EDITOR'S CHOICE

Effectiveness of Delayed Surgical Treatment for Distal Radius Fractures With Loss of Reduction

Tolga Keçeci, MD,* Bekir Karagöz, MD,† İsmail Ağır, MD‡

CME Continuing Medical Education

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Disclosures for this Article

Editors

Ryan Calfee, MD, MSc, has no relevant conflicts of interest to disclose.

Authors

All authors of this journal-based CME activity have no relevant conflicts of interest to disclose. In the printed or PDF version of this article, author affiliations can be found at the bottom of the first page.

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Ryan Calfee, MD, MSc, has no relevant conflicts of interest to disclose. The editorial and education staff involved with this journal-based CME activity has no relevant conflicts of interest to disclose.

Learning Objectives

Upon completion of this CME activity, the learner will understand:

- Risk factors for loss of closed reduction for distal radius fractures.
- The expected patient-reported outcomes for delayed versus early surgery for distal radius fractures.
- The complication profile of delayed versus early surgery for distal radius fractures.

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Purpose This study investigated the effectiveness of volar plate surgery in patients with distal radius fractures (DRFs) initially treated nonsurgically but later experiencing reduction loss during follow-ups. Specifically, it assessed the impact of early surgery (E) (<3 weeks) versus delayed surgery (D) (3−6 weeks) on wrist function in surgically treated DRFs.

*From the *Department of Orthopaedics and Traumatology, Ordu University Training and Research Hospital, Ordu, Türkiye the †Department of Orthopaedics and Traumatology, Eskisehir City Hospital, Eskisehir, Türkiye; and the ‡Department of Orthopaedics and Traumatology, Adıyaman University Training and Research Hospital, Adıyaman, Türkiye.*

Received for publication October 6, 2023; accepted in revised form July 15, 2024.

Corresponding author: Tolga Keçeci, MD, Department of Orthopaedics and Traumatology, Ordu University, Cumhuriyet mah. 1242. Sk. No: 8A/1 Altınordu/Ordu, 52200 Türkiye; e-mail: tolgakececi@hotmail.com.

0363-5023/24/4911-0006$36.00/0
https://doi.org/10.1016/j.jhsa.2024.07.006

Methods This retrospective study included 131 patients who underwent surgery after loss of reduction. Among them, 42 patients had delayed surgery, whereas 89 received early surgical treatment. The mean follow-up duration was 18 months. The primary outcome measure was Disabilities of the Arm, Shoulder, and Hand scores. Secondary outcomes included Short Form-12 physical component summary and mental component summary scores, postoperative range of motion, and radiological measurements such as radial length, radial inclination angle, and volar tilt angle. Fracture types were categorized using Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association classification based on radiological images.

Results All 131 DRFs achieved radiological union. Mean Disabilities of the Arm, Shoulder, and Hand scores were 8.0 (range, 0−78) and 10.8 (range, 0−73) for groups E and D, respectively, and the difference was not considered clinically relevant. Short Form-12 physical component summary scores (49.4 for E; 45.3 for D) and Short Form-12 mental component summary scores (52.3 for E; 53.5 for D) were similar in the two groups. Radiological measurements and range of motion were similar in the two groups. Complications, including carpal tunnel syndrome, superficial radial nerve neuropraxia, and complex regional pain syndrome, occurred in 12 (13.5%) E group patients and 9 (21.4%) D group patients.

Conclusions Clinical and radiological results of early and delayed surgery after loss of reduction in secondary displaced DRF were similar. However, complication rates were higher in delayed surgery. *(J Hand Surg Am. 2024;49(11):1104−1110. Copyright © 2024 by the American Society for Surgery of the Hand. All rights are reserved, including those for text and data mining, AI training, and similar technologies.)*

Type of study/level of evidence Prognostic IV.

Key words AO-classification, plate fixation, radius fracture, range of motion, timing of surgery.

DISTAL RADIUS FRACTURE (DRF) is one of the most common fractures in the upper extremity. This important public health concern is associated with osteoporosis in the elderly and with high-energy trauma in the young population.[1] The choice of treatment modality depends on multiple considerations, including patient age, patient expectations, bone quality, occupational factors, overall health status, fracture type, and associated injuries.

