The Journal of Orthopaedics Trauma Surgery and Related Research

© J ORTHOP TRAUMA SURG REL RES 14(1) 2019

Research Paper

Results of volar plating for distal radius fractures using single direct lateral approach

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Received: 03.09.2018

Accepted: 15.02.2019

Published: 22.02.2019

Abstract

Background: The purpose of this prospective study was to evaluate the results of volar plating

for distal radius fractures using a single direct lateral approach.

Methods: Twenty-three patients with distal radius fractures (AO type C2 and C3) were recruited into the study between Jan 2014 and Dec 2016 at our tertiary care hospital in Delhi. There were 19 males and 4 females with a mean age of 40.6 years. Open reduction and volar internal fixation with a locking T plate through a direct lateral approach were done. They were followed up at six weeks, three months and six months. Assessments of pain, motion, grip strength and standard radiographs were performed. The Modified Mayo Wrist Score (MMWS) were recorded.

Results: The radiographic results at the final follow-up showed a mean of 18.15° of radial inclination, 17.25° of volar tilt, 9.7 mm of ulnar variance. An excellent or good result was obtained in 87% of patients according to MMWS. Two patients developed numbness over superficial radial nerve distribution area post-surgery but recovered 6 weeks post-surgery with no residual numbness at final follow up. All patients had a bony union. No patients had the median nerve, radial artery and tendon injury with the direct lateral incision.

Conclusion: Internal fixation of distal radial fractures with a volar locking plate system through a direct lateral incision is a safe and stable fixation with good clinical outcomes can be achieved.

Level of Evidence: Level 3

Keywords: Distal radius fractures, internal fixation, volar locking plate, direct lateral incision, modified mayo wrist score

INTRODUCTION

Distal Radius Fractures are one of the common fractures of the upper extremity showing one-sixth of all fractures. These fractures make it a topic of significant interest due to its high incidence and the advances in treatment [1].

Treating these fractures aims at having adequate pain free movement letting patients return to their day to day activities while reducing known complications [1].

Anatomical fracture reduction and early mobilization of the joint due to the advancement of new plating systems [2,3] has increased the surgical treatment. Implants such as dorsal plates, volar plates, radial plates, fragment-specific fixation, and intramedullary nails have been developed increasingly for the management of distal radius fractures [4-10].

Distal Radius approaches can be broadly divided into volar, radial and dorsal [11]. Only some comparative studies have been published analyzing the dorsal and volar approaches [12,13]. There are no articles in the literature showing results of volar plating through a direct lateral approach. In this article, we have shown our experience of direct lateral approach for fractures of the distal radius.

MATERIALS AND METHODS

The prospective study was conducted between Jan 2014 to Dec 2016 at our 675 bedded, tertiary care hospital. Patients who presented with distal radius fractures falling in the category of Type C2 and Type C3 of AO classification [14] and between 20-70 years of age were included in our study.

Patients below 20 years of age, Pathological fractures, fractures associated with active infection and Type A, Type B and Type C1 of AO classification [14] were excluded from the study. Patients who refused to participate in the study or were lost to follow-up were also excluded from the study.

Twenty-three patients were included in the study and followed for a period of 6 months. Selected patients were postoperatively assessed for the functional and radiological outcome at each follow up (Fig. 1). Informed consent was obtained from all individual participants included in the study. Same Surgical team and one orthopedic observer was appointed to collect the data in each follow-up.

All the patients with preoperative AP and Lateral X-ray views of the wrist were reviewed to note the type of the fracture, the location, and extent of articular depression, and fracture extension into the diaphysis. Fractures were classified according to AO classification. Preoperative planning is done according to the type of fracture. The neurovascular status was noted.

Antibiotics Prophylaxis (Inj. Cefazolin 1g) Intravenous was administered before tourniquet inflation in closed fractures.

