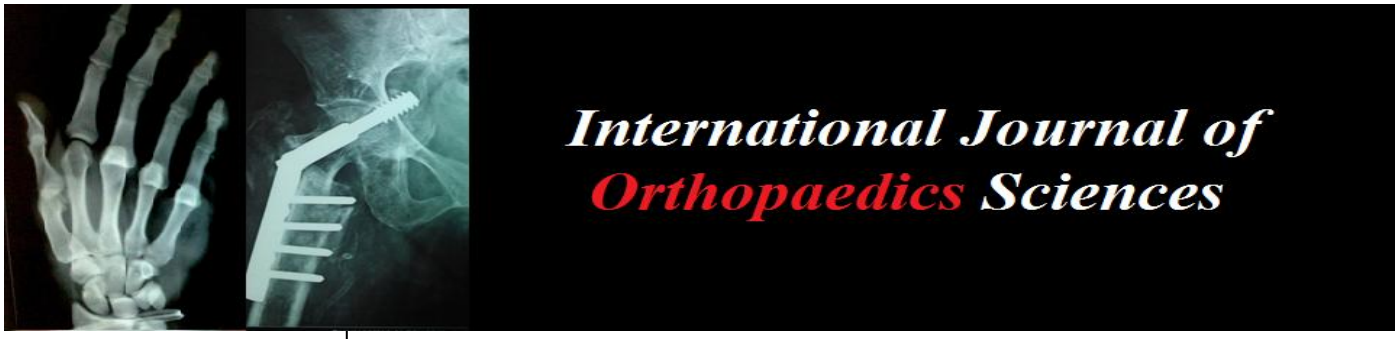

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Volar locking plate is a better option for the treatment of distal end radius fractures-our experience in 30 cases: A prospective study

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Abstract
Distal end radius fractures constitute 17% of all fractures and 75% of all forearm fractures. Due to population explosion, aging society, & enormous increase of high-speed RTAs', these fractures are expected to increase in the coming decades. Hence the distal radius fracture requires a new reassessment and a new concept for adequate and optimized timely treatment.
Various surgical techniques have been reported in literature but open reduction and internal fixation with a volar plate system is currently advocated for the treatment of distal radius fracture resulting in good reduction and immediate stability. It has become popular because it
a. Provides direct control and maintainance of physiologic palmar tilt,
b. Prevent collapse and
c. Avoid bridging the radio carpal joint.

The purpose of this study was to evaluate functional outcome in patients with distal radius fractures treated with a fixed angle locking compression plate in terms of union, restoration of alignment and function and complications.
Material and Methods: The study was conducted at Medical College in AP from September 2016 - February 2018. Thirty patients with distal radius fractures (18 males and 12 females) were treated by open reduction and internal fixation with volar locking plate.
Results: The results were assessed using the demerit score system of Gartland and Werley based on objective and subjective criteria, residual deformity and complications. We had 20 (67%) excellent, 6 (20%) good, 4 (13%) fair results and no poor results.
Conclusion: We conclude that Locking plates by volar approach provide successful results for the treatment of both extra articular and intra articular unstable fractures of distal radius.

Keywords: Distal radius fracture, open reduction internal fixation, volar locking plate

Introduction
Fractures of distal end radius are the most common fractures of the upper extremity, constituting 17% of all fractures and 75% of all forearm fractures [3]. Due to population explosion, with an aging society, & enormous increase of high-speed motor vehicle accidents, the number of distal radial fractures can be expected to increase in the coming decades. Hence the distal radius fracture requires a new reassessment and a new concept for adequate and optimized timely treatment.
The increased life expectancy and the related osteoporotic changes in the skeleton adds to complications. The family history of osteoporosis, fractures and smoking leads to higher risk. Distal radius fractures occur most often in older postmenopausal women. It is four times more common in women than in men, mostly aged 60-70 years.
Distal radial fractures are treated by wide arrays of technique such as closed manipulation, POP cast reduction and percutaneous pins, pin and plaster, ligamentotaxis external fixation & internal fixation etc.
Open reduction and internal fixation are indicated to address the unstable distal radius fractures and those with articular incongruity that cannot be anatomically reduced and

maintained through closed manipulation and ligamentotaxis and percutaneous pinning.

