

## Determinants of Distal Radius Fracture Management in Polytrauma Patients

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# Determinants of distal radius fracture management in polytrauma patients

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## Abstract

**Background** Over 640,000 distal radius fractures occur annually in the United States. No studies have been performed looking specifically at polytrauma patients who sustain distal radius fractures. We sought to determine variables affecting management of distal radius fractures in polytrauma patients. **Methods** An IRB-approved review of trauma patients from 2008–2011 was performed. Records for patients with distal radius fractures were examined, assessing age, gender, Glasgow Coma Score, Injury Severity Score, mechanism, type, and characteristics of injury, as well as operative repair. A logistic regression was performed using SPSS 15.0.

**Results** The database identified 12,054 patients, 434 sustaining a distal radius fracture. No statistically significant difference in operative repair based on mechanism of injury ( $p=0.465$ ) was identified. A total of 285 patients (65.7 %) underwent surgery for distal radius fractures. In univariate analysis, younger age was the only statistically significant demographic predictor of surgical intervention ( $p=0.003$ ). In both univariate analysis and logistic regression, open, intra-articular, displaced, and comminuted fractures, as well as those with concomitant ulna fractures were statistically significantly associated with operative repair. Fracture displacement was the most likely variable to be associated with surgical intervention (OR=12.761, 95 % CI [7.219, 22.556]) ( $p<0.001$ ).

**Conclusions** In polytrauma patients, surgery for distal radius fractures is associated with younger age, open, intra-articular,

displaced, and comminuted fractures, as well as concomitant ulna fractures. Displaced fractures were almost 13 times more likely to undergo surgical intervention than non-displaced fractures. Gender and mechanism of injury are not predictive of surgical intervention.

**Keywords** Distal radius fractures · Polytrauma · Surgery

## Introduction

Over 640,000 distal radius fractures occur annually in the United States [7, 21], representing one-sixth of all fractures treated in emergency departments [7, 15]. While studies have shown a bimodal occurrence affecting younger males and elderly populations [7, 18, 26], distal radius fractures tend to increase dramatically with advancing age [6, 31]. In addition, distal radius fractures have been reported to be 4 times more common in women, particularly after the age of 35 [17, 29], likely owing to the increasing presence of osteopenia in this patient population [25, 29]. With increasing prevalence over time [3, 20, 27], these injuries have become increasingly common with a wide variety of available treatment modalities [16, 24, 30].

Distal radius fractures are most commonly the result of a fall onto an outstretched hand [17, 19]. However, high energy mechanisms, such as falls from height or motor vehicle collisions, can lead to displaced or comminuted fracture patterns [8, 17]. Further, all distal radius fractures should be reduced, regardless of need for future surgical intervention [8, 14]. This recommendation is based upon potential adverse sequelae of unreduced fractures including nerve [2] and blood vessel compression, as well as tendon impingement. Additionally, appropriate reduction limits post-injury swelling, decreases pain, and potentially prevents nonunion or malunion of the fracture fragments [8, 12]. After reduction, many surgical options are available including closed reduction with percutaneous pinning, open reduction and

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internal fixation, and external fixation if significant bone loss, comminution, or intra-articular involvement exists [1, 13, 16, 20, 30]. Indications for surgical intervention are dependent upon multiple factors including, but not limited to, the patient's baseline level of function, fracture characteristics, and fracture stability [5, 11].

No studies have been performed looking specifically at polytrauma patients who sustain distal radius fractures. This patient population is unique in that initial evaluation and treatment focuses on life-threatening injuries. As a result, polytrauma patients may have concomitant injuries that would preclude typical, timely surgical intervention for a distal radius fracture.

We propose that an increasing trauma severity portends non-operative distal radius fracture management. Further, it is our hypothesis that surgical intervention for polytrauma patients with distal radius fractures will be influenced by factors other than fracture characteristics. Variables such as age, Glasgow Coma Score, Injury Severity Score, and mechanism for injury may play a role in determining which patients undergo inpatient surgical intervention. We also expect that gender, as a reflection of the higher incidence of osteopenia in the female patient population [23, 25, 29], will play a role.

## Materials and Methods

We performed an IRB-approved retrospective review of the Lehigh Valley Health Network Trauma Registry for patients with distal radius fractures from January 1<sup>st</sup>, 2008 through December 31<sup>st</sup>, 2011. Patients were assessed for the following: age, gender, comorbidities, Glasgow Coma Score (GCS), Injury Severity Score (ISS), blood alcohol level, mechanism of injury, type of fracture (open versus closed), characteristics of the fracture (displacement, comminution, intra-articular involvement, concomitant ulna fracture), other ipsilateral injuries, and operative repair. A univariate analysis was performed to determine the likelihood of independent variables to contribute to surgical management of distal radius fractures. Multiple logistic regression modeling was used to evaluate the relationship of fracture characteristics with surgical repair. All analyses were performed using SPSS 15.0 (SPSS Inc, Chicago, IL). Alpha was set at 0.05 with 95 % confidence intervals.

