Using Kapandji Technique in Management of Distal Radius Fractures

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Abstract
In partially or completely displaced fracture of the distal radius, achieving satisfactory reduction and maintenance of good reduction may be difficult. Especially to accomplish the anatomic volar tilt remains a problem.

KeyWords: Distal radius , Fracture , Kapandji.
DOINUMBER:10.48047/NQ.2022.20.19.NQ99384 NEUROQUANTOLOGY2022;20(19):4199-4207

Introduction:

Fractures of the distal radius account for one sixth of all fractures seen and treated in emergency rooms [(1)].These fractures are the most common fracture occurring in adults, yet there is no clear consensus on their management [(2-8)].

The goal of treatment is to restore congruity to the radiocarpal and distal radio-ulnar joint surfaces and to restore and maintain the length of the radius [(9, 10)]. When stable, extra-articular fractures and minimally displaced intra-articular fractures have been treated successfully with closed reduction and cast immobilization [(11, 12)]. Many surgical techniques are used to fix unstable distal radius fractures, including percutaneous pinning, external fixation, and plate fixation. The goal of surgical treatment of distal radius fractures is early restoration of hand and wrist function through the restoration of alignment and articular surface congruity.

1.Non-operative:

Closed reduction:

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. Closed reduction is normally done in Emergency department with a hematoma block. and it is performed through direct manipulation of the fracture or indirectly via ligamentotaxis. Normally, closed reduction is a combination of both techniques [(13)].

Cast immobilization:

The goal with plaster treatment is to maintain the reduced position of the fracture without compromising finger function. The cast should be well molded, without obstructing full motion of the MCP-joints or the elbow. A well-molded cast minimizes fracture movement, which will decrease pain. The use of a dorsal slab will obviously decrease the risk of plaster-induced compartment syndrome; on the other hand, instability of the fracture with associated pain and aggravate oedema[(13)].

Above elbow plaster, for instance, “sugar-tong plaster”, may occasionally be used when there is a concomitant distal ulna fracture and still conservative management is the treatment of choice [(14)].

Immobilization position:

The comfortable and safe position to immobilize the wrist is in neutral radial-ulnar deviation and neutral or slight extension. Moderate ulnar deviation is accepted to preserve radial length with the support from the intact ulna. Immobilization in extreme flexion and ulnar deviation was historically the only option as internal fixation was not available. However, the advice at the time was to not use this position for the entire immobilization period due to the detrimental effects on hand function as finger flexion is difficult, stresses the median nerve [14].

Immobilization time:

Treatment period should be long enough to allow consolidation of the fracture before mobilization. With a functional cast or brace this period would normally be 4–6 weeks depending on fracture type. or until radiographic evidence of union has occurred. Frequent radiographic examination is necessary to detect loss of reduction [15].

2 - Operative:

Indications:

1. **American Academy of Orthopedic Surgeons (2009)** suggests operative fixation as opposed to cast fixation for fractures with:
- Post-reduction radial shortening >3 mm.
- Dorsal tilt >10°
- Intra-articular displacement (gap) >2 mm
- Intra-articular step-off >2 mm [16].
2. **Secondary loss of reduction (unstable fracture):** Several factors have been associated with redisplacement following closed manipulation of a distal radius fracture:
- The initial displacement of the fracture:The greater the degree ofdisplacement, the moreenergy 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).
3. Metaphyseal comminution or bone loss
4. DRUJ incongruity
5. Open fractures [17].

Operative Techniques:

Percutaneous pinning:

Closed reduction and percutaneous Pinning through the skin and wrist casting in neutral position is a simple and effective way to maintain the anatomical axis of the bone after DRFs[18].This is primarily used for extra-articular fractures or two-part intra-articular fractures. 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 [19].

Percutaneous pinning technology not indicated in patients with severe comminuted fracture or with severe osteoporosis. Obvious dorsal comminution can easily lead to fracture collapse because good support is not achievable.[20]

Percutaneous pinning can be associated with some side effects such as pin loosening, infection around the pin, malunion, stiffness of the wrist joint, decrease hand strength and damage to the superficial radial nerve[18]

