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Open Reduction Internal Fixation of Distal Radius Fractures: Retrospective Cohort Analysis of the Geriatric Population Using the NSQIP Database

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Abstract

Background: Distal radius fractures (DRFs) are the most common upper extremity fractures with more than 600 000 cases per year in the United States and account for up to 18% of fractures in the geriatric population. The purpose of our study was to identify the influence of age on 30-day postoperative outcomes while adjusting for patient demographics and comorbidities. **Methods:** The National Surgery Quality Improvement Program database was queried for patients having undergone open reduction internal fixation (ORIF) of DRFs. Current Procedural Terminology codes 25607, 25608, and 25609 between the years 2007 and 2016 were collected and analyzed. Patients were divided into 2 groups: group 1, 18 to 64 years; and group 2, 65 years and older. Patient demographics; preoperative, perioperative, and postoperative variables; and complications were recorded and analyzed. **Results:** In all, 5894 patients were identified; group 1 consisted of 4056 patients aged $<$64 years, and group 2 consisted of 1838 patients aged 65 years and older. The total complication rate was 2.7% for all patients, 2.2% for group 1, and 3.4% for group 2. The most common complications included surgical site infection for group 1 and urinary tract infection for group 2. Univariate analysis demonstrated association between age $\geq$65 years and complication (hazard ratio, 1.55; 95% confidence interval, 1.12-2.14; $P = .009$). However, after controlling for statistically significant factors, age was not an independent predictor of complications ($P = .685$). Admission status, American Society of Anesthesiologists classification, operative time, renal failure, and bleeding disorders were independent predictors of 30-day complications across all patients. **Conclusion:** Our data suggest that patients aged 65 years and older without high-risk comorbidities should be offered ORIF of DRFs as their complication risk remains low.

Keywords: distal radius, fracture/dislocation, diagnosis, elderly, upper extremity trauma, complications, volar plating

Introduction

The ideal treatment for distal radius fractures (DRFs) in the geriatric population remains unclear, and parameters for determination of surgical management are poorly defined. Multiple studies have shown no difference in clinical outcomes of nonsurgical versus surgical treatment (regardless of fixation strategy) in elderly patients.[1-4] However, surgical treatment was associated with the highest quality-adjusted life years.[2] Although most DRFs in elderly patients continue to be managed nonoperatively, the use of internal fixation has increased in the United States.[5]

Increased age has been associated with increased postoperative complications in open reduction internal fixation (ORIF) of DRFs in the geriatric population.[6-8] However, it is unknown whether age alone is associated with an increase in complications while controlling for other comorbid conditions. An understanding of age as a risk factor, in addition to traditional radiographic parameters, will allow physicians to mitigate risk by optimal patient selection.

The purpose of this investigation was to compare the risk profile of geriatric versus nongeriatric cohorts

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following ORIF of DRFs using the American College of Surgeons National Surgery Quality Improvement Program (ACS-NSQIP) database. Furthermore, we aim to identify the effects of other preoperative, perioperative, and intraoperative variables on outcomes across all patient populations.

Methods

Data Source

The ACS-NSQIP database is a population-based international, prospective database that collects preoperative and 30-day outcome data for patients undergoing surgical operations across multiple subspecialties. Patients are identified prospectively and randomly sampled at eligible hospitals.

Study Population

The NSQIP database was queried for patients based on Current Procedural Terminology codes. The following codes were used: 25607 (open treatment of extra-articular DRF with internal or external fixation), 25608 (open treatment of intra-articular DRF with internal fixation of 2 fragments), and 25609 (open treatment of intra-articular DRF with internal fixation of 3 or more fragments). Patients with incomplete NSQIP data were excluded from analysis.

