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Original Research Article

Study of clinicoradiological and functional outcomes in intraarticular distal end radius fractures managed by volar locking plate

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ABSTRACT

Background: Various modalities of fixation are available for management of distal end radius fractures. Assessment of the functional and radiological outcomes of intra-articular distal end radius fractures managed with volar locking plate was attempted with the present study.
Methods: In this prospective interventional study, thirty adult patients with closed distal radius fractures with intra-articular extension were comprehensively evaluated and managed. Open reduction and internal fixation (ORIF) was performed via volar approach (modified Henry`s approach) using 2.7mm volar locking compression plates (LCPs). Patients were followed up at 2 weeks, 1 month, 3 months and 6 months after surgery. The patients were evaluated functionally by Mayo score and radiologically by Lidstrom classification.
Results: There were 18 (60%) patients having excellent, 8 (26.7) good, 2 (6.7%) fair and 2 (6.7%) with poor result according to Mayo scoring. According to Lidstrom scoring, at the last follow up, 16 (53.3%) patients had excellent, 11 (36.7%) patients good, 2 (6, 7%) patients fair and 1 (3.3%) patient had poor result. The functional status of the patient improved significantly from at 1month (20±3.47) to 6 months post-operative follow up (23.67±2.91). The mean range of motion improved significantly at 1 month, 6 months and last post-operative follow-up.
Conclusions: Volar locking plate gives good to excellent clinico-radiological and functional outcomes in most of the fractures of the distal end radius with intraarticular extension.

Keywords: Distal end radius fracture, Volar locking plate, Radiological outcome, Functional outcome

INTRODUCTION

Fractures of distal end of radius occur more frequently than any other in the human skeleton, majority of the injuries being closed.[1] Intra-articular distal end radius fractures needs special attention because articular incongruity and non-anatomical reduction may lead to stiffness of wrist, pain and secondary osteoarthritis.[2-4] Hence every attempt should be made towards acceptable anatomical reduction and fixation of these fractures.

Various modalities of fixation like plaster cast application, Kirschner wire fixation, dorsal or volar plates fixation are available for management of these fractures.[5] To achieve desirable anatomical reduction and better functional outcome, locking plates are lately being favoured.[6] Further, biomechanical studies have demonstrated that fractures fixed using locked plates have greater stability than either dorsal or volar non – locked plates. Volar plates have the added advantage of causing lower incidence of extensor tendons related complications.[7-9]

Although volar locking plates are being used by many surgeons now-a-days, locally relevant systematic data regarding outcome in such cases is lacking. With the present study, assessment of the functional and radiological outcomes of intra-articular distal end radius

fractures managed with volar locking plate was undertaken.

METHODS

This was a prospective interventional study, conducted in the department of Orthopaedics at a tertiary care government hospital from June 2016 to October 2018 (2 years and 5 months).

Inclusion criteria

Inclusion criteria were patients in the age group of 18-70 years, patients with distal radius fractures with intra-articular extension and closed fractures.

Exclusion criteria

Exclusion criteria were patients with pathological fracture, compound fracture, any previous fractures around the wrist, patient having another fracture in same limb, patient not willing to give regular follow up and patient not consenting to participate.

Thirty consecutive patients fulfilling mentioned selection criteria were thus finally enrolled. Initially, all the patients with distal end radius fractures (with or without intra-articular extension) presenting with pain, swelling, deformity and inability to use the wrist joint following injury/fall were examined in the emergency department. True postero-anterior and lateral radiographs were taken and fractures were immobilized in below elbow slab. The fractures were then classified according to the AO (Association for Osteosynthesis) classification system and only AO type B and C fractures were included.[10] All these patients were admitted in the ward and operated on as early as possible; depending on the local condition of tissue and fitness of the patient for anaesthesia. After informed written consent, open reduction and internal fixation (ORIF) was performed via volar approach (modified Henry`s approach) and using 2.7 mm volar locking compression plates (LCPs).[11] Patients were advised limb elevation and active finger mobilization exercises in the immediate post-operative period. Distal neuro-vascularity was assessed regularly. Intravenous antibiotics were given for initial 3 post-operative days and then changed to oral antibiotics for next 5 days. Post operatively the wrist was immobilized in a below elbow slab for 15 days. Immediate postoperative radiograph were taken. Suture removal was done for all the cases between 12 to 14 days from surgery. After suture removal, the slab was removed and gentle active wrist mobilization exercises were started. Exercises against resistance were started about 6 weeks after surgery.