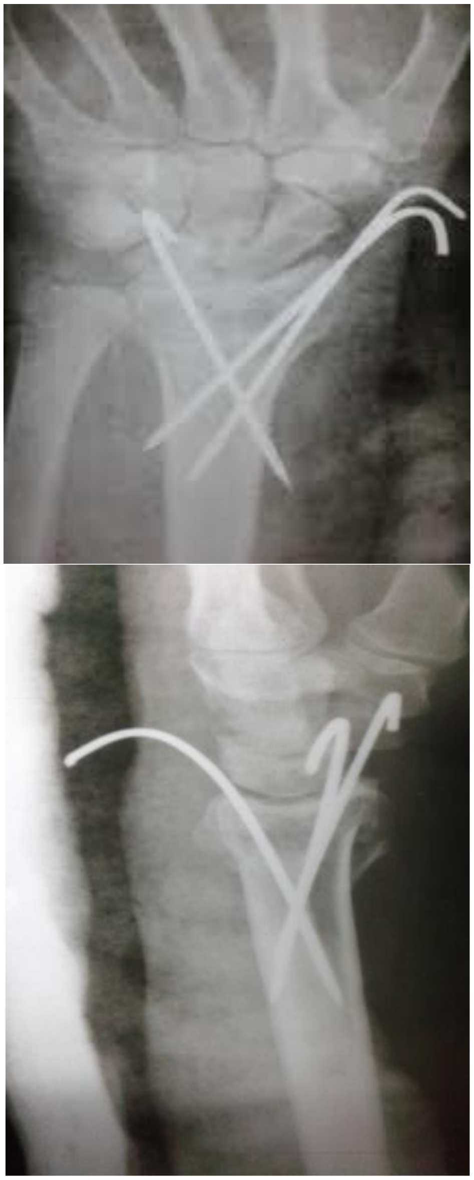

Figure (1): Transulnar pinning with multiple pins [21]

A variety of pinning methods have been described; the most popular is oblique radial styloid to proximal ulnar cortex, as well as placement of the pins through the fracture site (kapandji technique) .[22]

Kapandji Technique:

Kapandji's two pin intrafocal technique gained widespread popularity in Europe following its description in 1976 with numerous publications reporting on this technique. Early advocators of the technique adhered to Kapandji's original description with the use of two pins; however, as indications expanded modifications of the technique began to occur. Peyroux et al. reported on a case series of 159 patients with distal radius fractures treated with Kapandjiintrafocal pinning. Their study advocated the use of a third dorsal medial pin in distal radius fractures with significant dorsal comminution[23]. In 1987 Kapandji published an article discussing his technique 10 years after its initial introduction. In this article he also described the use of a third dorsal to volar posteromedial pin for complicated fractures involving multiple fragments and/or with articular surface involvement [24].

Since the introduction of the intrafocal pinning technique many modifications of the procedure have appeared within the orthopedic literature. Most modifications incorporate the buttressing effect of intrafocal pinning and augment this fixation with additional stabilization methods. Modifications have ranged from intrafocal intramedullary pinning to combined static and intrafocal pinning to intrafocal pinning with plate stabilization. The use of Kapandji pinning has not only been limited to dorsally displaced distal radius fractures as it has also been described for treatment of anterior displaced fractures. In 1995 Hoël and Kapandji described two additional anterior approaches to his intrafocal pinning technique to address volar displaced fractures [25]**.**

Indications:

Kapandji's technique was originally indicated for displaced, extraarticularColles' fractures with minimal posterior comminution in young patients with good bone stock. Colles' originally description of the fracture pattern included a "depression" of the "posterior surface" of the arm with the ulna "projecting towards the palm and inner edge of the limb". Colles' fractures are presently described as a distal radius fracture with dorsal comminution, dorsal angulation, dorsal displacement, radial shortening, and associated fracture of the ulna styloid [(26)].

The basic principle of intrafocal pinning is to create a buttress effect on a displaced distal fragment thus preventing subsequent collapse and allowing for anatomic healing. This is most readily achieved in fractures with a large fragment, minimal comminution, and good quality bone. Articular involvement, multiple fragments, and comminution do not preclude the use of intrafocal pinning as long as adequate reduction can be maintained. Irreducible fractures are not amendable to pinning and require direct visualization and reduction. Classically described for dorsal angulated and displaced fractures, this technique has also been applied in volar angulated and displaced (Smith's) fractures as well [(27)].

One must obviously be cognizant of the relevant local anatomy including the Radial Artery, Palmar Cutaneous Branch, and the Median Nerve, however. The Kapandjiintrafocal pinning has traditionally been performed in the adult population; however, its use has also been recently documented in the pediatric population [(28)].