Data Collection

Patient demographic variables included age, sex, weight, and height. Body mass index (BMI) was calculated from each patient's height and weight. Preoperative variables included a history of diabetes mellitus, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), hypertension (HTN), renal failure requiring dialysis, bleeding disorder (patients with any condition that places the patient at risk of excessive bleeding, eg, vitamin K deficiency, hemophilia, thrombocytopenia, and chronic anticoagulation therapy that has not been discontinued prior to surgery), and preoperative transfusion. Patient perioperative variables included admission status, American Society of Anesthesiologists (ASA) class, history of smoking, and chronic steroid use. Intraoperative variables included total operation time. Finally, postoperative variables included length of stay (LOS).

Complications

Complications were defined as any one or more of the following: readmission, reoperation, superficial surgical site infection (SSI), deep SSI, organ/space infection, pneumonia (PNA), pulmonary embolus (PE), ventilation requirement >48 hours, progressive or acute renal failure, urinary tract infection (UTI), stroke, cardiac arrest, myocardial infarction (MI), or transfusion requirement. For analyses, patients were categorized based on the presence or absence of any one or more complications. The rate of complication was calculated based on the number of patients with complication.

Statistical Analysis

The primary objective of the study was to determine whether age alone is an independent risk factor for complications after surgery for a DRF. Patients were stratified into 2 groups: <65 vs ≥65 years of age. Clinical and pathologic characteristics were compared with the Student *t* test for continuous variables and χ^2 test for categorical variables. All included complications occurred within 30 days of surgery and were defined as stated above. Factors found to be significant by univariate analysis ($P < .05$) were used in the multivariate logistic regression model, which was used to examine the effect of age on postoperative complication and to calculate odds ratios (OR) and 95% confidence intervals (CI). Variables considered in the multivariate model included age, admission status, ASA class, total operation time, BMI, diabetes, COPD, HTN, renal failure requiring dialysis, and bleeding disorders. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 25 (Chicago, Illinois). All reported *P* values were 2-sided, and a value of $P < .05$ was considered statistically significant.

Results

Patient Characteristics

A total of 8032 patients were identified between 2007 and 2016. Of these, 5894 patients had complete data and were used for this study. There were 4056 patients under the age of 65 (68.8%) and 1838 patients aged 65 years and older (32.8%). More of the patients were women (73.5%) than men (26.5%), and more had outpatient admission (84.1%) than inpatient (15.9%) status. Most patients were categorized as ASA class II (55.1%), followed by class III (25.1%). Class IV status was rare in this population (1.5%). The average operative time was 78.5 minutes (range, 16-231 minutes), and the average LOS was 0.48 days (range, 0-13 days). The most prevalent comorbid condition found in this population was HTN (33.2%), followed by cigarette smoking (18.3%) and diabetes (8.6%). Comorbidities of CHF, dialysis, and preoperative transfusion were rare (<20 patients). The complication rate for the entire cohort was 2.6% (Table 1).

Table 1. Characteristics of Operative Distal Radius Patients.

	No. of patients, %		
	All	With complication	Without complication
Factors	N = 5894	n = 154	n = 5740
Age, y			
<65	4056 (68.8)	91	3965
≥65	1838 (31.2)	63	1775
Sex			
Male	1564 (26.5)	36	1528
Female	4330 (73.5)	118	4212
Admission status			
Outpatient	4959 (84.1)	95	4864
Inpatient	935 (15.9)	59	876
ASA class			
I	1082 (18.4)	11	1071
II	3246 (55.1)	61	3185
III	1478 (25.1)	74	1404
IV	88 (1.5)	8	80
BMI, mean (range), kg/m^2	28.0 (14-49)	29.49 (16-48)	27.91 (14-49)
Total operative time, mean (range), min	75.8 (16-231)	88.36 (18-228)	75.57 (16-231)
Length of stay, mean (range), d	0.48 (0-13)	1.7 (0-13)	0.44 (0-12)
Diabetes mellitus			
No	5389 (91.4)	128	5261
Yes	505 (8.6)	26	479
Cigarette smoking			
No	4813 (81.7)	124	4689
Yes	1081 (18.3)	30	1051
Chronic obstructive pulmonary disease			
No	5677 (96.3)	137	5540
Yes	217 (3.7)	17	200
Congestive heart failure			
No	5880 (99.8)	153	5727
Yes	14 (0.2)	1	13
Hypertension			
No	3938 (66.8)	71	3867
Yes	1956 (33.2)	83	1873
Dialysis			
No	5876 (99.7)	149	5727
Yes	18 (0.3)	5	13
Chronic steroids			
No	5786 (98.2)	149	5637
Yes	108 (1.8)	5	103
Bleeding disorder			
No	5754 (97.6)	138	5616
Yes	140 (2.4)	16	124
Preoperative transfusion			
No	5885 (99.8)	152	5733
Yes	9 (0.2)	2	7
Any complication			
No	5740 (97.4)	—	—
Yes	154 (2.6)		

