"Management of dorsally displaced distal radius fracture by volar fixation using locking compression plate."

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Abstract:

Introduction: Dorsally angulated and displaced fractures of distal radius are common and tend to suffer secondary treatment after conservative treatment. Present study was planned to evaluate the functional and radiological results of treating unstable dorsally displaced fractures of distal radius with locking compression plate

Material & methods: 25 cases of dorsally displaced distal radius fractures (9 men and 16 women; mean age ,49.8 years) were fixed by volar locking compression plate and followed up followed for six months minimum.

Results: Lidstorm's anatomical criteria showed 23 grade I (excellent) and 2 grade II (good) results while functional results 10 excellent, 10 good outcome while 3 patients exhibiting fair & 2 poor results. Only one patient had superficial infection**.**

Conclusion: From present study we may conclude that volar locking plate is a safe and effective treatment for dorsally displaced unstable fractures of distal end radius

Key words: bone plate, radius fracture, fracture fixation, locking

INTRODUCTION:

Nowadays with improved quality of life with increased Life expectancy is definitely increased so more and more world population is becoming gray. This geriatric group of population has the problem of old age like osteoporosis , poor vision and loss of balance associated with them. This has led to increased test to interval chances of fall resulting into lower radial fracture.

Dorsally angulated and displaced fractures of distal radius are common and tend to suffer secondary treatment after conservative treatment. Restoration of radial length, volar tilt, and radial inclination are important for good clinical outcome. Because distal radius is foundation of wrist joint and indispensable part of ligamentous support, reconstruction of the articular congruity and stable fixation reduces the incidence of posttraumatic arthritis and early functional rehabilitation[1].

As far as choice of approach is considered dorsal approach is associated with high rate of complications[2,3]. Double plating is associated with loss of reduction related to comminution and osteoporosis[4]. Volar approach has advantages, including more spacious volar aspect of distal radius, avoidance of dorsal dissection and associated problems of extensor tendons, and possible deprivation of blood supply to the dorsal metaphyseal fragments[5]. In order to help to accomplish this new concept of biological plate fixation, new implants such as locking compression plate (LCP) have been introduced. Locking minimizes the compressive forces exerted by the plate on the bone. This method of screw plate fixation which provides angular and axial stability and it means that the plate need not touch the bone at all. Precise anatomical contouring of a plate is not necessary.

This technique better preserves blood supply to fracture fragments and also prevents the loss of primary reduction of fracture fragments caused by inadequate contouring of a plate and secondary displacement of unstable fracture in elderly patients with osteoporotic bone[6]

Present study was undertaken to evaluate the functional and radiological results of treating the dorsal unstable distal radius fractures with volar locking plate.

MATERIAL AND METHODS :

A longitudinal prospective study was conducted at CPR Hospital, Kolhapur . From August 2007 to July 2009 ,25 patients with distal radius fractures were treated with open reduction and internal fixation with locking compression plate.

Inclusion criteria was dorsally displaced fracture of unstable type as per criteria of Cooney et al[7,8]. Exclusion criteria were fractures of immature skeleton, dorsal Barton fractures, distal radius fractures extending to shaft of radius, and concomitant fractures of the same limb.

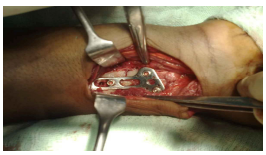
Surgical technique:

15 patients were operated under Brachial Block while 10 patients under general anesthesia.

Photograph 1) Pre and post operative radiographs showing good alignment and fixation

Tourniquet was applied. Standard Henry approach was used.

Photograph 2) Volar Incision



Photograph 3)Plate application

The virtual place under flexor tendons was developed and the distal and radial borders of pronator quadratus were lifted and retracted ulnarly. Open reduction was done with intrafocal leverage, traction by an assistant, and fixation by temporary Kirschner wires. As the subchondral screws hold the articular surface well, bone grafting was not done in any of the patients. The plate used was a 3.5 mm obliquely T shaped locking compression plate of 316L stainless steel and of Indian manufacturing make(uma surgicals).

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. After fixing the distal fragments with subchondral locking screws, radial length was gained when necessary by pushing the plate distally. More volar tilt can be achieved during distal screw placement when the wrist is volarly flexed as much as possible by an assistant. The optimum placement of distal screws is important. They must be 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. Dorsal comminution may not afford stable purchase dorsally; however it is not crucial to the stability of the stability of the whole mechanism. The first standard screw can be either left in situ or exchanged with another locking

screw. The locking screws are in the vertical limb of the plate to end the procedure[1].

Protection with dorsal below elbow slab was given for two weeks. Early motion of digits, elbow and shoulder was started on next day. Intravenous antibiotics were given one hour before anesthesia, continued for 48 hrs. postoperatively and then oral antibiotics were given for one week. Patient was discharged at third postoperative day after first dressing. Follow up of each patient was done at the end of first, second, fourth, sixth week and after 3 months and 6 months. Physiotherapy and occupational therapy was started at the end of two weeks.

