

## TO COMPARE FUNCTIONAL OUTCOME, COMPLICATIONS & RESULTS OF OPEN REDUCTION & INTERNAL FIXATION WITH CLOSED REDUCTION & EXTERNAL FIXATION IN VOLAR DISPLACED DISTAL RADIAL FRACTURES

Ketan Gupta<sup>1</sup>, Nishant Gaonkar<sup>2</sup>, Kapale Jineshwar Sudhir<sup>3</sup>, Nirav Patel<sup>4</sup>, Vaibhav Koli<sup>5</sup>, Sudeep Date<sup>6</sup>, Aminuddin Qureshi<sup>7</sup>, Gaurang Chanchpura<sup>8</sup>

### HOW TO CITE THIS ARTICLE:

Ketan Gupta, Nishant Gaonkar, Kapale Jineshwar Sudhir, Nirav Patel, Vaibhav Koli, Sudeep Date, Aminuddin Qureshi, Gaurang Chanchpura. "To Compare Functional outcome, Complications & Results of open Reduction & Internal Fixation with Closed Reduction & External Fixation in Volar Displaced Distal Radial Fractures". Journal of Evidence based Medicine and Healthcare; Volume 2, Issue 9, March 02, 2015; Page: 1155-1167.

**ABSTRACT:** Distal radius fractures account for 17% of all fractures in adults. The fracture of the lower end of radius crush the mechanical foundation of man's most elegant tool, the hand. No other fracture has a greater potential to devastate hand function. Today, open reduction of the fracture with internal fixation and closed reduction of the fracture with external fixation, forms the mainstay of the treatment of an uncomplicated distal end radius fracture in a patient unless specifically contraindicated. **AIMS AND OBJECTIVES:** To compare functional outcome, complications & results of two commonly used surgical methods; Open reduction & internal fixation with volar placed buttress plate and Closed reduction & external fixation with 'Jess fixator' and internal fixation with 'k-wire' in volar displaced distal radial fractures. **MATERIALS AND METHODS:** Total 30 cases were included in the study. 15 patients were treated with Open reduction & internal fixation with volar placed buttress plate and 15 were treated with Closed reduction & external fixation with 'Jess fixator' and internal fixation with 'k-wire' in volar displaced distal radial fractures. Patients were followed up at regular intervals and Anatomical and functional outcomes were evaluated in all the patients. **RESULTS:** Patients treated with Open reduction & internal fixation, 8 showed excellent results, 5 good and 2 fair results. Patients treated with closed reduction and external fixation 4 showed excellent results, 5 good, 4 fair and 2 showed poor results. **CONCLUSION:** O.R.I.F is generally preferred modality gives better results in terms of functional recovery and decrease morbidity to patient. **KEYWORDS:** Volar displaced distal radial fractures; open reduction and internal fixation; closed reduction and external fixation.

**INTRODUCTION:** Distal radius fractures account for 17% of all fractures in adults. Thousands of articles were published after Abraham Colles described a very common fracture of the distal end radius in 1814 in the Edinburgh Medical and Surgical Journal, have not yet created a consensus as a treatment programme.<sup>1</sup> The fracture of the lower end of radius crush the mechanical foundation of man's most elegant tool, the hand. No other fracture has a greater potential to devastate hand function.<sup>2</sup> A thorough understanding of the pathophysiology and treatment of distal end radius is important as high energy trauma to distal end radius in adults is becoming more common and long term functional results are unclear, these common injuries