Note. ASA class = American Society of Anesthesiologists classification; BMI = body mass index.

Patient Characteristics Between Age Groups

Group 1 (<65 years) had a mean age of 49.0 years, and group 2 (≥65 years) had a mean age of 74.5 years. Although both groups had a majority of female patients, a significantly larger percentage of women was found in the geriatric population compared with those <65 years of age (88.3% and 66.7%, respectively). Significant differences also included admission status, ASA class, BMI, total operative time, LOS, diabetes mellitus, cigarette smoking, COPD, HTN, chronic steroid use, bleeding disorder history, and preoperative transfusions. Both groups had a majority of patients in ASA class II. Patients ≥65 years of age had a higher percentage of patients in the ASA class III category (36.7%) compared with those <65 years of age (14.2%) (Table 2).

The total complication rate for those <65 years of age was 2.2%, whereas the total complication rate for those ≥65 years of age was 3.4% ($P = .008$) (Table 2). The most common complication for group 1 was superficial SSI, whereas the most common complication for group 2 was UTI. Significant differences in complications were found for PNA, PE, and UTI (Table 3).

Predictors of Complication

Univariate logistic regression models showed the following variables to be significantly associated with complication (OR high to low): dialysis (14.78), preoperative transfusion (10.78), bleeding disorder (5.25), admission status (3.45), COPD (3.44), HTN (2.41), ASA class (2.39), diabetes (2.23), and age (1.55). Although BMI (1.04) and total operative time (1.01) are statistically significant, they are less likely to be clinically significant given a low hazard ratio (HR). Notably, CHF and smoking do not appear to increase risk of complication (Table 4).

Multivariate logistic regression models showed the following variables to be associated with complication (OR high to low): dialysis (4.21), bleeding disorder (2.54), admission status (2.38), and ASA class (1.66). Although the total operative time (1.01) is statistically significant, it is less likely to be clinically significant given a low HR (Table 5).

Discussion

The expanding older population has resulted in an increased incidence of DRFs. These patients may have higher risk of complications given the likelihood of additional comorbidities. Thus we used a large, nationally representative cohort in an effort to define the significance of age in postoperative complications while controlling for preoperative and perioperative variables.

Our results clarify that age alone does not reliably predict an increased complication rate among patients undergoing ORIF for DRFs. Individual comorbidities in a generally sicker population are therefore more likely responsible for the increase in complication observed in the geriatric population. Along a similar vein, a retrospective study conducted by Wilson et al demonstrates that a frailty index, formulated according to preoperative comorbidities, is highly predictive of DRF postoperative complications.[7]

Multivariate analysis revealed admission status (inpatient vs outpatient), ASA class, total operative time, dialysis, and bleeding disorders to be independent predictors of complication. A recent large-scale study by Whiting et al corroborates that both inpatient status and ASA class are associated with increased rates of major and total complications in operative treatment for DRFs.[8] Based on our findings and other recent investigations, surgeons should plan accordingly for an increased risk of complication among patients with these higher risk variables.

