Adult Closed Distal Radius Fracture Reduction: Does Fluoroscopy Improve Alignment and Reduce Indications for Surgery?

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Efi Kazum¹, Assaf Kadar¹, Zachary T. Sharfman¹, Hila Otremsky¹, Roy Gigi¹, Yishai Rosenblatt¹, Oleg Dolkart¹, and Tamir Pritsch¹

Abstract

Background: This study compared the radiological outcomes of adult closed distal radius fractures (DRFs) reduction with and without fluoroscopy. We hypothesized that fluoroscopy-assisted reduction would not improve radiographic alignment or decrease the need for surgery. **Methods:** Hospital medical records and radiographic images of all patients who presented with DRFs between April to June 2009 and April to June 2013 were reviewed. All patients underwent closed reduction and immobilization with or without fluoroscopic assistance. Reduction attempts were noted and pre- and postreduction posteroanterior and lateral radiographs were reviewed for fracture stability. **Results:** Eighty-four patients underwent reduction without fluoroscopy (group 1), and 90 patients underwent reduction with the aid of fluoroscopy (group 2). According to accepted radiographic guidelines, nonsurgical treatment was indicated for 62% of patients in group 1 and 56% of patients in group 2 ($P = .44$). In addition, no significant difference between the groups was observed in any postreduction radiographic parameters ($P > .53$) or postreduction alignment of unstable fractures ($P = .47$). **Conclusions:** Reduction without the use of fluoroscopy demonstrated noninferiority when compared with fluoroscopy-assisted reduction in the emergency department for closed adult DRFs.

Keywords: distal radius fractures, emergency department, mini-c-arm, outcomes, reduction

Introduction

Distal radius fractures (DRFs) are the most common fractures seen in the emergency department (ED). These fractures represent approximately 3% of all upper extremity injuries, and more than 640 000 are recorded annually in the United States alone.² Closed reduction and immobilization has traditionally been the mainstay of treatment. This treatment aims to obtain acceptable fracture alignment and maintain long-term stability. Fluoroscopy-assisted reduction offers several advantages. Fluoroscopy offers real-time assessment of fracture alignment during reduction and may expedite patient care by decreasing waiting time for postreduction films.

Fluoroscopy-assisted reduction is a common practice but definitive research regarding improved alignment and decreased need for surgery is lacking. This study compared the radiological and clinical outcomes of adult closed DRFs reduced with and without fluoroscopy. We hypothesized that fluoroscopy-assisted reduction would not significantly improve radiographic alignment or decrease the need for surgery.

Methods

The local institutional review board approved this retrospective cohort study. Hospital medical records and radiographic images of all patients who presented to our level I trauma center between April and June 2009, a time period before the introduction of the mini-c-arm fluoroscopy to our ED, were reviewed (group 1). Patients presenting between April and June 2013, after the mini-c-arm fluoroscopy was implemented for routine use, were reviewed for inclusion in the fluoroscopy-assisted reduction group (group 2). These time periods were chosen to allow for adequate time to mitigate the effects of a learning curve after the introduction of fluoroscopy-assisted reduction in the ED. Patients were eligible

¹Hand and Elbow Unit, Orthopedic Division, Tel Aviv Sourasky Medical Center, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

Corresponding Author:

Oleg Dolkart, Hand Surgery Unit, Orthopedic Division, Tel Aviv Sourasky Medical Center, Sackler Faculty of Medicine, Tel Aviv University, 6 Weizmann Street, Tel Aviv 6423906, Israel.
Email: dolkarto@gmail.com

for inclusion in this study if they were above the age of 18, had a DRF, and presented during the study period. Patients were excluded if they had open physis, nondisplaced fractures, pathological fractures, or did not undergo reduction. Pre- and postreduction posteroanterior and lateral radiographs were reviewed in all patients.