Contraindications:

In severely comminuted or osteoporotic fractures, the trabecular bone of the metaphysis provides little inherent stability. These fractures were considered a contra-indication to percutaneous pin fixation[(29)]

Infection, fractures accompanied by an open soft tissue damage necessitate surgical irrigation and debridement. Periosteum and, less frequently, pronator quadratus entrapment are the most typical causes of irreducible fractures [(30)]

Advantages of kapandji technique:

It has the following benefits: Minimal blood loss, with only a small amount of effort, a nearly anatomical closed reduction can be produced which is important regarding the osteoporotic quality of the bone commonly encountered in elderly people, Short operative time, which is critical given the elderly patients' longer anesthetic duration. Short hospital stay time, decreased time of immobilization in comparison to closed reduction [(31)].

Disadvantages:

The main disadvantage of the Kapandji technique is that it does not provide enough stability and is challenging to maintain the prior anatomical reduction. The fracture tends to collapse in elderly patients.[(32)]

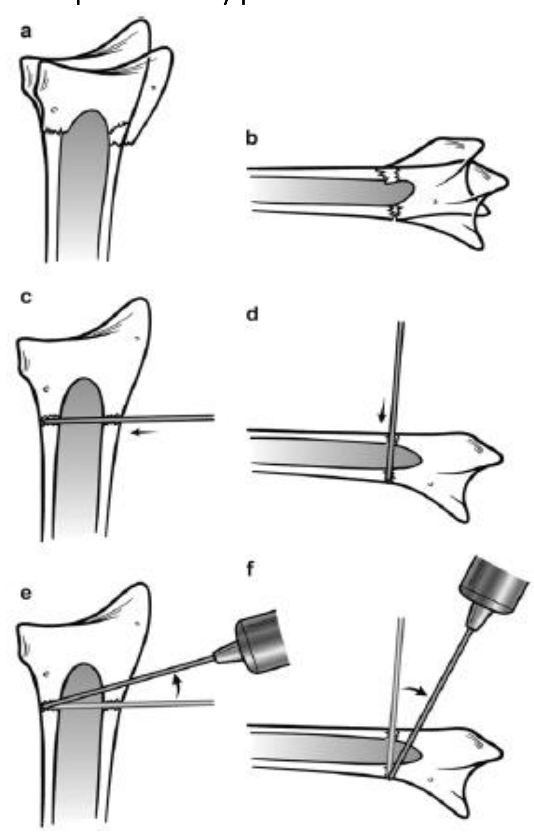

Figure (2): Kapandji original two pin intrafocal technique. (a,b) Angulated fracture in PA and lateral projections. (c,d) Placement of K-wire through fracture to engage volar cortex. (e,f) Manipulation of K-wire, distally, to improve alignment and reduce fracture [(33)]

Technique:

The operation can be performed under general or regional anesthesia. A tourniquet should be placed over the arm at the surgeon's discretion. First, the fracture is reduced under fluoroscopic guidance. Finger traps may be used before or during the case with 5–10 lbs of counter traction applied to aid in reduction **Figure (31)**. The goal of the reduction is to restore radial height while recreating anatomic radial inclination and volar tilt. Often one hand can be used to maintain reduction and allow for fracture manipulation while the other hand directs fixation [33]

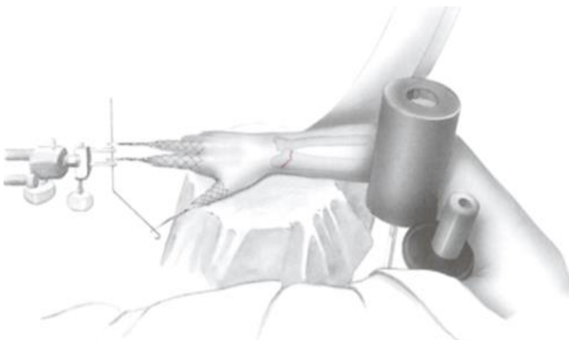

Figure (3): Traction and counter traction [34]

The order and number of Kirschner wires inserted will depend on multiple factors including: technique, fracture pattern, and quality of bone. The original technique described by Kapandji begins with a lateral Kirschner wire. A number of wire sizes can be used. They typically prefer 0.045 in. Kirschnerwires. The wire is mounted on a wire driver and directed in- line with the fracture gap. Prior to insertion a small cutaneous incision is made and dissected bluntly down to bone to avoid injury to the sensory branches of the radial nerve as well as the extensor tendons **Figure (32)**. The wire is inserted into the center of the fracture gap. The drill is then raised inclination. The wire is then passed through the far cortex securing the fixation. Kapandji's original description then involved insertion of a dorsal to volar wire in a similar fashion with the starting point centered about the third metacarpal axis [26].

