Full length article

The incidence of deep vein thrombosis and pulmonary embolism after fracture of the tibia: An analysis of the National Trauma Databank

Ronald Auer^a, John Riehl^{b,*}^a King's Daughters' Hospital, USA^b Baptist Health Care and the Andrews Institute, 1717 North E. Street, Suite 208, Pensacola, FL 32501, USA

ARTICLE INFO

Article history:

Received 28 May 2016

Accepted 14 January 2017

Available online 27 January 2017

Keywords:

DVT

VTE

Thrombosis

Lower extremity fracture

Chemical prophylaxis

ABSTRACT

Controversy exists regarding the routine use of chemical prophylaxis in isolated lower extremity fractures. The incidence of VTE in specific fracture locations in the lower extremity is largely unknown, and represents key information necessary to determine the need for prophylaxis. A large cross-sectional study using the National Trauma Databank was performed evaluating for the incidence and risk factors of VTE in isolated tibia fractures. The overall incidence of DVT and PE are extremely low in cases of isolated tibia fractures, which brings into doubt a role for routine use of chemical prophylaxis for these fractures.

© 2017

1. Introduction

Deep vein thrombosis (DVT) and pulmonary embolism (PE) are known complications after trauma and lower extremity fracture, which carry significant morbidity and mortality.¹ The incidence of venous thromboembolic events (VTE) varies based on the level of injury and inherent patient factors.² Multiple studies have investigated the incidence and risk factors associated with VTE (i.e. PE and DVT) after lower extremity fracture.^{2–4} The 9th edition of the American College of Chest Physicians guidelines strongly recommends for the use of thromboembolic prophylaxis after major orthopaedic surgery including hip and knee arthroplasty and hip fracture surgery but recommends against the routine use of chemical prophylaxis in patients with isolated injuries distal to the knee.⁵

The decision to give prophylaxis is typically based on patient risk factors and fracture pattern yet controversy exists in many lower extremity fractures. Previous studies have attempted to identify patient risk factors and comorbidities that warrant prophylaxis. Jameson et al. studied the National Health Service hospital database and suggested ankle fracture fixation in patients over 50 as being a risk factor for VTE.⁶ After studying the American College of Surgeons (ACS) National Trauma Data Bank (NTDB), Knudson et al., proposed risk factors for VTE, including lower extremity fracture with an Abbreviated Injury Score (AIS) over 3

(i.e. femur fracture or open tibia fracture).² Shibuya et al. performed an analysis of the NTDB and showed the incidence of DVT and PE in isolated foot and ankle fractures to be 0.28% and 0.21%, respectively, recommending against routine prophylaxis.⁷

The incidence of VTE in specific fracture locations in the lower extremity is largely unknown, and represents key information necessary to determine the need for prophylaxis. To the best of our knowledge, no large, cross-sectional study has evaluated the incidence of VTE in fractures of the tibia. We hypothesize that the incidence of VTE in all tibial fractures will be low and vary significantly based on fracture location and patient factors.

2. Methods

The National Trauma Data Bank (NTDB) is a registry of data collected from participating trauma centers across the United States. 148,936 patients from the NTDB data set (2009–2011) were identified with tibia and fibula trauma. We excluded patients with any concomitant fractures in addition to that in the tibia or fibula ($n=51,569$; Table 1) or those presenting in critical condition ($n=11,291$) where critical condition was defined as an injury severity score (ISS) of more than 15. A total of 86,076 patients were eligible for the present analyses.

The NTDB includes data on patient demographics and comorbidities and hospitalization data, including procedures, complications, and trauma types (Table 2). Each injury was assigned an abbreviated injury score for six distinct body regions (head, face, chest, abdomen, extremity, and external). The scores of the three most severely injured body regions were then squared

* Corresponding author.

E-mail address: jtriehl@hotmail.com (J. Riehl).

Table 1

Inclusion and Exclusion “International Classification of Diseases,” 9th revision.

