Radiographic Outcomes of Dorsal Distraction Distal Radius Plating for Fractures With Dorsal Marginal Impaction

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Abstract

Background: The purpose of this study is to compare radiographic outcomes of patients treated with dorsal spanning plates with previously reported normal values of radiographic distal radius anatomy and compare the results with prior publications for both external fixation and internal fixation with volar locked plates. **Methods:** Patients with complex distal radius fractures including dorsal marginal impaction pattern necessitating dorsal distraction plating at the discretion of the senior authors (M.A.T. and M.A.I.) from May 30, 2013, to December 29, 2015, were identified and included in the study. Retrospective chart and radiograph review was performed on 19 patients, 11 male and 8 female, with mean age of 47.83 years (22–82). No patients were excluded from the study. **Results:** All fractures united prior to plate removal. The average time the plate was in place was 80.5 days (49–129). Follow-up radiographs showed average radial inclination of 20.5° (13.2°–25.5°), radial height of 10.7 mm (7.5–14 mm), ulnar variance of –0.3 mm (–2.1 to 3.1 mm), and volar tilt of 7.9° (–3° to 15°). One patient had intra-articular step-off greater than 2 mm. **Conclusions:** Dorsal distraction plating of complex distal radius fractures yields good radiographic results with minimal complications. In cases of complex distal radius fractures including dorsal marginal impaction where volar plating is not considered adequate, a dorsal distraction plate should be considered as an alternative to external fixation due to reduced risk for infection and better control of volar tilt.

Keywords: distraction plating, dorsal marginal impaction

Introduction

Distal radius fractures are among the most common fractures encountered in orthopedics, and the incidence is increasing over time.¹⁰ When possible, volar locked plating is the preferred treatment for displaced fractures requiring open treatment.^{9,11} However, some fracture patterns may not be amenable to volar plating or may be more suitably treated with other techniques to provide the best outcome. When the dorsal rim of the distal radius is fractured and depressed, the carpus is often unstable and the fragments may be too small for fixation by volar plating. This pattern, known as dorsal marginal impaction (Figure 1), has historically been treated with external fixation or Kirschner wires (K-wires).

External fixation involves bulky instrumentation that can be difficult to manage and unsightly. This exposed hardware also has risk for pin site infection or loosening that may cause loss of reduction or other complications.

Percutaneous placement of pins may also cause neuropathies as the distal radius has closely associated motor and sensory nerves. Complication rates have been reported as high as 53% for K-wire fixation and 67% for external fixation.^{1,14} Another concern with external fixation of distal radius fractures is the difficulty of controlling volar tilt as cadaveric studies have shown difficulty with this reduction relying wholly on ligamentotaxis.² Multiple clinical papers have also shown poor postoperative volar tilt measurements after external fixation.^{1,2,14}

First described by Burke and Singer, dorsal distraction plating utilizes a spanning/distraction plate to reduce the fracture via ligamentotaxis, and has the added benefit of

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Figure 1. Posteroanterior and lateral radiographs with accompanying computed tomography images of distal radius fracture with dorsal marginal impaction.

buttressing the dorsal cortex of the distal radius.³ The shorter working distance makes the construct more stable in addition to removing the risk for pin site complications as the plate is buried under the skin.¹⁵ In cases of polytrauma, the rigidity of the dorsal distraction plate construct allows patients increased weight bearing to facilitate transfers in the early postoperative period.¹³ This technique allows access to the carpus for management of concomitant injuries and access to the joint surface, which may be reduced under direct visualization and then augmented with K-wires, bone graft, or additional hardware. In addition, the distraction across the joint and immobilization also serve to protect the articular repair.

The normal anatomy of the distal radius has been previously described including radial inclination of 23.6° , radial height of 11.6 mm, ulnar variance of -0.6 mm, and volar tilt of 11.2° .⁸ Restoring this alignment and maintaining it to union is the primary goal of open treatment. In addition, intra-articular step-off of less than 2 mm has been shown to reduce the incidence of posttraumatic arthritis.⁷ This study aims to compare radiographic outcomes of patients treated with dorsal spanning plates with these previously reported norms and compare the results with prior publications for both external fixation and internal fixation with volar locked plates.

Methods

After obtaining approval and waiver of Health Insurance Portability and Accountability Act (HIPAA) consent from our institutional review board, we conducted a retrospective chart and radiograph review for all distal radius fractures at our institution that were treated with a dorsal distraction plate from May 30, 2013, to December 29, 2015. When imaging demonstrated volar rim fracture with marginal impaction and

dorsal subluxation of carpus with fragments that were too small to capture with volar to dorsally directed screws, the decision was made to proceed with dorsal distraction plating. There were no patients excluded from the study.

Nineteen patients, 11 male and 8 female, with mean age of 47.83 years (22-82) with distal radius fractures necessitating dorsal distraction plating were examined. Of the 19 fractures, 7 were of the dominant extremity, and 12 were nondominant extremities. Injury mechanisms were motor vehicle accident (4), motorcycle accident (2), fall from moving vehicle (1), fall from a height (3), and ground level fall (9).

