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Understanding Variations in the Management of Displaced Distal Radius Fractures With Satisfactory Reduction

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Abstract

Background: The American Academy of Orthopaedic Surgeons has set forth Clinical Practice Guidelines (CPGs) to help guide management of closed, displaced distal radius fractures (DRFs). There still exists variation in practice regarding operative vs nonoperative decision-making. This study aims to identify which factors influence the decision to treat DRFs not indicated for surgery by the CPGs after initial closed reduction. **Methods:** Fifteen sets of DRFs and clinical vignettes were distributed via email to over 75 orthopedic residency programs, Orthopaedic Trauma Association, and New York Society for Surgery of the Hand membership. A Qualtrics survey collected respondent demographics, choice of treatment, and rationale. **Results:** Responses were received from 106 surgeons and resident trainees. The odds of selecting operative management for fractures with 5 or more radiographic instability signs versus 3 or 4 was 3.11 ($P <$ .05). Age over 65, higher patient activity level, and dominant-hand injury were associated with greater odds of operative management (3.4, 30.28, and 2.54, respectively). In addition, surgeons with more years in practice and high-volume surgeons had greater odds of selecting operative management (2.43 and 2.11, respectively). **Conclusions:** Assessment of instability at the time of injury, patient age and activity level, as well as surgeon volume and time in practice independently affect the decision to manage well-reduced DRF with surgical or nonsurgical treatment. The source of heterogeneity in the treatment of these fractures is borne at least in part from a lack of formal direction on the importance of prereduction instability from the CPGs.

Keywords: distal radius, fracture/dislocation, diagnosis, wrist, treatment, research & health outcomes, radiocarpal, clinical practice guidelines

Introduction

Closed, displaced distal radius fractures (DRFs) are among the most common upper-extremity fractures in the United States. They occur with an estimated incidence of 16.2 fractures per 10 000 persons annually and represent the most common upper-extremity fracture for individuals younger than 18, older than 50, and in females overall.[1] When the expertise is available, the initial emergency department management of displaced injuries may consist of closed reduction, splint immobilization, and immediate postreduction radiographs. Soon thereafter, treating physicians must decide on the definitive management to decrease adverse outcomes related to delays in care.

The American Academy of Orthopaedic Surgeons (AAOS) has set forth Clinical Practice Guidelines (CPGs) to help steer physicians to definitive treatment plans by providing criteria for operative and nonoperative management. These criteria are based primarily on postreduction radiographic alignment but also consider patient age and activity

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level. The guidelines published in 2020 for nongeriatric patients (defined as under age 65) recommend operative treatment for fractures with postreduction radial shortening >3 mm, dorsal tilt >10°, or intraarticular displacement or step-off >2 mm, to improve radiographic and patient-reported outcomes with moderate evidence. For geriatric patients (defined as over age 65), strong evidence suggests that operative treatment does not lead to improved long-term patient-reported outcomes compared to nonoperative treatment.[2] Despite these CPGs, there is marked disagreement among surgeons about what the definitive treatment (operative or nonoperative) should be for patients. Even after an initially displaced DRF has been reduced to a radiographic alignment within the CPGs criteria for nonoperative management, many surgeons will elect to proceed with surgical management. This indicates that there exist some factors that are driving the treatment of these injuries not accounted for in the formally written guidelines.

One important consideration in the management of displaced DRFs is fracture stability. Several investigations have identified radiographic findings that imply instability.[3-10] When a displaced DRF undergoes closed reduction to achieve anatomic or near-anatomic alignment, the assessment of prereduction radiographic instability may play a role in selecting the appropriate definitive management, particularly when the CPGs recommend nonoperative treatment.

Despite the work supporting the relevance of prereduction radiographic analysis to predict outcomes of displaced DRFs, the current CPGs do not give guidance on the role they should play in selecting the definitive management after closed reduction. Therefore, surgeons make decisions about the management of these injuries that are influenced by factors such as prereduction radiographic evaluation, patient demographics, and their own past experiences. This individualized approach can produce the variation observed in the choice of treatment of displaced DRFs and lead to nonuniformed outcomes. The negative aspects of these heterogenous outcomes are borne by patients who, at one extreme, suffer complications related to surgery that may not have changed functional outcomes and, on the other, endure a suboptimal outcome with nonoperative treatment.

The purpose of the present study is to identify which radiographic, patient, or surgeon factors influence the decision to treat DRFs not indicated for surgery by the AAOS CPGs, after initial closed reduction, with surgical or nonsurgical treatment. Primarily, we hypothesize that surgeons are more likely to select operative management of closed DRFs with more radiographic signs of instability at the time of injury regardless of satisfactory reduction based on the AAOS CPGs. Secondarily, we hypothesize that age >65 years will decrease the odds of selecting operative management of these fractures and that surgeon demographics will not influence management decision of these fractures.