OPERATIVE PROCEDURE

Patients were operated under general anesthesia in a supine position on OT table with a tourniquet on the operating side with the hand abducted away from the body in a neutral position with radial side upwards.

Radial styloid, anatomical snuff box, extensor pollicis Brevis tendon (extensor compartment I) and extensor pollicis longus tendon (extensor compartment III) were marked. A skin incision of about 10 cm was given in longitudinal fashion starting 2 cm distal from the radial styloid over the anatomical snuffbox extending proximally to it depending on the fracture extent (Fig. 2). Subcutaneous tissue was incised along the skin incision. The branches of a radial sensory nerve in the subcutaneous tissue were identified, gently mobilized and retracted. The first compartment's tendon sheath was released along with the incision length and both the abductor pollicis longus and extensor pollicis Brevis tendons were retracted dorsally. Incise the periosteum over the radial surface and elevate the pronator quadratus subperiosteally over the volar surface (Fig. 3).

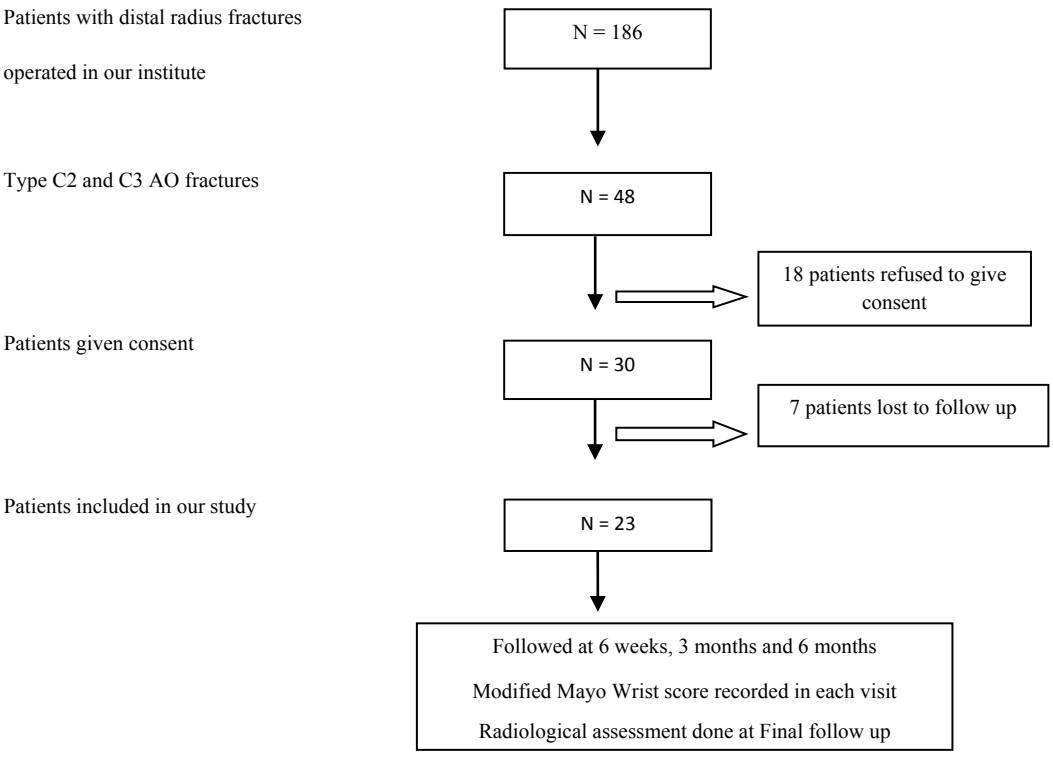

Fig. 1. Flow chart of patients included in the study

Fig. 2. Incision over anatomical snuff box between extensor compartment tendons 1 and 3

Fig. 3. Incising periosteum over Radial surface to elevate Pronator quadratus subperiostealy without incising muscle mass

