



# International Journal of Orthopaedics Sciences

ISSN: 2395-1958  
IJOS 2018; 4(1): 235-238  
© 2018 IJOS  
www.orthopaper.com  
Received: 16-11-2017  
Accepted: 21-12-2017

**Dr. Channareddy H**  
Associate professor,  
Department of Orthopaedics,  
Basaveswara medical college  
hospital and research centre,  
Chitradurga, Karnataka, India

## Evaluation of results of comminuted intra-articular fractures of the distal end of the Radius treated by external fixation

**Dr. Channareddy H**

DOI: <https://doi.org/10.22271/ortho.2018.v4.i1d.33>

### Abstract

Thirty patients with comminuted intra-articular fractures of the distal end radius, less than 65 years old (mean age 38 years) have been treated by external fixation. Fractures were classified according to Frykman's Classification. Radiological results were assessed using Stewart's criteria. Functional results were evaluated with Demerit point system of Gartland and Werly as modified by Sarmiento.

It improves extra-articular alignment (radial angle, radial length and Volar tilt). The articular surface was restored to normal congruity or to within 1mm step-off in 23 patients. Only three patients had step-off more than 2 mm. The most common complications were pintract infections in three patients and radial nerve neuritis in two cases.

At mean follow-up of twenty-five months anatomical results and functional results were good to excellent in 83.33% (n=25) and 86.66% (n=26) respectively. Anatomical results correlated with functional results. Results suggest that the external fixation gives better anatomical and functional results and remains a viable surgical alternative for management of comminuted intra-articular displaced distal radius fracture.

**Keywords:** Distal radius fracture, articular fracture of distal radius, ligamentotaxis, external fixator.

### Introduction

Fractures of the distal radius continue to be one of the most common skeletal injuries treated by orthopaedic or trauma surgeons<sup>[1]</sup>. Articular fractures of distal radius occur mainly in young individuals and are frequently comminuted. A variety of methods have been devised to obtain near normal anatomical reduction of these fractures. These include pins and plaster, percutaneous pinning, external fixation alone or with percutaneous pinning, formal open reduction and internal fixation<sup>[2-4]</sup>.

Most surgeons abandoned pins and plaster method because of multiple complications<sup>[5]</sup>. Percutaneous pinning is often limited by the inability to obtain satisfactory closed reduction in the presence of severe comminution<sup>[4]</sup>. ORIF is also advocated but remains a technical challenge and may not be possible with severely comminuted metaphyseal and articular fragments also the degree of soft tissue stripping required often negates any potential benefits<sup>[6]</sup>.

External fixation is an important advance in the management of comminuted intra-articular fractures of distal end radius. It is frequently sufficient for restoring radial length, inclination and articular congruity<sup>[4, 7]</sup>.

This study was designed to assess the radiological and functional outcome of comminuted intra-articular fractures of distal end radius treated with uniplanar bridging external fixator device.

### Materials and methods

Thirty adults less than 65 years old who sustained comminuted intra-articular fractures of distal end radius were treated by external fixator (uniplanar, bridging – ligamentotaxis) between 2014 and 2017 in a tertiary care academic institution constituted the study. The fractures were classified according to Frykman's classification<sup>[2]</sup>. We included only the intra-articular fractures of distal end radius (Frykman type III to VIII) and Frykman type I and II

**Correspondence**  
**Dr. Channareddy H**  
Associate professor,  
Department of Orthopaedics,  
Basaveswara medical college  
hospital and research centre,  
Chitradurga, Karnataka, India

which are extra-articular fractures of distal radius were excluded from the study. The Frykman classification of distal radius fractures is shown in table no1.

**Table 1:** Distal Radius fracture type by Frykman classification system

Frykman Type	Number of Fractures
III	0
IV	9
V	2
VI	2
VII	10
VIII	7
total	30

We included thirty patients in this study. The mean age was 39.86 years (range 21-64) at the time of injury. There were 24 men and 6 women. Twenty two (73.33%) fractures were high energy injuries and 8 were low energy injuries. Frykman type VII and VIII (comminuted and unstable fractures) were the commonest type. Non dominant hand(n=15) has injured equally as dominant hand(n=15). Out of 30 cases 4 were open fractures and 12 had associated injuries.

