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Clinical and Radiological Comparison of Displaced Extra Articular Distal Radius Fracture Treated With Plaster or External Fixator

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ABSTRACT

There is no consensus regarding management and assessment of outcome in displaced fractures of distal radius. After closed reduction and casting they reangulate or redisplace. If we defined them as unstable then such a definition is only retrospective. Workers have attempted to predict instability on initial presentation. Our aim was to analyze and compare the functional and anatomical outcome of management of these fractures by closed reduction with cast immobilization or external fixation and determine the relation between classifications and treatment outcomes. A randomized prospective study on 48 potentially unstable fractures of distal radial metaphysis was done. Clinical assessment was done and preoperative radiographs of both affected and unaffected distal radius were analyzed. The consenting patients were allotted to these two groups. In group 1 after closed reduction and cast immobilization was done [twenty five patients] and in group 2 external fixation was applied in [23 patients]. Patients of either group were followed up to one year. The range of movements and grip strength were compared with opposite side. Both wrists were radiographed and parameters were compared. Using Garland and Werley demerit system¹ for functional analysis 90.5% of patients in external fixation group had excellent to good results but only 20% patients in cast immobilization group had good results. Preserving radial length is the most important factor for preservation of function of the wrist. In ligamentotaxis with external fixation, radial length, ulnar variance and radial angulation are restored to normal but correction of volar tilt though adequate, is not complete. Casting could not maintain reduction in unstable fractures resulting in poor anatomical results. Though both external fixation and casting take the same treatment period, the former does decrease the time for rehabilitation, has the advantage of ligamentotaxis and make sure the maintenance of anatomical reduction till union.

Keywords: ligamentotaxis; radial length; casting; external fixator; functional; analysis.

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INTRODUCTION

Perfect anatomical reduction of a displaced fractures of distal radius achieved by closed methods gets redisplaced. Universally most of these are closed and managed by closed reduction and casting. They are inclined to reangulate or redisplace even when reduced satisfactorily in usual cast resulting in a poor functional outcome [1-3]. For this common fracture, the classifications, methods of management and assessment of the outcome is unsettled. There are proponents of less aggressive anatomical reduction [2] and of precise anatomic reduction [5, 6]. Retrospectively a displaced fracture of distal radius considered unstable if its alignment cannot be sustained in a forearm plaster after closed reduction. [4] The problem in these fractures is prevention of re-displacement after initial reduction. For this one needs a close watch. Studies have found that re displacement could be prevented by different methods preventing the malunion. The objective of this study is to find the amount of correction achieved to normal anatomy with different types of treatment and to analyze and compare the functional and anatomical outcome of management of unstable extra articular fractures of distal radius. The methods employed after closed reduction were either cast immobilization or external fixation.

METHODOLOGY

A prospective study done in our centre from on skeletally mature patients with dorsally angulated extra-articular fracture of distal radial metaphysis of AO type A2 or A3. Open fractures, stable fractures with dorsal angulation $< 20^\circ$, intra articular fractures, volar angulated fractures; previous ipsilateral or contra lateral fractures of wrist or with dementia or psychiatric illness were excluded from the study. There were 48 patients. Of them 31 were females and rest males. The mean age is 49.5 years for males and 50.3 years for females. 73% patients had metaphyseal comminution. All had fall on an out stretched hand six of these patients in their house and rest on road. Two patients in external fixation group had associated fractures i.e. closed metatarsal fracture left foot in one patient and closed bimalleolar fracture right ankle in another patient. When presented for the first time their general medical condition, movements of the shoulder, elbow, forearm, fingers were noted. Also condition of skin, local nerve function and vascularity were assessed. The preoperative postero anterior and lateral radiographs of both affected and unaffected distal radius were ordered and the radial length, dorsal angulation of the distal fragment, radial inclination of the distal fragment, ulnar variance, dorsal comminution, step at the fracture site and gap were noted. The alternate patients were allotted to these two groups. The patients were shown audio visual aids of the external fixator and plaster. Those who were not willing for external fixator is treated in plaster after closed reduction – i.e.group1. Those who were willing for the external fixator were treated with it i.e. Group2