There are several limitations to our study, first of which is the retrospective nature of this database study. Furthermore, the NSQIP database is limited to 30 days of complications and does not take into account postoperative outcome measures such as overall range of motion, functional status, postoperative radiographic parameters, or hardware complications that may be important to a physician's approach in treatment selection. In addition, the limited nature of this database does not allow us to account for death as a complication, as cause of death cannot be further delineated as a result of surgery or by other cause. Furthermore, the NSQIP database includes only operative patients, and therefore, our study cannot directly compare complications in patients treated surgically versus nonsurgically. Of note, all patients undergoing closed reduction with percutaneous fixation were excluded from this study. This may lead to a significant number of patients and possibly add further confounding factors to the data set. Finally, it is important to note that fractures in the database cannot be standardized for radiographic factors. Surgeons may have a higher threshold for operative treatment in the elderly population as they recognize the reduced impact of radiographic alignment on outcome for older adults. Therefore, a selection bias may be present with greater displacement in the elderly cohort.

Conclusions

Although the complication rate for ORIF of DRFs is relatively low overall (2.6%), geriatric patients have an increased risk of complications compared with those younger than 65 years of age. However, age alone was not shown to be an independent risk factor for complication when controlling for additional demographics and comorbidities. Our data suggest that older patients with an optimal risk profile should not be deterred from undergoing ORIF of their DRFs. These data may help improve patient selection as well as preoperative and postoperative planning for

Table 2. Comparison of Patient Characteristics Between Age Groups.

Factors	No. of patients, %		*P* value
	<65 y	≥65 y	
	n = 4056	n = 1838	
Age, y			**<.001**
<65 (mean)	4056 (49.0)	0	
≥65 (mean)	0	1838 (74.5)	
Sex			**<.001**
Male	1349 (33.3)	215 (11.7)	
Female	2707 (66.7)	1623 (88.3)	
Admission			**<.001**
Outpatient	3519 (86.8)	1440 (78.3)	
Inpatient	537 (13.2)	398 (21.7)	
ASA class			**<.001**
I	993 (24.5)	89 (4.8)	
II	2339 (57.7)	907 (49.3)	
III	695 (17.1)	783 (42.6)	
IV	29 (0.7)	59 (3.2)	
BMI, mean (range), kg/m^2	28.17 (15-49)	27.47 (14-49)	**<.001**
Total operative time, mean (range), min	78.55 (16-231)	70 (16-188)	**<.001**
Length of stay (range), d	0.33 (0-7)	0.8 (0-13)	**<.001**
Diabetes mellitus			**<.001**
No	3804 (93.8)	1585 (86.2)	
Yes	252 (6.2)	253 (13.8)	
Cigarette smoking			**<.001**
No	3119 (76.9)	1694 (92.2)	
Yes	937 (23.1)	144 (7.8)	
Chronic obstructive pulmonary disease			**<.001**
No	3966 (97.8)	1711 (93.1)	
Yes	90 (2.2)	127 (6.9)	
Congestive heart failure			.128
No	4049 (99.8)	1831 (99.6)	
Yes	7 (0.2)	7 (0.4)	
Hypertension			**<.001**
No	3177 (78.3)	761 (41.4)	
Yes	879 (21.7)	1077 (58.6)	
Dialysis			.224
No	4046 (99.8)	1830 (99.6)	
Yes	10 (0.2)	8 (0.4)	
Chronic steroids			**<.001**
No	3999 (98.6)	1787 (97.2)	
Yes	57 (1.4)	51 (2.8)	
Bleeding disorder			**<.001**
No	4026 (99.3)	1728 (94.0)	
Yes	30 (0.7)	110 (6.0)	
Preoperative transfusion			**<.001**
No	4055 (100)	1830 (99.6)	
Yes	1 (0)	8 (0.4)	
Any complication			**.008**
No	3965 (97.8)	1775 (96.6)	
Yes	91 (2.2)	63 (3.4)	

Note. Complication = any one or more of the following: readmission, reoperation, superficial surgical site infection, deep surgical site infection, organ/space infection, pneumonia, pulmonary embolus, ventilation requirement >48 hours, progressive or acute renal failure, urinary tract infection, stroke, cardiac arrest, myocardial infarction, or transfusion requirement. ASA class = American Society of Anesthesiologists classification; BMI = body mass index.
Bold print signifies significant *p* values.