## ORIGINAL ARTICLE

---

must be evaluated thoroughly and treated adequately. The causes of injury are fall on outstretched hand, work related accidents, car accidents, sport injuries.<sup>2</sup> Distal end radius fractures include Barton's fracture-dorsal, Barton's fracture-volar, chauffer's fracture, Colle's fracture, intra-articular fracture distal radius. The treatment options are quiet varied depending on the exact nature of fracture, activity level and surgeons personal preferences. There are no contraindications to the nonsurgical management of a closed distal radius fracture. Indications for surgical treatment should be based on radiographic findings after initial reduction, expected functional needs, associated medical conditions and other traumatic injuries.<sup>3</sup> Several techniques are now available for the treatment of distal radius fractures. The Orthopedic surgeon must be aware of the advantages, disadvantages and limitations of each method to select the proper treatment modality for each patient. The type of the fracture, the degree of comminution, the age of the patient, the patient's socio-economic status may influence the method of treatment. Various modalities of treatment for this fracture include closed reduction with cast immobilization, external fixation and internal fixation. Today, open reduction of the fracture with internal fixation and closed reduction of the fracture with external fixation, forms the mainstay of the treatment of an uncomplicated distal end radius fracture in a patient unless specifically contraindicated. Recent advances in evaluation of fracture patterns and results of treatment have demonstrated the need for surgical intervention in fractures demonstrating instability with or without articular incongruity. The degree of disability after fracture distal end radius has been seen to correlate with the amount of residual deformity. Methods for maintaining the reduction with additional fixation have been reported to improve the results. One of these methods is external fixation with Schanz screws. This method employs the principle of Ligamentotaxis for maintaining the reduction and restoration of anatomy without disturbing the fracture biology. This procedure has added advantage in the treatment of highly comminuted, intra articular, unstable fractures. The complex distal radius fractures present in a variety of patterns that differ by the area and degree of involvement of articular and metaphyseal fracture components, such fractures constitute a minor subgroup of all distal radius fractures more complex in nature and inappropriate for treatment with simpler methods, such as closed, percutaneous methods, frequently open reduction and internal fixation is required. So finally we should strive to attain the goal that "One consolation only remains, that limb will at some remote period again enjoy perfect freedom in all its motions completely exempt from pain."

**AIMS AND OBJECTIVES:** To compare functional outcome, complications & results of two commonly used surgical methods; Open reduction & internal fixation with volar placed buttress plate and Closed reduction & external fixation with 'Jess fixator' and internal fixation with 'k-wire' in volar displaced distal radial fractures.

**MATERIALS AND METHODS:** In our study 30 patients with fresh closed fracture of distal end radius displaced volarly were selected. 15 cases each were treated with open reduction and internal fixation with volar placed buttress plate, and closed reduction and fixation with 'Jess fixator' with K-wire fixation. The patient selected between age group of 20-60 years of either sex. Patients with, pathological fractures and those with a history of premature osteoporosis drug

## ORIGINAL ARTICLE

---

abuse or alcohol abuse and compound fractures were excluded from this study. Parental antibiotics and analgesics were given accordingly fracture limb was temporarily splinted in below elbow slab and pillow cover elevation was given. Anteriorposterior and lateral roentgenograms of the wrist were taken in all cases; emphasis was made to take elbow joint to rule out possible associated fractures or dislocation. Other X-ray necessary were taken. Associated medical problems were solved. All necessary investigations blood, urine, E.C.G. X-ray were done, if required blood transfusion was given and anaesthetic fitness for surgery was done.

**OPEN REDUCTION AND PLATING:** The patient was placed on the regular operating table and after induction of anaesthesia, general anaesthesia or brachial plexus block was used in all patients, patient was placed in the supine position with affected upper limb placed over side table. Tourniquet was applied to affected upper limb, and was inflated after extinguishing the upper limb. The fracture site was exposed, with volar radial (Henry) approach the entire radial surface as far medial as the distal radio-ulnar joint is exposed. Interval is developed between flexor carpi radialis and radial artery and pronator quadratus muscle is exposed which is elevated to expose the volar surface of the distal radius, volar capsule is prevented to release which may result into carpal instability. Reduction of radial styloid fragment (lateral column) is done and secure to the shaft fragment with temporary or permanent kirschner wires, than reduction of medial column volar and dorsal fragment is done, and if necessary holded with percutaneous pin from dorsomedial aspect distally into the radial shaft proximally, than apply volar butters plate (Elles plate or T-plate), if secure fixation is achieved the kirschner wires are removed. After placing a suction drain the wound is given wash with normal saline and is closed in layers, pronator quadratus is kept as it is and subcutaneous suturing is done with interrupted suturing with vicryl no. 2-0 sutures and skin is closed with ethilon no. 2-0. The wrist was immobilized in a B/E slab. The patient is transferred to the post-operative ward.

