

## “A study of management of intra-articular fractures of distal end radius by external fixator”

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### Abstract

A fracture of the distal radius is one of the commonest skeletal injuries treated by the orthopaedic surgeon. Thirty to forty years ago the distal radial fractures were considered benign and conservative treatment was the rule. Pain and disability have resulted from subsequent mal-unions of fractures of distal radius, which were managed by conservative methods like plaster cast alone. Recently surgical treatment has been widely recommended and performed to prevent sequelae of mal-union, like pain and disability. There were 16 male and 4 female patients, between the age group of 23 to 50 years with an average age of 38.2 years. The injury occurred due to low energy trauma like, fall on outstretched hand in 8 patients. In 12 (60%) patient's injury occurred due to high velocity trauma like road traffic accidents (in 10) and fall from height. The dominant (right hand) was affected in 9 cases (45%) and left hand in 11 cases. Five patients had associated fractures and injuries; like, head injury and clavicle injury in one patient, ipsilateral Monteggia fracture-dislocation in another patient, the third patient had fracture L3 vertebra without neurological deficit, the fourth patient had contra lateral inter-trochanteric fracture and the fifth one had clavicle fracture. Two patients had bilateral intra-articular fractures but only right side was considered for the study. Three patients had open fractures, Grade I in one patient and Grade II (Gustilo and Anderson) in two patients. One patient had allergic dermatitis over left hand and forearm, which was treated by the dermatologist and then was operated. Pre-operative evaluation of all the patients and the fractures was done by clinical and radiological examination by taking X-rays of wrist in both antero-posterior and lateral views. The fracture fragments were analyzed, involvement of radiocarpal, radioulnar joints were assessed and were classified according to the Frykman's Classification of fractures of distal end of radius. There were 2 cases of Type III, 1 case of Type IV, 3 cases of Type VI, 9 cases of Type VII and 5 cases of Type VIII. Most of the fractures (70%) belonged to Type VII and Type VIII.

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### Introduction

A fracture of the distal radius is one of the commonest skeletal injuries treated by the orthopaedic surgeon. In fact, these injuries account for approximately one sixth of all fractures seen and treated in orthopaedic emergency<sup>1,2</sup>. Distal radius fractures crush the mechanical foundation of man's most elegant tool, the hand.

Thirty to forty years ago the distal radial fractures were considered benign and conservative treatment was the rule. The population involved supposedly considered of osteoporotic old women who were functioning well despite poor results and exact reduction was not mandatory. Since then, a growing number of young male, manual workers and sport enthusiasts have suffered high velocity injuries, often resulting in complex intra-articular fractures. Pain and disability have resulted from subsequent mal-unions of fractures of distal radius, which were managed by conservative methods like plaster cast alone. Re-displacement or loss of reduction after conservative treatment is another feature, which was not well recognized in the past. In

cast immobilization, compressive forces are produced by contraction of flexor tendons, which in turn causes loss of reduction<sup>3,4</sup>.

This has prompted a reevaluation of the treatment of these injuries. The rapid expansion of knowledge regarding the functional anatomy of the hand and wrist, the recognition by treating physicians of the ever increasing functional demands of the people and improved methodologies of achieving and maintaining anatomic restoration of these fractures have generated a renewed interest in addressing the following mentioned anecdotal comments in a more precise manner. Common generalizations regarding fractures about the distal radius were as follows, which are not true in present days.

1. Despite deformity these all do well.
2. You can always do Darrach's Procedure.
3. Arthritis is not a problem as wrist is not a weight bearing joint.
4. External fixation will inevitably cause wrist stiffness.
5. There is no place for surgical intervention as the fragments are too small.

Recently surgical treatment has been widely recommended and performed to prevent sequelae of mal-union, like pain and disability. The aim of the treatment is to obtain a good or perfect reduction of the intra-articular fractures and to restore the functions of the extremity at the earliest possible time. Several

investigations of factors affecting the functional outcome of fractures of the distal radius have more convincingly shown that patients function more effectively when the anatomy is restored<sup>5,6,7</sup>.

