Association Between Diabetes, Obesity, and Short-Term Outcomes Among Patients Surgically Treated for Ankle Fracture

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Background: Although obesity is widely accepted as a risk factor for surgical complications following orthopaedic surgery, the literature is unclear with regard to the effect of obesity on outcomes of ankle fracture surgery, particularly in the setting of competing risks from diabetes. We hypothesized that obesity would be independently associated with more frequent complications, longer hospital length of stay, and higher costs of care among patients with and without diabetes.

Methods: With use of data from 2001 to 2010 from the Nationwide Inpatient Sample, we identified all adult patients who underwent surgical treatment for a primary diagnosis of an isolated ankle fracture or dislocation. We then divided patients into four groups according to the presence or absence of diabetes or obesity: Group A included patients with neither diagnosis; Group B, obesity alone; Group C, diabetes alone; and Group D, both diagnoses. Multivariable regression models were constructed to determine the association between diagnostic group and in-hospital complications, hospital length of stay, and imputed costs of care, while controlling for other conditions.

Results: The final sample included 148,483 patients (78.4% in Group A, 5.0% in Group B, 13.6% in Group C, and 3.0% in Group D). The median age was 53.0 years, and most patients (62.2%) were female and had a closed bimalleolar or trimalleolar fracture (62.2%). In the unadjusted analysis, the frequency of in-hospital complications (2.6%, 4.2%, 5.3%, and 6.5% in Groups A, B, C, and D, respectively; $p < 0.001$), length of stay (3.0, 3.6, 4.4, and 4.8 days, respectively; $p < 0.001$), and costs of care ($9686, $10,555, $11,616, and $12,804, respectively, in 2010 U.S. dollars; $p < 0.001$) increased across groups. Patients with obesity alone (Group B) (adjusted odds ratio [OR] = 1.4; 95% confidence interval [CI] = 1.3 to 1.6), diabetes alone (Group C) (OR = 1.1; 95% CI = 1.0 to 1.2), and both diagnoses (Group D) (OR = 1.4; 95% CI = 1.2 to 1.5) had more frequent in-hospital complications than those with neither diagnosis.

Conclusions: We found that patients with concurrent diagnoses of diabetes and obesity had higher health-care utilization and costs than those with neither diagnosis or with obesity alone or diabetes alone. The delay in the diagnosis of diabetes may somewhat obscure the true effect.

Level of Evidence: Prognostic Level III. See Instructions for Authors for a complete description of levels of evidence.

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An ankle fracture is one of the more commonly encountered orthopaedic injuries in the United States, with a yearly incidence of 184 fractures per 100,000 persons. Nearly 25% of these injuries will ultimately undergo surgical fixation[1,2]. Surgical fixation of ankle fractures is often accomplished safely, although adverse events, such as mechanical

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TABLE I Elixhauser[18] Comorbidity Index Measures

Congestive heart failure
Cardiac arrhythmia
Valvular disease
Pulmonary circulation disorder
Uncomplicated and complicated hypertension
Paralysis
Neurological disorder
Chronic pulmonary disease
Hypothyroidism
Renal failure
Liver disease
Peptic ulcer disease
AIDS/HIV (acquired immune deficiency syndrome/ human immunodeficiency virus)
Lymphoma
Metastatic cancer
Solid tumor without metastases
Rheumatoid arthritis
Collagen vascular disease
Coagulopathy
Weight loss
Fluid and electrolyte disorder
Blood-loss anemia
Iron-deficiency anemia
Alcohol abuse
Drug abuse
Psychosis
Depression

and infectious wound complications, have been reported in up to 8% of cases[3-6]. Several patient characteristics, including concurrent diagnoses of venous stasis, peripheral neuropathy, peripheral vascular insufficiency, and diabetes, have been associated with poor postoperative outcomes[7-9].

