DISTAL RADIUS FRACTURE

Universal cast treatment gave way to neutralization with a bridging external fixator, which in turn was replaced by dorsal buttress plating.
The significance of these short-term advantages for the patient must now be weighed against the financial impact of routine operative intervention has cost.
Although some patients still seem to confirm Abraham Colles' famous remarks that the casted wrist "will at some remote period again enjoy perfect freedom in all of its motions and be completely exempt from pain," an increasing preponderance of published studies support the need for operative intervention in this aging population.
Catalano et al. have indicated that although there is a correlation between articular incongruity and radiographic arthrosis.

Young indicated that in elderly patients (mean age 72 years) the radiographic outcome did not correlate with functional outcome.
Current data confirm that patients over the age of 65 with extra-articular fractures are more likely to be satisfied with closed treatment than younger patients, but that there are still some geriatric patients who will not accept shortening and angulation The perception that internal fixation allows immediate range of motion, and therefore an improved functional arc of motion at the end of treatment, has been questioned. Immediate motion may not change the outcome as much as the other factors associated with patient demographics and fracture reduction.
The perceived differences between the techniques are short term, and patient perception of outcomes may equalize between 6 months and 1 year regardless of the operative technique used.

EPIDEMIOLOGY

6% of all fractures treated
3 main peaks of fracture distribution:
- children age 5-14,
- Males under age 50
- Females over the age of 40 years.

In females the incidence rises sharply after the age of 40 from approximately 37/10,000 to 115/10,000 at age 70 years

The injury in younger population is related to higher energy injuries (21% of all fractures) rather than to simple falls.

RELEVANT ANATOMY

The distal radius consists of the (1) metaphysis, (2) scaphoid facet, (3) lunate facet, and (4) sigmoid notch.

Distally the radius has a somewhat trapezoidal shape. The radial styloid rotates palmarly 15 degrees off the axis of the radius, which makes capture difficult from a dorsal approach.

The "palmar ulnar corner" is often referred to as the keystone of the radius. It serves as the attachment for the palmar distal radioulnar ligaments and also for the stout radiolunate ligament.

EXAMINATION

Routine hand examination

Define deformity [Dinner fork]; IRUJ disruption; Median N and EPL

Range of movement

Grip prehension

CRPS

Essex-Lopresti lesion. Disruption of inferior radio-ulnar joint with fracture of radial.

Attention should then be directed to soft tissue considerations.

PREFERRED METHOD

1. Manipulate and Below elbow cast
2. If no relief in pins and needles is seen within 6 hours, then an immediate carpal tunnel release should be performed.
3. Sling elevation and Re X ray in 10 days and COP; X ray at 3 weeks
4. Cast for 6 weeks and X rays
5. Surgery for selected cases

IMAGING

1.The standard series of PA, lateral, and oblique x-ray views is useful to visualize a suspected fracture of the distal radius.

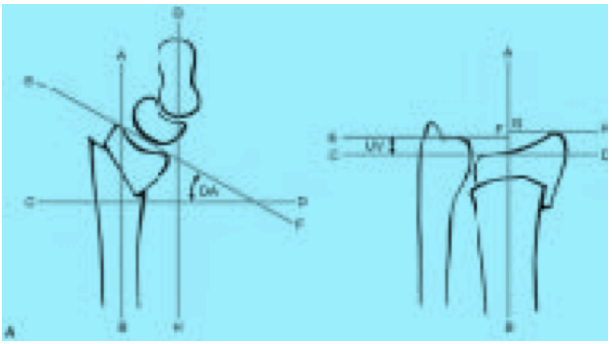
Dorsal/Palmar Tilt

Normal measurements

Radial inclination	23°
Volar inclination	11°
Radial height	12 mm

Radial styloid is slightly anterior to the shaft

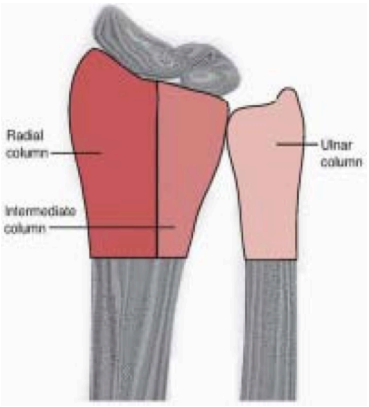
On a true lateral view a line is drawn connecting the most distal points of the volar and dorsal lips of the radius. The dorsal or palmar tilt is the angle created with a line drawn along the longitudinal axis of the radius



