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Predictors of Adverse Events for Ankle Fractures: An Analysis of 6800 Patients

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ABSTRACT

Ankle fractures are one of the most common injuries seen by orthopedic surgeons. It is therefore essential to understand the risks associated with their treatment. Using the American College of Surgeons National Surgical Quality Improvement Program® database from 2006 to 2013, the patient demographics, comorbidities, and 30-day complications were collected for 5 types of ankle fractures. A bivariate analysis was used to compare the patient demographics, comorbidities, and complications across all Common Procedural Terminology codes. A multivariable logistic regression model was then used to assess the odds of minor and major postoperative complications within 30 days after open treatment. A total of 6865 patients were included in the analysis. Of these patients, 2507 (36.5%) had bimalleolar ankle fractures. The overall rate of adverse events for ankle fractures was low. Bimalleolar fractures had the greatest rate of major (2.6%, n = 64), minor (3.8%, n = 94), and total (5.7%, n = 143) complications. When controlling for individual patient characteristics, bimalleolar fractures were associated with 4.92 times the odds (95% confidence interval 1.80 to 13.5; $p = .002$) of developing a complication compared with those with a medial malleolar fracture. The risk factors driving postoperative complications for all ankle fractures were age >65 years, obesity, diabetes, American Society of Anesthesiologists score >2, and functional status ($p < .05$). Although the overall rate of adverse events for ankle fractures was low, bimalleolar fractures were associated with 5 times the odds of developing a complication compared with medial malleolar fractures. Orthopedic surgeons must be aware of the risk factors that increase the rate of ankle fracture complications to improve patients' quality of care.

Orthopedic surgeons frequently treat ankle fractures, with an estimated 260,000 Americans sustaining an ankle fracture annually (1). In Rochester, Minnesota, Daly et al (2) found that the incident of ankle fractures occurred in 187 per 100,000 persons, an increase from the previous decade. A Finnish study by Kannus et al (3) also found that the incidence of osteoporotic ankle fractures more than doubled from 1970 to 1994 among those aged ≥60 years. Also, in a more recent study, Kannus et al (4) found that low-trauma ankle fractures among older patients increased 319% within 3 decades (369 in 1970 versus 1545 in 2000) and predicted that ankle fractures within the elderly population will more than triple by 2030. Because the elderly population is expected to increase drastically in the coming decades, the United States can also expect to see a similar increase in age-related ankle fracture incidents.

Unlike other common musculoskeletal injuries, such as fractures of the hip, ankle fractures occur within a wide range of patients. One study of 314 ankle fractures found that 40% of fractures occurred because of moderate trauma (e.g., slipping) and occurred mostly in older patients. However, one third of the ankle fractures had resulted from sports-related injuries, which had a greater fracture incident in

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males aged 15 to 25 years (200 per 100,000 person-years for males) compared with that in males aged ≥65 years (0 per 100,000 person-years). Females aged 15 to 25 years also had a greater incidence of sports-related ankle fractures compared with elderly females (2). In general, ankle fractures constitute 21% of all sports-related injuries and peak in males aged 15 to 24 years (4,5).

Ankle fractures treated with open reduction and internal fixation (ORIF) can have adverse outcomes owing to complications such as wound infections and thromboembolic events (6–10). Given the commonality of ankle fractures, the increasing costs of healthcare, and payers in general increasingly wary of complications, it is important for orthopedic surgeons to understand the risk factors for postoperative complications (11). Previous studies have shown that diabetes, age, and obesity are significant risk factors for complications; however, these studies were limited by sample size or had only studied specific populations (6–10,12–15). SooHoo et al (15) found that open injury, diabetes, and peripheral vascular disease were associated with complications within 90 days, 1 year, and 5 years postoperatively. Few studies have investigated the short-term rate and risk factors for postoperative complications after ORIF of ankle fractures.

Using the American College of Surgeons National Quality Database® (ACS-NSQIP) our study aimed to (1) determine the rate and (2) classify the risk factors that can lead to minor and major postoperative complications within 30 days after ORIF of ankle fractures. We also sought to investigate the rate of adverse events stratified by the type of ankle fracture procedure to better understand how the risks differ among the various fractures. Recognition of the risk factors associated with postoperative complications for common injuries such as ankle fractures is essential for orthopedic surgeons to risk stratify patients and improve the quality of care.

Patients and Methods

Using the ACS-NSQIP database from 2006 to 2013, we identified 6865 patients who had undergone ORIF of an ankle fracture using the Current Procedural Terminology (CPT) codes: ORIF of a medial malleolar fracture (CPT code 27766), ORIF of a lateral malleolar fracture (CPT code 27792), ORIF of a bimalleolar fracture (CPT code 27814), ORIF of a trimalleolar fracture without fixation of the posterior lip (CPT code 27822), and ORIF of a trimalleolar fracture, including fixation of the posterior lip (CPT code 27823).

