

Original Research Article

Evaluation of functional outcome by modified mayo wrist score in intra-articular distal end radius fracture managed by plate osteosynthesis

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ABSTRACT

Background: Fractures of distal end of radius continue to pose a therapeutic challenge. Intra articular and extra articular malalignment can lead to various complications like post traumatic osteoarthritis, decreased grip strength and endurance, as well as limited motion and carpal instability.

Methods: A prospective study of forty patients with intra-articular distal end radial fractures treated under the department of orthopaedics, PIMS, Udaipur, were included in this study. All patients managed by plate osteosynthesis were followed up to 9 months.

Results: When outcome according to modified Mayo wrist scoring system was assessed, only one patient (2.50%) scored with poor grade. 11 (27.50%) were graded as excellent, 19 (22.50%) as grade good, 9 (22.50%) as grade fair. 32 (80%) patients had union within 2-3 months and 06 (15%) patients had union in 3-4 months. There were 2 (5%) case of delayed union.

Conclusions: Assessment of functional outcome by modified mayo wrist score in intra-articular distal end radius fracture managed by plate osteosynthesis gives an excellent scoring system to assess outcome of communitied intrarticular distal radius fractures with reference to function of the hand and wrist of the individual. Also, it will help to predict the likely functional outcome in relation to fracture pattern of distal radius.

Keywords: Mayo wrist scoring system, AO classification, Distal radius fractures

INTRODUCTION

Distal end of radius fractures still presents a therapeutic challenge. A variety of complications, including post-traumatic osteoarthritis, diminished grip strength and endurance, restricted motion, and carpal instability, can be brought on by intra- and extra-articular misalignment.¹

For unstable distal radius fractures and those with articular incongruity that cannot be anatomically reduced and maintained through external manipulation and ligamentotaxis, open reduction and internal fixation is recommended, provided that there is enough bone stock to allow for early range of motion.

In order to directly control and maintain physiological palmar tilt, prevent collapse with external fixation, and avoid bridging the radiocarpal joint, internal fixation of metaphyseal bending fractures has gained popularity. The distal fragment can be approached from either a dorsal or a volar approach and is typically large enough and intact enough to provide adequate purchase. It is preferable to have palmar plating because the screws directly support against collapse and loss of palmar tilt. Extensor tendon injury is more likely when fragments are smaller and more distal because a dorsal plate must be positioned distally on the dorsum of the radius.^{2,3}

There are two types of plates for fractures of distal radius: conventional plates and fixed angle locking compression

plates. When using conventional plates comminution must be less, they poorly hold the cancellous bone fragments, toggle of screws in the distal holes of the plate leads to settling and loss of reduction.³

By compressing the plate to the bone with bicortical screws, stability is achieved with traditional plates and screws. The locking screws support subchondral bone and resist axial forces when fixed angle locking plates are used. It is not necessary to compress the locking compression plate to the bone in order to maintain the periosteal blood supply.

Fixed angle construct provides additional strength to fixation by constructing a scaffold under the distal radial articular surface.

Volar fixed angle locking plates are a successful treatment for extra articular distal radius fractures that are unstable, allowing for early post-operative rehabilitation.⁴ Due to the locking compression plates' angular stability, reduction can be maintained over time.

Primary stability created with a locking screw in a plate prevents secondary displacement regardless of the bone, allowing for successful treatment in patients with young and osteoporotic bones.

The palmar locking compression T-plate restores stability similar to that of an intact radius under a 100N axial load, making it superior to traditional palmar or dorsal T-plates.⁴

The creation of fixed angular stable fixation techniques should increase stability and maintain a decrease in fractures in osteoporotic bones and unstable fractures.

The purpose of this study was to evaluate functional outcome of patients with intra-articular fractures treated with plate osteosynthesis by modified mayo wrist score. Originally published in 1987 in clinical orthopaedics and related research, the modified Mayo wrist score is an adaption of the Green and O'Brien score that involved the removal of the radiographic evaluation section as the modification of the point assignments for the remaining questions.

The modified Mayo wrist score requires both patient and physician participation in order to assess pain, the active flexion/extension arc (in comparison with the contralateral side), grip strength (in comparison with the contralateral side), and the ability to return to regular employment or activities. Scores range from 0 to 100 with a score of 0 indicating a worse wrist condition and 100 indicating a better wrist condition.⁵

Aims and objectives

Aims and objectives of the study were to study the functional outcome of operative management of intra-articular distal end radius fracture with locking

compression plates, and to study the effectiveness and complications of distal end radius fractures treated with locking compression plate.