Radial Length

Radial length is measured on the PA radiograph. It is the distance in millimeters between a line drawn perpendicular to the long axis of the radius and tangential to the most distal point of the ulnar head and a line drawn perpendicular to the long axis of the radius and at the level of the tip of the radial styloid.

Functionally 3 columns [Peine: Column concept]



Radial column: Radial styloid
Scaphoid fossa

Intermediate Lunate fossa
Sigmoid fossa

Ulnar column Ulnar head and styloid
TFCC

Ulnar Variance

This is a measure of radial shortening and should not be confused with measurement of radial length. Ulnar variance is the vertical distance between a line parallel to the medial corner of the articular surface of the radius and a line parallel to the most distal

point of the articular surface of the ulnar head, both of which are perpendicular to the long axis of the radius.

Radial Inclination

On the PA view the radius inclines towards the ulna. This is measured by the angle between a line drawn from the tip of the radial styloid to the medial corner of the articular surface of the radius and a line drawn perpendicular to the long axis of the radius

CLASSIFICATION

Group I: Simple Colles' fracture with no involvement of the radial articular surfaces

Group II: Comminuted Intraarticular Colles'

Melone's Classification

Emphasized the effect of the impaction of the lunate on the radial articular surface to create four characteristic fracture fragments

Type I: Stable fracture without displacement. This pattern has characteristic fragments

Type II: of the radial styloid and a palmar and dorsal lunate facet.

Type II: Unstable "die punch" with displacement of the characteristic fragments and comminution of the anterior and posterior cortices

Type IIA: Reducible

Type IIB: Irreducible (central impaction fracture)

Type III: "Spike" fracture. Unstable. Displacement of the articular surface and also of the proximal spike of the radius

Type IV: "Split" fracture. Unstable medial complex that is severely comminuted with separation and or rotation of the distal and palmar fragments

Type V: Explosion injury

The OTA/AO classification

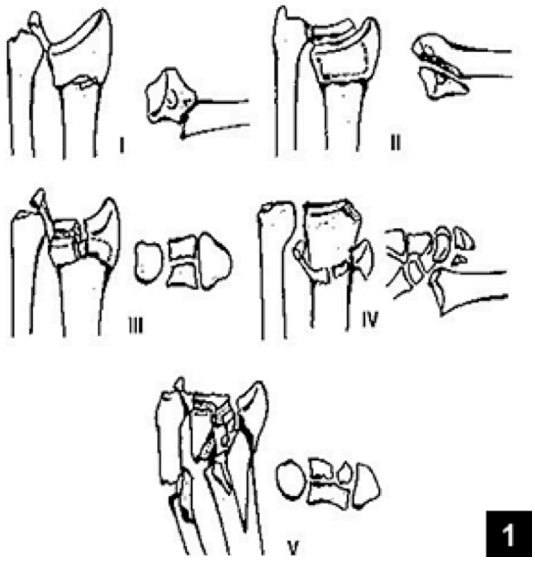
Type A: Extraarticular fracture.

Type B: Partial articular fracture. Subgroups are based on lateral (radial styloid) dorsal fragments.

Type C: Complete articular. Subgroups are based on the degree of comminution of the articular surface and the metaphysis.

These classifications are based on the location of the fracture line(s), the displacement of the distal fragment, the extent of articular involvement, and the presence of an ulnar styloid fracture.

