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# National Trends in Venous Thromboembolism in the Adult Craniofacial Trauma Population

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**Background:** Venous thromboembolism (VTE), specifically deep vein thrombosis (DVT) and pulmonary embolism (PE), is a major complication in plastic surgery; however, there is a paucity of evidence about the incidence of VTE in the craniofacial subpopulation. We investigated the incidence and risk factors for VTE in the adult craniofacial trauma population.
**Methods:** This retrospective review identified patients from the 2016 and 2017 Healthcare Cost and Utilization Project's National Inpatient Sample with a diagnosis for an initial encounter of a facial fracture. International Classification of Disease codes identified patients with DVT or PE. Groups were identified: adult craniofacial patients with and without a VTE diagnosis. The groups were analyzed to determine risk factors for developing a VTE during inpatient admissions.
**Results:** A total of 203,240 patients were identified based on a diagnosis for an initial encounter of a facial fracture. Among those, 3350 (1.65%) were diagnosed with a DVT and 1455 (0.72%) with a PE. Risk factors for VTE were male sex ($P = 0.011$), longer hospital stay ($P = 0.000$), and higher Elixhauser comorbidity index ($P = 0.000$). Additionally, PE was an independent predictor of mortality [odds ratio (OR), 2.129] but DVT was not (OR, 1.148). Cranial and frontal fractures were independently associated with an increase in DVT (OR, 2.481) and PE (OR, 1.489).
**Conclusions:** This study demonstrates that craniofacial trauma patients are at risk for VTE and should be risk-stratified for chemoprophylaxis therapy. Further studies in thromboembolism prophylaxis for facial fractures are warranted as the data are limited. *(Plast Reconstr Surg Glob Open 2022;10:e4393; doi: 10.1097/GOX.0000000000004393; Published online 23 June 2022.)*

## INTRODUCTION

Venous thromboembolism (VTE) is a serious risk to all patients undergoing surgery. VTE represents a range of diseases that include deep vein thrombosis (DVT) and pulmonary embolism (PE). It is widely known that patients undergoing plastic and reconstructive surgical procedures are at significant risk for VTE complications.[1–7] PEs have significant morbidity and mortality with serious long-term complications that can arise such as right ventricular dysfunction and chronic pulmonary hypertension.[1] DVTs also have serious side effects if they remain undiagnosed and untreated. Progression includes the development of PEs and severe postthrombotic syndrome.[1] Prevention of VTE offers a significant way to reduce morbidity and mortality in all patients.[8–10]

DVT and PE are significant complications that have not been sufficiently studied across all plastic surgery populations. In 2008, the VTE prevention study was funded by the Plastic Surgery Foundation, and steps were made to further establish a universal system for prophylaxis.[11] Additional studies, including one by Seruya et al,[12] formulated a specific scoring system for the plastic surgery population. VTE after craniofacial surgery has been found to have an incidence of 0.55%.[13] Aesthetic procedures were found to have a low risk of VTE (<1%) and routinely do not require chemoprophylaxis.[14,15] Higher-risk procedures that involve general anesthesia and longer operating times can result in an increased risk for VTE complications. One single-center study found incidence to be 7.5% among the

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highest risk patients.[12] Other plastic surgery populations have been analyzed for their specific risk. In particular, the body contouring population was reported to have a 1%–3% risk of VTE complications.[6]

Several studies have examined fractures in the craniofacial population using large population databases including the American College of Surgeons National Surgical Quality Improvement Program and the Nationwide Emergency Department Sample.[16–18] The studies showed that the most common causes of facial fractures are falls, motor vehicle accidents, and being struck by something.[17] Additionally, it has been noted that patients with facial fractures are often viewed as high risk for surgery, with 17%–20% of patients being classified as American Society of Anesthesiology class III or IV.[18] Complications in relation to in-hospital stays for facial fracture patients include a reported mean length of stay of 6.2 days, a mortality rate of 3.2%, and mean total charges for the hospital stay exceeding $60,000.[17]

Effectively preventing VTE events offers morbidity and mortality benefits, as well as lower overall healthcare costs. Identifying risk factors for patients who have craniofacial fractures for risk stratification can allow for physicians to properly determine the most appropriate chemoprophylaxis therapy. This will enable plastic surgeons, who are managing patients with craniofacial fractures, to accurately determine proper prophylaxis based on a patient's risk for developing a VTE.