All the fractures underwent closed reduction and external fixator (uniplanar) application under GA or regional block. Patients had regular follow-up and final clinical review at 6-33 months with mean follow up of 25 months.

Surgical technique: Limited open surgical technique of Sietz<sup>[8]</sup> was used in most cases. Procedure was done under brachial plexus block or short GA.

**Post-operative treatment**

Elevation of the hand, motion of fingers, elbow and shoulder exercises encouraged as soon as tolerated. Functional use of the injured hand for light daily activities was encouraged.

External fixator removed at 4-6 weeks (average 4.6 weeks) depending upon early radiological and clinical union. When needed removable splint was given for one or two weeks after removal of external fixator and physiotherapy was continued till maximum functional recovery.

**Radiological assessment**

PA and lateral radiographs of injured wrist and normal wrist were taken at injury, immediate post-op, at 2 weeks, 6 weeks and 6 months and at final followup.

Volar/dorsal tilt, radial inclination (radial angle) and radial length (shortening) were measured according to the method described by Vander linden and Ericson<sup>[9]</sup>. These measurements are scored and then graded using the criteria described by Stewart *et al.*<sup>[10]</sup>. Articular incongruity and post-traumatic osteo arthritis were assessed in final radiographs and graded using Knirk and Jupiter’s criteria<sup>[11]</sup>.

**Functional assessment**

Results were assessed and graded using the Demerit point system of Gartland and Werley<sup>[12]</sup> modified by Sarmiento *et al.*<sup>[13]</sup>. It takes into account deformity, subjective evaluation, ROM, grip strength and complications. Subjective evaluation includes pain, disability, limitation of motion and restriction of activities. ROM is measured with standard goniometer in both normal and injured wrist. Grip strength is measured using hand dynamometer (Jamar) and expressed as percentage of normal side. The functional outcome is graded as excellent, good, fair or poor.

**Observation and results**

**Anatomical results**

The mean values of radiological parameters of distal radius from injury to follow-up are shown in table no 2.

**Table 2:** Radiological parameters of distal radius (measured in the x-rays) (n=30)

Time	Mean volar/ dorsal tilt degree range	Mean loss of Radial Angle degree range	Mean loss of Radial Length mm range
Pre-operative	-27.16 (18-55)	11.84(6-20)	4.32(1-20)
Immediate post Operative	+1.8 (-10+14)	3.2(0-12)	0.48(0-3)
2 weeks post-op	-2.0(-12+11)	3.4(0-15)	1.00(0-7)
6 weeks post-op	-2.0(-12+11)	3.4(0-15)	1.44(0-8)
6 months post-op	-2.0(-12+13)	3.3(0-15)	1.53(0-8)
Final follow-up	-2.0(-12+13)	3.3(0-15)	1.53(0-8)

-- = dorsal angle, + = volar angle or tilt

From the table no.2 it is evident that original deformity of 27.16° dorsal angulation was corrected to normal volar tilt of +1.8° at surgery, but there was post-operative loss of reduction of 4° and recurrence to dorsal tilt of -2.0°. There is a slight change in radial angle. The radial length lost progressively from post-operative to 6 weeks. The radiographs were also assessed for articular incongruency as shown in table No.3.

**Table 3:** Distal radius average articular incongruity (in mm)

Time	Step-off (n=28) mean range	Gap (n=28) mean range
Pre-operative	2 (0-12)	2 (0-9)
After surgery	1 (0-3)	0 (0-3)
At 2 weeks	1 (0-5)	0 (0-2)
At 6 weeks	1 (0-5)	0 (0-2)
At 6 months	1 (0-5)	0 (0-2)
Final followup	1 (0-5)	0 (0-2)

Intra-articular step-off was present in 28 of 30 patients pre-operatively. Incongruity was reduced to normal in 18 cases and to within 1mm step-off in 5 patients in post-op radiograph. Remaining 7 cases, 4 patients had 1-2 mm and 3 cases had > 2 mm incongruity.

