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Venous thromboembolism events following spinal fractures: A single center experience

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ABSTRACT

Objective: :Venous thromboembolic events (VTE), including deep venous thrombosis (DVT) and pulmonary embolism (PE), are a major cause of readmission, morbidity, and mortality after spine surgery. Patients with spinal fractures are particularly at an increased risk for VTE. The objective of this study is to understand VTE risk factors in this patient population and to examine current institutional practices.

Patients and Methods: :We retrospectively examined records from 195 consecutive patients with spinal fractures who underwent spinal stabilization surgeries- amongst a cohort of 6869 patients who underwent spinal surgery. We collected data on patient demographics, surgery, hospital course, and 30-day rates of VTE, readmission, reoperation. Multivariable logistic regression was used to identify independent predictors of each outcome.

Results: :Among 195 patients undergoing surgery for spinal fractures, 9.2% experienced a VTE, compared to 2.3% among all other spine patients (OR 4.466, $p < 0.0001$). 48.7% spine fracture patients received chemoprophylactic anticoagulation, compared to 35.7% of all other spine patients (OR 2.657, $p < 0.0001$). Within 30 days of surgery, estimated blood loss (EBL) was associated with VTE (OR 1.001, $p = 0.0415$) and DVT (OR 1.001, $p = 0.049$), and comorbid cardiac disease burden showed a trend toward significance in predicting both VTE (OR 1.890, $p = 0.0956$) and DVT (OR 4.228, $p = 0.0549$). Number of levels in surgery predicted PE within 30 days of surgery (OR 1.573, $p = 0.0107$).

Conclusions: : Compared to all other patients undergoing spine surgery, patients with spinal fractures are more likely to receive chemoprophylactic anticoagulation, but nevertheless have a higher rate of VTE events. EBL and comorbid disease burden predict VTE events in patients with spine fractures.

1. Introduction

Venous thromboembolic events (VTE) including both deep venous thrombosis (DVT) and pulmonary embolism (PE) are major causes of morbidity and mortality after spine surgery. There is debate about the incidence after spinal surgery, ranging from 0.3% to 31% based on patient population and diagnostic methodology [1]. Furthermore, there is no clear consensus about thromboprophylaxis in spinal surgery due to a paucity of scientific evidence in this group of patients [2–4]. Even with minimal literature, Glotzbecker et al. [5] showed that many surgeons abide by their own personal experiences over the evidence-based research. It has been well established that VTE complications lead to poor outcomes after trauma [6]. With the increasing age of our patient population and improved surgical techniques to improve survival for severe traumatic experiences, these patients are at a heightened risk for VTE. Recently, within this trauma patient population, spinal fracture was an independent risk factor for VTE after spinal surgery [7,8].

Thromboprophylaxis, either mechanical, chemical, or in combination, have been shown to decrease incidence of VTE after trauma [1,2,9,10]. The current chemoprophylaxis recommendation for trauma patients is to use low-molecular-weight heparin (LMWH) [11,12]. However, there are still concerns over safety, timing, and mode of anticoagulant therapy that could result in bleeding complications [3,13–17]. Therefore, it is critical to determine a consensus for VTE prophylaxis to balance the risk-benefit relationship.

The purpose of this study is to elucidate factors that increase the

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post-operative VTE incidence in patients with traumatic spinal fractures. In this single institution study, we also investigate our current practices.

2. Patients and methods

2.1. Data source

All patients who underwent spine surgery in the Departments of Neurological Surgery or Orthopedic Surgery of Northwestern University between January 1st, 2009 and May 31st, 2015 were identified using the Northwestern University Electronic Data Warehouse (EDW). The EDW is a clinical data repository jointly funded by Northwestern Memorial Hospital, Northwestern Medical Faculty Foundation, and Northwestern University Feinberg School of Medicine. Spine surgeries were detected using Current Procedural Technology codes, and all identified primary spine surgeries were included in the analysis. If patients had multiple procedures requiring different admissions during this timeframe, each operation was analyzed separately. We excluded any patients undergoing minor spine surgeries (including electrode placements or hardware removal) or secondary procedures (operations for wound dehiscence and hematoma evacuations). For each spine surgery included in the study, data was collected about the patient, the procedure, and the post-operative management and recovery. The study was approved by Northwestern's Institutional Review Board.

2.2. Patient data

We collected the following patient data: age at surgery, gender, body mass index (BMI), smoking status (never, current, quit < 1 year ago), race (Caucasian, African American, Hispanic, Asian/Pacific Islander, Other/Unspecified), number of comorbidities present (hypertension, cardiac, renal, pulmonary, and endocrine disease), history of VTE 12 months prior to surgery, and history of bleeding disorders as identified by the ninth edition of International Classification of Disease codes.

2.3. Procedure data

We collected the following data about the procedures performed: total surgery time, number of levels in surgery, autograft, dislocation, site of surgery (cervical, thoracic, lumbar, other), estimated blood loss (EBL), transfusions, and prophylactic inferior vena cava (IVC) filter placement within 6 months prior to surgery.