Distal radius fracture site was exposed with radius shaft. Wrist joint was not opened up. Fracture reduction was done with direct and indirect techniques. Displaced Dorsal fragments were directly reduced under supervision through the same incision (Fig. 4). Provisional fixation was done with K wires across the fracture site. Final fixation was done with 3.5 mm and 2.7 mm pre-contoured locking T plate placed just proximal to the articular surface extending from DRUJ till radial styloid and fixed with locking and cortical screws proximal and distal to fracture site under C arm guidance (Fig. 5). Final fixation was observed with the plate positioned on the fracture site (Fig. 6). Plate position, placement of screws, postoperative reduction, and fracture fixation was confirmed using C-arm (Fig. 7a and 7b). Care was taken not to insert the screws in the wrist joint. In some cases, with separate radial styloid fracture, additional Kirschner wire was inserted through the same incision. Finally, an incision was closed with subcutaneous vicryl and skin staples. The patient was given below elbow volar slab postoperatively. Postoperative radiographs were reviewed to assess the adequacy of articular reduction, metaphyseal-diaphyseal reduction, alignment and placement of screws.

Post-operative antibiotic coverage was given for a period of 24 hours. Active digital movements and limb elevation were encouraged to prevent swelling of the fingers. First, wound inspection is done after 48 hours. On 2nd-3rd post, op day patient was discharged. The wrist was immobilized for 2 weeks after which splint was removed and the patient was encouraged to start wrist movements to prevent stiffness. Gradual mobilization was started with flexion, extension, supination and pronation movements at the wrist joint. Lifting light weight, pen holding was started after 2 months. Restrictions were applied on any kind of heavy manual labor, contact sports, lifting heavy weights for a period of 5-6 months. Patients were called for

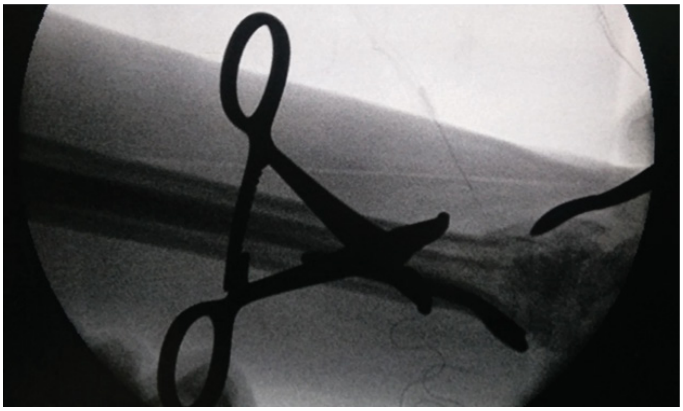

Fig. 4. Reducing dorsal displaced fragment directly under supervision through same direct lateral incision