Various surgical interventions are available presently, like, percutaneous direct pinning, elastic intra-focal pinning, external bone grafting and plate fixation. There is current enthusiasm for the use of external fixation in the treatment of intra-articular fractures of distal radius. This trend has been based on the positive experience of the Surgeon; who have been able to use external fixation to improve the anatomic as well as functional results in patients who have sustained these severe injuries. In a more recent study by Edward, the functional outcome after external fixation proved excellent<sup>8</sup>.

To be safe and effective, the external fixator should have low rate of complication, be non-obstructive and be stiff enough to maintain alignment under adverse loading conditions. With the improved components and better understanding of the principles that governs the safe and effective use, the external fixator has become an indispensable tool in the hands of experienced trauma surgeons. The external fixation is one of the simple surgical procedures proposed for comminuted intra-articular fractures of distal radius, which is effective in reduction of these fractures.

### Aims and Objectives

1. To study the fracture healing by closed reduction and external fixation in the management of intra-articular fractures of distal end of radius.
2. To achieve optimum anatomical reduction and to restore optimum functions of the wrist.
3. To assess the anatomical and functional results in the patients treated with external fixators in the management of intra-articular fractures of distal end of radius.

### Materials and Methods

At Government VIMS (MCH) Hospital, Bellary, 20 patients with intra-fracture of distal end of radius were treated with external fixator during the period of Jan 2003 to June 2004, in the department of orthopaedics. Clearance was obtained from ethical committee for the present study before the study was started. The patients were selected from outpatients who attended the hospital for treatment. Patients between the age group 20-50 years of both sex with traumatic intra-articular fractures of the distal radius with for surgery were selected. The inclusion criteria were intra-articular fracture of distal radius with or without associated fractures. The exclusion criteria were, patients with pathological fractures, grade 3 open fractures and patients who were not willing for the procedure.

### Anaesthesia

All the patients were operated under regional block (Brachial block).

The Ball and Socket type of external fixator was used in our study. This fixator consists of a ball and socket joint attachment with the schanz pins. In our study the ball and socket type of external fixator was applied in all cases. We have used two 3-3.5mm schanz screws for radius and two 2.5 mm schanz screws for the second metacarpal, and 4mm connecting rods.

Instruments used for the procedure:

1. External fixator set
2. 4.5 mm hexagonal screw driver
3. Spanner
4. Drill bits
5. Manman Electric Drill and Hand drill
6. T Handle
7. Scalpel Blade
8. Retractors and small bone levers
9. Periosteal Elevator
10. Image Intensifier/Portable X-ray

### Surgical Technique

Under regional block anaesthesia (Brachial block), patient was placed supine on the operating table. The forearm and hand were scrubbed with betadine and saline. The tourniquet was applied over the arm. The forearm and hand were painted with betadine and draped. The operating forearm placed on a radiolucent arm-board.

This technique involved two 2-2.5cm incision, one approximately 10 cm proximal to the radial styloid overlying the radial aspect of the forearm and other overlying the dorso-radial aspect of the base of the index metacarpal.

Through the proximal incision, radial sensory nerve and tendons were protected from injury while approaching the radius between extensor carpi radialis longus and brachioradialis at their musculotendinous junction. Periosteum was elevated. The radius was drilled with 2.7mm drill bit by using Manman electric drill. With T Handle 3 - 3.5 mm, 2 schanz screws were fixed.

A second incision was made over 2<sup>nd</sup> metacarpal. The dorsal interosseous muscle was elevated off the base of the index metacarpal. Similarly 2<sup>nd</sup> metacarpal was drilled with 1.5 mm drill bit and then fixed with two 2.5mm schanz screws. The proximal screw was passed through 3<sup>rd</sup> metacarpal base also.

Then, with fixator pins securely in place, the external fixator device was fixed. The clamps were loosened and longitudinal traction was given with manual molding of the fracture fragments back into a more normal alignment and gentle flexion and ulnar deviation was maintained. The reduction was confirmed through image intensifier and then external fixation device was locked into place. The tension across the wrist generated by the external fixator device which

provides enough ligamentotaxis was confirmed by image intensifier wherein, radiocarpal articulation was seen to be 1 mm wider than the mid-carpal joint in A-P projection. In three patients portable X-ray was used.

At the end of the surgical procedure, the hand and forearm are placed in soft sterile dressing. No cast or splint was applied. The fingers were left free for movement. The tourniquet was removed and fingers were looked for capillary refilling. Intravenous cephalosporins were given for 2 days along with analgesics followed by oral cephalosporins for 5 more days.

