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Incidence and factors predicting pulmonary embolism and deep venous thrombosis following surgical treatment of ankle fractures

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ABSTRACT

Background: The purpose of this study was to identify the incidence and risk factors associated with pulmonary embolism and deep venous thrombosis following open reduction and internal fixation of ankle fractures.
Methods: This was a retrospective study of patients in California undergoing operative treatment of an ankle fracture from 1995 to 2005. The main outcome measure was readmission for pulmonary embolism or deep venous thrombosis within 90 days of surgery.
Results: A total of 57,183 patients from the California discharge database were identified. The readmission rate for pulmonary embolism was low at 0.34%. The risk was increased in patients aged 50–75, those with open fractures, and those with higher Charlson comorbidity score. The overall rate of readmission for deep venous thrombosis was also low at 0.05%.
Conclusions: The overall rate of thromboembolic disease was low in this large patient sample. Increased age and comorbidity were associated with an increased risk.

1. Introduction

Lower extremity surgery and immobilization are known risk factors for deep venous thrombosis (DVT) and venous thromboembolism (VTE). Prophylaxis after ankle surgery is not routine in United States, given that reported rates are low and prophylaxis itself is associated with complications [1]. However, the consequences of venous thromboembolism can be serious, with some pulmonary emboli leading to death [2–4]. If patients at greater risk for VTE could be identified and treated, these serious complications could be avoided. The purpose of this study was to identify risk factors that place patients at the highest risk for VTE. Our hypothesis was that patients with more severe injuries and those with more medical comorbidities would be at the highest risk of deep venous thrombosis and pulmonary embolism.

2. Methods

2.1. Data source

Data for all hospital discharges in California in the years 1995–2005 were obtained from California's Office of Statewide Health Planning and Development (OSHPD) through the patient discharge database. This database is compiled annually by OSHPD and includes discharge abstracts from all non-federal hospitals in California. Each discharge abstract includes codes for up to 20 inpatient procedures and 24 diagnoses per hospitalization. All procedures and diagnoses are coded using the International Classification of Disease, 9th Revision, Clinical Modification (ICD-9-CM). Also included are patient demographic information (race, ethnicity, gender, expected source of payment, age, and ZIP code of residence), outcomes (in-hospital mortality), and site of hospitalization (unique hospital identifier and ZIP code) [5]. Deaths were identified from the state death file [6]. The study protocol was reviewed and approved by the UCLA institutional review board. Due to the nature of these secondary data analyses, waiver of patient consent was granted.

2.2. Inclusion and exclusion criteria

The patient sample consisted of patients undergoing open reduction and internal fixation of a lateral malleolar, bimalleolar, or trimalleolar ankle fracture during the study period. The specific ICD-9-CM procedure codes used to identify the cohort sample are available in Appendix 1. Patients with non-California ZIP codes were excluded as these patients are more likely to be readmitted outside the state during the observation period. The unit of analysis was hospital discharge for each individual patient.

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2.3. Outcomes studied

The short-term outcomes of deep venous thrombosis (DVT) and pulmonary embolism (PE) were reported for the first 90 days following the primary procedure. These complications were identified using ICD-9 codes consistent for inpatient readmissions associated with these outcomes. DVT and PE were defined using coding algorithms based on those used in prior studies [5]. Patients with DVT or PE were identified by searching for readmissions after surgery in which diagnosis codes for DVT or PE were reported in the OSHPD discharge database. The specific ICD-9-CM codes used to identify DVT or PE are available in Appendix 1.

2.4. Predictors

The predictive variables of interest include patient and provider characteristics, which were used in the regression models as covariates to adjust for their effect. These independent variables included patient characteristics such as age, gender, race/ethnicity, and insurance type. Comorbid disease was assessed using the Charlson score, as well as the separate inclusion of complicated or uncomplicated diabetes and peripheral vascular disease as covariates. Complicated and uncomplicated diabetes were identified using the Charlson system of coding, with complicated diabetes defined those diabetic patients with end-organ damage [7,8]. The Charlson comorbidity index assesses 17 comorbid conditions using ICD-9 codes and has been validated for use in administrative database studies [7,8]. Race and ethnicity are reported by the hospital based on patient self-report, and insurance type is reported by hospitals for each patient. Patients were categorized into three age groups: less than 50 years, 50–75 years, and greater than 75 years of age.