Fig. 5. Inserting locking screws through the plate

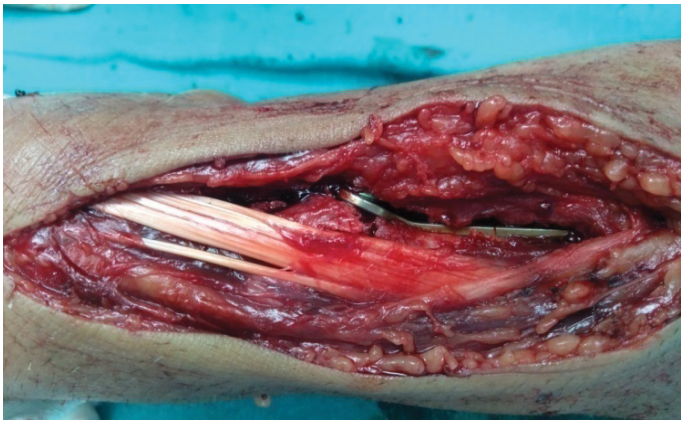

Fig. 6. Showing Superficial radial nerve and extensor compartment 1 with implant

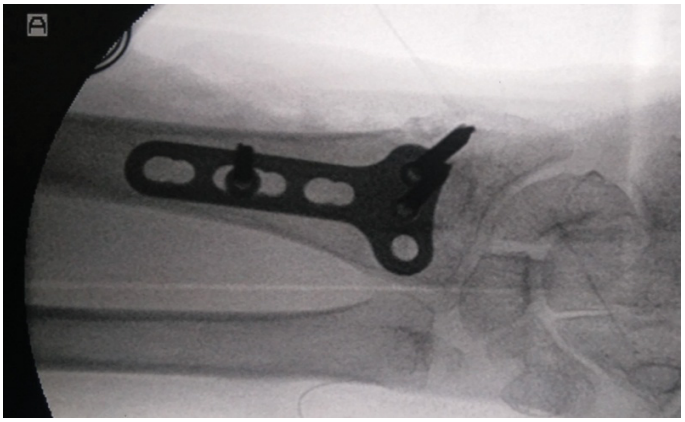

Fig. 7a. Preoperative X-rays seen under C arm-AP

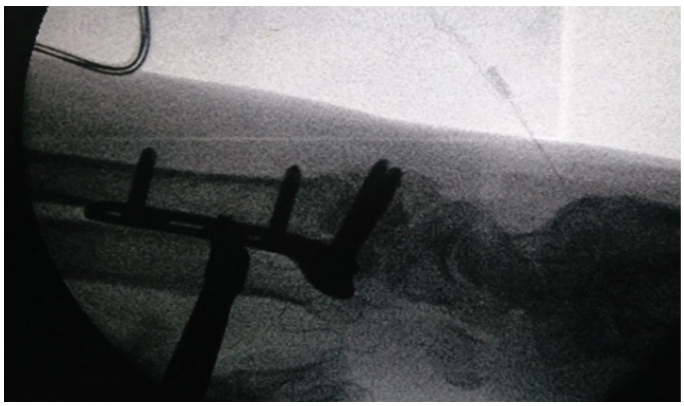

Fig. 7b. Peroperative X-rays seen under C arm-lateral

a review at 2 weeks, 6 weeks, 12 weeks, and at monthly intervals thereafter till bony union and maximal functional recovery to assess the fracture healing and wrist joint movements.

All the patients who satisfied the selection criteria were called for follow up at 6 weeks, 3 months and 6 months and were questioned and examined regarding functional recovery according to the scoring proforma and their responses noted. The results were analyzed according to the Modified Mayo wrist score (MMWS) modification of Green and O'Brien score [15,16] which includes subjective Pain, wrist active range of motion i.e flexion and extension arc measured with Goniometer as a percentage of opposite side, Grip strength measured with Digital Hand Dynamometer as percentage of opposite side and activities level that were statistically compared with each follow-ups. The scores were graded as poor (<65), fair (65-79), good (80-89), and excellent (90-100).

Statistical analysis in our study was done using Wilcoxon signed ranks test and Friedman test through spss with a p-value (<0.05) to see statistical significance between clinical scoring at each postoperative follow-up. Radiological assessment was done on the basis of follow up X-rays which includes volar tilt, radial inclination, ulnar variance, and radiocarpal incongruity.

RESULTS

Forty-eight patients with Distal radius fractures of Type C2 and Type C3 of AO classification had been treated in our institution between Jan 2014 to Dec 2016. Seven patients had been lost to followup. The remaining 23 patients with type C2 (n=13) and C3 (n=10) fractures were included in this prospective study (Table 1). Nineteen patients were men and four patients were women. Twelve were a result of vehicular accidents and eleven were a result of trivial fall on outstretched hand. The age of the patients varied from 21 to 70 years (mean 40.6 years) with maximum patients in 21-40 yrs age group. Dominant hand was involved in 12 patients and non-dominant hand in 11 patients. The duration of follow-up was 6 months. 5 patients had associated ulnar styloid fracture. No patients had preoperative median nerve palsy.

