(International Print/Online Journal)

SJIF IMPACT FACTOR: 4.617
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 2, Issue 6, Page No: 91-101
November-December 2019

IJMSCR

Evaluation of Functional results of distal end radius fractures managed by ligamentotaxis with or without percutaneous K -wire augmentation

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Type of Publication: Original Research Paper
Conflicts of Interest: Nil

ABSTRACT

Purpose of the study: Objectives of management for a distal end radius fracture should be restoration of range of motion and grip strength while facilitating the patient's early reinstation to normal daily activities and minimizing the chances of post traumatic arthritis. Fractures of the distal radius continue to be the one of the most common fracture treated by an orthopedic surgeon accounting for 15-20% of all fractures. All these fractures need good reduction for better functional outcome. There are multiple treatment methods from casting to arthroscopic surgeries. The purpose of this study was to evaluate functional results of fractures distal end radius managed by ligamentotaxis with or without k-wire wire augmentation

Patients and method: This prospective study was conducted at bone and joint hospital (GMC Srinagar) between June 2016 to July 2018. 40 patients with fracture of the distal end of radius were managed by ligamentotaxis and were followed regularly and final functional assessment was done at one year.

Results: 40 patients with distal end radius fractures were managed by ligamentotaxis with or without k-wire wire augmentation. Functional results were excellent in 19, good in 15, fair in 4 and poor in 2 by using mayo wrist score . Most common complications seen in our study were Pin Tract Infections (20%) and Restricted Wrist Motion (5%).

Conclusion: Ligamentotaxis by External fixation is an excellent alternative method of treatment for fractures of distal end radius. It is minimally invasive and cost effective with better and early functional recovery.

Keywords: Distal radial intra-articular fractures, Ligamentotaxis , k -wire

INTRODUCTION

Distal radius fractures are the most common fractures treated by an orthopedic surgeon. In fact, these injuries are the most common fractures of the upper extremity and account for approximately 15-20% of all fractures seen and treated in the emergency rooms [(1,2)] .Most of these fractures are caused by fall on out stretch hand and road accidents.

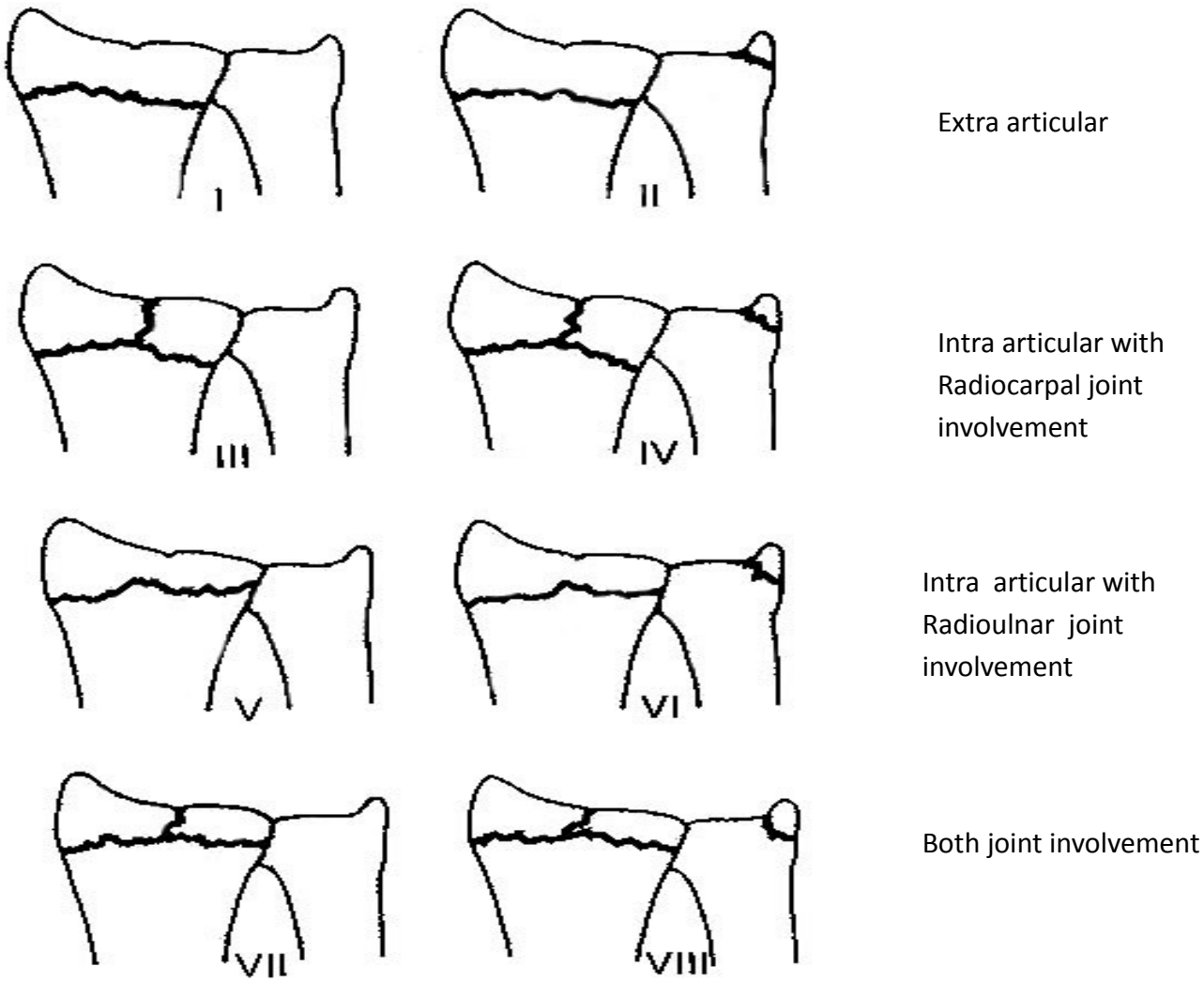
Intra-articular distal radius fractures are usually caused by high-energy trauma in young adults. High-energy injuries frequently cause shear and impacted fractures of the articular surface of the distal aspect of the radius with displacement of the fracture fragments.