**Post-operative care and rehabilitation**

The check X-rays were taken in both P and lateral views.

Active exercises of fingers, thumb, elbow, forearm and shoulder were commenced from the day 1 of operation. On the 3<sup>rd</sup> post-operative day the dressing was removed .The pins were cleaned and small dressing around the pins was applied. Patient was discharged after the 3<sup>rd</sup> day with an advice to clean the pins daily and was reviewed after 1 week followed by fortnightly. The patient was followed up after 2 weeks, 4 wks, 6wks, 8 wks and 12 wks. on demonstration of the radiological union, the external fixator was removed after 5-7 weeks (average 6 weeks) and physiotherapy of the wrist was commenced. A removable splint for forearm was applied during night time and was removed during day time for physiotherapy. The follow up period was ranging from minimum 3 months to a maximum of 15 months (Average 5.3months). During the follow up, all the patients were observed for any possible complication. Each patient was evaluated for functional recovery at the end of three months and also at the latest follow visit up by clinical and radiological examination.

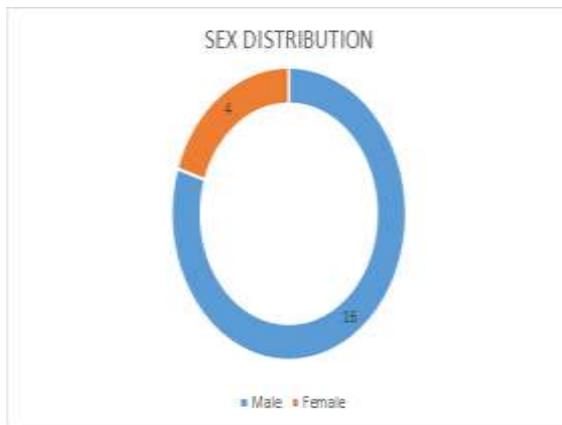
The criteria for evaluation include subjective evaluation for presence of pain, range of motion, ability to do activities of daily livings (ADLs) and grip strength. Evaluation and scoring of results were done as per the modified clinical scoring system of "Green and O'Brien" (1978).

**Results**

There were 16 male and 4 female patients, between the age group of 23 to 50 years with an average age of 38.2 years.

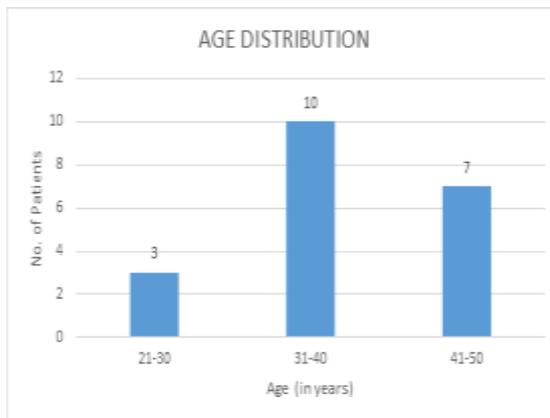
**Table 1 & Graph 1: Sex wise distribution of cases**

Sex	No of Cases
Male	16
Female	4



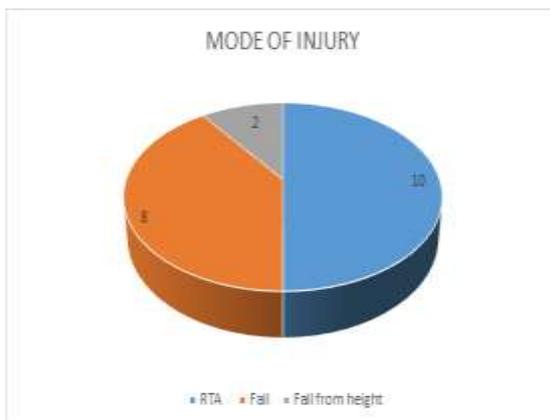
**Table 2 & Chart 2: Age wise distribution**

