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Treatment Modalities of distal radius fractures: Review article

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ABSTRACT

Distal fractures of the radius comprise the largest portion of orthopaedic fractures, accounting for one sixth to one fourth of all fractures treated in clinical emergency departments (97). Among all fractures, dorsally displaced distal radius fractures (DDDRF) are the most common. As the population is ageing, the specific incidence of this fracture type will, undoubtedly, increase in the coming years. In the past, many of these fractures were managed nonoperatively. However, the high incidence of malunion, associated with nonoperative management led to poor clinical outcomes, including pain and disability. Advances in internal fixation techniques have resulted in increased reliance on operative approaches for the management of DDDRF (1). Treatment options include manipulation and casting, Kirschner wire fixation, volar or dorsal locking plates and external fixation. The use of volar locking plates for distal radial fractures (DRF) has become increasingly popular. One of the benefits of volar locking plates is increased pullout strength in osteoporotic bone (99,100). All displaced fractures should undergo closed reduction, even if it is expected that surgical management will be needed. Fracture reduction helps to limit post injury swelling, provides pain relief, and relieves compression on the median nerve (2).

Keywords: dorsally displaced distal radius fractures (DDDRF), volar locking plate**,** Kirschner wires placed

INTRODUCTION

The injury produced depends on the position of the wrist, the magnitude and direction of force, and the physical properties of the bone. A fall on the outstretched hand with the wrist in 40° to 90° of dorsiflexion produces a distal radius fracture with dorsal displacement. The radius probably first fractures in tension on its palmar surface, followed by compression on its dorsal surface, resulting in dorsal comminution. The lunate in particular can exert a compressive force on the distal radius, producing a so- called die-punch fracture. The ulnar styloid fracture component of the Colles' fracture results from a force transmitted through an intact triangular fibrocartilage complex.**(3)**

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The diagnosis depends on:

- History.
- Clinical picture.
- Radiological assessment.

History:

Patient reports falling on outstretched hand. Other mechanisms include: RTA (road traffic accident); direct trauma; FFH (fall from height).

Clinical picture:

- Swelling which occupies the wrist and metacarpal region and may cause fullness of the distal 1/3 of the forearm.
- Tenderness and crepitus.
- Deformity with variable degree of prominence of the ulnar head. The radial styloid process may be at the same level of that of the ulna or at even more proximal level.
- Neurological and vascular assessment should be done for treatment planning and patient follow up[(3)].

Radiological assessment:

Anteroposterior view: It shows the following:

- Fracture outlines and the degree of extension to the radiocarpal and distal radioulnar joints[(4)].
- Degree of radial deviation of the distal fragment (the normal is 22 to 30°).
- Radial shortening by measuring the radial length. The normal radial length is about 11-12 mm.
- Radial width.
- Articular step off.

Lateral view: It shows the following:

- Tilt of the distal fragments either volar or dorsal. Normally the volar tilt measures 10-12°.

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- Cortical comminution and the impaction of cancellous bone.
- Sublaxation of the radioulnar joint.

Fracture stability:

The following radiological signs should alert the surgeon that an initial satisfactory closed reduction would not be maintained by a splint or cast or what is called (The criteria of fracture instability)[(5)]:

1. Dorsal comminution exceeding more that 50% of the dorsal to palmar distance
2. Palmar metaphyseal comminution.
3. Initial dorsal tilt > 20°.
4. Initial displacement > 1cm.
5. Initial shortening >5mm.
6. Associated ulnar fractures.
7. Intra-articular extension.
8. Massive osteoporosis.

The unstable fractures have the tendency to re-displace after the initial reduction with the recurrence of the deformity[(5)].

Management of Distal Radius Fractures

The basic principle of fracture treatment is to obtain accurate fracture reduction and then to use a method of immobilization that will maintain and hold that reduction. A number of options for treatment are available to prevent the loss of reduction in an unstable fracture of the distal end of the radius[(6)].

Factors affecting treatment include

Local factors: bone quality, soft tissue injury, fracture comminution, fracture displacement, and energy of injury[6].

Patient factors: Patient age, lifestyle, hand dominance, associated medical conditions, associated injuries, and compliance[6].