Successful outcomes can be achieved through closed reduction and casting in some cases of unstable extra-articular DRFs or intra-articular DRFs with minimal displacement.[2] However, the risk of secondary displacement increases in fractures with metaphyseal angulation exceeding 20°, metaphyseal collapse-related shortening exceeding 3 mm, dorsal comminution, concurrent ulna fractures, substantial displacement on initial radiographs, compromised bone quality, or advanced age.[3−6] Although the necessity of achieving precise anatomical alignment in such fractures is debated, clinical and biomechanical studies emphasize the importance of restoring radial length and addressing palmar tilt and radial tilt, albeit to varying degrees.[7,8]

Surgical intervention may be required for DRFs that do not meet radiological criteria for an acceptable reduction during initial attempts at closed reduction.[9,10] Evidence regarding the impact of the timing of surgical intervention on functional or patient-reported outcomes following DRF is available in the literature.[11] However, there is a lack of information about the results of surgical treatment in fractures that show secondary displacement after reduction. Current National Institute for Health and Care Excellence Guidelines recommend surgery within 72 hours in cases requiring intervention because of redisplacement after close reduction.[12] Nevertheless, these recommendations may lack sufficient evidence to provide clear guidance for surgeons.

Numerous studies have compared the outcomes of early and delayed surgery for DRFs.[11,13−21] However, there is insufficient evidence to establish clear guidelines for the treatment of secondarily displaced fractures. Existing studies have used various timeframes as cutoffs for early or delayed surgery, including 3 days and 1, 2, and 3 weeks.[13,16,18,19,21] There is no clear accepted timing in the literature for distinguishing between early surgery and delayed surgery; however, the process of fracture healing

provides insights into the rationale for timing surgical intervention. In the initial days, hematoma formation occurs at the fracture site.[22] Subsequently, fibrocartilage callus develops, but mineralization has not yet commenced. After approximately the third week following injury, the mineralization phase begins, leading to the replacement of soft callus with hard callus.[22,23]

In this study, we have chosen the initiation of mineralization (end of the third week) as the cutoff value to distinguish between early and delayed surgery. Our study aimed to compare the clinical and radiologic outcomes of volar plate interventions performed for early versus delayed surgery for secondarily displaced DRFs. When performing surgery on fractures that lose reduction after the third week, the fracture healing tissue likely needs to be removed. This procedure may negatively affect the quality of reduction and fixation. However, if the reduction is outside the acceptable limits, we still advocate for repeating the reduction with open surgery between the third and sixth week. We hypothesize that there will be no difference in clinical or radiological outcomes between patients who undergo early surgery (<3 weeks) and those who undergo delayed surgery (3−6 weeks) after loss of reduction.

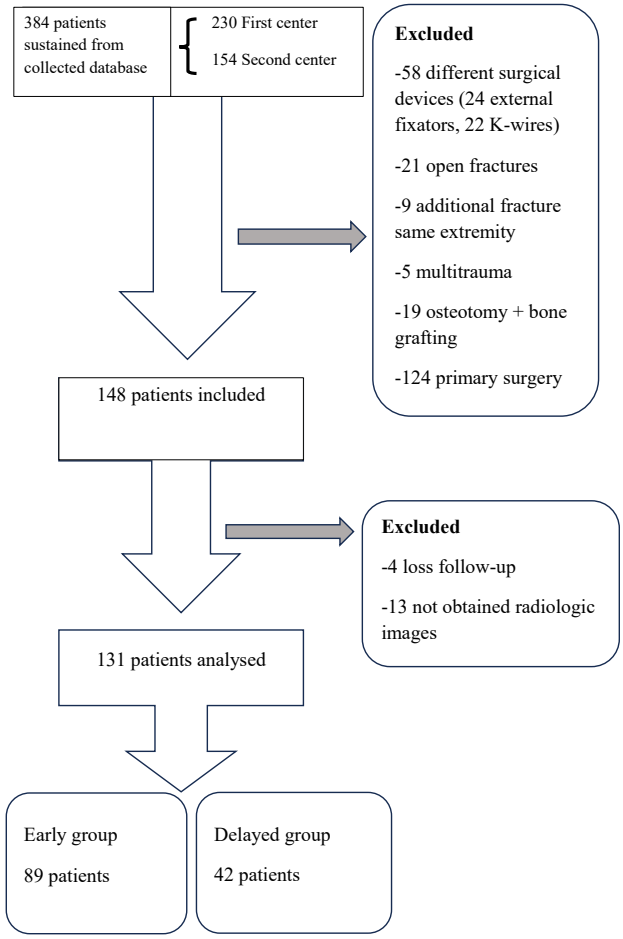

FIGURE 1: Flow chart of patients' selection.

