

ORIGINAL ARTICLE

Comparative Study of Functional Outcome of Intra-articular Distal End Radius Fracture Treated by External Fixator versus Volar Locking Plate: A Short Term Study.

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ABSTRACT

Introduction: Intraarticular distal end radius fractures are one of the common fractures. Both internal and external fixations are recommended for these fractures. This study investigates the functional outcome of these fractures, comparing the outcome between external and internal fixation.

Materials and methods

97 patients with intra-articular distal end radius fracture were screened and 83 consented for the study. Patients with multiple injuries, extreme co-morbid conditions, compound injuries and injuries with neurovascular deficit were excluded (n=13). Total of 70 patients were randomised to receive either external fixation (Group I) or open reduction and volar plating (Group II). Modified Green and O'Brien score was used to assess the outcome.

Results: 10 patients (6 group I, 4 group II) were lost to follow up. The two groups were comparable with respect to demographics and type of fracture according to modified AO classification. At the end of six months there were 10% excellent result (3/30), 23% were rated good (7/30), 46% as fair (14/30) and 20% poor (6/30) in the external fixator group. In the plating group there were 30% excellent result (9/30), 50% had good result (15/30), 16% rated fair (5/30) and 3% as poor (1/30). However at the end of one year there were 33% excellent result (10/30), 50% good (15/30), 10% were rated fair (3/30) and 6.6% as poor (2/30) in group I. In comparison in the plating group there were 43% excellent result (13/30), 53% good results (16/30), 3% were rated fair (1/30) and there were no poor results. There were 8 complications in group I, 4 Pin Track Infection, 2 adhesive capsulitis, 1 complex regional pain syndrome, 1 adhesive capsulitis and one loss of reduction. In group II there were 5 complications, 2 superficial infections, two complex regional pain syndrome and one tendon irritation due to long screws.

Conclusion: Although the results were better in the volar plate group at 6 months, there was no difference at one year and complications rates were also comparable. Thus both methods can be used for treatment of intra-articular fractures with good results and acceptable complication rates.

Key words: Intra-articular fractures, Volar locking plates, External fixator.

INTRODUCTION:

Fractures of the distal end of radius are among the common fracture involving the upper extremity. High energy trauma is involved in these fractures especially in the younger age group. Intra-articular involvement is often seen in such scenario which further adds to the complexity of management. The rationale behind treatment is to attain an anatomical reduction and provide a stable fixation. This is to achieve early satisfactory functional outcome. The optimal management of these fractures has changed dramatically over last two decades. The two commonly and widely used method of treating these fractures include open reduction internal fixation using plates (volar, dorsal, combined volar/ dorsal plates and locking plates) and indirect reduction using external fixator. The purpose of our study was to assess the functional recovery using the Modified Scoring System of Green and O'Brien treated of intra-articular distal radius fractures treated with these two modalities of treatment.¹

MATERIAL AND METHODS:

Between 2004 to 2008 patients a prospective randomised study for treatment of distal radius fracture was set up. The AO classification for distal radius fractures has been shown to have a low reproducibility and interobserver reliability especially with the sub-classification.^{2,3} A simpler version of the classification was adopted which included C1 as simple intra-articular fracture, C2 with simple articular involvement and comminuted metaphyseal involvement and C3 with comminution both in the articular and metaphyseal region.⁴ 97 patients were screened and 83 consented for the study. Patients with multiple injuries, extreme co-morbid conditions including coronary artery disease and diabetes, compound presentation, those with evidence of neurovascular insult, bilateral fractures and patients who were likely not to actively participate in the rehabilitative protocol were excluded from the study. 13 patients out of 83 were excluded from the study as they had one or more components of the exclusion

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Figure 1a. 30 y/o, C2 type fracture of left side (Case 10) treated by use of External Fixator (1b). Follow up at one year showing good functional outcome (c,d)

