



Orthopaedics

“STUDY OF DISPLACED DISTAL RADIUS FRACTURES BY LIGAMENTOTAXIS IN DEPARTMENT OF ORTHOPEDICS AT PINNAMANENI SIDDHARTHA INSTITUTE OF MEDICAL SCIENCES AND RESEARCH FOUNDATION”.

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ABSTRACT

Background: Fracture of the distal end of radius is one of the most common fractures. It occurs in both middle aged and elderly patients. Patients with fracture distal end of radius have serious complications more frequent than generally appreciated and failure in management may cause permanent disability. As treatment methods are continually improving and best suitable method of management has to be followed in each case, an increasing preponderance of published studies support the need for operative intervention in these patients.

Materials and Methods: Between March 2018 to March 2020 in department of orthopedics at Dr.PSIMS & RF, 30 patients with fracture distal radius of Gustilo – Andersons type I and II were included in this study. These patients were treated by closed reduction of fracture and Percutaneous fixation with K-wire under C-arm guidance. The results of this study were analysed using Mayo Wrist Scoring.

Results: In our study, we followed Frykman classification to classify the fractures. Unstable fractures were identified and managed with external fixator & Ligamentotaxis. The mean age of the patients was found to be 44 years with male preponderance (53%) as compared to females (47%). statistical analysis was done with Mean, SD. ANOVA test was applied to find significance. $P < 0.05$ was considered as statistically significant. in current study P values < 0.001 in palmar flexion and dorsiflexion implies there is functional outcome which is significant in the study and p value < 0.04 and p value < 0.03 for supination and pronation respectively signifies there is a significant functional outcome.

Conclusions: The external fixation and Ligamentotaxis proved to be a very useful method for treating unstable distal radius fracture. The distal radius fracture is no longer a simple fracture to treat by cast alone, and more aggressive treatment is needed to restore the articular congruity and functional outcome. Ligamentotaxis with external fixation for the management of these fractures play a considerable role in achieving a good functional outcome.

KEYWORDS : Ligamentotaxis, Distal Radius fracture, External Fixator, Osteoarthritis.**INTRODUCTION**

Fracture of the distal radius is among the most frequent fractures seen in an emergency department. Many methods like closed reduction and casting, pins and plaster, Percutaneous pinning, external fixation with Ligamentotaxis, internal fixation, combined internal and external fixation and arthroscopic assisted reduction have come up.¹ In a young, active individual with a severely comminuted fracture, an acceptable closed reduction may be achieved easily but difficult to maintain. When reduction is lost, a shortened, dorsally angulated carpus with subsequent poor function and early osteoarthritis secondary to articular incongruity may occur.

Percutaneous pinning has all the disadvantages of external fixator like inability to achieve direct reduction, immobilization of radio carpal joint and pin tract infections.² It also lacks some of the advantages of external fixators like adjustability, known strength and reusability for a specific patient. Many unstable distal radial fractures are treated by closed reduction and casting with even small degrees of mal alignment adversely affects functional outcome has stimulated interest in external fixation and ligamentotaxis. External fixation for distal radius fracture relies on the principle of Ligamentotaxis in which, a distraction force applied to the carpus aligns the fragments by means of intact ligaments. Distraction assisted reduction and maintenance of distal radius fracture is a widely used and reliable treatment method.³

If the principles of ligamentotaxis are applied rationally, the factors that cause instability are identified clinically and managed surgically, a satisfactory

METHODOLOGY

This study was conducted in Dr.Pinnamaneni Siddhartha Institute of Medical Sciences And Research Foundation from March 2018 to March 2020. Based on the principle of ligamentotaxis, Patients with

unstable distal radius fractures were selected and treated with the external fixator.

All the patients have been evaluated with X rays of the wrist with the antero-posterior view and lateral view. The patients for whom external fixation and ligamentotaxis was planned, below elbow plaster splint was temporarily given to relieve pain and limb elevated for oedema to subside. Injection tetanus toxoid was given to all the patients. All the patients were given per-operative prophylactic antibiotics.

INCLUSION CRITERIA:

Adults between age group of 20 years and 60 years, Closed and open fractures (Gustilo – Andersons type I and II), Fractures less than 1 week old, Comminuted and Intra articular fracture of distal end radius.