All patients underwent surgery at a mean interval of 5 days (range 1-10 days) depending upon 1st consultation and fitness for surgery. Tourniquet was applied in all the patients.

The direct lateral incision was given in all the patients. Articular congruity and reduction were visualized with fluoroscopy. 3.5 mm locking plate was applied in 15 patients and 2.7 mm locking plate in 8 patients. The mean duration of the surgery was 38 min. Primary bone grafting was done in 8 patients.

All patients were followed up at 6 weeks, 3 months, 6 months and the functional outcome of our patients were graded by the Modified Mayo wrist score. At final follow up, 3 patients had mild to moderate pain, functional status in 21 (91.3%) patients returned to regular employment, the range of motion was full in 19 (82.6%) patients and 75-99% in 3 (13%) patients. Grip strength 75%-100% of the normal side was seen in 22 (95.6%) patients. The mean grip strength on the injured side was 91% (range, 65%-100%) of that on the uninjured side. Nineteen patients had scores between 90 and 100, one patient had scores between 80 and 89, two patients between 65 and 79 and one patient in less than 65 at final follow up (Table 2). The mean score at final follow up of 6th months was 90.4+13.05 (range, 45-100). 87% of our cases got Excellent to Good results. We found poor to fair results in patients who developed an infection with a stiff joint. We found a statistically significant difference in functional outcome score MMWS between 6 weeks and 3 months, 3 months and 6 months follow up with p=0.000 (<0.05) in both the scenarios. Active range of movements at the final follow up is shown in Table 3. Radiological assessment at final follow up showed a mean of 17.25+3.68 degrees for volar tilt, 18.15+ 3.22 degrees for radial inclination and 9.7+2.36 mm for an ulnar variance.

No patients had a deep infection. One patient had stitch abscess due to vicryl which gets resolved on the removal of threads and antibiotic therapy. Tenderness at the surgical site was seen in 2 patients. All patients had a bony union. Two patients had pain in flexion and extension at the wrist joint. One patient of the same had painful pronation and supination movements with prominent ulnar styloid and stiff joint. Two patients developed Numbness over the superficial radial nerve distribution area post-surgery but recovered 6 weeks following surgery with no residual numbness at final follow up shown in Table 4.

DISCUSSION

The current thinking that the wrist joint does not endure any

Table 1. Fracture distribution according to type

AO classification	No. of cases
Type C2	13
Type C3	10
Total	23

Table 2. Modified Mayo wrist score at final follow up (6th month)

Modified Mayo Wrist Score	No. of patients	Mean Scores
Poor (<65)	1	45
Fair (65-79)	2	72.5+3.53
Good (80-89)	1	80
Excellent (90-100)	19	95.2+5.13
Total	23	90.4+13.05

Table 3. Mean range of active movement in degrees at Final follow up (mean values are shown in bold with the range in brackets below)

Final Follow Up	Range of Movement
Extension	**84.9** ± 16.9 (10-90)
Flexion	**85.4** ± 13.2 (30-90)
Supination	**84.7** ± 14.1 (30- 90)
Pronation	**84.6** ± 15.6 (20-90)

Table 4. Complications

Complications	No. of cases
Median nerve injury	0
Radial artery injury	0
Tendon rupture	0
Implant Failure	0
Superficial Infection	1
Tenderness (surgical site)	2
Stiff wrist joint	2

Table 5. Comparison of functional outcome according to the Modified Mayo wrist score [24-26]

Outcome	Excellent	Good	Fair	Poor
Arora R, et al. [24]	27.19%	47.36%	20.17%	5.26%
Kenny K, et al. [25]	88%	8%		
H. Drobetz, et al. [26]	46%	22%	24%	8%
Present study	82.6%	4.34%	8.69%	4.34%

articular surface incongruity and additional extra-articular malalignment without significant loss of function completely out rules the impression of early1800s that 'the limb at some remote period of time will enjoy perfect freedom in all its motions and be completely exempt from pain with the deformity remaining throughout life' [17].

