Surgical Reconstruction of a Late-Presenting Volar Radiocarpal Dislocation

Eric P. Hofmeister, MD, Brian T. Fitzgerald, MD, Michael A. Thompson, MD, and Alexander Y. Shin, MD

Radiocarpal dislocations are rare and usually associated with fractures of the distal radius.[1,2] Isolated volar dislocations of the radiocarpal joint are exceedingly rare, and fewer than 20 cases have been reported.[3-16] Although reported treatment of this acute injury has ranged from closed reduction and casting[3,5,9] to percutaneous pinning,[6,9] most recent reports have recommended open reduction and internal fixation when feasible.[4,7,11-15] Total wrist fusion has also been reported as a treatment.[17] Surgical reconstruction of a delayed volar radiocarpal (VRC) dislocation has not been reported.

This entity differs from a volar Barton fracture, as the major destabilizing force is the volar ligaments as opposed to a large volar articular fragment. When the injury is purely ligamentous, or only a small volar articular rim fracture fragment is present, fixation can be challenging.

We report the case of a 7-week-delayed presentation of a VRC dislocation with a volar articular radius rim fracture. This case illustrates surgical reconstruction as a treatment and the use of a specific volar wireform (TriMed, Inc, Valencia, Calif) in conjunction with Kirschner wires (K-wires), suture anchors, and immobilization that yielded an excellent functional result.

Case Report

A right-hand–dominant man in his early 20s was involved in a low-speed motor vehicle accident in which he sustained an isolated injury to his dominant wrist. The man was initially evaluated by a local emergency department physician and was noted to have an "abnormal-appearing wrist" and x-rays significant for a VRC dislocation. The dislocation was reported to be closed-reduced and splinted. The patient was referred for definitive treatment but failed to follow up; he presented again 7 weeks after injury.

The patient had minimal pain and complained of decreased range of motion (ROM). On physical examination, his wrist was deformed and minimally tender. Active ROM was 15° flexion, 30° extension, 10° radial deviation, and 20° ulnar deviation. Supination was 40°, and pronation was 45°. The patient was neurovascularly intact, including normal static 2-point discrimination. Digital ROM was full and symmetric to the opposite hand. Provocative testing for carpal tunnel syndrome was negative, and there was no evidence of thenar motor weakness. X-rays showed a VRC fracture-dislocation with ulnar translocation of the carpus and a small volar distal radius fracture (Figures 1A, 1B). Given the delay in presentation, there was concern that a partial or complete fusion/malunion of the radius volar rim to the dorsal lunate had developed. Although, further imaging (eg, a computed tomography scan) may have defined this more clearly, we felt it would not change our management or approach to the problem.

"We chose a combined volar-dorsal approach to address... this unusual injury..."

After extensive preoperative counseling, operative reconstruction was elected. Open reduction and primary reconstruction of the VRC and dorsal radiocarpal (DRC) ligaments and open reduction and internal fixation of the volar radial fragment were performed. A dorsal longitudinal approach between the third and fourth dorsal compartments and transposition of the extensor pollicis longus were used. Inspection of the dorsal ligaments demonstrated that the DRC ligament, the proximal portion of the dorsal intercarpal (DIC) ligament, and a large portion of the dorsal capsule were all avulsed, while the intracarpal ligaments were intact. The radiocarpal dislocation could not be reduced from the dorsal approach because of a bony union between a chondral defect of the dorsal lunate and volar radius. A volar extended carpal tunnel approach was made, and the entire VRC ligamentous complex was found to be patulous, incompetent, and avulsed off proximally on the distal radius with a large periosteal sleeve. The malunion was released, and reduction was performed.

CDR Hofmeister, MC, USN, is Director, Orthopaedic Hand Surgery Division, and Orthopaedic Intern Director, Dr. Fitzgerald is a staff Orthopaedic Hand Surgeon, and CAPT Thompson, MC, USNR, is a staff Orthopaedic Hand Surgeon and Director of Orthopaedic Residency Education, Naval Medical Center San Diego, San Diego, California.
Dr. Shin is Professor of Orthopaedic Surgery, Mayo Medical College, Department of Orthopedic Surgery, Division of Hand Surgery, Mayo Clinic, Rochester, Minnesota.