EXCLUSION CRITERIA:

Patients with pathological fractures, Fractures with neurovascular complications and Fractures associated with other bones in ipsilateral wrist, hand or forearm were excluded from the study.

On presentation, the following were evaluated.

- 1) Condition of skin
- 2) The Condition of local nerve function
- 3) Condition of vascularity
- 4) Tendon function
- 5) The Function of elbow, shoulder and fingers.
- 6) Forearm rotation
- 7) General medical condition.
- 8) Preoperative radiographs of the affected distal radius were taken.
- 9) Posteroanterior and lateral X rays were taken.

Then, the limb was Scrubbed, painted and draped. The metacarpal pins

were applied first. A 1cm stab incision made over the metaphyseal flare of the second metacarpal. Blunt dissection was carried out avoiding injury of the superficial radial nerve and first dorsal interosseous muscle.

The Second metacarpal was drilled with 2.0mm drill bit while protecting soft tissues using drill guide. Then 2.5mm × 100mm Schanz pin inserted. A second pin was applied distally by the same method.

Radial pins were applied 10cm proximal to radial styloid. 1 cm stab incision was made along the line joining lateral condyle Humerus and Lister's tubercle of distal Radius: blunt dissection carried out to reach radial shaft avoiding injury to radial sensory nerve and extensor tendons.

The Radial shaft was drilled with 2.5mm drill bit while protecting soft tissues with a drill guide. Drilling was done in such a way that pins were placed on radial side and 30° dorsally. A 3.5mm × 100mm Schanz pin inserted. The Second radial pin was applied distal to first pin by the same method.

The metacarpal pins were connected to universal clamps, and radial pins were attached to another universal clamps. The ball clamps were connected to the distraction rod. Check X rays were taken and fine-tuning of distraction done. No more than 2 - 3mm distraction was applied over the radiocarpal joint.

The Limb was kept elevated for 24 – 48 hours. Parenteral antibiotics were given for two days followed by oral antibiotics for one more week. Pin sites were regularly inspected, and Betadine dressings are given.

Patients were discharged on next day (post op day 1) and reviewed on third and sixth week. On every visit, the extent of finger movements was noted. Pin site was examined for infection.

At sixth week after confirming union radiologically, the external fixator was removed, and sterile dressing and elastocrepe bandage applied.

Active wrist mobilisation was started. Patients were reviewed on third month of treatment. Every time functional and radiological assessment was made and compared to the healthy side.

The results of this study were analysed using MAYO WRIST SCORING⁴. Cooney et al. modified the Green and O'Brien score in 1987 by changing the demerit items and removing radiographic indices. The resulting outcome measure was referred to as the Mayo Wrist Score.⁵

Mayo Wrist Score assesses four domains: pain, grip strength, the range of motion, and Functional status. Each domain is scored out of 25 points to produce a total score out of 100 Points. High scores correlate with proper function.

Scores of 90 to 100 points denote “excellent” function and a score of less than 65 is considered “poor.”

Bony union was achieved in all patients. DRUJ pain occurred in 2 patients and DRUJ instability in 1 patient. At the end of 3 Months, the patient was evaluated using the MAYO WRIST SCORING system as follows. It consists of

A. PAIN:

FINDINGS	SCORE
NONE	25
MILD, OCCASIONAL	20
MODERATE, TOLERABLE	15
SEVERE OR INTOLERABLE	00

B. FUNCTIONAL STATUS:

FINDINGS	SCORE
RETURNED TO REGULAR EMPLOYMENT	25
RESTRICTED EMPLOYMENT	20
ABLE TO WORK BUT UNEMPLOYED	15
UNABLE TO WORK BECAUSE OF PAIN	00

C. RANGE OF MOVEMENTS:

FINDINGS (percentage of normal/dorsiflexion-plantarflexion arc)	SCORE
100 / >or = to 120 degrees	25
75-99 /91-119 degrees	15
50-74 /61-90 degrees	10
25-49 /31-60 degrees	05
00-24 /<or= to 30degrees	00

D. GRIP STRENGTH:

FINDINGS	SCORE
100 % OF NORMAL	25
75-99 % OF NORMAL	15
50-74 % OF NORMAL	10
25-49 % OF NORMAL	05
00-24 % OF NORMAL	00

FINAL RESULT:

EXCELLENT	90-100
GOOD	80-89
FAIR	65-79
POOR	<65

OBSERVATIONS AND RESULTS

In this study, we followed Frykman classification to classify the fractures. Unstable fractures were identified and managed with external fixator & ligamentotaxis.