According to Stewart’s criteria<sup>[10]</sup> the anatomical results at final follow-up were graded 33.33% (n=10) excellent, 50% (n=15) good, (83.33% good to excellent), 16.66% (n=5) fair and no(n=0) poor results. There was a positive correlation between the radiological and functional results as determined by the co-efficient of correlation (r = + 0.89).

**Functional results**

At final follow-up the ROM wrist and forearm achieved is shown in table 4

**Table 4:** Median ROM of wrist and forearm in degrees

ROM	At fixator Removal (4-6 weeks)	At 3 months	At final Follow-up	Percent of Normal side
PF	37	46	52(30-80)	83.87
DF	25	46	56(20-80)	87.50
UD	12	20	23(08-37)	76.66
RD	3	6	12(0-20)	60.00
Pron	52	72	74(25-90)	92.50
Sup	25	57	66(25-90)	86.40

PF-Palmarflexion, DF-Dorsiflexion, UD- Ulnardeviation, RD-Radial deviation, Pron- Pronation, Sup-Supination.

The average grip strength was 72% (range 30-100%). On subjective evaluation 80% had satisfactory results. According to the rating scale of Gartland and Werley modified by Sarmiento et al, the functional results at final follow up were graded as 40%(n=12) excellent results, 46.66%(n=14) good results (Good to excellent results were 86.66%) and 6.66%(n=2) each fair and poor results.

### Complications

Nine patients out of 30 developed complications, giving a complication rate of 30%. The most common complication was pintract infection in 3 fractures (10%) of which two were open fractures. All pintract infections were superficial and resolved with oral antibiotics. Second most common complication was neuritis of superficial radial nerve in 2 patients (6.66%). Both were in early part of the study where closed insertion of pins was done. These were transient and subsided after removal of fixator. Shoulder stiffness, Sudeck's osteodystrophy, finger stiffness, carpal tunnel syndrome occurred in one case each (3.33% each).

### Discussion

External fixator is well established in the treatment of comminuted intra-articular fractures of distal end radius [14]. It works on the principle of ligamentotaxis first described by Vidal *et al.* [15]. It is defined as "in comminuted wrist fractures, prolonged distraction applied across the wrist aligns the fracture fragments and realigns the joint surfaces via the preserved capsule ligamentous structures".

The vast majority of patients were adult males involved in high velocity injuries which explains the comminuted intra-articular nature of these injuries.

In females these comminuted fractures were caused by low velocity injures because of osteoporosis. There was significant improvement in the reduction of fractures from pre-operative to post-operative radiographs. There was some loss of reduction in the post-operative period upto two weeks (volar tilt), this compares with most other series [16, 17].

There was loss of radial length over a period of 6 weeks until fracture healing with little further loss upto 6 months follow-up. The mean loss of radial length from post reduction to 6 weeks is 0.96mm similar to the literature reports of Jenkins [18]. Three patients had more than 5mm shortening and 4 patients had 2-4 mm shortening. This loss of radial length occurred mainly in severely comminuted fractures (Frykman types VII and VIII) and in elderly patients with osteopenic bone with gradual settling of the fracture.

The important observations we could make in our study is that the external fixator often fails to maintain the volar tilt, corrects radial angulation and maintains radial length well except in cases where there is a large metaphyseal void due to severe impaction and severe comminution.