Address correspondence to: Eric P. Hofmeister, c/o Clinical Investigation Department (KCA), Naval Medical Center San Diego, 34800 Bob Wilson Dr, Suite 5, San Diego, CA 92134-1005 (tel, 619-532-8134/40; fax, 619-532-8137; e-mail, eric.hofmeister@med.navy.mil).

Am J Orthop. 2008;37(2):96-99.

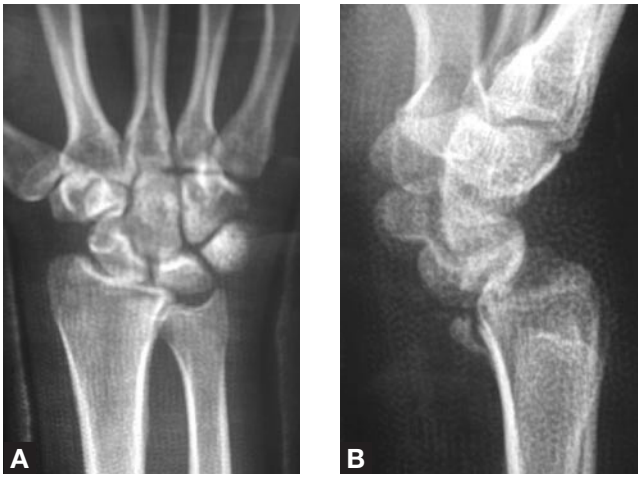

Figure 1. Posteroanterior **(A)** and lateral **(B)** x-rays at initial presentation. Note volar radiocarpal dislocation with ulnar translocation of the carpus and a small volar distal radius fracture.

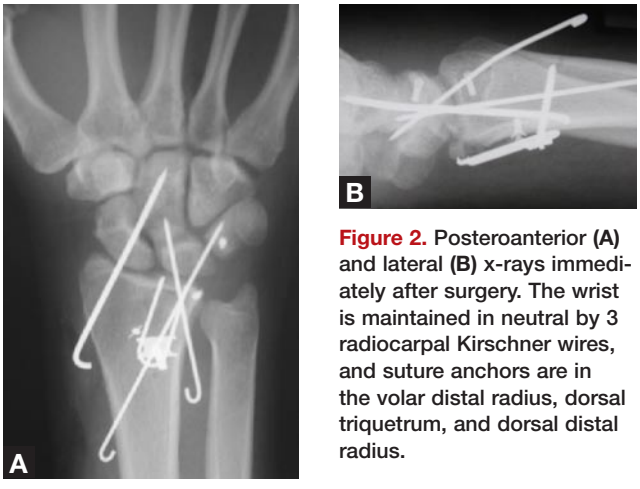

Figure 2. Posteroanterior **(A)** and lateral **(B)** x-rays immediately after surgery. The wrist is maintained in neutral by 3 radiocarpal Kirschner wires, and suture anchors are in the volar distal radius, dorsal triquetrum, and dorsal distal radius.

Inspection of the dorsal lunate from the dorsal approach revealed a chondral lesion 8x12 mm in size. After the ulnar translocation was corrected, the radiocarpal and midcarpal joints were reduced and pinned with multiple smooth Kirschner pins. The pins were cut short and buried subcutaneously. The volar short and long radial lunate ligaments and the radioscaphocapitate ligaments were imbricated using 3-0 nonabsorbable suture, passed through drill holes, and tied over the dorsal cortex. The complex was further stabilized with a suture anchor. Because of the small size and comminution of the volar lip fracture of the distal radius, it was reduced and stabilized with a fragment-specific volar wireform. The dorsal capsule was repaired, and the DRC and DIC ligaments were restored back to their anatomical location and tensioned by reefing and tightening the redundant tissues with the wrist in slight flexion. Two suture anchors (1 in the dorsal, ulnar radius and 1 in the dorsal triquetrum) were utilized (Figures 2A, 2B).

