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Functional and radiological outcomes of volar locking compression plate in surgical management of fractures of distal end radius

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Abstract

Background: Management of fractures of distal end radius has remained a controversial issue. They are treated via a variety of methods, but the best of treatment has not been defined yet. This study was performed to evaluate functional and radiological outcomes of volar locking plate in surgical management of such fractures.

Material and Methods: In this prospective study 30 patients aged above 18 years of fracture distal end radius were treated with open reduction and internal fixation with volar locking plates, followed by early mobilization. Patients were followed up regularly and functional assessment were done at 3 weeks, 3 months and 6 months using modified Mayo wrist score.

Results: Radiologically all patients had union at 3 months. 66.67% patients had excellent, 23.33% good and 10% showed satisfactory results on modified Mayo wrist score. No major complications were observed in the present study. One patient developed superficial infection which was resolved with serial dressing and broad spectrum antibiotics. Two patients developed hypertrophic scars. Two other patients developed asymptomatic hardware prominence (plate on radial border).

Conclusion: Locking compression plate provides stable fixation for early mobilization of patient, leading to early resumption to pre trauma functional level of an individual with minimal complications.

Keywords: Fractures of distal end radius, volar locking plate, modified Mayo wrist score, minimal complications

Introduction

Fractures of lower end radius are most common fractures of the upper extremity, encountered in practice and constitute 17% of all fractures and 75% of all forearm fractures [1].

The fracture is most frequently due to a fall onto a hyperextended wrist, with a combination of axial load and bending forces that produce the fracture of the distal metaphyseal part of the radius. Distal radial fractures have a bimodal age distribution, consisting of a younger group who sustains relatively high-energy trauma to the upper extremity and an elderly group who usually sustains low energy trauma [2].

A prospective, multicentric, epidemiological study estimated the incidence of these fractures to be 37 per 10,000 among women and 9 per 10,000 among men aged 35 years and above [3].

There is an overall increase in the incidence of these fractures in the last few decades. The pediatric and the elderly population are at greatest risk for this injury. The increase in the pediatric population can be attributed to surge in sports activities and road traffic accidents (RTA) while the growth of active elderly population is directly responsible for the increase seen in this age group. Most fractures in the elderly are the result of trauma due to a low energy force, with a fall from standing height being the most common [4].

To categorize distal radius fractures, AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification is simple, reproducible and has value in research and documentation [5].

Closed reduction and casting has historically been the mainstay of treatment. It was considered optimal in undisplaced fractures and in the elderly. However complications from conservative method include residual pain, impaired joint mobility,

malunion and reflex sympathetic dystrophy [6, 7]. Percutaneous Kirschner wire (K-wire) fixation and pin-in-plaster technique for both intra as well as extraarticular fractures had minimal manipulation and negligible devascularization of the bone as the potential advantages. However nerve injury and pin tract infection were associated complications with this mode of treatment. Similar complications were also reported using non bridging external fixator for comminuted distal radius fractures [8, 9].

Dynamic compression plates with rigid fixation disturbed the vascular supply of the bone fragments leading to non-union and delayed union. These insights led to the development of “biological osteosynthesis” [10]. To accomplish this concept locking compression plates (LCP) were introduced. By directly restoring the anatomy, plating allows secure internal fixation with resultant early return of wrist function. Furthermore, the increase in the incidence of sympathetic dystrophy with immobilisation over long durations is circumvented by this method of fixation. This new fixation technique of using LCP for treating distal end radius fracture shows promise in terms of stable intraoperative fixation and restoration of acceptable anatomy, resulting in early mobilisation and good recovery of function. This holds true even for osteopenic bones. Stable internal fixation with minimal complications can be achieved using distal radius LCP [11].

Material and methods

This prospective study was conducted in Department of Orthopedics of our institute over 30 patients. The plan of study was duly approved by institutional ethical committee of our college. Inclusion criteria included patients with closed distal radius fracture, duration less than 2 weeks, age above 18 years, healthy skin at the incision site, stable hemodynamic status and general condition of the patient and exclusion criteria were pathological fractures, open fractures, fractures with open physis, poor skin condition, any medical contraindication to surgery, patients not giving consent for surgery.

Radiological examination was carried out for knowing the type of fracture. Fractures were then classified according to the AO classification system depending upon the degree of comminution. Special investigation CT Scan with 3D reconstruction was done in suspected or overt multi fragmental displaced intra articular fractures for the purpose of classification and pre-operative planning.