Methods

Fractures and Vignettes

After institutional review board approval, a retrospective image repository search of DRFs was conducted from 2015 to 2020. Fifteen radiographs were selected for the survey. All included both prereduction and postreduction films. A complete series consisted of a posterior-anterior (PA) and lateral views. Radial inclination, ulnar variance, articular diastasis, and sagittal angulation were measured in Synapse Mobility Enterprise Viewer (FUJIFILM Healthcare Americas Corporation) by 2 authors (JNAA and VC). These components were measured as defined by Ng and McQueen.[11]

Fracture measurements were recorded for both injury and postreduction imaging. Three of the 15 radiographs had initial closed reductions that were not acceptable based on the current AAOS CPGs and were used as controls. In addition, all radiographs were evaluated for carpal malalignment, intraarticular involvement, the presence of a postreduction hooked volar cortex (alignment of the volar proximal and distal fracture edges), shear-type injuries, volar and dorsal ulnar corner fragments, radial styloid fragments, coronal fracture, concomitant ulnar styloid fractures, and metaphyseal comminution.[11,12]

Fifteen vignettes were generated to accompany each set of radiographs (see Figure 1 and Supplemental Materials). The vignettes provided patient age, gender, occupation/functional status, and hand dominance (Table 1).

Survey

The Qualtrics Suite (Provo, Utah) was used to create a 15-vignette survey consisting of questions regarding respondent demographics and patient vignettes. Patient vignettes were accompanied by prereduction and postreduction radiographs (Figure 1). Participants were asked to choose definitively between operative and nonoperative management and were subsequently asked to select the patient demographic and/or radiographic factors that influenced their decision. The survey was distributed via an email link to 77 orthopedic residency programs primarily in the Northeast and a regional and national orthopedic society (the Orthopaedic Trauma Association and New York Society for Surgery of the Hand membership). The identity of respondents was kept anonymous.

Data and Statistical Analysis

All statistical analyses were performed using R Version 4.2.2 (R Foundation for Statistical Computing, Vienna, Austria). Management decision (operative vs nonoperative) was analyzed against number of prereduction fracture instability signs (group A: <3, group B: 3-4, and group C: ≥5), patient demographics (age, activity level, and hand dominance), and

Figure 1. Case vignette example. Case vignettes each consisted of injury and postreduction radiographs, followed by a series of questions related to management. Please see supplemental materials for additional case vignettes and radiographs.

respondent demographics (time in practice, surgeon volume, surgical subspecialty, and practice setting). For the purpose of the analysis, patient age of 65 was used as a cutoff with those younger than 65 being placed in the nongeriatric group and those aged 65 years or older placed in the geriatric group. Patient activity level was binary (high or low) based on the occupation/functional status in the vignette. For example, an occupation of surgeon, hunter, or musician was considered high activity, and the status of home ambulator or retired community ambulator was considered sedentary. A power analysis was performed before the survey period, which determined that at least 97 respondents would be needed to produce an effect size of 0.250 with alpha set to 0.05 and beta set to 0.20. Odds ratios were calculated through multivariate regression with 95% confidence intervals (CI). All P values were two-sided, and a value of .05 was considered statistically significant.

Results

Respondent Demographics

Time in practice. There were 106 respondents, 82 attending surgeons and 24 trainees. Of attending surgeons, 6.1% (n = 5)

Table 1. Case Characteristics.

Case #	Age group	Activity level	Hand dominance	Instability factors (#)
1	Non-geriatric	Active	Dominant	3
2	Geriatric	Sedentary	Dominant	5
3	Non-geriatric	Active	Non-dominant	4
4	Non-geriatric	Active	Dominant	5
5	Non-geriatric	Active	Non-dominant	4
6	Geriatric	Sedentary	Dominant	8
7	Geriatric	Active	Non-dominant	6
8	Non-geriatric	Active	Dominant	2
9	Non-geriatric	Active	Non-dominant	3
10	Geriatric	Active	Non-dominant	2
11	Geriatric	Sedentary	Dominant	2
12	Non-geriatric	Active	Dominant	5
13	Geriatric	Active	Non-dominant	3
14	Geriatric	Sedentary	Dominant	4
15	Non-geriatric	Active	Non-dominant	4

Table 2. Respondent Time in Practice.