Following surgery, the wrist was immobilized with a short-arm cast until the pins were removed at 12 weeks. The patient required narcotic pain medication for 3 weeks after surgery. Two weeks after surgery, he rated his pain level 4 on a scale

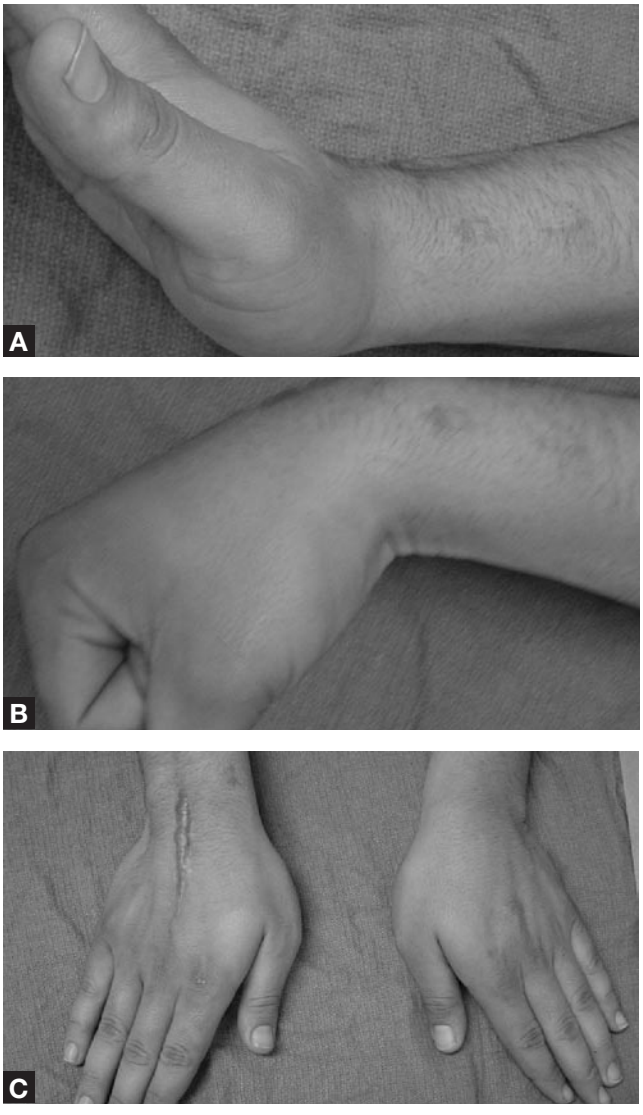

Figure 3. Final active range of motion of the wrist including wrist extension **(A)**, flexion **(B)**, and ulnar deviation (C). Note nearly symmetric ulnar deviation, which would be blocked with residual ulnar translocation.[11]

of 1 (least) to 10 (most); by 4 weeks, this rating had improved to 2. A formal, progressive occupational therapy program was initiated, and, by 6 months after initial surgery, the patient reported being pain-free and had returned to full activity.

Thirty-six months after surgery, the patient complained of pain only with pull-ups and heavy lifting. Active ROM was 50° flexion, 45° extension, 25° radial deviation, and 35° ulnar deviation (Figures 3A–3C). The patient demonstrated symmetric supination and pronation and grip strength of 90% compared with the opposite side. Since then, he returned to full activities, except heavy lifting. Final x-rays showed no volar subluxation and minimal ulnar translocation of the carpus (Figures 4A, 4B).

Discussion

Radiocarpal dislocations are rare but severe injuries that are often accompanied by radial and ulnar styloid fractures, radial articular rim fractures,[1,2] scaphoid fractures, or lunate

