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Fractures of distal end of Radius: A study on fracture reduction and stable fixation

[1]Dr. B. Narendra Reddy, [2]Dr. P. Anil Babu
[1]*(Associate Professor, Department of Orthopaedics, NRI Medical College, China Kakakni, Guntur Dt. AP)*
[2]*(Assistant Professor, Department of Orthopaedics, Guntur Medical College, Guntur, AP)*

Abstract: *The fractures at distal end of radius are one of the common fractures encountered regularly. The vulnerability of distal end of radius to sustain a fracture is due to being a weak cortico cancellous junction and mode of injury can result in a variety of fractures in this region. The impact involved in the traumatic incident and the position in which the impact is received, can cause multiple fracture lines and different displacements. Our study is designed as a cross sectional study to involve fractures of distal end of Radius, that need to be treated with one of the options of fracture fixation viz., K wire, or Volar Plate or External fixation, and to know the indications for using more than one device in any given case. All together78 cases are included in the study with fractures of distal end of radius. We would like to conclude that, a combination of hardware is required when dealing with distal radius fracture, where single fixation is not reproducing radiological measurements at the distal end of radius.*

Keywords: *distal end of radius, fractures with comminution, radiological measurements, combination of hardware, stable fixation*

I. Introduction

The fractures at distal end of radius are one of the common fractures encountered regularly. The vulnerability of distal end of radius to sustain a fracture is due to being a weak cortico cancellous junction and mode of injury can result in a variety of fractures in this region. The impact involved in the traumatic incident and the position in which the impact is received, can cause multiple fracture lines and different displacements. According to AO/OTA classification the different types of fractures are 23-A extraarticular fracture, 23-A1 ulna fractured, radius intact, 23-A2 radius, simple and impacted, 23-A3 radius, multi fragmentary, 23-B partial articular fracture of radius, 23-B1 sagittal, 23-B2 coronal, dorsal rim,23-B3 coronal, palmar rim, 23-C complete articular fracture of radius,23-C1 articular simple, metaphyseal simple,23-C2 articular simple, metaphyseal multifragmentary,23-C3 articular multifragmentary(9) (Fig.1). According to classification by mechanism of injury, they are I Bending, II Shear, III Impaction, IV Avulsions with fracture-dislocation, V High velocity(8) (Fig.2).

Fractures with simple fracture lines like, most type I distal radial fractures can be successfully treated non operatively. This management in “low-demand” patients can produce satisfactory results after nonsurgical treatment of isolated distal radial fractures, regardless of radiographic or clinical appearance of the wrist. In younger patients, near-normal function and clinical and radiographic appearance are expected. Disability of the upper limb can be a consequence of distal radius fracture. The outcome of treatment is based on objective clinical variables, as strength or range of movement (ROM); sometimes these variables do not correlate with the functional level of the patient. A significant increase in the upper limb disability can occur after 1 year of follow-up in the patients treated conservatively, once the patient resumes pre injury activity (1).

Usually volar locked plate is a preferred choice for articular unstable distalradius fractures. Radiological measurements to be considered are radial height, radial inclination, volar tilt and ulnar variance, both preoperatively and postoperatively, to estimate the correction to be considered as anatomical reduction. The majority of patients will have near complete recovery of ROM, if all radiological measurements are restored. Ulnar variance and volar tilt are the most important radiographic parameters to be restored to obtain good functional outcome in distal radius fracture. Small variations of other radiographic parameters seem to not affect the final outcome (2).

Comminuted fracture management at distal end of Radius has two options of treatment, External fixation and internal fixation with a fixed angle plate for comminuted unstable intra-articular and extra-articular distal radius fractures. The passive wrist ROM at the final follow-up evaluation in External fixation patients will be less compared with Open Reduction and Internal Fixation. The fixed angle plate fixation maintains the Radial length and tilts better than External Fixation for obvious reasons (3). But the ORIF has got its own complications like, very distal palmar plate position can interfere with the flexor tendon system, too long screws can penetrate the extensor compartments, and distal screws in comminuted fracture patterns can cut through the subchondral bone and penetrate into the radiocarpal joint(4).

The advantages over weigh this option of Fixed-angle plate osteosynthesis at the distal radius in the elderly patient with a significant improvement in the treatment of distal radial fractures in terms of restoration of the shape and function of the wrist associated with a low complication rate, when there is minimal comminution. This technique with its simple palmar access, allows exact anatomic reduction of the fracture, allows early return to function, and minimizes morbidity in the elderly patient. Secondary correction loss can be prevented by this procedure(5). When restoring radiological parameters due importance should be given and literature suggests that ulnar variance and volar tilt are the most important radiographic parameters to be restored to obtain good reduction in distal radius fractures. Small variations of other radiographic parameters seem to not affect the final outcome at minimum 3 years follow-up(6).