Table 01: Total Number Of Cases

Total number of cases	30
Bilateral	00
Total number of wrists	30
Compound fractures	01 (Grade 1 compound)

There is a male preponderance where 16 of the patients are males and 14 of the patients were females. The side of injury is about 50% on both sides. Mode of injury: 53% is by RTA and 47% is by fall

AGE:

Table 02: Age Distribution Of Cases

Age	Frequency	Percent
20-30	6	20.0
30-40	6	20.0
40-50	10	33.3
50-60	8	26.7
Total	30	100.0

ASSOCIATED INJURIES

Table 03: Associated Injuries

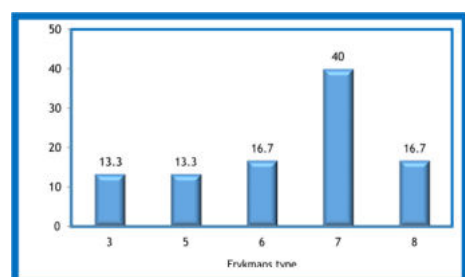
Associated injuries	Frequency	Percent
LEFT FEMUR SHAFT FRACTURE	1	3.3
RIGHT ACETABULAR FRACTURE	1	3.3
RIGHT FEMUR SHAFT FRACTURE, BOTH BONE LEG LEFT	1	3.3
NIL	27	90.0
Total	30	100.0

ADDITIONAL PROCEDURES

Table 04: Additional Procedures

K wire fixation	23
Bone grafting / Bone marrow injection	01
Ulnar Gutter slab	18

FRYKMAN TYPE OF DISTRIBUTION:



GRAPH: 01

In external fixation (ligamentotaxis) group, the fracture reduction was first achieved under anaesthesia by the same method as for closed reduction group.

In our study, according to the system out of 30 wrists treated the results were as follows. The results of the procedure were analysed radiographically and clinically at three months postoperatively. Three patients had superficial pin tract infections which are treated with antibiotics and pin tract care. All subsided without sequelae.

In five cases the fragments are displaced even after ligamentotaxis, so it is augmented with K wire fixation in those cases. One case with metaphyseal comminution removal of external fixator at six weeks resulted in metaphyseal collapse resulting in reduced radial length. This indicated the need for keeping the fixator for longer time in cases of metaphyseal comminution with risk of late metaphyseal collapse

One patient developed radial sensory nerve deficit which recovered after three months. We did not encounter iatrogenic fracture of the metaphyseal due to pin insertion which is reported in literature, this probably reflects need for careful predrilling and using drilling template. In case of compound injuries also external fixators allowed excellent access for wound care. This study also provided a chance to analyse the Frykman Classification. Frykman classification proved to be descriptive but not predictive. Even in cases of Frykman VII and VIII injuries excellent results and good results were obtained, provided the injuries were due to low- velocity violence. The results of high energy injuries were modest probably because of the associated soft tissue and ligamentous injury.

In statistical analysis Data were entered in MS-Excel and analyzed in SPSS V22. Descriptive statistics were represented with percentages, Mean with SD. ANOVA test was applied to find significance. P<0.05 was considered as statistically significant. And our results are depicted in a tabular form and are as follows:

Table 05:statistical Analysis Of Results With Mean, Standard Deviation And P-value

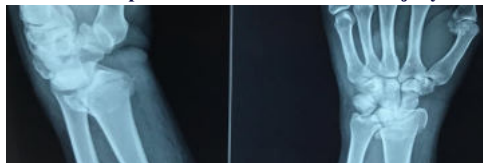
Variable	Results						P-value
	EXCELLENT		GOOD		FAIR		
	Mean	SD	Mean	SD	Mean	SD	
Age	41.33	18.04	41.95	11.48	48.83	10.09	0.45
Palmar flexion	76.67	5.77	65.24	10.78	46.67	9.83	<0.001
Dorsi flexion	76.67	5.77	70.00	9.49	47.50	16.05	<0.001
Supination	76.67	5.77	65.71	9.78	58.33	10.33	0.04
Pronation	76.67	5.77	67.86	8.45	59.17	12.01	0.03

Thus results with a p value less <0.05 are significant and in current study values < 0.001 in palmar flexion and dorsiflexion implies there is functional outcome which is significant in the study and p value < 0.04 and p value <0.03 for supination and pronation respectively signifies there is a significant functional outcome. Thus identification of soft tissue injury and high-velocity injuries may prove to be useful in the management. This recognition led us to use an additional support with ulnar gutter slab for the first few days to few weeks in case of high-velocity injuries indicated by mode of injury and gross swelling.