Fernandez [1993] proposed a mechanism-based classification system that would address the potential for ligamentous injury and thereby assist in treatment recommendations



1

Type I: Metaphyseal bending fractures with the inherent problems of loss of palmar tilt and radial shortening relative to the ulna (DRUJ injuries)

Type II: Shearing fractures requiring reduction and often buttressing of the articular segment

Type III: Compression of the articular surface without the characteristic fragmentation; also the potential for significant interosseous ligament injury

Type IV: Avulsion fractures or radiocarpal fracture dislocations

Type V: Combined injuries with significant soft tissue involvement because of the high energy nature of these fractures

Acceptable position

Radial length	Within 2-3 mm of the contralateral wrist
Palmar tilt	Neutral tilt (0 degrees)
Intra articular step-off	<2 mm
Radial angle	<5 degrees loss
Carpal malalignment	Absent

Radial Inclination

Cadaver data indicate that the carpus shifts ulnarly in response to loss of radial inclination, thereby resulting in increased load on the triangular fibrocartilage complex (TFCC) and the ulna. Although this effect is not as severe as other deformities, clinical studies demonstrate a correlation between decreased radial inclination and decreased grip strength. In addition, long term follow up indicates that this increases the risk of degenerative changes by 90%.

NON-OPERATIVE TREATMENT

Cotton Loder: Historical cast in extreme palmar flexion [CTS, Stiffness]

Bohler: Cast and pins: historical

Princliple: Do not put in excessive flexion; Do not cross the distal palmar crease; Commence early mobilization including forearm rotation

A cast with a dorsal mold may prevent dorsal displacement; however, a cast does not resist collapse caused by an axial load. Resistance to collapse is dependent on an intact palmar buttress. Several authors have documented that when comminution extends into the palmar buttress, collapse occurs even in the face of cast immobilization.

Lunate impaction fractures typically result secondary to axial load. Although cast immobilization prevents dorsal displacement, it does not resist axial loads, and as such cannot resist redisplacement of the lunate facet over time.

Prediction of Instability

1. > 80 years of age : with a displaced fracture of the distal radius are three times more likely to be unstable than 30 years of age.
2. The greater the degree of initial displacement (particularly radial shortening), the [>20 degrees of dorsiflexion]
3. The extent of metaphyseal comminution [with palmar comminution]
4. Displacement following closed treatment is a predictor of instability, and repeat manipulation is unlikely to result in a successful outcome.
5. Shortening more than 1 cm and radial deviation more then 10 degrees.

Mackenney

An independent 85 year old lady with a dorsally displaced fracture of the distal radius with metaphyseal comminution and a positive ulnar variance of 2 mm. The calculated probability of malunion is 82%.

MUA

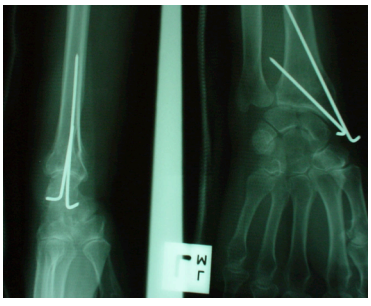
Increasing the degree of the deformity and then applying longitudinal traction reduce reduction of the distal metaphysis.

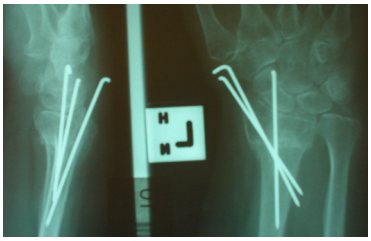
Only when sufficient traction has been applied can the distal metaphyseal fragment be reduced on the shaft.

The initial goal is to reapproximate the palmar cortex.

Finally, palmar tilt is restored using gentle pressure on the distal fragment.

Care is taken to avoid excessive palmar flexion of the radiocarpal joint, which can result in an acute carpal tunnel syndrome.





Post-reduction radiographs are obtained at 7, 14, and 21 days.

Traditionally, distal radius fractures have been placed in a cast for 5 to 6 weeks, but there is evidence that the less severe fractures can be safely immobilised for 3 weeks

SURGERY

The optimal timing of the surgical intervention is dependent on the associated soft tissue factors and the proposed surgical procedure.

a. Percutaneous Pinning

This technique can be used for both metaphyseal instability and intra-articular displacement. It is minimally invasive and inexpensive. It relies on the ability to reduce the distal segment and to maintain the reduction while the pins are applied. For the larger fragments, 0.62-inch Kirschner wires may be used.