Table 3. Comparison of Complications Between Age Groups.

	No. of patients with complication		
Complication	<65 y	≥65 y	*P* value
Superficial SSI	9	1	.148
Deep incisional SSI	1	0	.501
Organ/Space SSI	2	0	.341
Pneumonia	3	6	**.021**
Pulmonary embolism	0	2	**.036**
Ventilator >48 h	0	0	—
Progressive renal insufficiency	2	1	.936
Acute renal failure	0	1	.137
UTI	6	18	**<.001**
Stroke	1	0	.501
Cardiac arrest needing CPR	1	0	.501
MI	0	1	.137
Postoperative transfusion	8	9	.052
DVT/Thrombophlebitis	0	2	**.036**
Sepsis	2	1	.936
Readmission, %	28, (0.69)	18, (0.98)	.243
Reoperation, %	47, (1.16)	16, (0.87)	.319

Note. SSI = surgical site infection; UTI = urinary tract infection; MI = myocardial infarction; DVT = deep venous thromboembolism; CPR = cardiopulmonary resuscitation.
Bold print signifies significant *p* values.

Table 4. Univariate Analysis of Operative Distal Radius Patients.

	Univariate analysis	
Factors	OR (95% CI)	*P* value
Age, y		**.009**
<65	—	
≥65	1.55 (1.12-2.14)	
Sex		.37
Male	—	
Female	1.19 (0.82 - 1.74)	
Admission		**<.001**
Outpatient	—	
Inpatient	3.45 (2.47-4.81)	
ASA class	2.39 (1.90-3.01)	**<.001**
BMI, kg/m^2	1.04 (1.02-1.07)	**.001**
Total operative time	1.01 (1.01-1.01)	**<.001**
Diabetes mellitus	2.23 (1.45-3.45)	**<.001**
Cigarette smoking	1.08 (0.72-1.62)	.71
Chronic obstructive pulmonary disease	3.44 (2.04-5.80)	**<.001**
Congestive heart failure	2.88 (0.37-22.15)	.31
Hypertension	2.41 (1.75-3.33)	**<.001**
Dialysis	14.78 (5.20-42.00)	**<.001**
Chronic steroids	1.84 (0.74-4.57)	.19
Bleeding disorder	5.25 (3.04-9.08)	**<.001**
Preoperative transfusion	10.78 (2.22-52.30)	**.003**

Note. OR = odds ratio; CI = confidence interval; ASA class = American Society of Anesthesiologists Classification; BMI = body mass index.
Bold print signifies significant *p* values.

Table 5. Multivariate Analysis of Operative Distal Radius Patients.

	Multivariate analysis	
Factors	OR (95% CI)	*P* value
Age ≥65 y	0.92 (0.62-3.44)	.685
Inpatient	2.38 (1.65-3.44)	**<.001**
ASA class	1.66 (1.23-2.23)	**.001**
BMI, kg/m^2	1.02 (0.99-1.05)	.14
Total operative time	1.01(1.004-1.01)	**<.001**
Diabetes mellitus	1.12 (0.69-1.86)	.621
Chronic obstructive pulmonary disease	1.81 (0.998-3.26)	.051
Hypertension	1.40 (0.94-2.08)	.097
Dialysis	4.21 (1.28-13.88)	**.018**
Bleeding disorder	2.54 (1.37-4.70)	**.003**
Preoperative transfusion	1.86 (0.33-10.44)	.479

Note. OR = odds ratio; CI = confidence interval; ASA class = American Society of Anesthesiologists Classification; BMI = body mass index. Bold print signifies significant *p* values.

patients undergoing surgery for these common wrist fractures. Additional studies are needed to evaluate the long-term complication rates in this cohort of patients compared with their nongeriatric cohorts.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

Authors are required to ensure the following guidelines are followed, as recommended by the *International Committee of Medical Journal* Editors, Uniform Requirements for Manuscripts Submitted to Biomedical Journals. Informed consent was obtained from all individual participants included in the study.

Declaration of Conflicting Interests

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