METHODS

A prospective study of forty patients with intra-articular distal end radial fractures treated at department of orthopaedics, PIMS, Udaipur, after obtaining proper approval from institutional ethical committee between January 2021 to September 2022 is presented. All patients were managed by plate osteosynthesis and followed up for 9 months.

Inclusion criteria

All adults (aged 20-60 years), both male and female intra articular fractures of distal end radius were included in the study.

Exclusion criteria

Patients aged below 20 years or above 60, patients medically unfit for surgery, compound fractures associated with vascular injuries, and patients not willing for surgery were excluded.

Pre-operative evaluation and care

About 40 patients with distal radius intraarticular fractures were treated in this the study. All of them were skeletally matured, came with pain, swelling, deformity and inability to use the wrist joint following injury. True posteroanterior and true lateral radiographs were taken. Distal radius fractures were classified according to AO classification and managed initially in the casualty with closed reduction and Dorsoradial short arm POP under hematoma block.

Then patients were evaluated with chest X-ray, electrocardiography (ECG), complete hemogram, renal function test (RFT), random blood sugar, blood grouping and typing required for anaesthetic fitness for surgery. Most of the patients were posted for surgery with 1-5 days in elective operation theatre. Distal neurovascularity, adjacent joint movements, skin condition and other comorbid conditions and associated injuries were assessed.

Radiological evaluation

Standard posteroanterior and lateral views of the involved wrist joint, CT of the involved wrist joint if required and CT and the X rays are used to assess the morphology of the fracture based on which the implants to be used and the surgical approach to the fracture are decided.

Anaesthesia

Among 40 patients, 25 patients were given supraclavicular block, 5 patients were given combined supraclavicular and axillary block and 10 patients were given general

anaesthesia. all of them were given pre operative test dose of anaesthetic drugs and antibiotics.

Surgical procedure for volar locking compression plate: through modified henry's (AO) approach

After regional anaesthesia, patient in supine position with the arm in a radiolucent forearm table and the upper arm tourniquet was used in all cases in order to provide bloodless field during surgery. Under strict aseptic precaution, parts were painted and draped upto midarm.

The C-arm was draped with sheets and was positioned perpendicular to the fracture table for further use during surgery to check for articular reduction and plate positioning.



Figure 1: (a) Skin incision is made along the radial border of flexor carpi radialis tendon; and (b) incision is deepened between flexor carpi radialis and the radial artery.

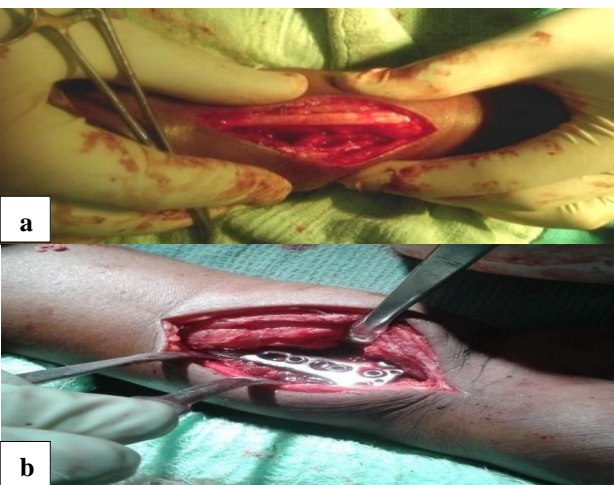


Figure 2: (a) The pronator quadratus muscle elevated using an L shaped incision; and (b) application of volar locking plate.

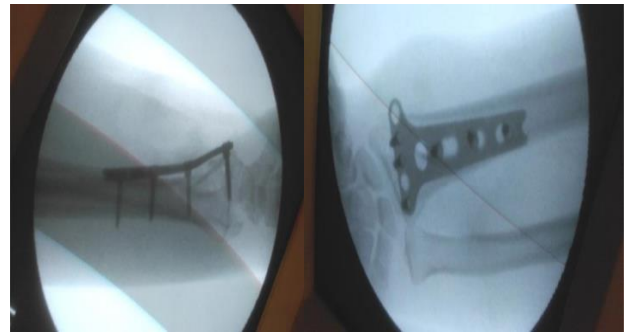


Figure 3: The fracture is reduced under C-arm guidance and fixed with a plate.