MATERIALS AND METHODS

Institutional ethics committee approval and written informed consent from the patients was obtained. Data from tertiary hospitals in two separate cities were retrospectively analyzed to identify all cases of distal radial fracture fixation over a 7-year period, from January 2015 to January 2022. The inclusion and exclusion criteria of the patients added to the cohort are shown in Figure 1. The data included cases involving open reduction with plate fixation, closed reduction with K-wire fixation, and closed reduction with external fixation techniques. This study focused only on patients who underwent volar plate surgery for DRF and were aged 18 years or older. Patients with less than 6 months of follow-up, those with additional fractures in the same extremity as the DRF, cases of multiple traumas, those with open fractures, those with other pathologies interfering with wrist function, patients undergoing osteotomy procedures with bone grafting, and individuals with inaccessible radiological records were excluded from the study.

In patients admitted to the emergency department with DRFs, those with displaced and dorsally comminuted fractures or intra-articular displaced fractures were treated with primary surgery. Closed reduction and casting were performed on the remaining fractures under emergency room conditions. Nonsurgical treatment was recommended based on radiological criteria after closed reduction, and loss of reduction was detected during follow-up. After reduction, the fractures were followed weekly. Surgical intervention was reserved for cases where fractures did not meet specified radiologic criteria and was based on the presence of at least two of the following detected at any time during the follow-up period of up to 6 weeks: dorsal tilt exceeding 15°, ulnar variance greater than 5 mm, radial inclination less than 15°, or an intra-articular step-off exceeding 2 mm.

Data collection

Data were retrieved from patient charts and electronic records in both participating facilities. Information collected included age, sex, dominant and fracture sides, passive joint range of motion measurements, and postoperative complications. The Quick Disabilities of the Arm, Shoulder, and Hand

(QuickDASH) score and Short Form-12 (SF-12) physical component summary and mental component summary scores were obtained through patient interviews at the final follow-up. The interviewers were blinded to whether patients had early or delayed surgery.

Grouping

Patients who underwent surgery were divided into two groups: an early group (E), consisting of patients who underwent surgery within the first 3 weeks after injury, and a delayed group (D), consisting of patients who underwent surgery between 3 and 6 weeks. Patients who underwent surgery after 6 weeks were excluded from the study.

Radiological evaluation

Two experienced surgeons used preoperative anteroposterior and lateral radiographs to classify fracture types using the Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Orthopaedic Trauma Association (OTA) classification. In cases of disagreement, a third surgeon's opinion was sought. The fractures were evaluated in the subgroup according to AO/OTA types A, B, and C. Radiographs were used to measure radial length, radial inclination angle, and volar tilt angle.

Surgical technique

In all cases, a modified Henry approach was employed with the use of an arm tourniquet. Volar fixation was achieved by using five different titanium locking plates over a 7-year period. The fracture was stabilized using a volar plate, and when necessary, augmented with K-wires. Intraoperative fluoroscopy was used to assess reduction, plate positioning, and ulnar variance. When dorsal reduction with an additional dorsal incision was necessary, this was performed, but no additional dorsal fixation material was performed aside from K-wires. In some delayed fractures, osteoclasis was necessary, but there was no need for osteotomy or grafting. All surgical procedures were performed by one of nine experienced orthopedic surgeons.

Postoperative care

Following surgery, the wrist was immobilized in a wrist splint for a duration of 2 weeks. Active finger exercises were initiated immediately, with active wrist exercises commencing 2 weeks postsurgery. At the 8-week mark following surgery, strengthening and weightlifting exercises were introduced, and patients were referred to a hand therapist. The patients were re-evaluated at least 6 months after completing physical therapy. Radiographs were taken during the postoperative follow-up (Fig. 2).

Statistics

Descriptive statistical methods such as mean, standard deviation, frequency, and percentages were used to summarize the study data. The power of the sample was insufficient to permit a statistical analysis of the findings.