Various surgical techniques have been reported in literature but open reduction and internal fixation with a volar plate system is currently advocated for the treatment of distal radius fracture resulting in good reduction and providing immediate stability. Moreover, the patients can be mobilized early and quickly potentially reducing wrist stiffness [8].

Internal fixation of metaphyseal bending fractures has become increasingly popular due primarily to (a) Directly control and maintain physiologic palmar tilt, (b) Prevent collapse with external fixation, and (c) Avoid bridging the radio carpal joint.

Though the distal fragment typically has sufficient size and integrity to provide adequate purchase and may be approached from either a dorsal or a volar approach, palmar plating is preferred. The screws directly buttress against collapse and loss of palmar tilt. With smaller and more distal fragments, a dorsal plate has to be positioned distally on the dorsum of the radius making extensor tendon injury more likely [1].

When using conventional plate comminution must be less, they poorly hold the cancellous bone fragments, toggle of screws in the distal holes of the plate leads to settling and loss of reduction.

The stability is achieved by compression of plate to bone by bi-cortical screws.

With fixed angle locking plates, the locking screws support subchondral bone and resist axial forces. Compression of locking compression plate to bone is unnecessary and preserves periosteal blood supply [4]. Fixed angle construct provides additional strength to fixation by constructing a scaffold under the distal radial articular surface [6]. They are an effective treatment for unstable extra articular distal radius fractures allowing early post-operative rehabilitation [2]. Because of angular stability of locking compression plate, secondary displacement is no longer a problem irrespective of the bone grafting enabling good results in osteoporotic bones and young patients [3].

The purpose of this study was to evaluate functional outcome of patients with distal radius fractures treated with a fixed angle locking compression plate in terms of union, restoration of alignment and function and complications.

Material and Methods

The present study was conducted in the department of Orthopaedics at our medical college between September 2016 to February 2018. Thirty patients with distal radius fractures (18 are males and 12 are females) were treated by open reduction and internal fixation with locking plate.

Inclusion Criteria

Adults (aged over 18 years) both Male and Female with unstable, Extra articular and comminuted or intra articular fractures of distal end radius.

Exclusion Criteria

- Patients aged below 18 years.
- Patients medically unfit for surgery
- Compound fractures associated with vascular injuries.
- Patients who are not willing for surgery.

Radiographic Examination

Standard radiographs in PA and lateral views were taken for confirmation of the diagnosis and also to know the type of fracture. Oblique views were also taken in a few patients who had complex comminuted fractures. The fracture fragments were analyzed and involvement of radio carpal and distal radioulnar joints were assessed and classified according to the Frykman's and AO classification. The operations were performed under Brachial Block in all cases and General Anesthesia in 3 cases using pneumatic tourniquet with standard volar approach.

The optimal placement of the distal screws is important: they must be inserted at the radial styloid, beneath the lunate facet, and near the sigmoid notch. The screws must not penetrate the dorsal radial cortex (screws should have minimum purchase of 70 % of distal radial metaphyseal width). As the screws are placed in a very sub chondral manner, there is a high risk that there may be some inadvertent penetration of the joint. Special care must be taken to exclude this with imaging. As the plate is so distal, flexor tendon irritation is common and so this plate usually has to be removed.

More volar tilt can be achieved during distal screw placement when the wrist is volar flexed as much as possible by an assistant. Moreover, radial length can be 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.

Pronator quadratus muscle was used at the time of closure, to cover, in part, the implants that were applied to the anterior surface of the radius. The operated limb was supported with an anterior below elbow POP slab with the wrist in neutral position.