The reliability of conventional radiography when classifying distal radius fractures (DRF) is fair to moderate. The inter observer reliability ranged from poor to fair and did not improve when using an additional CT. Additional CT scanning has implications for the accuracy of scoring the fracture types, especially for simple fracture types. All together these are the radiological measurements that need to be achieved during reduction of fracture at distal end of radius ,(A) Radial inclination (RI; average 22 degrees). (B) Radial length (RL; average 12 mm). (C) Ulnar variance (UV; average 0 to -2 mm). (D) Radial tilt (RT; average 11 degrees volar). The treatment modalities should aim at restoring them.

II. Materials And Methods

Our study is designed as a cross sectional study to involve fractures of distal end of Radius, that need to be treated with one of the options of K wire, or Volar Plate or External fixation, and to know the indications for using more than one device in any given case. All together 78 cases are included in the study with fractures of distal end of radius. The inclusion criterion are (1) fractures of radius with distal metaphyseal comminution , **(2)** fractures of radius with distal epiphyseal comminution (3) both simple and open type fractures,(4) fractures in matured skeleton. The exclusion criterion are (1) Paediatric fractures invoving Growth plate injuries, **(2)** fractures without comminution at any of the meataphysis or epiphysis distally in the radius.

With the said inclusion and exclusion criterion the study cohort consists of fractures at distal end of Radius from 23-A2 to 23-C2 of AO/OTA classifications and from Type II to V as per mechanism of injury classification. The distribution of cases in the cohort is given in Table 1.

Pre operative preparation: All the cases are thoroughly examined for any coexisting life threatening and limb threatening conditions. All the cases are investigated to know the surgical profile along with AP and Lateral view radiographs. All the simple fracture cases are initially given POP slab for splinting and to keep the limb absolutely elevated. All the open fractures are given thorough lavage with normal saline and Povidone iodine paint on the intact skin before a sterile dressing and POP slab for splinting is applied. iv Cefuroxime is given initially for all open fractures.

Operative Procedure: Once the patient's fitness to undergo surgery is established, they are taken up for either open reduction and internal fixation or closed reduction and internal fixation or external fixation. The cases are prepared after anaesthesia with through scrubbing of the skin, Povidone iodine painting and draping is done. The fracture reduction is attempted by traction and counter traction initially to achieve radiological measurements. The traction and counter traction are continued till all the fragments are reduced. The same reduction technique is not able to reduce the fragments into normal range of radiological measurements in comminution extending either to metaphysic or epiphysis, where there are multiple fracture fragments. These fragments need to be either reduced by open reduction or by an additional K wire to get hold of all the fracture fragments and for joy stick maneuvers to keep these fragments in reduced positions and to fulfill the radiological measurements in AP and Lateral views with image intensifier with and without traction before closure of the procedure.

At this juncture the fragments which are not getting reduced are of questionable soft tissue attachments also, in which case if they have intact soft tissue attachments would have got reduced by the traction counter traction already applied in a sustained manner. There is another possibility that, impacted fragments need open reduction to disimpact them to achieve radiological measurements. The comminuted fracture, if it were to be treated with open reduction and internal fixation, should offer fragments which can be held together by the volar plate that is going to be used for internal fixation. We made a templating with plate for the fragments with traction and counter traction with Ellis plate on the skin ,to know, whether the fragments offer a bone chunk to be held by plate and screws or there is a possibility of Ellis plate crossing the watershed area , or the screws are driven through fracture lines rather than fractured fragments. The same reduction technique, if it is unable to reduce the fragments in gross comminution or impaction or communution in one aspect and minimal comminution on other aspect (referring to medial and lateral aspect of the distal end of radius), the on table templating with Ellis palte will foretell the reducibility of only one aspect of the fracture, with other aspect with gross comminution, which will lead to collapse of the comminution segment once it is taken up for open reduction. This situation, will deserve reduction, without meddling with the retained soft tissue attachments, which is better handled with External fixation, augmented by K wire fixation. The templating on the skin , if associated with one aspect getting good hold another aspect with bone chunks not amenable for a screw fixation through the plate holes, can have a K wire fixation through bone chunks of smaller size , without gross comminution. Open fractures in our study group are treated with thorough debridements, careful reduction of exposed fragments. Fracture stability is achieved by a Joshi's External Stabilization System fixator, and augmented by parallel K wires on to the aspect which is not getting reduced by ligamentotaxis. At each internal fixation, the joint is passively moved through 50% of range of movements to see whether the fixation is stable or not , with in radiological measurements.

The fixation techniques and hardware need to be customized where gross comminution is seen on the table with traction and counter traction in an anaesthetized patient. The real reducibility of fractures is seen with traction and counter traction, which is not possible before the patient is anaesthetized. In every case, we have assessed the reduction of the fractures to fulfill the radiological measurements in AP and Lateral views with image intensifier with and without traction through 50% Range of Movements before closure of the procedure.

III. Results

Our study group with 78 patients has the following case distribution as per classifications. The cohort has the following distribution as per AO/OTA classification: 23-A Extra articular with impacted multi fragmentary :28 cases, 23-B partial articular fracture of radius:39 cases, 23-C complete articular fracture of radius: 11cases.The cohort has the following distribution as per the mode of injury: II Shear:20 cases,III Impaction:8 cases, IV Avulsions with fracture-dislocation:31cases.,V High velocity:19 cases. The various treatment modalities used for internal fixation with stable and radiological measurements are (1) Multi planar K wire : 29, (2) Ellis plate :17, (3)Ellis plate and K wire :11cases,(4)External fixation:14 cases,(5)External fixator and K wire:7cases.