Inclusion
823 Fracture of tibia and fibula
823.0 FX UPPER TIBIA/FIBULA-CL
823.00 Fx tibia upper end closed
823.01 Fx fibula upper end closed
823.02 Fx tibia and fibula upper end closed
823.1 FX UPPER TIBIA/FIBULA-OP
823.10 Fx tibia upper end open
823.11 Fx fibula upper end open
823.12 Fx tibia and fibula upper end open
823.2 FX SHAFT TIB/FIB-CLOSED
823.20 Fx tibia shaft closed
823.21 Fx fibula shaft closed
823.22 Fx tibia and fibula shaft closed
823.3 FX TIBIA/FIBULA SHAFT-OP
823.30 Fx tibia shaft open
823.31 Fx fibula shaft open
823.32 Fx tibia and fibula shaft open
823.40 Fx tibia torus
823.41 Fx fibula torus
823.42 Fx tibia and fibula torus
823.8 FX TIBIA/FIBULA NOS-CLOS
823.80 Fx tibia unspecified closed
823.82 Fx tibia and fibula unspecified closed
823.9 FX TIBIA/FIBULA NOS-OPEN
823.90 Fx tibia unspecified open
823.92 Fx tibia and fibula unspecified open
Exclusion (Any other lower body orthopaedic trauma)
808.0–808.9 Pelvic and Acetabulum Fracture
820.0–820.9 Hip Fracture
821.0–821.39 Femur Fracture
824.0–826.1 Foot and Ankle Fracture

and summed to create a composite score of severity. ISS is correlated with mortality, morbidity, and hospitalization time and is part of the NTDB data set. Obesity in the NTDB was defined as a body mass index (BMI) of 40 kg/m² or greater. The Common Procedural Terminology (CPT) codes were used to classify procedures in the NTDB into six categories based on treatment of the tibia fracture including: closed reduction with fixation, open reduction with or without fixation, closed reduction without fixation, immobilization without manipulation, soft tissue only procedures (e.g., wound debridement), other, and unspecified procedures (Table 3). Our inclusion criteria for this study were 1) fracture of the tibia/fibula with no other documented fractures; and 2) ISS less than 15. We excluded patients with 1) multiple fractures; 2) isolated ankle fractures; 3) procedure code listed as “other”; 4) patients without valid complication codes; 5) more severe concomitant injuries (ISS greater than or equal to 15).

2.1. Statistical analysis

Rates of DVT and PE in patients with tibia and fibula trauma and the association of DVT or PE with other hospital complications were calculated using a chi-square test or Fisher’s exact test, as necessary. Logistic regression models were used to calculate adjusted odds ratios (ORs) and 95% confidence intervals (CIs).

Factors were selected based on independent associations with deep vein thrombosis (DVT) or pulmonary embolism (PE) in bivariate analyses. Any factor with a *p* value <0.02 and a frequency of >.01% of the population was included. Gender, age, ISS and the following comorbidities were included in all analyses: hypertension, smoking history, diabetes, impaired sensorium, obesity, and bleeding disorder. DVT models were additionally adjusted for alcoholism. PE models were additionally adjusted for respiratory disease. Angina and the immobilization procedures were associated with DVT but were rare and were not included in the analysis.

Table 2

Variables used in analysis.

Demographics
Age (1 year increments)
Gender (Male/female)
Injury Severity Score (continuous, <15)
Length of hospital stay (minutes)
Comorbidities
Hypertension requiring medication
Current smoker
Diabetes mellitus
Respiratory Disease
Alcoholism
Impaired sensorium
Obesity (Body mass index >40 kg/m ²)
Bleeding Disorder
Congestive heart failure
History of Cerebrovascular Accident
Myocardial infarction within 6 months
Functionally dependent health status
Dialysis
Disseminated cancer
Steroid Use
Angina within 1 month
Esophageal varices
Peripheral vascular disease
Chemotherapy for cancer within previous 30 days
Ascites within 30 days
Fracture
Fracture types (see Table 1)
Open/Closed Fracture
Procedure
Use of pharmacological DVT prophylaxis
Surgical or non-surgical procedure (See Table 3)
Complication
Extremity compartment syndrome
Pneumonia
Drug or alcohol withdrawal syndrome
Deep vein thrombosis
Acute renal failure
Acute respiratory distress syndrome
Pulmonary embolism
Decubitus ulcer
Organ/space surgical infection
Cardiac arrest with Cardiopulmonary resuscitation
Unplanned intubation
Superficial surgical infection
Myocardial infarction
Deep surgical site infection
Graft
Stroke/Cerebrovascular accident

Table 3

Categories of tibia and fibula fracture procedures using Common Procedural Terminology (CPT) Codes.