## PATIENTS AND METHODS

### Database

The National Inpatient Sample (NIS) created by the Healthcare Cost and Utilization Project was used to collect data on patients with an initial encounter for a cranial or facial fracture in 2016 and 2017. NIS is the largest all-payer national database that is derived from administrative data and contains encounter-level, clinical, and nonclinical information for all patients. The data analyzed are a sample of all in-patient encounters during each year. Patient demographics, all diagnoses (up to 30 per patient), payer information, and cost are listed in the database.[19]

### Study Population

The International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM) was used to identify the study population. The study population included adult patients (>18 years old) undergoing initial encounter of facial fractures (ICD-10-CM code S.02). Facial fractures were further broken down by location: cranial/frontal (ICD-10-CM code S.020), orbital/midface (ICD-10-CM code S.022, S.023, and S.024), and mandible (ICD-10-CM code S.026). Codes for subsequent encounters and sequelae were excluded from the study. ICD-10-CM codes used for DVT and PE are I.82 and I.26, respectively. Codes for chronic embolism and thrombosis were excluded. Patients were then divided into groups: adult craniofacial patients with a DVT and/or PE diagnosis and adult patients without a DVT and/or PE diagnosis.

### Takeaways

**Question:** Is the adult craniofacial trauma population at risk for venous thromboembolism (VTE) and what are the risk factors?

**Findings:** The adult craniofacial trauma population is at a significant risk for VTE. The rate of DVT is 1.65% and PE is 0.72%. Other risk factors included male sex, a greater number of comorbidities, and nonelective admission. DVT and PE resulted in increased costs and longer hospital stays. Cranial and frontal fractures had a higher rate compared with other areas of the face.

**Meaning:** Plastic surgeons need to be aware of patients with facial fractures as they are at risk for VTE.

### Study Variables

Patient demographic characteristics analyzed within the Agency for Healthcare Research and Quality data dictionary included age, sex, race, insurance status, length of hospital stay, elective admission status, total charges, and mortality. The previously validated Elixhauser comorbidity index was used to identify and characterize the chronic diseases among the study population.[20] Hospital variables defined according to the Agency for Healthcare Research and Quality included geographic location, metropolitan, and teaching status.

### Outcomes

The primary outcome of this study was the development of DVT and/or PE. Secondary outcomes that were examined included the length of stay, total charges of inpatient hospital stay, and mortality.

### Statistical Analysis

All statistical analyses were performed using Stata 16 (StataCorp, College Station, Tex.). Survey-weighted univariate chi-squared and Student t tests were used for the analysis of categorical and continuous variables, respectively. The independent impact of DVT and PE on outcome variables was determined using multivariable logistic and linear regressions when appropriate. A $P$ value less than 0.05 was considered to be statistically significant.

## RESULTS

The NIS estimated that a total of 203,340 patients were diagnosed with a facial fracture collectively in 2016 and 2017. One thousand, four hundred fifty-five patients were diagnosed with a PE (0.71%), 3350 were diagnosed with a DVT (1.64%), and 4355 were diagnosed with either a PE or DVT (2.14%). The combined results can be seen in Supplemental Digital Content 1. (**See Figure, Supplemental Digital Content 1**, which shows the overall incidence DVT and PE in facial fracture was 1.64% and 0.71%, respectively. http://links.lww.com/PRSGO/C128.) In-hospital mortality associated with facial fractures in 2016 was 5.48% and in 2017 was 5.37%. DVT did not result in statistically significant increases in mortality (2016, 7.12%, $P = 0.215$ and 2017, 6.96%, $P = 0.186$).

PE was associated with statistically significant increases in mortality (2016, 11.9%, $P = 0.001$ and 2017, 11.0%, $P = 0.001$). Results can be seen in Table 1.

On univariate analysis, patients more likely to have a DVT or PE were men (no PE/DVT 69.1% versus DVT 75.1% and PE 66%, $P = 0.011$), reported a longer length of hospital stay (no PE/DVT 6.34 days versus DVT 25.5 days and PE 21.8, $P = 0.000$), had a higher Elixhauser comorbidity index (no PE/DVT 2.25 versus DVT 3.03 and PE 4.00, $P = 0.000$), and were admitted on a nonelective basis (no PE/DVT 96.8% versus DVT 98.9% and PE 97.2%, $P = 0.004$). Age was not associated with a difference in DVT or PE (no PE/DVT 52.5 years versus DVT 51.8 years and PE 54.8 years, $P = 0.684$) nor was race (White: no PE/DVT 65.6% versus DVT 65.4% and PE 65.9%, $P = 0.809$). Insurance status showed statistically significant differences for DVT or PE (private insurance: no PE/DVT 26.4% versus DVT 33.5% and PE 35.2%, $P = 0.000$) (Table 2).