Patients were recommended to follow up at 2 weeks, 1 month, 3 months and 6 months. Routine x-rays were taken at each follow-up to assess the fracture healing. Clinical functional outcome assessment was done by Modified Mayo Score which include pain, grip strength, functional status and range of motion.[12] Pain assessment was done by using the visual analogue scale (Wong Baker faces pain rating scale).[13] Wrist range of motion was measured by goniometer and compared with contralateral side (normal side). At each follow up, flexion, extension, supination and pronation were measured in degrees and compared with contralateral side. Grip strength was assessed using the JAMAR hand dynamometer and compared with the contralateral wrist (expressed as percentage of normal).[14] The radiographic assessment consisted of serial radiographs. The specific radiographs including anteroposterior and lateral projections were taken at every follow up. The radiological outcome was scored based on the Sarmiento's modification of Lidstrom criteria which comprised of recording and grading palmar tilt, radial angulation, articular congruency and radial length.[15]

The data was analysed using SPSS (version 20); by applying chi-square test, unpaired t-test & ANOVA wherever applicable.

Approval from Institutional Ethics Committee was obtained before start of the study. Informed written consent was obtained from each patient before participation in the study.

RESULTS

Thirty participants fulfilling the selection criteria during the study period were considered for analysis. The mean age of patient was 37.7±13.3 years (range- 18-66 years), with most belonging to 18-40 years age group (21, 70%), followed by 41-60 years age group (6, 20%). Majority (23, 76.7%) were males, with only 7 participants (23.3%) being females.

Road traffic accidents (18, 60%) were commoner mode of injury than fall from height (12, 40%). Typing of fractures by AO classification revealed type C fracture in 17 (56.7%) patients and type B fractures in 13 (43.3%) patients. Most of the patients (19, 63.3%) were operated within the 3-6 days of injury.

The mean radial inclination of patients was 8.1±3.5 degrees in the preoperative period and 19±3.1 degrees in the immediate postoperative period and the improvement in mean radial inclination from pre-operative to immediate postoperative period was highly significant ($p<0.001$). Further, the mean radial inclination was observed to remain stable at 3 months (18.6±3.3 degrees) and also at last follow up (18.67±3.4), indicating no significant change in radial inclination during immediate postoperative period, after 3 months and at the last follow up.

The mean radial length of patients preoperatively was 3.26±1.55 compared to 9.33±1.7 in the immediate postoperative period, the improvement being highly significant ($p<0.001$). The mean radial length then

remained stable at 3 months (9.1±1.86) and at last follow up (9.0±2.03) indicating no significant change in radial length during immediate postoperative period, after 3 months and at the last follow up; along with confirming that there was no loss of reduction with time.

The mean volar tilt of patients preoperatively was 14.56±5.8, which was reduced to 9.56±1.43 in the immediate postoperative period. So there was significant improvement in mean volar tilt from pre-operative to immediate postoperative period ($p<0.001$). After immediate postoperative period (9.56±1.43), the mean volar tilt remained stable at 3 months (9.13±1.59) and at last follow up (9.16±1.80), indicating that there was no significant change in volar tilt after immediate postoperative period, at 3 months and last follow ups.

The mean intra-articular step of patients preoperatively was 2.20±0.84, which was 0.93±0.53 in the immediate postoperative period. So there is significant decrease in mean intra-articular step from pre-operative to immediate postoperative period ($p<0.001$). The intra-articular step remained stable at 3 months (0.76±0.67) and last follow up (0.80±0.71), indicating insignificant change in the intra-articular step after postoperative, 3 months and last follow up, along with no loss of reduction.

