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Original Research

Acute on Chronic Distal Radius Fracture: A Case Series and Technique Description

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Purpose: Distal radius fractures are the most common fractures in adults. Because of the prevalence of these injuries, patients may present with a repeat distal radius fracture on the same wrist through the site of a malunion. We clinically refer to this as an acute on chronic distal radius fracture. In this setting, the restoration of acceptable alignment can be challenging. There is little guidance in the literature for the management of these fractures. We report our experience with acute on chronic distal radius fractures. The secondary fracture plane was used to correct the prior deformity, and the construct was fixated with a fixed angle volar locking plate.
Methods: Records of patients with malunion of the distal radius who experienced an acute fracture of the ipsilateral distal radius were reviewed. Inclusion required treatment with open reduction internal fixation using a distal fragment first technique and a volar locking plate through the extended flexor carpi radialis approach. Clinical outcomes and complications were collected.
Results: Across 13 patients, the mean follow-up term was 13 months (range, 6–40 months). Radiographic union was noted in all patients. The mean visual analog scale score for pain was 1.8, and the mean Quick Disabilities of the Arm, Shoulder, and Hand score was 21.9. There were no recorded complications.
Conclusion: Our results and described technique provide reproducible guidance for the management of acute on chronic distal radius fractures. These cases can be managed using the secondary fracture plane, a distal fragment first technique, and a volar locking plate to correct the preexisting deformity.
Type of study/level of evidence: Therapeutic IV.

As the worldwide population ages, there is an expectation for an increasing incidence of distal radius fracture (DRF) in adults.[1,2] Surgical management of DRF is increasing; however, most cases are conservatively managed with casting.[2,3] Conservatively managed DRF cases have higher rates of malunion than those in surgically managed cases.[4–6] Recent evidence demonstrates a trend in improvement of outcomes after surgical management of DRF.[7]

Because of the prevalence of these injuries, patients may present with a repeat DRF on the same wrist through the site of a malunion. We clinically refer to this as an acute on chronic DRF—an acute DRF in a previously malunited DRF. These were not cases with nonunion of the distal radius. The DRFs in predictable patterns and, often, the acute or secondary fracture lines occur in close proximity to the primary fracture lines. These scenarios present an opportunity to concomitantly address the primary and secondary fractures. The difficulty in surgical correction increases with the degree of preexisting deformity. There is a paucity of evidence to guide surgeons in the treatment of acute on chronic DRFs.

Declaration of interests: D.M.M. is on the speaker's bureau for Skeletal Dynamics and Axogen. J.L.O. reports being a beneficiary, along with family members, of irrevocable trusts; owns stock in Skeletal Dynamics; and reports reimbursements for expenses incurred when he speaks or presents on the company's behalf. No benefits in any form have been received or will be received by the other author(s) related directly or indirectly to the subject of this article.

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Table 1
Case Characteristics and Clinical Outcomes for 13 Patients Who Experienced an Acute on Chronic Distal Radius Fracture on an Ipsilateral Malunion Treated With a Volar Locking Plate

Patient	Case Characteristics				Clinical Outcomes			
	Sex	Follow-Up (mo)	Age (y)	Dominant Side Injury	Wrist FE % Contralateral*	Forearm PS % Contralateral†	VAS Score for Pain‡	*Quick*DASH Score
1	F	13	82	Y	80	100	0	20
2	F	6.5	79	N	70	95	6	22.7
3	F	14	70	Y	90	100	1	18.2
4	F	11	73	Y	90	90	4	13.6
5	F	8.5	72	Y	80	95	0	22.7
6	F	9	71	N	100	95	2	9.1
7	F	21	78	N	90	95	0	27.3
8	M	40	60	N	85	90	0	38.6
9	F	11	73	Y	80	85	2	9.5
10	F	7	77	N	85	90	1	21
11	F	6	65	N	90	90	5	25.5
12	M	9	44	N	70	80	2	17.8
13	M	13	55	N	75	80	1	39
Mean		13	69		83%	91%	1.8	21.9

DASH, Disabilities of the Arm, Shoulder, and Hand; F, female; FE, flexion-extension; M, male; N, no; PS, pronosupination; VAS, visual analog scale; Y, yes.
* Wrist flexion-extension is presented as a percentage of the contralateral side.
† Forearm pronosupination is presented as a percentage of the contralateral side.
‡ Visual analog scale score for pain is presented as the score at rest.