With increase in longevity and activity in middle age to elderly population, there is an increase of these fractures .Abraham Colles is widely credited for the description of the most common type of distal radius fracture. Colles' fracture specifically is defined as metaphyseal injury of cortico-cancellous junction (within 2−3 cm of articular surface) of the distal radius with characteristic dorsal tilt, dorsal shift, radial tilt, radial shift, supination and impaction [(3).] In 1854, Smith claimed that a fall on the back of a flexed wrist results in palmar displaced distal radius fracture [(4)]

The articular surface of the distal aspect of the radius tilts 21 degrees in the antero-posterior plane and 5 to 11 degrees in the lateral plane[5] .The dorsal cortical surface of radius thickens to form the Lister tubercle as well as osseous prominences that support the extensors of the wrist in second dorsal compartment.

A central ridge divides the articular surface of the radius into a scaphoid facet and a lunate facet. The triangular fibrocartilage extends from the rim of the sigmoid notch of the radius to the ulnar styloid process. Only the brachioradialis tendon inserts onto the distal aspect of the radius; the other tendons of the wrist pass across the distal aspect of the radius to insert onto the carpal bones or the bases of the metacarpals.

In addition to the extrinsic ligaments of the wrist, the scapholunate interosseous and lunotriquetral interosseous ligaments maintain the scaphoid, lunate and triquetrum in a smooth articular unit that comes into contact with the distal aspect of the radius and the triangular fibrocartilage complex. Because of the different areas of bone thickness and density, the fracture patterns tend to propagate between the scaphoid and lunate facets of the distal aspect of the radius. The degree, direction and extent of the applied load may cause coronal or sagittal splits within the lunate or scaphoid facet[5,6,7]. There are many classification for fracture distal end radius like Grantland/Werley ,Frykman ,Weber (AO) ,Melone ,Fernandez (mechanism) and Column theory. Frykman classification (fig1) is most commonly used classification and we used this classification in our study.



Frykman classification (based on pattern of intra articular involvement)

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Radiographic imaging is important in diagnosis, classification, treatment and follow-up assessment of these fractures. The routine minimal evaluation for distal radius fractures must include two views -a Postero-anterior (PA) view and lateral view[8]. Radiological assessment include in given table 1.

Table 1: Normal radiological parameters

Parameter	Range	Average
Radial inclination	13-30 ^{0}	23^0
Radial length	8-18^0	11^0
Volar / palmar tilt	0-28^0	11^0
Ulnar variance	+1 -0- -1 mm	-

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. Patients with fracture distal end of radius have serious complications more frequently than generally appreciated and failure in management may cause permanent disability. Restoration of normal alignment and articular congruence is essential for a good functional outcome in terms of early wrist motion; improvement in range of motion and grip strength [9].Non-operative management is reserved for undisplaced stable fractures and requires no fixation [10]. Symptomatic relief is achieved by immobilization with below elbow cast for 4 -6 weeks . in displaced and unstable intraarticular fractures, operative fixation is imperative in maintaining an acceptable reduction. Various methods for surgical management are available. For several decades, principle of ligamentotaxis is used for closed reduction and spanning external fixator for 4-6 weeks has been a well-established treatment of distal end radius fracture [11]. External fixator can be augmented by K- wires inserted by an array of techniques; across fracture site in crossed manner or using intrafocal Kampandji technique [12] to maintain reduction .The percutaneous pin fixation provides additional stability [13,14].

