Review article

Intra-articular Fractures of the Distal Radius Treated via Dorsal Approach: A Narrative Review

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Abstract

Distal radius fractures are common injuries, accounting for a significant portion of emergency room cases, and affecting both young adults and the geriatric population. High-energy trauma usually causes intra-articular fractures in younger individuals, while older adults often suffer from extra-articular fractures. Treatment aims at anatomic reduction and stable fixation to restore function, with options including closed reduction and casting, percutaneous fixation, external fixation, and open reduction internal fixation (ORIF) via dorsal or volar approaches.

The dorsal approach offers advantages like direct visualization of fracture fragments and support against dorsal collapse, making it ideal for complex fractures with dorsal comminution. Comparative studies show similar clinical and radiological outcomes between dorsal and volar plating, though each approach has associated complications. The introduction of low-profile locking plates has decreased tendon irritation associated with dorsal plating, increasing its effectiveness for certain fracture patterns. Although some research suggests a greater likelihood of implant removal with dorsal plating, both methods are effective in restoring wrist function. Further high-quality studies are needed to determine the best surgical approach for various types of distal radius fracture.

Distal radius fractures – An overview

Distal radius fractures (DRFs) are among the most frequently encountered fractures in emergency room accounting for one-sixth of all fractures seen, affecting both the young and the elderly [1]. The presence of an intra-articular component in DRFs usually indicates high-energy trauma, commonly observed in young adults. Such injuries often cause shear and impacted fractures of the articular surface at the distal end of the radius, resulting in displaced fracture fragments. Conversely, extra-articular fractures are more frequent in the elderly, whereas high-energy intra-articular fractures are more common in younger adults [2]. There might be a need for different treatment approaches due to variations in bone quality, fracture characteristics, associated soft tissue injuries and patient's functional demand between these age groups [3].

Prevalence of distal radius fractures

The DRFs account for 17.5% of all fractures in adults. Factors contributing to the rising rates of DRFs include lifestyle, increased life expectancy, increased travelling, childhood obesity, and higher osteoporosis rates in the elderly. Studies have shown that DRFs primarily affect young males and postmenopausal females [4].

Pathophysiology of distal radius fractures

"Distal radial fracture" is a broad term for any radius fracture near the wrist, but the various types can differ in presentation, mechanism of injury, and its management. Familiarity with the specifics of each type is key to appropriate treatment (Table 1) [5].

Treatment options

The primary goal of fracture treatment is to achieve accurate reduction of the fracture fragments, followed by maintaining this reduction by application of an immobilization method. Although restoring normal function is the ultimate objective in managing DRF, the best approaches to achieve this remains a topic of debate. It might be particularly challenging to treat intra-articular fractures of the distal radius using traditional conservative methods. Therefore, a variety of treatment options are available to prevent loss of reduction in unstable DRFs, each offering distinct benefits and considerations [2].

Closed reduction and casting

Treatment of DRF mainly involves closed reduction and immobilization in a splint or cast, which has been the standard for nondisplaced and stable fractures. Closed reduction is typically performed under various forms of anesthesia, including procedural sedation, hematoma block, regional nerve block, intravenous regional anesthesia, or general anesthesia. Each sedation method has its own risk of complications, and due to limited literature, no single method is universally recommended [6].

Fractures exhibiting minor comminution and minimal or no displacement are generally suitable for closed reduction and cast immobilization. Specifically, type I Melone's fractures can typically be managed conservatively [2].

Percutaneous fixation

Multiple authors have described the use of Kirschner wires for minimally invasive stabilization of extra-articular fractures [6]. Glickel et al. found that closed reduction and percutaneous pinning for DRFs led to excellent long-term outcomes, with all fractures healing within 6 weeks. There were minimal differences in range of motion and grip strength compared to the uninjured wrist, supporting this as an effective, low-cost treatment for two- and three-part fractures [7].

A Cochrane meta-analysis of 13 clinical trials on percutaneous pinning for DRFs found limited evidence for its effectiveness and noted high complication rates, especially with Kapandji fixation and biodegradable pins. Although percutaneous pinning may improve anatomical outcomes compared to plaster casts, its exact role and methods are still uncertain [8].

