Association of Bleeding Disorders and Risk of Complications Following Open Reduction and Internal Fixation of the Ankle

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Abstract

Background: Open reduction and internal fixation (ORIF) of the ankle is a common procedure performed to correct ankle fractures in many different patient populations. Diabetes, peripheral vascular disease, and osteoporosis have been identified as risk factors for postoperative complications following surgery for ankle fractures. To date, there have not been any studies evaluating postoperative outcomes in patients with bleeding disorders undergoing operative treatment for ankle fractures. The aim of this study was to determine the postoperative complication rate following ORIF of the ankle in patients with a bleeding disorder vs those without a bleeding disorder.

Methods: From 2006 to 2018, patients undergoing operative treatment for ankle fracture were identified in the National Surgical Quality Improvement Program database. Two patient cohorts were defined: patients with a bleeding disorder and patients without a bleeding disorder. Patients who underwent either inpatient or outpatient ORIF of the ankle were included in this study. In this analysis, demographics, medical comorbidities, and postoperative complications variables were assessed between the 2 cohorts. Bivariate and multivariate analyses were performed.

Results: Of 10,306 patients undergoing operative treatment for ankle fracture, 9,909 patients (96.1%) had no bleeding disorder whereas 397 patients (3.9%) had a bleeding disorder. Following adjustment on multivariate analysis, compared to patients who did not have a bleeding disorder, those with a bleeding disorder had an increased risk of any postoperative complications (odds ratio [OR] 1.48, 95% confidence interval [CI] 1.05-2.08, P = .024), requirement for postoperative blood transfusion (OR 2.86, 95% CI 1.53-5.36, P = .001), and extended length of hospital stay greater than 5 days (OR 1.46, 95% CI 1.10-1.93, P = .010).

Conclusion: Patients with bleeding disorders are associated with increased risk of postoperative complications following ORIF for ankle fractures. Determining patient risk factors and creating optimal preoperative and perioperative management plans in patients with bleeding disorders undergoing ORIF can be beneficial in reducing postoperative complications, improving patient outcomes, and reducing overall morbidity.

Level of Evidence: Level III, retrospective cohort study.

Keywords: ankle fracture, open reduction internal fixation, bleeding disorder, complications

Introduction

Ankle fractures are a common injury among young, active individuals who sustain high-energy trauma as well as elderly individuals who often have comorbidities that place them at increased risk of fracture.13,18 Open reduction and internal fixation (ORIF) of the ankle is frequently the procedure of choice when operative management is indicated.17 Prior studies have found that patients with comorbidities such as diabetes, peripheral neuropathy, and osteoporosis were at an increased risk for postoperative complications and worse functional outcomes following ORIF.20,32 Age, body mass index (BMI), and history of smoking were also identified as risk factors associated with a higher rate of complications.7 Common complications following ORIF include surgical site infections and thromboembolic events.4,52
Bleeding disorders have been previously found to be a risk factor for higher complication rates in certain orthopaedic procedures. One study investigating outcomes following total hip arthroplasty in patients with hemophilia found an increased rate of complications including infection and aseptic loosening. A longitudinal study following total hip arthroplasty in patients with hemophilia without a bleeding disorder.

Measures such as determining preoperative platelet counts, working with the patient’s primary care clinician to determine safe platelet levels, adjusting the patient’s current medications, and constructing a team with experience of operating on patients with bleeding disorders can ensure greater procedural success. During the operation, the patient’s blood volume should be maintained, and the patient’s care team should be prepared to administer coagulation factors or antifibrinolytic agents as necessary. Following the operation, the patient should be closely monitored for any unexpected hemostatic changes.

Although outcomes in patients with bleeding disorders following total hip replacement and total knee replacement have been previously studied, to this date, complications following ORIF for ankle fractures in patients with bleeding disorders have not been investigated. Our hypothesis was that patients with bleeding disorders undergoing ORIF of the ankle, in an inpatient or outpatient setting, would have more postoperative complications. Specifically, we hypothesized that this patient population would require more postoperative blood transfusions compared to patients without a bleeding disorder.