In group 1, after an axillary block, traction given to dis-impact the fracture, by gradual pronation, flexion and ulnar-deviation of the distal fragment along with the hand, fracture was reduced. A dorsal below elbow plaster was applied and circulation checked. Check X-rays were taken to confirm reduction. A cuff and collar was applied. Once the swelling subsides the outer bandage was tightened, while still maintaining reduction and traction and the slab was converted into below elbow cast. There were 25 patients in this group.

In group 2, after closed reduction, to maintain reduction, the limb was painted and draped ; external fixation was applied with precautions preventing soft tissue injury.. Two Shantz pins were put in the 2nd metacarpal and were connected to multiaxial ball clamp and 2 pins in the dorsal side of radius and these were connected to another multiaxial ball clamp. These two ball clamps were connected to a distraction rod. Check X rays and fine tuning of distraction done. No more than 2- 3 mm distraction was applied over radio carpal joint. There were 23 patients in this group. A successful reduction is defined as step deformity of 2mm or less, neutral palmar tilt or better and radial shortening of less than 5mm as compared to normal side.

All procedures were carried out under brachial plexus block or intravenous anaesthesia within 72 hours after injury. The mean duration between injury and procedure was two days. In both the groups, limbs were kept elevated and six pack exercise regimen to mobilize the interphalangeal and metacarpophalangeal joints of fingers was done thrice daily. In both groups patients were assessed on week 1, week 2, week 4 and week 6. After six weeks, union was confirmed with radiographs and cast removed. An elastocrepe bandage was then applied and active wrist movements started.

In addition for the second group, postoperative parental antibiotics were given for two days followed by oral antibiotics for a week. Pin sites were regularly dressed with Betadine®. Patients were discharged the fifth day and reviewed every week till six weeks. At six weeks after radiographic confirmation of union external fixator was removed and sterile dressing applied. An elastocrepe bandage was then applied and active wrist movements started.

After six weeks in both groups active wrist mobilization was started. Patients were reviewed every three months. During every visit functional and radiological outcome were noted and were compared to normal side. They were reviewed every three months. Every time functional and radiological assessment were made and compared to the normal side.

RESULTS

The figures 1 A to J and 2 A to K show the results for the cast immobilization and external fixator (EF) patients respectively. In external fixation group, 21 patients were available and two patients were lost for follow up. Out of remaining twenty one patients, 16 were followed up to one year and five up to six months, with evaluation for pain, working ability, grip strength and complications like stiffness, deformity, reflex sympathetic dystrophy, median nerve deficit and Extensor pollicis longus tendon rupture. The range of palmar flexion, extension, radial and ulnar deviation, supination, pronation and grip strength were noted and compared with opposite unaffected side. Both wrists were radio graphed and parameters were compared.

Figure 1



Figure 1 A 60 year old lady fell on her outstretched left hand .[A and B] are her initial anteroposterior and lateral radiographs showing fracture of distal radius with shortening and dorsal tilt .She was treated by cast immobilisation .[C,D]are her immediate postoperative x-rays showing reduction.[E ,F] are the one

year follow up radiographs showing significant reduction in with radial length, ulnar variance and radial angulation are not fully restored to normal. Also correction of volar tilt is not complete .Clinical result of movements showing her wrists in dorsiflexion [G], Volar flexion [H],supination[I] and pronation[J].



Figure 2 A 50 year old had a fall on outstretched left hand [A and B] An initial anteroposterior and lateral radiographs shows fracture of distal radius with shortening and dorsal tilt [C].She was treated by external fixation.[D,E] the immediate postoperative x-rays showing reduction.[F,G] are the one year follow up radiographs showing in ligamentotaxis with radial length, ulnar variance and radial angulation are restored to normal but correction of volar tilt though adequate, is not complete. Post-operative dorsiflexion [H], volar flexion [I],supination[J] and pronation[K].