Closed reduction with fixation
93.54 Application of splint
93.56 Application of pressure dressing
93.59 Other immobilization, pressure, and attention to wound
79.16 Closed reduction of fracture with internal fixation, tibia and fibula
79.46 Closed reduction of separated epiphysis, tibia and fibula
Open reduction with or without fixation
79.26 Open reduction of fracture without internal fixation, tibia and fibula
79.36 Open reduction of fracture with internal fixation, tibia and fibula
79.56 Open reduction of separated epiphysis, tibia and fibula
Closed reduction without fixation
79.06 Closed reduction of fracture without internal fixation, tibia and fibula
Immobilization, special dressing
93.50 Other immobilization, pressure, and attention to wound
93.51 Application of plaster jacket
93.53 Application of other cast
Soft tissue procedures, such as wound debridement
79.66 Debridement of open fracture site, tibia and fibula
Other and unspecified procedures
79.96 Unspecified operation on bone injury, tibia and fibula

Table 4
Comorbidity frequencies (n = 80,633 patients with valid complication codes).

Comorbidity	Patients	(%)
Hypertension	16,719	(20.73)
Smoking history	8619	(10.69)
Diabetes	7554	(9.37)
Respiratory disease	5359	(6.65)
Alcoholism	5046	(6.26)
Impaired sensorium	3967	(4.92)
Obesity	3189	(3.95)
Bleeding disorder	1649	(2.05)
Congestive heart failure	1557	(1.93)
Cerebrovascular accident	955	(1.18)
Myocardial infarction	749	(.93)
Dependent status	579	(.72)
Dialysis	390	(.48)
Disseminated cancer	260	(.32)
Steroid use	247	(.31)
Angina	166	(.21)
Esophageal varices	141	(.17)
Peripheral vascular disease	81	(.1)
Chemotherapy	69	(.09)
Ascites	29	(.04)

Table 5
Procedure frequencies (n = 78,253 with valid CPT codes).

Procedure	Patients	(%)
Open Reduction with or without fixation	29,701	(40.48)
Closed reduction with fixation	17,728	(24.16)
Closed reduction without fixation	9416	(12.83)
Soft tissue procedure	8836	(12.04)
Immobilization	2235	(3.05)
Prophylaxis	311	(0.42)
Combination	33,949	(46.27)

Table 6
Frequency of Complications (n = 78,309 with recorded complication data).

Complication	Patients	(%)
Extremity compartment syndrome	1071	(1.37)
Pneumonia	572	(0.73)
Drug or alcohol withdrawal syndrome	467	(0.60)
Deep vein thrombosis	416	(0.53)
Acute renal failure	366	(0.47)
Acute respiratory distress syndrome	295	(0.38)
Pulmonary embolism	276	(0.35)
Decubitus ulcer	209	(0.27)
Organ/space SSI	189	(0.24)
Cardiac arrest with CPR	153	(0.20)
Unplanned intubation	126	(0.16)
Superficial SSI	125	(0.16)
Myocardial infarction	112	(0.14)
Deep surgical site infection	72	(0.09)
Graft	59	(0.08)
Stroke/CVA	34	(0.04)

Other factors examined were the six procedural categories, open/closed fracture status, and the following comorbidities: congestive heart failure, cerebrovascular accident, myocardial infarction, dialysis, disseminated cancer, steroid use, and esophageal varices. We also examined length of hospital stay, number of injuries, and presence of additional trauma beyond the tibia and fibula. Each was associated with DVT/PE; however ISS is highly correlated with all of these factors and were not individually included in the analysis in order to prevent causing these factors, along with ISS, to confound the results.

P values <0.05 were considered statistically significant. All statistical analyses were performed using SAS version 9.3(SAS Institute, Cary, NC).

3. Results

We initially identified 148,936 patients with fractures of the tibia other than ankle fractures. A total of 51,569 patients were removed for concomitant fractures and 11,291 patients were excluded for having an Injury Severity Score (ISS) greater than or equal to 15. A total of 86,076 patients were deemed eligible for analysis in our dataset.

3.1. Demographics and outcomes

For patients with a known gender, 64.6% were male and 45.4% were female. The average age was 40.6 ± 20.89 years. The average ISS was 6.50 ± 3.03 in patients with a known ISS. Fracture codes include a distinction of open or closed injuries and the possibility of multiple codes exists for segmental injuries of the tibia. A total of 63,313 (80.5%) fractures were closed, 16,755 (21.6%) were open and the status was unknown for 171 (0.26%) fractures.

The number and percentage of those patients with comorbidities, within the population of those with valid comorbidity codes (80,633 patients) was recorded and listed in Table 4. The most common comorbidity was hypertension (20.7%) followed by current smoker (10.6%). The incidence of peripheral vascular disease, chemotherapy and ascites as comorbidities was equal to or less than 0.1% and were removed from the analysis.