Materials and Methods

All patients who underwent ORIF for ankle fracture were identified through the utilization of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database. NSQIP is a large multicenter registry that includes data, such as preoperative, demographic, comorbidity, and postoperative data, from more than 750 hospitals. Trained surgical clinical reviewers at each participating institution enter data into this database. Many prior studies have demonstrated high interrater reliability with data collection using this database, with agreement rates higher than 98%. Over the years, this national database has been widely used in orthopaedic operative procedures to track the clinical course of individual patients.

Patient Selection

To identify patients who underwent ORIF for ankle fracture from the years 2006 to 2018, Current Procedural Terminology (CPT) codes 27766, 27792, 27814, 27822, and 27823 and International Classification of Diseases, Ninth Revision and Tenth Revision (ICD-9 and ICD-10) codes for common complications were used. Both open and closed ankle fractures were included in this study. Fracture of the medial malleolus, lateral malleolus, bimalleolar fracture, and trimalleolar fractures were included. In this study, patients were excluded if they had missing data, such as if their gender and race were unknown. Two patient groups were stratified in this study: patients who had a bleeding disorder and patients without a bleeding disorder. Bleeding disorder was defined as any patient with a chronic, persistent, active condition that places the patient at risk for excessive bleeding. This includes patients who have an underlying hematologic disorder, such as vitamin K deficiency, hemophilia, and thrombocytopenia. Bleeding disorder patients who are included in this study have a diagnosis of a hematologic disorder in their medical records and the condition is active at the time of their surgery. Patients with active heparin-induced thrombocytopenia, a past medical history of thrombocytopenia, a low platelet count at the time of surgery, and Von Willebrand disease are also included in this patient population. Patients who are on chronic anticoagulation therapy (anticoagulants, antiplatelet agents other than aspirin, thrombin inhibitors) that have not been discontinued prior to surgery are also classified as having a bleeding disorder. Patients on chronic aspirin therapy or nonsteroidal anti-inflammatory drugs are not classified as having a bleeding disorder. Also, patients who were administered a 1-time prophylactic dose of anticoagulants before surgery are not included in this group of patients. More information regarding the inclusion and exclusion criteria of patients with bleeding disorders can be found as supplemental material (Supplementary Material S1).

Patient Characteristics

Patients’ demographic and clinical characteristic data collected from the database included gender, race, American
Society of Anesthesiologists (ASA) classification, smoking status, functional status, age, and BMI. Patient medical comorbidities and intraoperative variables included congestive heart failure, chronic obstructive pulmonary disease, hypertension, dialysis requirement, renal failure, weight loss in the past 6 months, chronic steroid usage, diabetes mellitus status, dyspnea, and type of anesthesia used during the operative procedure.

**Postoperative Outcomes**

Based on previous literature, major complications (cardiac arrest, pulmonary embolism, intubation, myocardial infarction, sepsis, septic shock, renal failure, and/or mortality) and minor complications (urinary tract infection, deep vein thrombosis, pneumonia, superficial surgical site infection, and/or deep surgical site infection) were categorized.\(^6,15\) Thirty-day postoperative outcomes were also classified into clinically relevant domains. These domains included wound (superficial surgical site infection, deep surgical site infection, organ or space infections, and/or wound disruption), cardiac (cardiac arrest and/or myocardial infarction), pulmonary (pneumonia, reintubation, and/or failure to wean off ventilator for more than 48 hours), renal (renal failure and/or renal insufficiency), thromboembolic (deep vein thrombosis, pulmonary embolism, and/or stroke), and sepsis (sepsis and/or septic shock). Postoperative transfusion, extended length of hospital stay, reoperation, and readmission were further collected from the database. Based on existing literature, extended length of stay was defined as greater than 5 days.\(^11\)

**Statistical Analysis**

Statistical analyses were performed using the Statistical Package for the Social Sciences (version 26; IBM, Armonk, NY) software. Patient demographics, comorbidities, and postoperative complications data were analyzed with bivariate analysis using Pearson chi-squared test and analysis of variance. Demographic and comorbidity variables were included in the multivariate analyses for P values less than .20 to identify the independent risk factors for postoperative complications.\(^6,27\) Postoperative complication variables with a P value < .05 were selected for multivariate analyses. A P value < .05 was the cut-off value for statistical significance in this study.