Although obesity has been a well-described risk factor for postoperative complications following other orthopaedic procedures[10-12], the relationship between obesity and postoperative complications following surgical fixation of ankle fractures is unclear. For example, obesity was associated with lower patient satisfaction with the outcome in one study[13], while others have shown similar complication rates between obese and nonobese patients[3]. The ability to clearly define the relationship between obesity and postoperative outcomes is made difficult by the high rate of associated comorbid medical conditions in this population, which, independently, increase the likelihood of poor outcomes. Notably, obesity can be seen in up to 50% of diabetic adults[14]. This comorbidity may partly explain the higher rates of poor outcomes among patients with diabetes. As nearly 34% of U.S. adults are considered obese[14], a better understanding of the relationship between obesity and postoperative outcomes in the context of multiple comorbid diseases is useful.

Currently, few studies have investigated the effect of concomitant diagnoses of diabetes and obesity on ankle fracture fixation compared with the effect of either diagnosis in isolation. More clearly defining this relationship could help explain the association between obesity and postoperative outcomes in this setting and suggest targets for intervention to mitigate postoperative risks. With use of the Nationwide Inpatient Sample (NIS)[15], we conducted this study to determine in-hospital complication rates, hospital lengths of stay, and

TABLE II Description of Discharges for Patients Who Underwent Inpatient Surgical Intervention for an Ankle Fracture Between 2001 and 2010 in the U.S.

	N	%
Sample	148,483	100.0
Age: 53 ± 18.2 yr*		
Diagnostic group		
Neither diagnosis	116,397	78.4
Obesity only	7449	5.0
Diabetes only	20,246	13.6
Both obesity and diabetes	4391	3.0
Sex		
Male	55,239	37.2
Female	92,363	62.2
Missing	881	0.6
Median income†		
$1-$38,999	30,660	20.6
$39,000-$47,999	30,708	20.7
$48,000-$62,999	28,441	19.2
≥$63,000	26,340	17.7
Missing	32,334	21.8
Elective admission	23,927	16.1
Injury type		
Closed unimalleolar fracture	15,846	10.7
Closed bimalleolar or trimalleolar fracture	92,413	62.2
Dislocation or open fracture	9177	6.2
Not specified	31,047	20.9
Elixhauser[18] comorbidities‡		
No conditions	64,033	43.1
1 to 2 conditions	64,624	43.5
3 to 4 conditions	16,868	11.4
5 or more conditions	2958	2.0
Venous stasis	451	0.3
Peripheral neuropathy	2865	1.9
Peripheral vascular disease	2458	1.7

*Median and standard deviation. †Based on patient's home zip code. ‡As listed in Table I.

hospital costs for patients with neither obesity nor diabetes and those with obesity alone, diabetes alone, or both diagnoses concurrently. We hypothesized that obesity alone would be independently associated with more frequent complications of care, longer length of hospitalization, and higher costs of care and that this may be made worse by a concurrent diagnosis of diabetes.

Materials and Methods

We conducted a cross-sectional study using NIS data from 2001 to 2010. Data for the NIS are collected at the state level from hospital discharge and administrative records, reported to the Agency for Healthcare Research and Quality (AHRQ), and made publicly available to researchers via the Healthcare Cost and Utilization Project (HCUP). The records are drawn from approximately 1000 nonfederal hospitals (short-term, general, and specialty) and include nearly 8 million discharges per year. Hospitals that are sampled contribute 100% of their discharges during the study period. Each discharge abstract includes sociodemographic and hospital characteristics and clinical variables, including up to twenty-five diagnostic and fifteen ICD-9-CM (International Classification of Diseases, Ninth Revision, Clinical Modification) procedure codes. These discharge abstracts are typically compiled for billing purposes by trained clerical personnel, who base all entries on documentation within the medical record that was entered by clinicians. As a result, patients would only carry the diagnosis of diabetes if it had been formally made by a physician. Specific testing was not done.