The number and percentage of those patients with a procedure code, within the population of those with valid procedure codes (78,253 patients) was recorded and listed in Table 5.

Complication codes were recorded for 78,309 patients with the most common complication in our population being extremity compartment syndrome (1.37%, n = 1071) as summarized in Table 6. The incidence of DVT and PE was 0.53% and 0.35%, or approximately 5 and 3 per 1000, respectively. When calculating the incidence of VTE according to length of stay the incidence was significantly higher for those patients staying longer than 3 days for both DVT (1.27% vs 0.1%) and PE (0.87% vs 0.05%). The average length of stay was approximately 4.6 days. The length of stay was significantly correlated with having additional injuries other than the tibia fracture.

3.2. DVT risk factors

On bivariate analysis, we found that age was significantly higher for patients with DVT (50.26 ± 16.8) and without DVT (40.6 ± 20.8) ($p < 0.0001$), respectively. Male patients were significantly more likely to have a DVT ($p = 0.012$). The ISS was significantly higher ($p < 0.0001$) for those patients with DVT (8.25 ± 3.5) than for those without (6.4 ± 3.02). The open or closed status of a fracture was known for over 99% of fractures. The presence of a closed, open, or status unknown fracture was not found to have a statistical effect on the occurrence of DVT ($p = 0.83, 0.40$ and 0.5 respectively).

Analysis of comorbidities showed that hypertension, smoking history, diabetes, respiratory disease, alcoholism, impaired sensorium, obesity, bleeding disorder, dependent status, steroid use and angina were significantly associated with an increased incidence of DVT ($p < 0.05$ for all comorbidities). The presence of any comorbidity was a significant risk factor for DVT compared to those patients without a comorbidity (0.76% compared to 0.38%).

Analysis of procedures performed showed that closed reduction with fixation and immobilization were associated with an increased incidence of DVT ($p = 0.03$ and 0.0017 respectively). The most commonly performed procedure was open reduction

Table 7

Fracture code frequency and incidence of DVT and PE.

Fracture code	Observed	Valid complication codes available	% DVT	% PE
823 Fracture of tibia and fibula	54	11	0.00%	0.00%
823.0 FX UPPER TIBIA/FIBULA-CL	82	29	0.00%	0.00%
823.00 Fx tibia upper end closed	21202	12896	0.64%	0.47%
823.01 Fx fibula upper end closed	5385	2552	0.35%	0.16%
823.02 Fx tibia and fibula upper end closed	5322	3321	0.63%	0.36%
823.1 FX UPPER TIBIA/FIBULA-OP	9	4	0.00%	0.00%
823.10 Fx tibia upper end open	2078	1151	0.78%	0.26%
823.11 Fx fibula upper end open	598	283	0.71%	0.35%
823.12 Fx tibia and fibula upper end open	883	463	0.43%	0.22%
823.2 FX SHAFT TIB/FIB-CLOSED	48	27	0.00%	0.00%
823.20 Fx tibia shaft closed	9136	5447	0.15%	0.18%
823.21 Fx fibula shaft closed	5563	2158	0.37%	0.32%
823.22 Fx tibia and fibula shaft closed	10513	7348	0.26%	0.22%
823.3 FX TIBIA/FIBULA SHAFT-OP	23	10	0.00%	0.00%
823.30 Fx tibia shaft open	3621	2103	0.19%	0.10%
823.31 Fx fibula shaft open	1696	618	0.65%	0.00%
823.32 Fx tibia and fibula shaft open	5088	3091	0.32%	0.39%
823.40 Fx tibia torus	64	35	0.00%	0.00%
823.41 Fx fibula torus	34	11	0.00%	0.00%
823.42 Fx tibia and fibula torus	78	44	2.27%	0.00%
823.8 FX TIBIA/FIBULA NOS-CLOS	26	9	0.00%	0.00%
823.80 Fx tibia unspecified closed	6386	3646	0.22%	0.08%
823.82 Fx tibia and fibula unspecified closed	9228	6704	0.21%	0.10%
823.9 FX TIBIA/FIBULA NOS-OPEN	8	2	0.00%	0.00%
823.90 Fx tibia unspecified open	1850	976	0.41%	0.20%
823.92 Fx tibia and fibula unspecified open	3873	2377	0.13%	0.13%

Table 8

Logistic regression analysis results, including only significant variables, for risk factors associated with DVT (N = 67,192) {DVT cases = 367} Adjusted for gender, age, injury severity score, hypertension, smoking history, diabetes, alcoholism, impaired sensorium, obesity, and bleeding disorders.