**Results**

**Demographics**

Overall, 10306 patients underwent ORIF for ankle fracture and were included in the analysis after the exclusion criteria was applied. A total of 9909 patients (96.1%) did not have a bleeding disorder whereas 397 patients (3.9%) had a bleeding disorder. Compared to patients who did not have a bleeding disorder, those with a bleeding disorder were more likely to be older (66.3 vs 50.1 years; \(P < .001\)), white (85.6% vs 73.4%; \(P < .001\)), have a higher BMI (33.3 vs 30.8; \(P < .001\)), and have an ASA classification of III (66.2% vs 25.7%; \(P < .001\)). On the other hand, patients without a bleeding disorder were more likely to be a smoker (26.5% vs 19.4%; \(P = .002\)) and more likely to have an independent functional status (95.1% vs 84.7%; \(P < .001\)) (Table 1).

**Comorbidities**

Relative to patients without a bleeding disorder, patients who had a bleeding disorder were more likely to have comorbidities, including congestive heart failure (2.8% vs 0.4%; \(P < .001\)), chronic obstructive pulmonary disease (8.8% vs 3.2%; \(P < .001\)), hypertension (73.8% vs 34.3%; \(P < .001\)), requirement for dialysis (2.5% vs 0.6%; \(P < .001\)), renal failure (1.5% vs 0.2%; \(P < .001\)), and requirement for steroid use (3.5% vs 1.7%; \(P = .005\)). On the other hand, patients without a bleeding disorder were more likely to be nondiabetic (88.0% vs 63.7%; \(P < .001\)), have no dyspnea (96.7% vs 90.7%; \(P < .001\)), and have undergone neuraxial anesthesia (8.3% vs 5.8%; \(P = .016\)) (Table 2).

**Complications**

On bivariate analysis, following ORIF for ankle fracture, compared to patients who did not have a bleeding disorder, those with a bleeding disorder were more likely to develop any thirty-day postoperative complications (13.1% vs 3.8%; \(P < .001\)), including major complications (2.0% vs 1.0%; \(P = .505\)), minor complications (6.5% vs 2.4%; \(P < .001\)), wound complications (2.5% vs 1.3%; \(P = .031\)), pulmonary problems (2.3% vs 0.4%; \(P < .001\)), renal complications (0.5% vs 0.1%; \(P = .013\)), sepsis complications (1.0% vs 0.3%; \(P = .016\)), postoperative transfusion (4.5% vs 0.5%; \(P < .001\)), extended length of hospital stay greater than 5 days (22.2% vs 5.6%; \(P < .001\)), and hospital readmission (6.8% vs 2.6%; \(P < .001\)). There was no difference in thromboembolic complications between the 2 cohorts (\(P = .400\)) (Table 3). Within the major complications, patients with a bleeding disorder were more likely to require unplanned reintubation (1.0% vs 0.2%; \(P < .001\)) and develop septic shock (0.5% vs 0.0%; \(P < .001\)) (Table 4). Within the minor complications, patients with a bleeding disorder were more likely to develop urinary tract infections (2.8% vs 0.8%; \(P < .001\)) and pneumonia (1.6% vs 0.2%; \(P < .001\)) (Table 5).

Following adjustment on multivariate analysis to control for demographics and comorbidities, relative to patients who did not have a bleeding disorder, those with a bleeding
disorder had an increased risk of any postoperative complications (odds ratio [OR] 1.479, 95% confidence interval [CI] 1.052-2.080; \( P = .024 \)), requirement for postoperative blood transfusion (OR 2.863, 95% CI 1.528-5.364; \( P \leq .001 \)), and extended length of stay more than 5 days (OR 1.455, 95% CI 1.096-1.932; \( P = .010 \)) (Tables 6 and 7).

### Table 1. Demographics and Clinical Characteristics Among Patients Undergoing Operative Treatment of Ankle Fracture.\(^a\)