Table 1 and 2 shows the details for the casting and external fixator patients respectively. Paired samples T test showed both the methods of treatment produced statistically significant results. One sample T test for External Fixation gave significantly better results when compared to cast immobilization group.

TABLE-1: CASES TREATED BY PLASTER IMMOBILIZATION.

S.No.	Age	Sex	Side of Injury	AO type	Preoperative					Post operative				Plain	Fn. status	stiffness	OUTCOME												G&W	L&F	RESULT
					RL	VT	RA	UV	DC	RL	VT	RA	UV				% OF NORMAL						Df fr.N.								
																	PF	DF	RD	UD	SP	PR	GS	RL	VT	RA	UV				
1	70	M	R	A2	6	-22	14	+3	-	12	+2	22	0	M	R	+	62	61	50	80	75	89	60	11	21	21	11	17	II	F	
2	60	F	L	A2	4	-24	15	+2	-	11	+3	20	0	M	R	-	63	66	75	40	67	76	65	33	20	51	11	15	II	F	
3	46	M	L	A3	-2	-42	10	+4	+	10	0	22	+1	M	W	+	50	78	50	67	88	75	70	63	32	44	48	81	I	V	G
4	52	F	R	A3	5	-30	14	+4	+	12	+5	20	0	M	R	-	44	67	67	80	67	74	60	44	28	62	21	18	I	V	F
5	45	F	L	A2	3	-26	14	+4	-	12	+6	22	0	M	W	-	67	88	100	75	66	82	70	44	22	22	21	18	II	I	F
6	60	F	L	A3	0	-24	8	+3	+	12	+6	20	-1	M	R	-	55	78	100	60	74	82	70	33	26	72	21	12	I	V	F
7	40	M	R	A3	-2	-10	10	+5	+	12	+5	22	+1	M	W	+	69	75	66	60	86	75	70	44	28	54	40	10	I	V	F
8	60	M	R	A3	5	30	12	+4	+	11	0	22	+1	N	W	-	56	66	96	82	78	67	66	55	30	53	12	10	I	V	F
9	42	F	L	A3	8	-15	14	+1	+	12	+4	20	0	M	U	+	56	36	33	60	78	86	50	33	20	61	21	11	II	I	P
10	44	F	R	A3	2	-30	14	+6	+	12	+5	20	0	M	R	-	44	67	67	80	67	74	60	44	28	42	18	10	I	V	F
11	53	F	L	A3	-2	-15	8	+8	+	10	0	20	+1	M	R	-	54	78	100	80	66	74	60	66	22	82	21	18	II	I	F
12	48	F	L	A3	4	-26	15	+4	+	11	+4	22	0	M	R	-	54	67	100	60	67	74	55	55	25	60	14	10	II	I	F
13	50	M	R	A3	6	-20	10	+5	+	13	+6	18	+1	M	W	-	66	74	100	60	66	74	66	55	23	31	14	10	II	I	F
14	42	F	L	A2	5	-20	16	+3	-	12	+7	22	0	N	W	-	74	82	100	80	67	76	70	33	16	60	07	10	II	I	G
15	43	F	L	A2	6	-24	18	+3	-	11	+3	22	+1	N	W	-	78	88	100	80	78	88	85	22	11	41	18	10	I	I	G
16	57	F	R	A3	-3	-32	12	+7	+	11	0	18	+1	M	R	-	56	66	100	60	66	66	60	55	30	82	21	14	I	V	F
17	42	M	R	A3	2	-36	12	+7	+	12	0	20	+1	M	W	-	66	74	100	80	74	74	70	55	33	72	10	10	I	V	F
18	56	F	L	A3	5	-22	14	+4	+	12	+4	20	0	N	W	-	74	74	100	60	74	88	80	55	32	81	12	10	II	I	F
19	44	M	L	A2	4	-	1	+	-	1	+	2	0	N	W	-	7	8	1	8	7	8	9	3	2	3	2	8	II	I	G