Table. Volar Radiocarpal Dislocations Reported in the Literature

Author	Year	No. Pts	Treatment	Outcome	Follow-Up (mo)
Bohler[10]	1930	2	CR	Ulnar translocation	Not reported
Rosado[3]	1966	1	CR	Full motion, weak grip	18
Dunn[9]	1972	2	CR & percutaneous pinning	Full, painless motion	18
Bellinghausen et al[16]	1983	2	CR	Volar subluxation, ulnar translocation	36
Fehring & Milek[8]	1984	1	CR & casting	VISI, function unknown	Not reported
Moneim et al[5]	1985	1	CR & casting	Volar subluxation; full, painless motion	57
Penny & Green[4]	1988	1	OLR & pinning	Full, painless motion	16
Fennel et al[7]	1992	1	OLR & pinning	Mild pain, decreased grip	32
Howard et al[6]	1997	1	CR & percutaneous pinning	DISI; full, painless motion	18
Mudgal et al[13]	1999	1	OLR & pinning	Poor function	10
Dumontier et al[18]	2001	4	OLR & pinning	Unknown	Not reported
Freeland et al[17]	2006	1	Total wrist fusion	Mild wrist pain	42

Abbreviations: CR, closed reduction, OLR, open ligament repair; VISI, Volar intercalated segment instability; DISI, Dorsal intercalated segment instability.

fractures.[1] Although these injuries are associated with variously sized articular rim fractures,[10] a thorough literature search failed to identify any reports of a VRC dislocation with an articular rim fracture with no other accompanying fractures treated in a nonacute setting. All VRC dislocation case series and case reports describing acute treatment are summarized in the Table.

In the spectrum of carpal dislocation injuries, the variant involving radiocarpal dislocation is termed the *inferior arc injury*.[14] Force transmission through the wrist causes tensioning of the stout volar extrinsic ligaments against the juxta-articular margin, and bony injury can occur in 1 of 2 patterns—small- or large-fragment fractures. We believe that our patient sustained what Graham[14] termed the *small-fragment fracture* inferior arc injury.

What constitutes optimal management of these injuries is not known. The approach that seems reasonable is to achieve anatomical realignment of bones and joints by either open or closed methods and to stabilize the joint(s) as needed to allow for adequate healing of capsuloligamentous tissues. These injuries are challenging to treat, and opinions vary as to fixation methods, from open or percutaneous radiocarpal or intercarpal pinning to wrist fusion (Table).

In the series of 27 acute radiocarpal dislocations reported by Halikis and colleagues,[19] only 4 cases were volar. Given recurrent radiocarpal instability and secondary ulnar translocation of the carpus, the authors recommended open reduction, ligamentous repair, and K-wire fixation for 2 months in patients with volar ligamentous avulsions. All 4 patients with volar dislocations were lost to follow-up. In the series of 12 acute radiocarpal dislocations reported by Mudgal and colleagues,[13] only 1 case was volar. These authors also recommended aggressive open reduction, primary repair, and temporary radiocarpal fixation.

