TO COMPARE THE FUNCTIONAL OUTCOME OF INTRA ARTICULAR DISTAL END OF RADIUS FRACTURE TREATED BY CONVENTIONAL POP CAST AND EXTERNAL FIXATATOR FIXATATION

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ABSTRACT

Introduction

Distal end of radius fractures frequently have a high degree of comminution, instability, and associated with soft tissue injuries. Treatment of this distal radius fracture is controversial and there is no single definitive treatment method that is considered the standard of care.

Objective

1. To compare the functional results of the conventional POP cast and external fixator fixation of intra articular distal end of radius fracture.
2. To compare the radiological changes with that of functional outcome.

Methodology

It was a prospective study comparing the functional outcome of distal intra-articular radius fracture when managed by conventional POP cast and external fixatator fixation. The final outcome was decided on the basis of modified Gartland and Werley scoring system. Total 50 patients (19 – 54 years) were recruited. 30 were treated by closed reduction and POP cast and 20 by external fixation. Radiological parameters were graded according to Schecks criteria and fracture comminution was classified according to Frykman's classification.

Results

The functional outcome of the treatment was a subjective evaluation in which 80% of the patients had pain in external fixation as compared to 63% in closed reduction POP cast group. The restriction of activities was in 10% of the patient in external fixation group as compared with 33% in closed reduction POP cast group. The final scoring system as modification of Gartland and Werley point system had 5 ± 3 conventional pop cast group and 4 ± 4 in external fixation group. (p = 0.3764). On radiological evaluation, there was no significant difference in radial length, radial angle and volar tilt in two groups.

Conclsion

The results show no statistically significant difference between the two modes of interventions. External fixation provides easy mobilization of fingers and reduces edema and stiffness of joints. The active ranges of movements at the wrist joints were significantly better in external fixation group.

KEY WORDS

Fractures, distal end radius, intra-articular, conventional POP cast and external fixator.

INTRODUCTION

Distal end of radius fractures account for 14% of all extremity injuries and 17% of all fractures treated in the emergency department.[1] Distal radius fractures occurring as a result of a high-energy injury represent a subset of fractures, often with significant injury and impairment to the upper extremity. These fractures frequently have a high degree of comminution, instability, and associated with soft tissue injuries.

Distal radius fractures crush the mechanical foundation of man's most elegant tool, the hand. No other fracture has a greater potential to devastate hand function and no metaphysis of bone is embraced by more precious soft tissues. It is remarkable that this common fracture remains one of the most challenging of all fractures that are treated non-operatively. Many physicians believe that no special treatment is needed as the resulting deformity rarely results in loss of function. However this concept is being increasingly challenged.

A consensus exists that although minimally displaced stable fractures usually can be managed successfully by closed methods of treatment; unstable articular fractures frequently require more invasive techniques to maintain an accurate reduction during the healing process. Foremost among these techniques is external fixation employing the concept of continuous distraction, commonly termed ligamentotaxis. Ligamentotaxis neutralizes the deprimental compression forces, which are likely to cause displacement of unstable articular fracture components leading to progressive radial shortening. It is a significant advancement in the management of distal radius fractures.

Treatment of distal radius fracture is controversial; there is no single definitive treatment method that is considered the standard of care. Most studies are retrospective in nature and use various classification and inconsistent outcome tools, especially in regard to comminuted fractures with joint incongruity.

In an epidemiology survey of all fractures of the forearm that were treated over a 5- year period in Malmo, Sweden, Alffram[2] and Bavar recorded nearly 2000 fractures of the distal end of radius, which was 74.5% of all fractures of the forearm.

OBJECTIVES

1. To compare the functional outcome of the following aspect amongst patients treated by closed reduction POP cast and External fixator fixation of intra articular distal end of radius fractures.
   a) Subjective evaluation-Pain, Loss of movement, Weakness and Restriction of activities.
   b) Range of movement- Palmar flexion, Dorsi flexion, Ulnar deviation, Radial deviation, Supination and Pronation.
   c) Grip strength
2. To compare the following aspect amongst radiological changes with that of the functional outcome.Radial length, Radial angle, Volar tilt, and Distal radio-ulnar joint distance.