After taking detailed informed and written consent all patients were operated using either regional block or general anaesthesia. Patient was placed supine on orthopedic table

with radiolucent operating side table. Dissection was done using standard FCR approach. Open reduction and fixation was done using appropriate sized plate depending on the fracture pattern. The reduction, plate and screw’s position and length was confirmed per operatively under image intensifier. After confirmation of position of plate, fracture fragments were fixed using appropriate sized screws. Below elbow POP slab was given for 5 days for relief of pain.

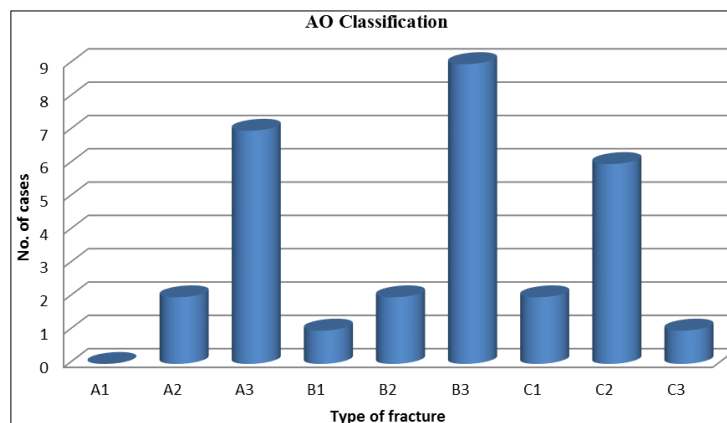
Post operatively all patients received broad spectrum intravenous antibiotics for a minimum of 5 days and then shifted to oral antibiotics till suture removal. On first post op day post-operative X-ray forearm with wrist (AP and Lateral view) was done and fingers, elbow and shoulder physiotherapy was started. First post-operative dressing was done within 48-72 hours of surgery and sutures were removed on 10th to 12th post-operative day. Gentle wrist exercises were started after suture removal as per tolerance and compliance of the patient. Patient was discharged with advice to do active wrist physiotherapy exercises, active finger movements and hand grip exercises.

Regular follow ups were done at 3 weeks, 3 months and 6 months for clinical ad radiological assessment. The outcomes were evaluated clinically in terms of pain, range of motions and complications. Radiological assessment was done for fracture union and anatomical parameters like volar tilt, radial inclination and ulnar variance. The value and practice of active physiotherapy was reinforced at each follow up. Final evaluation of the patient was done at 6 months as per Modified MAYO Score.

Observations and results

The study was started in January 2017 and completed in January 2019. Most of the patients in the study belonged to younger age group with age ranging from 19 to 55 years. The mean age of patients in the study was 33.03 years. There were 20 male patients (66.7%) and 10 female patients (33.3%). Road traffic accidents (i.e. high velocity trauma) was observed to be the most common mode of injury accounting for 46.67% of the cases whereas moderate velocity trauma (i.e. direct injury & fall from height) and low velocity trauma (i.e. trivial fall from standing height) were 26.67% each. Out of total patients, 17 patients had involvement of left side while 13 patients had involvement of right side. All patients had right handed dominance.

Most common type of fracture was observed to be AO type B3, accounting for 30% of the cases. Associated fractures were observed in 8 patients. The average time to surgery after episode of trauma in the present study was 5.47 days ranging from 1 to 12 days.



Graph 1: Fracture Classification

Depending upon fracture anatomy, fractures were fixed through volar approach. Stainless steel variable angle locking compression plate (VALCP, 2.7 mm) was used to fix fractures in 18 patients, while 12 patients were managed by using 3.5 mm stainless steel T-Plates.

Final assessment was done according to the modified Mayo Wrist Score (Pain intensity, Grip strength, Functional status, Range of motion). Radiological assessment (Union status, Volar tilt, Radial inclination, Ulnar variance) was also done at final follow up.

Pain Intensity: 21 patients had no pain, 9 patients had mild, occasional pain. There was no evidence of moderate or intolerable pain.

Functional Status: 27 patients returned to regular employment, 3 patients had restricted employment. There was no case of unemployment or unable to work because of pain.

Range of Motion (ROM): 20 patients had 100 percent ROM of normal opposite limb, 9 patients had 75-100 percent ROM of opposite limb, 1 patient had 50-75 percent ROM of opposite limb, 0 patients had 25-50 percent ROM of opposite limb.

Grip strength: Out of 30 patients, 29 patients had 100% of grip strength of normal opposite hand and 1 patient had grip strength 75-100% of normal opposite hand. 20 patients had final score between 91 to 100 (excellent outcome), 7 patients had score between 81 to 90 (good outcome) and 3 patients had score between 61 to 80

(satisfactory outcome) according to the Modified MAYO Wrist Scoring system. None of the patient had poor outcome.

