International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2019; 5(3): 828-833

www.orthopaper.com
Received: 24-05-2019
Accepted: 28-06-2019

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A clinical prospective study of volar plating in distal radius fracture

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DOI: https://doi.org/10.22271/ortho.2019.v5.i3n.1635

Abstract
Background and objective: Incidence of fractures of distal radius are increasing due to more geriatric population and road traffic accidents and at the same time surgical treatment option for the same are modified continuously. The fundamental goal & treatment of distal radial fractures is restoration of normal or near normal alignment and articular congruity.
Method: 30 patients with fractures of distal radius were selected who were admitted in JSS Hospital, Mysore between September 2015 and September 2018.Patients were treated with open reduction and internal fixation with volar plate through a volar approach and followed up till functional recovery and assessed clinico radiologically.
Result: The study comprised of 22 male and 8 female patients aged from 21 to 62 years with mean age of 43.35 years. The average duration from date of injury to date of surgery was 2.35 days. The follow up ranged from 9 to 18 months. Using the demerit scoring system of Gartland and Werley, we had 40% excellent, 46.66% good, 6.66% fair and 6.66% poor results.
Interpretation and Conclusion: In carefully selected patients even in the face of osteoporosis, fixation of fractures of distal end of radius with a volar plate has satisfactory outcome for both the patient and the surgeon and must be considered part of a surgeons Armamentarium in the contemporary treatment of osteoporotic fractures of distal radius.

Keywords: Distal radius; communited, intra articular, open reduction, internal fixation, volar plate

Introduction
Fractures of distal end of radius continue to pose a therapeutic challenge. Malalignment of intra articular and extra articular fractures lead to various complications like post traumatic osteoarthritis, decreased in grip strength and endurance, as well as limited range of motion and carpal instability.
Open reduction and internal fixation is indicated to address the unstable distal radius fractures and those with articular incongruity that cannot be anatomically reduced and maintained through external manipulation and ligamentotaxis, provided sufficient bone stock is present to permit early range of motion [1, 2, 3].
Internal fixation of metaphyseal bending fractures has become increasingly popular primarily due to (a) directly control and maintain physiologic palmar tilt, (b) prevent collapse with external fixation, and (c) avoid bridging the radiocarpal joint. Palmar plating is preferred, as the screws directly buttress against collapse and loss of palmar tilt [4, 5, 6].
Volar Barton's fractures of the distal end of radius are one in which there is anterior subluxation of carpus with the fracture fragment. The volar Barton's fractures are mechanically unstable injuries. Investigations into the pathomechanics of displaced intra-articular fractures of the distal radius highlight the problems of arthritis, pain, swelling, weakness, limited range of motion and instability associated with non-anatomic reduction of intra-articular fragments. Factors affecting the prognosis of these injuries include degree of articular involvement and anatomy of reduction.
Various methods of treatment have been advocated for the management of volar Barton's fractures. It includes closed reduction and immobilization in plaster cast, closed reduction and percutaneous internal fixation with either k-wire, or Steinmann pins and open reduction and internal fixation using pins or buttress plate [7, 8, 9, 10].

Rohit Arora *et al*. in 2007 [11] analyzed the radiological and clinical outcomes of patients with distal radius fractures treated with open reduction and palmar internal fixation with locking compression plate. They concluded that fixation of unstable displaced distal radius fractures with a fixed angle plate provides sufficient stability with minimal loss of reduction on follow up of 114 patients for a minimum of 12 months [11].

RE Anakwe (2010) [12] Conducted a study on locked volar plating for complex distal radius fractures. Over a 12 month period 21 patients with type C distal radius fractures were treated using locked volar plating and stated that locked volar plating for complex distal radius fractures produces better results when assessed using patient reported measures of outcome. Further work should address whether locked volar plating offers superior outcomes and patient satisfaction compared to external fixation [12].

The purpose of this study was to evaluate functional outcome of patients with distal radius fractures treated with a volar plate.

Objectives

1. To study the functional outcome of operative management of fractures of distal end of radius by internal fixation with volar plates.
2. To study the effectiveness and complications of distal end radius fractures treated with volar plate.

Methodology

Thirty adult patients with distal radial fractures treated at J.S.S. Medical College and Hospital, Mysore, Karnataka state between September 2015 and September 2018 under the Department of Orthopaedics, were included in this study.

Inclusion criteria

Adults (Aged over 21 years), both male and female with unstable, comminuted or intra articular fractures of distal end radius. Patients willing for treatment and given-informed written consent.

Exclusion criteria

1. Patients aged below 21 years.
2. Patients medically unfit for surgery.
3. Compound fractures associated with vascular injuries.
4. Patients not willing for surgery.
5. Medical disorders that have impact on bone physiology.