Hospital surgical volume was also included as a covariate. Surgical volume was defined as the average aggregate number of open reduction and internal fixation procedures performed yearly during the study period. Hospitals were categorized as low volume if they were in the lowest 40th percentile by annual volume among hospitals where ankle fracture surgery was performed. Intermediate volume hospitals were defined as the next 40th percentile; high volume hospitals were defined as the highest 20th percentile. Additional hospital characteristics included were hospital size, rural location, and teaching status, each of which are reported by hospitals in the OSHPD database.

Fracture type was included as a covariate using two methods. First, fractures were classified by into three categories: lateral malleolar, bimalleolar, and trimalleolar fractures. Second, open fractures were identified and the presence of an open injury included as a covariate. Fracture type and the presence of open fracture were defined using ICD-9 coding algorithms. The specific ICD-9 coding algorithms used to identify fracture type and the presence of an open injury are included in Appendix 1.

2.5. Statistical analysis

All statistical analyses were performed using Stata/SE 8.0. (StataCorp, College Station, TX). The patient sample is described with descriptive statistics. Results reported using descriptive statistics include patient demographics and annual rates of open reduction and internal fixation. Raw rates of complications are also reported for patients by fracture type and also separately for patients with diabetes and peripheral vascular disease. We used multivariate regression techniques to identify the independent effect of the predictor patient and provider variables on the risk of complications. Multivariate logistic regression models were used to estimate the impact of multiple patient characteristics on the outcomes of DVT and PE while accounting for various provider characteristics (hospital volume, teaching status, rural location, hospital size). The strength of association between the risk of short-term complications and each of the provider and patient covariates was expressed as odds ratios for a complication with respect to a reference group. Ninety-five percent confidence intervals and p-values are reported as well.

3. Results

3.1. Patient sample

A total of 57,183 patients underwent open reduction and internal fixation of an ankle fracture during the 11-year study period. Table 1 shows the annual incidence of each procedure. Table 2 lists demographic information for the patients undergoing ORIF. The mean age of the patient population was 51 years and 63% of the patients were female. There were a total of 9109 lateral malleolar fracture, 25,639 bimalleolar fractures, and 22,435 trimalleolar fractures. A total of 3940 (6.89%) of the fractures were associated with an open injury. The incidence of uncomplicated diabetes was 8.24% while diabetes complicated by end-organ damage was found in 2.13% of patients. A total of 1.02% of patients had associated peripheral vascular disease.

3.2. Complication rates

The overall rate of deep venous thrombosis occurring on the initial hospitalization or requiring readmission within 90 days

Table 1
Incidence ankle fractures requiring open reduction and internal fixation in California, 1995–2005.

Year	Number of cases (n = 57,183)		
	Lateral malleolar fractures	Bimalleolar fractures	Trimalleolar fractures
1995	873	2184	2110
1996	859	2110	2006
1997	769	2152	1944
1998	797	2309	2174
1999	815	2294	2014
2000	856	2327	2104
2001	846	2400	2076
2002	845	2398	2083
2003	860	2549	1996
2004	810	2564	1989
2005	779	2352	1939
Total	9109	25,639	22,435

Table 2
Demographics of patient sample.

Age	51 years (range 18–103)
Gender	
Male	37%
Female	63%
Race/ethnicity	
White	70%
Hispanic	18%
Black	7%
Asian-Pacific Islander	3%
Other	3%
Insurance type	
Private	45%
Medicare	26%
Medicaid	10%
Other	19%
Charlson comorbidity	0.43 ± 0.99
Uncomplicated diabetes	8.24%
Complicated diabetes	2.13%
Peripheral vascular disease	1.02%
Open fracture	6.89%