Radiographic alignment parameters for acceptable reduction in an active, healthy patient include (Figure 1):

Radial length: within 2 to 3 mm of the contralateral wrist

Volar tilt: neutral tilt (0 degrees), but up to 10 degrees dorsal angulation

Intra-articular step-off: < 2 mm

Radial inclination: < 5 degree loss

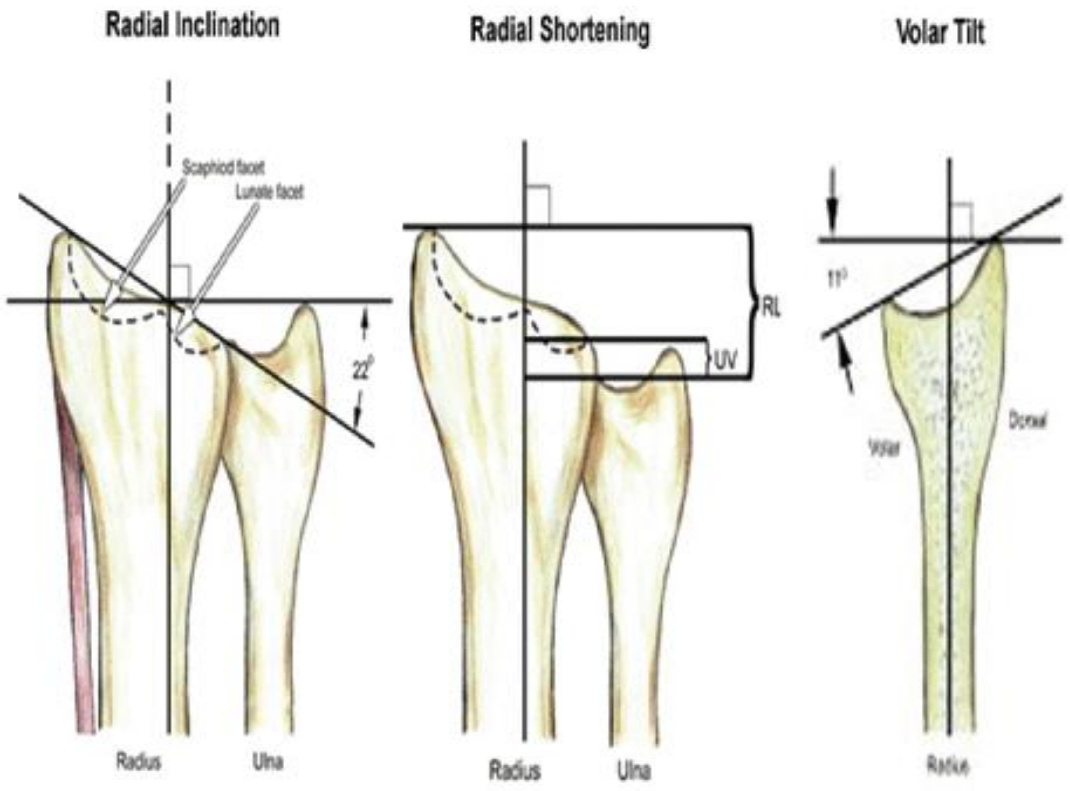

Figure 1. Tilt and angles at distal radius.[6]