Variable	Odds Ratio	95% Confidence Interval	p-value
Gender	1.59	1.25–2.02	0.0002
Age	1.02	1.02–1.03	<0.0001
Injury severity score	1.18	1.14–1.21	<0.0001
Obesity	2.38	1.65–3.41	<0.0001
Prophylaxis	3.32	1.35–8.12	0.0088
Alcoholism	1.44	1.03–2.01	0.0351

a). Logistic regression results using OPEN ICD code (n = 15391; DVT = 85)

Variable	Odds Ratio	95% Confidence Interval	p-value
Age	1.02	1.01–1.03	0.0026
Injury Severity Score	1.16	1.07–1.27	0.0007
Bleeding disorder	3.27	1.24–8.63	0.0166

b). Logistic regression results using CLOSED ICD code (n = 58737; DVT = 314)

Variable	Odds Ratio	95% Confidence Interval	p-value
Gender	1.77	1.37–2.29	<0.0001
Age	1.02	1.01–1.03	<0.0001
Injury Severity Score	1.19	1.15–1.22	<0.0001
Obesity	2.44	1.66–3.59	<0.0001

c). Logistic regression; Closed reduction with fixation (n = 15267; DVT = 70)

Variable	Odds Ratio	95% Confidence Interval	p-value
Age	1.02	1.01–1.03	0.003
Injury Severity Score	1.19	1.11–1.28	<0.0001

d). Logistic regression; Open reduction with or without fixation (n = 25605; DVT = 138)

Variable	Odds Ratio	95% Confidence Interval	p-value
Gender	1.51	1.03–2.22	0.0357
Age	1.03	1.02–1.04	<0.0001
Injury Severity Score	1.18	1.13–1.25	<0.0001
Smoking	1.83	1.18–2.86	0.0075
Obesity	2.42	1.36–4.32	0.0027

e). Logistic regression; Soft tissue procedures (n = 7380; DVT = 34)

Variable	Odds Ratio	95% Confidence Interval	p-value
Age	1.04	1.01–1.06	0.0013
Injury Severity Score	1.18	1.03–1.35	0.014

Table 9

Logistic regression analysis results, including only significant variables, for risk factors associated with PE (N = 67,192) {PE cases = 255} Adjusted for gender, age, injury severity score, hypertension, impaired sensorium, obesity, respiratory disease, and bleeding disorders.

Variable	Odds Ratio	95% Confidence Interval	p-value
Gender	1.54	1.16–2.04	0.0025
Age	1.02	1.02–1.03	<0.0001
Injury severity score	1.11	1.07–1.15	<0.0001
Impaired sensorium	1.82	1.21–2.74	0.0041
Obesity	1.66	1.04–2.65	0.0354

a). Logistic regression results using OPEN ICD code (n = 15391; PE = 63)

Variable	Odds Ratio	95% Confidence Interval	p-value
Injury Severity Score	1.24	1.13–1.38	<0.0001

b). Logistic regression results using CLOSED ICD code (n = 58737; PE = 211)

Variable	Odds Ratio	95% Confidence Interval	p-value
Gender	1.44	1.07–1.94	0.0165
Age	1.02	1.02–1.03	<0.0001
Injury Severity Score	1.1	1.06–1.14	<0.0001
Impaired Sensorium	1.82	1.17–2.83	0.0083
Obesity	1.71	1.03–2.84	0.0398

c). Logistic regression; Closed reduction with fixation (n = 15267; DVT = 48)

Variable	Odds Ratio	95% Confidence Interval	p-value
Age	1.02	1.00–1.04	0.0163
Injury Severity Score	1.1	1.01–1.20	0.032
Obesity	2.83	1.08–7.38	0.0341

d). Logistic regression; Open reduction with or without fixation (n = 25605; DVT = 106)

Variable	Odds Ratio	95% Confidence Interval	p-value
Age	1.02	1.01–1.03	0.0056
Bleeding disorder	3.41	1.59–7.30	0.0016
Impaired sensorium	1.89	1.00–3.58	0.0498

e). Logistic regression; Soft tissue procedures (n = 7380; DVT = 27)

Variable	Odds Ratio	95% Confidence Interval	p-value
Injury Severity Score	1.29	1.11–1.50	0.0011
Bleeding disorder	5.23	1.10–24.86	0.0376

with or without fixation (40.5%) however a combination of the listed procedures occurred 46.3% of the time. Analysis of the fracture coding and risk for VTE showed that the most frequently occurring fracture was a closed fracture of the upper end of the tibia. A summary of the incidence of VTE according to the fracture code is seen in Table 7. The highest incidence of DVT was seen in closed fractures of the tibia and fibula, torus fractures of the tibia and fibula, and fractures of the upper end of the tibia and fibula.

