



Treatment of Intra Articular Fractures of Distal Radius Using External Fixator: A Short Term Study

Authors

**Mehmood Ul Hassan Mufti¹, Sheikh Ajaz², Muhammad Ashraf Khan³
Raja Rameez Farooqi⁴, Hilal Ahmad Kotwal⁵**

1,2,3,4,5 Post-Graduate Dept of Orthopaedics Bone and Joint Hospital Brazulla Srinagar Jammu and Kashmir

Corresponding Author

Mehmood Ul Hassan Mufti

Post Graduate Dept of Orthopaedics Bone and Joint Hospital Brazulla Srinagar Jammu and Kashmir INDIA

Email: mehmood.mufti@gmail.com phone no. 9622660686

Abstract

Background: Severely comminuted intra-articular fractures of the distal end of the radius are difficult to treat. Failure to achieve and maintain nearly anatomic restoration can result in pain, instability, and poor function. We report the results of a retrospective study of the use of a standard protocol of closed reduction and external fixation of these fractures.

Methods: Fifty patients underwent closed reduction and external fixation with or without augmentation with k-wires. Thirty-three patients required additional k-wires. The mean time until the external fixator was removed was seven weeks.

Study Design & Settings: Observational prospective study at a tertiary care hospital from September 2013 to August 2015.

Results: At a mean of thirteen months postoperatively, the mean arc of flexion-extension was 82% of that on the uninjured side and the mean grip strength was 83% of that on the uninjured side. The mean articular step-off was 1 mm and the radial length was restored to a mean of 11 mm. According to the modified Green and O'Brien clinical rating system, twenty-five had a good or excellent result. Thirteen patients had minor Kirschner-wire-related problems.

Conclusions: Closed reduction and external fixation of intra-articular fractures can restore radiographic parameters to nearly normal values, maintain reduction throughout the period of fracture-healing, and provide satisfactory functional results.

Introduction

Treatment of displaced fractures of the distal end of the radius has changed over the course of time. In the past, closed reduction with immobilization in a plaster cast was considered the treatment of choice. Dr. Abraham Colles, in reference to fractures of the distal aspect of the radius, stated:

“One consolation only remains, that the limb will at some remote period again enjoy perfect freedom in all its motions, and be completely exempt from pain; the deformity, however, will remain undiminished throughout life” ¹severely comminuted intra-articular fractures of the distal end of the radius are challenging to treat.

Restoration of congruity of the articular surface is the most critical factor for a good functional result.²⁻⁸ Restoration of radial length (the distance from the radial styloid process to the distal head of the ulna), radial tilt angle, and volar tilt angle is also important^{2-7,9}. Failure to achieve and maintain nearly anatomic restoration can lead to degenerative arthritis, distal radioulnar and midcarpal instability, and ulnar impaction syndrome, with resultant pain, decreased motion and strength, and poor function.^{4,6,10-15} We report the results of a prospective study of the use of closed reduction and external fixation of intra-articular fractures in fifty patients who were followed for a minimum of one year.

Material & Methods

A Prospective observational study of 50 patients was made, who were treated with closed reduction under fluoroscopy, distraction with the external fixator with or without K-wire fixation as deemed necessary, for intra-articular distal radius fractures at the Department of Orthopaedic Surgery, at our tertiary care centre over a period from September 2010 to August 2012. Patients included in the study were adults (Age 20 – 60), patient with intra-articular fractures of distal end of radius (AO Type B/C), all closed and Grade I (Gustillo and Anderson) compound fractures and presenting within 72 hours of injury. Patients with Grade II and III open fracture distal radius, pathological fractures, rheumatoid arthritis, concomitant injuries of same limb, bilateral distal end radius fractures and neurovascular injuries were excluded.

The specific radiographic criterion for considering closed reduction as acceptable was more than a 2-mm step-off of the distal articular surface of the radius^{2,7}.