METHODOLOGY

This was prospecti-ve study of either sex, having closed intra-articular fractures of distal end of radius. A total of 50 patients, (19-54 years), were selected among them 30 patients were treated by closed reduction and POP cast and 20 underwent through external fixation. The study was conducted at Birat Medical College, Biratnagar, Nepal from June 2014 to May 2016. Approval of the study was obtained from the institutional ethical committee. Informed and written consents were obtained from the patient and patient relatives. Pre operative evaluation was done in both groups which include history regarding the mode of injury, clinical and radiological assessment. Radiological assessment of fracture pattern was assessed with antero-posterior(AP)/ posterior -anterior(PA) and lateral radiographic views of the wrist. The fracture pattern was classified according to Frykman's classification. Radiographic assessment also includes radial length, radial angle and volar tilt.

The radial length (radial height) is measured on the PA view radiograph as the distance between one line perpendicular to the long axis of the radius passing through the distal tip of the radial styloid. A second line intersects distal articular surface of ulnar head.

The radial angle (radial inclination) represents the angle between two lines-one drawn perpendicular to the long axis of the radius at the ulnar corner of the lunate fossa and the other between that point in the lunate fossa and the tip of radial styloid. This was measured on the PA view of radiograph.

The volar tilt (radial tilt) represents the angle between a line along the distal radial articular surface and the line perpendicular to the longitudinal axis of the radius joint margin. This was measured on the lateral view of radiograph.

The patient with previous deformity of the same limb, mentally retarded patients with osteoporosis of the bone and previous surgery at the same site and neurovascular injuries were excluded.

Closed reduction and POP cast immobilization group: - fractures were reduced under sedation or hematoma block and below elbow or above elbow plaster of Paris (POP) cast was applied. Most of the patients were given cast in palmar flexion and ulnar deviation of the wrist but some were given cast in dorsiflexion position after evaluating the fracture pattern Frykman type VII fractures had volarly displaced. The volarly displaced Volar Barton fractures were given the cast above elbow in dorsiflexion position. Patients were called after 24 hours for inspection to assess distal circulation, swelling and tightness of plaster cast. Plaster cast was applied for 5 to 6 weeks depending upon clinical and radiological union. Reduction was attempted again in selected cases in which fracture re-displaced within 10 days of initial closed reduction.

External fixator fixation group: - The Bridging external fixator was used to achieve ligamentotaxis effects. On the first post-operative day active and assisted range of motion of the fingers, forearm, elbow and shoulder was started. The

post-operative dressing was removed after two days, and patients were instructed regarding the care of pin sites.

X-rays were taken immediately after surgery, at 2 weeks and then after 6 weeks to assess the fracture alignment and union. Fixator was removed after clinical and radiological evidence of union. On outpatient basis below elbow cast was given for another 2 weeks to prevent fracture through the pin sites. Patients were advised to undergo physiotherapy for 6 to 8 weeks following removal of fixators.

In the both groups the final assessment of the functional end results in the present series was based on a clinical examination carried out in accordance with a pre-determined plan i.e. (swelling, tenderness, active mobility of the wrist, grip strength and distance between the pulp of the fingers and the palm).

Radiological evaluation – antero-posterior and lateral radiograph were taken at the time of injury, immediately after reduction, at 2 weeks and at time of last follow up which was at 6 months. Measurements of radial length, radial angle and volar tilt were measured. Also the distance between the distal end of the radius and ulna at the level of the distal radio-ulnar joint was measured.

Chi-square test was used to analyze the categorical data while student t test was used for continuous

data for comparing the final outcome of the functional end results on the basis of modified Gartland and Wereley scoring system.[3] Statistical analysis was done using EPI Info 2000 software. *P*<0.05 was considered as statistically significant.

RESULTS

The average age of the patients was 34±11 years in closed reduction pop cast group and 33± 8 years in external fixator group. The frequency of sex in our study was male 38(76%) and female 12(24%).