Data

A total of 131 patients, consisting of 59 women and 72 men, aged between 18 and 83, were included in the study. The primary outcome measure was QuickDASH scores, whereas secondary outcome measures included SF-12 (physical component summary and mental component summary), radiological measurements, and assessments of the degree of range of motion (ROM).

RESULTS

Descriptive information and statistics for the patients are presented in Table 1. In group D, the proportion of women was higher than that of men. The groups were similar in terms of fracture side, dominant side, or fracture of dominance side.

The QuickDASH and SF-12 scores of patients in groups E and D are summarized in Table 2. The mean physical component summary SF-12 scores and QuickDASH scores of groups E (8.0) and D (10.8) were similar.

The two groups were also similar in terms of wrist ROM (Table 2). Radial length and volar tilt angle in group D were similar to those in group E (Table 2).

Complications, including carpal tunnel syndrome, superficial radial nerve neuropraxia, and complex regional pain syndrome, occurred in 12 (13.5%) E group patients and 9 (21.4%) D group patients (Table 3).

DISCUSSION

This study demonstrates that both early and delayed surgery for open reduction and volar plating of DRFs result in similar clinical and radiological outcomes. Radiologic measurements and wrist ROM values were also similar. However, we found more complications in the delayed surgery group. Additionally, there were higher rates of complications in both groups compared with the literature.

In the management of DRF, Lafontaine et al[1] have introduced instability criteria that may guide deciding between surgical or nonsurgical treatment.

FIGURE 2: Radiography images of a 32-year-old male patient with AO A2 type distal radius fracture. **A** Images at the time of admission. **B** Images within acceptable limits after the first reduction and plaster cast. **C** Detection of loss of reduction at the third week following reduction. **D** Open reduction and volar plate fixation due to loss of reduction. AO, Arbeitsgemeinschaft für Osteosynthesefrage.

Additionally, various studies have highlighted the importance of factors beyond these criteria, such as patient age and low bone mineral density, in determining instability.[24,25] Nesbitt et al[24] have suggested that individuals older than 58 years of age have a higher risk of secondary displacement in unstable DRFs. The mean age of the groups in our cohort was 46 and 50 years, respectively.

The surgical treatment of intra-articular fractures may pose greater challenges than that of extra-articular fractures. Thus, it may be necessary to employ fragment-specific implants and different techniques for fractures with diverse configurations, such as lunate fossa and volar shear fractures. However, volar-locked plates may also be useful in these types of fractures. Our surgical approach to such fractures involves attempting fixation with a volar locking plate; if unsuccessful, we prefer fragment-specific implants. However, it is evident that larger study groups are needed to further investigate these fractures. In our evaluation of these fractures, we classified them only into types B and C according to the AO/OTA classification. We refrained from performing a detailed intra-articular fracture evaluation because the number of patients available for each fracture type was insufficient.

The minimum clinically important difference represents the smallest change in an outcome score perceived as clinically significant.[26] Literature suggests the minimum clinically important difference for QuickDASH score falls between 10.8 and 15.[27] In our study, the mean QuickDASH scores were 7.9 in group E and 10.8 in group D, suggesting that the difference was unlikely to be clinically relevant.

In our study, QuickDASH scores and wrist ROM measurements were consistent with those reported in the literature.[13,16–18,28,29] In a prospective study by Sirniö et al,[14] poor postoperative outcomes were observed in patients older than 50 years of age who underwent delayed surgery for DRFs. In our study, QuickDASH and SF-12 scores were similar between the two groups operated on less than 3 weeks and between 3 and 6 weeks after injury.

We observed a complication rate of 16% with complications in 12 (13.5%) patients in group E and 9 (21.4%) patients in group D. These complications included carpal tunnel syndrome (2 vs 3 cases), superficial radial nerve neuropraxia (6 vs 2 cases), and