Our objective was to report results for fixation of acute on chronic DRFs, in which the secondary fracture plane was used to correct the deformity.

Materials and Methods

A retrospective chart review from 2010 to 2020 (institutional review board approval #1-1533379-1) was performed for patients with malunion of the distal radius who experienced an acute fracture of the ipsilateral distal radius. All DRFs were collected using a Current Procedural Terminology code search. Then, the operative notes were reviewed to determine which patients met the inclusion criteria. The inclusion criteria required a follow-up of 6 months and recording of clinical outcomes, including wrist flexion/extension, forearm pronosupination, a Quick Disabilities of the Arm, Shoulder, and Hand score, and a visual analog scale score for pain. Wrist and forearm ranges of motion were compared with that of the contralateral side. Additionally, inclusion required treatment with open reduction internal fixation using a distal fragment first technique and a volar locking plate (VLP) through the extended flexor carpi radialis (FCR) approach. Complications and concomitant surgical procedures were collected. We defined major complications as radiographic or clinical nonunion, loss of reduction, deep infection, tendon pathology, chronic regional pain syndrome, and nerve injury. Minor complications were superficial stitch abscess, loss of full motion, and persistent pain. Radiographic data were collected for evidence of bony union, preoperative and postoperative radial tilt, and height. Radiographic union was defined as trabecular bridging across the fracture line. Radiographic measurements were done using VXVue software (Medlink Imaging). The exclusion criteria included DRFs that did not meet the case definition of an acute on chronic fracture, acute on chronic DRFs that were treated with methods other than this technique, and acute on chronic DRFs with concomitant ipsilateral upper-extremity fractures. We excluded 7 patients who had less than the 6-month required follow-up, and an additional 2 patients were excluded on the basis of treatment parameters that did not align with the inclusion criteria.

Surgical technique

The extended FCR approach provides adequate exposure of the volar distal radius, which facilitates fracture fixation.[8–10] The incision is 8–10 cm long and is placed directly over the FCR tendon. The incision extends distally to the distal pole of the trapezial ridge and crosses the wrist flexion creases in a zigzag manner to prevent hypertrophic scar formation. As initially described by Orbay et al,[10,11] the watershed line and transitional fibrous zone are identified across the prominent volar rim of the lunate fossa. The anatomy may often be distorted in these cases. The watershed line can be identified with respect to the origin of the radiocarpal ligaments. The transitional fibrous zone is incised along the watershed line and continued proximally along the radial edge of the pronator quadratus insertion. In cases of malunion, the dorsal periosteum is typically hypertrophic and contracted, which may impede the reduction. Pronating the proximal fragment allows dorsal exposure of the secondary fracture plane and excision of the contracted periosteum. The brachioradialis may be lengthened to prevent deforming forces on the radial styloid. If there are soft tissue contractures, they can be released from the extensor surface of the radius. The distal fragment first technique begins by fixing a VLP to the distal fragment. The plate is then brought down and fixed to the radial shaft. Thus, the plate provides a mechanical advantage to counteract the tension from the contracted tissues consequential to the preexisting deformity. This technique can facilitate the restoration of height and volar tilt. In certain cases, a distal radioulnar joint (DRUJ) capsular release may be required because of a shortened, contracted capsule, which can result from a malunion with a malaligned DRUJ. This procedure has been previously described as a treatment for the functional detriment that may arise because of a shortened DRUJ capsule.[12]

Postoperative rehabilitation consisted of immobilization with a short arm orthosis for 1 week, with immediate finger motion and forearm rotation. After the first postoperative visit, light hand use for daily activities was encouraged, and reasonable weight-lifting restrictions were allowed. These restrictions were removed when radiographic union was achieved, typically occurring at 4–10 weeks after surgery. Those who failed to regain full-finger range of motion by the first postoperative visit or forearm rotation by the first month were referred to physical therapy.