Table 1: Show the Age and Sex Frequency.

Variabales		POP Cast Group	External Fixator Group
Age		34±11years	33± 8 years
Sex	Male	21 (42.0 %)	17 (34%)
	Female	9 (18%)	3 (6%)

The most common cause of the distal end of radius fracture in our study was FOOSH (56%) followed by RTA. Table 2 shows the modes of injury encountered in our study.

Table 2: Mode of Injury

Mode	No. of Patients	%age
RTA	22	44%
FOOSH	28	56%
Total	50	100

(RTA- road traffic accident, FOOSH- fall on out stretch hand)

The most common type and sides of fractures were as mentioned in Table III and IV respectively.

Table 3: Fracture Classification (Frykman's Grade) n = 50

Type	Close reduction POP cast		External fixation			
	Number	%	Number	%	Total	%
III	4	13.33	-		4	8.00
IV	3	10.00	-		3	6.00
V	1	3.33	-		1	2.00
VI	2	6.67	1	5.00	3	6.00
VII	10	33.33	9	45.00	19	38.00
VIII	10	33.33	10	50.00	20	40.00
Total	30	100.00	20	100.00	50	100.00

Table 4: Side of involvement of fractures

Side Involved	Close reduction POP cast		External fixation			
	Number	%	Number	%	Number	%
Dominant	16	53.33	11	55.00	27	54.00
Non dominant	14	46.67	9	45.00	23	46.00
Total	30	100.00	20	100.00	50	100.00

Table 5: Subjective, Range of Movement and Grip Strength Evaluation

		POP Cast	External Fixation	P Value
Subject Evaluation	Pain	63.3%	80.0 %	
	Loss of movement	66.7%	65.0%	
	Weakness	33.3%	20.0%	
	Restriction of activities	33.3%	10.0%	
Range Of Moment	Palmar Flexion	56 ± 12º	59 ± 13º	0.5
	Dorsi Flexion	46 ± 16º	60 ± 12º	0.004
	Ulnar deviation	15 ± 4º	21 ± 5º	0.0001
	Radial deviation	14 ± 4º	19 ± 3º	0.0008
	Supination	72 ± 8º	81 ± 10º	0.0017
	Pronation	69 ± 8º	81 ± 9º	0.0001
Grip Strength	Normal Hand	25 ± 4 Kg	27 ± 2 Kg	0.0169
	Injured Hand	21 ± 4 Kg	20 ± 3 Kg	0.9656
	Difference Normal to Injured Hand	4 ± 2 Kg	6 ± 3 Kg	0.0306

Table 6: Radiological Evaluation

	Before Treatment			After Treat ment			Difference		
	Pop Cast	Ext. Fixator	P value	Pop cast	Ext. Fixator	P Value	Pop Cast	Ext Fixator	P value
Redial Length	6±3mm	5±5 mm	0.4472	8±2 mm	10±4 mm	0.1319	-2.4±3mm	-4.7±4 mm	0.0386
Redial Angle	17±6º	14±12º	0.2864	20±3º	19±7º	0.5577	-3.0±6º	-5.0±12º	0.4794
Volar Tilt	-5.1±13º	0.3±13º	0.1725	0.26±9º	10±8º	0.0004	-5.0±12º	-9.0±15º	0.2512
DRUJ Distance				2.1±1.1mm	1.3±1.8 mm	0.0886			

Final Score

The final scoring system was as modification of Gartland and Werley point system had 5 ± 3 in closed reduction pop cast group and 4 ± 4 in external fixation group. (p = 0.3764)

DISCUSSION

Thirty Years ago, the distal end of radius fractures were considered benign and conservative treatment was the rule. The population involved supposed consisted of osteoporotic old women who were functionally satisfied despite poor results and exact reduction was not mandatory, since good results were not said to be correlated with good reduction. Cosmetic deformity from malunion were noticed, but deemed unimportant.