Postoperatively patient was kept in ward for 10 days. Check x-ray was taken post operatively. Sterile dressings were done on 2nd, 5th and 8thpost operative day. Sutures were removed on 10thpost operative day and patient was discharged with below elbow pop slab. Patients were assessed clinically and radiographically at 8weeks, 12 weeks, and 24 weeks to assess the fracture union and document the progress of patient's recovery. After clinical and radiological union results are evaluated as per Demerit point system of Gartland and Werley

Observations and Results

The following observations were made from the data collected during the study of locking plate in distal radius fractures.

Age of the patients with distal radius fractures

Age in Years	No. of cases	Percentage
18-30	6	20
31-40	12	40
41-50	6	20
51-60	4	13
61-70	2	7

In this series 6 (20%) patients were between 18-30 years, 12 (40%) between 31-40 years, 6 (20%) between 41-50 years, 4 (13%) between 51-60 years and 2 (7%) patients between 61-70 years. Distal radius fractures more common in age group of 31-40 years old due to RTA.

The age of the patients ranged from 18-70 years with an average of 40.6 years.

Sex Incidence

Age in Years	No. of cases	Percentage
Male	18	60
Female	12	40

In the present study the fracture distal radius was more in males than females.

Side of Involvement

Side	No. of Cases	Percentage
Right	21	70
Left	9	30

In the present study fracture distal end of radius is more on the right side when compared to left.

Mode of Injury

Mechanism of Injury	No. of Cases	Percentage
Road traffic accident (RTA)	21	70
Fall on out stretched hand (FOOH)	9	30

In our study there were 21 (70%) patients with road traffic accidents and 9 (30) patients fell on their outstretched hand domestically.

Type of fracture according to Frykman's classification

Type	No. of Cases	Percentage
I	5	16.7
II	3	10
III	7	23.3
IV	5	16.7
V	2	6.6
VI	2	6.7
VII	3	10
VIII	3	10

Out of 30 cases, 5(16.7%) of the fractures were of Type I Frykman's Classification, 3 (10%) of Type II, 7 (23.3%) of Type III, 5 (16.7%) of Type IV, 2 (6.6%) of Type V, 2(6.7%) of Type VI, 3 (10%) of Type VII and 3 (10%) of Type VIII fractures.

AO Classification

Type	No. of Cases	Percentage
A1	0	0
A2	8	26.7
A3	4	13.3
B1	6	20
B2	2	6.7
B3	4	13.3
C1	3	10
C2	2	6.7
C3	1	3.3

8 (26.7%) of the fractures were of AO Type A2, 4 (13.3%) of Type A3, 6 (20%) of Type B1, 2 (6.7%) of Type B2, 4(13.3%) of Type B3, 3(10%) of Type C1, 2 (6.7%) of Type C2, and 1(3.3%) of Type C3. There were no cases of AO type A1 fractures among the 30 cases in the present study.

Closed/open fracture as per Gustilo-Anderson classification

Type	No. of cases	Percentage
Closed	29	97
Open Type – I	1	3

29 (97%) of the fractures were of closed Type and 1 (3%) was Open Type, as per Gustillo and Anderson Classification.

Extra Articular and Intra Articular Fracture

Type	No. of cases	Percentage
Extra articular Fractures	12	40
Intra articular Fractures	18	60

12 (40%) of the fractures were of Extra particular Type and 18 (60%) were intra articular fractures

Associated Injuries

Associated Injuries	No. of cases
Ipsilateral fracture shaft of femur	1
Contusion head injury	2
Total	3

3 (10%) patients had associated injuries.

Duration of Operation from Date of Injury

Duration	No. of cases	Percentage
1-5 days	28	93
6-10 days	2	07

Surgery was done between 1-5 days in 28 (93%) patients and between 6-10days in 2 (07%) patients as an elective procedure.

