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Original Research Article

A descriptive longitudinal study of functional outcome in intra-articular distal end radius fracture with volar displacement treated by locking compression plate

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ABSTRACT

Background: The distal radius metaphysis is composed mainly of cancellous bone. On articular surface there is a biconcave articulating surface with the proximally placed carpal row (scaphoid and lunate fossae) and also a notch for articulation with the ulna. Objective of the research was to study the functional outcome in distal end radius fracture with volar displacement treated by locking compression plate.
Methods: A hospital based descriptive, longitudinal study was conducted with 114 patients aged between 20-60 years to assess functional outcome in patients of distal end radius fracture with volar displacement treated by locking compression plate.
Results: According to demerit point score system of Gartland and Werley, 75 (69.4%) patients had excellent score while 24 (17.5%) and 15 (13.1%) patients had good and fair score respectively. No patient had poor score. 6 (5.3%) and 2 (1.8%) patients had superficial infection and hypertrophic scar respectively while 1 (0.9%) patient had developed malunion.
Conclusions: Volar plating has excellent functional outcome with minimal complications thus proving that it is the prime modality of treatment for distal radius fractures.

Keywords: Intra-articular distal end radius fracture, Locking compression plate, Volar displacement

INTRODUCTION

The distal radius metaphysis is composed mainly of cancellous bone. On articular surface there is a biconcave articulating surface with the proximally placed carpal row (scaphoid and lunate fossae) and also a notch for articulation with the ulna.[1]

The most common fracture treated is the fracture of the distal radius. Although sometimes stated otherwise, the outcome of these fractures is not uniformly good regardless of the treatment instituted. The distal end of the radius fractures very often continues to pose a therapeutic challenge. Some of these fractures are acquired by high energy trauma of severe degree which often results in intra-articular involvement and comminution. Treating such injuries is posing a challenge to surgeon. These fractures are mostly unstable and are difficult to reduce anatomically, and these are associated with a high prevalence of complications such as post-traumatic osteoarthrosis after intra-articular fracture of the distal end of the radius. It is also well recognized that extra-articular malalignment can result in decreased grip strength and endurance as well as limited motion and carpal instability. There are variable results of closed reduction, percutaneous pin fixation, pins and plaster, and internal and external fixation and that have been determined predominantly by the pattern of the fracture.[3]

Restoration of wrist function is the primary goal to be achieved in the treatment of fractures involving distal radius. It is well accomplished that the restoration of disrupted radial anatomy, maintenance of accurate and stable reduction, and early hand mobilization are required for good functional outcome. Open reduction and internal fixation have been indicated in fixating the unstable fractures involving distal radius and those with articular incongruity which cannot be anatomically reduced and maintained through external manipulation and ligament taxis, given that sufficient bone stock is present to allow the early range of motion.[3]

Unstable bending fractures of the radial metaphysis are ideally suited for open reduction and internal fixation. Internal fixation of metaphyseal bending fractures has become increasingly important predominantly due to: directly controlled and maintained physiologic palmar tilt, prevent collapse with external fixation, and avoid bridging of the radiocarpal joint.

The distal fragment typically has enough size and integrity to provide adequate purchase and it may be approached from either a dorsal or a volar approach. Palmar plating is generally preferred, as the screws directly buttress against collapse and loss of palmar tilt. With small sized fragments which are more distal fragments, a dorsal plate has to be positioned distally on the dorsum of the radius, thus making extensor tendon injury more likely.[4]

Intra-articular fractures of the distal radius represent a therapeutic challenge as compared with unstable extra-articular fractures.[4] Apart from being more difficult to reduce and stabilize with internal fixation, these injuries frequently result in malunion, which may result in a less satisfactory long-term functional outcome, if not anatomically reduced.[5,6] For a long time, plaster casts remained the mainstay of treating intra-articular fractures of distal radius. Due to collapse of the fracture fragments occurs, radial shortening, angulation and articular incongruity that may result in permanent deformity. This loss of reduction causes an unacceptable deformity and relative ulnar lengthening leading to pain over the medial side of the wrist. Hence the present study was done at our tertiary care centre to assess the functional outcome in distal end radius fracture with volar displacement treated by locking compression plate and evaluate the residual joint stiffness and range of motion after the locking compression plate.