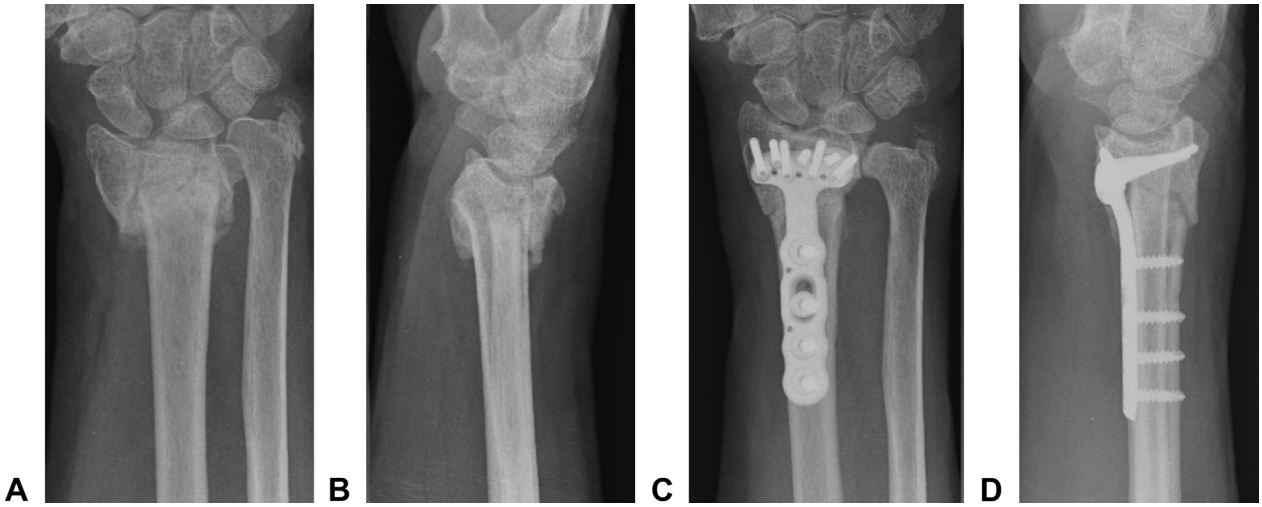

Figure 1. Preoperative **A** anteroposterior and **B** lateral radiographs showing acute DRF with evidence of malunion. Postoperative **C** anteroposterior and **D** lateral radiographs demonstrating correction of the acute and preexisting deformity using a VLP.

