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Original Research Article

A prospective study of functional evaluation of distal radius fracture by external fixator using the principle of ligamentotaxis

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ABSTRACT

Background: Preservation of the articular congruity is the principal prerequisite for successful recovery following distal radius fractures. The best method of obtaining and maintaining an accurate restoration of articular anatomy however, remains a topic of considerable controversy. External fixation as a method of treatment for distal end of radius fracture has more than 60 years of documented clinical experience. The main aim of the study is to evaluate the results obtained by treatment of distal end radius fractures by external fixation using the principle of ligamentotaxis.
Methods: In a prospective controlled study, 30 cases of distal end radius fractures with intra articular extension were treated with uniplanar bridging type of external fixation using the principle of ligamentotaxis. Mean age of the patients was 40.2 years, external fixator was applied for a mean duration of 6 weeks.
Results: In this study there were 8 patients with excellent results comprising 27%, 14 patients with good results comprising 47%, 7 patients with fair results comprising 23%, 1 patient with poor results comprising 3%.
Conclusions: In a prospective investigation, static external fixators were applied to 30 intra-articular fractures of the distal end of the radius. Fixator was kept up for a total of six weeks. The results were 8 excellent, 14 good, 7 fair, and 1 poor. Only one complication, pin loosening (10%), occurred. This series concludes that ligamentotaxis by external fixation consistently produces a good result in the management of intra-articular distal end of radius fractures in younger age groups (50 years).

Keywords: Distal radius fracturs, External fixation, Ligamentotaxis, Intra-articular fractures, Distal end radius

INTRODUCTION

Fractures involving the distal end of radius are one of the frequently encountered injuries in orthopaedics. Intra-articular fractures of the distal radius represent a therapeutic challenge compared to unstable extra-articular fractures.[1]

Conventionally these fractures were treated with closed reduction and immobilization with casts. Even though union of these fractures occurs, it has very high incidence of going in for malunion and joint disability and instability especially those with comminution and intra articular extension, these fractures can be managed either by external fixation with Kirschner wire (K-wire) or by open reduction and internal fixation (ORIF) using volar fixed angle locked plate, which is also used for treating unstable fractures.[2-4]

Moreover, there is a changing trend in the age group, seen more commonly in the younger age group as a result of Road traffic accidents and trauma, leading to complicated fractures especially with intra articular extension & comminution. Over past few years, the importance of alignment correction, preservation of normal radial length and reconstruction of congruity of radiocarpal and radioulnar joints has been emphasized. Residual joint incongruity of seemingly minimal extent can lead to disabling arthrosis.

In order to treat these fractures optimally, we ought to understand the extent of displacement, the degree of articular disruption, the stability and reducibility of each fracture as well as any concurrent injury to adjacent nerves, tendons or carpal structures, ought to be assessed carefully. For an optimal result to occur there should be an accurate restoration of skeletal anatomy and most importantly supervised rehabilitation by skilled physiotherapy.

Anderson and O' Neil, were the first to introduce use of external fixation in the treatment of these fractures. Since then, there is trend to use external fixators in management of these fractures as they give improved results both functionally and improved anatomic reconstruction.[19]

To be safe, effective and to give improved results the fixator chosen should be easy to use, allow re -reduction, low rate of complications and should be stiff enough to maintain the alignment.

Clinical outcome of the distal radius fractures (limited range of motion, reduced grip strength, and radiographic abnormalities) does not always reflect the pain and disability of the injured wrist.[5,6]

Objectives

Objectives of the study were to study the role of external fixation and to determine the importance of anatomical reduction in distal radius fractures, to study the role of ligamentotaxis in the management of distal radius fracture, to know the advantages, disadvantages, and complications by using external fixator and to evaluate the results of fracture distal end of radius managed with external fixator with principle of ligamentotaxis.

METHODS

All the patients were evaluated with x-rays view-Posterio anterior and lateral views.

Fractures classified according to Frykman classification.

In the elderly patient's diabetes was ruled out and so was hypertension. Random blood sugar estimation, E.C.G and blood pressure recording were made.

Routine blood investigation [Haemoglobin, bleeding time, clotting time, urine routine and microscopy] were done. Consent for surgery was taken.

Study type

Prospective study of cases fulfilling the inclusion and exclusion criteria during the study period of 2 years from Jan 2020-june 2022 (time bound study).

Study place

The study conducted at Raja Rajeswari medical college and hospital.

Study period

The study conducted for two years from Jan 2020-June 2022 (time bound study).

Selection criteria

Inclusion criteria

The inclusion criteria followed will be adults between age group of 20-60 years both gender with close and open comminuted intra-articular fractures of distal radius admitted in the department of orthopaedics at Raja Rajeshwari Medical Hospital, Bangalore will be studied, closed and open fractures, fractures less then 2 weeks old, comminuted fracture distal end radius and intra articular fracture of distal end radius, who will give written consent. Patients who will be medically fit for surgery were included in the study.