The radial styloid is pinned to the proximal shaft in a reduced position. Once the lateral cortex is reconstituted, then the intermediate column (lunate facet) is pinned from dorsal ulnar to proximal radial. Finally, any central impaction fragments can be supported using subchondral transverse wires.

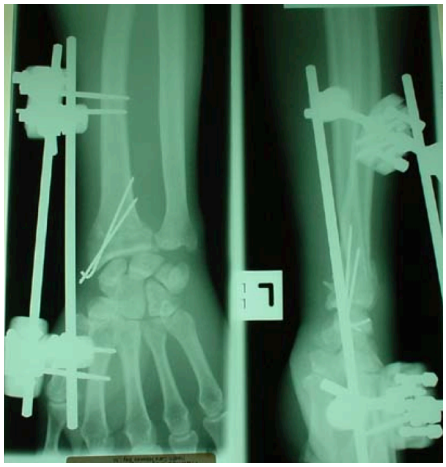
.b. Kapandji [Extra focal fixation]

The wires are inserted both radially and dorsally directly into the fracture site. The wires are then levered up and directed into the proximal intact opposite cortex. The fragments are thus buttressed from displacing dorsally or proximally. In addition to being relatively simple and inexpensive, this technique can be very effective. A difficulty with this technique is the tendency to translate the distal fragment in the opposite direction of the pin.

External Fixator

External fixation neutralizes the axial load imparted by physiologic load of the forearm musculature. External fixation may be performed in a "bridging" technique in which the fixation crosses the radiocarpal joint or in a "nonbridging technique" in which the distal fixation pins are placed in the subchondral bone and radiocarpal motion is permitted.

Bridging external fixator: The philosophy was that the intact wrist capsule and ligamentous structures would "indirectly" reduce both the metaphyseal displacement and any impacted articular fragments, and open reduction would not be necessary.



Several detailed studies have documented that external fixation alone may not be sufficiently rigid to prevent some degree of collapse and some loss of palmar tilt during the course of healing, with some degree of collapse being seen in up to 50% of patients and significant collapse in up to 10% of patients.

Adjunctive Fixation. Supplemental Graft: In an effort to allow the fixator to be removed earlier and to prevent collapse of the fracture, many authors have advocated the use of supplemental bone graft or a bone graft substitute within the fracture site. Cassidy and coauthors performed a prospective randomized study comparing closed manipulation and percutaneous introduction of a calcium phosphate bone cement to treatment with external fixation or cast application. Although significant clinical differences were seen at 6 and 8 weeks postoperatively, there were no substantial differences at 3 months.

Nonbridging external fixation is indicated for extra-articular or minimal intra-articular dorsally displaced fractures with metaphyseal instability and it is applicable to most of these fractures. The technique is not suitable for the treatment of volar displaced fractures. Fewer cases with displaced articular extensions are suitable for nonbridging ex fix, as after fixation of the joint surface they may lack the necessary space in the distal fragment for the distal pins.

Surgical technique of External Fixator

1. Under II, fracture is reduce
2. Stab incision and 2 proximal Schanz pins in the radius [Parallel]
3. Distal through the neck and base of II metacarpal [avoid extensor tendon by flexing the MPJ.
4. Fix to the frame and check under Image intensifier
5. Adjust and tighten

Other fixation

1. Hybrid fixation: not used
2. Combined internal and external fixation

3. **Arthroscopic reduction** of intra-articular fixation:

Arthroscopy has demonstrated residual displacement of articular fragments in 33% to 71% of fractures following reduction under fluoroscopy.

Imaging is difficult to detect 1 mm displacement

The incidence of interosseous ligament injuries associated with intra-articular fractures appears to be approximately 50% for scapholunate ligament injuries and 20% for lunotriquetral injuries.

Triangular fibrocartilage injuries occur in approximately 40% of fractures and direct chondral injury in up to 30% of fractures.

Complications of External Fixation [See under complications].