Duration of Fracture Union

Time of Union	No. of cases	Percentage
2-3 months	22	73
3-4 months	06	20
>4 months	02	07

In the present study 22 (73%) patients had union within 2-3 months and 06 (20%) patients had union in 3-4 months. There was 2 (07%) case of delayed union.

Complications

Complications	No. of cases	Percentage
Extensor polices longus tendon irritation	1	3
Arthritis	1	3
Total	02	6

1 (3%) patient had extensor policies longus tendon irritation because of long volar to dorsal screw. 1 (3%) patient had developed arthritis of the wrist joint due to improper reduction and articular step.

None of the patients had median nerve complications. There were no intra operative complications.

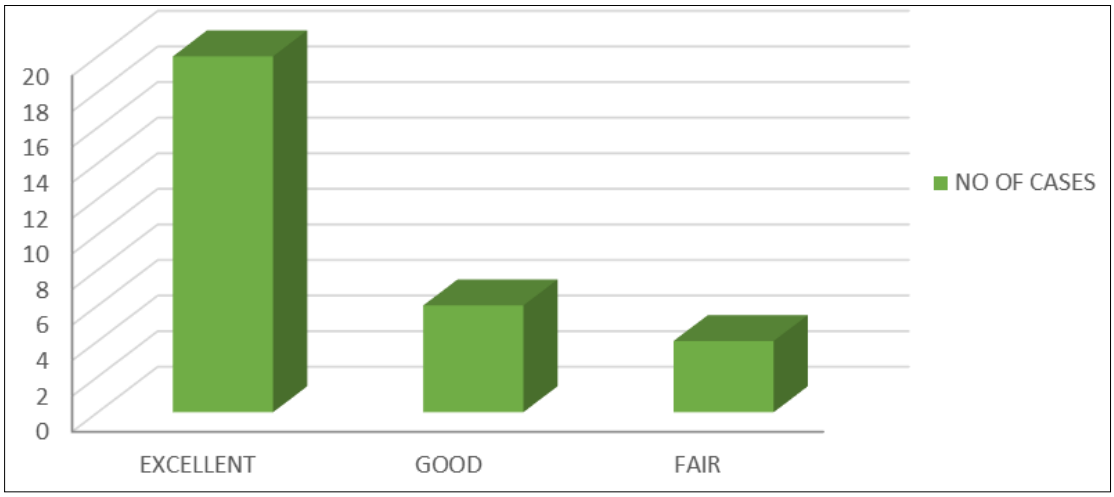
Functional Results

The results were assessed using the demerit score system of Gartland and Werley based on objective and subjective criteria, residual deformity and complications.

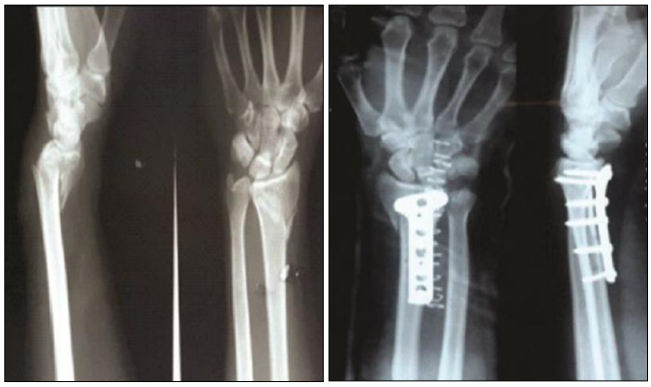
Results	No. of cases	Percentage
Excellent	20	67
Good	06	20
Fair	04	13
Poor	0	0

Using the Demerit score system of Gartland and Werley, we had 20 (67%) excellent results, 6 (20%) good results, 4 (13%) fair results and no poor results.