Since then, growing number of young male workers and sports enthusiasts have suffered high velocity injuries, often resulting in complex intra-articular fractures. Pain and disability have resulted from subsequent malunions. Re-displacement or loss of reduction after conservative treatment is another feature which was not well recognized in the past. This factor of re-displacement was also overlooked for a long time.

As the Orthopedic community recognizes the complexity of this injury and focus attention on the anatomical restoration that is important for optimal function, a variety of treatment options are being investigated. Regardless of age of patient, vocation or recreational interest, therapies are sought to maximize the potential for pain-free motion and acceptable cosmetic results.

Table 7: Comparative study of wrist movement

Authors and years	Number of Patients	% of I/A involve-ement	Treatment method	Dorsi flexion	Palmar flexion	Radial Devi-ation	Ulnar Devi-ation	Pronation	Supination
Cooney [5] 1979	60	88	Ext. Fix.	58º	52º	18º	30º	80º	75º
Cooney et al[6] 1980	100	NA	Ext. Fix.	50º	48º	9º	26º	73º	70º
Foster et al	-	-	Ext. Fix.	47º	59º	22º	32º	-	-
Foster et al	-	-	Ext. Fix.	58º	56º	26º	33º	-	-
Gairon et al	-	-	-	55º	46º	11º	19º	80º	71º
Nakata et al[7] 1985	-	-	-	77 %	77 %	73 %	82 %	84 %	78 %
Vaughan et al[8] 1985	52	100	Ext. Fix.	54º	48º	19º	32º	80º	78º
Jack Lennox et al 1989	20	NA	Ext. Fix.	54.7º	55.9º	19.4º	29.6º	65.2º	71.2º
Edwards et al 1991	30	100	Ext. Fix.	70º	64º	19º	27º	83º	90º
Fernandez et al [9] 1991	40	100	Various	63º	60º	10º	25º	77º	73º
Kaemffe et al 1993	26	NA	Ext. Fix.	55º	39º	17º	25º	84º	78º
Zanotti et al[10] 1997	25	100	Ext. Fix.	58º	66º	19º	29º	90º	77º
Persent study pop cast group	30	100	POP	46±16º	56±12º	14±4º	15±4º	69±8º	72±8º
Present study external fixation group	20	100	Ext. Fix.	60±12º	59±13º	19±3º	21±5º	81±9º	81±10º

Fractures in the distal end of the radius has been estimated to account for more than one-sixth of all fractures seeing and treated in emergency department[4].

After reviewing the articles (Table 7) on the treatment of intra-articular distal end of radius fractures we didn't find any prospective study while comparing the two methods of treatment.

Palmer et al[11] conducted after an extensive study of activities of living (ADL). The normal functional wrist range of movement was 5º Flexion, 30º of extension, 10º of radial deviation, and 15º of ulnar deviation. Ryu et al[12] in a similar study concluded that ADL could be accomplished with 70% of maximal wrist motion, or 40º of flexion, 40º of extension, and 40º of combined radial and ulnar deviation. The ranges achieved in our study fits within both these ranges.

Radiological criteria for success includes the radial length (radial height) in PA view measurement averages 10-13mm, Radial angle (radial inclination) in PA view measurement averages 21º-25º and volar tilt (radial tilt) in Lateral view measurement averages 11º. Studies have shown that the radial length is the single most important factor affecting the final outcome. Loss of radial length results in an attenuation in weight transmission across the wrist joint, manifested by limited rotation of the forearm and impingement of the ulna and radius. Since the classic paper of Knirk and Jupiter[13] which demonstrated that the largest tolerable articular step was 2 mm, numerous articles have appeared demonstrating that the long term outcome of treatment of intra-articular fracture depends more on integrity of the articular surface than on any other measures.

Radiological parameters were measured and graded according to Schecks[14] criteria. Our study showed average radial length was 8 ± 2 mm in closed reduction POP cast group and 10 ± 4 mm in external fixation group, radial angle was 20 ± 3º in closed reduction POP cast group and 19 ± 7º in external fixation group and volar tilt was 0.26 ± 9º in closed reduction POP cast group and 10 ± 8º in external fixation group. These comparison shows that the radiological parameters of our study vs. others studies which is shown in table 8.