Age (in years)	No of Patients
21-30	3
31-40	10
41-50	7



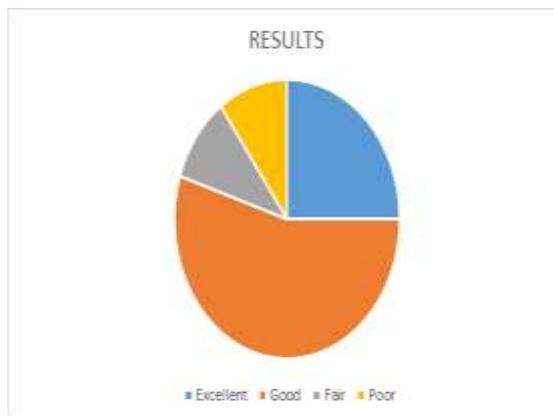
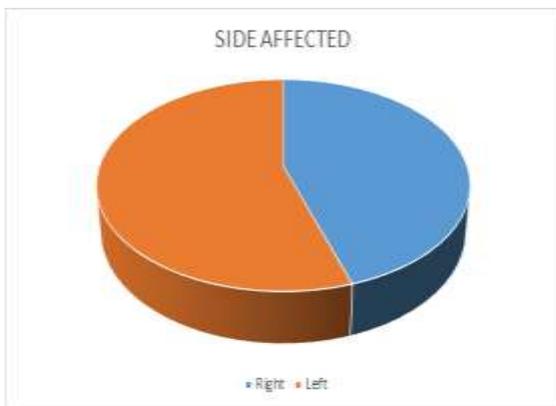
**Table 3 & Chart 3: Distribution of cases according to mode of injury**

Mode of Injury	No. of Cases
RTA	10
Fall	8
Fall from height	2



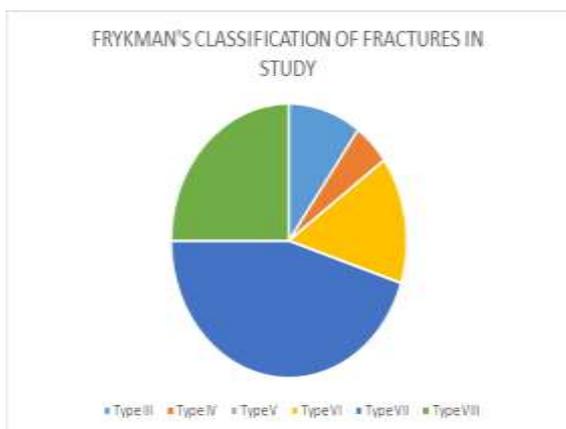
**Table 4 & Chart 4: Distribution of 20 cases according to side affected**

Side	No. of Cases
Right	9
Left	11



**Table 5 & Chart 5: Distribution of 20 intra articular fractures of distal radius as per frykman's classification**

Frykman's Type	No. of Cases	Percentage
Type III	2	10
Type IV	1	5
Type V	0	0
Type VI	3	15
Type VII	9	45
Type VIII	5	25



**Table 6: Results**

Results	No of Cases	Percentage
Excellent	5	25
Good	11	55
Fair	2	10
Poor	2	10

The injury occurred due to low energy trauma like, fall on outstretched hand in 8 patients. In 12 (60%) patients injury occurred due to high velocity trauma like road traffic accidents (in 10) and fall from height. The dominant (right hand) was affected in 9 cases (45%) and left hand in 11 cases. Five patients had associated fractures and injuries; like, head injury and clavicle injury in one patient, ipsilateral Monteggia fracture-dislocation in another patient, the third patient had fracture L3 vertebra without neurological deficit, the fourth patient had contra lateral inter-trochanteric fracture and the fifth one had clavicle fracture. Two patients had bilateral intra-articular fractures but only right side was considered for the study. Three patients had open fractures, Grade I in one patient and Grade II (Gustilo and Anderson) in two patients. One patient had allergic dermatitis over left hand and forearm, which was treated by the dermatologist and then was operated.

Pre-operative evaluation of all the patients and the fractures was done by clinical and radiological examination by taking X-rays of wrist in both antero-posterior and lateral views. The fracture fragments were analyzed, involvement of radiocarpal, radioulnar joints were assessed and were classified according to the Frykman's Classification of fractures of distal end of radius. There were 2 cases of Type III, 1 case of Type IV, 3 cases of Type VI, 9 cases of Type VII and 5 cases of Type VIII. Most of the fractures (70%) belonged to Type VII and Type VIII (Table & Chart 5).