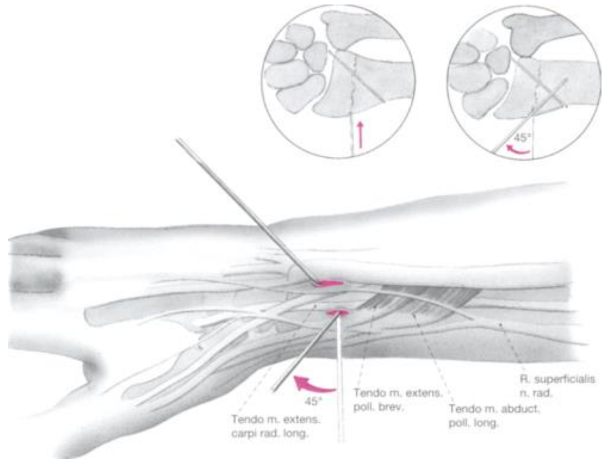

Figure (4): Entry point of k wires**.** [34]

It is important to evaluate the amount and location of the dorsal comminution in order to place a wire that can support areas of comminution. Common entry points include between the second and third extensor compartments and the fourth and fifth extensor compartments. The wire is again driven into the fracture gap, levered distally, and driven into the far volar cortex. If two dorsal to volar wires are to be used, then both wires are first introduced into the fracture gap. The wires are simultaneously levered distally to improve palmar tilt, then driven into the far cortex. Modifications of the technique include placements of static wires, anterior to posterior directed wires, external fixation, and plate fixation [33].

After pin insertion, fluoroscopy is used to evaluate alignment and stability. Passive finger and wrist flexion is examined to ensure no tendons have been tethered. Any skin tethering is released with a blade. Pins can be cut and left buried or bent and cut approximately 1 cm from the skin. Caps may be placed over pins left outside the skin. A well-padded sugar-tong splint is placed postoperatively. Pins are removed approximately 4 weeks postoperatively. The patient typically is transitioned from a splint to a short arm cast after 1 week. The patient remains in a cast for approximately 6 weeks and transitioned into a removable splint at which time formal occupational therapy and/or home therapy is initiated. Alternatively, a removable splint may be employed early on as described by Kapandji[26].

Kapandji advocated immediate wrist mobilization without a plaster cast as one of his primary goals of percutaneous pinning. Immediate mobilization was initially widely practiced; however, currently common practice is to provide a period of immobilization postoperatively obviously, this depends upon one's comfort with patient reliability [33].

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 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 (Fig. 33)[16].

Open reduction and internal fixation is commonly used treatment for unstable distal radius fractures despite its relatively higher complication rate due to deep dissection of soft tissue around the fracture region, and the need for a removal surgery for intra-articular fracture cases [35].

Figure (5): Right: volar Barton fracture. Left: intra-articular distal radius fracture[36]

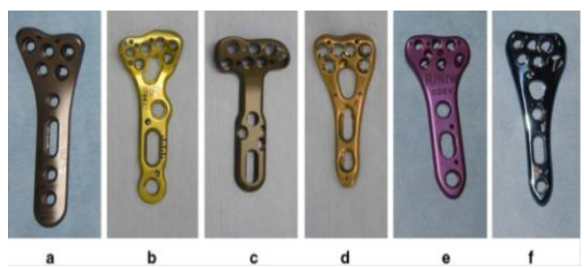

Figure (6): Six current designs of widely used plates: a VariAx (Stryker), b Acu-Loc2 (AcuMed), c DVR (Zimmer Biomet), d VALCP (DepuySynthes), e MODE (JAPAN MEDICAL DINAMIC MARKETING INC) and f HYBRIX (Mizuho) [37].

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. 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 (Fig. 35)[38].

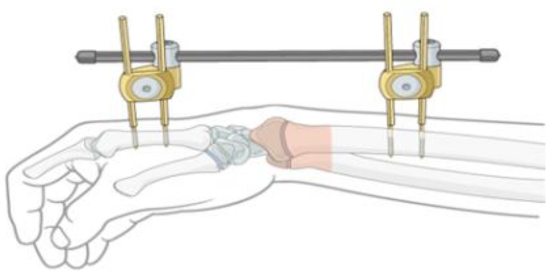

Figure (7): External fixator for distal radius[38].

- External Fixation Advantages: Easy to apply, Access to wound/pins, 'Neutralizes' fracture site, Frees up the elbow.[39]
- External Fixation Disadvantages: Does not necessarily reduce the fracture alone, Possible pin-tract infection, more stiffness with excessive distraction.[39]

Arthroscopic-Assisted Fracture Reduction:
Intra-articular fractures of the radius can be arthroscopically assessed, and reduction of the articular components and assessment and repair of ligamentous injury can then be undertaken [40].

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