Table 1: Radiological parameters assessed as per modified Lidstrom score.

	Radial inclination	Radial length	Volar tilt	Intraarticular step	Ulnar variance
Follow up	(Mean±2SD)	(Mean±2SD)	(Mean±2SD)	(Mean±2SD)	(Mean±2SD)
Pre-operative	8.1±3.49	3.26±1.55	-14.56±5.81	2.20±0.84	1.53±0.82
Immediate post-operative	19±3.11	9.33±1.70	9.56±1.43	0.93±0.53	-0.63±0.71
At 3 month after surgery	18.63±3.34	9.1±1.86	9.13±1.59	0.76±0.67	-0.60±0.72
Last FU	18.67±3.37	9.0±2.03	9.16±1.80	0.80±0.71	-0.83±0.34

Figure 1: Radiological follow-up of a 32 year male patient with left lower end radius fracture operated with open reduction internal fixation with 2.7 mm volar locking plate. (A) Preoperative, (B) immediate post-operative, (C) at 3 months follow-up, (D) at last follow-up.

The mean ulnar variance of patients preoperatively was 1.53±0.82, while in the immediate postoperative period it was -0.63±0.71 indicating significant decrease ($p<0.001$). After immediate postoperative (-0.63±0.71). The ulnar variance remained stable at 3 months (-0.60±0.72) and at last follow up (-0.83±0.34), indicating no further significant change (Table 1) (Figure 1).

Significant decrease in mean VAS score was observed from preoperative (8.53±0.62) to 1 month (5.1±0.66) and 3 months (1.2±0.40) post operatively. The mean grip strength was 59.23±10.72 at 1 month follow up, which significantly improved to 84.9±9.24 at 6 months and further to 94.0±2.82 at last follow up.

According to Mayo scoring, there was significant ($p<0.001$) improvement in pain from 1 month post-operative follow up (15.83±2.30) to 6 months (20.5±2.40) and at last follow up (24.0±2.03). There were 18 (60%) patients having excellent, 8 (26.7) good, 2 (6.7%) fair and 2 (6.7%) with poor result according to Mayo scoring. While according to Lidstrom scoring, at the last follow up, 16 (53.3%) patients had excellent, 11 (36.7%) patients good, 2 (6, 7%) patients fair and 1(3.3%) patient had poor result.

The functional status of the patient improved significantly from at 1month (20±3.47) to 6 months post-operative follow up (23.67±2.91).

The mean range of motion improved significantly at 1 month, 6 months and last post-operative follow-up (Figure 2).

AO type C fractures were observed to have had poorer outcome than AO type B fractures. In AO type C fractures, only 41% could score excellent on Lidstrom indicating that AO Type C had difficult to get anatomical reduction. Also, according to Mayo scoring, AO type B had more patients in excellent to good outcome category than AO type C, indicating that AO type C fractures had more severe trauma than AO type B fractures (Table 2).

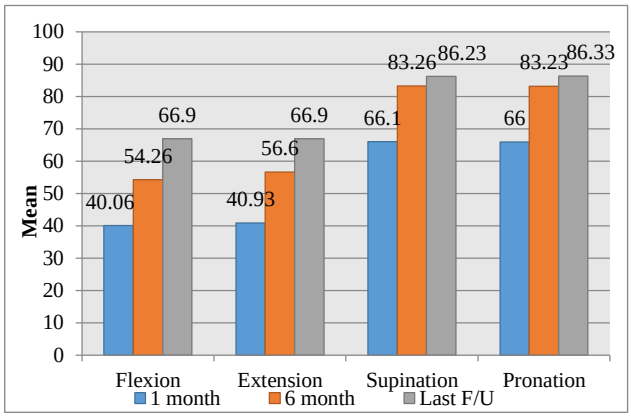

Figure 2: Mean range of motion at 1 month, 6 months and last post-operative follow up.

Table 2: Relationship between AO classification and Lidstrom score and Mayo score at last follow up.