METHODS

A hospital based descriptive, longitudinal study was conducted with 114 patients to assess functional outcome in patients of distal end radius fracture with volar displacement treated by locking compression plate.

Study design

It was a hospital based descriptive longitudinal study.

Study duration

The duration of the study was 18 months November 2019 to April 2021.

Study area

The study was done at our tertiary care centre, Dr. Vithalrao Vikhe Patil Medical College and General Hospital in the department of orthopedics on attending OPD/IPD.

Study population

All patients with distal end radius fractures attending OPD/IPD of the tertiary care hospital who fulfilled the inclusion criteria.

Sample size

The sample size was 114 patients.

Sample size was calculated by OpenEpi version 3 method with prevalence of 8% with reference to the study of Meena et al.[8,9]

Inclusion criteria

The study included patients with age of the patients was from 20 years to 60 years; closed fracture cases; intra-articular fractures with relatively small, comminuted fragments, which may preclude fixation with standard periarticular plates; intra-articular distal end radius fracture with volar displacement; patients willing to participate in the study with informed consent; and patients who can understand Marathi/Hindi/English language.

Exclusion criteria

The study included patients with age of the patients under 20 years; malunion and non-united cases of distal end radius fracture; pathological fractures involving distal end radius; compound fractures involving distal end radius; distal radial fracture that can be adequately treated with a traditional, non-bridging fixation system; open fractures of the distal radius with volar wounds; and patients unwilling to undergo internal fixation for cosmetic or psychological concerns.

Methodology

The study was done at our tertiary care centre in the department of orthopedics on all patients with distal end radius fractures after due permission from the Institutional Ethics Committee and Review Board and after taking written informed consent from the patients.

Once the patients were enrolled for the study, a thorough history and physical examination was done as per

proforma. An informed consent was taken in written from patients or patient's attendant.

Pre-operative preparation

Patients were given slab support for the duration till swelling subsides for around 3-5 days. Adequate analgesics either oral or parenteral were given to provide relief from pain. Pre-anesthetic evaluation was carried out and patients were taken up for surgery after obtaining informed written consent. Parenteral antibiotics were started the night prior to the surgery and continued thereafter. Questionnaire were evaluated according to Likert scale. The fracture was reduced and surgery proceeded.

Surgical procedure

The patient was placed supine on the operating table. The affected limb was elevated for 2–3 minutes and exsanguinated. Then a mid-arm pneumatic tourniquet was applied and the limb was placed on a side arm board. The incision for volar fixation of the distal radius is typically performed through the distal extent of the Henry's approach. An incision is made between the flexor carpi radialis tendon and the radial artery.

After exposure and debridement of the fracture site, the fracture is reduced and provisionally fixed under fluoroscopy with K-wires, reduction forceps or suture fixation. The appropriate plate is selected following the fracture reduction. First a standard cortical screw was applied to the most distal oval hole of the vertical limb of the plate in order to temporarily secure the plate to the proximal fragment. This allowed concomitant proximal and distal plate adjustment.

The optimal placements of the distal screws were important; they were inserted at the radial styloid, beneath the lunate facet and near the sigmoid notch. The distal screws can be of either monocortical or bicortical engagement. More volar tilt was achieved during distal screw placement when the wrist is volarly flexed as much as possible by an assistant. Moreover, radial length was further improved by pushing the whole plating system distally while using the oval plate hole and screw as a glide. The final position of the plate was confirmed using fluoroscopy.

Once stable fixation was achieved and hemostasis secured, the wound was closed in layers and sterile compression dressing was applied. The tourniquet was removed and capillary refilling was checked in the fingers. The operated limb was supported with an anterior below elbow POP slab with the wrist in neutral position.

All patients were evaluated according to demerit point score system of Gartland and Werley and according to pain intensity domain of Mayo's wrist score. All the patients were followed up for a period of 6 months.