All patients underwent closed reduction and immobilization. The procedure was carried out by the orthopedic staff with the assistance of an ED nurse. All reductions were performed under hematoma block with 10 mL of lidocaine 1%. Traction was applied followed by manual manipulation and short arm cast or splint immobilization in accordance with that described by Bong et al.¹ Fluoroscopic guidance with the Fluoroscans Insight 2, Hologic, Bedford, Massachusetts, was used for all patients with fluoroscopy-assisted reduction.

Demographic data were obtained from patients' charts. Radiographic assessment was performed by two orthopedic residents and one senior fellowship trained hand surgeon. The observers were blinded to the patient's treatment protocols. Prereduction posteroanterior and lateral wrist radiographs were evaluated for fracture stability using Lafontaine's criteria.⁴ The radiographs were evaluated for articular involvement (intra- or extra-articular), degree of comminution, stability, and associated ulnar fracture. Radial inclination (degrees), volar tilt (degrees), radial shortening, intra-articular gaps, and step-offs (mm) were measured via postreduction posteroanterior and lateral films using PACS software (Centricity Enterprise, GE Healthcare, Barrington, IL). Postreduction fracture alignment was considered acceptable in accordance with the criteria described by Ruch et al.,⁸ namely, less than 5° of dorsal angulation, less than a 2 mm articular step-off and intra-articular gap, less than 5° of radial angle loss, and shortening less than 3 mm.

Statistical Analysis

Power analysis was performed using IMB SPSS 21 (SPSS Inc, Chicago, Illinois) at a beta of 0.8 and alpha of 0.05. It was determined that 50 patients in each group would be adequate to detect significant differences in re-manipulation and surgery rates. Data were analyzed with the SPSS for Windows Version 21.0 (SPSS Inc, Chicago, Illinois). Data are presented as mean $\pm$ standard deviation. Univariate analyses were performed with the Fisher exact test for categorical data, and Student's *t* test for continuous *P* value less than .05 was considered as statistically significant.

Results

A total of 174 patients with displaced DRFs were included in this study. Eighty-four patients underwent reduction without fluoroscopy, and 90 patients underwent reduction

Table 1. Patients Demographics and Fracture Type.

	Control group	Mini-c-arm group	<i>P</i> value
No. of patients	84	90	
Age (mean $\pm$ SD)	63.18 $\pm$ 19.8	63.49 $\pm$ 21.0	.92
Gender			
Female, n (%)	59 (70)	67 (74)	
Male, n (%)	25 (30)	23 (26)	.61
Fracture characteristics, n (%)			
Extra-articular	46 (54)	47 (52)	
Intra-articular	38 (46)	43 (48)	.76
Simple	44 (52)	52 (57)	
Comminuted	40 (48)	38 (43)	.54
Stable	48 (57)	54 (60)	
Unstable	36 (43)	36 (40)	.75
Associated ulnar fracture	27 (32)	11 (12)	.001

with the aid of fluoroscopy. Postreduction radiographs of all 174 patients were available for analysis. Demographic data, including age and gender, did not differ between groups. Fracture characteristics such as articular involvement, comminution, and fracture stability did not differ between groups. The nonfluoroscopy group had significantly more associated ulnar fractures when compared with the fluoroscopy group (nonfluoroscopy: 32%; fluoroscopy: 12%, *P* = .001). No significant difference was observed in the proportion of stable and unstable fractures according to Lafontaine's criteria (*P* = .75). All demographic data and fracture characteristics are presented in Table 1.

No significant difference was observed between the 2 study groups in any postreduction radiographic parameters (*P* > .53). Postreduction radial inclination, volar tilt, shortening, and intra-articular gaps and step-off measurements are presented in Table 2. When considering all patients in each group, no significant difference was observed in the amount of patients for whom surgery was indicated according to their postreduction radiographs. Thirty-two patients (38%) in the nonfluoroscopy group and 40 patients (44%) in the fluoroscopy group had unacceptable postreduction fracture alignment (*P* = .44, Table 3). Thirty-six patients in each group had unstable fractures according to Lafontaine's criteria. Of these patients, 17 patients in the nonfluoroscopy group and 13 patients in the fluoroscopy group had acceptable postreduction alignment for which surgery was not indicated (*P* = .47).