Fractures were classified according to Farnandez classification[9](Annexure II). Follow up radiographs were taken at each follow up to assess reduction and bony union. Radioloigcal parameters including volar tilt, radial inclination and ulnar variance were measured before and after surgery, as well as at comparison with the contralateral arm.

The subjective, objective and radiographic findings were quantified by Lidstrom's system[10].(annexure III) The outcome of each fracture was graded as excellent, good, fair or poor. The subjective evaluation consisted of pain, disability, restricted activity and limitation of motion. Objective evaluation consisted of grip power, range of motion of the wrist and forearm, and complications such as finger contracture and median nerve injury.

OBSERVATIONS AND RESULTS :

Final assessment of all 25 patients was done at six months. The mean age (9 men and 16 women) was 49.8 years.18 patients (72%) patients had fractures involving their right hand(dominant). Majority of injuries were caused by slip or fall on outstretched hand (72%),while 20% injuries were due to fall from height and 8% were due to road traffic accident.Closed fracture was the commonest type of fracture (96%) and only one patient had grade I open fracture.Distribution as per Fernandez classification was type I(n=9), type II(n=8), type III(n=6), type IV(n=0), type V(n=2)

The mean interval between injury and surgical intervention was 5.5 days (range 1-9 days). Preoperative radiographic evaluation showed that the mean dorsal angulation was 20^0, (range $8\text{-}44^0$), mean radial inclination was 14.5^0 (range $4\text{-}29^0$), Mean radial shortening was 3mm (range 1-5mm).

TABLE – I :

Parameter	Normal Range	Average Results after six months
Volar Angle	0-22°	**11^0**
Radial Angle	16-28°	**22^0**
Radial Length	**11-12mm**	**11mm**

No patient had secondary displacement. All fixations were maintained throughout the follow up period so that the final assessments were the same as intra operative alignments.

Average movements achieved at the end of one year were dorsiflexion 69^0, palmarflexion 64^0 , radial deviation 23^0, ulnar deviation 35^0, supination 89^9 and pronation 80^0

Grip strength was excellent in 52%(n=11), good in 44%(n=13), poor in 4%(n=1).

According to Lidstorm's criteria the results of this study are as follows

Table II A: Anatomical End Results

A.	Satisfactory	Cases	Percentage %
	Grade I	23	92%
	Grade II	2	8%

Satisfactory anatomical results was observed in 100% cases.

Table II B: Functional end results

Results	No. of Cases	Percentage %
Excellent	10	40
Good	10	40
Fair	3	12
Poor	2	8
Total	25	100

Out of 25 patients, 20 (80%) patients showed satisfactory functional results. In these 10 patients had full range of movements and excellent grip strength and 10 patients had terminal loss of movements and little loss of grip strength. Only 5 cases(20%) showed unsatisfactory functional results with gross restriction of wrist movement and poor grip strength which could be explained by the fact that these patients had grossly comminuted intra-articular fractures and/or with metaphseal comminution.

In the present series final anatomical and functional end results were 80% satisfactory (good and excellent) and 20% unsatisfactory (fair and poor)

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.

No patient had experienced a change in daily activity or occupation after six months.

Complications included superficial infection in one patient which healed with dressings for ten more days. Three patients had hypertrophic scars which were treated conservatively. No patient had carpal tunnel syndrome, tendinitis, dorsal screw penetration, screw loosening, pull out of plate and screws, loss of reduction, malunion or nonunion.

DISCUSSION :

The dorsal surgical approach with dorsal plate fixation is biomechanically effective in dorsally displaced fracture of distal radius. Leung etal[6] demonstrated no statistical difference between axial loading transmission through intact radius and distal radius fracture fixed with volar locking plate. In fact advantages of volar plating over dorsal plating are as follows.

The volar cortex of the distal radius was often not comminuted when compared with dorsal cortex. So that anatomical reduction of volar cortex may avoid shortening of the radius. The palmar cortex is flat for application of plate than on dorsal cortex. The dorsal approach often requires dissection of extensor retinaculum ,sometimes resection of Lister tubercle. The extensor pollicis tendon is commonly exposed to mechanical attrition by plate and screws. In the volar approach, the space of parona provide more room for implant placement. The pronator quadratus also acts as barrier to minimize irritation of extensor tendons[1].

Radiological Parameters in present study : Average results after six months, we had an average Volar angle of 11°, radial angle of 22° and radial length of 11 mm. In all cases, volar tilt was maintained-(Table I)

Kamano etal[11] in a series of 33 patients maintained a mean volar tilt of 9^0 and had 12 excellent results, 20 good results, and one fair result.

Orbay and Fernandez[9] reported in series of 31 patients showed no secondary displacement and mean postoperative volar tilt 50 and the functional results were 19 excellent and 12 good.