A 5 cm skin incision was made starting just distal to the proximal wrist crease and medial to the radial artery pulsation, incision deepened by dividing the deep fascia. Flexor carpi radialis was retracted ulnarwards and radial artery with brachioradialis retracted radially exposing the pronator quadratus. Care was taken not to injury the sensory branch of median nerve and radial artery. The wrist was pronated and pronator quadratus was divided and elevated from the radial side of radius exposing the distal radius fracture. The fracture was then reduced by direct visualization of the fragments. The central lunate fragment which plays a key role in load transmission if found depressed was elevated with a small osteotome and subarticular cancellous or peg bone grafting was done if needed.



Figure 4: Views wound is washed and closed over a suction drain.

Post operative care

Strict limb elevation was maintained for all patients post operatively. In the immediate post operative period, adequate pain relief was given in consultation with anesthetics. Intravenous antibiotics were given till the 2nd post operative day following which oral antibiotics were started.

Post operative X-ray was taken on the 1st post operative day. Check dressings were done on the 2nd and 5th post operative day. Drain removal was done on the 2nd post operative day. Suture removal was done on the 12th post op day.

Patients were reviewed at 3 months, 6 months and 9 months and subsequent x rays were taken to assess union. Finger and elbow mobilization was started immediately after surgery. Wrist mobilization was started 1 week post operatively as pain tolerated. Strengthening exercises were started 6 weeks post operatively.

Table 1: Protocol.

V antibiotics	First two days after surgery
Check dressings	2 nd and 5 th post op days
Suture removal	12 th post op day
Finger and elbow mobilisation	Immediate post op
Wrist mobilisation	1 week post op
Strengthening exercises	6 weeks post op

Outcome assessment

Functional outcome was assessed using modified mayo wrist scoring system.

Table 2: Outcome assessment.

Parameters	N
Pain (25 points)	
No pain	25
Mild occasional	20
Moderate tolerable	15
Severe to intolerable	0
Functional status (25 points)	
Return to regular employment	25
Restricted employment	20
Able to work, unemployment	15
Unable to work because of pain	0
Range of motion (25 points) percentage of normal	
100	25
75-99	15
50-74	10
25-49	5
0-24	0
Dorsiflexion-plantar flexion arcs if only injured hand reported	
120 ⁰ or more	25
91 ⁰ -119 ⁰	15
61 ⁰ -91 ⁰	10
31 ⁰ -60 ⁰	5
0-30 ⁰	0
Grip strength (25 points) percentage if normal	
100	25
75-99	15
50-74	10
25-49	5
0-24	0

Excellent: 90-100 points, good: 80-89 points, fair: 65-79 points, poor <65 points

Functional assesment

Clinical parameters

All measurement were performed by the principal investigator post -treatment at 3, 6 and 9 months.

Range of motion

Measurement of range of motion of involved wrist using a goniometer was done as follow:

Flexion/extension arc

Patient was sitting with the elbow flexed 90° with forearm pronated resting on a table; hand was in 0° ulnar-radial deviation. The stationary arm of goniometer was parallel to the longitudinal axis of ulna (marked from olecranon to ulnar styloid process) the moving arm was aligned to the border of the 5th metacarpal and the fulcrum was just over the ulnar styloid process.

Grip strength

Grip strength was assessed using hand dynamometer and compared with the opposite side and calculated as percentage.



Figure 5: (a) Active wrist flexion; (b) active wrist extension.

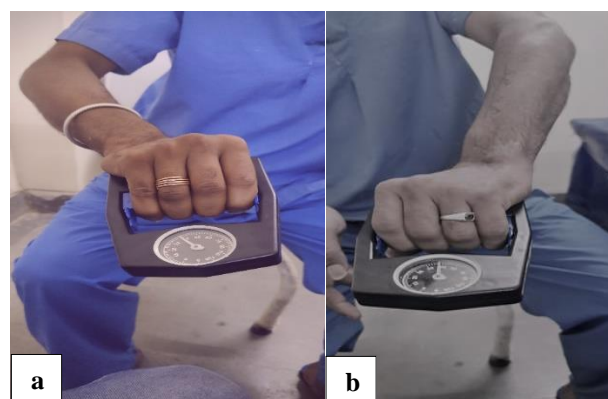


Figure 6: (a) Normal hands; (b) operated hands.

Statistical analysis

The data observed was entered in Microsoft excel and evaluated using relevant statistical test by Graph Pad Prism 8. P value of <0.05 was considered significant.

RESULTS

In the present study 32 (80%) patients had union within 2-3 months and 06 (15%) patients had union in 3-4 months. There was 2 (5%) case of delayed union (Table 3).

Table 3: Duration of fracture union.