There were 22 (73.33%) males and 8 (26.66%) females between the age group of 26-62 years with mean of 43.3 years. 24 (80%) patients had right side involvement (dominant wrist) and 6 (20%) had left side involvement. Of the 30 cases, injury occurred due to road traffic accident in 22 (73.33%) patients and fall on the out stretched hand in 8 (26.66%) patients. Four (14.28%) patients had associated fractures which included ipsilateral fracture shaft of femur, contusional head injury (14.28%), fracture lower third ulna (57.14%), fracture right pubic rami (14.28%). No patients had median nerve involvement, open type fractures or tendon injuries.

Pre-operative evaluation

Following admission to the hospital, a careful history was elicited from the patients and/or attendants to reveal the mechanism of injury and the severity of trauma. All patients were thoroughly examined. Their general condition associated systemic diseases and associated injuries were noted. All the findings were duly recorded in the patient proforma. The involved forearm was immobilized in a below elbow POP slab and kept elevated. Pain and inflammation were managed using analgesics like diclofenac sodium 50mg twice daily.

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 analysed and involvement of radio carpal and distal radioulnar joints were assessed and classified according to the Frykman's and AO classification.

Surgical procedures

The duration from the date of injury to date of operation ranged from 1-6 days (average 2.35 days). All cases were treated with a volar plate using a volar Henry approach.

Implants used were Ellis, T-plates, LCP plates of varying length. All the statistical methods were carried out through the SPSS software (version 21.0).

Results

The present study consists of 30 cases of distal radius fractures treated at J.S.S. Medical College and Hospital, Mysore, treated between September, 2015 to September, 2018. All cases were followed up periodically during the period 2015 to 2018. The following are the observations made to the available data analysed as follows.

In this series 12 (40%) patients were between 21-30 years, 8 (26.66%) between 31-40 years, 4 (13.33%) between 41-50 years, 4 (13.33%) between 51-60 years and 2 (6.66%) patients between 61-70 years. The age of the patients ranged from 26-62 years with an average of 43.3 years.

Table 1: Type of fracture according to Frykman's classification

Type	No. of cases	Percentage
I	6	20
II	4	13.33
III	10	33.33
IV	4	13.33
V	2	6.33
VI	0	0
VII	0	0
VIII	4	13.33

Of the 30 cases, 6 (20%) of the fractures were of Type I Frykman's classification, 2 (13.33%) of Type II, 10 (33.33%) of Type III, 4 (13.33%) of Type IV, 2 (6.33%) of Type V and 4 (13.33%) of Type VIII. There were no cases of Type VI and VII fractures.

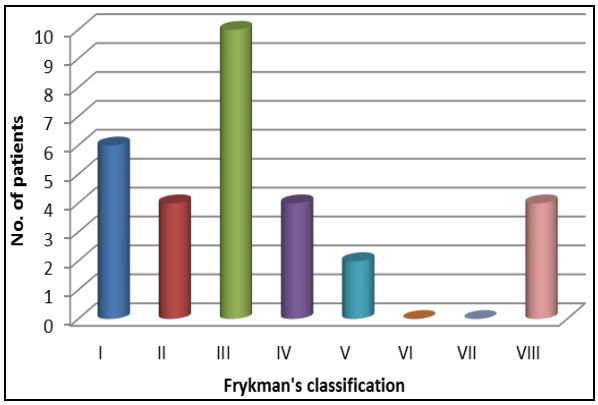


Fig 1: Showing frykman's classification of fractures

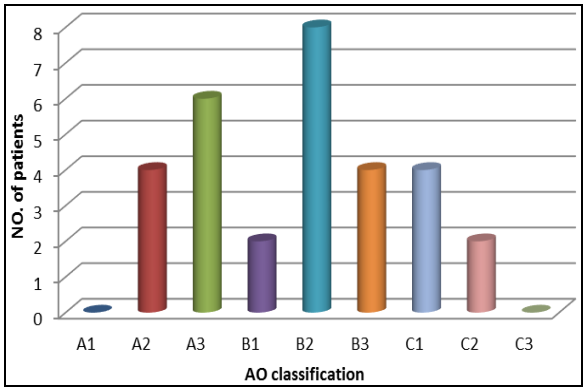


Fig 2: type of fractures according to AO classification

Of the 30 cases 4 (13.33%) of the fractures were of AO Type A2, 6 (20%) of type A3, 2 (6.66%) of type B1, 8 (26.66%) of type B2, 4 (13.33%) of type B3, 4 (13.33%) of type C1, 2 (6.66%) of type C2. There were no cases of AO type Al and C3 fractures.