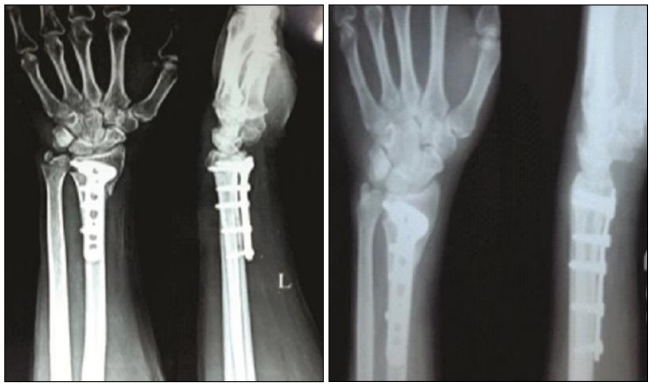
Functional Results



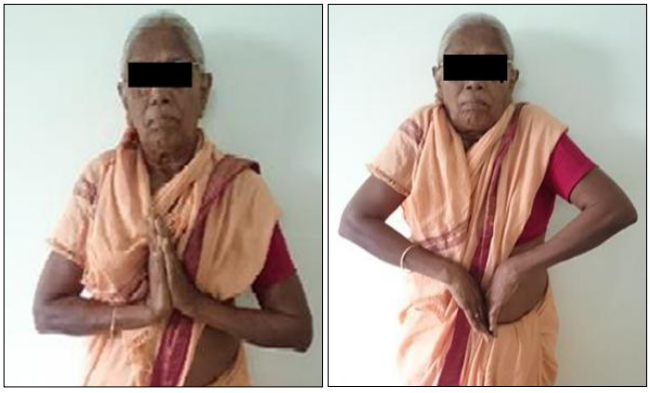
Example Case 1



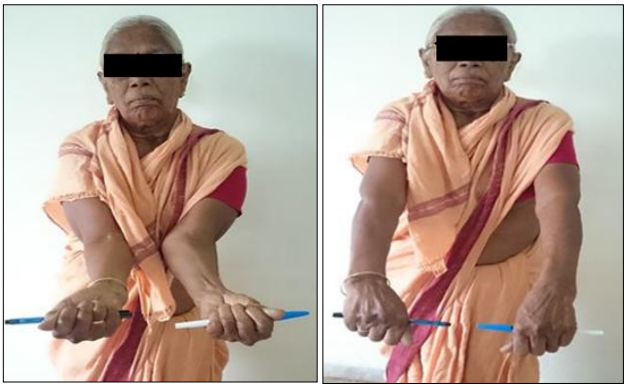
Pre-Operative **Post-Operative**



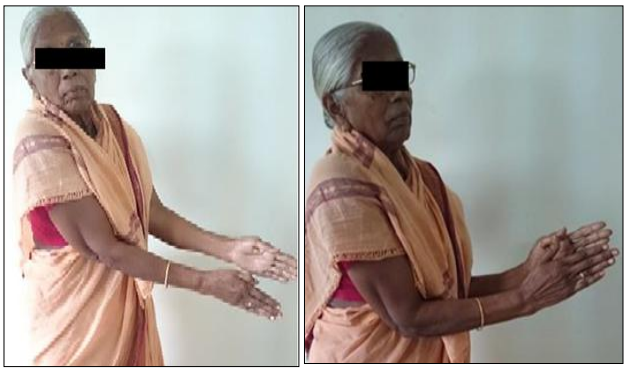
6 Weeks Follow Up **24 Weeks Follow Up**



Dorsi Flexion **Palmar Flexion**



Supination **Pronation**



Ulnar Deviation **Radial Deviation**

Discussion

More than 190 years have passed since Colles described the fracture of the distal end of the radius. It is remarkable that this common fracture remains one of the most challenging of the fractures to treat. There is no consensus regarding the description of the condition and the appropriate outcome.

The main objective of its treatment is the re-establishment of anatomic integrity and to maintain inter-articular integrity and the radial length and avoid complications. Fracture healing depends on a minimal gap, adequate stability, and sufficient blood supply.