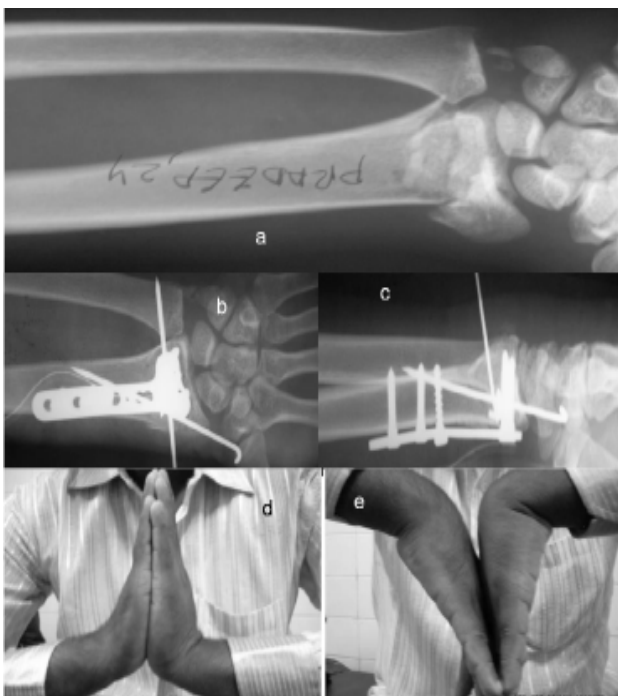


Fig 2- a- 28 y/o male, C3 type fracture of right wrist (Case 16), treated by using Volar locking plate with K-wires (b,c). One year follow up showed good clinical outcome (d,e).

criterion. Two patients had bilateral distal radius fracture, two had evidence of neurodeficit in the form of median nerve neuropathy, two patients had co-morbid conditions including diabetes and coronary artery disease, and there were five associated injuries including ipsilateral elbow dislocation, distal humerus fracture and styloid fracture and two compound injuries. Random sequence was generated by using online random sequence generation. The patients after inclusion were then randomly allocated into two groups using

opaque sealed envelopes. Group I was treated by External Fixator and Group II treated by open reduction and internal fixation (ORIF) using volar locking plates. Consent was taken from all the patients in their local language.

Table 1: Modified Scoring System of Green and O'Brien

CATEGORY	SCORE	FINDING
PAIN	<ul style="list-style-type: none"> • 25 • 20 • 15 • 0 	<ul style="list-style-type: none"> • None • Mild occasional • Moderate, tolerable • Severe
ROM	<ul style="list-style-type: none"> • 25 • 15 • 10 • 0 	Percentage of normal <ul style="list-style-type: none"> • 100 • 75-99 • 50-74 • 0-24
	<ul style="list-style-type: none"> • 25 • 15 • 10 • 0 	Movement arc <ul style="list-style-type: none"> • 120 or more • 91-119 • 61-90 • 30 or less
FUNCTIONAL STATUS	<ul style="list-style-type: none"> • 25 • 20 • 15 • 0 	<ul style="list-style-type: none"> • Return to regular employment • Restricted employment • Able to work but unemployed • No work
GRIP STRENGTH	<ul style="list-style-type: none"> • 25 • 20 • 15 • 0 	Percentage of normal <ul style="list-style-type: none"> • 100 • 75-99 • 50-74 • 0-24
RESULTS		
Excellent(E)	• 90-100	
Good(G)	• 80-89	
Fair(F)	• 65-79	
Poor(P)	• <65	

SURGICAL PROCEDURE:

All procedures were performed within a week of trauma.

Reduction was considered to be satisfactory if the following criterion was met 1) Dorsal tilt < 10° 2) Volar tilt < 20° 3) Articular gap < 2mm 4) Radial shortening < 5mm compared to the opposite side. (4)

TECHNIQUE:

In Group I, a 3.5mm external fixator was used. Fluoroscopic confirmation of the reduction by ligamentotaxis was confirmed. Two constructs were created using two half pins of 3.5mm in the radial shaft and two half pins of 2.5mm in the second metacarpal avoiding the sensory radial nerve and the extensor tendons. These were then connected to a third rod in the reduced position. Additional 1.6mm K-wires were passed