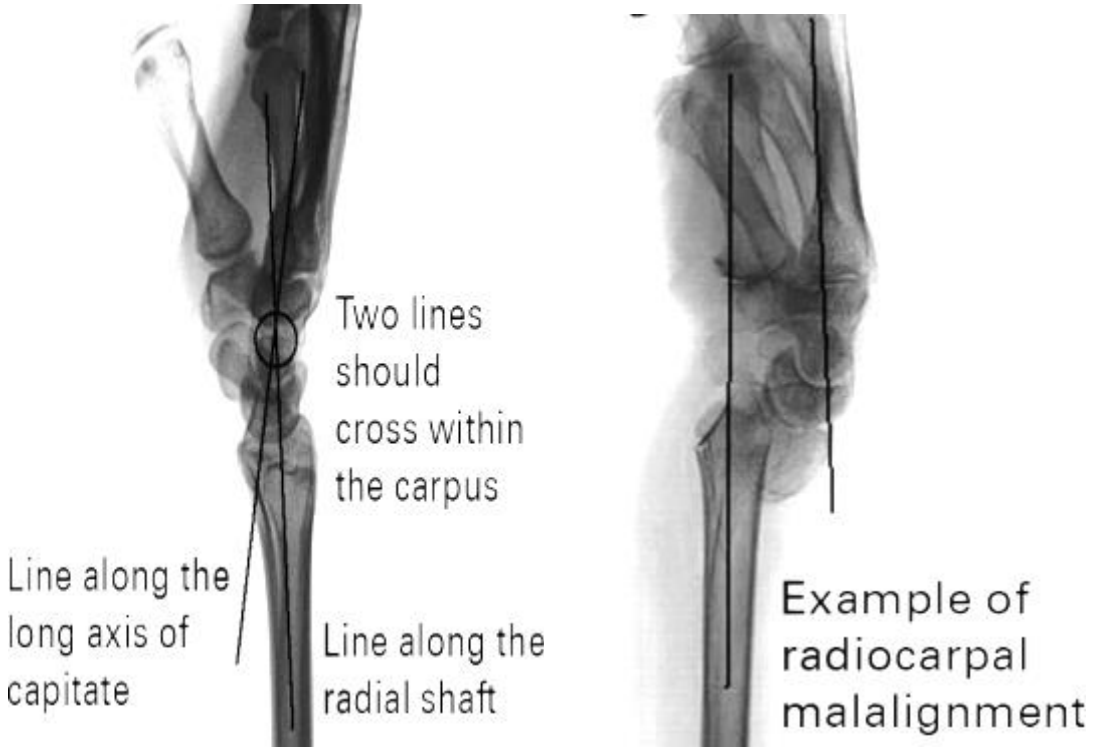

Figure 2. Carpal alignment.[7]

Carpal alignment: after distal radius fracture may have the most influence on outcome. Carpal alignment is measured by the intersection of two lines on the lateral radiograph**:** one parallel and through the middle of the radial shaft and the other through and parallel to the capitate. If the two lines intersect within the carpus, then the carpus is aligned. If the two lines intersect out with the carpus, then the carpus is malaligned (Figure 2) [7].

Types of management:

A) Non operative

All displaced fractures should undergo closed reduction, even if it is expected that surgical management will be needed. Fracture reduction helps to limit post injury swelling, provides pain relief, and relieves compression on the median nerve[8].

Cast immobilization is indicated for: non displaced or minimally displaced fractures, displaced fractures with a stable fracture pattern expected to unite within acceptable radiographic parameters and low-demand elderly patients in whom future functional impairment is less of a priority than immediate health concerns and/ or operative risks[8].

B) Operative:

■ Indications:

1) **Articular step-off:** It has become apparent through the work of several authors that restoration of articular congruency is potentially of greater importance than other criteria . It has been reported that the development of post-traumatic osteoarthrosis in 100% of wrists with articular incongruities of 2.0 mm or more. However, other investigators found that displacement of even 1.0 mm resulted in pain and stiffness of wrist[(9)].

2) **Secondary loss of reduction:** Several factors have been associated with redisplacement following closed manipulation of a distal radius fracture[(9)]:

- The initial displacement of the fracture: the greater the degree of displacement, the more energy is imparted to the fracture making closed treatment most likely will be unsuccessful.
- The patient's age**:** Elderly patients with osteopenic bones tend to displace, particularly late.
- The extent of metaphyseal comminution (the metaphyseal defect).

Displacement following closed treatment is a predictor of instability, and repeat manipulation is unlikely to result in a successful radiographic outcome[(9)].

3) Metaphyseal comminution or bone loss

4) DRUJ incongruity

5) Open fractures

Operative Techniques:

1-Percutaneous pinning:

This is primarily used for extra-articular fractures or two-part intra-articular fractures. It may be accomplished using two or three Kirschner wires placed across the fracture site, generally from the radial styloid, directed proximally and from the dorso-ulnar side of the distal radial fragment directed proximally (Figure 3-a). Trans-ulnar pinning with multiple pins has also been described. Percutaneous pinning is generally used to supplement short arm casting or external fixation. The pins may be removed 6 to 8 weeks postoperatively, with the cast maintained for an additional 2 to 3 weeks[(10)].