TABLE 1. Descriptive Statistics for Early and Delayed Fixation Groups

Characteristic	Groups (n/%)		Total
	Early	Delayed	
Time to surgery (d) Median (IQR)	8 (1)	23 (4)	9 (14)
Mean rank	45	110.5	
Follow-up (mo)	44.66 (81)	40.59 (84)	43.36 (84)
Mean (range)			
Sex			
Female	32 (54.2)	27 (45.8)	59 (100)
Male	57 (79.2)	15 (20.8)	72 (100)
Injury side			
Right	51 (70.8)	21 (29.2)	72 (100)
Left	38 (64.4)	21 (35.6)	59 (100)
Dominant side			
Right	82 (66.7)	41 (33.3)	123 (100)
Left	7 (87.5)	1 (12.5)	8 (100)
Injury dominance			
Yes	46 (68.7)	21 (31.3)	67 (100)
No	43 (67.2)	21 (32.8)	64 (100)
AO type			
A	11 (52.4)	10 (47.6)	21 (100)
B	44 (77.2)	13 (22.8)	57 (100)
C	34 (64.2)	19 (35.8)	53 (100)
Smoker			
No	52 (69.3)	23 (30.7)	75 (100)
Yes	37 (66.1)	19 (33.9)	56 (100)
Total	89 (67.9)	42 (32.1)	

AO, Arbeitsgemeinschaft für Osteosynthesefrage; IQR, interquartile range.

TABLE 2. Means, Standard Deviations and Difference Between Means Test Results of Age, QuickDASH, and SF-12 for Early and Delayed Group Patients

Characteristic	Group	
	Early, Mean (SD)	Delayed, Mean (SD)
	89	42
Age (y)	46.6 (13.7)	50.4 (15.0)
QuickDASH score	8.0 (17.3)	10.8 (13.5)
PCS 12	49.4 (9.2)	45.4 (7.9)
MCS 12	52.3 (7.1)	53.6 (7.0)
Range of motion		
Flexion	86.6 (6.3)	85.5 (6.0)
Extension	87.7 (4.8)	87.4 (4.6)
Radial deviation	28.4 (3.7)	26.7 (4.8)
Ulnar deviation	28.0 (4.6)	25.8 (5.6)
Radiologic measurements		
Volar tilt angle	10.6 (3.2)	9.0 (4.4)
Radial inclination	17.1 (4.1)	16.3 (4.0)
Radial length	10.3 (2.3)	9.9 (2.3)

AO, Arbeitsgemeinschaft für Osteosynthesefragen; MCS, mental component score; PCS, physical component score.

TABLE 3. Complications of Patients

Complication	n (%)		Total
	Early	Delayed	
Complex regional pain syndrome	4 (4.5)	4 (9.5)	8 (6.1)
Carpal tunnel syndrome	2 (2.2)	3 (7.1)	5 (3.8)
Superficial radial nerve injury	6 (6.7)	2 (4.8)	8 (6.1)
Total	12 (13.5)	9 (21.4)	21 (16)

complex regional pain syndrome (6 vs 4 cases). The radial sensory nerve neuritis seen in both groups was likely due to percutaneous placement of Kirschner wires for temporary fracture fixation. All patients resolved their symptoms with nonsurgical treatment, and surgical intervention was not necessary. Campbell et al[28] examined DRFs treated with a volar plate and found higher reoperation rates in delayed surgery cases. Delayed surgery has been associated with high complication rates in the literature.[29] In another recent study, Ahmad et al[30] found that the time until surgery did not affect the postoperative complication rate, reporting a complication rate of 14.7%. In our study, the complication rate of patients who underwent surgery after 3 weeks was 1.5 times higher, and our overall complication rate was higher compared with the literature. However, the impact of these higher complication rates on the outcomes of clinical scores appears to be negligible.

This study has limitations. The most important limitation of this study is the small sample, which precluded any in-depth statistical analysis. The retrospective nature of this study introduces a potential risk of bias. To reduce this risk, we implemented blinding for the interviewers responsible for evaluating the patients' scores with respect to their groupings. Involving nine different surgeons across two medical centers introduces potential variability in

techniques. Additionally, the study did not account for early postoperative superficial infections or later-stage arthritis when evaluating complications from patient records. Additionally, it cannot be ensured that all complications are recorded in retrospective records. Other limitations of the study are the lack of evaluation of articular congruity, as well as the absence of an objective scale, such as grip strength measurement, which could have provided further insights into the outcomes of the surgical interventions.

In conclusion, the results of this study demonstrated that delayed surgery and early surgery in DRF with loss of reduction after nonsurgical treatment were similar. However, delayed surgical treatment was associated with a 1.5 times higher complication rate.

CONFLICTS OF INTEREST

No benefits in any form have been received or will be received related directly to this article.

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