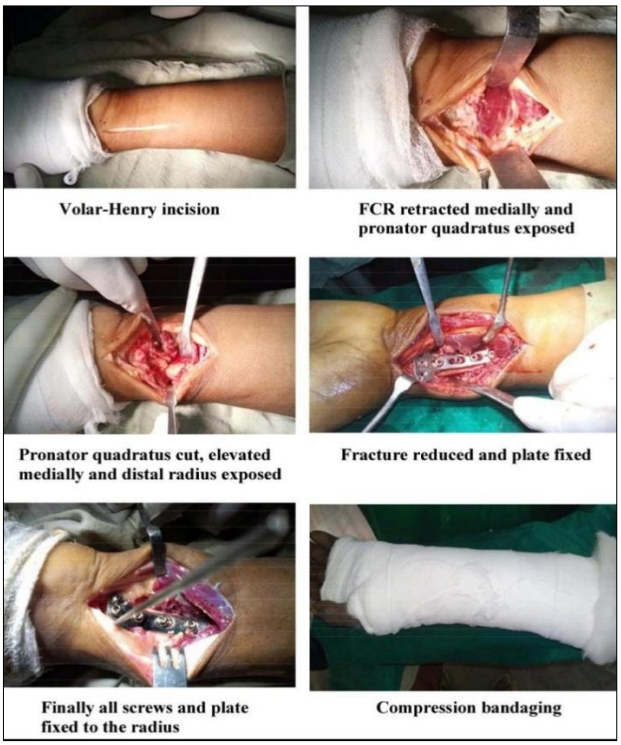

Figure 1: Pictorial representation of the surgical procedure.

Figure 2: Preoperative X-ray.

Statistical analysis

Quantitative data is presented with the help of mean and standard deviation. Comparison among the study groups is done with the help of unpaired t test as per results of normality test. Qualitative data is presented with the help of frequency and percentage table. Association among the study groups is assessed with the help of Fisher test, student 't' test and Chi-square test. 'P' value less than 0.05 is taken as significant**.**

Appropriate statistical software, including but not restricted to Microsoft (MS) excel, statistical package for

the social sciences (SPSS) version 20 will be used for statistical analysis. Graphical representation will be done in MS excel 2010.

Figure 3: Post-operative X-ray.

RESULTS

In the present study, patients in the age group of 20-60 years were included with mean age being 38.37 years, of which 83 (72.8%) patients were male and 31 (27.2%) of them were female. Of total patients, 56 (49.1%) patients had body mass index (BMI) in the normal range while 35 (30.7%) and 23 (20.2%) patients were overweight and obese respectively. 11 (9.6%) patients had diabetes mellitus while 7 (6.1%) and 3 (2.6%) patients had hypertension and ischemic heart disease respectively. The main cause of injury was road traffic accident (RTA) (66.7%) followed by fall (33.3%). It was observed in our study that there was dominance of right side (63.2%) as compared to left side (36.8%).

It was observed in our study that according to Frykman classification, 36 (31.6%) patients had type I and II fractures while 51 (44.8%) patients had type III and IV fractures. 12 (10.5%) patients had type V and VI fractures and 15 (13.1%) patients had type VII and VIII fractures.

In the present study, the injury to surgery interval for 42 (36.8%) and 44 (38.6%) patients was 1-3 days and 4-7 days respectively while it was >7 days for 28 (24.6%) patients. The mean injury–surgery interval was 4.96±2.70 days. It was noted in the present study that the mean duration of surgery was 53.11±7.43 minutes and mean amount of blood loss documented was 171.91±31.14 ml.

Also, it was found that the duration of fracture union was 2-3 months and 3-4 months for 98 (85.9%) and 10 (8.8%) patients respectively and >4 months for 6 (5.3%) patients with mean duration of fracture union being 2.70±0.86 months.

In our study, 6 (5.3%) and 2 (1.8%) patients had superficial infection and hypertrophic scar respectively while 1 (0.9%) patient had developed malunion. On the basis of demerit point score system of Gartland and Werley, 75 (69.4%) patients were found to have excellent score while 24 (17.5%) and 15 (13.1%) patients had good and fair score respectively. No patient had poor score.

Table 1: Demographic and baseline intra-articular distal end radius fracture characteristics of patients enrolled in study.