Case Selection

From the NIS databases, we identified hospital discharges with a primary diagnosis code for ankle fracture or dislocation (ICD-9-CM 824.x or 837.x; n = 212,296) and a concurrent surgical intervention (ICD-9-CM 79.00, 79.06, 79.09, 79.10, 79.16, 79.19, 79.20, 79.26, 79.29, 79.30, 79.36, 79.76, 79.79, 79.80, 79.86, 79.89, 79.90, 79.96, or 79.99; n = 183,357). Consistent with prior studies[4], we excluded discharges for patients with evidence of polytrauma (n = 25,020; see Appendix) and those who were younger than eighteen years of age (n = 9854) (Fig. 1). To evaluate the relationship between diabetes (ICD-9-CM 250.0 to 250.9), obesity (ICD-9-CM 278.0), and our primary outcomes, we categorized patients into four mutually exclusive diagnostic groups: patients without diabetes or obesity (Group A); patients with obesity alone (Group B); patients with diabetes alone (Group C); and patients with both obesity and diabetes (Group D). Given the often long delay in the diagnosis of diabetes, the subset of patients who had clinical symptoms of diabetes but had not yet been diagnosed by the time of discharge could not be identified using the NIS database and were, therefore, included in the nondiabetic groups.

Defining the Outcomes

We defined three outcomes: in-hospital complications, length of stay, and extrapolated in-hospital costs. In-hospital complications were a composite outcome of intraoperative complications, postoperative complications, and mortality. To assess intraoperative and postoperative complications, we used a previously reported ICD-9-CM coding algorithm[4], which defines complications on the basis of diagnostic and procedural coding (see Appendix). Intraoperative morbidity included accidental puncture or laceration of structures and hemorrhage complicating a procedure. Postoperative complications included mechanical wound or infectious, urinary, pulmonary, gastrointestinal, and cardiovascular complications. In-hospital mortality is a defined variable in the data set, as are variables for length of stay and total hospital charges. For cost analysis, we used the AHRQ cost-to-charge ratio file to convert charges to direct costs of care[16]. Then we adjusted the dollar amount for inflation to 2010 U.S. dollars[17]. This adjusted dollar amount was used as the dependent variable in the cost analysis.

