TREATMENT OF INTRA - ARTICULAR FRACTURE OF DISTAL RADIUS WITH STATIC EXTERNAL FIXATORS – LIGAMENTOTAXIS - A PROSPECTIVE STUDY

Praveen M. Anvekar¹, Sachin S. Nimbargi², Srinath S.R³, Anil S. Nelivigi⁴

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ABSTRACT: BACKGROUND: Unstable distal end radius fracture with intra articular extension is difficult to reduce and maintain the reduction despite continued refinements in treatments if treated non- operatively. Most have recommended some type of skeletal fixation to maintain the reduction. It is a challenging problem to many surgeons with large variety of treatment options and cost involved. The purpose of this study was to stabilize & asses the efficiency of external fixators in the management of intra-articular fractures of lower end of radius. **METHODS:** A total of forty patients with forty distal radius intra articular fractures were included in our study between Jan 2009-Jan 2011. The average age of the patient was forty years and all of them were below 70 years or less. All the patients were treated with static external fixators by ligamentotaxis. At 3, 6 and 12 months post operatively patients were assessed using Gartland and Werely point system. Arthritis was graded on radiograph according to modification to Knirk and Jupiter criteria. **RESULTS:** At the end of 1 year 70% had good or excellent results according to the scoring system of Gartland and Werely point system, 25% had fair and 5% had poor results of which one patient had radiocarpal arthritis. **CONCLUSION:** In our series with intra articular fracture of distal end radius with proper case selection, meticulous technique, low cost affective static external fixators we were able to achieve 70% good and excellent results.

KEYWORDS: Intra- articular fracture of distal end radius, External fixators, Ligamentotaxis.

INTRODUCTION: Distal end radius fractures are very common and estimated to account for 1/6th of all fractures that are seen & treated in emergency rooms.

It is remarkable that this unstable intra-articular fracture remains one of the most challenging problems. (Fractures that are treated non-operatively) despite continued refinements in treatment. If these fractures are allowed to collapse, radial shortening, angulation & articular incongruity may cause permanent deformity & loss of function ¹.

Although some authors have reported satisfactory results with closed reduction & immobilization in cast, most have recommended some type of skeletal fixation to maintain the reduction.

A variety of methods have been devised to avoid loss of reduction, including pinning the distal fragment percutaneously, immobilizing the wrist & forearm in supination, above elbow casts, fixing the fracture fragments with pins incorporated in the plaster cast, using an external fixator.

The basic principle in many of these methods is to provide fixed traction, which prevents shortening of the radius. If satisfactory reduction is obtained by distraction & manipulation, but combination precludes maintenance of the reduction by cast or percutaneous pinning, then external

fixation is usually the treatment of choice ¹. External fixation is an established method for the treatment of certain types of distal radial fractures ^{2,3,4,5,6}.

To be safe & effective an applied external fixator should have low rate of complications, be non-obstructive & be stiff enough to maintain alignment under adverse loading conditions.

With the improved components & better understanding of the principles that governs the safe & effective use, the external fixator has become an indispensable tool in the hands of experienced trauma surgeons. There are few complications with this technique such as stiffness of the fingers, loss of reduction, problems with radial sensory nerve and pin tract infections ^{7,8,9,10}. The main disadvantage of a static external fixator across the wrist may be a permanent loss of wrist motion ^{11,12}.

MATERIALS & METHODS: Forty patients with intra-articular fracture of the distal end of radius were treated with external fixators at S.S.I.M.S & R.C Hospital, Davangere, between Jan 2009 & Jan 2011 under Dept of Orthopaedics.

There were 22 males & 18 females between age group of 20-65 yr.

Commonest mode of injury was fall on outstretched hand with wrist in dorsiflexion.

All fractures were classified using Frykman's classification.

The dominant wrist right was affected in 24 patients & 7 patients had associated fractures, fracture shaft of femur 1, fracture of ulna, fracture clavicle 3, and fracture shaft of Tibia 2.

Pre-op evaluation consisted of careful inspection of the deformity & swelling of the wrist. Tenderness was elicited over the lower end of radius & relative positions of radial & ulnar styloid process were altered. Movements of the wrist & forearm were painful & restricted.

There was no median nerve injury or tendon injuries recorded in our series of 40 patients.

Routine X Rays of anterior and posterior views were taken and fracture fragments were analyzed and involvement of radio-carpal and distal radioulnar joint were assessed & were classified according to Frykman's classification.

In all elderly patients ECG was taken, B.P recorded, Diabetes mellitus was ruled out.

Routine blood & urine investigations were done, consent for surgery was taken.

All patients were immobilized in dorsal POP slab until the time of surgery.