Persistent intra-articular step-off of >2 mm was found in 3 patients. Two patients had unreduced die-punch fragment (dorsally rotated, volar medial fragment) and one had comminuted intra-articular fracture with volar Barton component. The depressed lunate fragment are often not reduced by ligamentotaxis alone unless soft tissue attachments are sufficient [19]. These fractures are treated by open reduction [3, 11, 19]. The Volar barton type of intra-articular fractures are also not well reduced and maintained by external fixation resulting in articular step-off, are better treated by Volar Buttress plate [20]. All the three patients developed radiographic OA (Grade II-1 Grade III-2) and two had clinical symptoms. We agree with Knirk and Jupiter [11] that incongruity > 2mm results in OA. So ORIF should be done in young active individuals with residual articular incongruity more than 2mm following failed closed reduction and external fixation. Axelrod and Mc Murty [3] reached similar conclusions.

On subjective evaluation we found 80% has good to excellent results. Range of motion of wrist and fore-arm showed rapid improvement upto 3 months with further slow recovery until 2 years. We found recovery of ROM to 85% (range 76-92%) of normal side, similar to the series reported by Cooney [21].

The complication rate in our series is 30%. It is similar to the reported range of 32-34% in the literature [20, 21], but higher than the studies of others [8, 22] which reported a rate ranging from 4-17%. The higher rate in our series compared to these series were due to the fact that we didn't use limited open surgical technique (open placement of pins) in the initial cases. The cases of radial neuritis were due to closed percutaneous placement of pins which involved superficial radial nerve and in one case tendons were involved resulting in finger stiffness. Meticulous pin care hygiene should have avoided pintract infection in one case.

A review of the literature suggests that external fixation resulted in good functional results in 75-97% of patients [21, 23]. The total satisfactory functional results in our series were 86.66%, an outcome similar to that reported in the literature [21], all reported 82-90% excellent to good results. Direct comparison are impossible because other authors used different fracture classification and wrist function rating systems. Our results are less than 93% the one reported by Cylburn [22]. He used dynamic fixator which allows wrist movements and criteria for evaluation was different. Edwards *et al.* [23] reported 97% satisfactory results but he excluded severest injuries from evaluation and he also used additional percutaneous pinning in some cases. We have treated exclusively by external fixator alone. No additional fixation was used.

On comparison of anatomical results with functional results it was found that anatomical results were satisfactory in 83.33% and functional results were satisfactory in 86.66%. Our results supports the hypothesis by many authors that ultimate functional results after fractures of the distal radius correlate directly with restoration of normal anatomy [2, 12, 20, 21].

In one meta-analysis [24] with 46 articles, with comparison of surgical treatment of unstable distal radius fractures treated by external fixation (917 patients) and internal fixation (603 patients), their study offers no evidence to support one treatment method over the other. In another meta-analysis [25] from 12 trials, 491 fractures treated by external fixation and 520 with ORIF, the authors concluded that ORIF yields significantly better functional results, fore-arm supination and restoration of anatomic volar tilt, whereas external fixation results in better wrist flexion, grip strength and remains a

viable surgical alternative.

### Conclusion

The present study shows that external fixation alone often fails to maintain volar tilt, easily corrects radial angulation and maintains radial length well except in cases of large metaphyseal void due to severe impaction. It gives better anatomical and functional results. If after closed reduction depressed and rotated articular fragments with incongruity > 2mm are present, additional procedures are required in order to obtain anatomical joint reconstruction. Limited or formal open reduction and internal fixation with k-wires or volar or dorsal plating should be strongly considered. "Limited open surgical approach" should be used in all cases to minimize pin related complications.

We conclude that external fixation for comminuted intra-articular fractures of the distal radius is useful and successful method in young and old adults. Adherence to the above mentioned principles assures a strong and painless wrist with excellent motion and good grip strength with acceptable complications.