Exclusion criteria

The patients with pathological fracture, non-union, fracture with neurovascular complications, patients 60 years. patients medically unfit and patients not willing for surgery were excluded from the study.

Statistical methods applied

Descriptive

The descriptive procedure displays univariate summary statics for several variables in a single table and calculates standardized values (z scores). Variables can be ordered by the size of their means (in ascending and descending order), alphabetically, or by order in which the variables were selected (the default).

Frequencies

The frequencies procedure provides statics and graphical displays that are useful for describing many types of variables. For a first look at the data, the frequencies procedure is a good place to start.

Crosstabs

The crosstabs procedure forms two-way and multiway tables and provides a variety of tests and measures of association for two-way tables. The structure of the table and whether categories are ordered determine what test are measure to use.

Chi-square test

The chi square test procedure tabulates variable into categories and computes a chi-square statistic this goodness-of-fit test compares the observed and expected frequencies in each category to test either that all categories contained the same proportion of values or that each category contains user-specified proportion of values.

Anesthesia

Regional anaesthesia was given in all of the 30 cases. The external fixator used in this series consisted of 2.5 mm Schanz pin, 2 in number, 3 mm Schanz pin, 2 in number, universal rod 2 in number, universal clamp 4 in number.

Operative technique

The patient was placed supine on the operation table. No Tourniquet was used. Intravenous antibiotics in the form of 1 gm of ceftriaxone was administered before the start of the procedure. The arm, Forearm, hand was scrubbed with Betadine scrub and was painted with betadine and then draped. The limb was placed on side board (Hard).

Under C arm control closed reduction of the fracture was carried out. Following which K wires were used when required to reduce fracture fragments. Two stab incisions, one at the lateral aspect of the shaft of the 2nd metacarpal and another, one inch distal to the former. Through each incision, one Schanz pin was drilled passing through 4 cortices (i.e., 2nd and 3rd metacarpal). Another two stab incisions were made, the first approximately 8 cm proximal to fracture site and another one inch proximal to the first incision. Taking care not to injure the tendons, nerves and vessels (bar e area), one Schanz pin was passed through each incision and penetrating both cortex of the radius. The universal rod was then connected to all the 4 Schanz pin by means of clamps. Under image intensifier guidance, further distraction if necessary was carried out by the fixator. At the end of the procedure sterile dressing was applied over the pins. No cast or splint was given.

Antibiotics (Intravenous) was continued over the next postoperative day and was then switched over to oral antibiotics (cefuroxime 500 mg bd) for the next 5 days.

All the cases were operated within 1 to 3 days of injury.

Post-operative care and rehabilitation

Immediate post-operative check x-rays were taken in both AP, PA and lateral views. Active exercises of all the fingers, Elbow and shoulder were carried out.

The patient was discharged on the 2nd post-operative day after the first dressing change the patient was called for follow-up at the interval of one week for the next 6 weeks. The patient was assessed subjectively for pain at the fracture site; clinically for tenderness and loosening of the pins.

The external fixator was removed on the 6th week without any anaesthesia. Check X-ray was taken in AP, PA and lateral view. The range of motion at the wrist was recorded and any deformity was assessed. Physiotherapy was carried out regularly for 2 weeks.

All the cases were followed at an interval of 6 weeks, 3 months & 6 months. The follow up ranged from 1 month to 6 months with an average of 3 months.

Ethical approval was taken.

RESULTS

All the patients were followed up clinically and radiologically 6-8 months with average 7.2 months.

Table 1: The demerit point system.[20]

Variables		Points
A	Residual deformity (range, 0-3 points)	
	Prominent ulnar styloid	1
	Residual dorsal tilt	2
	Radial deviation of hand	2-3
B	Subjective evaluation (range, 0-6 points)	
	Excellent: No pain, disability or limitation of motion	0
	Good: Occasional pain, slight limitation of motion and no disability.	2
	Fair: Occasional pain, some limitation of motion, feeling of weakness in wrist, no particular disability if careful and activities slightly restricted	4
	Poor: Pain, limitation of motion, disability and activities markedly restricted.	6
C	Objective evaluation (range, 0-5 points)	
	Loss of dorsiflexion (<45 o)	5
	Loss of ulnar deviation (<15 o)	3
	Loss of supination (<50 o)	2
	Loss of palmar flexion (<30 o)	1
	Loss of radial deviation (<15o)	1
	Loss of circumduction	1
	Loss of pronation (< 50 o)	2
D	Complications (range 0 to 5)	
	Arthritic change	
	Minimum	1
	Minimum with pain	3
	Moderate	2
	Moderate with pain	4
	Severe	3
	Severe with pain	5
E	Final results (range of points)	
	Excellent	0-2
	Good	3-8
	Fair	9-20

In our series after evaluation with the demerit system our results were as follows: Excellent: 8 cases had no deformity of the wrist, and there was no pain. There was no restriction of movement of wrist and forearm. They did not have any complications. Hence, they were rated as excellent. Good: 14 patients had no deformity of the wrist but had some limitation of wrist movements. They were rated as good. Fair: 7 patients had pain, limitation of movement at the wrist that was less than 50% of that of normal. In this group 3 patient had ulnar styloid prominence and the result was rated as fair. Poor: 1 patient had pin loosening with almost stiff wrist and finger.