The results of the logistic regression analysis, with only the significant variables included, are listed in Table 8. Each analysis was performed with and without prophylaxis included which showed no difference in the results. Obesity and prophylaxis were shown to be the highest risk factors for DVT (OR 2.38 and 3.32 respectively). Logistic regression analysis results of the open/closed fracture status and the procedures performed are also listed in Table 8, similarly with only the significant variables included. Age of the patient was the most frequently appearing risk factor throughout the analysis.

Patients with a DVT were more likely to have additional complications listed compared to patients without a DVT. A summary of these results are listed in Table 10. Pneumonia (n = 38, 9.1%) and extremity compartment syndrome (n = 16, 3.85%) were the most frequently reported complications in the DVT group.

3.3. PE risk factors

On bivariate analysis, we found that age was significantly different between patients with (49.83 ± 16.14) and without (40.63 ± 20.86) a PE ($p < 0.0001$). Gender was not a significance risk factor for the presence of PE ($p = 0.2$). The ISS was significantly higher ($p < 0.0001$) in patients with a PE than without: 7.60 ± 3.46 and 6.48 ± 3.02 , respectively. The presence of a closed, open or status unknown fracture was not found to be associated with an increased incidence of PE ($p = 0.52$, 0.24 and 0.45 respectively).

Analysis of comorbidities showed that hypertension, respiratory disease, impaired sensorium, obesity and bleeding disorder were associated with an increased incidence of PE (all $p < 0.007$). The presence of any comorbidity was correlated with PE ($p < 0.0001$) compared to those without comorbidities. The incidence of PE in those with at least one comorbidity was 0.48% compared to 0.27% in those without.

Immobilization was the only procedure shown to have an increased incidence of PE in the group ($p = 0.03$). The highest incidence of PE was seen in the generic coding of fracture of tibia and fibula, open fracture of the upper end of the tibia and fibula and open tibia and fibula shaft fractures.

The results of the logistic regression analysis, with only the significant variables included, are listed in Table 8. As previously

Table 10

Associated complications with DVT and PE.

	DVT				
	With (n = 416)		Without		
Complication	Patients	(%)	Patients	(%)	p-value
Drug or alcohol withdrawal syndrome	8	1.92	459	0.59	0.0038
ARDS (Acute respiratory distress syndrome)	14	3.37	281	0.36	<0.0001
Acute renal failure	14	3.37	352	0.45	<0.0001
Cardiac arrest with CPR	4	0.96	149	0.19	0.0093
Extremity compartment syndrome	16	3.85	1055	1.35	0.0002
Graft/prosthesis/flap failure	6	1.44	53	0.07	<0.0001
Unplanned intubation	14	3.37	112	0.14	<0.0001
Myocardial Infarction	7	1.68	105	0.14	<0.0001
Pneumonia	38	9.14	534	0.69	<0.0001
Surgical Site Infection	4	0.96	121	0.16	0.0046
Stroke/CVA	1	0.24	33	0.04	0.1657
Decubitus ulcer	6	1.44	203	0.26	0.0009
	PE				
	With (n = 276)		Without		
Complication	Patients	(%)	Patients	(%)	p-value
Drug or alcohol withdrawal syndrome	3	1.09	464	0.6	0.2281
ARDS (Acute respiratory distress syndrome)	9	3.26	286	0.37	<0.0001
Acute renal failure	4	1.45	362	0.46	0.0414
Cardiac arrest with CPR	8	2.9	145	0.19	<0.0001
Extremity compartment syndrome	13	4.71	1058	1.36	0.0001
Graft/prosthesis/flap failure	1	0.36	58	0.07	0.1881
Unplanned intubation	7	2.54	119	0.15	<0.0001
Myocardial Infarction	3	1.09	109	0.14	0.0074
Pneumonia	18	6.52	554	0.71	<0.0001
Surgical Site Infection	2	0.73	123	0.16	0.0723
Stroke/CVA	1	0.36	33	0.04	0.1131
Decubitus ulcer	4	1.45	205	0.26	0.0066

stated all analyses were performed with and without prophylaxis which did not change the results. Impaired sensorium and obesity were shown to have the high risk for PE (OR 1.82 and 1.66 respectively). Logistic regression analysis results of the open/closed fracture status and the procedures performed are also listed in Table 9, similarly with only the significant variables included. The most frequently appearing risk factor was a higher ISS.