In theory, the locking plate minimizes the compressive forces exerted on the bone to achieve stability, which may prevent periosteal compression and associated impairment of blood supply. In unstable intra-articular fractures, re-establishment of inter-articular integrity of the wrist and maintaining the radial length are often not possible with closed methods. In

such cases, where an open reduction is required, various surgical methods and fixation materials can be used. A better understanding of wrist anatomy and functioning through the studies conducted in the recent years, as well as the increasing expectations of patients have expanded the borders of surgical treatment.

The present study was undertaken to assess the functional outcome of operative management of distal radial fractures using a volar locking compression plate. We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment. Our analysis is as follows.

1. Age distribution: In our study, Distal radius fracture was more common in age group of 31 to 40 years old and were related to RTA.

Series	Minimum age in yrs	Maximum age	Average age
Kevin C. Chung *et al*., (2006) [2].	18	77	45
R.E. Anakwe *et al*., (2010) [5].	22	67	48
Zhibing Tang et l., (2012) [7].	23	72	49.8
Present study	18	70	40.6

2. Sex distribution

Our study had a male preponderance with 18 male patients and 12 female patients and is comparable to the following previous studies mentioned in the table below.

Series	Males	females
Kevin C. Chung *et al*., (2006) [2].	37	50
R.E. Anakwe *et al*., (2010) [5].	8	13
Zhibing Tang et l., (2012) [7].	10	7
Present study	18	12

3. Involved side

Series	Right	left
Kevin C. Chung *et al*., (2006) [2].	50	37
R.E. Anakwe *et al*., (2010) [5].	15	6
Zhibing Tang et l., (2012) [7].	12	5
Present study	21	9

4. Mode of injury

In our study 70% of the patients had road traffic accident and 30% had a fall on the out- stretched hand.

Series	RTA	FOOH
Kevin C. Chung *et al*., (2006) [2].	42	45
R.E. Anakwe *et al*., (2010) [5].	14	7
Zhibing Tang *et al*., (2012) [7].	11	6
Present study	21	9

5. Complications

We encountered only two complications

a. 1(03%) patients had arthritis of wrist joint
b. 1(03%) patient had extensor pollicis longus tendon irritation due to long screw placement through the cortex.

6. Results

Kevin C. Chung *et al*., (2006) [2] outcome measures included radiographic parameters, grip strength, lateral pinch strength, the Jubsen Taylor test, wrist range of motion and Michigan hand questionnaire to compare with normal side. In his series decrease in mean grip strength, mean pinch strength and mean flexion of the wrist was 86%.

R.E. Anakwe *et al*., (2010) [5] outcome was assessed using clinical examination grip strength measures, radiographs and PRWE (patient related wrist evaluation) scoring. In his series 95% patient had very high level of satisfaction, good functional outcome and increased grip strength.

In present study- patients, with excellent results (67%), had no residual deformities or pain with full ROM at wrist without any complications. Radio logically Radial length, volar tilt and articular step-off were within acceptable limits.

Patients with good results (20%) had minimal residual deformities, pain and slight limitation. Rest of their findings was within acceptable parameters.

Patients with fair results (13%), along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint.

Conclusion

Due to aging society, & enormous increase of high-speed motor vehicle accidents, the number of distal radial fractures can be expected to increase in the coming decades.

We conclude that Locking plates by volar approach provide successful results for the treatment of both extra articular and intra articular unstable fractures of distal radius. It provides effective anatomic realignment, allows early joint motion. Close placement to joint interface and screwing capability in different orders are its biomechanical superiorities. Volar approach provides both access with minimal surgical trauma on distal radius and fixation with a better adaptation to surrounding tissues.

Precontoured LCP help restore radial length, stabilizes palmar angulation, maintain intra-articular congruity, reduces radio carpal arthritis, avoid decrease in grip strength, provide better fixation in an osteoporotic bone, quicker recovery and better functional range of movement.

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