The operative technique utilized a dorsal approach to the radius through the third dorsal compartment with retraction of the extensor pollicis longus. Dorsal arthrotomy was performed allowing direct visualization and reduction of the articular surface. The plate was fixed to the radial diaphysis and third metacarpal. The fracture was pulled out to length manually or with a push/pull screw or lamina spreader. Reduction was primarily accomplished via ligamentotaxis.

Additional instrumentation was utilized as needed to achieve adequate reduction and fixation. This included K-wires in 5 patients (Figure 2), radial styloid plates in 2 patients, an additional dorsal buttress plate in 1 patient, a volar buttress plate in 3 patients, and a suture anchor to repair the triangular fibrocartilage complex (TFCC) in 1 patient. One additional patient had K-wire fixation of a concomitant scapholunate dissociation.

Once fracture union was achieved, the plate was removed and all patients underwent the same intensive physical therapy protocol with the goal being to restore range of motion. Postoperative radiographs from the latest follow-up visit for each patient were examined, and the radial inclination, radial height, ulnar variance, volar tilt, and intra-articular step-off were recorded. This was done

utilizing Viztek Opal-Rad PACS software (Konica Minolta Medical Imaging, Garner, North Carolina).

Results

All fractures united prior to plate removal. The average time the plate was in place was 80.5 days (49-129). No infections or tendon ruptures were recorded. Two patients required tenolysis at the time of plate removal due to poor finger motion. No additional surgeries were required.

Follow-up radiographs showed average radial inclination of 20.5° (13.2°-25.5°), radial height of 10.7 mm (7.5-14 mm), ulnar variance of -0.3 mm (-2.1 to 3.1 mm), and volar

tilt of 7.9° (-3° to 15°). One patient had intra-articular step-off greater than 2 mm. These results are compared with those of previous authors who have utilized dorsal spanning plate, external fixation, and volar plating (Table 1).

Discussion

The results of our study were highlighted by 100% union rate. Previous studies of external fixation for complex distal radius fractures have had nonunion reported as a complication.^{1,14} The complications reported in these studies also included pin site infection rates of 23% and 37.5%.^{1,14} The lack of infections in our study clearly highlights the benefits of a buried construct.

The final radiographs showed that the fractures healed in good alignment (Figure 3). The measured inclination, height, variance, and tilt were all near anatomic norms. They also compared favorably with other studies utilizing dorsal spanning plates, external fixators, and volar plates. The notable difference in these parameters is that volar plating and dorsal distraction plating better controlled volar tilt than external fixation.

Our study also had only 1 patient with intra-articular step-off greater than 2 mm. Given the importance of the articular reduction in preventing posttraumatic arthritis, we believe the fully open approach with direct joint visualization is preferable to less invasive techniques that involve a proximal and distal incision with sliding of the plate.⁵

Another modification of this technique known as the Harborview method has been described with distal fixation to the second metacarpal rather than the third.⁶ The reported benefits of this technique are improved radial inclination and height as well as volar tilt of the radial styloid and scaphoid fossa. This position also allows a better power grip with the wrist ulnarly deviated.⁵ We prefer the original method described by Burke and Singer due to the concern for forces across the lunate facet.³ Anderson et al reported collapse of the ulnar border of the radius and lunate facet as a complication of external fixation for these types of

Figure 2. Postoperative posteroanterior and lateral radiographs showing dorsal distraction plating of distal radius fracture with the use of Kirschner wires to augment alignment and fixation.

Table 1. Radiographic Outcomes.

	Radial inclination (degrees)	Radial height (mm)	Volar tilt (degrees)	Ulnar variance (mm)
Dorsal spanning plate				
Our results	20.5	10.7	7.9	-0.3
Ruch et al ¹³	NR	NR	4.6	0
Richard et al ¹²	20	NR	5	0.6
External fixation				
Anderson et al ¹	18.6	8.3	-5.5	NR
Dienst et al ⁴	21	9	0	NR
Weber and Szabo ¹⁴	17.1	11.7	-2	NR
Volar plate				
Orbay and Fernandez ¹¹	20	NR	6	0
Mignemi et al ⁹	22	10.5	7	0.9

Note. NR = not reported.

Figure 3. Posteroanterior and lateral radiographs after plate removal showing union in good alignment of distal radius fracture treated with dorsal distraction plating.

fractures.¹ Furthermore, Ruch et al reported that the more ulnar position of the implant when fixed to the third metacarpal allows distraction across the radiolunate joint and direct buttressing of the lunate facet.¹³ While both methods may be beneficial in various fracture patterns, we have utilized third metacarpal fixation for our patients and the radiographic outcomes have not suffered as a result.

The limitations of this study include its retrospective nature. The sample size is also somewhat small, but given the severity of fracture treated with this technique, it is similar to previously published results. This study was also limited to a radiographic evaluation, and clinical outcomes including patient-reported outcomes were not evaluated.

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.

Statement of Informed Consent

Informed consent was obtained from all individual participants included in the study.

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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