Time of union (months)	No. of cases	Percentage
2-3	32	80
3-4	6	15
>4	2	5

The movement of the wrist joint- flexion, extension, radial deviation, ulnar deviation, pronation and supination were evaluated using Goniometer and calculated in degrees and compared with normal side of the wrist. The normal ranges of movements of the wrist joint in various planes were already said in the literature (Table 4).

When outcome was recorded according to modified Mayo wrist scoring system at various time interval postoperatively, at the first quarter i.e. after 3 months postoperatively majority of patients 28 (70%) had poor grading and 12 (30%) had fair grade. None had good or excellent outcome.

The results improved in the second quarter i.e. after 6 months postop to 34 (85%) having fair results, 3 (7.50%) had excellent, 2 (5%) had good and only 1 (2.50%) had poor grade due to delay in union.

Table 4: Postoperative assessments.

Character	No. of cases	Percentage
PAIN (functional outcome at 9 months)		
No pain	37	92.5
Mild	03	7.5
Moderate	Nil	Nil
Severe	Nil	Nil
Range of movements (%)		
100	05	12.5
75-99	25	62.5
50-74	10	25
0-49	00	00
Return to work		
Regular work	24	60
Restricted work	15	37.5
Able to work unemployed	01	2.5
Unable to work due to pain	00	00
% of opposite side grip strength		
100	15	37.5
75-99	25	62.5
50-74	00	0
0-49	00	0

These results improved significantly after 9 months of follow-up to 30 (72%) having good to excellent grade, 9 (22.50%) had fair grade. Only 1 patient (2.50%) had poor grade due to delay in union and stiffness in muscles, which was improved with physiotherapy (Table 5).

When outcome according to modified Mayo wrist scoring system was assessed, only one patient (2.50%) scored with poor grade. 11 (27.50%) were graded as excellent, 19 (22.50%) as grade good, 9 (22.50%) as grade fair. Males recovered well according to modified mayo wrist scoring system than females (Table 6).

Table 5: Outcome according to modified Mayo wrist scoring system in follow-up.

Outcome	After 3 months		After 6 months		After 9 months	
	N	%	N	%	N	%
Excellent (14)	-	-	3	7.50	11	27.50
Good (21)	-	-	2	5.00	19	47.50
Fair (55)	12	30.00	34	85.00	9	22.50
Poor (30)	28	70.00	1	2.50	1	2.50

Table 6: Outcome according to modified Mayo wrist scoring system and gender wise distribution.

Outcome	Female (n=13)		Male (n=27)		Total (n=40)	
	N	%	N	%	N	%
Excellent	1	7.69	10	37.04	11	27.50
Good	9	69.23	10	37.04	19	47.50
Fair	3	23.08	6	22.22	9	22.50
Poor	0	0.00	1	3.70	1	2.50

DISCUSSION

Distal radius fractures are the most frequently seen upper extremity fractures. The main objective of its treatment is the re-establishment of anatomic integrity and functioning. In unstable intra-articular fractures, re-establishment of inter-articular integrity of the wrist and maintaining the radial length are often not possible with closed methods. In such cases, where an open positioning is required, various surgical methods and fixation materials can be used. A better understanding of wrist anatomy and functioning through the studies conducted in the recent years, as well as the increasing expectations of patients have expanded the borders of surgical treatment. Besides, improvements in fixation materials have provided new opportunities.

Due to their intra-articular and unstable nature, B and C type were classified AO system distal radius fractures are treated surgically. Today, open positioning and plate fixation are the widely recognized surgical methods. Locked plates are in the progress of replacing conventional support plates. While facilitating the positioning, those anatomical plates with screw-plate interlocking feature have more biomechanical strength against forces applied on the fracture surfaces. Because of their biomechanical strength, locked plates are preferred in osteoporotic and/or multiple fractures. However, there is no consensus neither about how to approach to distal radius nor the positioning of the plate.

The present study was undertaken to assess the functional outcome of operative management of distal radial fractures using a volar locked compression plate. We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment. Our analysis is as follows.

Age distribution

In our study, distal radial fracture was more common in the 3rd to 5th decade with an average of 42.5 years. Most of the intra articular, comminuted and unstable fractures requiring operative management occurred in young individuals are due to high energy trauma such as road traffic accident and fall from tree. Fractures occurring in old individuals are due to trivial fall and usually will be extra articular which in most cases can be treated with closed reduction and cast application.