The fractures were assessed preoperatively by wrist radiographs (PA and LATERAL) and were classified according to the AO/ASIF classification system. Seven patients (14%) had 23.B2 type of fracture, seventeen patients (34%) had 23.B3 type of fracture, ten patients (20%) had 23.C1, eight

patients (16%) had 23.C2 type of fracture and eight patients (16%) had 23.C3 type of fracture.

Demographic Data

The fifty patients who were included in the study consisted of twenty-nine men and twenty-one women who ranged in age from eighteen to fifty-nine years (mean, thirty-eight years). Thirty patients presented initially at our institution, and twenty were referred secondarily. The dominant wrist was injured in 28 patients and the non-dominant wrist, in 22. The initial injury resulted from a high-energy mechanism in forty patients: fifteen were injured in a fall from a height; while as twenty-five had injury during a road traffic accident. The injury resulted from a lower-energy mechanism in ten patients: seven fell while walking or running, three were injured while doing household activity.

Surgical Technique

A general aesthetic was administered to thirty-one of the fifty patients, and a supra-clavicular block was used in nineteen. The external fixator was initially placed, with use of standard technique^{11,17}. Pins were placed in the neck and base of the second metacarpal¹⁸. The most distal pin in the radius was placed at least 2 cm from the fracture site, and the proximal pin was placed at least 2 cm^{11,17} proximal to the distal pin.

Manual traction was placed on the fixator to help to reduce the fracture and to correct radial length and displacement through ligamentotaxis¹⁹. The reduced position of the fracture fragments was checked with fluoroscopy, and it was determined, in thirteen patients, additional k wires were used to maintain reduction. Satisfactory reduction with slight distraction of the radiocarpal joint was confirmed with fluoroscopy¹¹. The external fixator remained until bone-healing was demonstrated on plain radiographs; it was removed at a mean of seven weeks (range, five to nine weeks) postoperatively. Bone-healing was determined radiographically by the appearance of bridging trabeculae across the fracture site and clinically by the fracture site being non-tender to palpation.

Twenty-three of the patients had the Kirschner wires removed when the fixator was removed. The wires were removed earlier from ten patients who had pin-track-related problems.

The time from the injury to the definitive operation ranged from one to fourteen days (mean, three days)

Postoperative Management

All patients began active and passive range-of-motion exercises of the hand, forearm, elbow, and shoulder on the day after the operation⁵.

Follow-up Assessment

Fracture Classification

Fracture classification: Fractures were categorized on preoperative radiographs (without traction or computed tomographic scans) within the AO classification^{6-9,20-22}. Intra articular Type-B/C fractures, the most severe within the AO system, are divided into three sub classifications according to whether the comminution^{4,19,21}.

Objective Assessment:

At the final follow-up examination, patients were tested for range of motion, for grip strength with a hand held dynamometer. Measurements of the contra lateral side served as controls⁸.

Subjective Assessment:

At third, sixth month and at final follow-up visit, a quick dash questionnaire was given and the scoring was done and recorded.

Assessment of Radiographic Parameters:

Standard guidelines were utilized to determine selected radiographic parameters,^{4,5,8,23,24} which were analysed on posteroanterior and lateral radiographs made at five time points: preoperatively before any reduction manoeuvres, immediately after the operation, at third months at sixth month and at the final follow-up evaluation. Values for the contralateral side were determined from posteroanterior and lateral radiographs made at the final follow-up examination.⁸

TABLE I Functional Outcome at Final Follow-up Visit

Outcome measure	Injured wrist	unInjured Wrist	Injured Percentage	Wrist as of Uninjured Wrist
Extension	$65^\circ \pm 11^\circ$	$75^\circ \pm 13^\circ$	87%	
Flexion	$64^\circ \pm 9^\circ$	$74^\circ \pm 9^\circ$	86%	
Total arc of flexion-extension	$129^\circ \pm 21^\circ$	$149^\circ \pm 22^\circ$	86.5%	
Supination	$78^\circ \pm 17^\circ$	$84^\circ \pm 7^\circ$	92%	
Pronation	$85^\circ \pm 5^\circ$	$89^\circ \pm 15^\circ$	95%	
Total arc of supination-pronation	$163^\circ \pm 22^\circ$	$173^\circ \pm 22^\circ$	94%	
Radial deviation	$22^\circ \pm 7$	$32^\circ \pm 6$	68%	
Ulnar deviation	$33^\circ \pm 6$	$45^\circ \pm 7$	73%	
Total arc of radioulnar deviation	$55^\circ \pm 13$	$77^\circ \pm 13$	71%	
Grip strength	33±5kg	45±7kg	73%	