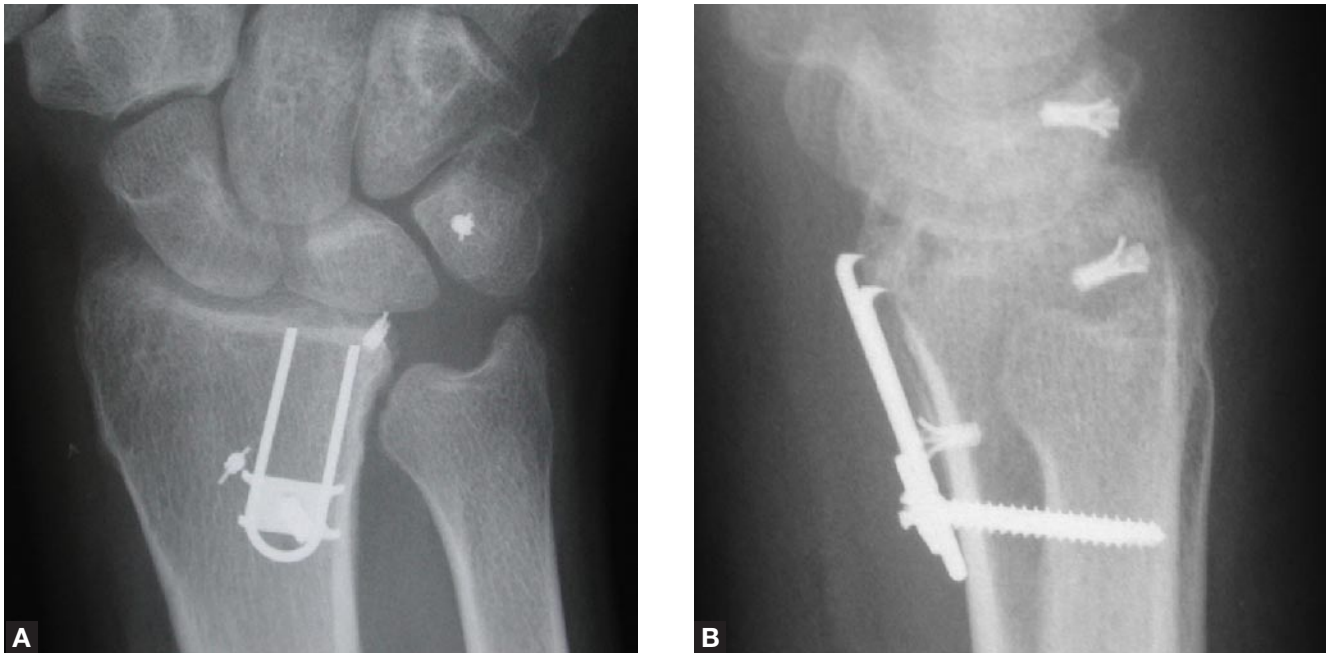

Figure 4. Final posteroanterior **(A)** and lateral **(B)** x-rays. More than half the lunate is within the lunate fossa, the proximal scaphoid is not displaced over the scaphoid ridge, and there is no gap of the radioscaphoid joint—all representing lack of ulnar translocation.[11] Also, volar subluxation of the carpus has been corrected and maintained.

Ulnocarpal translocation can be a problematic sequela of radiocarpal dislocation. Rayhack and colleagues[11] identified this difficult, sometimes unrecognized instability pattern in posttraumatic wrists. Of their 8 patients, who presented a mean of 7 months after injury, 7 had recurrent ulnar translocation despite surgical repair. Other studies have highlighted the problem of residual ulnar translocation.[3,4,12] Patients with residual ulnar translocation can develop progressive pain, functional impairment, and arthritis. In some cases, partial and complete wrist fusions have been used to treat posttraumatic pain and deformity.[5,11,17-19]

Choice of surgical approach has also not been well defined in the literature. The challenge in our patient's case was complicated by a treatment delay, which allowed the deformity to become fixed by ligament contracture and radiolunate fusion. Several authors have advocated using both volar and dorsal approaches to treat palmar radiocarpal dislocations in an acute setting,[1,2,4,6,12,13] and there is support for the combined approach in the chronic setting as well.[11] We chose a combined volar–dorsal approach to address the volar radiolunate fusion plus the avulsion of all major capsuloligamentous stabilizers.

We feel that a combined approach to this unusual injury was justified. The dorsal approach allowed us to repair the injured DRC and DIC ligaments anatomically. Use of radiocarpal pins to try to minimize the chance of persistent ulnocarpal translocation after reduction is well documented.[6,11,13,18,20] K-wires should be at least 0.045 inch, depending on patient size, and the patient should be immobilized while these pins are in place. Relative to the chondral injury caused by the injury itself, we feel that any additional insult to the cartilage from pins traversing the wrist joint is minimal. Hardware failure or pin migration is possible and should be discussed with patients before surgery. Even with anatomical restoration of bone and joint alignment, chronic instability may cause degenerative arthritis, functional disability, and pain.

The fixation construct used to stabilize the volar articular fragment was chosen because we felt it would afford adequate stability to the volar rim injury and because we had ample experience with fragment-specific fixation and wireform constructs. An equally adequate construct might have been one of many types of volar distal radius plates. However, given the extreme distal level of the fracture, a volar plate would need to be placed in pure buttress fashion, as distal screw fixation would not be feasible. As Graham[14] pointed out, "often the small bony avulsions are of inadequate size to fix by conventional means … other devices should be considered."