Open Reduction and Internal Fixation

1. Traditional AO oblique T plate [high profile]
2. Pi plate: low profile and recessed screw and malleolable. High rate of tendon rupture
3. Forte plate [Zimmer]: oblique T plate with recessed screw heads; Preshaped
4. Fragment specific fixation: Multiple small low profile plates and K wires Placed in an orthogonal position
5. Fixed angle volar plating: DVR: Threaded screws and subchondral pegs

Internal fixation of periarticular fractures has many potential advantages including direct fixation of articular fragments, early range of motion of the joint, and avoidance of constrictive dressings or casts. In a recent prospective randomized trial of 144 intraarticular fractures, internal fixation was found to have superior results to bridging external fixation supplemented by percutaneous pinning radiographically and using the Gartland and Werley outcome score, especially for C2 fractures.

Dorsal Plating

Technically familiar to most surgeons

Avoids the neurovascular structures on the palmar side.

Further, the fixation is on the compression side of most distal radius fractures and provides a buttress against collapse.

Despite the initial success with the technique, there were increasing reports of

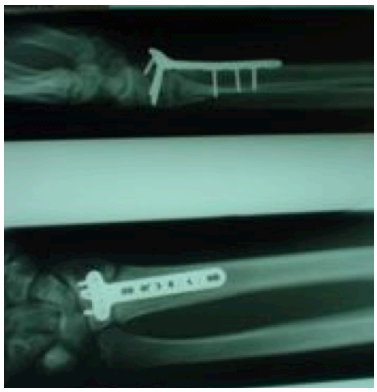
extensor tendon ruptures because of prominent hardware, particularly at Lister tubercle.

There may be a higher incidence of complications associated with the routine use of this approach when compared with the palmar approach.

Operative Technique.

1. A longitudinal incision is centered over the fracture in line with the ulnar aspect of Lister tubercle.
2. The extensor retinaculum is incised in a z-plasty manner: Divide between III and IV compartment
3. Subperiosteal EPL and retract radially
4. Traction is then applied by either an assistant or by the use of finger traps with weights suspended off the end of the table. Care should be taken to ensure that the hand is not pronated relative to the forearm. The metaphyseal void can then be filled with graft and the articular surface assessed.
5. Avoid injury to the scapholunate interosseous ligament. Skin hooks can be placed under the capsular flaps and the articular surface can be visualized and reduced.
6. If an arthrotomy is not performed, then the articular surface should be visualized using a 20-degree inclined fluoroscopy view to assess for palmar displacement of the lunate facet and screw penetration into the articular surface.
7. The addition of K-wires or a screw through the radial styloid to engage the proximal cortex of the radius is helpful to prevent palmar collapse.

Volar Plate



It does not depend on the buttress effect. [cf. Dorsal plate]

The only bone stock available for fixation is the immediate subchondral bone distally

These volar fixed-angle plates have significant strength

Early rehabilitation: mobilise in 10 days

Fewer soft-tissue and tendon problems.

Anterolateral approach

1. A flexor carpi radialis (FCR)/radial artery interval or through a midline flexor

tendon/ulnar neurovascular bundle interval.

2. The FCR/radial artery approach is preferable for (1) fixation of dorsally displaced fractures with dorsal comminution and (2) fixation of partial articular fractures (articular shear fractures).

3. The skin incision is centered over the FCR, with care being taken to avoid injury to the palmar cutaneous branch of the median nerve that lies ulnar to the tendon.

4. The radial artery is mobilized, and dissection is carried radially by releasing the brachioradialis tendon from the radial styloid.

5. Identify the joint line

6. Elevate the pronator quadratus

7. Using this approach, the comminution on the dorsum of the radius can be visualized and graft can be placed.

8. Articular depression can also be seen by pronation of the radius away from the rest of the articular surface. The depressed articular surface may be visualized from within the fracture site.

9. Disadvantage of this approach is in the visualization of the palmar ulnar corner of the radius.

Fixation of the plate:

1. Reduce initially [MUA] < I.I
2. Leveling wires are placed immediately below the joint surface.
3. The plate must be placed precisely in the appropriate location on the radius so that the fixed-angle supports are immediately beneath the subchondral bone.
4. Once the distal subchondral fixation is in place, the plate is seated to the volar cortex of the diaphysis, resulting in increased volar tilt and radial inclination
5. This manoeuvre also places tension into the dorsal extensor apparatus and indirectly reduces the comminuted dorsal metaphyseal fragments.
6. Securing the plate to the radial shaft with bi-cortical screws.