Training level/years in practice	*n* (%)
Trainees, *n* = 24	
PGY-1	5 (4.7)
PGY-2	6 (5.7)
PGY-3	4 (3.8)
PGY-4	6 (5.7)
PGY-5	3 (2.8)
Attending surgeons, *n* = 82	
0-5 years	5 (6.1)
6-10 years	15 (18.3)
11-20 years	23 (28.0)
21-30 years	25 (30.5)
31+ years	14 (17.1)

Note. PGY = postgraduate year.

were in their first 5 years of practice, 18.3% (n = 15) were in years 6 to 10, 28% (n = 23) were in their second decade of practice, 30.5% (n = 25) in their third, and 17.1% (n = 14) had more than 3 decades of experience. Among trainees, 3 were postgraduate year (PGY)-5, 6 were PGY-4, 4 were PGY-3, 6 were PGY-2, and 5 were PGY-1 (Table 2).

Surgical subspecialty and practice/training setting and location. More than half of respondents reported having undergone hand specialty training, being either orthopedic hand/upper extremity fellowship trained or plastic surgeons with hand fellowship training (65.1%; n = 69). Of the remaining respondents, 22.6% reported being trainees (n = 24), and the remaining 12.3% were composed of the following: 2 general orthopedists, 4 orthopedic traumatologists, 1 plastic surgeon with no hand fellowship training, and 6 practicing in other orthopedic subspecialties. The majority of respondents (84.9%) were located in the Northeast (n = 90), with 9.43% (n = 10) coming from the Southeast, and 5.66% (n = 6) from the Midwest. When grouped by setting, 80.2% (n = 85) of the respondents reported frequent academic involvement in their work setting. The remaining 19.8% (n = 21) reported infrequent or no academic involvement in their practice (Table 3).

Surgical volume. Eighty-two attending surgeons reported on their DRF operative volumes. Of this group, 41.5% (n = 34) operate on <3 fractures per month, 47.6% (n = 39) operate on between 3 and 5 per month, and 10.9% (n = 9) on 6 or more times per month.

Control Fractures and Overall Consensus

The control vignettes, cases 1, 2, and 3, (Supplemental Materials) had 93% (83 of 89 respondents), 74% (61 of 82 respondents), and 98% (86 of 88 respondents) of respondents opt for operative management, respectively. This represents high consensus among respondents for the control fractures. Case 2's vignette presented a poorly reduced DRF in an active, elderly individual. The relative increase in the raw rate of nonoperative management for this case shows a tendency for demographics like age to influence the management decisions in spite of poor radiographic alignment.

The experimental cases (4-15) had an overall raw rate of 44.5% (465 of 1045 responses) for operative management. There was low consensus among respondents in the experimental cases of fractures that had adequate radiographic alignment after closed reduction.

Table 3. Respondent Subspecialty, Practice Setting, and Location.

	n (%)
Specialty identification	
Hand/upper extremity	69 (65.1)
Orthopedic trauma	4 (3.8)
General orthopedics	2 (1.9)
Other orthopedic subspecialty	6 (5.7)
Plastic surgery w/o hand fellowship training	1 (0.9)
Trainee	24 (22.6)
Practice setting and location	
Northeast	90 (84.9)
Southeast	10 (9.4)
Midwest	6 (5.7)
Academic involvement	85 (80.2)
Little to no academic involvement	21 (19.8)

Impact of Number of Prereduction Instability Signs on the Odds of Operative Management

A multivariate analysis of patient and respondent demographics showed the impact of the number of prereduction instability factors on management decisions. Group C fractures had significantly higher odds of being indicated for operative management (3.11; 95% CI 2.12-4.62) than group B fractures. There was no difference in the odds of being indicated for operative management between group C and group A fractures (0.95; 95% CI 0.67-1.35). Group B fractures had significantly lower odds of being indicated for operative management than group A fractures (0.31; 95% CI 0.20-0.46).

Impact of Patient Demographics on the Odds of Operative Management

Age, hand dominance, and patient activity level all played a role in respondent management decision. When considering age, the odds of indicating operative management for patients in the nongeriatric group were significantly higher than those for geriatric patients (3.40; 95% CI 2.55-4.56). When considering hand dominance, respondents had 2.54 (95% CI 1.81-3.59) times the odds of indicating operative management for patients with dominant-hand injuries compared to those with nondominant-hand injuries. Activity level was a strong predictor of management decisions. The odds of being indicated for operative management were significantly higher for active patients than for sedentary patients (30.28; 95% CI 14.5-64.7).