External fixation

External fixation is regarded as a superior treatment option compared to plaster immobilization for patients with intra-articular comminuted DRFs. Other indications for external fixation include [2]:

- Unstable extra-articular fractures with significant comminution
- Associated comorbidities

Table 1. Common distal radius and forearm fractures: Mechanisms, characteristics and X-ray appearance

Fracture Type	Mechanism of Injury	Characteristic Features	X-Ray Appearance
Colles' Fracture	FOOSH	Metaphyseal fracture ~1.5 inches proximal to carpal articulation; dorsal angulation and displacement	"Dinner-fork" deformity
Smith's Fracture	Fall onto dorsum of hand or direct blow	Volar angulation of distal fragment; reverse Colles'	"Garden-spade" deformity
Chauffeur's Fracture	FOOSH with wrist blow	Intra-articular fracture of the radial styloid; variable fragment size	Variable, intra-articular
Die-Punch Fracture	Axial loading of lunate	Intra-articular fracture involving lunate facet of radius	Lunate facet impaction
Galeazzi Fracture-Dislocation	FOOSH	DRUJ dislocation	Radius fracture, DRUJ disruption
Barton's Fracture	Forced dorsiflexion/ pronation or fall	Intra-articular rim fracture of distal radius; classified as dorsal or volar	Avulsed fragment displacement
Greenstick Fracture	Bending forces	Incomplete fracture; convex surface fracture with intact concave surface	Bony bending
Buckle/Torus Fracture	Axial loading	Incomplete fracture; buckling of bony cortex and periosteum without true fracture lines	Buckled cortex and periosteum
Salter-Harris Fracture	Various	Fractures involving epiphyseal plate, classified I-IX	Varies by type

FOOSH: Fall On an Outstretched Hand; DRUJ: Distal Radioulnar Joint

- Presence of significant swelling
- Severe open fractures with substantial soft tissue damage and neurovascular compromise

External fixation utilizes the principle of ligamentotaxis to apply traction and restore alignment. It is considered the most effective way to overcome the muscle forces that can cause collapse of comminuted DRFs. Recent studies have provided increasing support for the use of external fixation in managing unstable intra-articular DRFs, demonstrating its effectiveness in achieving stable fixation and facilitating recovery [2].

Egol, et al conducted a prospective randomized study comparing bridging external fixation with supplemental Kirschner wire fixation to volar locked plating for unstable DRFs. The researchers found that both treatment methods resulted in similar functional outcomes and complication rates [9].

Open reduction internal fixation

Dorsal

Internal fixation of DRFs is typically used for significant dorsal comminution or displacement. However, high rates of tendon irritation and extensor pollicis longus ruptures have made dorsal plating less favorable, necessitating routine removal of these plates to avoid complications. As a result, virtually all dorsal bridge plates warrant routine removal to avoid tendon complications. Dorsal plating is now primarily reserved for fractures with severe dorsal comminution that cannot be stabilized with volar plating [6].

Volar

Internal fixation for DRFs has gained significant attention since the introduction of volar locking plate in the early 2000s. Numerous studies support the effectiveness of internal fixation, despite concerns about the higher costs. Volar plates are believed to be superior to dorsal plates due to their more biologically friendly approach to extrinsic tendons and better preservation of the metaphyseal blood supply. However, drawbacks of volar fixation include the risk of flexor pollicis longus tendon irritation and subsequent rupture due to plate prominence, potential intra-articular screw penetration, and irritation of the extensor tendons from prominent screws in the dorsal cortex. Retrospective and comparative studies have shown that volar plate fixation is successful in treating unstable DRFs, reinforcing its position as a reliable treatment option [6].

Rozental et al. conducted a study comparing open reduction and internal fixation using a volar plate with percutaneous fixation for treating dorsally displaced unstable DRFs. The results indicated that the volar plate group had significantly better early functional recovery, as measured by Disabilities of the Arm, Shoulder and Hand scores, making it the preferred method for patients requiring a faster return to function [10].