Most (34) of the cases were done under general anaesthesia but only 6 cases were given brachial block.

Static External fixator were used in this series, consisted of

- a) 3.5mm Shanz screws for distal radius -2 no.
- b) 2.5mm Shanz screws for II metacarpal -2 no.
- c) Aesculap clamps -4 no.
- d) 4mm connecting rods -2 no.

SURGICAL TECHNIQUE: Patient was placed supine on the operating table under general anaesthesia or Brachial block. The arm, forearm and hand were scrubbed with soap, savlon, and water and was painted with betadine and spirit & draped. The involved upper limb was then placed on the side arm board.

With strict aseptic precautions, two stab incisions were made over the lateral aspect of the distal radius about 2-4cms apart, from approximately 8-10cm proximal to the radial styloid.

Through the incisions care was taken not to injure the tendons, muscles, nerves and the periosteum was displaced till the drill bit touches the bone. The radius was predrilled with 2.5mm drill bit and with T-handle 3.5-mm shanz screws were fixed. Then two more stab incisions were given over the lateral aspect of the index (2nd) metacarpal, one near the base and another over the shaft with an inch apart. Similarly it was drilled with 1.5mm drill bit and then fixed with 2.5mm shanz screws.

Then the external fixator joints were fixed to the shanz pins and 4mm connecting rod was inserted through the joints. The system was assembled but not fixed keeping the joints loose. Closed reduction of the fracture done by applying longitudinal traction with manual moulding of the fracture fragments back into a more normal alignment. The wrist was placed in little flexion and ulnar deviation. The closed reduction was confirmed by C-arm and after satisfactory reduction achieved, the external fixation device was tightened and the reduction was assessed once again carefully by clinically and by C-arm.

At the end of surgical procedure sterile dressings were applied to the pins. No cast or splint was applied but the limb was placed in elevation.

Antibiotics (Injection Ceftriaxone 1gm IV BID first day, then orally Cefixime 200mg BD for 5 days) were given along with analgesics and serratiopeptidase.

Average duration from the date of injury to the date of surgery was 1-3 days.

POST OPERATIVE CARE AND REHABILITATION: Immediate postoperative check X-rays were taken in both anterior posterior & lateral views. The reduction of the fracture was confirmed and note of radial height, radial angulation and palmar angulation were made.

Tension across the wrist generated by the external fixation device should provide enough ligamentotaxis, so that on an anterior-posterior X-ray the radiocarpal articulation was seen to be 1mm wider than the midcarpal joint.

Active finger, thumb, elbow and shoulder exercises are encouraged post-operatively immediately from the day of operation to promote circulation, avoid edema, stiff fingers and stiff shoulder.

Dressings were removed on 4th postoperative day in the outpatient department. The pins were cleaned with spirit on every alternate day for 2 weeks and educated the patient regarding the cleaning of pins and active movements of the thumb, fingers, elbow, shoulder, pronation/supination of the forearm throughout the period of healing.

The patient was discharged on 2nd postoperative day and advised active movements of fingers and reviewed weekly.

The patient was assessed subjectively for pain at fracture site, clinically for tenderness and loosening of pins.

Second check X-ray was taken on follow up at 6th week, the fracture union was assessed clinically by absence of tenderness and radiologically the bridging callus formation. Then the external fixator was removed at 6 to 8 weeks under short general anesthesia. Additional splintage was given for 1-2 weeks after the fixator removal in few cases. The range of movements was recorded and any deformity was assessed compared with uninjured side. The patient was advised not to lift heavy weight for 4 weeks.

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Physiotherapy of wrist was started for 6 weeks, such as flexion-extension, pronation-supination, adduction and abduction of the wrist, along with hot water fomentation and under water exercises.

All cases were followed at an interval of 6 weeks, 3 months, 6 months and 12 months.

The follow-up ranged from 3 months to 12 months with an average follow-up of 7.5 months.

There were no cases of pin tract infection or pin loosening, no breakage of pins or loss of fixation as long as they were followed till the external fixation removal. In one of our study, the patient insisted to remove the external fixator, so external fixator was removed at 5 weeks, following this there was redisplacement of fracture fragments and collapse with radial shortening.

Criteria for results at 6 weeks include deformity, subjective evaluation, range of movements, complication according to modified Gartland and Werley scoring system.

RESULTS: The assessment of anatomical & functional outcome was made according to modified Garland & Werley scoring system as follows ¹³.

Demerit score system modified after Gartland & Werley (1951).