CASE ILLUSTRATIONS

CASE 1

Lateral and Antero-posterior views at the time of injury



Lateral and Antero-posterior view of left wrist post surgery



Lateral and Antero-posterior views of left wrist at union after surgery



CASE -1

Palmar flexion of left wrist



Dorsiflexion of left wrist



Pronation of left wrist.



Supination of left wrist



CASE 2 Antero-posterior and lateral views of right wrist at the time of injury



Lateral and anteroposterior views of right wrist after surgery



Antero-posterior and Lateral views of right wrist at union after surgery



CASE 2

RIGHT HAND DORSI-FLEXION. RIGHT HAND PALMAR-FLEXION



RIGHT HAND PRONATION. RIGHT HAND SUPINATION**DISCUSSION**

Fractures of the distal radius is the most common fracture encountered by Orthopaedic trauma surgeons around the world. Fractures of the distal radius account for 17.5% of all adult fractures.⁶ In the history of fractures of the distal radius reflects the evolution of the understanding of many conditions in orthopaedic trauma. The credit for recognition of the true nature of the injury is shared between petit, pouteau and colle's prior to whose writings it was believed that the injury was a carpal or distal radioulnar joint dislocation. According to information from Edinburgh in 2010 to 2011 (unpublished data) and Finland in 2008,⁷ There is higher incidence in females than males by two to three times in all studies, men who sustained distal radius fractures are significantly younger than women. In the current study there is a male predominance 53.3% when compared to the female population with 46.7%. The average age of all distal radius fractures in adults has been reported to be between 57 and 66 years with females being on average in their 60s and men in their 40s. this implies there is gender and age-specific distribution curves. In the current study there is an increase in fractures in elderly aged between forty to sixty years which accounted to 60% when compared to younger people with 40%. As stated by Melone, there is a raise of frequency for the comminuted fractures of lower end of the radius in younger age groups in recent years due to increased incidence of road traffic accidents.⁸ Sudheer U et al.⁹ study had a high incidence in young males. It is observed that the right upper limb is affected in almost all series may probably due to the dominant hand.¹⁰ In current study there is higher incidence in elderly age group, due to the trivial trauma with fall on an outstretched hand which accounted for 60%, which indicates that there is an increased chances of fracture with increased age as there are increased incidence of osteoporosis in elderly age group and in younger age groups due to road traffic accidents which accounted for 40%.

According to study by Sudheer et al.⁹ there is a right-sided predominance may be due to dominant hand and in current study there is an equal distribution of side of injury 50% but, there is increased frequency in injury to the dominant hand. With increase in age there are increase chances of fracture which accounts for decrease in bone density and softening of bone which increases chance of fracture, When compared to younger age groups who have good bone density which may require higher forces for a fracture to occur, this implies the fracture of distal radius is dependant on bone mineral density, age of an individual and amount of load that is exerted on distal radius. Most of the cases resulted from high-velocity injuries and fall on outstretched hand, and These cases presented with pain, swelling of the wrist and painful movements.

Few cases were delayed due to the medical conditions and in cases of gross oedema to subside, but Most of the patients were operated on the day of admission in the emergency operation theatre. Rajani Ranjan et al.¹¹ who got 76.9% excellent results and 15.38% of good results and fair to poor in 7.69%, out of which most of the patients in his study group are males and of road traffic accidents which when compared to current study on distal radius, we have considered the intra articular fractures according to frykmans classification out of thirty patients treated with the ligamentotaxis 70 % have good results and 10 % have excellent results and 20% have obtained fair results, out of which 66.6% of excellent results are in younger age and 57.1% of good results obtained in elder age groups. This implies there is more excellent results in the younger patients who have more bone density than the older people who have considerably lesser bone density.

In current study results are assessed in different statistical analysis and

results with a p-value less <0.05 are considered significant. p-value < 0.01 in palmar flexion and dorsiflexion implies there is a functional outcome which is significant in the study and p-value < 0.04 and p-value <0.03 for supination and pronation respectively signifies there is a significant functional outcome.