Chi-squared analysis of hospital characteristics showed that patients were more likely to have a DVT or PE if they were from a large hospital defined by the Healthcare Cost and Utilization Project database (no PE/DVT 65.9% versus DVT 71.8% and PE 71.5%, $P = 0.005$), the hospital was classified as being an urban/teaching hospital (no PE/DVT 83.8% versus DVT 87.8% and PE 89.0%, $P = 0.001$), the hospital was located in the western United States (no PE/DVT 22.4% versus DVT 30.0% and PE 24.1%, $P = 0.000$), and the hospital ownership being a government, nonfederal (public) hospital (no PE/DVT 19% versus DVT 21.5% and PE 21.0%, $P = 0.037$) (Table 3).

Patients with facial fractures had a greater Elixhauser comorbidity index (no PE/DVT 2.25 versus DVT 3.03 and PE 4.00, $P = 0.000$) (Table 3). Comorbidities were independently analyzed using logistic regression analysis. Odds ratios (ORs) greater than one for comorbidities were found to be associated with an increased risk of VTE. ORs less than one were found to be protective for PE/DVT (Table 4). Multivariate models were created to assess the independent impact of DVT and PE on mortality. DVT was not associated with increased mortality for 2016 [OR, 1.15; 95% confidence interval (CI), 0.72–1.83] and 2017 (OR, 1.15; 95% CI, 0.75–1.78). In contrast, PE was found to be associated with an increased risk of mortality in both 2016 (OR, 2.22; 95% CI, 1.27–3.89) and 2017 (OR, 2.07; 95% CI, 1.26–3.42) (Table 5). Location of fracture was broken down into three groups: cranial/frontal, orbital/midface, and mandible fractures. Cranial and frontal fractures were the only groups with an independent association of increase in PE (OR, 1.49; 95% CI, 1.04–2.13) and DVT (OR, 2.48; 95% CI, 2.00–3.07). Orbital/midface fractures were not associated with a PE (OR, 1.24; 95% CI, 0.19–1.75) or DVT (1.19; 95% CI, 0.96–1.47).

**Table 1. In-hospital Mortality Associated with DVT and PE in Patients with Facial Fractures**

| | No DVT/PE (%) | DVT (%) | *P* | PE | *P* |
|---|---|---|---|---|---|
| 2016 | 5.38 | 7.12 | 0.215 | 11.9 | 0.001 |
| 2017 | 5.37 | 6.96 | 0.186 | 10.98% | 0.001 |

Additionally, mandible fractures were not associated with a PE (OR, 1.01; 95% CI, 0.69–1.47) or DVT (OR, 0.97; 95% CI, 0.75–1.25) (Table 6). The results showed that patients with cranial and frontal fractures are at a higher risk for VTE.

Location of fracture (cranial/frontal, orbital and midfacial, and mandible) was further analyzed to examine the impact on three key study variables: length of stay, Elixhauser comorbidity index, and total charges. Results showed significant differences for the location subgroups in the three key study variables (Table 7). There was an increased length of stay, higher comorbidities, and greater total charges for each of the facial fracture subgroups. The results for the fracture region subgroups were consistent with the findings from the entire facial fracture group.

## DISCUSSION

This study identifies that the craniofacial trauma population is at significant risk for VTE. To the authors' knowledge, previous studies have yet to identify risk factors for VTE in the craniofacial trauma population. We found that there are significant differences for risk of VTE based on hospital characteristics that were defined in the NIS database. Bed size, location/teaching, region, and control/ownership all showed significant differences in the risk of VTE. However, individual patient characteristics did not show as many differences in risk of VTE. Only primary payer and sex showed differences, whereas age and race did not show any differences. Other studies utilizing the NIS database examining VTE complications found similar outcomes when looking at patient-specific demographics that were similar to the ones examined in this study for VTE.[21] These results highlight a need in the surgical community to identify specific reasons for disparities throughout basic patient demographics.