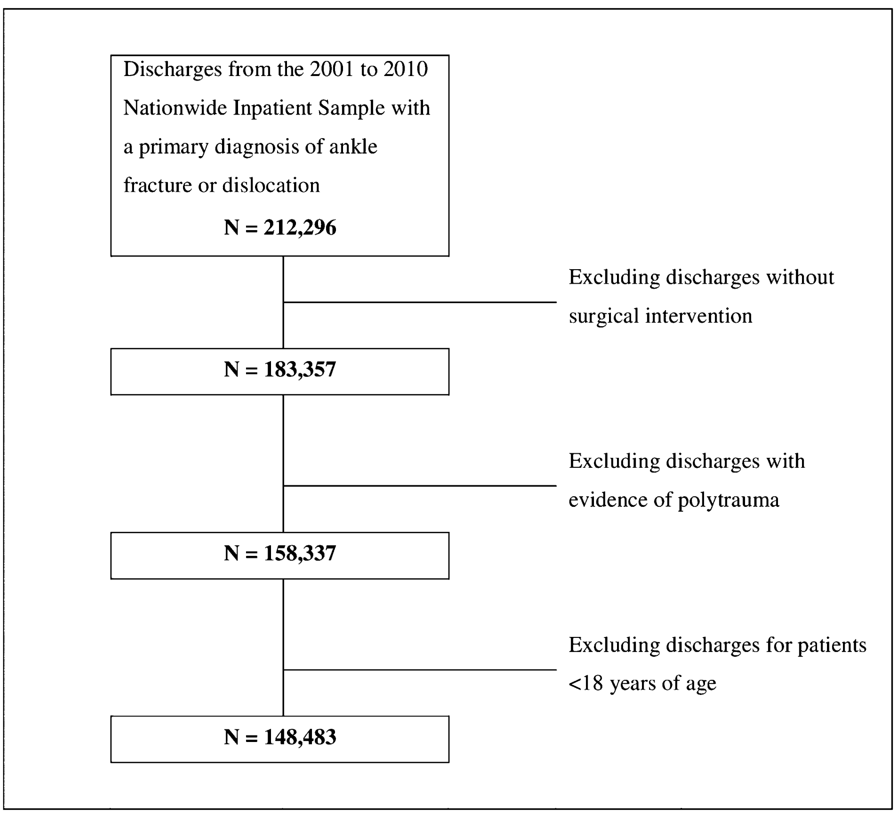

Fig. 1
Patient selection process to identify discharges for surgically treated ankle fractures from the 2001 to 2010 Nationwide Inpatient Sample.

TABLE III In-Hospital Outcomes According to Presence of Diabetes and Obesity Among Patients Surgically Treated for Ankle Fracture

	Neither Diagnosis	Obesity Alone	Diabetes Alone	Both Diabetes and Obesity	P Value
In-hospital complications					
Percentage	2.6	4.2	5.3	6.5	<0.001
Unadjusted OR (95% CI)	Reference	1.7 (1.5-1.9)	2.1 (2.0-2.3)	2.6 (2.3-3.0)	<0.001
Adjusted OR (95% CI)*	Reference	1.4 (1.3-1.6)	1.1 (1.0-1.2)	1.4 (1.2-1.5)	<0.001
Length of stay *(days)*					
Unadjusted mean (95% CI)	3.0 (3.0-3.0)	3.6 (3.5-3.6)	4.4 (4.3-4.4)	4.8 (4.7-4.9)	<0.001
Adjusted mean (95% CI)*	3.2 (3.2-3.2)	3.5 (3.4-3.6)	3.7 (3.6-3.7)	3.9 (3.8-4.0)	<0.001
In-hospital costs *(2010 USD)*					
Unadjusted mean (95% CI)	9686 (9619-9753)	10,555 (10,300-10,810)	11,616 (11,461-11,770)	12,804 (12,481-13,128)	<0.001
Adjusted mean (95% CI)†	9932 (9867-9997)	10,511 (10,267-10,755)	10,595 (10,437-10,752)	11,539 (11,225-11,853)	<0.001

*Adjusted for age, sex, income quartile, whether the procedure occurred during an elective admission, the number of comorbidities, fracture subtype, and whether the patient had venous stasis disease, peripheral neuropathy, or peripheral vascular disease. †Adjusted for the aforementioned factors as well as for regional wage variations.

Covariates

Additional covariates were collected to describe the patient population and for use in subsequent regression analysis. Patient characteristics included age, sex, race (white, black, Hispanic, other, or missing), quartile of income based on the patient's home zip code, whether the hospitalization was identified as an elective admission, injury type (closed unimalleolar fracture, closed bimalleolar or trimalleolar fracture, dislocation or open fracture, or not specified), and twenty-eight comorbid conditions previously defined by Elixhauser et al. and modified by Quan et al. (Table I)[18,19]. Additionally, we identified whether patients had a concurrent diagnosis of venous stasis disease (ICD-9-CM 454.0 to 454.2, 454.8 to 454.9, 459.3x, or 459.81), peripheral neuropathy (ICD-9-CM 337.1, 355.0 to 355.9, or 357.2), or peripheral vascular disease (093.0, 437.3, 440.x, 441.x, 443.1 to 443.9, 447.1, 557.1, 557.9, or V43.4).