.Rizzo, B.A. Katt, J.T. Carothers[12] in their comparative. Study of Locked Volar plating versus pinning and external fixation in the treatment of unstable intra articular distal radius fractures had on average volar tilt of 11° and radial angle of 23° and radial length of 11 mm in volar plate group at the final follow up. K. Murakammi, Yoshihiro Abe and Kazuhisa Takahashi[13], in their study of surgical treatment of unstable distal radius fractures with volar locking plates had a mean volar tilt of 8.1° radial angle of 20°

It has been shown by Palmer A.K.[14] and Mino D.E. that radial shortening is the primary cause of poor end results and it leads to changes in the load within the wrist joint. Patients in present series with poor results had significant radial shortening and articular incongruity.

Movements after six months . K. Egol, M. Walsh, W. Tejwani[15] and others in their prospective trial of bridging external fixation and supplementary Kirschner wire fixation versus volar locked plating for unstable fractures of the distal radius got the following functional results in volar plate group at end of 12 weeks. Dorsiflexion - 72%, Palmarflexion - 67%, Radial deviation - 69%, Ulnar deviation 67%, Supination - 81% pronation - 94%

N. Schmelzer - Schmied, P. Wieloch, A.K. Martini[16]in their comparative study of external fixation, locking and non locking palmar plating for unstable distal radius fractures in the elderly had an average movements of 64° dorsiflexion, 61° palmar flexion, 21° radial deviation, 26° ulnar deviation, 79° supination and 79° pronation in the locking plate group.

K. Murakami[13] and others in their study had an average movements of 61° dorsiflexion, 55° palmar flexion, 23° radial deviation, 35° ulnar deviation, 87° supination and 87° pronation.

M. Rizzo, B.A. Katt, J.T. Carothers[12] in their study had an average of 69° dorsiflexion, 64° of palmar flexion, 23° radial deviation, 34° ulnar deviation 76° supination and 78° pronation in the locked volar plate group.The results of movements at six months in present study are comparable to the majority of the above series, the average results in present series are as follows Dorsiflexion - 69°, Palmarflexion - 64°, radial deviation - 23°, Ulnar deviation - 35°, supination - 80°, pronation 80°

Grip Strength

K. Murakami[13] in their series reported the mean grip strength in the involved limb was 84% of the grip strength in the contralateral limb for patients who had injured their dominant hand and 73% for those who had injured their non-dominant hand. In present series, we had good to excellent grip strength in 92% patients.Also according to a study of Y. Zenke, A. Sakai, T. Oshige[17]and others - the presence of an associated ulnar styloid fractures does not adversely affect the outcome in patients with a fracture of the distal radius treated by volar plating.

According to N.Schmelzer, Schmied. P. Wieloch[16] the locking plate fixation demonstrated the best radiological and functional results, than that of external fixation and non-locking palmar plating.Erick D. Peterson, David G. Dennison[17], in 2007 in their study concluded that fixed angle volar plate fixation for distal radius fractures in patients with chronic immunosuppression was associated with union, no wound healing problems or infections and with functional wrist and forearm motion and grip strength.

CONCLUSION:

Volar application of locking compression plate for dorsally displaced fracture is a safe alternative. It provides stable fixation , early mobilization with excellent radiographic and functional results and minimal complications.

LIMITATIONS :

The drawback of present study was that the patients recruited were heterogeneous in terms of the type of fracture and patient demographic background. Recruitment focused on specific fracture type in a similar population would have been better. It is difficult to conduct a prospective double blind comparison of volar and dorsal fixation on the distal radius as recruiting patients is difficult.

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ANNEXURE I

Criteria of Cooney[8] et al for deciding unstable fracture.

1. Marked dorsal comminution of distal end radius
2. Dorsal angulation more than 20^0
3. Radial shortening more than 10mm
4. Fractures involving wrist with articular step more than 3mm
5. Loss of reduction with dorsal angulation of more than 10^0 and 50 mm or more of radial shortening after closed reduction.

Annexure II

Fernandez[9] classification

Type I: Extra articular bending fractures

Type II: Intra articular shearing fractures

Type III: Compression injuries leading to complex articular fractures and radial

pilon fractures

Type IV: Avulsion fractures of ligament attachment

Type V: high velocity injuries involving multiple forces and extensive injuries

ANNEXURE III:

Lidstorm's[10] criteria

Lidstorms anatomical criteria[21] :

Grade I:No significant deformity.
Dorsal angulation not exceeding neutral position.
Radial shortening < 3 mm.

Grade II:Slight deformity
Radial shortening 3-6 mm.
Dorsal angulation 1-10°

Grade IV:Severe deformity
Radial shortening more than 12 mm
Dorsal angulation more than 15°
Loss of movements up to 40°

Lidstorms criteria for functional end results :

Excellent:No residual disability.
Full wrist and forearm movements.
No loss of grip strength.
No deformity.
Good:Minimal disability.
Loss of movements up to 20°
Slight loss of grip strength.
Minimal deformity
Fair:Moderate disability.
Loss of movements up to 40°
Moderate loss of grip strength.
Moderate deformity.
Poor:Gross disability.
Gross limitation of wrist and forearm movements.
Severe loss of grip strength.
Gross deformity.

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