In current study all the patients have been assessed for the pain at 3 months out of which 73.3% of the patients doesn't have pain and 23.3% of patients have moderate pain and 3.3% of the patients have severe pain. 3.3% of the severe pain patients are old age patients and with high velocity injury patients who require more time to heal as there is decreased rate of bone formation and less mobility of the wrist following removal of external fixator.

Although there are many treatment modalities like plaster of paris casting following reduction there are high chances of collapse and malunion due to loss of reduction in the cast, so with the results been unsatisfied, Cooney et al, in 1979, critically reviewed external fixator and reported a good result for eighty five percent of patients with decreased radial shortening and improved volar tilt. since then external fixation has been a popular and reliable method for the treatment of these frequently seen fractures De palma hypothesized that a residual dorsal tilt of the distal end of the radius of more than 5 degrees led to a poor result. In his study, The treatment with external fixator maintains good reduction and to prevent the recurrence of deformity. It reduces the rate of malunion, which is evident by radiological analysis. Ligamentotaxis is the principle of molding fracture fragments into alignment as a result of tension applied across a fracture by the surrounding intact soft tissues.¹² Skeletal traction maintained by distractor between radius and second metacarpal bone appears to provide appropriate stabilization of fragments. Distractor provides stability & sustained traction prevents shortening due to either bone loss or late resorption of cancellous bone from metaphysis. The use of external fixator requires adherence to post-operative protocol, involving pin care to avoid septic complication around the pin site. Unless this is maintained external fixation cannot be expected to provide good result.¹³

Preservation of radial length is the essential factor for retaining of function. Loss of radial length can lead to ulnar impaction or dysfunction of Distal Radio-Ulnar Joint, with a limited range of motion in supination and pronation, depending on the volar or dorsal subluxation of the ulnar head within the sigmoid notch. The main disadvantage of the method is its inability to maintain volar tilt, and in cases of over-distractor, it produced a dorsal tilt.

So, in cases with metaphyseal comminution, the fracture takes a long time to consolidate. So in cases with metaphyseal comminution, the external fixator has to be kept for a long time, or there should be an addition of cancellous bone graft¹⁰ to avoid metaphyseal collapse. Residual dorsal angulation can precipitate ulnar impaction, mid-carpal instability and altered stress concentration which may lead to early arthritis. Porter, in his study, felt that loss of function did not occur until at least 20 degrees of palmar tilt was lost. In ligamentotaxis with external fixation, radial length, ulnar variance and radial angulation are restored to normal, but the restoration of volar tilt though adequate is not complete. This is attributed to the fact that volar ligaments are stronger and become taut on distraction before the dorsal ligaments which are in a relative 'Z' orientation. So, on distraction, the palmar cortex is brought out to length before dorsal cortex preventing full correction of dorsal tilt The external fixator was also unable to correct the depressed lunate fossa¹⁴, which may need additional procedures like pinning and elevation of the depressed fragment.

The ulnar styloid fractures with displacements > 3 mm indicate higher degrees of fracture displacements and injury to triangular fibrocartilage & it needs to be fixed. We encountered DRUJ pain in two patients and DRUJ instability in one patient. It might have been useful to have cross-pinned the ulna to the radius in supination.

In the current study we found that the results were excellent to good in number of cases and the frame we used is economical, easy to apply, tolerated well by the patients and gives access to wound care. We conclude that external fixation and ligamentotaxis applied to complex distal radius fractures when added with or without augmented K-wire fixation and bone grafting can provide direct augmentation of fracture stability and a proper wrist function. Our study equaled previous studies on unstable distal radius fractures treated by ligamentotaxis in results.

CONCLUSION AND SUMMARY

Fractures of the distal radius though common and appear simple, affect the function of the wrist considerably. Most of these fractures are unstable resulting in loss of reduction and hence malunion, altered wrist kinematics, reduced range of motion and early arthritis.

The external fixation and ligamentotaxis proved to be a very useful method for treating unstable distal radius fracture. The distal radius fracture is no longer a simple fracture to treat by cast alone, and more aggressive treatment is needed to restore the articular congruity and functional outcome. Ligamentotaxis with external fixation for the management of these fractures play a considerable role in achieving a good functional outcome.

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