Results

The mean duration of follow-up of the fifty patients was thirteen months (range, twelve to eighteen months).

Fracture Outcome:

Fracture Classification:

Within the AO classification, Seven patients (14%) had 23.B2 type of fracture, seventeen patients (34%) had 23.B3 type of fracture, eight

patients (16%) had 23.C2 type of fracture and eighteen patients (36%) had 23.C3 type of fracture.

Objective Outcome

The mean values for range of motion and grip strength for the fifty patients are given in Table I. The mean total arc of flexion-extension at the final follow-up evaluation was 129° (range, 90° to

140°), 86% of the value for the uninjured side; the mean total arc of supination/pronation was 163° (range, 115° to 180°), 94% of the value for the uninjured side; and the mean total arc of radioulnar deviation was 55° (range, 30° to 64°), 71% of the value for the uninjured side. The mean grip strength on the injured side was 33 kg (range, 21 to 43 kg), 73% of the grip strength on the uninjured side.

Subjective Outcome

All the patients were satisfied with the outcome. The rating of satisfied, even when given by patients with wrist stiffness and/or moderate pain, reflected the patients' appreciation of the substantial recovery that they achieved after a severe wrist injury. All the patients indicated that they would have the surgery again under similar circumstances. Thirty-six patients' reported no

pain at the final follow-up examination and twelve had only mild or occasional pain. Two patients reported moderate but tolerable pain. Forty-four patients had returned to work by the time of the final follow-up evaluation, and ten had resumed their preinjury employment. The mean time until the patients returned to work was six months (range, 0.25 to thirteen months). Thirty patients reported that they had participated in sports before sustaining the wrist injury. By the time of the final follow-up evaluation, all thirty had returned to sports, including football, fishing, cricket, volleyball, and skiing. The mean time until the patients returned to sports was ten months (range, two to thirty months). The quick dash score at the final follow up was 10.92 ± 8.52 as shown in table iii.

TABLE II Radiographic Findings for Fractures of the Distal End of the Radius.

Outcome measure	Injured wrist					Injured Wrist*
	Immed. Preop.	Immed. Postop.	At month	3 month	6 month	
Radial tilt angle† (deg)	11±6	22±6	21±5	21±4	21±3	23±5
Radial length† (mm)	3±5	11±3	11±4	11±2	11±3	12±4
Palmer tilt†(deg)	1±15	6±6	6±4	6±4	6±5	11±7
Articular Step-off† (mm)	3±4	1±1	1±1	1±1	1±1	0±0

*The values are given as the mean and standard deviation. †There was a significant improvement from the preoperative radiographic examination to that performed immediately postoperatively ($p < 0.05$). The change in the palmer tilt angle of the distal part of the radius from the preoperative radiographic examination to that performed immediately postoperatively was calculated for each fracture with reference to the normal of 11° of volar tilt^{4,15,22,25}.

Radiographic Outcome

The mean values for radiological parameters for the fifty patients are given in Table ii. Comparison of the injured and uninjured wrists at the final follow-up evaluation demonstrated, with the numbers available, no significant differences in the

mean radial tilt angle, radial length, ulnar variance. (Table II). The mean tilt angle of the distal end of the radius for the injured wrists at the final follow-up visit was significantly less than that for the uninjured wrists.