| Demographics                        | No Bleeding Disorder (n = 9909) | Yes, Bleeding Disorder (n = 397) | \( P \) Value |
|-------------------------------------|---------------------------------|----------------------------------|---------------|
| Sex, n (%)                          |                                 |                                  | .256\(^b\)    |
| Female                              | 6034 (60.9)                     | 253 (63.7)                       |               |
| Male                                | 3875 (39.1)                     | 144 (36.3)                       |               |
| Ethnicity, n (%)                    |                                 |                                  | <.001\(^b\)   |
| White                               | 7271 (73.4)                     | 340 (85.6)                       |               |
| Black or African American           | 1200 (12.1)                     | 32 (8.1)                         |               |
| Hispanic                            | 1024 (10.3)                     | 18 (4.5)                         |               |
| American Indian or Alaska Native    | 110 (1.1)                       | 4 (1.0)                          |               |
| Asian                               | 245 (2.5)                       | 3 (0.8)                          |               |
| Native Hawaiian or Pacific Islander | 59 (0.6)                        | 0 (0.0)                          |               |
| ASA, n (%)                          |                                 |                                  | <.001\(^b\)   |
| I                                   | 1762 (17.8)                     | 7 (1.8)                          |               |
| II                                  | 5375 (54.3)                     | 66 (16.7)                        |               |
| III                                 | 2543 (25.7)                     | 262 (66.2)                       |               |
| IV                                  | 215 (2.2)                       | 61 (15.4)                        |               |
| V                                   | 2 (0.0)                         | 0 (0.0)                          |               |
| Smoker, n (%)                       |                                 |                                  | .002\(^b\)    |
| Independent                         | 9316 (95.1)                     | 333 (84.7)                       |               |
| Partially dependent                 | 460 (4.7)                       | 57 (14.5)                        |               |
| Totally dependent                   | 25 (0.3)                        | 3 (0.8)                          |               |
| Age, y, mean (SD)                   | 50.08 (17.73)                   | 66.29 (13.90)                    | <.001\(^c\)   |
| BMI, mean (SD)                      | 30.83 (7.25)                    | 33.33 (8.79)                     | <.001\(^c\)   |

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index.

\(^a\)Bolding equals significance, \( P < .05 \).

\(^b\)Pearson chi-square test.

\(^c\)Analysis of variance.

Discussion

Our study showed that patients with bleeding disorders were older, had a higher BMI, and were more likely to have comorbidities. Several prior studies investigating postoperative complications of ORIF among the general population found correlations between age, BMI, and various comorbidities with increased complication rate.\(^{7,12,32}\) Specifically, diabetes has been associated with higher complication rates including delayed bone healing, increased wound complications, and increased infection rates.\(^{20}\) Mehta et al\(^{18}\) reports an infection rate as high as 60% in diabetes patients undergoing ORIF. Patients with bleeding disorders in our study were not more likely to have diabetes, but were more likely to have other comorbidities compared to patients without bleeding disorders.

After controlling for demographics and comorbidities, bleeding disorders were found to be an independent risk factor for increased risk for any postoperative complications occurring within 30 days of ankle ORIF. This finding supported our initial hypothesis of patients with bleeding disorders having an increased risk of postoperative complications following ORIF compared to patients without a bleeding disorder. This is similar to the findings of a study done by Anderson et al that investigated complications following total hip and total knee replacements in patients with inherited bleeding disorders. These patients were found to have a higher rate of postoperative complications and less favorable outcomes compared to patients without bleeding disorders. This study also found that although the complication rate was increased, patients with bleeding disorders did not have an increased requirement for blood transfusion, whereas our study indicated that patients with bleeding disorders did have an increased transfusion requirement compared to those without bleeding disorders. This finding supported our additional hypothesis of patients with bleeding disorders requiring more blood transfusions. Anderson et al\(^{11}\) also showed that patients with inherited bleeding disorders experienced a reduction in pain similar to patients...
without bleeding disorders and had comparable patient satisfaction responses. Because of the limitations of the database used in our study, we did not have access to variables such as patient pain levels and satisfaction scores. Considering the increased rate of postoperative complications among patients with bleeding disorders following ORIF, measures should be taken to reduce the rate of complications and improve patient outcomes overall. By