Similarly, Karantana et al. compared outcomes of displaced distal radial fractures treated with a volar locking plate versus conventional closed reduction and percutaneous fixation in 130 patients. While the volar locking plate group showed better early functional outcomes and grip strength, no significant long-term differences were observed, suggesting it facilitates quicker initial recovery but does not provide lasting functional advantages over conventional treatment [11]. Recent American Academy of Orthopaedic Surgeons (AAOS) guidelines found insufficient evidence to make definitive recommendations for or against any treatment method. Despite the growing popularity of volar locking plate fixation, there is a lack of high-quality studies comparing it to other treatment options [6].

Fragment-specific fixation

Fragment-specific fixation employs a combination of low-profile small plates and clips that can be tailored to the specific fracture pattern and fragments involved. This method allows for internal fixation in highly comminuted fractures where standard plating is challenging, thus avoiding external fixation. Although technically demanding and time-consuming, requiring experienced surgeons and often multiple incisions, it offers a customized solution for complex fractures [6].

Dodds et al. compared the biomechanical stability of fragment-specific fixation and augmented external fixation for intra-articular DRFs. The findings showed that fragment-specific fixation offered comparable stability for 3-part fractures and significantly greater stability for 4-part fractures, supporting its use for early wrist motion in treating complex fractures [12].

Clinical overview of dorsal approach for partial articular fracture of the distal radius

Rikli and Regazzoni proposed a “3-column” theory to describe the anatomy of DRFs, categorizing the distal forearm into three distinct columns: the radial or lateral, intermediate, and ulnar or medial. In the “3-column” theory, the radial column includes the radial styloid and scaphoid fossa, the central column consists of the ulnar portion of the distal radius, sigmoid notch, and lunate facet, while the ulnar column is made up of the distal ulna, ulnar head, and triangular fibrocartilage complex [13, 14].

The primary aim of surgical treatment for DRFs is to achieve anatomical reduction and restore the three columns of the distal radius - the radial column, central column, and ulnar column. Restoring the anatomy is crucial to minimize the risk of post-traumatic arthritis. Surgical techniques that provide optimal exposure and visualization of the distal radius are essential to maximize the chances of achieving anatomical reduction of the fracture fragments [14].

The choice between dorsal and volar plating for DRFs is influenced by factors such as fracture type, location, direction of fragment displacement, and surgeon preference. Dorsal plating offers advantages like direct visualization of fracture fragments and the ability to provide support against dorsal collapse. Techniques utilizing dorsal plating are often considered ideal for treating complex fractures. Several studies have demonstrated the effectiveness and positive clinical