10	64	M	L	A3	4	-35	10	+	+	12	-5	20	+	-	N	R	-	89	100	67	100	100	100	65	0	13	0	0	5	II	G
11	60	F	R	A3	-2	-28	10	+	+	10	0	18	+	-	M	W	+	78	88	100	80	88	88	85	2	6	2	1	4	I	G
12	40	M	L	A3	3	-30	10	+	+	10	0	20	+	-	Md	W	+	88	94	100	80	88	100	85	1	10	2	1	4	I	G
13	55	M	R	A3	-2	0	5	+	+	11	8	20	+	Pi	M	W	+	88	100	92	100	88	88	86	1	2	0	1	10	II	F
14	46	F	R	A3	6	6	20	+	+	9	4	22	+	-	N	W	-	88	88	75	80	88	100	88	1	7	0	0	4	I	G
15	50	F	R	A3	2	-28	4	+	+	9	-4	8	0	-	N	W	-	88	100	100	100	88	100	100	0	13	0	0	0	I	E
16	52	F	L	A2	-4	-45	0	+	+	10	8	20	0	-	N	W	-	100	100	100	100	88	100	96	2	2	0	0	4	I	G
17	47	F	L	A2	5	-24	16	+	-	10	5	20	+	-	M	W	-	89	94	100	100	94	100	92	2	5	2	1	2	I	E
18	53	F	L	A3	3	-20	5	+	+	12	12	22	0	-	M	W	-	88	100	100	100	88	100	90	0	0	0	0	0	I	E
19	42	M	L	A3	3	-22	0	+	+	12	10	20	+	-	N	W	-	100	94	100	100	100	100	92	1	2	0	1	2	I	E
20	56	F	L	A3	6	-24	5	+	+	11	4	22	0	-	M	W	+	78	88	92	80	88	88	80	1	6	0	0	5	I	G
21	35	F	R	A3	5	-22	6	+	+	12	5	22	0	-	N	W	-	88	100	100	100	88	88	85	0	5	0	0	4	I	G
22	60	F	L	A2	6	-20	6	+	-	11	11	23	1	-	M	W	-	82	86	100	80	88	88	86	2	6	0	0	3	I	G
23	52	M	L	A2	4	-20	0	+	-	12	6	22	+	-	N	W	-	88	100	100	100	88	88	86	0	6	0	0	4	I	G

Abbreviations used in the tables:

Sex M → male F → female, Side of injury R → right, L → left

RL → Radial Length, VT → Volar Tilt, RA → Radial Angulation, UV → Ulnar Variance, DC → Dorsal Comminution

Compl → Complication, Pi → P, Pain → N → Nil M → Mild md → Moderate

Fn status → functional status, W → Working, R → Restricted work, U → Unable to work

PF → Palmar Flexion, DF → Dorsi Flexion, RD → Radial Deviation, UD → Ulnar Deviation

SP → Supination, PR → Pronation

GS → Grip Strength, Df fr N → Difference from Normal

G&W → Gartland and Werley Score, L&F → Lidstrom and Frykman Grade

In external fixation group, (EF) at one year, 81.25% patients had no pain and 87.5% patients returned to regular work. But in cast immobilization group (CI) 72% patients had mild or moderate pain and only 56% patients returned to regular work. At one year none in EF had stiffness, and four patients in cast immobilization had stiffness. They were evaluated as per modified criteria suggested by Gartland and Werley for functional assessment (consists of subjective evaluation, objective evaluation and complication and accordingly demerit points were awarded).