Impact of Surgeon Demographics on the Odds of Operative Management

Both respondent experience and surgical volume had an impact on the decision-making about these fractures, while orthopedic subspecialty and practice setting did not. Respondents with more than 5 years of experience had significantly higher odds of selecting operative management than those with fewer years of experience (2.43; 95% CI 1.20-5.19). Respondents who reported a high operative volume had significantly increased odds of selecting operative management compared to their low-volume counterparts (2.11; 95% CI 1.51-2.95). The odds of selecting operative management when respondents had hand/upper-extremity training did not significantly differ from that in those who did not (0.79; 95% CI 0.53-1.17). Respondents in primarily private practice settings did not differ in their odds of selecting operative management compared to those in a primarily academic setting (1.06; 95% CI 0.75-1.49; Figure 2).

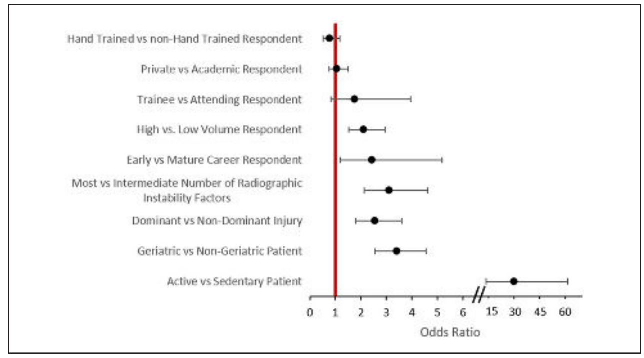

Figure 2. Odds of operative management.

Discussion

This study presents the findings from a survey of 106 surgeons and residents regarding their decision to definitively manage 15 DRFs not indicated for surgery by the AAOS CPGs after the initial closed reduction with operative or nonoperative treatment. Most respondents were from the Northeast region of the United States, with more than half of the surgeons having undergone hand fellowship training. The responses suggest that the decision to manage these fractures with operative or nonoperative treatment is dependent on key patient demographics and surgeon factors. The surgeon's assessment of fracture instability may also play a role in the decision to operate, which is not fully clarified.

Regarding instability, although group C fractures (≥5 instability signs at the time of injury), were significantly more likely to be indicated for operative treatment than group B fractures (3-4 instability signs), there was no difference in the odds of operative treatment between group C and group A fractures (≤2 instability signs). This suggests that quantity of prereduction instability factors may influence the decision-making of surgeons but is not independently driving clinical decision-making.

Understanding instability from a radiograph is a challenging undertaking. This has been an area of interest in the literature, and some authors have since identified radiographic findings at the time of injury that correlate with dynamic instability.[3-8] Lafontaine et al reported that dorsal angulation >20°, dorsal comminution, intra-articular fractures, and ulnar styloid fractures were individually significant radiographic risk factors for secondary displacement despite initial appropriate closed reduction.[3] Subsequent studies by Bhattacharyya et al,[4] Myderrizi,[5] Hove et al,[6] and Batra et al[7] reported instability markers similar to those set forth by Lafontaine with the additions of loss of radial height, osteoporosis, radiocarpal malalignment, and distal radioulnar joint involvement as predictors of secondary displacement. The importance of the quantity of instability signs at the time of injury has also been the topic of discussion of many authors. The works by Leone et al and Lafontaine et al support that radiographic outcomes worsen as the number of instability signs increased, specifically noting that ≥3 instability signs at the time of injury may correlate with radiographic loss of reduction and failure of closed treatment.[3,9] Bhattacharyya et al examined the relationship between these instability signs and patient functional outcomes and found that at ≥4 instability signs, the proportion of patients reporting "good" functional outcomes was greater when fractures were treated operatively (78%) than with closed treatment (58%).[4] The amount of instability produced by each instability sign has also been investigated. The study by Mackenney et al cite metaphyseal comminution and ulnar variance (>3 mm) as the most important predictors of early instability and fracture redisplacement at 2 weeks and dorsal angulation (>10°) and ulnar variance as important predictors of late instability and fracture redisplacement at 6 weeks.[10]

While many authors have attempted to define fracture instability through the presence or absence of certain factors, the degree to which these factors influence stability may exist on a spectrum. Schmidt et al[13] found that increasing dorsal angulation was associated with worse functional outcome scores and more importantly that this relationship was nonlinear. They studied dorsal angulation as a continuous variable and found that the decline in clinical outcome starts at 5°, but there is unlikely to be a noticeable difference until 20°.[13] As our study defined these instability factors as existent or nonexistent, we are unable to account for this nonlinear relationship in our analysis of survey responses. However, based on the findings of our study that quantity of instability factors alone is not driving management. It should be considered that surgeons may be factoring these relationships into their decision-making with each instability factor either independently or together in conjunction with others. As we may not necessarily have data to describe the nonlinear relationship of each instability factor, surgeons may be relying on a clinical gestalt from prior experiences.

