Surgical treatment of distal end of radius fracture with volar locking plate: Clinicoradiological outcome of 25 cases

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Abstract

Introduction: Distal radius reconstruction every time needs aggressive operative intervention is still a debate among researchers and upper extremity surgeons. There is a role of nonoperative treatment in geriatric population and unfit patients. Novel techniques and revolution of implants advocated the best clinical outcome.

Materials and Methods: We conducted a prospective study of 25 patients having AO OTA type A, B & C distal radius fractures treated with volar locking plate at our institute between 2015 to 2017. We include all close injuries in skeletally mature patients between ages 20-60 years. Outcome of the study was evaluated by using the Gartland and Werley score modified by Sarmiento & Patient Rated Wrist Evaluation (PRWE) score.

Results: 6 patients had AO OTA type A, 11 patients had type B and 8 patients had type C fractures. Mean palmar flexion was 77 degrees. Dorsi flexion was 82 degrees observed. Average supination and pronation were 85 & 80 degrees respectively. Radial & ulnar deviations average 11 and 25 degrees were observed. 80% of the patients had loss of radial inclination less than 9 degrees. All the patients had less than 6 mm radial shortening. Loss of palmar tilt less than 6 degrees was observed. More than 90% of the patients had excellent to good outcome based on Gartland and Werley score.

Conclusions: Volar plating is a proven method of choice in majority of distal end radius fractures regardless of comminution and fragments separation.

Keywords: Distal radius fractures, Internal fixation, Volar plate, AO OTA fractures.

Introduction

In current urbanisation and industrialisation, lower end radius injuries are widespread in emergency trauma hospitals.[1] in eighteenth century Dr Abraham Colles devised terminology which is now prevalent as one third of all adult skeletal injuries.[2]

Fifth to sixth decades persons with both genders are vulnerable to these injuries while females in their fourth decades which is perimanapausal age reported high incidence.[2] Road accidents play a major role sustaining these trauma while older persons has house fall with trivial insults.[3,4]

Pathoanatomy & biomechanics of radiocarpal & radioulnar joints have pivotal role in maintaining wrist functions and movements.[5] Problems associated with these fractures hamper strength of grip and early arthritis with carpal instability.

Congruity of articular surfaces can only achieved with ligamentotaxis and reconstruction of joint addressing each fragment along with early rehabilitation.[5] To date, valid components of treatment strategy includes reduction cast, ORIF with dorsal and volar approach locking plates and external fixators.[6]

Geriatric patients with less functional demands can be treated with non invasive cast reductions.[1] External fixators opt adequate ligamentotaxis but has inherent complications of pins with suboptimal articular reduction.[2]

Dorsal barton fractures with comminutions where buttress needed, dorsal approach low profile plates have excellent offset. But since no hardware is escaped without trouble, extensor tendons may damage.[7]

So volar plating is the mainstay of technique to achieve anatomic reductions and ligamentous reconstructions in majority of articular fractures of lower end of radius with less complications with meticulous surgeon.[7]

Materials and Methods

In our study, we included 25 patients having lower end of radius fracture coming to our institute as outdoor or emergency department treated with volar locking plates between years 2015 to 2017. Among them 15 are male and 10 are female with age ranges from 20 years to 60 years.

We use AO/OTA classification for distal radius fracture on the basis of plain radiographs. Patient's outcome measurements were determined using the Gartland & Werley score modified by Sarmiento & Patient Rated Wrist Evaluation (PRWE) score.

Inclusion Criteria

1. AO-OTA type A,B,C with subgroups
2. Close distal end radius fractures
3. Skeletally mature patients.

Exclusion Criteria

1. Fractures with diaphyseal involvement/ isolated radial styloid fractures.
2. Associated fracture of carpal bones.
3. Delayed presentation >2 weeks.
4. Pathological fractures.
5. Patient lost to follow-up.

Initial assessment of all the patients done to rule out any other associated injuries and splinting of affected limb was done. Clinical and radiographic evaluation of fracture was done by obtaining plain radiographs to evaluate loss of palmer tilt, dorsal angulation, radial shortening, loss of radial inclination and articular incongruity. Patients operated after proper counselling and informed consent. Operation done under regional or general anaesthesia using tourniquet and proper aseptic precautions.