Points		
Deformity	Prominent ulnar styloid	1
	Radial deviation	1-2
	Dinner fork deformity	1-3
	Maximum	6
Subjective	No pain, no limitation of motion	0
Evaluation	Occasional pain, some limitation of motion, weakness, pain, limitation of motion,	4
	Activities restricted	6
	Maximum	6
Range of Motion	Limitation of motion<20%	0
	Limitation of motion<50%	2
	Limitation of motion>50%	6
	Stiffness of wrist	6
	Maximum	6
Complications	None or minimal	0
	Slight crepitation	1-2
	Severe crepitation	3-4
	Median nerve compression	1-3
	Pulp-palm distance 1 cm	3
	Pulp-palm distance > 2cm	5
	Pain in distal radioulnar joint	1-3
	Maximum	15
Excellent		0-2
Good		3-7
Fair		8-18
Poor		19-33

6 patients of our series were rated as **excellent**, as they had no deformity of the wrist and there was no pain. Limitation of motion of the wrist and forearm was less than 20% to that of normal with no complications.

22 patients had no deformity of the wrist. Occasional pain and some limitation of motion were present initially. The limitation of motion of wrist and forearm was less than 20% to that of normal. 2 patients had loosening of pin, which was reinserted. Hence the result was rated as **good**.

10 patients had pain, limitation of motion and restricted activities around the wrist. The range of motion of wrist and forearm had limitation to less than 50% to that of normal. In this group 4 patients had prominence of ulnar styloid and the result was rated as **fair**.

2 patients had dinner fork deformity, pain, and limitation of motion of more than 50% weakness and restricted activities around the wrist. There was associated slight crepitation with involvement of superficial branch of radial nerve. Hence the result was rated as **poor**.

Radiographs demonstrated maintenance of radial length within 1mm of original reduction in all patients except in one who had a shortening 5mm after removal of the fixator.

The overall results according to the rating system modified based on Gartland & Werley 1951 demerit point rating was:

Excellent	-	06 (15%)
Good	-	22 (55%)
Fair	-	10 (25%)
Poor	-	02 (05%)

DISCUSSION: Fractures of distal radius are extremely common and a large majority is treated non-operatively. Having been recognized for nearly two centuries, fracture of the distal radius recently has become the focus of an intense interest regarding optimal management. These fractures are frequently articular injuries resulting in disruption of both radiocarpal and distal radio ulnar joint ¹⁴.

Preservation of articular congruity is the principle pre-requisite for successful recovery. The aims of treatment in intra-articular fractures are to allow early functional recovery of the limb, to improve long term function of the wrist, and to prevent cosmetic deformity ¹⁵.

Unstable comminuted fractures of the distal radius present a major problem in terms of stability and methods of immobilization¹⁶. The external fixator provides a simple and reliable means of treating unstable intra-articular fracture of the distal part of the radius according to the concept of Ligamentotaxis and its principles that was proposed by Vidal et al.

Several methods have been discovered to attain the goal of maintaining normal or near normal radial length and angulation (which is associated with various deformities and less than satisfactory clinical end results). External fixator has shown to be effective in the management of unstable intra-articular fracture of distal radius, were as the treatment by plaster does not.

We agree with Green ¹⁷ that a good functional result usually accompanies good anatomical result. Failure to identify the unstable fracture by the degree of displacement, the severity of comminution, the involvement of the radio carpal or radio ulnar joint and especially the loss of reduction after a cast is applied will lead to poor long term result.

The external fixation of the wrist fracture have addressed themselves to either the “redisplaced” or “unstable” fractures the later being defined by more severe Frykman grades (1967). However as Stewart et al (1985) have shown that the potential of the fracture to slip is related to its initial displacement, any fracture that was displaced sufficiently to require manipulative reduction, whether or not it was intra-articular or comminuted could be considered potentially unstable.

For an optimal outcome selection of patient is very important. Unreliable and poor motivated patients are not the candidates for external fixator¹⁷.

Successful use of external fixation of distal radius necessitates careful assessment of fracture patterns, appropriate patients selection, careful and meticulous surgical approach, appropriate choice of fixation device and pins, aggressive and early rehabilitation and post-operative monitoring. External fixation is indicated in Frykman’s type VII & VIII fractures, when dorsal comminution is present. The basic treatment principle is to obtain accurate fracture reduction and to maintain the reduction while protecting the wrist in the physiological position. So that the hand can be rehabilitated. It has suggested in the literature (Grana and Kopta 1979) that the external fixator is only warranted in younger patients with strong bony cortices¹⁶. Old age is not a contraindication for external fixation.

External fixation, with use of the principle of ligamentotaxis for reduction of the fragments ¹⁸, ¹⁹, has gained wide acceptance for the treatment of unstable fractures of the distal part of the radius. A number of studies have shown favorable results after external fixation of fractures of the distal part of the radius ^{1, 20}.