**CLOSED REDUCTION AND EXTERNAL FIXATION:** General anaesthesia or brachial block was given. The patient was put on fracture table in supine position with affected upper limb placed over side table. Gentle sustained longitudinal traction without severe hyperflexion or hyperextension and with manual molding of the fracture fragments back into a more normal alignment is then performed with gentle supination in slight dorsiflexion can be added to achieve reduction and fixation device is laced into place and reduction is carefully assessed under the image intensifier. It maintains overall length & angular and rotational alignment. If significant intra-articular comminution is present, articular restoration is achieved by percutaneously inserting a kirchner wire and is used a joy stick to maneuver the articular fragments. a kirchner wire is then inserted at the tip of the radial styloid, driven through the radial styloid, and anchored into the ulnar side of the more proximal shaft fragment, additional percutaneous kirschner wire is inserted if necessary transversely through the subchondral bone to provide subchondral support. Two 2.5cm incision taken, one centered approximately 10cm proximal to the radial styloid, overlying the radial aspect of the forearm and one overlying the doubled radial aspect of the base of the index metacarpal. Through the proximal incision, branches of the lateral antebrachial cutaneous nerve can be identified in the superficial subcutaneous tissue while the deeper and

# ORIGINAL ARTICLE

---

more prominent radial sensory nerve can be identified as it emerges from under the brachioradialis tendon at the interval between the brachioradialis and the extensor carpi radialis longus at their myotendinous junction. This permits protection of both tendons and nerves and, following local elevation of the periosteum direct vision of the radius. The radius is predrilled with hand drill and self-tapping two threaded sanz pins of size 3.5mm are placed. At the site of distal pin insertion at the base of index metacarpal, terminal branches of the radial sensory nerve is identified and carefully retracted. The first dorsal interosseous muscle is sharply elevated off the base of the index metacarpal. The bases of index and middle metacarpal are predrilled and two self-tapping threaded sanz pin of size 2.5mm is placed. After the precise location of the inserted sanz pins has been confirmed under the image intensifier, skin approximated with simple suture. With the fixator pins securely placed the external fixation device is applied to fixator pins. At the end of the surgery, the hand and forearm are placed in a bulky soft dressing; fingers are left free to go through a full range of motion.

Postoperatively Intravenous antibiotics 1<sup>st</sup> generation cephalosporin is continued for three days and then shifted to oral antibiotics for another five days. Post-operative radiographs in AP and lateral view of wrist were taken Limb elevation with Pillow cover given. All patients were given below elbow slab, and all were advised for active, passive movements of fingers, elbow and shoulder. Sutures removed on 11<sup>th</sup> post-operative day and patients were discharged and advice about physiotherapy and follow up. All patients were followed up at 4, 8, 12, 16, 20, weeks; Questioned carefully for symptoms or disability. Clinical evaluation done of scar, tenderness at fracture site. Range of motion of wrist both active & passive movements were determined. Any ulnar prominence if present were noted Tenderness over distal radio-ulnar joint was evaluated. In patients with O.R.I.F. slab was removed after one month of surgery. External fixator was removed at 8<sup>th</sup> week and was converted to plaster cast for one month. The final achieved range of movement at 6 months after treatment completion was noted. Radiographs of wrist AP and lateral views were taken to know progress of Union and extend of callus formation. Subsequent complication if any was dealt with accordingly. Residual dorsal tilt, radial inclination, shortening, ulnar prominence, were noticed on AP & lateral view at 6 months after treatment completion. Lindstrom's<sup>4</sup>; Gartland and Werley<sup>5</sup> criteria was used for anatomical and functional end results.

## **LINDSTROM'S CRITERIA<sup>4</sup> FOR ANATOMICAL END RESULTS:**

### **GRADE 1:**

- No significant deformity.
- Dorsal angulation not exceeding neutral position.
- Radial shortening <3 mm.

### **GRADE 2:**

- Slight deformity.
- Dorsal angulation 1 to 10 degrees.
- Radial shortening 3 to 6 mm.

# ORIGINAL ARTICLE

---

## GRADE 3:

- Moderate deformity.
- Dorsal angulation 11 to 14 degrees.
- Radial shortening 7 to 11 mm.

## GRADE 4:

- Severe deformity.
- Dorsal angulation >15 degrees.
- Radial shortening > 12 mm.

## LINDSTROM'S CRITERIA<sup>4</sup> FOR FUNCTIONAL END RESULTS:

### EXCELLENT:

- No deformity.
- No residual disability.
- Full wrist and forearm movements.
- No loss of grip strength.

### GOOD:

- Minimal deformity.
- Residual deformity.
- Loss of movements upto 20 degrees.
- Slight loss of grip strength.

### FAIR:

- Moderate deformity.
- Moderate disability.
- Loss of movements upto 40 degrees, Moderate loss of grip strength.