Characteristics	n (%)
Age (years) (mean±SD)	38.37±10.14
Gender	n=114
Male	83 (72.8)
Female	31 (27.2)
BMI based classification (kg/m^2)	
Normal (18-24.99)	56 (49.1)
Pre-obese (25-29.99)	35 (30.7)
Obese (≥30)	23 (20.2)
Laterality of intertrochanteric fractures	n=114
Right side	72 (63.2)
Left side	42 (36.8)
Mode of injury	n=114
Fall while standing	38 (33.3)
Road traffic accidents	76 (68.7)
Frykman classification	n=114
I and II	36 (31.6)
III and IV	51 (44.8)
V and VI	12 (10.5)
VII and VIII	15 (13.1)

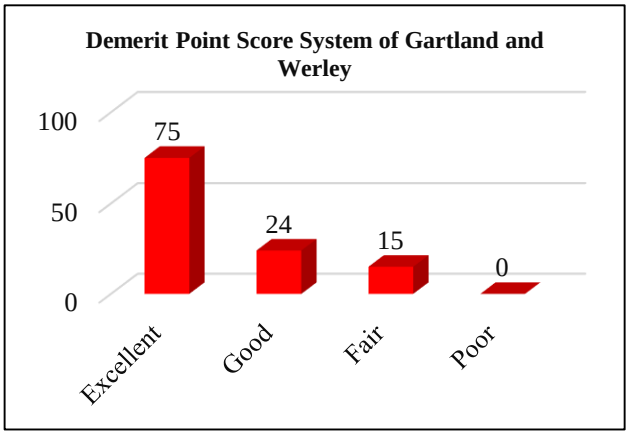

Figure 4: Distribution of patients according to demerit point score system of Gartland and Werley.

It was observed in the present study that according to pain intensity domain of Mayo's wrist score, 83 (72.7%) patients had excellent score while 23 (20.2%) and 8 (7.1%) patients had good and fair score respectively. According to functional status domain of Mayo's wrist score, 67 (62.3%) and 24 (17.5%) patients had excellent and good score respectively while 15 (13.1%) and 8 (7.1%) patients had fair and poor score respectively. According to range

of motion (ROM) domain of Mayo's wrist score, 60 (59.3%) and 15 (13.1%) patients had excellent and good score respectively while 24 (17.5%) and 15 (13.1%) patients had fair and poor score respectively. According to grip strength domain of Mayo's wrist score, 75 (65.7%) patients had excellent score while 16 (14.1%) and 23 (20.2%) patients had good and fair score respectively.

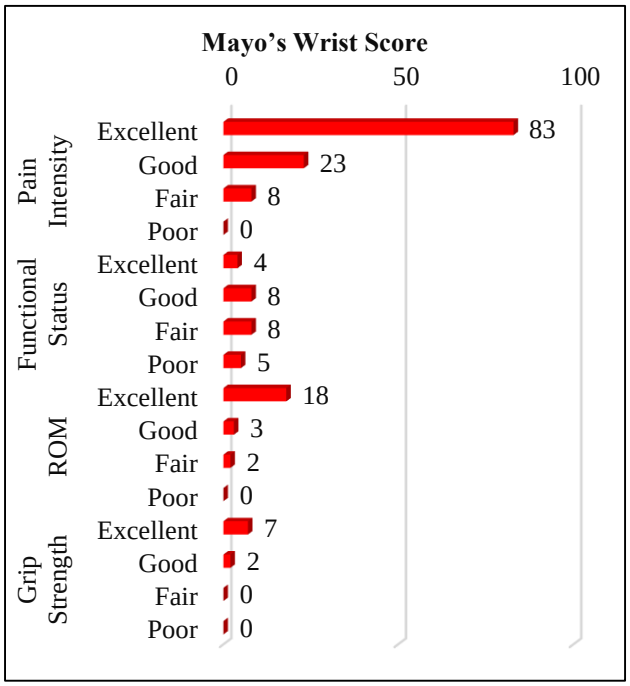

Figure 5: Distribution of patients according to Mayo's wrist score.