Table 2: Details of the patients in two groups

Group I: External fixator								Group II: Locking plate group							
TYPE	AGE	SEX	DOMINANCE	F/U (Months)	IMMOB.(wks)	Result at 6 months	Result at 1 Yr	TYPE	AGE	SEX	DOMINANCE	F/U (Months)	IMMOB.(wks)	Result at 6 months	Result at 1 Yr
C1	24	F	ND	12	5	F	G	C1	35	M	ND	14	3	E	E
C1	43	M	D	14	7	G	G	C2	38	F	ND	13	3	F	G
C1	45	F	D	15	7	P	F	C1	29	F	ND	16	2	E	E
C2	56	F	ND	13	6	F	G	C2	46	M	ND	15	2.5	G	G
C3	63	M	D	13.5	7	F	G	C2	48	M	D	13	2	G	G
C1	28	F	ND	12	7	E	E	C1	59	F	D	14	2	E	E
C2	48	F	D	14	6	F	G	C1	30	F	D	15	2	E	E
C3	50	F	ND	12	6	F	G	C3	22	M	ND	16	3.5	F	G
C1	29	F	D	13	6	F	G	C2	29	F	D	14	2.5	E	E
C2	30	M	ND	14	7	P	G	C3	64	M	ND	13	3	F	G
C3	36	F	ND	14	6	P	F	C1	29	F	D	14	2	G	G
C1	37	F	D	13.5	6	F	F	C1	47	F	ND	14	2	E	E
C1	39	M	ND	14.5	7	G	E	C2	49	M	D	15	2	G	G
C2	48	F	D	13	6	E	E	C2	36	F	D	14	2.5	G	G
C2	43	M	ND	12	6	F	G	C2	37	M	ND	16	3	F	G
C1	36	M	D	15	5	G	E	C3	28	M	D	14	3	G	G
C2	29	F	D	15	5	F	E	C2	45	F	D	16	2	E	E
C1	40	F	ND	13	5	E	E	C3	41	F	ND	14	3	G	G
C2	42	M	D	13	7	G	E	C1	58	F	D	13	2	E	E
C3	41	M	D	15	7	P	P	C2	51	M	D	13	2.5	G	G
C1	28	F	D	12	7	G	E	C3	34	F	ND	12	3	F	G
C2	40	F	ND	13.5	6	P	G	C1	56	F	ND	14	2.5	G	E
C3	52	M	ND	14	7	P	P	C1	29	M	D	15	3	E	E
C1	47	M	D	13.5	6	G	G	C2	34	F	ND	13	3	G	E
C1	39	F	ND	12	6	G	E	C2	47	M	D	13	3.5	G	G
C2	41	F	D	12	6	F	G	C1	29	M	ND	14	3	G	E
C1	40	M	D	13	7	F	G	C3	30	F	D	13	4	P	F
C2	35	F	ND	15	6	F	G	C2	41	F	ND	14	3	G	G
C1	34	M	ND	12	6	F	E	C1	43	M	ND	13	2.5	G	E
C2	38	F	ND	13	6	F	G	C1	43	F	ND	14	2.5	G	G

F/U: Follow-up, D: Dominant, ND: Non-dominant, Immob: Immobilization, E: Excellent, G: Good, F: Fair, P: Poor.

obliquely from the radial styloid and transversally to support the fragments. In cases where the impacted dorsal fragments could not be reduced indirectly (40%), a small incision was made and manipulation was attempted using a K wire or a small awl. Bone grafting was done additionally to support the fragments (Fig1, 2, 3a & b).

Table 3: Demographics of the two groups

Parameter	Group I	Group II
Age(Years)	40.0 (24-63)	40.2 (22-64)
Females	18 (60%)	17 (57%)
Dominant hand	15 (50%)	14 (47%)
Follow-up(Months)	13.4 (12-15)	13.9 (12-16)
Immobilization(Wks)	6.0 (5-7)	2.6 (2.5-4)
AO Type		
C1	14 (46.6%)	12 (40%)
C2	11 (36.6%)	12 (40%)
C3	5 (16.6%)	6 (20%)

In Group II exposure of distal radius was done by the volar approach through the sheath of flexor carpi radialis. After the fracture was exposed sub-periosteally, direct reduction was attempted and temporary fixation was done using K wires. After radiological confirmation of the reduction, Volar locking plate was used for fixation. K-wires were kept additionally if the radial fragment was found to be loose (Fig 4, 5, 6).

POST OPERATIVE CARE:

A single physiotherapist supervised the post operative rehabilitative program to avoid discrepancy. Early active and passive finger, elbow and shoulder mobilization was encouraged immediate post surgery. Patients in group II were given a splint post surgery. All patients were asked to follow up regularly at the physiotherapy centre at the time of slab or fixator removal.