Statistical Analysis

First, sociodemographic and clinical characteristics of the overall sample were presented using descriptive statistics. Second, a logistic regression model was constructed to calculate unadjusted and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) for the association between the diagnostic groups and in-hospital complications. The multivariable logistic regression model adjusted for age, sex, income quartile, whether the procedure occurred as a planned admission from a physician's office or immediately following an emergency room visit, the number of comorbidities, fracture subtype, and whether the patient had venous stasis disease, peripheral neuropathy, or peripheral vascular disease. No interaction terms were tested during the modeling process. Third, a linear regression model was constructed to compare the length of stay and hospital costs between diagnostic groups while adjusting for the same variables in the logistic regression model. An additional variable representing variation in regional wages was included in the linear regression model for hospital costs. For both models, length-of-stay and hospital-cost data were normally distributed, and no transformation was required. Unadjusted and adjusted results are presented as least square means (LSMs) with 95% CIs. For all models, a Spearman correlation matrix was used to assess the degree of multicollinearity between independent variables; no significant relationships were noted.

All p values were two-sided, and the 0.05 level was considered significant. This study was reviewed by our institutional review board and was considered exempt.

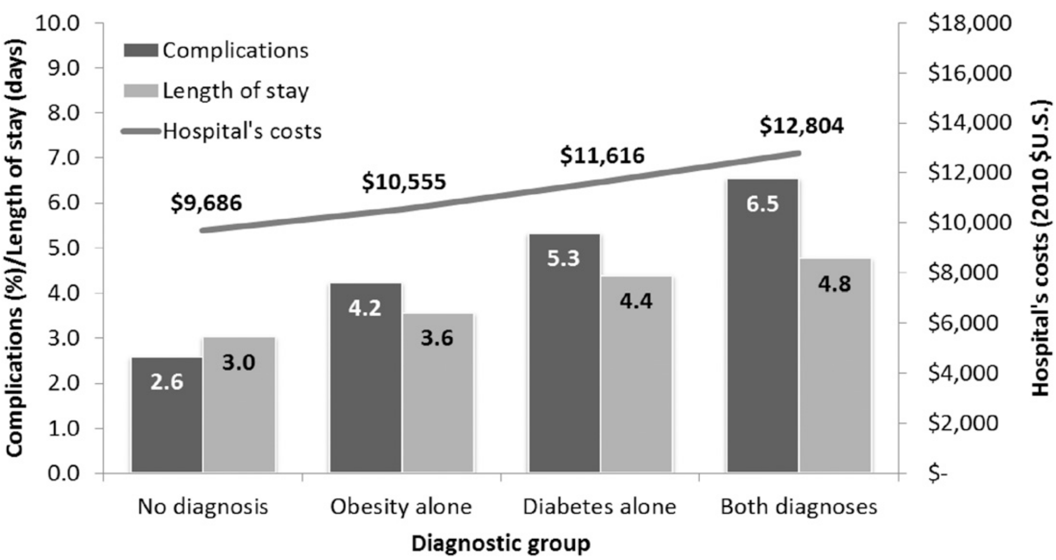

Fig. 2

Unadjusted outcomes for the frequency of in-hospital complications, length of stay, and hospital costs.

TABLE IV Multivariable Model Assessing Association Between Patient-Level Factors and In-Hospital Complications (Intraoperative Complications, Postoperative Morbidity, or Death)*