Studies have shown that as the dorsal angulation of the distal radial fragment increases there is substantial increase and transfer in the axial load from the radius to the ulna [18]. Also, as the dorsal angulation increases, distal radioulnar joint incongruity increases and tightens the interosseous membrane causing restriction of the forearm rotational movements [19,20]. And also can lead to mid carpal subluxation and instability, decreased wrist motion, pain and decreased grip strength [21]. So the anatomic reduction, stable fixation, and early rehabilitation are the recent aims of management of these fractures [17].

In the present study, Direct lateral approach for the internal fixation of intraarticular distal radius fractures with volar locking plates was used. The advantages what were found in direct lateral approach over other commonly used volar and dorsal approaches were that danger of median nerve injury and radial artery injury in this approach is not present as radial artery will remain on the volar aspect of the incision and will be retracted towards the volar side. There was no incidence of Flexor pollicis longus tendon rupture in this study in any follow up as contrary to other studies. As shown by one study that "Flexor pollicis longus (FPL) was the most commonly ruptured tendon with the flexor digitorum profundus (FDP) to the index finger being the second most common" [22]. The reason may be that it was approached through direct lateral approach without incising pronator quadratus muscle fibers, thus releasing muscle from its insertion, leaving complete muscle mass intact and lifting it subperiosteally. This may cover the volar plate at the end separating the FPL tendon from plate preventing the attrition rupture. Studies have also shown that flexor tendon attrition and rupture can be avoided by covering the plate with the Pronator Quadratus muscle thus reducing the friction [23-26]. Two patients in the present study developed numbness in the area distributed by superficial radial nerve but recovered 5-6 months following the surgery. One advantage of this approach, found in the study was that it was possible to manipulate, reduce or fix any articular fragment or dorsal communication but not possible to fix from the volar side through the same incision with no need to give any further second incision (Fig. 4). Another advantage is to fix radial styloid direct under supervision through the same incision.

The drawback found in this approach is unable to expose and difficulty in fixing the medial aspect of the distal radius in die punch fractures.

Locking T plates (3.5 mm and 2.7 mm) were used which were applied over the volar surface of the distal radius with an advantage of not placing the plates directly under the incision line with reduced incidence of any future irritation by the plates applied.

Post-operative radiographic measurements demonstrate that joint congruity was restored to normal in all, except in two cases with the residual articular step of 1 mm. The extra-articular parameters including volar tilt, radial height, radial inclination, and ulnar variance were improved uniformly. These radiographic improvements were maintained in all but three cases in which the radial length was found decreased.

The functional outcome according to the Modified Mayo wrist score (MMWS) modification of Green and O'Brien is encouraging compared to other studies as shown in Table 5. Twenty (87%) of the patients achieved an excellent or good outcome. It was found to be a statistically significant difference between 6 weeks and 3 months, 3 months and 6 months which shows the need for the physiotherapy, faster mobilization, and rehabilitation post-surgery. It was believed that these results were achieved partly due to an immediate and prolonged rehabilitation programme by the physiotherapists and patients extensive exercise programme and partly due to the fact that routinely wrist splinting for a longer period was not done in the majority of cases.

The strength of the present study is that all procedures were performed in a single center by or under the supervision of two experienced surgeons; thus, the principle and concept of fixation were consistent. The follow-up evaluations were also conducted with the same group of surgeons.

CONCLUSION

In conclusion, distal radial intraarticular unstable fractures can be treated safely using a single direct lateral approach with benefits of having reduced incidence of nerve, artery and tendon injuries with another benefit of using this approach in case of abrasion and ecchymosis over the volar side which allows early functional mobilisation with good reproducible radiographic and clinical results.

ETHICAL APPROVAL

Institutional Ethical committee approval was taken for the study (approval no. EC/10/14/932).

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