ANALYSIS:

The patients were assessed with regards to the type of fracture pattern, hand dominance, duration of follow-up, duration of immobilization, and the functional outcome as per the Modified Scoring System of Green and O'Brien (Table 1) at six and twelve weeks.

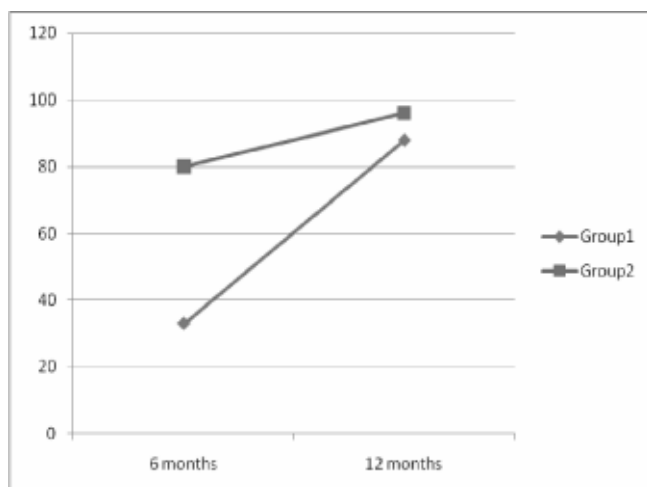
The modified scoring system is a comprehensive tool for evaluating the functional recovery of the patients. It consists of four parameters including pain, functional status, range of motion and grip strength. The results are analyzed from excellent to poor depending on the total score out of 100 points. Additionally, the results were divided into acceptable

Table 4: Results Based On Green And O'Brien Modified Scoring System

Result	Group I: External Fixator		Group II: Plate	
	6 month	12 months	6 months	12 months
Excellent	10%	33%	30%	43%
Good	23%	50%	50%	53%
Fair	46%	10%	16%	3%
Poor	20%	6.6%	3%	0%

and non-acceptable categories for the purpose of comparison. The acceptable category combined the excellent and the good results and the non-acceptable combined the fair and the poor results.

The data was entered using Microsoft Excel Sheet and assessed using SSPS-12 software. Statistical test used for

Table 5: Acceptable results between the two groups.

analysis included 't' test for the continuous data and 'chi square' test for category data. Value < 0.05 was considered to be significant (Table 2).

RESULTS:

Ten patients (six in group I and four in Group II, 14%) were lost to follow-up and were thus excluded from analysis. The two groups were comparable with regards to the demographics (Table 3). The average age in group I was 40 years compared to 40.2 years in group II ($P>0.1$). There were 18 females in group I compared to 17 females in Group II. The mean duration of follow-up was 13.35 months in group I and 13.96 months in group II ($P>0.1$). The fracture involved 50 % (15 patients) dominant hand in group I compared to 46.6% (14 patients) in group II. There was a significant difference in the period of post operative wrist immobilization, the mean period for which fixator was kept was six weeks compared to 2.6 weeks of immobilization in plating group when the splint was removed.

Both the groups were also comparable statistically with respect to the type of fracture. There were fourteen C1 (46.6%), eleven C2 (36.6%) and five C3 (16.6%) fractures in group I compared to twelve each in C1 (40%) and C2 (40%) and six C3 (20%) in group II.

According to the Green and O'Brien clinical scoring system, at the end of six months there were 10% excellent result (3/30), 23% were rated good (7/30), 46% as fair (14/30) and 20% poor (6/30) in the external fixator group. In the plating group there were 30% excellent result (9/30), 50% had good result (15/30), 16% rated fair (5/30) and 3% as poor (1/30). However at the end of one year there were 33% excellent result (10/30), 50% good (15/30), 10% were rated fair (3/30) and 6.6% as poor (2/30) in group I. In comparison in the plating group there were 43% excellent result (13/30), 53% good results (16/30), 3% were rated fair (1/30) and there were no poor results. The difference in the two groups at six months was non-significant ($P=0.08$), and at one year there was no

difference in the two groups ($p>0.1$) (Table 4).

The proportion of patients with acceptable results at six months in group I was 33% (10/30) compared to 80% (24/30) in group II ($P<0.05$). At one year the difference narrowed down to 83% (25/30) in group I and 96% (29/30) in group II ($P>0.1$) (Table 5).