### POOR:

- Gross deformity.
- Gross disability.
- Gross limitation of wrist and forearm movements.
- Severe loss of grip strength.

## GARTLAND AND WERLEY<sup>5</sup> CRITERIA FOR ANATOMICAL RESULTS AFTER SARMIENTO (MODIFIED BY LIDSTROM):

RESULTS	CRITERIA
EXCELLENT	No significant deformity Dorsal angulation < degrees Shortening < 3mm Loss of radial deviation < 4 degrees
GOOD	Slight deformity Dorsal angulation 1-10 degrees

# ORIGINAL ARTICLE

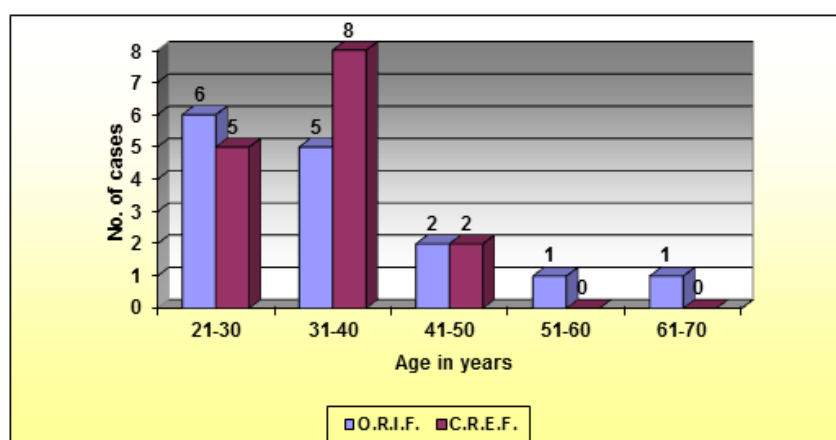
	Shortening 3-6 mm Loss of radial deviation 5-9 degrees
FAIR	Moderate deformity Dorsal angulation 11-14 degrees Shortening 7-11 mm Loss of radial deviation 10-14 degrees
POOR	Dorsal angulation > 15 degrees Shortening more than or equal to 12mm Loss of radial deviation > 15 degrees

## MODIFIED GARTLAND & WERLEY'S WRIST GRADING SYSTEM:

SUBJECTIVE	POINTS	OBJECTIVE	POINTS
Pain	20	Motion	20
Function	20	Strength(grip, pinch)	10
Motion	10	Healing	10
		Postoperative ulnar variance	10
		Complication	10
<b>Total</b>	<b>50</b>	<b>Total</b>	<b>50</b>

Grading of the result	
Excellent	91-100 points
Good	81-90 points
Fair	66-80 points
Poor	0-65 points

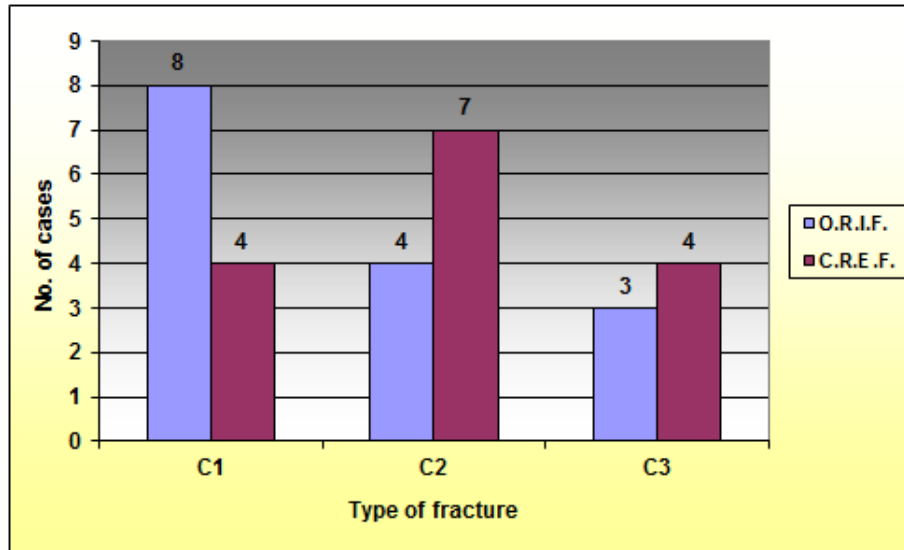
## OBSERVATIONS AND RESULTS:



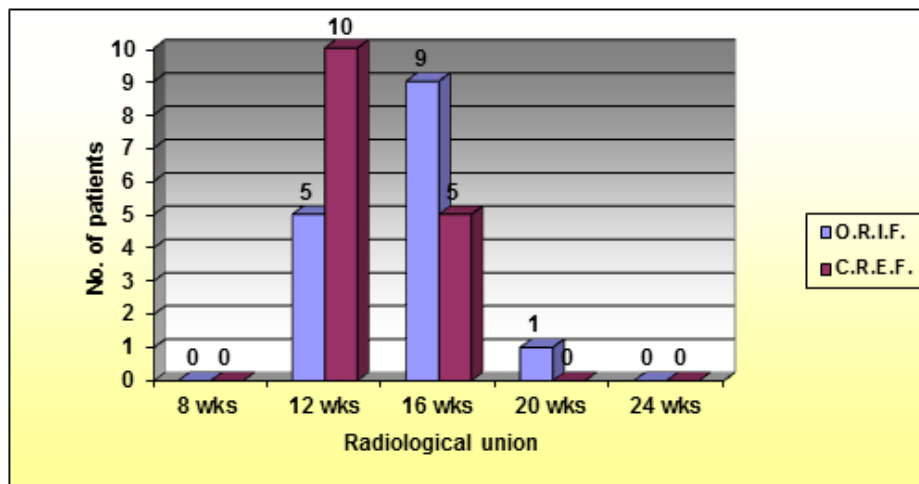
**Fig. 1: The age distribution of the study population in the two different surgical methods is as shown below**

# ORIGINAL ARTICLE

In our study majority of patients were male (20 cases). Road traffic accident was found to be the commonest mode of injury in 22 patients followed by fall from the height seen in 8 patients. Left side was more commonly involved (18 patients).



**Fig. 2: Type of fracture of the study population in the two different surgical methods is as shown below**



**Fig. 3: Radiological union in weeks of the study population in the two different surgical methods is as shown below**

# ORIGINAL ARTICLE

Tilt in degrees	O.R.I.F.	C.R.E.F.
>0	15	13
0	-	1
-1 to 10 <sup>0</sup>	-	1

Table 1: showing volar tilt achieved in two different surgical methods on final follow-up

Degrees	O.R.I.F.	C.R.E.F.
<10 <sup>0</sup>	2	4
≥ 10 <sup>0</sup>	13	11

Table 2: Showing radial angulation achieved in two different surgical methods on final follow-up

	Excellent	Good	Fair	Poor
O.R.I.F.	8	5	2	0
C.R.E.F.	5	6	2	2

Table 3: Showing subjective evaluation in two different surgical methods on final follow-up

Movement	O.R.I.F.	C.R.E.F.
Dorsiflexion	65 ± 5.67	58.6 ± 7.0
Palmar flexion	59.6 ± 8.55	52 ± 9.8
Radial deviation	18.1 ± 2.07	16.9 ± 1.8
Ulnar deviation	21 ± 3.57	20.7 ± 5.0
Supination	67.3 ± 8.84	62.3 ± 9.0

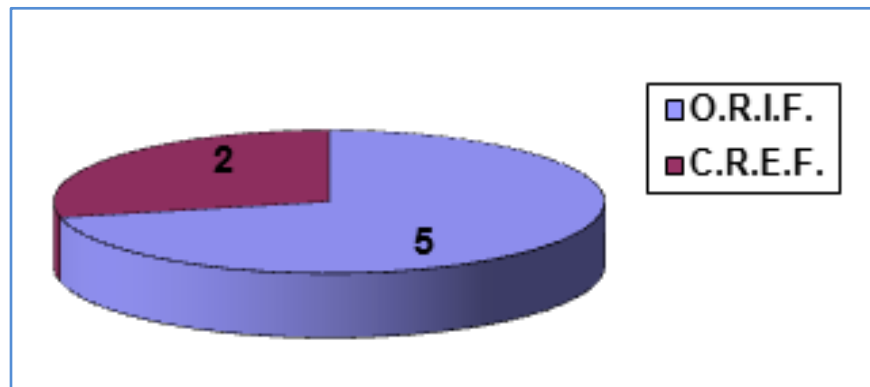
Table 4: Average range of movements achieved at final follow-up in two different surgical methods