Surgical Technique: Skin incision (Henry approach) taken at volar aspect of wrist between flexor carpi radialis tendon and radial artery. Skin subcutaneous tissue cut and haemostasis achieved. (Fig. 1)

Fig. 1: Exposure of pronator quadratus

By incising the tendon sheath and retracting the flexor polices longus to the ulnar side pronator quadratus is exposed.

By cutting pronator quadratus in L shape manner and retracting it, volar surface of distal radius is exposed (Fig. 2).

Fig. 2: Reduction done addressing each fragments and articular comminutions

Reduction done by manual traction and hold temporarily by k wires if necessary under IITV guide. Appropriate size plate selected and placed over volar surface of radius below the watershed line and temporarily fixed with cortical screw under IITV guidance. After confirming the desired reduction, remaining screws are fixed under IITV guide. (Fig. 3)

Pronator quadratus was repaired using absorbable sutures. Subcutaneous and skin closure was done. (Fig. 4)

Postoperatively radiographs were taken, the limb was kept elevated in below elbow plaster slab, active finger, forearm rotation and shoulder exercises were started at the earliest possible. The plaster slab was removed within 2 weeks, crepe bandage applied and active exercises of wrist, elbow and shoulder were started. Heavy lifting was not allowed until signs of fracture healing were radio graphically confirmed.

Fig. 3

Fig. 4

Evaluation of Outcome

Radio Logically: The follow up protocol was 6 weeks, 3 months, and 6 months. Clinical & radiographic assessments were performed at every visit. Radiological assessment included measurements of volar tilt, radial height & radial inclination & they were assesses according to the Sarmiento's modification of Lind storm criteria.

Clinical & Functional: Wrist range of motion was measured in flexion, extension, pronation, supination, ulnar deviation & radial deviation and was compared with uninjured limb. The overall function of the upper limb was assessed using the Gartland & Werley score, & patient rated wrist evaluation score (PRWE).

Case 1: 42 years male left side AO type c1 distal radius fracture

Pre op X-ray **Post op X-ray**

3 month follow up **Final follow up**

Case 1: Functional ROM at final follow up

Results

Mean age of our series of patients was 39 years. Most of the patients were in younger age group. Among 25 patients, there were 15 patients of less than 40 years of age. 16 patients were male and 9 were females.

There were 10 patients who had injury to right side, rest of 15 patients having injury to left side. All the patients were having right hand predominant.

Incidence of road traffic accident was more as compared to domestic fall down. This may be due to physically active young patients are more in our study.

Among the various classification of distal radius, we choose to consider A O / OTA classification for our study. (Graph 1)

According to AO classification, there were 12 patients having type B fracture. Among them type B 3 subtype was most common.

There were 96% of patients having excellent to good palmar flexion range at wrist at final follow up. One patient has fair outcome and she presented as residual dorsal tilt at final follow up. Most of the patients had palmar flexion range from 65–85 degrees. The average palmar flexion was 77 degrees.

All the patients have excellent to good results in terms of range of dorsi flexion at wrist at final follow up. All the patients had dorsi flexion range from 56- 85 degrees. The average dorsi flexion was 82 degrees.

There were 96% of patients having excellent to good supination range at wrist joint at final follow up. All the patients except one had supination range from 76-85 degrees. The average supination was 85 degrees.

All the patients have excellent to good pronation range at wrist joint at final follow up. Twenty two patients having pronation range from 76-85 degrees.

The average pronation at final follow up was 80 degrees.

In our study, 92% of the patients had excellent to good radial deviation range at wrist at final follow up. Most of the patients (23 patients) having radial deviation range from 10-20 degrees. The average radial deviation was 11 degrees.

All the patients in our study had excellent to good ulnar deviation range at wrist at final follow up. All of the patients having ulnar deviation range of 20-30 degrees. The average ulnar deviation at final follow up was 25 degrees.

X-rays of the patient were evaluated for Radiological assessment of Radial inclination, Radial shortening and Palmer tilt evaluated according to.

In our study, more than 80% of the patients had loss of radial inclination less than 9 degrees and had excellent to good results.

The average radial inclination at final follow up was 19 degrees.

In this study of 25 patients, all the patients had less than 6 mm radial shortening and had excellent to good results at final follow up. The average radial length at final follow up was 10 mm.