**Table 2.** Comorbidities and Intraoperative Variables Among Patients Undergoing Operative Treatment of Ankle Fracture.

| Comorbidities                   | No Bleeding Disorder, n (%) | Yes, Bleeding Disorder, n (%) | P Valueb |
|---------------------------------|-----------------------------|-------------------------------|----------|
|                                 | (n = 9909)                  | (n = 397)                     |          |
| CHF                             | 44 (0.4)                    | 11 (2.8)                     | <.001    |
| COPD                            | 320 (3.2)                   | 35 (8.8)                     | <.001    |
| Hypertension                    | 3396 (34.3)                 | 293 (73.8)                   | <.001    |
| Dialysis                        | 63 (0.6)                    | 10 (2.5)                     | <.001    |
| Renal failure                   | 16 (0.2)                    | 6 (1.5)                      | <.001    |
| Weight loss                     | 9 (0.1)                     | 1 (0.3)                      | .312     |
| Steroid use                     | 164 (1.7)                   | 14 (3.5)                     | .005     |
| DM status                       |                             |                              | <.001    |
| No DM                           | 8721 (88.0)                 | 253 (63.7)                   |          |
| Noninsulin-dependent DM         | 669 (6.8)                   | 67 (16.9)                    |          |
| Insulin-dependent DM            | 518 (5.2)                   | 77 (19.4)                    |          |
| Dyspnea                         |                             |                              | <.001    |
| No dyspnea                      | 9580 (96.7)                 | 360 (90.7)                   |          |
| Moderate exertion               | 300 (3.0)                   | 33 (8.3)                     |          |
| At rest                         | 28 (0.3)                    | 4 (1.0)                      |          |
| Anesthesia type                 |                             |                              | .016     |
| General                         | 8749 (88.3)                 | 351 (88.4)                   |          |
| Neuraxial                       | 825 (8.3)                   | 23 (5.8)                     |          |
| Regional                        | 114 (1.2)                   | 12 (3.0)                     |          |
| MAC                             | 209 (2.1)                   | 10 (2.5)                     |          |

Abbreviations: CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; MAC, monitored anesthetic care.

*Bolding equals significance, P < .05.

*Pearson chi-square test.

**Table 3.** Bivariate Analysis of Postoperative Outcomes of Patients Following Operative Treatment of Ankle Fracture.

| Complications                        | No Bleeding Disorder, n (%) | Yes, Bleeding Disorder, n (%) | P Valueb |
|--------------------------------------|-----------------------------|-------------------------------|----------|
|                                     | (n = 9909)                  | (n = 397)                     |          |
| Any complication                     | 372 (3.8)                   | 52 (13.1)                    | <.001    |
| Major complicationc                  | 121 (1.2)                   | 11 (2.7)                     | .050     |
| Minor complicationd                  | 246 (2.5)                   | 25 (6.5)                     | <.001    |
| Wound complication                   | 125 (1.3)                   | 10 (2.5)                     | .031     |
| Cardiac complication                 | 14 (0.1)                    | 2 (0.5)                      | .072     |
| Pulmonary complication               | 43 (0.4)                    | 9 (2.3)                      | <.001    |
| Renal complication                   | 9 (0.1)                     | 2 (0.5)                      | .013     |
| Thromboembolic complication          | 65 (0.7)                    | 4 (1.0)                      | .400     |
| Sepsis complication                  | 30 (0.3)                    | 4 (1.0)                      | .016     |
| Postoperative transfusion            | 51 (0.5)                    | 18 (4.5)                     | <.001    |
| Extended length of stay >5 d        | 559 (5.6)                   | 88 (22.2)                    | <.001    |
| Reoperation                          | 153 (1.5)                   | 10 (2.5)                     | .128     |
| Readmission                          | 189 (2.6)                   | 20 (6.8)                     | <.001    |

*Bolding equals significance, P < .05.

*Pearson chi-square test.

*cIncludes cardiac arrest, pulmonary embolism, myocardial infarction, unplanned intubation, sepsis, septic shock, acute renal failure, or mortality.

*dIncludes urinary tract infection, pneumonia, deep venous thrombosis, superficial surgical site infection, or deep surgical site infection.
reducing the risk of postoperative complications, the requirement for postoperative transfusions and the length of hospital stay could be decreased. This can further lead to lower cost for both the patient and the health care system.17,19 One way this can be done is to minimize the impact of patient comorbidities on postoperative complications. Malik et al17 discuss the need to optimize modifiable patient comorbidities in cases of elective ORIF and adjust cost of the procedure on an individual level based on the presence

Table 4. Bivariate Analysis of Major Complications Following Operative Treatment of Ankle Fracture.

