clinical NSQIP variables to CSHA-FI variables.

NSQIP	CSHA-FI
Functional health status prior to fx or surgery.	Changes in daily activities
Diabetes mellitus	History of diabetes mellitus
History of severe COPD	Lung problems
Current pneumonia	Respiratory problems
Congestive heart failure within 30 d prior to surgery	Congestive heart failure
History of myocardial infarction within past 6 mo prior to surgery	Myocardial infarction
Previous percutaneous coronary intervention	Cardiac problems
Previous cardiac surgery	
History of angina within 1 mo prior to surgery	
Hypertension requiring medication	Arterial hypertension
Impaired sensorium	Clouding or delirium
History of transient ischemic attack	Cerebrovascular problems
Cerebrovascular accident/stroke with neurologic deficit	History of stroke
History of revascularization/amputation for peripheral vascular disease	Decreased peripheral pulses
Rest pain/gangrene	

2.3. Inclusion criteria

Adult patients (18 years of age or older) who underwent surgery for spinal decompression with or without fusion or VP/KP, were identified via use of following *International Classification of Diseases Classification 9th Revision* (ICD-9) codes: thoracic fracture (T1-T6) with SCI (806.20, 806.30), thoracic fracture (T7-T12) with Spinal Cord Injury (SCI) (806.25, 806.35), thoracic fracture without SCI (805.2, 805.3), lumbar fracture with cauda equina injury (806.4, 806.5), and lumbar fracture without cauda equina injury (805.4, 805.5). Only patients who underwent surgery were included and identified via use of appropriate Current Procedural Terminology codes. Surgical intervention was defined as spinal decompression with or without fusion, and was compared to the alternative procedural treatment of VP/KP.

2.4. Data collection

The following baseline data were obtained for each patient: age, sex, body mass index (BMI), and mFI score. The mFI scores were calculated based on demographic data within the ACS-NSQIP database. The variables included and extracted from NSQIP are: changes in daily activities, history of diabetes mellitus, lung problems/respiratory problems, congestive heart failure, cardiac diseases, arterial hypertension, clouding/delirium, cerebrovascular diseases, history of stroke, and decreased peripheral pulses [20]. These extracted variables are consistent with previously published frailty index scoring systems using the ACS-NSQIP database [26].

2.5. Outcomes

The primary outcome measure was the development of at least one major perioperative complication during the 30 days following surgery. These complications were defined as 30-day mortality, intraoperative events (myocardial infarction or cardiac arrest requiring resuscitation), acute renal failure, ventilator use for over 48 h, cerebrovascular accident or stroke, myocardial infarction, cardiac arrest, pulmonary embolism, sepsis, septic shock, coma for over 24 h, and unplanned re-intubation. Other outcome data collected included operative time.

2.6. Statistical analysis

All analyses were performed using STATA. The primary independent variable was frailty status, and data were compared between frail patients and non-frail patients using two-tailed t-tests or chi-