VTE in plastic surgery has a wide range of incidences when examined across different procedures.[11] This is due to the nature of the procedure being performed. Aesthetic procedures, in general, offer a very low risk of VTE.[14] Previous studies have suggested that the risk for VTE in plastic surgery patients falls between 1% and 2%.[11] As previously mentioned, craniofacial surgical patients were found to have a lower incidence postoperatively (0.55%) when compared with the craniofacial trauma population. Furthermore, studies have suggested that the incidence of VTE in cosmetic procedures is lower than 1%.[3] Risk stratification and prophylaxis should be treated at the same level for craniofacial fractures when compared with other similar plastic surgery procedures.

A notable finding in our study is the significant increase in mortality associated with VTE in craniofacial fractures. It is widely known that there is an increase in mortality with a VTE event, with certain studies suggesting that mortality from VTE occurs in 10%–30% of medical and surgical patients.[22–26] Of note, up to half of the patients with symptomatic proximal vein DVTs subsequently develop PEs.[1] Our study finds that there is significant in-patient mortality for the craniofacial population when a VTE occurs. However, there are discrepancies when comparing DVT to PE. We found that only PE was associated with a statistically significant increase in mortality, whereas DVT was

**Table 2. Baseline Characteristics in Patients with Facial Fractures**

| Characteristic | No PE/DVT | PE/DVT | DVT | PE | *P* |
|---|---|---|---|---|---|
| Age, y | 52.5 | 52.5 | 51.8 | 54.8 | 0.684 |
| Woman, % | 30.9 | 26.8 | 24.9 | 34.0 | 0.011 |
| Race, % | | | | | |
| White | 65.6 | 64.7 | 65.4 | 65.9 | 0.809 |
| Black | 14.7 | 16.0 | 15.7 | 16.1 | |
| Hispanic | 12.7 | 12.3 | 12.3 | 9.7 | |
| Asian or Pacific Islander | 2.2 | 2.8 | 2.3 | 3.6 | |
| Native American | 1.0 | 0.8 | 0.9 | 1.1 | |
| Other | 3.7 | 3.5 | 3.3 | 3.6 | |
| Insurance, % | | | | | |
| Medicare | 33.1 | 27.2 | 26.6 | 30.7 | 0.000 |
| Medicaid | 22.0 | 25.0 | 26.1 | 20.7 | |
| Private insurance | 26.4 | 34.0 | 33.5 | 35.2 | |
| Self-pay | 10.7 | 6.6 | 6.5 | 6.2 | |
| No charge | 0.8 | 0.5 | 0.2 | 1.0 | |
| Other | 7.0 | 6.7 | 7.2 | 6.2 | |
| Elixhauser comorbidity index, n | 2.25 | 3.25 | 3.03 | 4 | 0.000 |
| Nonelective, % | 96.8 | 98.5 | 98.9 | 97.2 | 0.004 |
| Length of stay, d | 6.34 | 24.6 | 25.5 | 21.8 | 0.000 |
| Total charges, dollars | 103,889 | 401,273 | 414,087 | 360,404 | 0.000 |

not associated with an increase in mortality. This is likely because not all patients with DVT develop a PE. Patients with facial fractures who developed a PE were two times more likely to die. We believe that this is due to the high mortality associated with the development of a PE.

Hospitalized patients with facial fractures are known to be at increased risk for prolonged hospital stays, reported by Allareddy et al[17] for an average of 6 days. Our study presents similar information where the length of stay was determined to be 6 days for patients without a VTE complication. However, when factoring in VTE, that length of stay increases four times to 24 days. This shows that the VTE significantly affects the time patients stay in the hospital, and further prevention is necessary to decrease a patient's length of stay.