Patients with a PE were more likely to have additional complications listed compared to patients without a PE. Table 10 summarizes these results. Pneumonia (n = 18, 6.5%) and extremity compartment syndrome (n = 13, 4.71%) were the most frequently reported complications in the PE group.

4. Discussion

VTE is a known complication of trauma, lower extremity fractures, and some elective orthopaedic procedures. Multiple studies have recommended routine use of chemical prophylaxis in pelvic and hip fractures. Previous studies of distal fractures – which have frequently been categorized as fractures below the knee or any lower extremity fractures – have given conflicting recommendations regarding the use of chemical prophylaxis. Our goal was to perform an analysis of a large cohort of patients with specific fractures to identify risk factors associated with VTE. We were able to accomplish this through use of a large data set obtained from trauma centers across the United States (the NTDB). To the best of our knowledge, our present study is the first large cross sectional study of the incidence and risk factors of VTE in patients with tibia fractures. The incidences of DVT and PE were 0.53% and 0.35%, respectively, which is lower than previous studies.

Previous screening studies have used routine venography or ultrasound to evaluate for VTE. These studies show rates as high as 21% with ankle fractures and 11% with fractures below the knee.

These studies, however, may be grossly overstating the clinical relevance of VTE. Chemical prophylaxis of VTE is not without risks that include bleeding and problems with wound healing, thrombocytopenia, and anemia. Studies evaluating for symptomatic and clinically relevant VTE have lower rates. The present study contains database information obtained from a large number of patients and hospitals which likely more closely represents the rate of clinically relevant VTE that is experienced in patients with isolated tibia fractures.

Tibia shaft fractures are typically treated with intramedullary fixation and weight bearing immediately after surgery compared to tibial plateau and pilon fractures which are frequently treated with spanning external fixation followed by plate fixation and protected weight bearing.⁸ Previous studies have examined the incidence of VTE in body regions rather than with specific fracture locations. A prospective randomized controlled trial by Goel et al. showed no significant difference in the incidence of DVT with chemical prophylaxis or placebo in fractures below the knee, although tibia plateau fractures showed a trend towards increased risk of VTE.⁹ Unfortunately their study was prematurely closed due to lack of funding.

The incidence of VTE after tibia fracture is believed to be low. In a review of over 45,000 orthopaedic procedures, 1072 tibia fractures underwent internal fixation each receiving 7 to 10 days of thromboprophylaxis.¹⁰ The incidence of VTE varied based on fracture location: plateau 3.8%; diaphysis 2.2%; and distal tibia 1.7%. In the same study the rate of VTE in over 2400 ankle fractures was found to be 3.6%. They concluded that better prophylactic regimens are required in lower extremity fractures. Abelseth et al. performed routine venography post operatively and found 25 DVTs in 90 fractures of the tibia (54 shaft, 28 plateau and 8 plafond fractures).³ All DVTs were clinically occult. Significant risk factors included age, prolonged immobilization and operating room time.

Based on the low incidences of DVT and PE in this large cohort (0.53% and 0.35%), we call into question the need for the routine use of chemical prophylaxis for isolated tibia fractures. However, based on the logistic regression analysis specific high risk patients may benefit from chemical prophylaxis. Our analysis showed that age, male gender, increased ISS, higher BMI, impaired sensorium, pneumonia and compartment syndrome are at a higher risk for VTE. Surgeons should recognize these risk factors and consider them when choosing a thromboprophylactic agent to treat their patients.

Our analysis showed a higher rate of VTE with the reporting of chemoprophylaxis. Considering the number patients reported to have received DVT prophylaxis is extremely low (0.42%, 311/78,253) we suspect there is a considerable reporting bias for this variable. Because of this we do not consider it to be a risk factor for VTE. Shibuya et al. came to similar conclusions in their examination of the NTDB.⁷ Given the widespread and nondiscriminatory use of chemical prophylaxis in distal lower extremity fractures the rates of prophylaxis are likely higher than our study. Because of this we are unable to perform a direct comparison.