Table 8: Comparison of Radiological Parameters

Authors & Year	Treatment	Radial Length	Radial Angle	Volar Tilt
Schuind et al[15] 1989	Ext. Fix.	10.7 mm	22.1º	2.8º
Zanotti and Louis[10]1997	Ext. Fix.	13 mm	20.1º	3.5º
D'Anca et al 1984	Ext. Fix.	6 mm	20º	2º
Jarry Gainor	Ext. Fix.	12 mm	18º	3º
Jack Lennox 1989	Ext. Fix.	10.4 mm	21.25º	1.5º
Agee et al	Ext. Fix.	12.5 mm	18.7º	3.7º
Our Study	Pop cast Ext. Fix.	8 ± 2 mm 10 ± 4 mm	20 ± 3º 19 ± 7º	0.26 ± 9º 10 ± 8º

The radiological parameters were compared with that of functional outcome. In our study 85% of the patients had good to excellent radiological parameters according to the functional outcome. Out of the 3 parameters volar tilt was the least important factor in the functional outcome.

The functional outcome of the treatment is subjective evaluation to which the pain had 80% in external fixation group as compared to 63% in closed reduction pop cast group. The restriction of activities had 10% in external fixation group as compared with 33% in closed reduction pop cast group.

Since patient with external fixation could use their hand for routine activities, incidence of finger stiffness was very low. However they required good physiotherapy under supervision during initial period of management. In the past majority of complication in the fixation group were due to the pins infection. Since we were using limited open surgical technique, threaded pins and better construct for fixation, the complications were avoided. In the study by Henrik G Ahlborg et al[16], there were 27% pin related complications out of 314 fractures treated with external fixation. The same percentage of complication was found in the study of Howard PW et al[17], Soren Solgaard[18] and McQueen et al.[19]

Fractures through pin site is an uncommon complication with reported rates of 0 – 20% Vaughan et al[8], Schuind et al.[15]

In our study five were found pin tract infection out of 80 pins in external fixator group. These infections were superficial and healed on antibiotics and didn't cause any changes in the progression of the healing of the fractures.

The complication comparison of external fixatation of our study vs others studies are shown in table 9.

Table 9: Complication Comparison

Complication	Sanders RA et al[20] 1991	Weber et al[21] 1986	Mc Queen et al[19]	Vaughan et al[8]	Foster et al	Present Study
Pin Tract Infection	8	6	1	1	3	5
Pin Tract Osteomyelitis	2	3	1	-	3	-
Loose Pins	2	16	-	1	-	-
Broken Pins	2	-	-	1	-	-
Loss of Reduction	17	10	NA	NA	-	2
Radial Nerve Injury	7	2	1	2	-	-
Carpal Tunnel Syndrome	2	-	5	-	1	-
Finger Stiffness	8	-	1	-	-	-
ECR Tendinitis	1	-	-	-	-	-
Iatrogenic Fracture	-	5	-	1	1	-
Non-union	-	3	-	-	-	-
Mal-union	-	-	-	-	-	1
RSD	-	-	1	-	-	-
Compartment Syndrome	-	-	1	-	-	-
Arthritis	1	-	-	-	-	-

CONCLUSION

The results show no statistically significant difference between the two modes of interventions.

External fixation provides a better mode of treatment for comminuted intra-articular fracture of distal end radius as compared to conventional POP cast immobilization. It provides easy mobilization of fingers and reduces edema and stiffness of joints. The active range of movements at the wrist joints was significantly better in external fixation group.

RECOMMENDATIONS

The treatment of intra articular distal end radius fracture is controversial. There is no definitive treatment method which is considered the standard of care.

LIMITATION OF THE STUDY

This study would have been more informative if we had included the percutaneous pinning and internal fixation with plate.

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CONFLICT OF INTEREST

None declared.

FINANCIAL DISCLOSURE

None

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