	N	Frequency of Complications (%)	Adjusted OR (95% CI)
Diagnostic group			
Neither diagnosis	116,397	2.6	Reference
Obesity only	7449	4.2	1.43 (1.27-1.62)
Diabetes only	20,246	5.3	1.12 (1.04-1.22)
Both obesity and diabetes	4391	6.5	1.35 (1.18-1.54)
Age (median, 53.0 yr)	—	—	1.02 (1.02-1.02)
Sex			
Male	55,239	2.9	Reference
Female	92,363	3.3	0.76 (0.71-0.81)
Median income			
$1-$38,999	30,660	3.2	Reference
$39,000-$47,999	30,708	3.5	1.05 (0.96-1.15)
$48,000-$62,999	28,441	3.2	1.00 (0.91-1.10)
≥$63,000	26,340	3.2	1.01 (0.92-1.11)
Missing	32,334	2.6	1.02 (0.92-1.12)
Elective admission	23,927	2.3	0.83 (0.76-0.91)
Injury type			
Closed unimalleolar fracture	15,846	2.3	Reference
Closed bimalleolar or trimalleolar fracture	92,413	3.0	1.08 (0.97-1.21)
Dislocation or open fracture	9177	6.0	2.06 (1.79-2.37)
Not specified	31,047	3.2	1.46 (1.29-1.65)
Elixhauser[18] comorbidities, excluding diabetes and obesity			
No conditions	64,033	1.1	Reference
1 to 2 conditions	64,624	3.2	2.17 (1.98-2.38)
3 to 4 conditions	16,868	8.7	5.24 (4.72-5.82)
5 or more conditions	2958	15.3	9.04 (7.87-10.38)
Venous stasis	451	8.4	1.21 (0.86-1.70)
Peripheral neuropathy	2865	6.9	1.12 (0.96-1.32)
Peripheral vascular disease	2458	8.5	1.26 (1.09-1.47)

*C-statistic = 0.747.

Source of Funding

No external funding was used in this investigation.

Results

The final sample included 148,483 discharges for a surgically treated ankle fracture between January 2001 and December 2010. Overall, 78.4% of the patients had neither obesity nor diabetes (Group A), 5.0% had obesity alone (Group B), 13.6% had diabetes alone (Group C), and 3.0% had both diagnoses (Group D). The median age was 53.0 years, and more patients were female (62.2%) and had either a closed bimalleolar or trimalleolar fracture (62.2%). A smaller subset of discharges was for closed unimalleolar fracture (10.7%) or open fracture or dislocation (6.2%). In 20.9% of the discharges, the ankle fracture subtype was not explicitly coded. A concurrent diagnosis of venous stasis, peripheral neuropathy, or peripheral vascular disease was uncommon (0.3%, 1.9%, and 1.7%, respectively; Table II).

Comparison of Outcomes Across Diagnostic Groups

In the unadjusted analysis, there was a significant increase in the frequency of in-hospital complications, length of stay, and extrapolated hospital costs of care across diagnostic groups (Fig. 2). The frequency of in-hospital complications was 2.6% among patients with neither diagnosis (Group A), but increased to 4.2%, 5.3%, and 6.5% for patients with obesity alone (Group B), diabetes alone (Group C), and both diagnoses (Group D), respectively ($p < 0.001$). Similarly, the mean length of stay (3.0, 3.6, 4.4, and 4.8 days in Groups A, B, C, and D, respectively; $p < 0.001$) and hospital costs of care

($9686, $10,555, $11,616, and $12,804, respectively; $p < 0.001$) trended higher across diagnostic groups. After adjusting for the previously noted sociodemographic and clinical factors, the presence of obesity alone (Group B; adjusted OR = 1.4 [95% CI = 1.3 to 1.6]), diabetes alone (Group C; adjusted OR = 1.1 [95% CI = 1.0 to 1.2]), or both diagnoses (Group D; adjusted OR = 1.4 [95% CI = 1.2 to 1.5]) increased the likelihood of experiencing a complication of care compared with the likelihood for patients with neither diagnosis. Again, a similar trend toward higher adjusted mean length of stay (3.2, 3.5, 3.7, and 3.9 days in Groups A, B, C, and D, respectively; $p < 0.001$) and costs of care ($9932, $10,511, $10,595, and $11,539, respectively; $p < 0.001$) (Table III) was noted across diagnostic groups.