### References

- Lichtman DM, Bindra RR, Boyer MI, Putnam MD, Ring D, Slutsky DJ, *et al.* Treatment of distal radius fractures. *J Am Acad Orthop Surg.* 2010; 18(3):180-9.
- Frykman G. Fractures of the distal radius including sequale-shoulder hand finger syndrome, disturbance in the distal radioulnar joint and impairment of nerve function: a clinical and experimental study. *Acta orthop scand* 1967; 108:1-155.
- Axelrod TS, Mc Murty RY. Open reduction and interal fixation of comminuted intra-articular fractures of the distal radius. *J Hand surg* 1990; 15A:1-11.
- Szabo RM, Weber SC. Comminuted intra-articular fractures of the distal radius. *Clin orthop* 1988; 230:39-48.
- Chapman DR, Bennett JB, Bryan WJ, Tullos HS. Complications of distal radius fractures: Pins and plaster treatment. *J Hand surg* 1982; 7:509-512.
- McKenna JM, Harte. External fixation of distal radius fractures. *Injury*, 2000; 613-616.
- Jenkins NH. The unstable colles fractrures. *J Hand surg* 1989; 14B:149-154.
- Sietz WH Jr, Putman MD, Dick HM. Limited open surgical approach for external fixation of distal radius fractures. *J Hand surg.* 1990; 15A:288-293.
- Vanderlinden W, Ericson R. Colles fractures: How should its displacement be measured and how should it be immobilized? *J Bone Joint surg.* 1981; 63A:1285-1288.
- Stewart H D, Innes AR, Burke FD. Factors affecting the outcome of colles fractures: an anatomical and functional study. *Injury*, 1985; 16:289-295.
- Knirk JL, Jupiter J B. Intra-articular fractures of the distal end of the radius in young adults. *J Bone Joint surg.* 1986; 68A:647-659.
- Gartland JJ, Werley CW. Evaluation of healed colles fractures. *J Bone Joint surg.* 1951; 33A895-907.
- Sarmiento A, Pratt GW, Berry NC, Sinclair WF. Colle's fractures: functional bracing in supination. *J Bone Joint surg.* 1975; 57 A:311-317.
- Arora J, Malik AC. External fixation in comminuted, displaced intra-articular fractures of the distal radius: is it sufficient? *Arch Orthop Trauma surg.* 2005; 125:536-540.
- Vidal J, Buscayrete, Fischbache, Brahin B, Paran M, Escare P. Ligamentotaxis. *Acta orthop Belg* 1977; 43:781-789.
- Kawaguchi S, Sawada K, Nabeta Y, Hayakawa M, Aoki M. Recurrent dorsal angulation of the distal radius fracture during dynamic external fixation. *J Hand Surg Am.* 1998; 23(5):920-5.
- Bartosh RA, Saldana MJ. Intra-articular fractures of the distal radius: A cadaveric study to determine if ligamentotaxis restores radio palmar tilt. *J Hand surg.* 1990; 15A:18-21.
- Jenkins NH, Jones DG, Johnson SR, Mintowezyz WJ. External fixation of the colles fractures. *J Bone Joint surg* 1987; 69 B:207-211.
- Porter ML, Tillman RM. Pilon fractures of the wrist. Displaced intra-articular fractures of the distal radius. *J Hand surg.* 1992; 17B:63-68.
- Rikli D, Kupferk, Bodoky A. Long term results of external fixation of distal radius fractures. *J trauma.* 1998; 44:970-976.
- Conney WP, Linschied RL, Dobyys JH. External pin fixation for unstable colles fractures. *J BoneJoint surg.* 1979; 61A:840-845.
- Cylburn TA. Dynamic external fixation for comminuted intra-articular fractures of the distal end of the radius. *J Bone Joint surg.* 1987; 69A:248-254.
- Edwards GS Jr. Intra-articular fractures of the distal part of the radius treated with the small AO external fixator. *J Bone Joint surg Am.* 1991; 73(8):1241-50.
- Margaliot Z, Haase SC, Kotsis SV, Kim HM, Chung KC. A meta analysis of outcomes of external fixation versus plate osteosynthesis for unstable distal radius fractures. *J Hand Surg Am.* 2005; 30(6):1185-99.
- Wei DH, Poolman RW, Bhandari M, Wolfe VM, Rosenwasser MP. External fixation versus internal fixation for unstable distal radius fractures: a systematic review and meta-analysis of comparative clinical trials. *J Orthop Trauma.* 2012; 26(7):386-94.