Examining the results from the comorbidities draws comparisons to the current gold standard for determining VTE risk stratification in surgical patients, the 2005 Caprini Score.[11] The established scoring system gives out points for specific comorbidities and guides the necessary prophylaxis. Seruya et al[12] analyzed the scoring system for plastic surgery-related patients and determined that if a patient acquires over four points, they would be subjected to receive both mechanical (intermittent pneumatic compression devices) and chemical (once daily subcutaneous low-molecular weight heparin or enoxaparin) prophylaxis. Comorbidities that were examined in this study in addition to the 2005 Caprini Score include one point each for obesity (body mass index [BMI] > 25), age 40–60, chronic heart failure (CHF), and chronic pulmonary disease. Furthermore, age older than 60, and malignancy were given two points each, inherited and acquired coagulopathies were given three points each, and stroke and acute spinal cord injuries (paralysis) were given five points each.[27,28] Our study validates that certain comorbidities identified by the 2005 Caprini Scoring system are working to decrease the incidence of VTE. This is seen with a decrease in PE in patients with cardiac arrhythmias, CHF, and valvular heart disease as these patients are being appropriately anticoagulated. However, we found that coagulopathy was significant for an increased risk of DVT. This could point to the fact that coagulopathy alone is only three points in the scoring system, which

**Table 3. Hospital Characteristics Defined by the Healthcare Cost and Utilization Project with Associated Chi-square Analysis**

| Characteristic | No PE/DVT (n = 198,885) | DVT (n = 3350) | PE (n = 1455) | *P* |
|---|---|---|---|---|
| Bed size, % | | | | |
| Small | 9.4 | 6.4 | 8.6 | 0.005 |
| Medium | 24.8 | 21.8 | 19.9 | |
| Large | 65.9 | 71.8 | 71.5 | |
| Location/teaching, % | | | | |
| Rural | 2.9 | 1.2 | 1.7 | 0.001 |
| Urban nonteaching | 13.3 | 11.0 | 9.3 | |
| Urban teaching | 83.8 | 87.8 | 89.0 | |
| Region of hospital, % | | | | |
| Northeast | 18.7 | 13.6 | 14.4 | 0.000 |
| Midwest | 20.5 | 20.0 | 21.0 | |
| South | 38.4 | 36.4 | 40.5 | |
| West | 22.4 | 30.0 | 40.5 | |
| Control/ownership of hospital, % | | | | |
| Government, nonfederal (public) | 19.0 | 21.5 | 21.0 | 0.037 |
| Private, not-for-profit (voluntary) | 69.1 | 69.7 | 69.1 | |
| Private, investor-owned (proprietary) | 11.9 | 8.8 | 10.0 | |

**Table 4. List of Comorbidities Defined by the Agency for Healthcare Research and Quality in the National Inpatient Sample with Associated Independent Impact on DVT/PE**