With regard to patient demographics, age >65 years significantly decreased the odds of selecting operative treatment for DRFs compared to age <65 years. Higher activity level and dominant-hand injury both independently increased the odds of selecting operative treatment. While surgeon factors like practice model and hand fellowship training did not affect the decision-making in this cohort, high surgical volume (≥4 DRFs treated surgically per month) and mature practice (≥5 years in practice) both independently increased the odds of selecting operative treatment. These findings offer insights into the differences observed in the treatment approaches for isolated, closed, displaced DRFs that have been successfully realigned to meet the criteria for nonoperative treatment, as outlined in the AAOS CPGs for DRFs in nongeriatric patients.

The importance of certain patient demographics is emphasized by the current AAOS CPGs. The value of considering age (which is used as a proxy for activity level in the CPGs) in the selection of closed or operative treatment has been the topic of many high-level studies. The randomized studies by Martinez-Mendez et al[14] and Saving et al[15] both support operative treatment for DRFs in patients older than 60 and 70 years of age in favor of improved radiographic and functional outcomes, respectively. These studies provide high-level evidence supporting surgical management of these fractures based on clinically significant patient-reported outcome scores. A more recent multicenter trial by the CROSSFIRE study group discussed the functional outcomes of closed treatment of isolated, closed, displaced DRFs of various morphologies (extra-articular or complete articular). They found that in patients older than 60 years, closed treatment was not clinically significantly worse or different from operative treatment with internal fixation.[16] This study provides level I evidence on this subject, supporting that surgical treatment in this patient population does not consistently improve subjective patient outcomes when compared to nonsurgical treatment. The value of this study is magnified by its rigorous methodology and a notable consideration of age as well as baseline functional status in the patient inclusion criteria. While some comparative studies may provide varying answers, systematic reviews on the topic have consistently identified that nonoperative management of DRFs in elderly patients yield clinically similar functional results, without the additional cost or risk of operative treatment.[17-19]

Not only are prereduction instability and key patient demographics important in the decision to manage well-reduced DRFs operative or closed, surgeon demographics also independently influenced the choices made in our cohort. This study found that higher surgical volume and more time in practice tended to increase a surgeon's odds of selecting operative treatment. These findings are corroborated by the results of the work by Doermann et al[20] that showed surgeons with more than 10 years in practice and those with surgical volumes >100 fractures per year were more likely to choose operative treatment for their fractures. The authors of this study propose that surgical volume and years of practice can serve as reliable indicators of expertise in managing these injuries. Experienced surgeons are more likely to be familiar with the nuances involved in managing such cases, enabling them to predict which fractures and patients are more likely to respond poorly to nonoperative treatment. In addition, higher-volume surgeons may find the streamlined radiographic monitoring and fewer office visits associated with uncomplicated operative treatment advantageous compared to the nonoperative approach. It is reasonable to assume that a physician's experience plays a pivotal role in guiding their treatment decisions. The report by the Science of Variation group supports this line of thinking, stating that in the absence of formal guidance and when faced with inconclusive evidence, surgeons rely on their training and practice experiences as well as personal perspective and the culture of treatment in their locale to make decisions.[21] In cases of well-reduced DRFs, there is a lack of formal, objective guidelines concerning the role of radiographic prereduction instability in making treatment decisions. As a result, surgeon demographics and individual experiences have a significant impact on determining the appropriate management approach. This variability in decision-making contributes to the observed heterogeneity in how these fractures are managed. Given the complexity of DRFs and the intricate interplay between prereduction instability and postreduction alignment, it is reasonable to consider whether a comprehensive assessment encompassing both prereduction and postreduction parameters could provide a more nuanced approach to treatment decision-making. Surgeons may find value in considering the broader spectrum of factors, including those present before reduction, to ensure that the most appropriate treatment strategy is selected for each individual patient.

Conclusions

Patient age and activity level, as well as surgeon volume and time in practice, independently affect the decision to manage well-reduced DRF with operative or nonoperative treatment. The value of the quantity and quality of prereduction instability factors in the decision-making process for these fractures has yet to be clarified. The source of heterogeneity in the treatment of these fractures is borne at least in part from a lack of formal direction on the importance of prereduction instability from the current AAOS CPGs. Future iterations of the AAOS guidelines will benefit from incorporating guidance on the importance of assessing prereduction instability when making management decisions.

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 (5).

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study by agreement to participate and completing the anonymized survey.

Declaration of Conflicting Interests

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