| Major Complications | No Bleeding Disorder, n (%) | Yes, Bleeding Disorder, n (%) | P Valueb |
|---------------------|-----------------------------|-------------------------------|----------|
|                     | (n = 9909)                  | (n = 397)                     |          |
| Cardiac arrest      | 6 (0.1)                     | 1 (0.3)                       | .151     |
| Pulmonary embolism  | 28 (0.3)                    | 0 (0.0)                       | .289     |
| Myocardial infarction | 8 (0.1)                 | 1 (0.3)                       | .312     |
| Unplanned reintubation | 19 (0.2)               | 4 (1.0)                       | <.001    |
| Sepsis              | 26 (0.3)                     | 2 (0.5)                       | .069     |
| Septic shock        | 4 (0.0)                      | 2 (0.5)                       | <.001    |
| Acute renal failure | 5 (0.1)                      | 1 (0.3)                       | .103     |
| Mortality           | 25 (0.3)                     | 0 (0.0)                       | .316     |

*aBolding equals significance, P < .05.

*bPearson chi-square test.

Table 5. Bivariate Analysis of Minor Complications Following Operative Treatment of Ankle Fracture.

| Minor Complications | No Bleeding Disorder, n (%) | Yes, Bleeding Disorder, n (%) | P Valueb |
|---------------------|-----------------------------|-------------------------------|----------|
|                     | (n = 9909)                  | (n = 397)                     |          |
| Urinary tract infection | 81 (0.8)                   | 11 (2.8)                      | <.001    |
| Pneumonia           | 24 (0.2)                     | 5 (1.6)                       | <.001    |
| Deep venous thrombosis | 41 (0.4)                  | 4 (1.0)                       | .078     |
| Superficial surgical site infection | 69 (0.7)   | 2 (0.5)                       | .649     |
| Deep surgical site infection | 31 (0.3)    | 3 (0.8)                       | .131     |

*aBolding equals significance, P < .05.

*bPearson chi-square test.

Table 6. Multivariate Analysis of Postoperative Outcomes of Patients Following Operative Treatment of Ankle Fracture.

| Complications | P Value | Odds Ratio (Yes, Bleeding Disorder/No Bleeding Disorder) (95% CI) |
|---------------|---------|---------------------------------------------------------------|
| Any complication                      | .024    | 1.479 (1.052-2.080)                                           |
| Major complicationb                  | .267    | 0.649 (0.302-1.393)                                           |
| Minor complicationc                  | .200    | 1.339 (0.857-2.092)                                           |
| Wound complication                  | .698    | 1.147 (0.574-2.293)                                           |
| Pulmonary complication               | .207    | 1.654 (0.756-3.618)                                           |
| Renal complication                  | .880    | 1.145 (0.196-6.685)                                           |
| Sepsis complication                 | .698    | 1.249 (0.406-3.839)                                           |
| Postoperative transfusion            | .001    | 2.863 (1.528-5.364)                                           |
| Extended length of stay >5 d        | .010    | 1.455 (1.096-1.932)                                           |
| Readmission                          | .326    | 1.296 (0.772-2.176)                                           |

*Abbreviation: CI, confidence interval.

*bBolding equals significance, P < .05.

*bIncludes cardiac arrest, pulmonary embolism, myocardial infarction, unplanned intubation, sepsis, septic shock, acute renal failure, or mortality.

*cIncludes urinary tract infection, pneumonia, deep venous thrombosis, superficial surgical site infection, or deep surgical site infection.
and absence of certain comorbidities. Another method to reduce the rate of complications is to improve preoperative and perioperative management for patients with bleeding disorders. This can be achieved by establishing a multidisciplinary care team which includes a hematologist in addition to an orthopaedic surgeon and anesthesiologist. Young et al\(^3\)\(^1\) discuss various primary and secondary hemostasis disorders and provide an outline of the main goals of management during operative procedures in this patient population. Many of these goals focus on maintaining a proper level of platelets and blood clotting factors throughout the procedure. Badulescu et al\(^2\) specifically focused on management of patients with hemophilia A and B undergoing total arthroplasty and state that recombinant coagulation factor VIII and/or an antifibrinolytic should be used during surgery. To maximize use of intraoperative hemolytic management, patients undergoing ORIF who need additional joint surgery could be candidates to address all operative treatments under 1 anesthetic. Feng et al\(^10\) found no difference in hematologic complications or total complications following multiple joint procedures under 1 anesthetic compared to a single joint procedure in patients with hemophilia. This could be an option for patients with bleeding disorders who would like to minimize the additive effect of postoperative complications following individual joint operations.