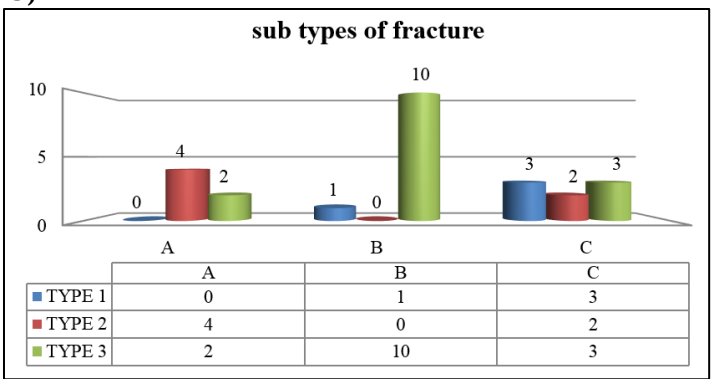
More than 60% patients had excellent to good results with regard to loss of palmar tilt less than 6 degrees. There were 9 patients showing loss of palmar tilt upto14 degrees and had fair outcome. It could be due to dorsal comminution and dorsal collapse on subsequent follow up.

Average palmar tilt at final follow up was around 7 degrees.

More than 90% of the patients had excellent to good outcome based on Gartland and Werley score. Among them two patients had fair outcome. Both of them had dorsal tilt at final follow up. Both of them were low demand patients.

We observed prominence at ulnar styloid in 3 patients (12%), residual dorsall tilt in 2 patients (8%), manus valgus in 3(12%), reflex sympathetic dystrophy in 1(4%) patient and hand grip strength weakness in 1(4%) patient.

Graph 1: Classification (AO)



Graph 2: Results showing range achieved by patients

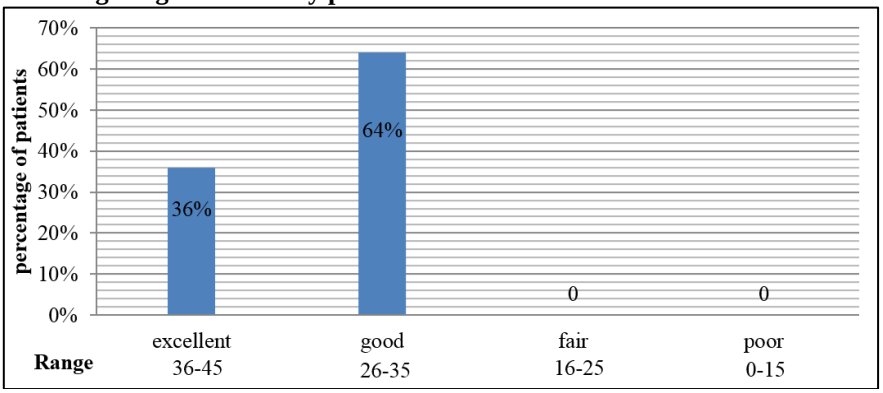


Table 1: Sarmiento's modification of Lind Storm criteria

Loss of radial inclination (degrees)	No. of Patients[%]	Results
<5	14[56%]	Excellent
5-9	8[32%]	Good
10-14	3[12%]	Fair
>14	0	Poor

Table 2: Scoring system (Gartland & Werley (G & W) Score)

G&W Score	Number of patients	Percentage
Excellent 0-2	21	84%
Good 3-8	2	8%
Fair 9-20	2	8%
Poor >20	0	0%
Total	25	100%

Table 3: Clinical outcome

	Palmer flexion	Dorsi flexion	Pronation	Supination	Radial deviation	Ulnar deviation
Average	74.6 (75)	80.2 (80)	86.6 (87)	81	10.6 (11)	25

Table 4: Radiological outcome

	Palmer tilt	Radial length	Radial inclination
Average	7.44 (7)	10.4 (10)	19.5 (19)

Discussion

Chung et al[9] hypothesized demographical and population based incidence of internal fixation of distal end radius is on disposal. Patients consulted first to hand surgeons are more likely to be treated by internal fixation. We have included 25 patients, among them 16 were male and 9 were female with an average age of 39 years (20–75 years) having distal end of radius fracture treated with volar locking plate from 2014 to 2016 in our institute.

We observed mean age in our study was 39 years. In a study by Kenny Kwan et al[10] mean age was 51 years.