DISCUSSION

A hospital based descriptive, longitudinal study was conducted with 114 patients to assess functional outcome in patients of distal end radius fracture with volar displacement treated by locking compression plate.

Proposed advantages of locked volar plating include improved pull-out strength even in osteoporotic bone.[8] Internal fixation using a dorsal plate, which is greatly advocated, achieves anatomical reduction with good stability. However, a variety of complication has been documented, including irritation of subcutaneous tissue, tenosynovitis of extensor muscle, rupture of extensor tendon and even chronic pain.[9]

In the present study, the injury to surgery interval for 42 (36.8%) and 44 (38.6%) patients was 1-3 days and 4-7 days respectively while it was >7 days for 28 (24.6%) patients. The mean injury–surgery interval was 4.96±2.70 days. This finding was like the studies of Prasath et al, Maj Chahar et al and Chavhan et al.[10-12]

Prasath et al prospective longitudinal study observed showed mean duration between the time of fracture and surgery was 3.3 days.[10]

Maj Chahar et al prospective study showed 13 patients were operated within 5 days, 7 were operated within 10 days.[11] The average time interval between injury and surgery was 5.6 days.

It was observed in our study that the duration of fracture union was 2-3 months and 3-4 months for 98 (85.9%) and 10 (8.8%) patients respectively and >4 months for 6 (5.3%) patients. The mean duration of fracture union was 2.70±0.86 months. Similar observations were noted in the studies of Prasath et al, Maj Chahar et al, MacDermid et al, Chung et al and Chavhan et al.[10-14]

Proposed advantages of locked volar plating include improved pull-out strength even in osteoporotic bone.[15] Internal fixation using a dorsal plate, which is greatly advocated, achieves anatomical reduction with good stability. However, a variety of complication has been documented, including irritation of subcutaneous tissue, tenosynovitis of extensor muscle, rupture of extensor tendon and even chronic pain.[16]

In the present study, 6 (5.3%) and 2 (1.8%) patients had superficial infection and hypertrophic scar respectively while 1 (0.9%) patient had developed malunion. This is similar to the studies of Prasath et al, Maj Chahar et al and Chavhan et al.[10-12]

In our study, on the basis of demerit point score system of Gartland and Werley, 75 (69.4%) patients had excellent score while 24 (17.5%) and 15 (13.1%) patients had good and fair score respectively. No patient had poor score. Also, the pain intensity domain, functional status domain and range of motion domain of Mayo's wrist score shows excellent score in majority of cases as given in results.

Locked volar plates were well tolerated and it had allowed early mobilization and it had provided good support for deforming muscle forces after the surgical reduction, even among patients with intra-articular fractures. Avoidance of malunion is important, since a poor anatomical result adversely affects recovery of function as was reflected in the difficulties patients with malunion had with activities of daily living.

Limitations

Potential limitations in this study includes the cutoff of 60 years in inclusion criteria which is arbitrarily chosen to compare our findings with the previous meta-analyses that mainly focused on patient populations 60 years and older. We acknowledge that better evidence is lacking, and further evaluation using individual patient data meta-analysis is needed. Also, we were not able to accurately classify all complications owing to insufficient or missing information. In addition, this review included a variety of fracture types. However, reports have shown patient-reported outcomes to vary in the setting of multiple-trauma or high-energy injury mechanisms.

CONCLUSION

Volar locking plate at the distal end radius fracture with volar displacement treated by locking compression plate signifies a significant improvement in the treatment of distal end radial fractures in terms of restoration of the shape and function of the wrist. The technically simple palmar access, with a low rate of complications, allows exact anatomical reduction of the fracture. The multidirectional fixed-angle system provides strong support for the joint surface even in osteoporotic bone and allows simple subchondral placement of screws with sustained retention of the outcome of reduction and correction loss can be avoided by this procedure with early mobilization.

It is well established that locked volar plating for distal radius fractures performs well when assessed by surgeon oriented and technical measures of success. Volar plating has excellent functional outcome with minimal complications thus proving that it is the prime modality of treatment for distal radius fractures. The technique is useful for complex articular injuries and performs well when judged by patient reported outcomes and pain intensity domain of Mayo's wrist score measures of satisfaction.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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