Surgical method	O.R.I.F.	C.R.E.F.
No. of patients	5	8

Table 5: Negative ulnar variance seen in two different surgical methods in final radiograph



# ORIGINAL ARTICLE



**Fig. 4: Showing Loss of volar tilt in two different surgical methods**

Surgical method	O.R.I.F.	C.R.E.F.
Mean (mm)	7.0	5.4

**Table 6: Mean of radial length achieved in two different surgical methods**

Complications	O.R.I.F.	C.R.E.F.
Finger stiffness	-	4
Shoulder hand syndrome	-	1
Carpal tunnel syndrome	-	-
Rupture of tendon of extensor pollicis longus	-	-
Sudecks osteodystrophy	-	-
Osteoarthritis	-	-
Pin-tract infection	-	2
Pin-tract loosening	-	1
Compartment syndrome	-	-
Infection in O.R.I.F. group	1	-
Tenosynovitis	1	-

**Table 7: Showing complications in two different surgical methods**

## COMPARISON OF TYPE OF FRACTURE WITH FINAL RESULT:

Type of fracture	Excellent	Good	Fair	Poor
C1	6	1	1	0
C2	2	2	0	0
C3	0	2	1	0

**Table 8a: Open reduction**

# ORIGINAL ARTICLE

Type of fracture	Excellent	Good	Fair	Poor
C1	3	0	0	0
C2	1	4	1	1
C3	0	1	3	1

Table 8b: Closed reduction

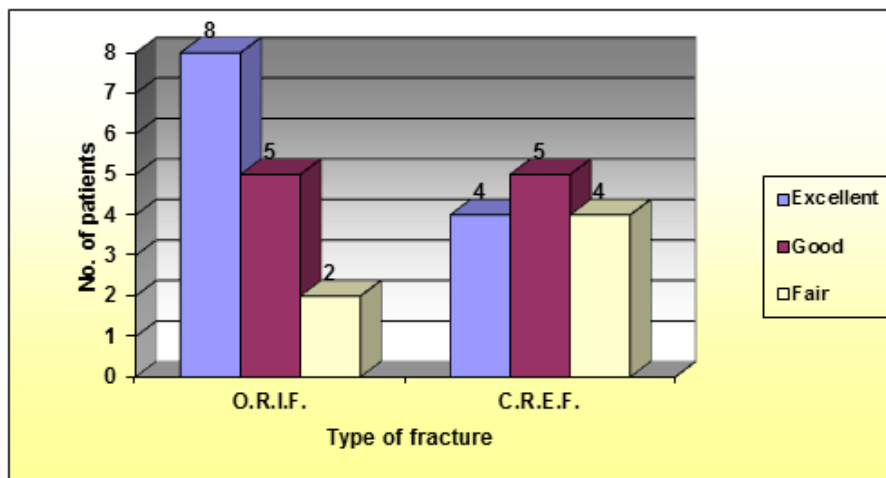


Fig. 5: Showing final results achieved in two different surgical methods

**DISCUSSION:** In the present series, a prospective study of thirty patients with volar displaced distal end radius fracture has been done. In the present series, the youngest patient was 21 years and the eldest was 65 years old. The mean age was 33.3 years. The maximum incidence being between 21 to 40 years of age accounting for 80%. Intra-articular fractures of the distal radius in young adults comprise a distinct and complex sub-group of injuries. Generally as a result of high energy impact the carpus which drives into the distal end of the radius resulting in comminution of its articular surface. In the present series according to AO classification C<sub>1</sub> fracture were 12 (40%) C<sub>2</sub> were 11(36.6%) and C<sub>3</sub> fractures were 7 (23.3%). Ulnar styloid fracture was present in 19 patients accounting for 63.3%. Mean of radiological union in O.R.I.F. group was 14.9 wks as compared to 13.3 wks in C.R.E.F. group. In the present series, 16 patients accounting for 53.3% patients had associated injuries. This finding was significantly high compared to Jakim I et al<sup>6</sup> and Cooney W et al<sup>7</sup> series which reported incidence of 18.2% and 7% respectively. This finding is attributed to the most common aetiological factor of high velocity trauma due to road accident being responsible for fractures of the lower end of radius in our series. The average volar tilt restored was 5.73 in patients treated with open reduction and internal fixation and 4.5 in the external fixator group. Residual dorsal angulation was present 5 patients in the external fixator group, accounting for 33% of the patients. In the series of Gartland and Werley<sup>8</sup> (1951), 81% had residual dorsal tilt (all patients were treated