Table 1: Final Functional Outcome (Modified Mayo Wrist Score)

S. No.	Final Functional Outcome	No. of Cases	Percentage
1.	Excellent	20	66.67%
2.	Good	7	23.33%
3.	Satisfactory	3	10%
4.	Poor	0	0
	Total	30	100

As per protocol X-Rays were done at 3 weeks, 3 months and 6 months. All fractures were found united at 3 months X-ray. There was no case of non-union or malunion requiring revision surgery.

Volar Tilt: 10 cases had volar tilt between 5 to 8.9 degrees, 6 cases had volar tilt between 0 to 4.9 degrees and 14 patients had volar tilt between 9 to 12 degrees. The average volar tilt observed in the present study was 7.33 degrees.

Radial Inclination: 1 case had radial inclination between 11 to 15 degrees, 13 cases had radial inclination between 16 to 20 degrees, 13 patients had radial inclination between 21 to 25 degrees and 3 patients had radial inclination between 26 to 30 degrees.

Ulnar Variance: 25 cases had ulnar variance ranging between -5 to 0 mm, 3 cases had ulnar variance of 0 mm and 2 cases had ulnar variance between 0 to +3 mm. The average ulnar variance as observed in the present study was -1.8 mm.



Pre-Op X ray

Post-Op X ray

3 months X ray showing union



Case 1: Functional Outcomes



Pre-Op X ray Post-op X ray 3 months X ray showing union



Case 2: Functional Outcomes



Pre-Op X ray Post-Op X ray 3 months X ray showing Union



Case 3: Functional Outcome

Discussion

The management of fractures of distal radius has always been a debatable and challenging issue for orthopaedic surgeons. The ultimate goal is to achieve proper reconstruction of disrupted anatomy and allow quick return of function without complications. The results of conservative management of these fractures have historically been unsatisfactory and many studies have reported better results with operative management. As a result conservative treatment is generally reserved for patients with minimally displaced fractures or for those who could not bear the stress of surgery. Also, the conventional fixation techniques like K-wires and external fixators have their own share of problems.

Locking plates offer more effective and suitable alternative for management of these fractures due to more angular stable construct, choice of fragment fixation on column basis and

better fixation for metaphyseal bone. Additional possible advantages of these plates include decreased soft tissue complications and absence of secondary displacement of fracture fragments even in the absence of adequate contouring of plates. The present study was therefore conducted in a prospective manner to evaluate the role of Volar locking compression plates in distal end radius fractures.

All patients had union radiologically at three months X-ray. However, union probably had occurred much earlier than three months. Similarly in the study conducted by Kwan *et al.* all fractures united at the three months follow up and in the study conducted by Wong KK *et al.* the time to union could not be determined because radiographs could not be taken frequently enough; some fractures healed long before the final radiographic assessment [12, 13].

There were minor variations in the anatomical parameters

(volar tilt, radial inclination and ulnar variance) in our study which were comparable with the other studies [13, 14, 15, 16] has not affected functional results significantly. However, significant variation in anatomy (post reduction) may result in cosmetic deformity, poor functional results and early symptomatic osteoarthritis.

Minor complications were reported in 5 of the patients (16.67%) enumerated and were resolved as detailed earlier. No major complications like deep infection, finger stiffness, tendon ruptures, nerve injury, vessel injury, non-union, malunion or implant failure were observed in the present study.

In the present study excellent to good results were obtained in 90% of the patients whereas 10% of the patients had a satisfactory outcome. Sugun *et al.* [17] reported excellent scores in 14 of their patients, good in 11, satisfactory in 20 and poor in one of their patient according to the MAYO wrist scores. According to MAYO wrist score Agarwala *et al.* reported excellent/good result in 88% and satisfactory result in 12% of patients and similar results were obtained in the study done by Chavhan *et al.* [14, 18] Results obtained in the present study are similar & comparable to the results reported in the literature in terms of union, anatomical parameters and functions with special feature of minimal complications.

Conclusion

Incidence of comminuted distal end radius fracture is on rise in younger population, mainly due to road traffic accidents involving two wheelers.

Varying degree of comminution is present in high velocity injury (RTA), hence pre-operative CT scan with 3D reconstruction can be a useful tool in pre-operative planning with suitable choice of implant.

Locking compression plates in the management of distal end radius fractures provides stable fixation for early mobilization of patient, leading to early resumption to pre-trauma functional level of a young individual.

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.

A separate set of study is required to evaluate the results of these plates and surgical procedure in geriatric age group with osteoporotic bone. Despite this our results are encouraging and add to the growing body of evidence in favor of open reduction and internal fixation of distal radius fractures using a volar locking plate construct in younger patients.

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