**Table 1** Patient Characteristics

	Surgery (n=285)	No Surgery (n=149)	<i>p</i>
Age, yr	46.89±26.73	55.09±29.25	0.003
Male/Female	140 (68.3 %)/145 (63.3 %)	65 (31.7 %)/84 (36.7 %)	0.276
GCS	14.42±2.16	14.23±2.60	0.452
ISS	13.94±9.28	13.33±8.37	0.498
Blood Alcohol Level (mg/dL)	38.45±81.69	70.36±103.85	0.079

GCS, Glasgow Coma Score; ISS, Injury Severity Score

## Results

Our database identified 12,054 trauma patients, of which 434 patients sustained a distal radius fracture. Of this subset, 285 patients (65.7 %) underwent surgical repair of a distal radius fracture.

### Demographics

The mean age of those undergoing surgical intervention was 46.89±26.73 compared to 55.09±29.25 for those who did not undergo surgical intervention (*p*=0.003). The rates of surgical intervention were not statistically different between males and females, 68.3 % and 63.3 %, respectively (*p*=0.276). No statistically significant correlation with surgical intervention was found with regard to GCS (*p*=0.452) or ISS (*p*=0.498). Blood alcohol level was also not statistically significantly associated with surgical intervention (*p*=0.079) (Table 1).

### Mechanism of Injury

Fractures were sustained in 282 falls (65.0 %), 128 motor vehicle collisions (MVC) (29.5 %), and 24 other subtypes (5.5 %) (i.e. assaults, bicycle accidents, explosives, and other miscellaneous mechanisms). Surgery was performed in 66.7 % of those fractures sustained in falls, 65.6 % of those sustained in MVC, and 54.2 % of those sustained in miscellaneous trauma. No statistically significant difference in operative repair was found with regard to mechanism of injury (*p*=0.465) (Table 2).

### Fracture Characteristics

Open fractures were repaired at a rate of 92.3 %, while only 62.0 % of closed fractures were repaired. Intra-articular fractures were repaired at a rate of 83.5 %, while 88.1 % of displaced, 83.7 % of comminuted, and 84.3 % of distal radius fractures with concomitant ulna fracture were repaired. In univariate analysis, all fracture characteristics analyzed were statistically associated with operative intervention (*p*<0.001) (Table 3).

A statistically significant stepwise logistic regression model was created to evaluate the role of each fracture characteristic as a determinant of surgical intervention (*p*<0.001)

**Table 2** Mechanisms of Injury ( $p=0.465$ )

	Surgery	No Surgery	Total
Falls	188 (66.7 %)	94 (33.3 %)	282 (65 %)
MVC	84 (65.6 %)	44 (34.4 %)	128 (29.5 %)
Other*	13 (54.2 %)	11 (45.8 %)	24 (5.5 %)
Total	285 (65.7 %)	149 (34.3 %)	434 (100 %)

MVC, motor vehicle collision; \*assaults, bicycle accidents, explosives, etc

(Table 4). Closed fractures were less likely to undergo surgical intervention when compared to open fractures (OR=0.380) (inversely showing that open fractures were 2.63 times more likely to undergo operative repair). Intra-articular fractures were 3.096 times more likely to undergo surgical repair ( $p<0.001$ ), while comminution and concomitant ulna fractures also predicted surgical intervention (OR=2.364, 95 % CI[1.303, 4.290] ( $p=0.005$ ), OR=2.858, 95 % CI[1.616, 5.053] ( $p<0.001$ ), respectively). Displacement was the fracture characteristic associated with the greatest likelihood for surgical intervention (OR=12.761, 95 % CI [7.219, 22.556]) ( $p<0.001$ ) (Table 4).

## Discussion

Previous studies have evaluated the role of patient and fracture characteristics with surgical intervention for distal radius fractures [5, 11, 19, 22, 31], with the typical exclusion of polytrauma patients. However, according to our hospital database, a significant number of patients sustain distal radius fractures in addition to other simultaneous multi-system injuries. Because of the robust nature of our trauma registry we were able to examine with detail the events of a traumatic injury and concomitant injuries identified either at the time of admission or throughout the course of hospitalization. As a result, we discovered the potential opportunity to elucidate the role of patient demographics, mechanisms of injury, and fracture characteristics as predictors of surgical intervention in polytrauma patients.

Analysis of over 12,000 patients at our Level 1 Trauma Center yielded 434 distal radius fractures. Of this subset, 65.7 % of patients underwent surgical intervention. The actual number of distal radius fractures seen at our institution is

**Table 4** Logistic Regression of Likelihood for Operative Management. (n=434,  $p<0.001$ )

Independent Variables	<i>p</i>	Adjusted OR [95 % CI]
Open	1.0 (reference)	
Closed	0.143	0.380 [0.104, 1.385]
Intra-articular	<0.001	3.096 [1.649, 5.809]
Displaced	<0.001	12.761 [7.219, 22.558]
Comminuted	0.005	2.364 [1.303, 4.290]
Concomitant Ulna Fracture	<0.001	2.858 [1.616, 5.053]

dramatically higher; however, the trauma registry captures only patients who have sustained polytrauma. As a result, isolated distal radius fractures were excluded from this analysis.