Open reduction and internal fixation using volar or dorsal locking plates have gained popularity in recent times and has shown promising results in volar or dorsal bartons fractures ([15, 16]. External fixation with or without percutaneous pinning is less invasive and cheaper as compared to plating. The advantage of ORIF with plating is exact reduction of fracture fragments, metaphyseal bony defects can be filled with bone grafts principally in osteoporotic bone besides allowing immediate early range of motion . Flexor and extensor tendon irritations and ruptures, carpal tunnel syndrome, screw loosening and CRPS [17] are the complications associated with plating.

Studies comparing volar locked plating with external fixation, have not given suggestion of superiority for either method over the other [18, 19, 20]. When there is severe comminution, K-wires and screws cannot help in union of the small fragments and there are high chances of loss of reduction. Also when there is severe soft tissue swelling and in case of open fractures open reduction and internal fixation is not possible. The same ligaments, retinacula, tendons, and periosteum that envelop the fracture which are the surgical barriers for open reduction of the fracture fragments, help achieve reduction of the fracture by ligamentotaxis.

Patients and methods: This prospective study was conducted at Govt. Medical College Srinagar in the department of Orthopaedics between June 2016 to July 2018. 40 patients with fracture of the distal end of radius, who fulfilled the inclusion and exclusion criteria, were included in the study.

Inclusion criteria

- Patient aged 18 years and above.
- Intraarticular fractures of distal radius.
- Communited fractures of distal radius.
- Open fractures of distal radius.
- Patients willing for treatment and giving informed and written consent

Exclusion criteria

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- Patients with Barton's fracture (isolated dorsal or volar lip fractures of the distal radius with subluxation of the carpus).
- Patients below the age of 18 years.
- Pathological fractures.
- Neurovascular deficit

Procedure: All cases were initially assessed and admitted in the Accident and Emergency department for Bone and Joint hospital GMC Srinagar. They were provided first aid in the form analgesia, splintage and other resuscitation measures. In case of compound fractures wound wash and wound debridement was done besides starting I/V antibiotics and checking the tetanus immunization status. Compound fractures were classified according to Gustilo and Anderson classification. The patients were subjected to history taking, thorough clinical examination with analysis of preoperative radiographs. The radiographic analysis includes evaluation of standard antero-posterior and lateral views of X- rays of the wrist joint of bilateral upper limbs.

All the cases were immediately classified under Frykman classification and splinted by below elbow slab. All necessary investigations were done besides pre- an aesthetic check up . All cases were operated within 3 days after admission. Maximum cases were done under supraclavicular or axillary block .one dose of 1.5gm cefuroxime was given one hour before surgery

Surgical technique: Under all aseptic precautions forearm and hand was cleaned and draped. Two 3.5-mm half-pins, 1cm apart at a 30-degree angle dorsal to the frontal plane of the forearm were inserted. The pins should perforate the medial cortex of the radius confirmed with fluoroscopy. A 2- to 3-cm incision over the dorsoradial aspect of the index metacarpal base and use blunt dissection with scissors to expose the metacarpal. Two 2.5-mm self-tapping half-pins at a 30- to 45-degree angle dorsal to the frontal plane of the hand and forearm were inserted and confirmed by fluoroscopy.

- Reduction was achieved by traction and manipulation, confirmed by fluoroscopy.
- Shanz pins were connected with clamps and connecting rods.
- In some unstable fractures K-Wire augmentation was done to maintain articular congruency and prevent displacements of fragments
- Wound irrigation was done and skin sutures were applied in compound fractures.

Postoperative care: Each patient was immediately shifted to recovery ward and distal neurovascular status was assessed. On 1st postoperative day pin site dressing was checked besides a check radiograph. Patients were discharged on 3rd postoperative day with advice about pin site care and finer range of motion exercises. Pin site infection and pin site loosening were assessed continuously. Each patient was asked to report outpatient department weekly for initial 3 weeks for check radiograph to look for any loss of reduction and articular incongruency. After 6 weeks, the external fixator was removed in outpatient department after checking with radiograph for union. Patients were started on intensive physiotherapy after removal of fixator .Clinical parameters evaluated were pain, swelling, tenderness, deformity any obvious nerve palsy, compression of the level of radial and ulnar styloid process on normal and abnormal side and any complication thereof recorded. Patients were assessed for range of motion of wrist, finger and elbow (for range of motion Goniometer was used). Radiological assessment was done for radial inclination, radial length, palmar tilt and ulnar variance..