Table 2: Sex distribution.

Sex	N	Percentage (%)
Male	22	73
Female	08	27

In this study of 30 patients, there were 22 males constituting 73% and 8 females constituting 27%. Indicating that males were more affected

Table 3: Age distribution.

Age (Years)	N	Percentage (%)
15-20	2	6
21-30	4	14
31-40	4	14
41-50	12	40
51-60	8	26

In this study there were 2 patients between the age group of 15-20 (6%), 4 patients between the age group of 21-30 (14%), 4 patients between the age group of 31-40 (14%), 12 patients between the age group of 41-50 (40%), 8 patients in the age group of 51-60 (26%).

The youngest patient was 19 years old and the oldest patient was 60 years old. The mean age group was 40.7.

Table 4: Mechanism of injury.

Mechanism	N	Percentage (%)
Road traffic accidents	20	67
Fall	10	33

In this study there were 20 cases of road traffic accidents, 10 cases of fall on out stretched hand.

Table 5: Type of fracture.

Type	N	Percentage (%)
III	15	50
VIII	9	30
VII	6	20

In this study of 30 cases of distal end radius fracture there were15 cases of type III fracture (50%), 9 cases of type VIII fracture (30%), 6 cases of type VII fracture (20%), Frykman classification.[18]

Table 6: Results of operative treatment.

Results	N	Percentages (%)
Excellent	8	27
Good	14	47
Fair	7	23
Poor	1	3
Total	30	100

In this study there were 8 patients with excellent results comprising 27%, 14 patients with good results comprising 47%, 7 patients with fair results comprising 23%, 1 patient with poor results comprising 3%.

Figure 1: Pre-op x-ray.

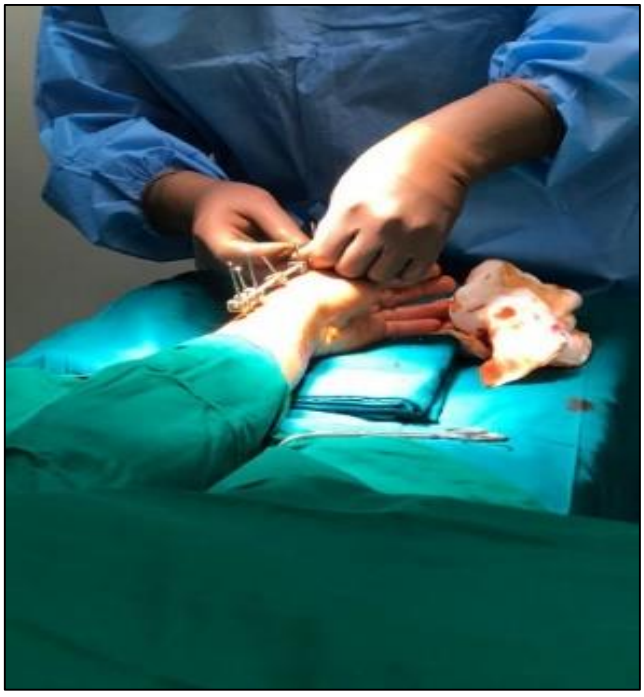

Figure 2: Intra-op images.

Figure 3: Clinical picture of patient.

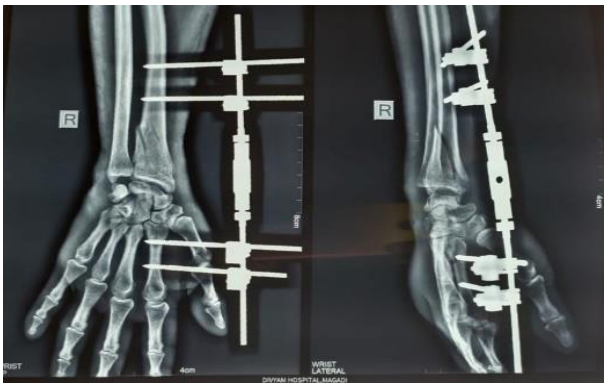

Figure 4: Immediate post-op x-ray with external fixator.

Figure 5: At six months.