Patient-Level Factors Associated with Complications of Care

The final model for complications of care had moderate discrimination, with a C-statistic of 0.747. The C-statistic is a parameter that describes how well a model predicts the outcome; a value of 0.5 suggests that the model predicts no better than chance, while a value of 1.0 indicates perfect predictive capability. From the full model, several patient-level factors, in addition to diabetes and obesity, were associated with complications of care. Female sex (adjusted OR = 0.76 [95% CI = 0.71 to 0.81]) and surgery during an elective admission (adjusted OR = 0.83 [95% CI = 0.76 to 0.91]) were associated with fewer complications of care. Conversely, increasing age in years (adjusted OR = 1.02 [95% CI = 1.02 to 1.02]) and the presence of peripheral vascular disease (adjusted OR = 1.26 [95% CI = 1.09 to 1.47]) were associated with an increased likelihood of experiencing a complication of care. Patients with a higher burden of comorbid medical conditions and those with an open fracture or dislocation more frequently experienced complications of care (Table IV).

Discussion

Patients with diabetes, obesity, or both diagnoses who underwent surgical fixation of an ankle fracture had more frequent in-hospital complications, had longer hospitalizations, and incurred higher hospital costs when compared with patients with neither diabetes nor obesity. Although the unadjusted complication rate increased steadily across the groups, there was a less clear relationship in the adjusted analysis, whereby accounting for other comorbid conditions resulted in a decrease in the OR for complications in all groups but less of a decrease in Group B, obesity alone (unadjusted OR, 1.7; adjusted OR, 1.4) compared with Group C, diabetes alone (unadjusted OR, 2.1; adjusted OR, 1.1) and Group D, both diagnoses (unadjusted OR, 2.6; adjusted OR, 1.4). This raises questions with regard to the true relative importance of each diagnosis in predicting perioperative complications; this deserves further investigation. It may also be related to the accuracy of the diagnosis of diabetes in a database that relies on administrative coders. The primary sources of data collection are billing forms compiled at the hospital level[15]. The accuracy of the data is dependent on the accuracy of the diagnostic and procedural coding used in these forms, which, for diabetes, has been found to be reasonably accurate[20]. Additionally, the IDC-9-CM coding structure used to define these variables in the current study is consistent with accepted practices in health services research[18,19]. Nevertheless, the extent to which inaccurate coding impacts the findings of this paper cannot be determined.

More discernible were the effects on health-care resource utilization, as measured by hospital length of stay and hospital costs, which increased across the groups despite adjustment for competing comorbidity.

Previous studies have investigated the relationship between diabetes or obesity alone and ankle fracture outcomes; however, to our knowledge, prior studies have not evaluated the interplay between these diagnoses. Specific studies evaluating the impact of diabetes on perioperative complications have found more frequent complications[4,8], particularly mechanical wound complications[7] and infections[1]. Patients with diabetes also have been noted to have longer hospital stays and higher hospital costs[4]. Conversely, the relationship between obesity and perioperative outcomes in this population is less well studied. Obese patients self-report worse outcomes than nonobese patients[13], but previous authors have found no difference in the complication rate between obese and nonobese patients[3]. The current study builds on this research by evaluating how concurrent obesity and diabetes diagnoses further exacerbate postoperative outcomes and increase postoperative resource utilization.

In addition to diabetes and obesity, we found several other patient conditions that were associated with more frequent complications of care following surgical fixation of an ankle fracture. As expected, an open fracture or dislocation was twofold more likely to have a complication than a closed unimalleolar fracture, and patients treated during an elective admission had less frequent complications. Beyond diagnoses of diabetes and obesity, the total number of comorbid medical conditions that a patient has was associated with more frequent complications. For example, patients with five or more comorbid medical conditions were ninefold more likely to have a complication than patients without any comorbid conditions.

We found that several patient factors were associated with more frequent complications, a finding that may provide some guidance for improving outcomes in this population. If surgical fixation is pursued, it may be important to co-manage the patient with a geriatrician or internist to help optimize the patient's underlying health. A previous study has shown an increased risk of wound complications with elevated perioperative blood glucose levels[21]. Therefore, appropriately controlling the patient's perioperative blood glucose levels could potentially improve complication rates.