Kapandji "intrafocal" pinning This is a technique of trapping the distal fragment by buttressing to prevent displacement (Figure 3-b).

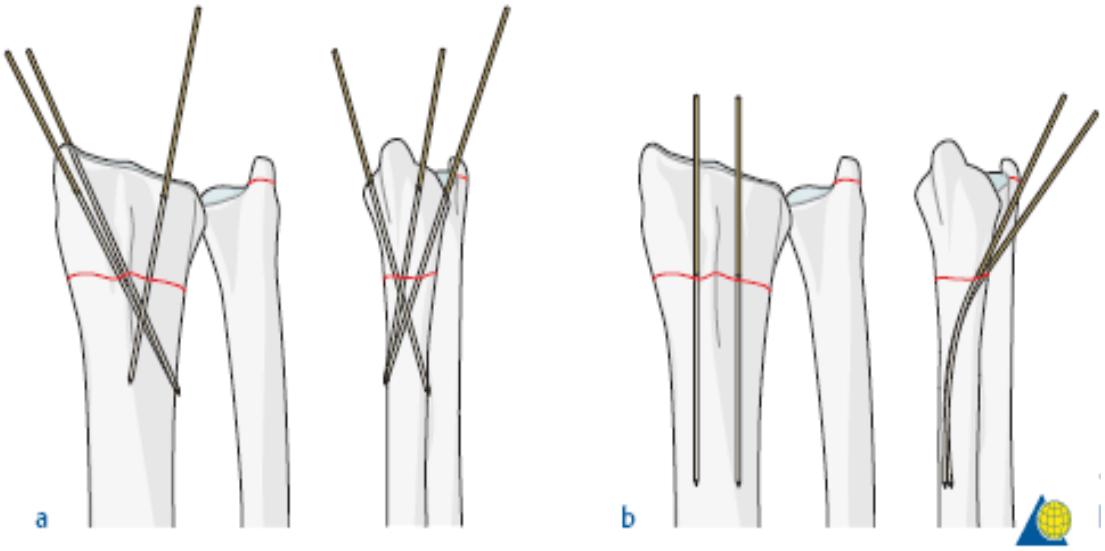

Figure 3. A-Pinning and B-Kapandji technique of distal radius fracture.[54]

2-External fixation:

External fixation is generally accepted as superior to plaster immobilization in the young patients with an intra-articular comminuted fracture of the distal radius. Other indications for external fixation include some unstable extra-articular fractures with significant comminution and failure to maintain reduction after an initial attempt at closed management in a cast, certain situations of multiple trauma, severe open fractures with significant soft tissue injury and neurovascular compromise, and bilateral injuries[11].

External fixation relies upon the principle of ligamentotaxis to apply traction and restore displacements. The use of an external fixation device is the only practical means of overcoming the force of the muscles of the forearm that pull comminuted distal radial fractures into a collapsed position. The use of an external fixator in the treatment of unstable intra-articular fractures of the distal radius has received support (Figure 4). [11]