In all the patient's other investigations like Hb%, Total blood cell count, Differential cell count, ESR, Random blood Sugar, Blood urea, Serum creatinine and ECG were done. Consent for surgery was taken.



### Complications

We came across the following complications:

One patient experienced short term numbness over the thumb, which recovered within 4 weeks. Another patient had adhesion of scar with musculo-tendinous junction on the forearm pin site, which was released and corrected. In few cases we found excessive scar over the pin site area. The complication rate was 5%.

No pin tract infection, pin breakage, open cortex defect, and fracture of metacarpal and radius.

### Discussion

One patient with Frykman's type 7 was operated after 20 days of injury. The procedure was delayed because the patient has ipsilateral Monteggia fracture and degloving injury over hand and forearm, and patient was not fit for surgery. In this case we could not get a good anatomical reduction due to absence of soft tissue hinges and hence the result was poor.

The average follow-up period was 58 months in Vaughan's<sup>9</sup> study, 25 months in Jayanth Arora<sup>10</sup> study and Cooney 1980<sup>11</sup> study. In our study in few cases we followed up the patients for 3-4 months. In few of the cases follow up was of long duration (6months to 15 months) in which we observed more excellent results. Hence for complete assessment of the outcome of the treatment long term follow up i.e., 6months to 2 years is necessary, so that the patient can undergo sufficient physiotherapy which has also been advised by Dienst (1997)<sup>12</sup>.

In three cases near anatomical restoration was not possible, because of the delayed application of external fixator, open fracture with extensive soft tissue injury (due to absence of soft tissue hinges) and associated ipsilateral forearm fractures. Hence the result was fair or poor.

We have observed loss of radial length by 1-6mm (average 2mm) after application of external fixator and could be due to failure of fixator to maintain the distraction or reduction in case of osteoporotic bone and with highly comminuted fractures. Same observation was also seen in Cooney et al., (2-8mm) and also in Rikli study<sup>13</sup> (2-3mm). This loss of radial length can be minimized by supplementation of external fixation with k wire which is also recommended by Reynolds (2011).<sup>14</sup>

As with any other study, osteoporosis was a frequent postoperative complication observed in our study but without any sign of reflex sympathetic dystrophy, Mackinnon and Holder (1984) observed RSD in less than 1% of patients<sup>15</sup>. Persistent osteoporosis was present in 17% of cases in Schuind (1984—85 and 89) study<sup>15</sup>. The minimum limitation of joint motion probably well tolerated by patients without affecting their activities of daily livings (ADLS) because, the majority of common hand tasks can be carried out with 70% of the maximum range of movements (Ryu, Cooney et al., 1991).<sup>15</sup>

The complications of external fixator were infrequent in our study. Complications like tendinitis or tendon rupture which are commonly seen in percutaneous pinning (Epinette et al., 1982 and Kapandji 1976) were not observed in external fixation. We have not observed pin track infection in our study.

Fracture at the site of pin during application or after removal of pins occurred in 1% of patients in Schuind study<sup>15</sup>. Seitz<sup>16</sup> has advised skillful pin placement with the external fixator facilitated with limited open technique. With limited open surgical incision technique, we observed no incidence of either open cortex defect or fracture of radius or metacarpal bones. We did not encounter any permanent damage to the superficial branch of radial nerve or tendon.

The carpal tunnel syndrome was not observed in our study. In literature it was observed less frequently in external fixator than plaster cast treatment (Schuind et al 1989) This could be probably because of better reduction

of the fracture, less wrist hyper flexion and avoidance of supplementary local constriction (Schuind 1990)<sup>15</sup>.

External fixation of intra-articular fractures of the distal radius has become an effective tool in treating these fractures according to the concept of ligamentotaxis that was proposed by Vidal et al. In absence of soft tissue attachment, severe fragments cannot be reduced only with external fixation but needs supplementation of K-wire alter manipulation of fragments<sup>14</sup>.

Sommerkamp T.G. et al<sup>17</sup> in their study to compare the results of dynamic with those of static external fixator, their results did not support the concept of early mobilization with dynamic external fixator, because of lack of a demonstrable improvement in the mobility or overall function of wrist and subsequent significant loss of reduction. Although some surgeons like Clyburg<sup>18</sup> have recommended wrist movements after 3 weeks of application of external fixator during fracture healing, additional complex biomechanical considerations, lack of clinical data and also high cost of dynamic external fixator (eg Wrist Jack) prevent our recommendation for active wrist movements with external fixator in-situ.