The average age in our study is comparable to the studies of Kilic et al, Chung et al, and Anakwe et al who had an average age of 45 years, 48.9 years and 48 years respectively.⁶⁻⁸ Arora et al had an average age of 57 years in their series (Table 7).⁹

Kilic et al reported maximum number of cases of AO C2 type of fractures. Chung et al reported maximum number of cases of AO C1 and A3 type of fractures.^{6,7} Anakwe et al reported maximum number of cases of AO C3 and C2 type of fractures.⁸ Arora et al reported maximum number of cases of AO A3 and C2 type of fractures.⁹ Our series is has maximum number of cases of AO type B2, B3 and C2 type of fractures (Table 8).

Complications

We encountered a complication rate of 12.5%, out of which 1 (2.5%) was due to delayed union and infection, caused by long volar to dorsal screw, 3 (7.5%) developed stiffness.

Kilic et al reported a complication rate of 11.1%, Chung et al reported a complication rate of 9.1%, Anakwe et al reported a complication rate of 4.8% and Arora et al reported a complication rate of 57%.⁶⁻⁹

Table 7: Compression of age distribution.

Series	Minimum age in years	Maximum age in years	Average in years
Kilic et al (2009) ⁶	18	77	45
Chung et al (2006) ⁷	18	83	48.9
Anakwe et al (2010) ⁸	22	67	48
Arora et al (2007) ⁹	17	79	57
Present study (2022)	18	50	42.5

Table 8: AO classification.

Reference	Type of fracture (%)								
	A1	A1	A3	B1	B2	B3	C1	C2	C3
Kilic et al (2009) ⁶	0	0	0	0	3	2	25	44	6
Chung et al (2006) ⁷	0	16	19	4	0	4	23	5	16
Anakwe et al (2010) ⁸	0	0	0	0	0	0	4	8	9
Arora et al (2007) ⁹	0	39	16	0	0	0	24	30	5
Present study (2022)	0	0	0	15	32.5	22.5	12.5	17.5	0

When results were recorded using the modified Mayo wrist scoring system at various postoperative time points, the majority of patients—28 (70%)—had poor grading and 12 (30%) had fair grading at the first quarter, or three months after surgery. None had a successful or superb outcome.

After six months post-op, the results improved to 34 (85%) with fair results, three (7.50%) with excellent, two (5%) with good, and only one (2.50%) with poor grades as a result of the union's delay.

After a 9-month follow-up, these results significantly improved, with 30 (72%) receiving good to excellent grades and 9 (22.50%) receiving fair grades. Only one patient (2.50%) received a poor grade because of a delayed union and muscle stiffness, both of which were alleviated by physiotherapy.

We had 27.5% excellent, 47.5% good, 20.5% fair, and 2.5% poor results in our series. Patients with excellent results experienced no pain or residual deformities. Motion range was within the range of normal function. They had no complications or arthritic changes. Within four days of the injury, they underwent surgery. The articular step-off, volar tilt, and radial length were all within acceptable bounds. They cooperated with the physical therapy. Patients who had positive outcomes had few residual deformities, pain, and minimal restriction. The rest of their research fell within reasonable limits.

Patients who had fair results also had minor complications, distal radio-ulnar joint pain, and residual deformity, pain, and limitation. Few of their motions were less than what was necessary for them to function normally.

Comparable to our series are Kiliç et al's, who had 44.4% excellent, 44.4% good, and 11.2% fair.⁶

In the study by Singh et al, 90% of the patients had excellent to good results, while 10% of the patients had a satisfactory result.¹⁰ According to the Mayo wrist scores, Sugun et al reported excellent scores in 14 of their patients, good in 11, satisfactory in 20, and poor in one of their patients.¹¹ Agarwala et al and Chavhan et al reported excellent/good results in 88% of patients and satisfactory results in 12% of patients based on the Mayo wrist score.^{12,13} Comparable outcomes were found in the studies.

In terms of union, anatomical parameters, and functions, the results obtained in the current study are similar to and comparable to those reported in the literature, with the unique feature of minimal complications.

Limitations

A longer follow-up of patients is required to assess the outcome. But as the patients are from rural and less educated belt hence is not feasible.

CONCLUSION

Present study has shown excellent results with minor complications in various fractures of younger group of patients with good bone stock. However longer follow up is required to see long term effects of these plates. Hence, we conclude that assessment of functional outcome by modified mayo wrist score in intra-articular distal end radius fracture managed by plate osteosynthesis gives an excellent scoring system to assess outcome of communitied intrarticular distal radius fractures with reference to function of the hand and wrist of the individual. Also, it will help to predict the likely functional outcome in relation to fracture pattern of distal radius.

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