Table iii. quick DASH Score at 3 months, 6 months and final follow-up(mean) (n=50)

quickDASH	3 months	6 months	Final follow-up
	32.5±7	21.7±5	10.92±8

Outcome of Evaluations with Clinical Rating Systems

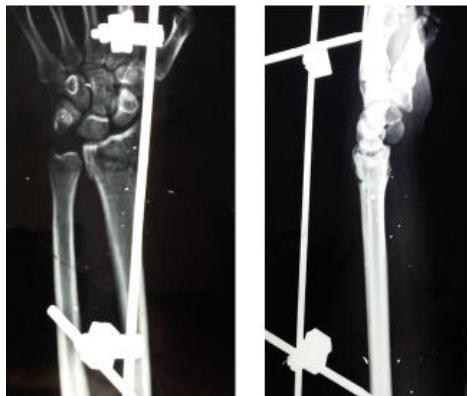
According to the modified clinical scoring system of Green and O'Brien 26, the functional result was excellent for one patient and good for four (29%

good or excellent results); the result was fair for eight patients and poor for four. The mean score (and standard deviation) was 66.5 ± 17.3 points (range, 25 to 90 points). The mean pain score was 20 points (range, 0 to 25 points), and the mean

return-to-work score was 21points (range, 0 to 25 points). The quick dash score at the final follow up was 10.92 ± 8.52 as shown in table iii.



Pre-operative PA and Lateral views



Post-operative PA and Lateral views



PA and Lateral views at final follow-up



Dorsiflexion and palmarflexion at final follow-up



Radial deviation at final follow-up



Ulnar deviation at final follow-up

Discussion

The findings of our retrospective study confirm the observation by others that anatomic restoration of the articular surface is a critical part of the operative treatment of intra-articular fractures of distal radius and has a direct influence on the final outcome.^{2,6,7,19} Bradway et al.¹⁹ and Knirk and Jupiter⁶ showed that >2 mm of articular incongruity (step-off) was associated with a high prevalence of post-traumatic arthritis and poorer functional results.

The treatment of distal radius fractures has undergone changes owing to the advances in technology. Improved imaging methods providing better understanding of fractures and elucidation of the effects of injury type on fracture formation and factors leading to instability have given way to new fixing methods and materials appropriate for the fracture. Distal radius is important in the kinematics of radiocarpal and radioulnar joints. Hence, anatomical reduction of the articular surface, stable fixation, restoration of the radial length, volar angulation and radial inclination are the prerequisite for good clinical outcome. All this reduces the incidence of post-traumatic osteoarthritis and allow early functional rehabilitation⁸. The degree of disability after distal end radius fracture has been seen to correlate with the

amount of residual deformity. Treatment options include closed reduction and pinning, bridging and non-bridging external fixation and open reduction with dynamic compression plate (DCP), precontoured locking and non locking plates and screw fixation through a variety of approaches⁹. Failure to reduce intra-articular fractures of the distal radius predisposes to pain, restricted movement and degenerative arthritis. Malposition is related to the radial height, radial angle, volar tilt and the accuracy of intra-articular reduction.¹⁰ In the treatment of comminuted distal radius intra articular fractures, surgeons may encounter serious complications such as difficult reduction and stabilization, loss of reduction, limitation of range of movement, post traumatic arthritis of the wrist. A brief classification should be made before treating the distal radial fractures. Among various classification systems, the AO classification system is the most suitable one because it reflects the severity of the fracture and helps the surgeon and the patient to know the possible outcomes.¹¹ The use of an external fixator alone or in conjunction with percutaneous or limited internal fixation, for unstable fractures of the distal end of the radius has produced good or excellent results. We attribute to these good or excellent results to the early removal of the fixator that allows early range-of-motion exercises and to avoid complications commonly associated with the prolonged use of external fixators.¹²

We believe that intra-articular (AO type-B/C) fractures of the distal part of the radius can be treated by closed reduction and external fixation. Our series demonstrates that this technique, supplemented by k-wires as needed, is a satisfactory treatment that can lead to a high rate of return to work and sports, a high level of patient satisfaction, and a low rate of complications.

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