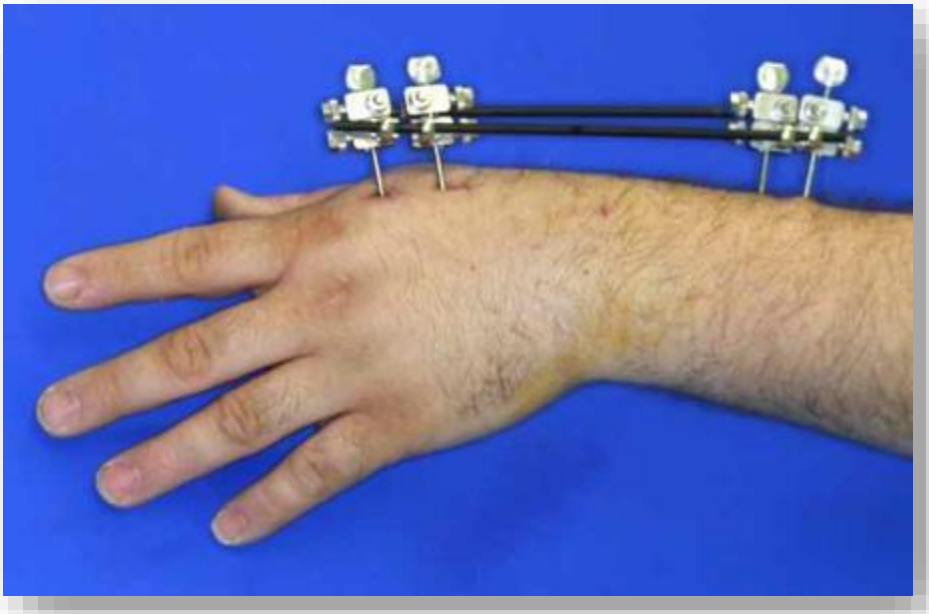

Figure 4. External fixator for distal radius fracture.[11]

3-Open reduction and internal fixation:

There are two groups of fractures for which open reduction and internal fixation is advisable. The first group includes the two-part shear fracture (Barton fracture), which actually is a radio-carpal fracture dislocation. Although anatomical reduction is possible by closed means in some cases, these fractures are very unstable and difficult to control in plaster. The second group includes complex intra-articular fractures in which the articular fragments are displaced, rotated or impacted and are not amenable to reduction through a limited operative exposure. [12]

a) Dorsal plating: This has several theoretic advantages. It is technically familiar to most surgeons, and the approach avoids the neurovascular structures on the palmar side. The fixation is on the compression side of the fracture and provides a buttress against collapse. Initial reports of the technique demonstrated successful outcomes with the theoretic advantages of earlier return of function and better restoration of radial anatomy than seen with external fixation (Figure 5) [12].

Dorsal plating has been associated with extensor tendon complications, but this complication is overcome by low profile plates[12].

b) Volar plating:

1) Non-locking: The primary indication is a buttress plate for the shear fracture of the volar Barton. This construct may be unable to maintain fracture reduction in the presence of dorsal comminution [(12)].

2) Locked plating: Locked volar plating has increased in popularity because this implant has been shown to stabilize distal radius fractures with dorsal comminution. It has surpassed external fixation as the most popular mode of fracture fixation of the distal radius (Figure 5) [(13)].

c)Fragment specific plating: Has been advocated for more complex fracture patterns involving several aspects of the radial and ulnar columns (Figure 6).[(14)]

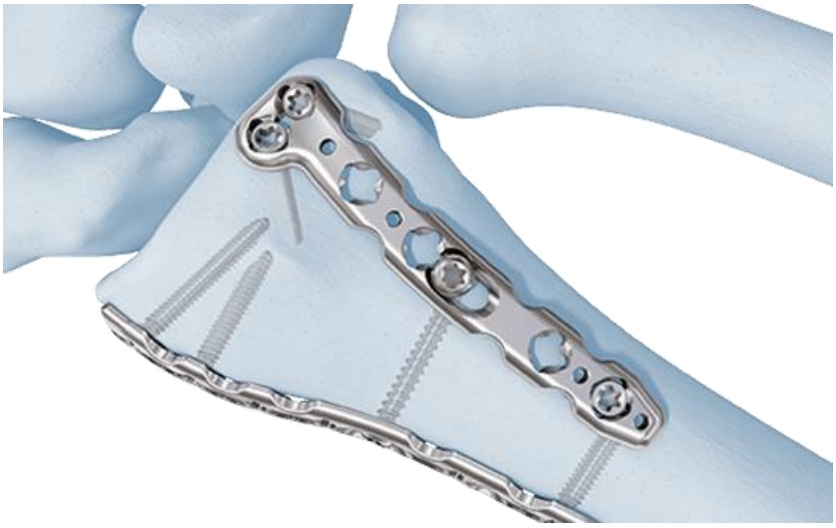

Figure 5. Dorsal plating of distal radius with low profile plates.[(12)]