In a study conducted by Kenny Kwan et al[10] mean supination and pronation were 86 and 80, we observed clinically 85 degrees supination and 80 degrees pronation. We have small sample size compared to this study which has sample size 75 patients. Radial and ulnar deviations are 11 and 25 degrees in our study while 23 and 37 degrees respectively in Denju Osada et al[14] series.

In our study the radiological outcome are within acceptable criteria. Clinical outcome in view of wrist range of motion and grip strength are also satisfactory. The total functional result on the basis of Gartland and Werley score was 76% of excellent and 8% of good outcome on final follow up at approximate 6 month of follow up.

The primary goal in treatment of unstable fractures of the distal radius is to achieve proper reconstruction of the disrupted anatomy and expedite return of hand function without complications. Volar plating is considered superior in clinical radiological and surgical outcome of patients compared to dorsal plating in majority of distal end radius AO type fractures.

Palmar flexion in our study mean 77’ achieved while in Denju Osadaet al[14] series 66’ achieved. Wrist dorsiflexion mean 75 degrees was in a study by Denju Osada et al,[14] while we achieved mean 82 degrees of dorsiflexion of wrist.

Surgical approach, fracture reduction, and volar plating techniques are easier than dorsal plating. Vascularity of dorsal distal radius is not hampered with volar plating. Extensor tendon handling in dorsal approach may injure these structures which is preserved inn palmar approach. Closure of the wound preceded by well coverage of healthy pronator quadratus breasting over volar plate.

With the advent of low profile fragment specific and other locking plates flexor tendons are very well preserved and safeguarded by volar plating if placed meticulously just before watershed line. In absence of severe comminutions, volar plating confers desirable and successful articular reduction and satisfactory outcome.

Anatomical reduction of the palmar cortex may avoid the shortening of the radius, which is important to its restoration. Plate requires bending according to AO principle of fracture reduction despite of relatively flat volar surface compared to dorsal distal radius.[13,14,11]

Sobky et al[12] biomechanical study indicates volar fixation of unstable distal radius fractures with a fixed angle device is a reliable means of stabilization.

Most complications of distal radial fracture treatment are the consequence of required immobilization of the wrist for between 4 and 6 weeks with either a plaster cast or an external fixator. This also applies to operative methods either by volar plating with non-locking screws, combined volar and dorsal plating AO OTA type A and B fractures with less comminution rarely need a period of immobilization although type C also don’t require immobilization fixed with latest locking low profile fragment specific plates.[11]

In order to achieve reproducibly good results, some aspects of the surgical technique are very important.

The distal locking screws have to be placed as close to the articular surface as possible. These screws act as a rake, maintaining reduction. Some oblique intraoperative views are recommended to precisely assess screws tips penetration and trajectory.[11]

We didn't observe tendon related injuries in our series of patients as flexor tendons are vulnerable to injury if plates are fixed beyond topographical boundary which in turn leads to flexor tendon synovitis. In our series no extensor tendons related problems encountered as these tendons are frequently irritated by longer tips of locking screws from plates fixed volarly.

Some of the patients present with complex regional pain syndrome. This may be due to prolong immobilization and inadequate physiotherapy. Study conducted on large series of patients Kenny Kwan et al[10] showed 11 complications at various stages of follow-ups postoperatively.

We have come across some of the complications. Among all, 3 patients having prominent ulnar styloid process and radial deviation of wrist and 1 patient having residual dorsal tilt. One patient developed RSD. One patient had loss of reduction subsequent follow up. None of our patient got infected.

Jupiter et al[8] study advocated mean Gartland and Werley score improved significantly from 4 points at six months to 2 points at two years.

We achieved Gartland and Werley score excellent results in 84% and good results in 8% of patients. Denju Osada et al[14] and Kenny Kwan et al[10] demonstrated 96% and 91% excellent results respectively.

Conclusion

1. Accurate anatomical reduction of distal end radius fracture with internal fixation with volar locking plate is promising and proven technique. Screws penetration inside joint and dorsal cortex can be avoided.
2. Volar plating has its own drawbacks but are less compared to other modality of treatments.
3. Flexor as well as extensor tendons are safeguarded by meticulous volar approach and by learning plate fixation techniques.

Conflict of Interest: Nil

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