Of the demographic variables analyzed in this study, only younger patient age was statistically correlated with surgical correction. As patients age, there is a general trend toward a higher threshold of disability required to undergo surgery. As such, younger patients with these injuries are more likely to undergo surgery for improved wrist and hand biomechanics. Previous studies have noted that operative management is less frequently indicated in trauma of the elderly because of physiologic and psychosocial changes that occur secondary to aging [10, 31]. Operative restoration of alignment and improved mechanics are typically more important in younger patients, whereby no benefit in the elderly population has been seen with regard to long-term post-operative wrist extension, Disabilities of the Arm, Shoulder, and Hand questionnaire scores, complications, or pain level despite surgical intervention [9, 22, 31].

No difference was noted when comparing distal radius fracture surgical intervention for females as compared to males. When considering that the characteristics of the fracture, not patient gender, likely dictated the decision for operative fixation, this result indirectly demonstrates that, in our polytrauma patient population, there is no significant difference in the severity of fractures between men and women. Further, no statistical trend was noted with regard to GCS, ISS, or blood alcohol level as they related to surgical intervention.

In this study, falls represented 65 % of all mechanisms for injury—52.9 % of all mechanisms in those  $\leq 64$  years old and 86.5 % of all mechanisms in those  $>64$  years old. Motor

**Table 3** Fracture Characteristics

	Surgery (n=285)	No Surgery (n=149)	<i>p</i>
Open/Closed	48 (92.3 %)/237 (62.0 %)	4 (7.7 %)/145 (38.0 %)	<0.001
Intra-articular (n=176)	147 (83.5 %)	29 (16.5 %)	<0.001
Displaced (n=277)	244 (88.1 %)	33 (11.9 %)	<0.001
Comminuted (n=208)	174 (83.7 %)	34 (16.3 %)	<0.001
Concomitant Ulna Fracture (n=229)	193 (84.3 %)	36 (15.7 %)	<0.001

vehicle collisions comprised approximately 30 % of fracture mechanisms, which is consistent with the overall frequency of trauma resulting from this mechanism [4]. No statistical correlation between mechanism for injury and surgical intervention was identified. This result may be anticipated as broad categories such as “falls” and “motor vehicle collisions” do not stratify the severity of the mechanism for injury, and as a result, the ultimate decision to pursue surgical intervention becomes predominantly based upon fracture characteristics.

As discussed previously, all distal radius fractures should undergo attempted closed reduction to minimize potential adverse sequelae [3, 5, 8]. In our study, displacement was found to be unequivocally linked to the decision to pursue operative management (12.8 times increased likelihood of operative intervention). In addition, concomitant ulna fractures and intra-articular involvement were also associated with a 3-fold and 4-fold increased likelihood for surgery, respectively.

Fifty-five other ipsilateral concomitant upper extremity injuries were noted in our study population. These included carpal, metacarpal, and phalangeal fractures and dislocations, humerus fractures, elbow dislocations, acute carpal tunnel syndrome, arterial injuries, and tendon lacerations. Of this subset of patients, 60.1 % (38/55) underwent operative intervention – this was not notably different from the overall study operative intervention rate of 65.7 % ( $p=0.412$ ). This suggests that the presence of an ipsilateral upper extremity injury resulting from the same mechanism does not influence the surgical decision-making process regarding whether or not to repair a distal radius fracture.

Comminution of the fracture resulted in a 2.5 times increased risk of requiring surgical repair. The biomechanical impact of these fracture patterns are significant as they can lead to weakness, chronic pain, deformity, arthritis, and a tendon excursion mechanical disadvantage, particularly if left untreated [14, 26]. As a result, surgeons will typically pursue fixation for fractures with these characteristics [5, 26, 28].

A limitation of our study is the retrospective nature of the review. However, this is minimized by the fact that the data was taken from a prospectively collected database, for which data is entered throughout a patient’s hospitalization by a trained trauma registry nurse. An additional limitation is that we do not have an isolated distal radius fracture control group. This cohort comparison may have yielded differential impacts of both demographics and fracture characteristics as determinants of surgical intervention. Further, no standardized follow-up data existed with regard to post-surgical outcomes in our study population.

While polytrauma patients are a unique subset, the determinants of distal radius fracture management in this population are, with the exception of patient age, almost completely

dependent upon fracture characteristics. Neither patient gender, mental status, overall injury severity, nor mechanisms for injury were predictive of surgical intervention.

This study is the first to evaluate determinants of distal radius fracture management in the polytrauma patient population. In this cohort, surgery for distal radius fractures was associated with younger age, open, intra-articular, displaced, and comminuted fractures, as well as concomitant ulna fractures. Displaced fractures were almost 13 times more likely to undergo surgical intervention than non-displaced fractures. Further, gender and mechanism for injury are not predictive of surgical intervention. While polytrauma patients by definition have multiple concomitant injuries, surgical management of distal radius fractures is predicted almost exclusively by fracture characteristics.

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**Conflict of interest** None of the authors have any conflicts of interest to declare.

**Statement of informed consent** No consent was obtained as this was a retrospective review of de-identified data.

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