The patient demographics, including body mass index (BMI), gender, race, smoking status, functional status (dependent versus independent), American Society of Anesthesiologists (ASA) class, preoperative comorbidities (e.g., diabetes, history of chronic pulmonary disease [COPD], history of congestive heart failure [CHF], dyspnea), and postoperative complications within 30 days of surgery, were collected for each patient. Complications, including major (i.e., death, deep superficial surgical site infection [SSI], myocardial infarction, deep vein thrombosis [DVT], pulmonary embolism [PE], coma, sepsis, and septic shock) and minor (i.e., wound dehiscence, superficial SSI, pneumonia, and urinary tract infection [UTI]), and the total number of adverse events were recorded.

A bivariate analysis using the chi-square test and Wilcoxon-Mann-Whitney *U* test, as appropriate, was performed to compare the demographic data and postoperative complications among the 5 types of ankle fracture procedures. The rate of postoperative complications for minor, major, and all adverse events was recorded for each CPT code. Statistical significance was set at $p = .05$.

To determine which patient variables were significant risk factors for the development of any complication for all ankle fractures, multivariate logistic regression analysis was performed to control for individual patient demographics, preoperative comorbidities, and type of surgery stratified by the CPT code. Variables such as age, sex,

Table 1
Demographic data and selected clinical characteristics of patients undergoing ankle fracture repair

Characteristic	ORIF of Medial Malleolus Fracture With or Without Internal or External Fixation (CPT code 27766)	ORIF of Lateral Malleolus Fracture With or Without Internal or External Fixation (CPT code 27792)	ORIF of Bimalleolar Fracture With or Without Internal or External Fixation (CPT code 27814)	ORIF Trimalleolar Ankle Fracture, Medial and Lateral Malleoli Only With or Without Internal or External Fixation (CPT code 27822)	ORIF Trimalleolar Ankle Fracture, Including Posterior Malleolus With or Without Internal or External Fixation (CPT code 27823)	*p* Value
Patients	471 (6.9)	2173 (31.7)	2507 (36.5)	1349 (19.7)	365 (5.3)	
Mean age (y)	45.4 ± 17.7	46.7 ± 17.7	53.4 ± 18.4	53.0 ± 17.3	54.2 ± 16.1	< .001
BMI (kg/m^2)						< .001
<20	25 (5.3)	62 (2.9)	95 (3.8)	44 (3.26)	6 (1.6)	
20 to 24.9	120 (25.5)	395 (18.2)	444 (17.7)	231 (17.1)	52 (3.9)	
25 to 29.9	158 (33.5)	755 (39.3)	819 (32.7)	449 (33.3)	137 (10.2)	
>30	168 (35.7)	961 (44.2)	1149 (45.8)	625 (46.3)	170 (46.5)	
Gender						< .001
Female	207 (43.9)	1039 (47.8)	1,606 (64.1)	976 (72.3)	263 (72.1)	
Male	264 (56.1)	1134 (52.2)	901 (35.9)	373 (27.7)	102 (27.9)	
Race						< .001
Black	34 (7.2)	242 (11.1)	225 (8.97)	125 (9.3)	22 (6.03)	
White	326 (69.2)	1406 (64.7)	1760 (70.2)	996 (73.8)	267 (73.2)	
Other	17 (3.6)	89 (4.1)	63 (2.5)	33 (2.45)	10 (2.74)	
Unknown	94 (20)	436 (20.1)	459 (18.3)	195 (14.5)	66 (18.1)	
Diabetes						< .001
No	433 (91.9)	1963 (90.3)	2,178 (86.9)	1,143 (84.7)	312 (85.5)	
Yes	38 (8.1)	210 (9.70)	329 (13.1)	206 (15.3)	53 (14.5)	
Active smoker						.020
No	332 (70.5)	1575 (72.5)	1897 (75.7)	1024 (75.9)	270 (74.0)	
Yes	139 (29.5)	598 (27.5)	610 (24.3)	325 (24.1)	95 (26.0)	
Functional status						< .001
Independent	440 (93.4)	2078 (95.6)	2305 (91.9)	1244 (92.2)	330 (90.4)	
Partially dependent	30 (6.37)	93 (4.28)	191 (7.62)	102 (7.56)	35 (9.59)	
Totally dependent	1 (0.21)	2 (0.092)	11 (0.44)	3 (0.22)	0 (0)	
ASA class						< .001
1	126 (26.8)	592 (27.2)	425 (17.0)	213 (15.8)	65 (17.8)	
2	235 (49.9)	1104 (50.8)	1266 (50.5)	725 (53.7)	190 (52.1)	
3	102 (21.7)	435 (20.0)	740 (29.5)	365 (27.1)	97 (26.6)	
4	8 (1.7)	42 (1.93)	75 (2.99)	45 (3.33)	12 (3.29)	
5	0 (0)	0 (0)	1 (0.04)	1 (0.074)	1 (0.27)	

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; CPT, Common Procedural Terminology; ORIF, open reduction and internal fixation.
Data presented as n (%) or mean ± standard deviation.