In group I at the end of one year there were 85% acceptable results in patients with C1 type of fracture (12/14), 100% with C2 type (11/11) and 40% with C3 type (2/5) which was comparable to those in Group II with 100% acceptable result for C1 and C2 pattern (12/12 in both) and 66% for C3 pattern (4/6).

There were no major complications in either group. There were a total of eight complications in Group I. This included four pin tract infections which were controlled by dressing and course of antibiotics, two cases of adhesive capsulitis and complex regional pain syndrome (CRPS) that resolved with physiotherapy and analgesics. One loss of reduction was noticed, however it was still under the acceptable limits and fixator was continued. One patient developed paraesthesia in the radial nerve distribution which recovered in three months.

In the plating group, there were five complications which included, two superficial infections that required antibiotics but they could be managed without any surgical intervention. Two patients developed CRPS and one patient (Case 14) had to be re-operated for a volar screw that was excessively long causing irritation of the extensor tendon.

DISCUSSION:

There has been lot of developments in the treatment of distal radius fractures in the last decade. External fixator has been used for their management since a long time. The development of locking plates has added to the armamentarium.

External fixator is often used along with K-wires to hold the fragments and importantly to achieve per-cutaneous reduction of the articular fragments. (5) Open reduction and internal fixation using volar locked plates helps attain reduction under vision and often excludes the requirement of additional implants for its angular stable construct. (6, 7) This especially avoids the use of dorsal plates which often require secondary procedure for early implant removal. (8-10) Rogachefsky suggested use of both internal and external fixation for AO type C3 fractures. (11) The ideal treatment of unstable intra-articular distal radius fracture still remains inconclusive.

Kreder et al in their study comparing external fixator with dorsal/volar plates found external fixator as a better modality of treatment and recommended ORIF to be used only when indirect reduction fails to achieve reduction. (12)

In contrast Leung et al concluded better results in patients who were treated with ORIF (using dorsal, volar, combined plates) had better functional score over those treated with indirect

reduction.⁽⁴⁾ However both these studies did not exclusively used locking plates.

In a study by Egol et al comparing indirect reduction and locked volar plates, they found better outcome in ORIF group at three months but the results were similar at the end of one year.⁽¹³⁾ Other studies have also demonstrated similar long term results with both treatment modalities.⁽¹⁴⁻¹⁶⁾

Early return to function was also noted by Rozenatal et al using locking plates.¹⁷ In a comparative study between external fixator, radial column plate and volar locked plate, Wei et al concluded locked volar plate provide accelerated return to function, however the results are comparable at one year with either method.⁽¹⁸⁾

Our study suggested that the functional outcome using locking plates was better at the end of six months though the difference tends to sublimate at one year.

The most probable reason for the above conclusion seems to be the significant difference in the period of wrist immobilization. This was also noted by other authors.^{(4, 13, 17, 19).}

We also clubbed the patients into acceptable (combined excellent and good results) and non acceptable (fair and poor results) categories. This was based on the assumption that the Modified Scoring System is very stringent with regards to the range of motion and strength.⁽⁴⁾ Also those patients with good and excellent result were both satisfied with their final result. This helped us to negate any possible error that might have occurred while evaluating these parameters. Again the difference was only significant at six months.

In both groups the functional results were comparable with respect to the fracture type. Thus it may be concluded that the type of fixation did not have a direct bearing on the fracture type. This was contrary to Leung et al who concluded, ORIF was better in type C2 fractures compared to external fixation and similar in AO type C1 and C2.⁴

The rate of complication in group I was 26%, majority being pin track infection. The complication rate in ORIF group was much lesser; however there were no major complications in either group. The complication rate in our series was comparable to other studies.^{20, 21, 22}

The limitations of our study were we had a short period of follow-up. Kreder et al in their study noticed stable functional status after one year with little changes afterwards and suggested that long term follow-ups are not required.⁽¹²⁾ The other limitation was that none of the involved personal could be blinded as the modality of fixation used was obvious. Also our dropout rate was 14%, however no intention to treat analysis was performed.

Thus our study confirms that volar locked plates should be used in patients with intra-articular fractures for early return to function.

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