The present study had several limitations, most of which are inherent to all database studies. First, this was a retrospective study that relies on data collected from multiple institutions across the United States. Despite the close monitoring of the ACS, there is likely to be some variability in the methods of data collection and reporting from each institution. This is an inherent limitation to large database studies. We also recognize that there were missing data in some instances which necessitated that we perform the available case analysis and disregard some data. This alters the data set based on which question is asked and may have the consequence of altering some of the results, however the effect should be minimal due to the large number of data collected.

Another instance where reporting bias may have affected the current study is that multiple comorbidities are identified and reported in the NTDB, but this is not an inclusive list. Multiple variables that are pertinent to a patient's risk profile are not reported including previous history of DVT/PE, personal or family history of hypercoagulable disorder, oral contraceptive use, hormone replacement therapy and family history of VTE. These variables would be expected to be associated with a higher risk of VTE, and therefore VTE prophylaxis should be tailored to the individual patient based on the presence or absence of any known risk factors.

In summary, the incidence of clinically relevant VTE is low in fractures of the tibia. Chemical thromboprophylaxis is not warranted in every patient's case. Identification of risk factors is imperative for the judicious use of these agents. We recommend against the routine use of chemical prophylaxis and alternatively recommend chemical prophylaxis use based on the presence of risk factors that are associated with these complications.

Source of funding

This project was funded by the Fischer Owen Fund, an institutional grant for resident research in the Department of Orthopaedic Surgery at University of Louisville.

Acknowledgments (as required by the NTDB agreement)

The American College of Surgeons, Committee on Trauma collects and maintains the National Trauma Data Bank® (NTDB). Therefore, use of any information from the NTDB must include a prominent citation. The citation is to read as follows, filling in the version number and year as:

Committee on Trauma, American College of Surgeons. NTDB Version X. Chicago, IL, 20XX The content reproduced from the NTDB remains the full and exclusive copyrighted property of the American College of Surgeons. The American College of Surgeons is not responsible for any claims arising from works based on the original data, text, tables, or figures [0].

Special thanks to Christina Pinkston, MS, for assistance with statistical analysis.

References

1. Klok Fa van Kralingen KW, van Dijk AP, Heyning FH, Vliegen HW, Kaptein AA, Huisman MV. Quality of life in long-term survivors of acute pulmonary embolism. *Chest*. 2010;138:1432–1440.
2. Knudson MM, Ikossi DG, Khaw L, Morabito D, Speetzan LS. Thromboembolism after trauma: an analysis of 1602 episodes from the American college of surgeons National Trauma Data Bank. *Ann Surg*. 2004;240:490–498.
3. Abelseth G, Buckley RE, Pineo GE, Hull R, Rose MS. Incidence of deep-vein thrombosis in patients with fractures of the lower extremity distal to the hip. *J Orthop Trauma*. 1996;10:230–235.
4. Geerts WH, Code KJ, Jay RM, Chen E, Szalai JP. A prospective study of venous thromboembolism after major trauma. *N Engl J Med*. 1994;331:1601–1606.
5. Falck-Ytter Y, Francis CW, Johanson NA, et al. Prevention of VTE in orthopedic surgery patients: antithrombotic therapy and prevention of thrombosis, 9th ed: American college of chest physicians evidence-based clinical practice guidelines. *Chest*. 2012;141:e278S–e325S.
6. Jameson SS, Augustine A, James P, et al. Venous thromboembolic events following foot and ankle surgery in the english national health service. *J Bone Jt Surg (Br)*. 2011;93-B:490–497.
7. Shibuya N, Frost CH, Campbell JD, Davis ML, Jupiter DC. Incidences of acute deep vein thrombosis and pulmonary embolism in foot and ankle trauma: analysis of the National Trauma Data Bank. *J Foot Ankle Surg*. 2012;51:63–68.
8. Kubiak EN, Beebe MJ, North K, Hitchcock R, Potter MQ. Early weight bearing after lower extremity fractures in adults. *J Am Acad Orthop Surg*. 2013;21:727–738.
9. Goel DP, Buckley R, deVries G, Abelseth G, Ni A, Gray R. Prophylaxis of deep-vein thrombosis in fractures below the knee: a prospective randomised controlled trial. *J Bone Jt Surg Br*. 2009;91B:388–394.
10. Lapidus LJ, Ponzer S, Pettersson H, de Bri E. Symptomatic venous thromboembolism and mortality in orthopaedic surgery—an observational study of 45 968 consecutive procedures. *BMC Musculoskelet Disord*. 2013;14:177–185.