## ORIGINAL ARTICLE

---

conservatively). In Cooney W et al<sup>7</sup> series, 50% patients had residual dorsal tilt, the reason being the extent of dorsal angulation prior to reduction being severe (average 21). In the O.R.I.F. group 2 patients had loss of volar tilt (13.3%) as compare to C. R. E. F. group 5 patients had loss of volar tilt. In the present series, the average radial angulation restored was 16.66 in O.R.I.F. and 13.6 in external fixator group. Cooney w et al<sup>7</sup> also reported that radial angulation is most easily corrected. The final anatomic restoration of the lower end of radius was determined by using Sarmiento (1980) criteria encompasses the three radiological measurements which we have seen above. 100% patients had excellent result in O.R.I.F. and 80% patients had excellent results and 20% patients had good results in C.R. E.F. Gartland and werley<sup>8</sup> (1951) in their sixty cases treated conservatively found that the radial tilt and shortening at the time of fracture healing was equal to the original deformity in all cases. Taleisnik and Watson<sup>9</sup> found that dorsal angulation can disturb radiocarpal function and cause midcarpal instabilities due to change in load distribution. Collins D.C.<sup>10</sup> stated the findings of Jenkins and Mintowto-Czyz. They found that decreased radial angulation may be related to load distribution, resulting in poor grip strength. Most investigators agree that maintaining radial length is one of the most crucial factors in regaining function of the wrist, and that shortening of 4mm to 6mm compromises function, especially at the distal radioulnar joint. The radial shortening due to loss of reduction was measured as the difference between the initial post reduction and final roentgenogram taken at final follow-up. In the present series mean of radial length achieved in open reduction is 7mm as compared to C.R.E.F in which 5.4mm of radial length is achieved on final roentgenogram. In the present series ulnar variance was present in 5 patients in O.R. & I F, as compare to 8 patients in C.R. & I F. On Subjective evaluation, done on the criteria by Gartland and werley<sup>8</sup> 13 patients (86.6 %) had excellent to good result in O.R.I.F. as compared to 11 patients (73.3 %) had excellent to good result in C.R.E.F. Amongst the remaining patients with fair to poor results, all had A.O. type 2 or 3 fracture except for one with type 1. According to criteria one patient in O.R.I.F. group has less than 15<sup>0</sup> of ulnar deviation, rest all well ahead of the minimum requirement for normal functioning of hand as compare to C.R.E.F two patients had less than 15<sup>0</sup> of ulnar deviation and one of them also has less than 15<sup>0</sup> of radial deviation and less than 30<sup>0</sup> of palmar flexion In the open reduction and plating 13 patients (86%) had excellent to good final results whereas 2 patients (13.3%) had fair to poor result, however in closed reduction and external fixator a patients (60%) had excellent to good final results, whereas 6 patients (40%) had fair to poor results. From the observation it is evident that the quality of final result deteriorates with severity of fracture, according to AO type. Of the 8 patients with C3 type of fracture, 3 patients accounts for excellent to good result however, the remaining 5% patients had fair to poor result. The most common complication was finger stiffness, in 26% of the patients who were treated with closed reduction and external fixator. In this external fixator group, other complication found was shoulder hand syndrome in one patient. Gartland and Werley<sup>8</sup> reported poor finger function in 18% of cases treated by conservative method. In Cooney W<sup>7</sup> series no patient had the above complicate non-compliance of the patients to do finger and shoulder exercise. None of our patients had carpal tunnel syndrome and rupture of tendon of extensor pollicis longus. These complications were reported in Cooney W series. In open reduction and internal fixation one patient had superficial infection of the wound which got resolved with