2.4. Outcomes data

We also collected data on the use of chemoprophylactic anticoagulation in our patients. Given recent data showing that spine surgeons using chemoprophylactic anticoagulation do so in the first few days following surgery [15], we defined chemoprophylaxis as anticoagulation given from one day prior to operation to three days post-operation. Patients who received anticoagulation outside of this window were assumed to be receiving it therapeutically. Information about complications within 30 days after the surgery included the cumulative 30-day incidence and timing of VTEs (defined as either DVT or PE), cumulative 30-day incidence and timing of epidural hematomas, cumulative 30-day incidence of post-epidural hematoma neurological deficit, all-cause readmissions, reoperations, and incidence of death.

2.5. Statistical methods

Microsoft Excel 2011 (Microsoft, Redmond, WA, USA) was used for data management, and SAS 9.4 (SAS Institute, Cary, NC) and Prism 6.0b (GraphPad Software, Inc., La Jolla, CA, USA) were used to conduct all statistical analysis. Parametric data was given as mean ± standard deviation and compared by the Student *t*-Test, and non-parametric data was compared using Mann-Whitney *U* test or Chi-square tests, as appropriate. Time-to-event data was analyzed using Mantel-Cox statistics. Regression analysis was performed using logistic regression, and candidate variables with $p < 0.10$ on single-variable logistic regression were included in multivariable logistic regression. A value of $p < 0.05$ was considered statistically significant.

Table 1
Patient characteristics for both the fracture and no fracture groups. SD – standard deviation.

	Fracture	No Fracture
Number	195	6674
Age (years) (mean ± SD)	54.9 ± 18.9	54.0 ± 15.5
Gender (%, n)		
Male	50.8% (99)	53.6% (3576)
Female	49.2% (96)	46.4% (3098)
BMI mean (SD)	27.90 ± 6.55	28.47 ± 6.24
Smoking (%, n)		
Never	82.6% (161)	86.2% (5619)
Current	15.9% (31)	13.8% (924)
Quit < 1 year ago	1.5% (3)	1.8% (121)
Race (%, n)		
Caucasian	64.1% (125)	69.4% (4630)
African American	8.2% (16)	9.5% (634)
Hispanic	8.2% (16)	5.3% (355)
Asian/Pacific Islander	0% (0)	0.3% (17)
Other	19.5% (38)	15.6% (1038)
Number of Comorbidities		
mean ± SD	2.7 ± 1.4	2.1 ± 1.5
median	3.0	2.0
Cardiac disease (%, n)	79.5% (155)	63.7% (4250)
Hypertension (%, n)	29.7% (58)	27.2% (1815)
Pulmonary disease (%, n)	64.6% (126)	48.0% (3204)
Endocrine disease (%, n)	75.4% (147)	59.9% (4001)
Diabetes Mellitus (%, n)	8.2% (16)	8.4% (560)
Renal disease (%, n)	20% (39)	10.5% (701)

3. Results

3.1. Patient demographics

A total of 6869 patients met the study inclusion criteria. There were 195 patients in the spine fracture group. The spine fracture patients were 54.9 ± 18.9 years old with an average BMI of 27.90 ± 6.55 kg/m^2. There was an even split between men and women with most of the patients identifying as Caucasian (64.1%). Most of the patients had never smoked (82.6%) (Table 1).

Compared to all other spine surgery patients, spine fracture patients were the same with respect to age (fracture 54.9 ± 18.9 v. non-fracture 54.0 ± 15.5, Δ=-0.9 [-3.1-1.3], p = 0.434), gender (50.8% men v. 53.6% men, p = 0.435), race (64.1% white v. 69.4% white, p = 0.116), BMI (fracture 27.90 ± 6.55 v. non-fracture 28.46 ± 6.24, Δ = 0.57 [-0.34-1.48], p = 0.220), and smoking status (fracture 15.9% v. non-fracture 13.8%, p = 0.403). Spine fracture patients have more comorbid diagnoses (3.0 v. 2.0, Δ=-1.0 [-1.0-0.0], p < 0.001).

3.2. Timing of anticoagulation and VTE

95 spine fracture patients (48.7%) received chemoprophylactic anticoagulation, compared to 35.7% of all other spine patients (OR 2.66 [2.00, 3.54], p < 0.001) (Table 2). The time to initiation of anticoagulation, as measured by post-operative day, was later among spine fracture patients than among other spine surgery patients (1.88 v. 1.73, log rank p = 0.025, OR 0.925 [0.764, 1.12]) (Table 3). There was no difference in timing between spine fracture patients and other spine surgery patients with respect to occurrence of VTE (4.28 v. 4.90, log rank p = 0.384, OR 1.241 [0.744-2.163], Fig. 1), DVT (3.27 v. 5.22, log