The duration of fixation varies from 5 weeks to 10 weeks as per the literature<sup>4,19,20</sup> but as per the study of Kaempffe et al., 1999<sup>21</sup>, outcome likely is improved with shorter duration (6 weeks) of external fixation. In our study series external fixation was maintained for 5-7 weeks on average of 6 weeks.

The results of our study are similar to the results in the literature i.e., Cooney et al<sup>22</sup> study 1979 in which good to excellent results are 87% and Klien et al., and Rikli et al<sup>13</sup>, study in which good to excellent results are 80%. In our study we have observed 80% of good to excellent results. The slight difference in results can be explained by the fact that, unlike above studies we used external fixator without augmenting it with any form of adjuvant treatment.

External fixation with distraction between the radius and second metacarpal is a simple, reliable and efficient technique for the treatment intra-articular fractures of distal radius. The skeletal traction maintained by this procedure has produced appropriate stabilization of fragments as seen in the Cooney et al., Study 1979 and 1983.

**Table 7: Comparison of study results with other studies in the literature**

Authors	Fixator	Criteria	Results		
			Excellent	Good	Fair or Poor
Cooney et al	Anderson	Intra-articular	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	47	47	6
Jenkins et al 1989	AO	Manipulation needed	40	53	7
Howard et al 1989	Hoffman	Comminuted	56	40	4

Present series 2004	Ball and Socket external fixator	Intra-articular	5	11	4
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### Summary

In our study series, 20 patients with intra articular fracture of distal radius were treated by a static ball and socket type of external fixator between the periods of Jan 2003 to June 2004. Most of the fractures (70%) were of Frykman's type 7 and 8. We had three cases of open fracture grade 1 in one patient and grade 2 in 2 patients. Mechanism of injury was high energy trauma like RTA (in 10) and fall from height (in 2) and simple fall (in 8). 2 patients had bilateral involvement who had history of fall from 20 ft height. Five cases had other associated injuries. External fixation was maintained for 6 weeks on an average.

Early mobilization of fingers started from the beginning of the treatment, which was very much necessary to prevent stiffness. The wrist Physiotherapy was also advised after removal of external fixator to achieve maximum range of movements. In our study we have observed good to excellent results in 80% of cases, fair results in 10% and poor results in 10% of cases. Complication rate was 5%. The present study results are similar to other studies in the literature like Cooney et al (1979,1983).

All the variables of the fractures i.e. radial length, radial angle and volar tilt should be achieved for an optimum outcome even though the volar tilt has got least Influence and it is difficult to regain volar tilt by ligamentotaxis and maintain it by external fixator. The study procedure was very useful in open fractures. Early application of external fixators should be carried out to gain good anatomical reduction. Even though we have not done supplementation with K-wire in our study, we observed that, supplementation of k-wire is necessary in case of severely comminuted fragments, where reduction is not possible with external fixator alone. External fixator is a useful, simple tool in management of intra articular fractures of distal radius to get optimal function of the extremity at the earliest possible time.

Our study series concludes that with precision in case selection and operative technique, ligamentotaxis consistently results in a favorable outcome in the management of intra articular fractures of distal end of radius. The ease of use of the external fixator and successful track record make it an extremely versatile tool for treating intra articular fractures of distal radius while minimizing the complications.

### Conclusion

The external fixation between the radius and the second metacarpal has produced appropriate stabilization of the fragments. External fixation was well accepted by the patients. This procedure was with minimal complications. As with any other study procedures, osteoporosis was frequent post-operative

complication usually without any clinical signs of reflex sympathetic dystrophy.

The external fixation for management of intra articular fractures of distal radius has to be supplemented with k-wires in severely comminuted fractures to get good anatomical reduction and to maintain joint congruence.

Our study series concludes that with precision in case selection and operative technique ligamentotaxis consistently results in a favorable outcome in the management of intra articular fractures of distal end of radius. The ease of use of the external fixator and successful track record make it an extremely versatile tool for treating intra-articular fractures of distal radius.