Based on these results, the following indications for the use of external fixator are suggested:

1. Intra-articular fractures of distal radius of young and active patients.
2. Open fractures of the distal radius.
3. Patients with distal radius fractures and other multiple injuries who need intensive care and nursing.
4. A failure to maintain reduction of such fractures in cast immobilization.

CONCLUSION: External fixator has recently become the treatment of choice for the complex distal radial fractures particularly when there is comminution and fracture is unstable, intra articular.

In our series 40 patients with comminuted intra articular fractures of distal radius were treated with static external fixator.

Most of the cases were of Frykman type VIII (25%). Mechanism of injury was fall in 26 and vehicular accidents in 14 cases. Four patients had other associated injuries.

Relatively large diameter pins (i.e. 3.5mm) for proximal radius were inserted by predrilling, pins engaged atleast 2 cortices each. This enhances the rigidity of the fixation and reduces the complications like pin loosening.

External fixation should be maintained for 6-8 weeks till the osseous union is complete, with further immobilization in plaster slab for additional 2 weeks if needed.

All the variable of fracture viz. radial angle, radial length and volar tilt should be achieved for an optimal outcome, though volar tilt has got least influence. It is difficult to regain volar tilt by ligamentotaxis and maintain it by external fixators.

It is useful in intra articular fracture of distal radius in young and active patients, open fractures, polytrauma patients and in fractures where anatomical reduction could not be maintained after closed reduction.

SUMMARY: In our series static external fixator was used in 40 intra articular fractures of distal radius in a prospective study. Fixator was maintained for 6-8 weeks and duration of follow up ranged 4 months to 11 months.

We had 6 excellent, 22 good, 10 fair and 2 poor result. Complication was 15%.

This series concludes that with precision in case selection, careful assessment of fracture patterns, careful and meticulous operative technique, aggressive early rehabilitation and postoperative monitoring, Ligamentotaxis consistently results in a favorable outcome in the management of intra articular fractures of distal end radius.

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DISTRIBUTION OF 40 UNSTABLE DISTAL RADIUS FRACTURES ACCORDING TO FRYKMAN'S CLASSIFICATION

Frykman type	No. of cases	Percentage
III	8	20
IV	6	15
V	6	15
VI	4	10
VII	6	15
VIII	10	25
Total	40	100

Frykman's Classification:

Fractures	Distal ulna Fracture Absent	Distal ulna fracture Present
Extra-articular	I	II
Radiocarpal joint	III	IV
Radioulnar joint	V	VI
Radiocarpal & Radioulnar joint	VII	VIII

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Arthritic Grading (Knirk and Jupiter 1986)

Grade	Findings
0	None
1	Slight joint space narrowing
2	Marked joint space narrowing
3	Bone on bone, Osteophyte formation

Pre Op X Rays

Immediate Post Op X Rays

Second patient

Pre operative X rays

Post Op X Rays

Follow Up

Graphs:

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Comparison of our result with other Authors

AUTHORS	FIXATOR	CRITERIA	ANATOMICAL RESULT			
			Median Degree Angle	Excellent	Good	Fair or Poor
COONEY et al 1979	Anderson	Intra-articular	21	32	55	13
D'ANCA et al 1984	Hoffman	Intra-articular	-	68	26	6
Schuind et al 1984	Hoffman	Unstable	-	57	37	6
Vaughan et al 1985	Anderson	Intra-articular	27	47	47	6
Jenkins et al 1987	AO	Manipulation needed	26	40	53	7
Howard et al 1989	Hoffman	Comminuted, severe	39	56	40	4
Our series 2009-2011	Static External Fixator	Intra-articular	21	8	20	12

AUTHORS:

1. Praveen M. Anvekar
2. Sachin S. Nimbargi
3. Srinath S.R
4. Anil S. Nelivigi

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Orthopaedics, S.S. Institute of Medical Sciences, Davanagere, Karnataka.
2. Assistant Professor, Department of Orthopaedics, S.S. Institute of Medical Sciences, Davanagere, Karnataka.
3. Associate Professor, Department of Orthopaedics, S.S. Institute of Medical Sciences, Davanagere, Karnataka.

4. Professor & H.O.D, Department of Orthopaedics, S.S. Institute of Medical Sciences, Davanagere, Karnataka.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Praveen M. Anvekar,
D. Ortho D.N.B Ortho,
Assistant Professor, Dept. of Orthopedics,
S.S. Institute of Medical Sciences & Research Centre.
Davanagere – 577004, Karnataka.
Email – dranvekar@gmail.com

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