Table 2: Clinical overview of dorsal approach for DRFs

Study	Patients	Follow up	Results			Conclusion
Smet, et al [16]	26 patients with intra-articular impacted fractures	39 months	VAS	1-4 (46%); ≥5 (23%)		The dorsal approach is a viable treatment for certain intra-articular fractures, providing direct control of intra-articular congruency and stable buttress locking fixation, which facilitates early mobilization.
			QuickDASH Score	20±10.77		
			Mayo Wrist Score	70±18.49		
			SANE Score	76%±18.95		
			Flexion-Extension Range of Motion	92° ± 30.79		
			Wrist Flexion	37°±18.12		
			Wrist Extension	54±17.34		
			Ulnar Deviation	23°±8.73		
			Radial Deviation	15°±11.66		
			Supination	82°±11.48		
			Pronation	77°±13.73		
			Grip Strength	29 kg±12.65		
Abe, et al [17]	112 patients with displaced intra-articular fractures who were treated with dorsal (n=38) or volar approach (n=68)	Dorsal plate (13±5.5); Volar plate (12.6±5.5)	• Clinical Results: No statistical differences in subjective and objective parameters, except for wrist flexion. • Complication Rates: No significant differences between volar and dorsal plated groups. • Serious Complications: One serious complication occurred after volar plating. • Reason for Dorsal Plating: Most common reason was irreducible dorsal die-punch fractures.			Dorsal and volar interlocking plates for displaced intra-articular DRFs yielded similar clinical outcomes, with no significant postoperative complications in the dorsal group.
Nasab, et al [18]	70 adult patients with closed fracture in proximal half of the radius or radius and ulna who were treated with dorsal (n=31) or volar approach (n=39)	16 weeks	Parameter	Volar Approach	Dorsal Approach	There was no significant difference in term of fracture union, early complications, and range of forearm rotation between volar and dorsal approach for the fixation of radius fractures in its proximal half.
			Radial Nerve Injury	3 patients	2 patients	
			Infection	1 patient	1 patient	
			Nonunion	1 patient	1 patient	
			Duration of Procedure	No significant difference	No significant difference	
			Mean Forearm Rotation (4 months)	135°	138°	
Wei, et al [19]	Quantitative meta-analysis of 12 trials (952 patients)		• No between-group difference in overall complication rate • Volar fixation » Increased neuropathy (RR 2.19; 95% CI 1.27, 3.76) » Increased carpal tunnel syndrome (RR 4.56; 95% CI 1.02, 20.44) » Reduced tendon irritation (RR 0.38; 95% CI 0.17, 0.86)			Dorsal fixation has a lower risk of neuropathy and carpal tunnel syndrome than the volar approach but a higher risk of tendon irritation.

Drummond, et al [20]	394 patients with DRFs treated with dorsal bridge plating (DBP) or volar plate fixation)	55.2 weeks	DASH score	25.7	
			Range of Movement	46.9° flexion, 48.8° extension, 68.4° pronation, 67.5° supination	DBP is a good alternative to volar plating for complex DRFs with satisfactory outcomes.
			Radiological Parameters	Radial Height: 10mm, Volar Tilt: 3.1°, Ulnar Variance: 0.5mm, Radial Inclination: 18.8°	
			Complication Rate	11.4% (Digital stiffness most common, improved with tenolysis)	

Abbreviations - VAS: Visual Analog Scale; QuickDASH: Quick Disabilities of the Arm, Shoulder, and Hand; SANE: Single Assessment Numerical Evaluation; RR: Relative Risk; CI: Confidence Interval; N/A: Not Applicable

outcomes associated with the dorsal approach for partial articular fractures of the distal radius (Table 2) [14, 15].

A case study presented a 60-year-old woman with a dorsally unstable, displaced intra-articular DRF treated via a dorsal approach. At one-year post-surgery, the patient achieved near full and painless range of motion in her wrist, with no significant complications or post-traumatic arthritis observed on radiographs. The study emphasizes that the dorsal approach provides reliable restoration of wrist function with a lower rate of neuropathic complications compared to other methods [15].

The existing research comparing dorsal and volar plating techniques for DRFs shows varying results in terms of complications. While some studies suggest a higher incidence of implant removal with the dorsal approach, the overall radiographic and clinical outcomes appear to be similar between the two methods. The introduction of newer, lower-profile locking plates has helped reduce certain complications associated with dorsal plating, potentially making it a suitable option for managing specific fracture patterns. However, more high-quality comparative studies are needed to definitively determine the optimal surgical approach for different types of DRFs [15].

Conclusion

The treatment of DRFs, particularly those involving intra-articular components, remains a complex and debated topic in orthopedic surgery. The dorsal approach for partial articular fractures of the distal radius offers distinct advantages such as direct visualization of fracture fragments and support against dorsal collapse, making it a valuable option in specific fracture patterns. Despite the higher complication rates associated with dorsal plating, advancements in low-profile locking plates have reduced these risks, providing comparable outcomes to volar plating in many cases. However, a surgeon should not hesitate in using combination of dorsal and volar approach in complex fracture patterns for anatomic reduction. Continued research and high-quality comparative studies are needed to improve treatment protocols and optimize patient outcomes, ensuring tailored approaches based on fracture characteristics and patient-specific factors.

Article information

Conflicts of interest

The authors has no conflict of interest to declare.

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Data availability

Data of this study are available from the author/s upon reasonable request

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