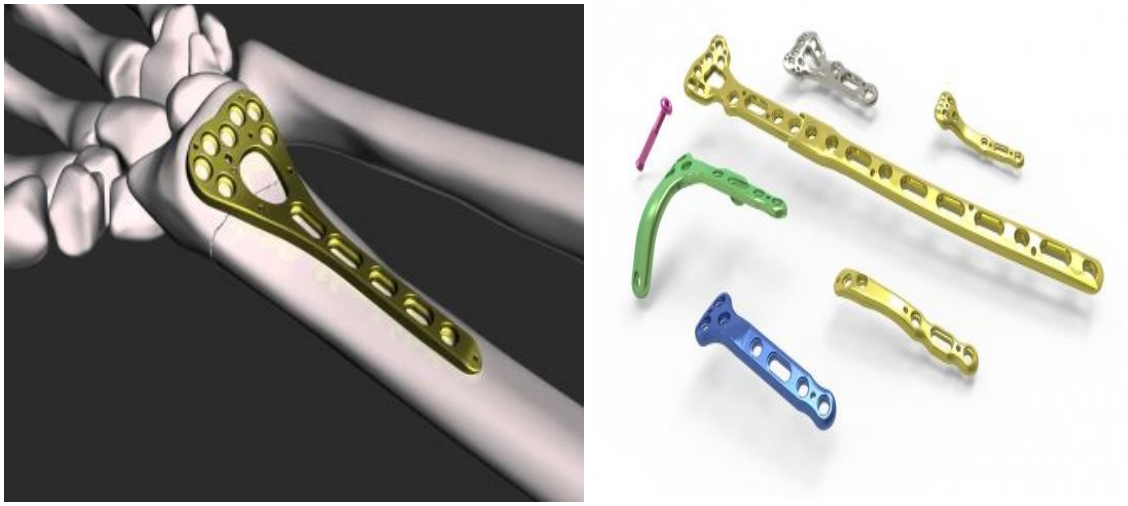

Figure 6. A-Right: Volar plate B-Left: Fragment specific distal radius plate.[(14)].

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Complications of Distal Radius Fractures

Complications after distal radius fractures occur for many reasons, and often vary depending on the method of treatment. Complications are divided chronologically in to immediate, early (<6 weeks) and late (>6 weeks).[15]

I. Immediate complications

1. Nerve injury:

Distal radius fractures complicated by nerve injury are relatively common, with a reported incidence varying from 0% to 17%. All nerves median, ulnar, or radial can be affected as they cross the wrist, although the median nerve is most frequently affected[16].

Median nerve injury can occur at the time of injury or during reduction or fixation. Direct injury, such as transection or entrapment of the nerve, is less common than secondary median neuropathy caused by increased carpal tunnel pressure[16].

Acute carpal tunnel syndrome can occur in fractures treated nonoperatively secondary to positioning. The Cotton-Loder position, which entails excessive wrist flexion and ulnar deviation, should be avoided, as a hyperflexed wrist increases the pressure in the carpal tunnel.[16]

In patients who have significant hand and wrist swelling, splints or bivalved casts should be used rather than circumferential casts. Patients should be encouraged to keep the hand elevated and actively flex and extend their fingers. The symptoms usually diminish as the swelling subsides. A carpal tunnel release should be considered if the symptoms are more severe or progressive, or if surgical intervention is planned that may increase swelling.[15]

2. Open Injury:

Open fractures of the distal radius are infrequent. However, open fractures of the distal ulna in association with a distal radius fracture are more common. Gustilo and Anderson type I injuries are the most common and may be easily missed, especially on the volar side of the wrist. Intravenous antibiotics should be administered and tetanus status assessed in the emergency department. These injuries require prompt irrigation, debridement, and fracture stabilization.[15]

3.Compartment syndrome (CTS):

Compartment syndrome is a rare complication following fracture of the distal end of the radius, with a prevalence of less than 1%.[16]

4.Missed associated injuries :

High-energy injuries may be associated with injuries remote to the wrist such as (elbow, shoulder, spine, lower limb) or local to the wrist such as (carpal or metacarpal injury). A careful history, thorough physical examination, and appropriate radiographs will identify other sites of injury[15].

CONCLUSION

Unstable intra-articular radius fractures that cannot be reduced or held reduced with pinning should be treated with locking plate systems.

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