| | DVT | | PE | |
|---|---|---|---|---|
| Comorbidities | OR (95% CI) | *P* | OR (95% CI) | *P* |
| CHF | 0.856 (0.583-1.256) | 0.426 | 0.150 (0.068-0.429) | 0.000 |
| Cardiac arrhythmias | 1.248 (1.009-1.543) | 0.041 | 0.182 (0.059-0.421) | 0.000 |
| Valvular disease | 0.606 (0.384-0.955) | 0.031 | 0.075 (0.050-0.288) | 0.000 |
| Pulmonary circulation disorders | 7.554 (5.532-10.317) | 0.000 | * | * |
| Peripheral vascular disorders | 0.773 (0.483-1.235) | 0.281 | 0.427 (0.336-1.867) | 0.763 |
| Hypertension, uncomplicated | 0.751 (0.612-0.923) | 0.007 | 0.299 (0.099-0.698) | 0.000 |
| Paralysis | 3.757 (2.794-5.053) | 0.000 | 0.485 (0.298-1.736) | 0.791 |
| Other neurological disorders | 1.453 (1.190-1.774) | 0.000 | 0.752 (0.287-1.920) | 0.442 |
| Chronic pulmonary disease | 0.770 (0.589-1.008) | 0.058 | 0.190 (0.087-0.548) | 0.000 |
| Diabetes, uncomplicated | 0.643 (0.446-0.928) | 0.018 | 0.405 (0.229-1.359) | 0.333 |
| Diabetes, complicated | 0.719 (0.497-1.041) | 0.081 | 0.209 (0.187-1.023) | 0.057 |
| Hypothyroidism | 0.492 (0.327-0.740) | 0.001 | 0.385 (0.247-1.425) | 0.369 |
| Renal failure | 0.550 (0.334-0.906) | 0.019 | 0.141 (0.131-0.714) | 0.006 |
| Liver disease | 0.747 (0.472-1.181) | 0.211 | 0.214 (0.295-1.571) | 0.284 |
| Peptic ulcer disease excluding bleeding | 1.338 (0.464-3.851) | 0.590 | 0.660 (5.635-42.588) | 0.117 |
| AIDS/HIV | 0.840 (0.205-3.447) | 0.809 | † | † |
| Lymphoma | 0.999 (0.219-4.559) | 0.999 | † | † |
| Metastatic cancer | 1.452 (0.705-2.991) | 0.312 | 0.902 (3.824-23.467) | 0.066 |
| Solid tumor without metastasis | 0.893 (0.473-1.688) | 0.728 | 0.164 (0.664-4.033) | 0.801 |
| Rheumatoid arthritis/collagen vascular | 0.842 (0.393–1.807) | 0.660 | 0.182 (0.302-1.619) | 0.273 |
| Coagulopathy | 1.527 (1.182-1.972) | 0.001 | 0.964 (0.443–2.784) | 0.068 |
| Obesity | 1.440 (1.034-2.005) | 0.031 | 0.605 (0.381-2.206) | 0.663 |
| Weight loss | 2.243 (1.777-2.832) | 0.000 | 0.729 (0.358-2.207) | 0.400 |
| Fluid and electrolyte disorders | 2.954 (2.482-3.516) | 0.000 | 0.706 (0.203-1.523) | 0.854 |
| Blood loss anemia | 1.443 (0.666-3.125) | 0.352 | 0.260 (2.274-17.344) | 0.483 |
| Deficiency anemia | 0.664 (0.370-1.191) | 0.169 | 0.244 (0.237-1.284) | 0.171 |
| Alcohol abuse | 0.631 (0.499-0.799) | 0.000 | 0.769 (0.373-2.306) | 0.306 |
| Drug abuse | 0.793 (0.604-1.041) | 0.095 | 0.761 (0.945-5.046) | 0.163 |
| Psychoses | 0.662 (0.353-1.242) | 0.198 | 0.136 (0.371-2.089) | 0.366 |
| Depression | 0.730 (0.546-0.974) | 0.033 | 0.690 (0.315-1.985) | 0.560 |
| Hypertension, complicated | 1.330 (0.852-2.079) | 0.210 | 0.271 (0.214-1.190) | 0.134 |

*Data points were omitted due to colinearity within the data point.
†Data points were omitted due to a low incidence within the population.

**Table 5. Independent Impact of DVT and PE on In-hospital Mortality**

| Outcome | Year | Complication | OR/B Coefficient | 95% CI | *P* |
|---|---|---|---|---|---|
| Mortality | 2016 | DVT | 1.1492 | 0.7246–1.8227 | 0.554 |
| | | PE | 2.2225 | 1.2694–3.8911 | 0.005 |
| | 2017 | DVT | 1.1539 | 0.7492–1.7773 | 0.516 |
| | | PE | 2.0733 | 1.2578–3.4173 | 0.004 |

would warrant the patient to not receive chemoprophylaxis with enoxaparin or a similar drug, possibly leading to the increase in risk for VTE. Additionally, obesity, which is given only one point in the 2005 Caprini Score, follows the same pattern as coagulopathies where it is significantly associated with an increased risk of DVT in our study. Risk factors included in this study that are also part of the 2005 Caprini Score that showed no increase in risk of VTE are malignancy, age, CHF, and chronic pulmonary disease. Due to no increased risk of VTE, the Caprini Score is sufficient in protecting patients with those risk factors. We are suggesting that, although the 2005 Caprini Scoring System is working and proving to be effective in decreasing VTE risk in certain populations, a more rigorous analysis of certain comorbidities in the scoring system should be in place for the craniofacial trauma population due to these newly found data.

**Table 6. Independent Association of PE and DVT by Location of Fracture**

| Location | Complication | OR (95% CI) | *P* |
|---|---|---|---|
| Cranial/frontal | PE | 1.489156 (1.040579-2.131106) | 0.029 |
| | DVT | 2.480771 (2.004381-3.070388) | 0.000 |
| Orbital/Mid-face | PE | 1.242591 (0.18811325-1.752327) | 0.216 |
| | DVT | 1.186179 (0.9573602-1.469689) | 0.118 |
| Mandible | PE | 1.008421 (0.6913614-1.470886) | 0.965 |
| | DVT | 0.9670991 (0.7496165-1.247679) | 0.797 |