Patients were assessed at 3 month, 6 month but final functional assessment was done at year by using wrist Mayo scores

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Wrist Mayo score	
Pain	point
No pain	25
Mild occasional	20

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Modrate	15
Severe	0
Work status	
Regular job	25
Resticted job	20
Able to work but unemployed	15
Unable to work due to pain	0
Range of motion	
>120 degrees	25
100 to 119 degrees	20
90 to 99degess	15
60 to 89 degrees	10
30 to 59 degrees	5
0 to 29 degrees	0
Grip strength (% of normal)	
90 to 100	25
75 to 89	15
50 to 74	10
24 to 49	5
0 to 24	0
Excellent	91 to 100
Good	80 to 90
Fair	65 to 79
Poor	<64

RESULTS: Following results were observed while treating 40 patients with fracture distal end radius with or without percutaneous k-wire augmentation.

Table 1: Distribution of cases by age

Age group (in years)	No. of patients	Percentage
18-35	21	52.5%
35- 50	11	27.5 %
35 – 60	5	12.5%
>60	3	7.5%

In our study mean age was 38.5 years and majority of patients belongs to age group 18-50 years (80%)

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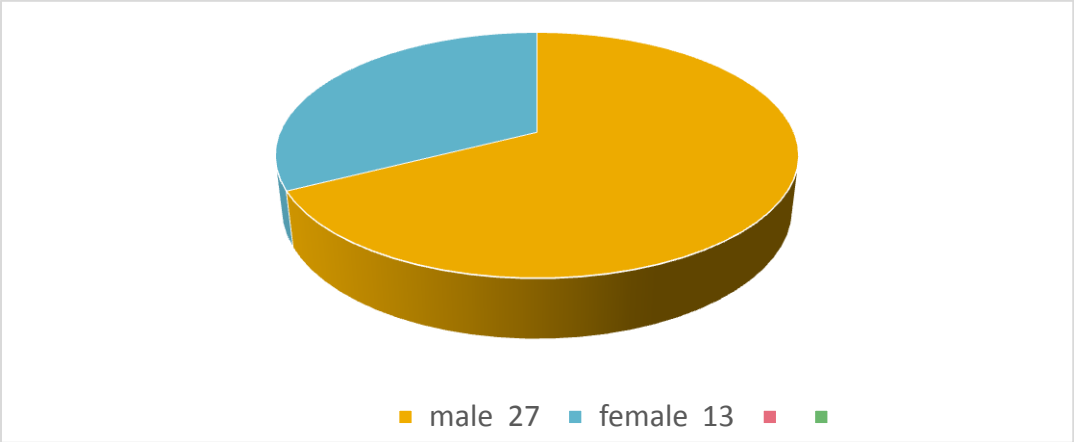
Fig 2: Distribution of cases by sex



Males predominated our study

Fig 3: Distribution of cases by side

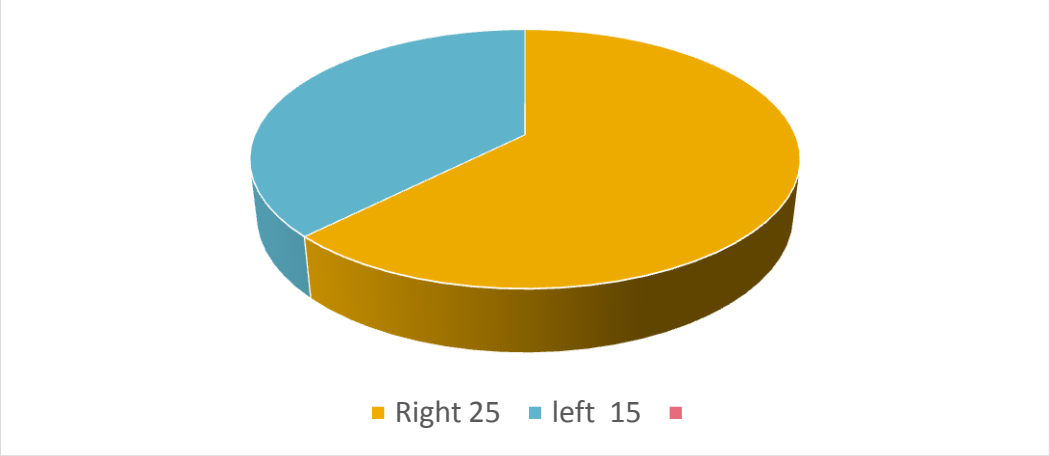


Table 2: Distribution of cases by mode of trauma

Mode of trauma	No. of cases	Percentage
Fall from height	13	32.5%
RTA	21	52.5%
Direct trauma	6	15%