Discussion

The principal results of this study demonstrated no advantage to fluoroscopy-assisted reduction of DRF in obtaining acceptable radiographic outcomes. Furthermore, no differences were observed in postreduction radiographic parameters and unstable fracture reduction alignment.

Table 2. Postreduction Radiographic Outcomes.

	Control group (n = 84)	Mini-c-arm group (n = 90)	P value
Radial inclination, degrees (SD)	19.24 (4.8)	19.44 (4.9)	.78
Volar tilt, degrees (SD)	0.45 (10.2)	-0.02 (9.1)	.74
Shortness, mm (SD)	-0.02 (2.3)	0.19 (2.54)	.55
Gap, mm (SD)	0.35 (0.8)	0.31 (0.8)	.81
Step-off, mm (SD)	0.21 (0.6)	0.15 (0.5)	.53

Table 3. Comparison of Clinical Outcomes.

	Control group (n = 84)	Mini-c-arm group (n = 90)	P value
Surgery indicated, n (%)			
Yes	32 (38)	40 (44)	
No	52 (62)	50 (56)	.44

Closed reduction and immobilization is the mainstay of acute treatment of displaced DRFs.⁸ The goal is to achieve and maintain acceptable fracture alignment, for which surgery is not indicated.^{3,7} The use of fluoroscopy in fracture reduction in the ED has gained popularity over the last two decades, due to the conception that real-time evaluation allows for superior outcomes and potentially limits the need for surgical intervention. Other theoretical advantages of fluoroscopy include expedited patient care and fewer attempts at fracture reduction. Although there are studies⁹ confirming that the use of fluoroscopy may be safe, it still increases the radiation exposure of the surgeon compared with plain radiographs.

Lee et al⁵ studied the effectiveness of fluoroscopy in closed reduction of adult DRFs. The study included 46 patients with forearm, wrist, digit, or hand fractures reduced in the ED with the aid of a fluoroscopy device, compared with 55 patients in a nonfluoroscopy group. They reported 100% and 85% success rate in the fluoroscopy group and nonfluoroscopy groups, respectively, and concluded that fluoroscopy-assisted reduction significantly improved outcomes. The results of this study are not in agreement with the aforementioned study. However, this may be explained by the inclusion of a variety of fracture types in Lee's study.⁵ Furthermore, the parameters for acceptable reduction were not specified. Lee and colleagues⁶ performed a separate retrospective study on 279 children with displaced forearm and DRFs who were treated in the ED with or without the aid of fluoroscopy. The authors concluded that the use of fluoroscopy in reduction decreased the number of reduction attempts, radiation exposure to patients, and the need for surgery in pediatric forearm and DRFs. Some factors that may contribute to the dissimilar results of our study and that of Lee and colleagues may be the profound differences between the pediatric and adult population with regard to fracture

patterns, bone properties, and the role of the periosteum in fracture reduction and stability.

Limitations

This study has several limitations, including those inherent to its retrospective design. To objectively assess the benefit of fluoroscopy-assisted reduction, indications for surgical intervention were determined by postreduction film measurements. All patients had posteroanterior and lateral view X-ray films but variation in hand positioning may have affected the accuracy of the measurement. In addition, due to insufficient data, no analysis of radiation exposure, or number of reduction attempts, was performed.

Conclusions

Reduction without the use of fluoroscopy demonstrated noninferiority when compared with fluoroscopy-assisted reduction in the ED for closed adult DRFs.

Authors' Note

The authors Efi Kazum and Assaf Kadar have contributed equally to this work.

Ethical Approval

The study was approved by the Tel Aviv Sourasky Medical Center Ethical Committee Study No. TLV-0514-12.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

Informed consent was obtained when necessary.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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