Careful assessment of the fracture pattern, appropriate patient selection, meticulous surgical technique, the appropriate choice of device and pins, recognition of the need for augmentation with limited open K-wire fixation and aggressive post-operative rehabilitation provide the foundation for successful management of intra articular fractures of the distal end of radius while minimizing the complications.

### Bibliography

- Owen RA., Melton LJ., Johanson KA., et al.: "Incidence of Colles' fracture in a North American community". *Am Journal Public Health* 1982;72:605-607.
- Jupiter JB., Lipton H.: "The operative treatment intra-articular fractures of the distal radius". *Clinical orthopaedics Related Research*, 1993;292:48-61.
- Jenkins NH, Jones DG., Johnson SR., Mintowt Czyn WJ.: "External fixation of Colles' fractures: An anatomical study". *J. Bone Joint Surg.* 1987;69-B: 207.
- Kongsholm J., Olerud C.: "Plaster cast Vs external fixation for unstable intra-articular Colles' fractures". *Clin. Orthop.* Apr. 1989;241:57.
- Mc Queen M., Caspers J.: Colles' fractures "Does the anatomic results affect the final function?" *J. Bone Joint Surg.* 1988;70-B. 649.
- Stewart H. D., Innes AR., Burke FD: "The hand Complications of Colles' fractures". *J. Hand surg.* 1985;10(B):103-106.
- Green DP: "Pins and Plaster treatment of comminuted fractures of the distal end of the radius". *J. Bone Joint Surg.* 1975;57-A:304-310.
- Edwards GS. Jr.: "Intra-articular fractures of the distal radius treated with the small AO external fixator". *J. Bone Joint Surg.* Sept 1991;73-A:1241-1250.
- Vaughan PA., Lui SM., Harrington JJ., Maistrelli GL.: "Treatment of unstable fractures of distal radius by external fixation". *J. Bone Joint Surg.* 1985;67-B:385.
- Jayant Arora, Harmesh Kapoor, et.al: "Closed reduction and plaster cast Vs external fixation in comminuted intra-articular fractures of distal radius". *Indian. J. Orthop.* April 2004; Vol-38:(2).113-117.
- Cooney WP., Dobyns JH., Linscheid RL.: "Complications of Colles' fractures". *J. Bones Joints Surg.* 1980;62-A:613.
- Dienst M., Wozasek GE., Seligsone D.: "Dynamic external fixation for distal radius fractures". *Clin. Orthop.* May 1997;338;160-171.

13. Rikli Damiel A MD et.al: "The role of external fixation in the management wrist fractures". *Techniques in Orthop.* June 2002;17(2):260-270.
14. Reynolds, Paul. MD; Beredjiklian, Pedro K. MD.: "External fixation of distal radius fractures: do benefits outweigh complications?". *Current Opinion in Orthop.* Aug.2001;12(4):286-289.
15. Schuind et. al. "Treatment of distal radius fractures by external fixation" By Cooney WP: 1995;203.
16. Seitz WH Jr., Froimson AL., Brooks DB., Postak PDBS., Parker RD., LaPorte JM., Greenwald AS.: "Bio-mechanical analysis of pin placement and pin Size for external fixation of distal radius fractures" *Clin. Orthop.* Feb 1990;251:207-212.
17. Sommerkamp TG., Seeman M., Silliman J., Jones A., Patterson S., Walker J. Semller M., Brown R., Ezaki M.: "Dynamic external fixation of unstable fractures of the distal part of the radius". *J. Bone Joint Surg.* Aug. 1994;76-A;1149-1161.
18. Clyburg TA: "Dynamic external fixation for comminuted intra-articular fractures of distal end of radius". *J. Bone Joint Surg.* 1987;69-A:248
19. Cooney WP. III, Linscheid RL., Dobyns JH.: "External pin fixation for unstable Colles' fractures". *J. Bone Joint Surg.* 1979; 61-A: 840.
20. Jonsson U.: "External fixation for redislocated colles' fractures" *Acta Orthop. Scand.* 1983;54:878-83.
21. Kaempfe, Frederik A. MD., et al.: "External Fixation for distal radius fractures: effects of distraction on outcome". *Clin. Orthop.* Nov. 2000; Vol-I (380):220-225.
22. Philippe Saffar.: "Current trends in treatment of distal radius fractures". *Fractures of the distal radius.* 1995;12-14.