Anatomical restoration of the torn ligamentous structures and temporary stabilization of the radiocarpal joint offer the wrist the optimal chance for improved functional outcome and can lead to excellent functional results, even if time since injury is several weeks. Furthermore, a low-profile volar wireform can be an excellent fixation method when a small radial avulsion fracture is present. For treatment of this unusual injury, we recommend anatomical reduction and operative repair of damaged structures with internal fixation supplementation.

Authors' Disclosure Statement and Acknowledgments

The authors report no actual or potential conflict of interest in relation to this article.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the US Department of the Navy, US Department of Defense, or US Government.

References

1. Bilos ZJ, Pankovich AM, Yelda S. Fracture-dislocation of the radiocarpal joint. *J Bone Joint Surg Am*. 1977;59(2):198-203.
2. Dobyns JH, Linschied RL. Fractures and dislocations of the wrist. In: Rockwood CA, Green DA, Bucholz RW, Heckman JD, eds. *Fractures in Adults*. Vol 1, 4th ed. Philadelphia, PA: Lippincott; 1998:791-796.
3. Rosado AP. A possible relationship of radio-carpal dislocation and dislocation of the lunate bone. *J Bone Joint Surg Br*. 1966;48(3):504-506.
4. Penny WH 3rd, Green TL. Volar radiocarpal dislocation with ulnar translocation. *J Orthop Trauma*. 1988;2(4):322-326.
5. Moneim MS, Bolger JT, Omer GE. Radiocarpal dislocation—classification and rationale for management. *Clin Orthop*. 1985;(192):199-209.
6. Howard RF, Slawski DP, Gilula LA. Isolated palmar radiocarpal dislocation and ulnar translocation: a case report and review of the literature. *J Hand Surg Am*. 1997;22(1):78-82.
7. Fennell CW, McMurtry RY, Fairbanks CJ. Multidirectional radiocarpal dislocation without fracture: a case report. *J Hand Surg Am*. 1992;17(4):756-761.
8. Fehring TK, Milek MA. Isolated volar dislocation of the radiocarpal joint. A case report. *J Bone Joint Surg Am*. 1984;66(3):464-466.
9. Dunn AW. Fractures and dislocations of the carpus. *Surg Clin North Am*. 1972;52(6):1513-1538.
10. Bohler L. Verrenkeungen der Handgelenke [in German]. *Acta Chir Scand*. 1930;67:154-177.
11. Rayhack JM, Linscheid RL, Dobyns JH, Smith JH. Posttraumatic ulnar translation of the carpus. *J Hand Surg Am*. 1987;12(2):180-189.
12. Viegas SF, Patterson RM, Ward K. Extrinsic wrist ligaments in the pathomechanics of ulnar translation instability. *J Hand Surg Am*. 1995;20(2):312-318.
13. Mudgal CS, Psenica J, Jupiter JB. Radiocarpal fracture-dislocation. *J Hand Surg Br*. 1999;24(1):92-98.
14. Graham TJ. The inferior arc injury: an addition to the family of complex carpal fracture-dislocation patterns. *Am J Orthop*. 2003;32(9 suppl):10-19.
15. Sems SA, Butler BA, Graham TJ. Injuries associated with fractures of the distal radius. *Am J Orthop*. 1998;27:23-32.
16. Bellinghausen H, Gilula LA, Young LV, Weeks PM. Post-traumatic palmar carpal subluxation. *J Bone Joint Surg Am*. 1983;65(7):998-1006.
17. Freeland AE, Ferguson CA, McCraney WO. Palmar radiocarpal dislocation resulting in ulnar radiocarpal translocation and multidirectional instability. *Orthopedics*. 2006;29(7):604-608.
18. Dumontier C, Reckendorf M, Sautet A, Lenaoble E, Saffar P, Allieu Y. Radiocarpal dislocations: classification and proposal for treatment. *J Bone Joint Surg Am*. 2001;83(2):212-218.
19. Halikis MN, Colello-Abraham K, Taleisnik J. Radiolunate fusion—the forgotten partial fusion. *Clin Orthop*. 1997;(341):30-35.
20. Weiss C, Laskin RS, Spinner M. Irreducible radiocarpal dislocation—a case report. *J Bone Joint Surg Am*. 1970;52(3):562-564.