Figure 6: Clinical photographs of patient follow-up.

DISCUSSION

Fractures of the distal end of radius continues to be one of the most common skeletal injuries of the upper limb. These fractures are frequently articular injuries resulting in disruption of both the radiocarpal and distal radio ulnar joints. Many external fixation devices are described to achieve reduction and fixation of the fragments without loss of position and acceptable functional results.[21] The ligamentotaxis is the basic principle in external fixator treatment.[22]

In our series the majority of the cases of intra-articular fractures of distal end of radius were seen in the younger age group of patients with road traffic accidents [Fall from motor bike] being the most common.

The application of cast in these patients would lead to loss of reduction and a poor functional outcome. In displaced intra articular fractures of distal radius, reduction is easy to achieve but difficult to maintain, due to intraosseous crushing, there is a void at the fracture site which can heal only after collapse, this collapse can be prevented by stabilizing either by packing cortico-cancellous bone graft in the void or by using metal to hold the fracture in place e.g., External fixator.

External pins through metacarpals rigidly fixed by distractor to distal part of radius probably provides the best stabilization for lower end radius fracture. This produces traction effect on comminuted distal radius, this effect has been named ligamentotaxis. Fixed traction with ligamentotaxis minimizes the shortening that may result from resorption of bone at fracture site. The tensile distraction of radius helps healing of comminuted dorsal fragment of radius to occur without displacement. External fixation also provides for retention of an anatomical reduction of the volar cortex obtained by traction with

gentle manipulation. The distal fragments therefore are stabilized volarly, dorsal displacement is prevented and so is angulation.

For an optional outcome selection of the patients is very important. Unreliable and poorly motivated patients are not the ideal candidates for external fixation.

In our results, all the younger patients have had good and excellent results while the older patients (i.e., 50-60 years) have developed the complications. One patient (male) developed pin loosening on the 4th week. The fixator was removed on the 5th week. The pin loosening could be as a result of osteoporosis. Another elderly patient developed shoulder hand syndrome. Even the remaining elderly patients had only fair to poor results.

Jenkins et al performed a prospectively controlled study in which patients with a distal radius fracture were treated either by plaster or by external fixation.[25] Ninety-four per cent of the external fixator group had a periarticular fixation. The external fixator proved more effective in holding the manipulated position and the radiological loss of union was minimal when compared with plaster group. Grewal et al prospectively randomized 62 patients to open reduction and dorsal plate fixation versus external fixation supplemented with Kwire.[26] The dorsal plate group had a significantly higher complication rate including pain, decreased grip strength, and increased tourniquet time; however, there was no difference in short form 36 or disabilities of the arm, shoulder, and hand scoring systems. Their recommendation was to avoid the use of dorsal plating.

Kapoor et al in their study on displaced intra-articular fractures of distal radius compared results following closed reduction and plaster, external fixation and open reduction with internal fixation, and in the final functional assessment (Sarmiento), the results were (1) plaster: 43% good and excellent, 50% fair, and 7% poor; (2) external fixator: 80% good and excellent, 20% fair and poor; and (3) ORIF: 63% good and excellent, 26% fair, and 11% poor.[27] They recommended that displaced severely comminuted intraarticular fractures should be treated with an external fixator.

With the recent development of volar locking plates for the distal radius, fragment-specific fixation has emerged as an option. ORIF using volar fixed-angle plates has also shown to be a valid treatment option for unstable, displaced distal radius fractures, but when compared with external fixator, volar plate requires open reduction, increased operative time, use of tourniquet, and on long-term follow-up, the results of external fixation are satisfactory.

Hence in our study the external fixators proved to be effective in younger patients but not very effective in elderly patients. Most of the patients recovered significant movement of the wrist and forearm with 2 weeks of physiotherapy. Often, intense physiotherapy is required to rehabilitate these patients.[23] The early mobilization of the wrist leads to normalization of blood supply, hastened functional recovery, earlier resolution of wrist swelling, and decreased joint stiffness.[24]

In the literature the duration of fixation varies from 4 weeks to 10 weeks. In our series external fixation was maintained for 6 weeks.

Our study results are similar to other studies in term of outcome, but we had less complication.

Limitations of the study include volar and dorsal bartons fractures which were treated with pre-contured locking plates.

CONCLUSION

External fixation and ligamentotaxis provides better functional and anatomical results in comminuted intra-articular and unstable extra-articular wrist injuries. The successful use of external fixator for distal end radius fractures requires careful assessment of fracture pattern, appropriate patient selecting, meticulous surgical techniques, appropriate choice of fixation, careful post operative monitoring and aggressive early institution of rehabilitation. The final functional result of treatment of distal radius factures not only depends on the anatomical restoration of the articular surface but also on the associated soft tissue injuries and articular damage.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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