Figures and Tables

FIG.1 AO / OTA CLASSIFICATION

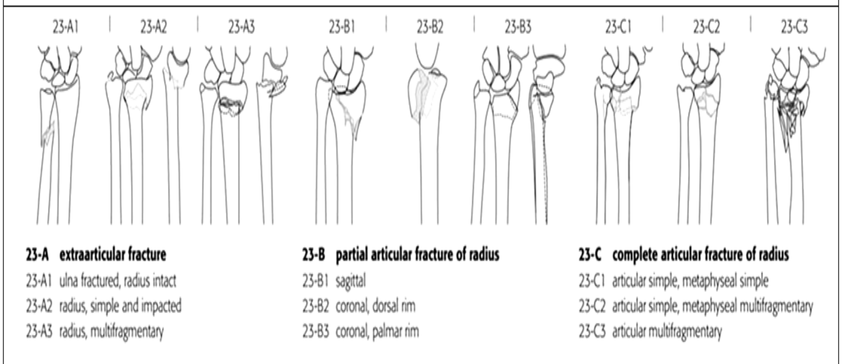


Fig.2 Mechanism of Injury

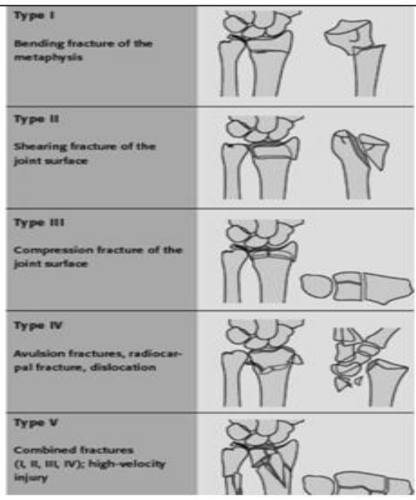


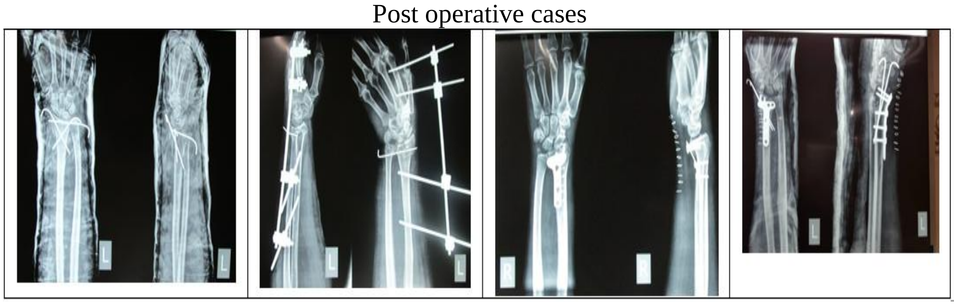
Table 1: Case distribution as per AO/OTA classification	Cases
23-A Extra articular with impacted multi fragmentary,	28
23-B partial articular fracture of radius,	39
23-C complete articular fracture of radius	11
Total	78

Table 2: Case Distribution : Mechanism of injury	Cases
II Shear	20
III Impaction	8
IV Avulsions with fracture-dislocation	31
V High velocity	19
Total	78

Table 3 : Treatment modality	Cases
Multi planar K wire	29
Ellis plate	17
Ellis plate and K wire	11
External fixation	14
External fixator and K wire	7
Total	78

Pre operative cases

Post operative cases



IV. Conclusion

We would like to conclude that, fractures at the distal end of radius are better assessed with traction and counter traction under anaesthesia. The on table templating in side operation theatre, with traction views will guide for the ideal hardware in the given situation.

Fractures caused by compressive forces like in Type III compression injuries require operative treatment if intraarticular damage is significant or radial shortening is severe. Restoration of the articular surface and radial angulation and length is crucial. Improper reduction and poor stability of fractures can lead to reduced forearm pronation and supination. Fixation with multiple Kirschner wires or plates often is necessary, and cancellous bone grafting frequently is required to fill impacted areas. Often a combination of open and closed techniques is necessary to treat type III fractures satisfactorily. Fractures with avulsed components like in Type IV avulsion fractures usually are associated with radiocarpal fracture-dislocations and are unstable. Secure reduction of the carpus to the distal radius frequently can be achieved only with Kirschner wires. Extensive ligament disruption may not produce anatomical reduction by ligamentotaxis. Fractures sustained due to high velocity trauma like in Type V high-velocity fractures are always unstable, frequently open, and difficult to treat. A combination of percutaneous pinning and external fixation often is necessary. Many of these fractures are so severely comminuted that open reduction is impossible(8). We would like to conclude that, a combination of hardware is required when dealing with distal radius fracture, where single fixation is not reproducing stable radiological measurements at the distal end of radius.

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