Table 2: Duration of operation from date of injury

Duration	No. of Cases	Percentage
1-5 days	27	90
6-l0 days	3	10

Surgery was done between 1-5 days in 27 (90%) patients as an elective procedure. Surgery was delayed upto the 6th day in 3 (10%), because the patients had history of ischemic heart disease and surgery was done once we got fitness from the cardiologist.

Table 3: Duration of fracture union

Time of union	No. of Cases	Percentage
2-3 months	24	80
3-4 months	5	16.66
>4 months	1	3.33

In the present study 16 (80%) patients had union within 2-3 months and 03 (16.66%) patients had union in more than 4 months.

Table 4: Range of motion

Movement (within normal functional range)	No. of Cases	Percentage	X^2 and P
Dorsiflexion (mm. 45°)	30	100	-
Palmarflexion (30°)	30	100	-
Pronation (50°)	30	100	-
Supination (50°)	30	100	-
Radial deviation (15°)	26	86.66	X^2=16.13; P=.000
Ulnar deviation (15°)	29	96.66	X^2=26.13; P=.000
Pain in distal radioulnar joint	3	10	X^2=19.2; P=.000
Grip strength (60% or less than on opposite side)	1	3.33	X^2=26.13; P=.000

In our study 30 (100%) patients had dorsiflexion within the normal functional range (Minimum 45°), 30 (100%) had palmar flexion within the normal functional range (minimum 30°), 30 (100%) had pronation within the normal functional range (minimum 50°), 30 (100%) had supination within the normal functional range (Minimum 50°), 26 (86.66%) had radial deviation within the normal functional range (minimum 15°) and 29 (96.66%) patients had ulnar deviation within the normal functional range (Minimum 15°). 29 (96.66%) patients had grip strength more than 60% compared to the opposite side. 1 (3.33%) had significant loss of grip strength (< 60% compared to the opposite side). 3 (10%) patients had pain in the distal radioulnar joint. None of the patients had stiffness of the wrist.

Table 5: Complications

Complications	No. of cases	Percentage
Extensor pollicislongus tendon irritation	1	3.33
Arhtirtis	2	6.67
Nil	27	90.00
Total	03	9.99

1 (3.33%) patient had extensor pollicis longus tendon irritation because of long volar to dorsal screw. 2 (6.66%) 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.

Evaluation of results

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

Table 6: Evaluation of results

Results	No. of Cases	Percentage
Excellent	13	43.33
Good	14	46.66
Fair	3	10
Poor	0	0

Using the Demerit score system of Gartland and Werley, we had 13 (43.33%) excellent results, 14 (46.66%) good results, 3 (10%) fair results and no poor results.

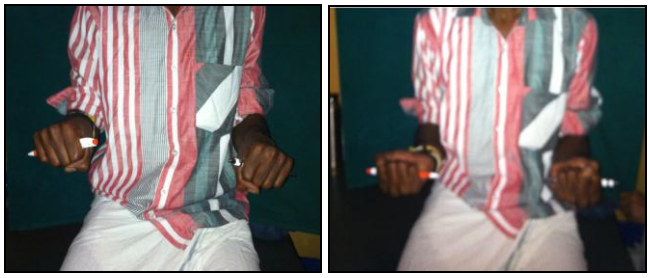
Case-2

Excellent

Preoperative Immediate Postoperative

6 weeks follow up 16 weeks follow up

8 months follow up 18 months follow up



1. Supination 2. Pronation

3. Dorsiflexion 4. Palmarflexion

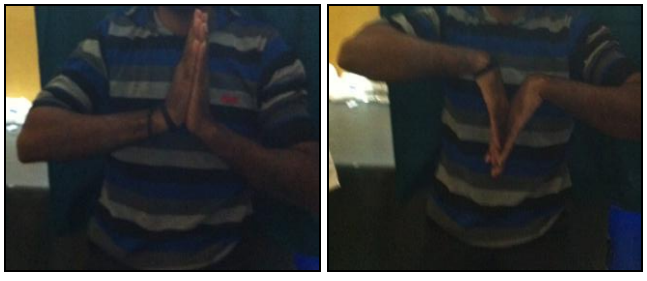
5. Radial deviation 6. Ulnar deviation

Case-7
Excellent

Preoperative Immediate Preoperative

8 weeks follow up 14 weeks follow up

1. Supination 2. Pronation



3. Dorsi flexion 4. Palmar flexion

Discussion

More than 190 years have passed since Colles described the fracture of the distal end of the radius. It is remarkable that distal radius fractures which is one of the 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.

Due to their intra-articular and unstable nature, B and C type were classified AO system distal radius fractures are treated surgically. Today, open positioning and plate fixation are the widely recognized surgical methods. Locked plates are in the progress of replacing conventional support plates. During the recent years, volar approach has become more popular. The present study was undertaken to assess the functional outcome of operative management of distal radial fractures using a volar 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.