## ORIGINAL ARTICLE

---

dressing and oral antibiotics, other patient had a long screw which lead to extensor tendon tenosynovitis, and plate was removed for that. Other complications arising from external fixation system comprised of pin tracts infection in two patients and pins site loosening in 3.3%. The pin track sepsis in both patients was superficial and it resolved with dressing and oral antibiotics. Pin site loosening developed late at end of 8 weeks. The pins were removed and plaster cast was given. Jakim I et al<sup>6</sup> reported an incidence of 5.9% of pin track infection and 2.3% of pin site loosening. Conney W et al<sup>7</sup> reported 11.67% incidence of pin related complications. Bohlers<sup>11</sup> early description in 1932 of pins and plaster immobilization for fractures of the distal radius has been the basis for subsequent techniques of closed reduction and skeletal traction. Chapman et al<sup>12</sup> also employing pins and plaster reported a high complication rate with greater than 50% related to pin associated infection or fracture. In the present series low incidence of pins related complications is attributed to the meticulous open application of self tapping pins in predrilled holes, with no soft tissue tension or impingement, firm anchorage, wound closure without tension. We followed the method of direct visualization for external fixator pin placement as advocated by Seitz et al<sup>13</sup>. Drilling through an open approach promotes central pin placement, avoidance of eccentric drilling, and the potential for open section defect and fracture.

**SUMMARY AND CONCLUSION:** The range of movement at wrist at treatment completion with O.R.I.F was better than C.R.E.F. Volar tilt, radial angulation, radial length achieved in O.R.I.F were more superior than C.R.E.F. Clinical and radiological union was seen in all cases, the time for radiological union with O.R.I.F was slightly more than C.R.E.F, due to the open reduction technique in plating. Complications of C.R.E.F are more in incidence than O.R.I.F which results in larger morbidity, less functional recovery. O.R.I.F is generally preferred modality gives better results in terms of functional recovery and decrease morbidity to patient.

### **BIBLIOGRAPHY:**

1. Abbarzadegon H Prediction of instability of Colle's fracture Acta 60(6) 1989.
2. Augusto Sarmiento Colle's fracture J.B.J.S. 57A no.3 April 1972. 311-317.
3. Bacorn R. W. et.al. Colle's fracture study of 2000 cases from the New York state workmen's compensation board. J. B. J. S 35A, 4, July 1953 643-658.
4. Lindstrom Anders: fractures of the distal radius: A clinical and statistical study of end results. Acta Orthop. Scand suppl.41, 1959.
5. Mcbride E.D: Disability Evaluation ed 4. Philadelphia J.B. Lippincott; 1948.
6. Jakim I., Pieterse H.S. External fixation for intra-articular fractures of the distal radius. J. B. J. S. 1991; 73-B: 302-306.
7. Conney W.P. Berger R.A. Treatment of complex fractures of distal radius. Combined use of internal fixation and external fixation and arthroscopic reduction. Hand Clin. 1993; Nov. 9(4): 603-612.
8. Gartland J.J. and Werley C.W. Evaluation of healed Colles' fracture. J. Bone Joint Surg. 1951; Vol.33-A: 895-907.
9. Taleisnik J, Watson HK. Midcarpal instability caused by malunited fractures of the distal radius. J Hand Surg (Am) 1984; 9: 350-7.

## ORIGINAL ARTICLE

10. Collins D.C. Management and rehabilitation of distal radius fractures. Orthop. Clin. North Am. April 1993; Vol.24, No.2: 365-378.
11. Bohler L. Treatment of fractures. Ed. 4, Baltimore, William Wood and Co. 1929.
12. Chapman DR, Bennett JB, Bryan WJ, Tullos HS. Complications of distal radial fractures: pins and plaster treatment. J Hand Surg 1982; 7A: 509-512.
13. Seitz WH., Jr External fixation of distal radius fractures. Indications and technical principles. Orthop Clinic North Am. 1993; 24: 255-264.

### AUTHORS:

1. Ketan Gupta
2. Nishant Gaonkar
3. Kapale Jineshwar Sudhir
4. Nirav Patel
5. Vaibhav Koli
6. Sudeep Date
7. Aminuddin Qureshi
8. Gaurang Chanchpura

### PARTICULARS OF CONTRIBUTORS:

1. Senior Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.
2. Assistant Professor, Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.
3. Assistant Professor, Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.
4. Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.

5. Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.
6. Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.
7. Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.
8. Resident, Department of Orthopaedics, Krishna Institute of Medical Sciences, Karad, Maharashtra, India.

### NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Ketan Gupta,  
Department of Orthopaedics,  
KIMS, Karad,  
Satara-415110.  
E-mail: ketangupta15@gmail.com

Date of Submission: 17/02/2015.  
Date of Peer Review: 18/02/2015.  
Date of Acceptance: 19/02/2015.  
Date of Publishing: 24/02/2015.