**Table 7. Location of Fracture and Highlighted Outcomes with Their Association of PE/DVT**

| Characteristic | Cranial/Frontal | | | Orbital and Midface | | | Mandible | | |
|---|---|---|---|---|---|---|---|---|---|
| | No PE/DVT | PE/DVT | *P* | No PE/DVT | PE/DVT | *P* | No PE/DVT | PE/DVT | *P* |
| Length of stay, d | 7.55 | 27.8 | 0.00 | 5.96 | 21.8 | 0.00 | 5.41 | 20.4 | 0.00 |
| Elixhauser comorbidity index, n | 2.19 | 3.42 | 0.00 | 2.48 | 3.41 | 0.00 | 1.71 | 3.00 | 0.00 |
| Total charges, dollars | 123,080 | 421,177 | 0.00 | 93,290 | 359,209 | 0.00 | 98,432 | 380,419 | 0.00 |

In light of this new evidence, we are suggesting the following risk satisfaction tool for the craniofacial fracture population with in-patient hospital stays (Table 8). Please note that all ambulatory patients with length of stay less than 24 hours do not require any chemoprophylaxis. Additionally, all patients with traumatic brain injuries and other brain injuries should follow the modified Berne-Norwood criteria. Postoperative patients should be evaluated using the well-established 2005 Caprini Score.[27] This updated guideline is based off the recommendations from the American Association for the Surgery of Trauma/American College of Surgeons-Committee on Trauma Clinical Protocol.[29]

In the current environment of value-based medicine, there is an increased focus on optimizing clinical outcomes, while reducing health care costs.[30,31] Physicians and the health care industry have been examining methods for controlling these costs within the plastic surgery community.[32,33] Research in hand surgery and wound management has outlined strategies for evaluating quality in their respective fields within plastic surgery.[34,35] Our study reports that the burden of health care costs for patients diagnosed with VTE exceeds $250,000 in total charges for hospitalized patients with facial fractures. Independently, both DVT and PE were associated with a shorter hospital stay. The added charges related to hospitalization associated with VTE are likely due to increased hospital stay and added management of the condition. Given these vast increases, developing and implementing proper VTE prophylactic strategies is critical to reducing the financial burden on patients and the health care system.

**Table 8. Recommendations for VTE Prophylaxis for Facial Fracture Trauma Patients Based off of the American Association for the Surgery of Trauma/American College of Surgeons-Committee on Trauma Clinical Protocol**

| VTE Prophylaxis for Facial Fracture Trauma Patients | |
|---|---|
| **All Patients Receive Enoxaparin 40-mg BID once Hemodynamically Stable Unless** | |
| Enoxaparin 30-mg BID | Age >65<br>CrCl between 30 and 60 ml/min<br>Pregnant |
| Enoxaparin 0.5-mg/kg BID | BMI > 30 |
| 5000 U heparin q8 h | CrCl < 30 ml/min and BMI < 30 |
| 75,000 U heparin q8 h | CrCl < 30 ml/min and BMI > 30 |

Fully ambulatory patients with expected LOS less than 24 hours do not require chemoprophylaxis

For patients with associated traumatic brain injuries, please refer to the modified Berne-Norwood criteria.[29]

For patients with active bleeding, only mechanical prophylaxis is recommended.

BDI, twice per day; BMI, body mass index; CrCl, creatinine clearance; LOS, length of stay.

Several limitations exist in the context of this study. First, the analyses were based on data collected from the NIS database and, therefore, are subject to limitations due to the retrospective nature of this study. Second, the results are subject to certain biases in coding because of the use of diagnostic and procedural codes used to identify and characterize specific individuals. To limit these biases, we used publicly available resources for characterizing the data, mainly the Elixhauser comorbidity analysis that is available for use online. The NIS database does not supply any available information pertaining to medications, laboratory values, and measures taken for VTE prophylaxis, whether that be ambulation, mechanical prophylaxis, and/or usage of low-molecular weight heparin and other alternatives. Additionally, facial fractures often occur in the presence of trauma, and the cause of mortality is not identified. Patients with polytrauma and multiple fractures were unable to be isolated from the dataset. Postoperative conditions were unable to be characterized due to the lack of billing codes associated. Steps were taken to minimize this, such as only using primary encounters for facial fractures, but this does not tell the whole picture when discussing facial fractures. Finally, there were no data on readmissions and VTE that occurred after discharge.

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