In our study, distal radial fracture was more common in the 3rd to 5th decade with an average of 43.13 years. Most of the intra articular, comminuted and unstable fractures requiring operative management occurred in young individuals are due to high velocity trauma such as road traffic accidents and fall from height. Our study had a male preponderance with 22 male patients and 8 female patients. Increased incidence in males is probably due to activities, riding vehicles and heavy manual labour. The right side (dominant wrist) was involved in 24 of the cases in our study. In our study 73.33% of the patients had road traffic accident and 26.66% had a fall on the out stretched hand. Based on AO classification, we had 2 (10%) A2 type fractures, 4 (20%) A3, 1 (5%) B1, 4 (20%) B2, 4 (20%) B3, 4 (20%) CI, and 1 (5%) C2 fractures.

We encountered a complication rate of 9.99%, out of which 1 (3.33%) was due to extensor policus longus tendon irritation, caused by long volar to dorsal screw, 2 (6.66%) developed arthritis of wrist joint secondary to improper reduction and articular step.

Ayhan Kilic *et al*. (2009) [13] reported a complication rate of 11.1%, Kevin C Chung *et al*. (2006) [14] reported a complication rate of 9.1%, RE Anakwe *et al*. (2010) [12] reported a complication rate of 4.8% and Arora Rohit *et al*. (2007) [11] reported a complication rate of 57%.

In our series, we had 43.33% excellent, 46.66% good, 10%, fair and 0% poor result. Patients, who obtained excellent results, had no residual deformities or pain. Range of motion was within the normal functional range. They had no arthritic changes or other complications. They were operated within 4 days after injury. Radial length, volar tilt and articular step-off were within acceptable limits. They were co-operative to physiotherapy. Patients with good results had minimal residual deformities, pain and slight limitation. Rest of the findings was within acceptable parameters.

Patients with fair results, along with residual deformity, pain and limitation also had pain in the distal radio-ulnar joint and minimal complications. Few of their movements were less than that required for normal function. Our series is comparable to that of Ayhan Kilic *et al*. (2009) [13] who had 44.4% excellent, 44.4% good, 11.2% fair.

Kevin C Chung *et al*. (2006) [14] outcome measures included radiographic parameters grip strength, lateral pinch strength, the Jubsen Taylor test, wrist range of motion and Michigan hand questionnaire compared to normal side. In his series decrease in mean grip strength, ear pinch strength and mean flexion of the wrist was 86% of normal side.

RE Anakwe *et al*. (2010) [12] system outcome was assessed using clinical examination grip strength measures, radiographs and PRWE (patient related wrist evaluation) scoring. In his series 95% patient very high level of satisfaction, good functional outcome and increased grip strength.

Rohit Arora *et al*. (2007) [11] used modified Green and Obrien score and he had 31 excellent, 54 good, 23 fair and 6 poor results.

Conclusion

The present study was undertaken to assess the functional outcome of operative management of distal radial fractures in adults by a volar plate and the following conclusions were drawn.

Distal radial fractures are more common in the 2nd to 5th decades. Male preponderance is due to their involvement in heavy manual labour, outdoor activities and riding vehicles. Most of the fractures in the younger individuals is due to motor vehicle accidents or high energy trauma which are usually intra-articular, displaced. The fractures occurring in the older individuals will be due to trivial fall on outstretched hand causing extra articular fracture in the osteoporotic bone.

Many of the literature denotes fracture of the distal radius are common in older individuals 4th to 6th decade, as our clinical trial was to study the effectiveness of the operative management of the distal radius fractures by a volar plate, we included the cases, requiring surgery which were comminuted and intra articular and occurred due to high energy trauma in young individuals. The mode of injury is either a road traffic accident or fall on the outstretched hand.

Distal radial fractures which occur due to road traffic accidents (high energy trauma) are mostly intra-articular, displaced and unstable (Frykman's Type III - VIII) and AO type B2, B3, C1 and C3.

Volar plates that are widely used to provide successful results especially for the treatment of intraarticular unstable fractures of distal radius. This method, which is effective in anatomic realignment, allows early joint motion, owing to its fixation strength. 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. In the subjects of our study, a successful anatomic alignment was acquired with volar approach, regardless of the direction of fracture angulation. The patients who were young adults in majority, went back to their daily activities with 90% recovery.

We encountered, three complications (9.99%) in our study. one being extensor tendon injury, which was because of long screws projecting dorsally. other complication being arthritis in two patient which was because of improper reduction and articular step. These complications can be prevented once the surgeon gets adapted to the procedure.

Use of volar plates in distal radius fractures provide good to excellent results and are effective in the correction and maintenance of distal radius anatomy. By using these plates, joint motions and daily functioning is recovered in a shorter time.

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