By this system, in EF group six patients (28.%) had excellent and thirteen (61.9%) had good results. In CI group, five (20%) had good, nineteen (76%) had fair and one (4%) had poor while none had excellent results. Anatomic evaluation was done as per Lindstrom and Frykman criteria.¹⁰ In external fixation group, eighteen (85.7%) had grade I (i.e. no deformity) and remaining grade II (i.e. mild deformity). In CI group, only one patient (4%) had grade one result and fifteen patients (60%) had grade III or IV result. In external fixation group, two patients (8.6%) developed pin site infection necessitating pin removal at five weeks in one patient. One patient developed superficial radial nerve sensory deficit. There were no metacarpal fractures, median nerve or tendon problem. The dominant side was involved in 39% in external fixation group and 44% in cast immobilization group.

DISCUSSION

The concern is if there was really any relation between classifications and treatment outcomes. Studies have attempted to identify risk factors to predict instability at the initial presentation itself. The common methods to prevent or minimize the loss of reduction of these unstable fractures are percutaneous pinning, immobilization with pins incorporated in the plaster, external skeletal fixation, limited open reduction with or without bone grafting or bone graft substitutes and extensive open reduction an internal fixation [6]. Both percutaneous pinning and external fixator cannot achieve direct reduction, immobilize of radio carpal joint have pin tract infections. However there is an advantage of adjustability with external fixators.

In general, most classification systems available for distal radius fractures are not reliable [7-9]. For example even the complete AO classification when applied in a distal radius fracture shows poor inter-observer reliability and the main group are sufficient to be used reliably to grade the severity of the lesion. [7]

From the initial anteroposterior and lateral radiographs the fracture is identified and evaluated for inherent biomechanical stability for example the comminution present on the dorsal cortex will dictate the treatment, [9, 10] since re-displacement is possible. [1] In such cases frequent follow up is required. [10]

Though external fixator for six week period is expected to cause more stiffness, recent findings are different. For example 29% excellent and 60% good result were obtained with external fixation when in patients above 60 years fixator kept for 8 weeks. [11] In our study, on anatomical grading by Lindstrom and Frykman system [10] 85.7% patients in external fixation group had grade I result i.e. no significant deformity. But only one patient in cast immobilization group was able to get grade I result and 60% of patients produced only grade III or IV results. Even a 4 mm of radial shortening produced equal loading of radius and ulna with wrist in valgus alignment. [12] Loss of radial length can lead to ulnar impaction or dysfunction of Distal Radio Ulnar Joint, with limited range of motion in pronation and supination, depending on the volar or dorsal subluxation of the ulnar head within the sigmoid notch. Residual dorsal angulation can precipitate ulnar impaction, midcarpal instability and altered stress concentration which may lead to early arthritis.

Loss of function occurs after 20 degrees of dorsal tilt [13]. In ligamentotaxis with external fixation, radial length, ulnar variance and radial angulation are restored to normal but correction of volar tilt though adequate, is not complete. As volar ligaments are stronger, they become taut on distraction before the dorsal ligaments. So, on distraction, it does not allow the dorsal side relative distraction to correct dorsal tilt. 60% of patients treated with cast immobilization had moderate to severe deformity. One patient had poor functional result and nineteen (76%) had fair results.

Most Fractures of the distal radius if not treated adequately will affect the function of the wrist significantly. The reasons are inadequate fixation causing loss of reduction, malunion, stiffness and early arthritis. Our study equaled the functional results of previous studies. [3, 14]

Achieving and maintaining a perfect anatomical reduction till union followed by mobilization gives an acceptable outcome. Radial and dorsal displacements were independently important. [15] As seen from this study AO types and outcome in our series did not correlate well. AO with poor prognosis gives good results. External fixation make sure that the reduction is maintained till union and it reduces the period of rehabilitation. [16, 17]

CONCLUSION

In dorsally angulated extra-articular distal radius fractures compared to cast group, ligamentotaxis with external fixation gave good to excellent results with minimal complications.

Note

All patients were explained the procedures and choices. All patients were given suitable anaesthesia for reduction of the fracture /and external fixator application. All patients were given sufficient post operative pain relieving medications.

No benefit in any form was received or will be received from a commercial party related directly or indirectly to the subject of this article.

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