	Excellent	Good	Fair	Poor
	N (%)	**N (%)**	**N (%)**	**N (%)**
AO classification type	**Lidstrom grades**			
B	9 (69.2)	2 (15.4)	2 (15.4)	0
C	7 (41.2)	9 (52.9)	0	1 (5.9)
	Mayo grades			
B	11 (84.6)	1 (7.7)	1 (7.7)	0
C	7 (41.2)	7 (41.2)	1 (5.8)	2 (11.7)

Only 3 patients reported complications, of which 2 had hardware irritation and one had wrist stiffness.

DISCUSSION

Various modalities of fixation are used for management of intra-articular distal end radius fractures. The increase in rigidity and the stable alignment between the metaphysis and the diaphysis with the locked volar plate allows faster mobilization, which is difficult to imagine with an unlocked volar plate, a dorsal plate or external fixation.[16] Conservative measures may also improve the reduction of type B and C fractures, but cannot assure the maintenance of reduction and most patients treated this way fall into malunion.[17] Dorsal exposure of the of the distal radius is known to cause tendon irritations and soft tissue complications.[18] So volar approach seems more suitable. In volar approach, least rate of complications has been observed with the modified Henry`s approach, which was used in the present study.[11]

The objective of the present study was to determine the clinico-radiological and functional outcomes in intra-articular distal end radius fractures managed with volar locking plates. Thirty relevant cases were enrolled and data analysed. Mean age of patients in our study was 37.7 years with road traffic accident being commonest mode of injury, indicating this fractures being peculiar to young, mobile adults. The male preponderance amongst participants further confirms the theory. This is in line with observations of previous similar studies.[1,8,19,20]

In present study, Out of 30 patients, 13 patients (43.3%) had an AO type B and 17 (56.7%) had AO type C fracture. Similar trend of type C outnumbering type B has been recorded by previous researchers.[8,20,21] Majority of the patients were operated within 3-6 days, with the mean time to surgery being 8 days, similar to the locally relevant study by Jose et al.[19]

No significant difference was observed in the various radiological parameters at the last follow, as compared to

immediate post-operative period and at 3 months; indicating that the fracture fixation was rigid in the present study and no further significant collapse of the fracture occurred post-surgery. Previous clinicians/ researchers also reported similar good radiological outcomes in fractures managed with volar locking plates, making case for surgeon-independence in the studied procedure.[8,9,19,21] Lidstrom score at last follow up shows good to excellent result in 90% of patient. Jose et al reported Lidstrom score to be good to excellent in 85.6% of the cases; while Kotian P et al observed the same in 75% of the studied participants.[19,23] Further, the scores were superior to those achieved with dorsal plates or unlocked volar plates.[16,18]

Decreasing trend in VAS score was observed at pre-operative period, at 3 months and 6 months post-operatively, which is similar to the finding of Kotian et al.[23] There was significant improvement in the pain status and grip strength (compared to opposite side) from 1 month to the last follow up, similar to the observations of Jose et al and Lattman et al, in previous similar studies.[19,24] Functional status of the patient improved significantly, from restricted work (20 patients) at 6 months to return to work (25 patients) at last follow up. There was significant improvement in the range of motion (flexion, extension, supination and pronation) at 1 month, 6 months and last post-operative follow-up. Chung et al also observed comparable improvement in range of motion at 6 months and one year post-operative follow-up.[1]

In the present study, functional evaluation according to Mayo score at last follow up revealed satisfactory results, with 18 (60%) patients having excellent and 8 (26.7%) having good outcomes. Jupiter et al reported nearly similar figures, while Jose et al observed relatively lower Mayo scores (20.75% excellent, 49% good).[8,19] Further enquiry revealed that patients scoring fair/poor in mayo scoring in the present study were either AO type C fracture or they had undue surgical delay. AO type C fractures were observed to have had poorer outcome than AO type B fractures, with only 41% of the patient managing excellent outcome on Lidstrom score, indicating that AO type C had difficult to get anatomical reduction and more severity of trauma than AO type B fracture.

In conclusion, it can be said that volar locking plate gives good to excellent clinico-radiological and functional outcomes in most of the fractures of the distal end radius with intraarticular extension.

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