Several studies have found an association between outpatient ankle surgery and lower postoperative complications.\(^22,24\) Qin et al\(^22\) found a lower rate of UTIs, pneumonia, venous thromboembolic events, and bleeding requiring transfusion in patients undergoing ORIF in an outpatient setting compared with those in an inpatient setting. In a study done by Shen et al,\(^24\) inpatient ORIF patients were found to have an increased rate of any complication (4%) compared with outpatient ORIF procedures (2%), including both major and minor complications. These studies are limited by the potential for selection and availability bias. However, based on the increased risk of any 30-day postoperative complications, patients with bleeding disorders may benefit from inpatient ORIF of the ankle to better manage any perioperative or immediate postoperative complications.

Future prospective well-controlled studies should evaluate outcomes data of inpatient vs outpatient ORIF of the ankle in this patient population to make more evidence-based recommendations about the safety of outpatient procedures in patients with bleeding disorders.

Aside from increasing complications after ORIF for ankle fractures, patients with hemophilia are also at an increased risk of hemophilic arthropathy.\(^16\) The ankle is among one of the most common joints, along with the knee, elbow, and hip, to be affected by hemophilic arthropathy. Recurrent intraarticular bleeding in the ankle can predispose patients to developing osteoarthritis, which could require future operative intervention.\(^3\)

There are several limitations of this study. Many of the limitations are related to the nature of the database. The data present in the NSQIP database only allows for investigation of short-term, 30-day postoperative complication rates. Therefore, conclusions regarding how long-term complications in patients with bleeding disorders compare to those without cannot be drawn from our study. As with any database study, this database is also subject to coding errors. Specifically, the diagnosis code entered at the visit may or may not be assigned correctly. This database is also liable to errors with regard to other data input and collection. However, these errors should affect both of our cohorts equally and would not alter our results significantly. Also, the NSQIP database does not account for surgeon factors or surgeon experience, which may affect the patients’ postoperative course. Additionally, NSQIP does not encompass all the factors that could be investigated. Our study was not able to determine whether the presence of a bleeding disorder resulted in different pain outcomes or patient satisfaction following ORIF compared to patients without a bleeding disorder. Other factors that the NSQIP database does not encompass are the wound healing time of patients and the risk for another surgical visit for wound washout or hematoma evacuation, which would be beneficial information with regard to this patient population. Furthermore, patients with bleeding disorders are all grouped into 1

| Complications              | Yes, Bleeding Disorder | P Value | Odds Ratio (Yes, Bleeding Disorder/No Bleeding Disorder) (95% CI) |
|----------------------------|------------------------|---------|---------------------------------------------------------------|
| Major complications        |                        |         |                                                               |
| Unplanned reintubation     |                        | .424    | 1.607 (0.503-5.141)                                           |
| Septic shock               |                        | .181    | 4.469 (0.498-11.013)                                          |
| Minor complications        |                        |         |                                                               |
| Urinary tract infection    |                        | .752    | 1.115 (0.568-2.190)                                           |
| Pneumonia                  |                        | .094    | 2.193 (0.876-5.490)                                           |

Abbreviation: CI, confidence interval.

*Bolding equals significance, \(P < .05\).
cohort in NSQIP without the ability to categorize patients into different kinds of bleeding disorders. This would cause difficulty in determining the management strategies for these patients, as patients with different types of bleeding disorder would undergo different treatment options pre- and postoperatively. However, our study highlights the need for future research to be done on this patient population to stratify these patients by the type of bleeding disorder to improve management and outcomes of these patients. Additionally, only 2 cohorts of patients who were both undergoing operative treatment for ankle fractures were investigated in this study. Therefore, the complications encountered by patients with bleeding disorders who choose nonoperative management of their ankle fractures are not known.

In conclusion, patients with bleeding disorders, as defined in this study by NSQIP, are at a higher risk of 30-day postoperative complications following ORIF. Patient demographics and comorbidities should be taken into account when discussing treatment options. Having a better understanding of all patient risk factors contributing to postoperative complications allows for more patient-centered, individualized decision making and maximizes successful patient outcomes following ORIF of the ankle.

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Supplemental Material
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