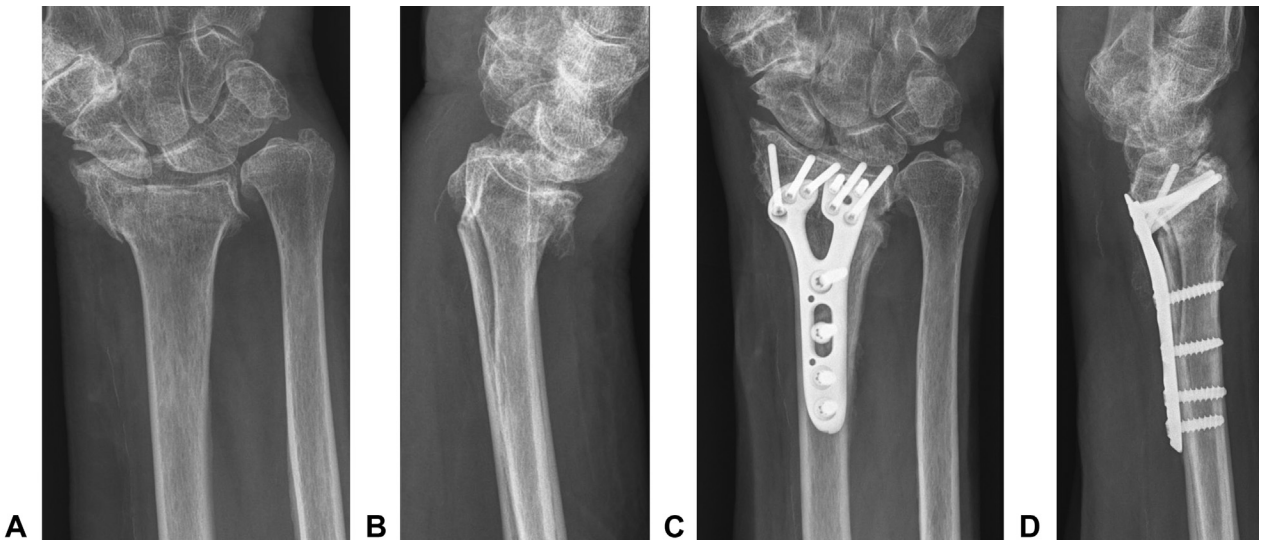

Figure 2. Preoperative **A** anteroposterior and **B** lateral radiographs showing acute DRF with evidence of malunion. Postoperative **C** anteroposterior and **D** lateral radiographs demonstrating correction of the acute and preexisting deformity using a VLP.

Results

A total of 13 cases met the inclusion criteria, with a mean patient age of 69.5 years (range, 44–82 years) across 10 (77%) women and 3 (23%) men (Table 1). The mean follow-up term was 13 months (range, 6–40 months). Radiographic union was noted in all patients. Preoperative tilt ranged from 20° to 40° dorsal, and radial height ranged from 3 to 15 mm ulnar positive. Postoperative tilt ranged from 0° to 10° volar, and the radial height ranged from 3 mm ulnar positive to 2 mm ulnar negative.

Compared with the contralateral side, the flexion-extension arc was 83%, and pronation supination was 92%. The mean visual analog scale score for pain was 1.8, and the mean Quick Disabilities of the Arm, Shoulder, and Hand score was 21.9. There were no recorded complications.

Two cases required an ulnar shortening osteotomy. This procedure was indicated in cases in which an appropriate longitudinal radioulnar relationship was not attainable after distal radius reduction and fixation. One patient required an autologous bone graft from the proximal ulna to correct a bone deficit after anatomic restoration (Figs. 1, 2).

Discussion

Although historically infrequent, acute on chronic DRFs may become more common because the worldwide population is aging.[1,13] These cases are problematic because of the preexisting deformity that complicates anatomic reduction. The surgeon can use the established techniques of primary DRF fixation to achieve satisfactory outcomes.

Our results demonstrate satisfactory outcomes in patients with preexisting deformities who sustained an acute fracture on preexisting distal radius malunion. Prior work has demonstrated that functional outcomes are associated with the restoration of native anatomy.[14] Correction of the preexisting deformity can be problematic; thus exacting technique is necessary. We attribute the current results to the successful correction of the acute and preexisting deformity, utilizing the following steps. Firstly is the extended

FCR approach, which provides the requisite visualization to evaluate each component of the distal radius. Adequate exposure is an integral component of surgical management, especially in the presence of preexisting deformity. We used the secondary fracture plane to access the primary fracture that had malunited. Secondly is the use of a VLP to facilitate reduction against the impedance of contracted soft tissues. By using the distal fragment first technique, the plate provides a mechanical advantage to obtain reduction. Thirdly is the understanding that additional procedures, such as a DRUJ capsular release or ulnar osteotomy, may be required to restore the anatomy. Lastly is the use of a rigid fixation construct, which allows immediate postoperative motion. The benefits of immediate postoperative motion after VLP fixation have been thoroughly elucidated.[15–17] These advantages may be even more pronounced in patients with distal radius malunion given the functional detriment that has been described in these cases.[18]

Malunion can lead to wrist instability because of disruption of the native bony relationship.[19] This instability can extend to the midcarpal bones and ultimately lead to limitations in wrist function or progress to arthritis. A prior malunion does not preclude surgical management of the acute fracture. Although distal radius malunion can be managed nonsurgically, a subsequent DRF presents an opportunity to restore anatomical alignment. Our results demonstrate that correcting both the acute and preexisting deformities can lead to satisfactory clinical results.

We acknowledge the limitations associated with small sample reports and retrospective study designs. The addition of preoperative values of the outcome metrics may improve the conclusivity of the findings. Further, a conservative treatment group for comparative analysis would provide a more complete evaluation of the reported treatment method. Given the relative infrequency of this clinical scenario, a sample of 13 cases provides the surgeon with proven and reproducible guidance for the management of an acute DRF that occurs on an ipsilateral distal radius malunion.

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