Table3: Types of Fracture According Frykman's classification

Frykmans type	No. of cases	Percentage
Type I	2	5%
Type II	3	7.5%
Type III	17	42.5%

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Type IV	8	20%
Type V	3	7.5%
Type VI	2	5%
Type VII	2	5%
Type VIII	3	7.5%

Table 4: Duration of External fixator

Duration (weeks)	No. of cases	Percentage
6	31	77.5%
>6	9	22.5%

Minimum duration of external fixator was 5 weeks and 2 days and maximum duration was 7 weeks with mean duration of external fixator was 6weeks.

Table 5: Distribution of cases by way of fixation

Type of fixation	No. of cases	Percentage
External fixator without K-WIRE wire fixation	28	70%
External fixator with K-WIRE wire fixation	12	30%

Table 6: Range Of Motion at wrist (Dorsiflexion-Palmar Flexion Arc)

DF-PF arc (degrees)	No of patients	Percentage
>120	25	62.5%
91-120	9	22.5%
61-90	6	15%
<60	-	-
Total	40	100%

Table 7: Functional outcome according Mayo wrist score

Score	No. of patients	Percentage
Excellent	19	47.5%
Good	15	37.5%
Fair	4	10%
Poor	2	5%

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In our study of 40 patients following radiological parameters were observed mean radial inclination at one year follow was 17.85 degrees with a range between 10-21 degrees, Mean radial length at final follow up was 7.88 mm with a range between 5-11 mm. The mean ulnar variance at final follow up was - 1.03 mm with a range between 0 to - 1.3 mm.

Table 8: complications

Complications	No. of cases	Percentage	Management
Pin track infection	8	20%	Oral antibiotics plus dressing
Restricted range of motion at wrist	2	5%	Asymptomatic
Malunion	1	2.5%	Asymptomatic
Extensor tendon tethering	2	5%	Improved after removal pin

Discussion

Because of high frequency of distal end radius fractures, management of these injuries is very important because articular incongruency and mal-reduction will lead to functional disabilities.

There are many methods to manage these injuries, closed reduction with casting, percutaneous pinning, and external fixation with ligamentotaxis and open reduction and plating. The aim our study was to evaluate the functional outcome distal radius fractures treated by spanning external fixator with or without augmentation with K -wires.

Mean age in our study was 38.5 years with maximum patients in age group of 18-50 years (80%) which comparable with other studies [(21)]. Males predominated our study with 27 male patients and 13 female patients .The increased incidence of male sex in distal end radius can be attributed to an over whelming large proportion of male patients and high outdoor activities and the female population largely work indoors (21). Right hand was slightly more involved than left hand. RTA and fall from height was mode of trauma in 85% cases. Around 62.5 % of the study population had type III or type IV fracture according to Frykman's classification. Similar results were observed in studies done by Supreeth et al and Manoj et al [(22, 23)].

Minimum duration of external fixator was 5 weeks and 2 days and maximum duration was 7 weeks with mean duration of external fixator was 6weeks.

Wrist dorsiflexion-palmar flexion arc of >100 degree was achieved in 85% of cases. Percutaneous k-wire augmentation was done in 12 cases (30%). Functional outcome was excellent in 19 (47.5%) ,good in 15 cases (37.5%) , fair in 4 cases (10%) and poor in 2 cases (5%).

Our study showed that management of distal end radius fractures by ligamentotaxis with external fixator with or without k-wire wire augmentation is a cost effective alternative method which is minimally invasive and is associated with minimal complications .Cooney et al demonstrated 90% of study participants had a better function with external fixation[(24,25)]. Hutchinson et al in his prospective study on evaluation of external fixation and pins with plaster technique showed that external fixation was better compared to pins with plaster [(26)]. Kreder et al in their multi-center study showed that external fixation group had a better outcome compared to internal fixation [(27)].

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Case 1

Excellent functional results

Case 2

Conclusion

Management of the distal end radius fracture by ligamentotaxis is an effective alternative method, providing better functional and anatomical results with minimum complications. It allows early mobilization and reduces edema stiffness of joints thus leading to better and early functional recovery. External fixation allows wound observation and wound coverage procedures for open fractures without compromising the reduction achieved

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