Our study had several limitations. First, administrative data are subject to miscoding, or undercoding, of specific diagnoses, including diabetes and obesity. The obesity groups in this study combined (Groups B and D) only accounted for 8.0% of all patients (5.0% and 3.0%, respectively). Previous obesity-directed investigations using NIS data have shown undercoding of obesity within hospital systems compared with the national prevalence of the disease[22]. The extent to which this could have impacted our results cannot be determined and is a potential confounder. According to the U.S. Centers for Disease Control and Prevention (CDC), roughly 25.8 million Americans (8.3%) had been diagnosed with diabetes as of the final year of data included in this study, 2010[23]. This is substantially less than the prevalence of diabetes in this study (16.6%). Previous studies have estimated that there can be as long as a six-to-twelve-year delay in the diagnosis of diabetes from the onset of the disease[24,25]. Therefore, there certainly may have been patients with undiagnosed diabetes in the nondiabetic groups, and undiagnosed diabetes remains a confounder.

Second, we are unable to stratify patients according to the severity of injury or fracture. To help minimize the influence of injury severity, we excluded patients with evidence of polytrauma and included a broad classification of fracture types as far as the diagnostic coding would permit. Finally, we also chose to study obesity as a dichotomous outcome and not further stratify by the degree of obesity according to body mass index (BMI). Although diagnostic coding does exist for specific BMI categories, those codes are not often utilized. The relationship between specific BMI thresholds and outcome may warrant further investigation.

In conclusion, patients with diabetes, obesity, and both diagnoses concurrently were found to have more frequent in-hospital complications of care than those with neither diagnosis, while having progressively longer hospitalizations and higher hospital costs across diagnostic groups. These results may help to inform patient-surgeon discussions around perioperative expectations as well as to provide data to health-care systems caring for these patients.

Appendix

Table V presents the ICD-9-CM codes used. ■

TABLE V ICD-9-CM Codes Used

	ICD-9-CM Codes
Patient selection	
Ankle fracture or dislocation	824.x, 837.x
Surgical intervention	79.00, 79.06, 79.09, 79.10, 79.16, 79.19, 79.20, 79.26, 79.29, 79.30, 79.36, 79.76, 79.79, 79.80, 79.86, 79.89, 79.90, 79.96, 79.99
Selected covariates	
Venous stasis	454.0-454.2, 454.8-454.9, 459.3x, 459.81
Peripheral neuropathy	337.1, 355.0-355.9, 357.2
Peripheral vascular disease	093.0, 437.3, 440.x, 441.x, 443.1-443.9, 447.1, 557.1, 557.9, V43.4
Injury type	
Closed unimalleolar fracture	824.0, 824.2
Closed bimalleolar or trimalleolar fracture	824.4, 824.6
Dislocation or open fracture	824.1, 824.3, 824.5, 824.7, 837, 837.0, 837.1
Not specified	824, 824.8, 824.9
Patient exclusion	
Secondary diagnostic coding to identify patients with polytrauma	800-823, 825-829, 830-836, 838-839, 840-844, 846-848, 850-854, 860-869, 870-890, 894-897, 900-904, 925-927, 929, 930-939, 940-949, 950-957
Specific comorbidity	
Diabetes	250.0 to 250.9
Obesity	278.0
Postoperative complications	
Mechanical wound	998.12, 998.13, 998.31, 998.32, 998.6, 998.83
Infectious	038.0-038.9, 790.7, 998.5, 998.51, 998.59
Urinary	997.5
Pulmonary	512.2, 518.5, 518.4, 518.81, 518.82, 997.3
Gastrointestinal	560.1, 997.4
Cardiovascular	410.0-410.9, 415.11, 427.5, 453.40-453.42, 453.8-453.9, 997.02, 997.1, 998
Intraoperative complications	
Accidental puncture or laceration during a procedure	998.2
Hemorrhage complicating a procedure	998.11

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