This technique has gained widespread acceptance

One concern over these locking plates is the potential for articular penetration with distal plate position on the palmar surface of the radius. The more distal the plate

placement on the radius, the more the screws need to angle back proximally to avoid penetration into the lunate fossa.

Extensor tendon problems can be caused by penetration of the screws through the dorsal cortex especially in the third dorsal compartment, bony spurs, or excessive gapping at the fracture site.

Too distal plate placement beyond the "watershed" has been cited as a reason for flexor tendon damage.

Anteromedial approach

Incision along palmaris longus

The flexor tendons are mobilized radially, and the ulnar neurovascular bundle is taken ulnarly.

With this approach the pronator quadratus is released from the ulna.

The incision may be extended distally to release the transverse carpal ligament, particularly if the patient had any median nerve symptoms preoperatively.

This incision is preferred when the majority of the comminution is at the palmar lunate facet.

Note that the location of the skin incision does not preclude the surgeon from developing the interval between the FCR and the radial artery through the same incision. This incision permits the development of both intervals if there is any question of the adequacy of the reduction.

In articular fractures both the radial and the intermediate columns must be reduced.

The first column to reduce is the one in which the cortex can be anatomically reduced and fixed using a K-wire.

First the plate is temporarily fixed to the shaft, preferably with either a unicortical screw or a screw in a sliding hole in the plate. The lateral view is useful to determine if screws placed through the plate are going to penetrate the articular surface.

Alternatively: Fix with subchondral screws distal and reduce the fragment to the shaft

Internal Fixation of Intra-articular Fractures

The approach to internal fixation of intra-articular fractures is determined by the location and degree of displacement of the intra-articular component and the degree of comminution. In general terms, for fractures that are primarily comminuted either palmarly or dorsally, the most direct approach may be performed. When the comminution involves both the palmar and the dorsal cortices, the use of a palmar locked plate is preferred. Rarely comminution extends very distally on the dorsal margin of the distal radius fracture. In this case the purchase of the locking screws applied from the volar surface may not provide adequate purchase, particularly in the dorsal lunate facet. In this case the surgeon may need to stabilize this fragment with an external fixator or one of the smaller plates, which may be applied through a separate incision between the fifth and sixth dorsal compartments.

Distraction plate

Background: extensive comminution with osteoporosis.

One approach: a dorsal 3.5-mm plate extra-articularly from the radius to the III metacarpal,

The articular surface was anatomically reduced and was secured with Kirschner wires or screws. Eleven of the twenty-two fractures were treated with bone-grafting.

The plate was removed after fracture consolidation (at an average of 124 days)

Conclusions: The use of a distraction plate combined with reduction of the articular surface and bone-grafting when needed can be an effective technique for treatment of fractures of the distal end of the radius with extensive metaphyseal and diaphyseal comminution. A functional range of motion with minimal disability can be achieved despite a prolonged period of fixation with a distraction plate across the wrist joint.

Ulnar Styloid Fractures

Fractures of the ulnar styloid occur in approximately 60% to 70% of distal radius fractures.

It is well accepted that the distal ulna is a common source of symptoms after injury. The disability that arises directly from the fracture versus the associated injury to the triangular fibrocartilage complex remains controversial.

The disruption may occur at the base of the ulnar styloid, the ulnar insertion of the distal radioulnar ligaments, or the radial insertion of the TFCC complex.

The indications for treatment of these injuries remain controversial. Although it is accepted that displacement of the radius results in acute disruption of the joint, whether these injuries require treatment is unknown.

Triangular Fibrocartilage (TFCC) Injuries

Lesions of the TFCC occur in roughly 40% to 70% of intraarticular fractures of the distal radius in young patients.

The majority of these lesions are peripheral avulsions, generally from the ulnar insertion compared with fewer central perforations.

Peripheral avulsions of the TFCC had DRUJ instability and worse outcome scores than other ligamentous injuries at 1-year follow-up.

Repair of these injuries acutely has been documented to restore stability and provide excellent results, yet the indications for acute repair have yet to be elucidated