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Dr. Ghanshyam C Jagani
Department of Orthopaedics
Inlaks and Budhrani Hospital
7-9, Koregaon Park, Pune,
Maharashtra, India

Dr. Jagdeesh B Panse
HOD & Senior Consultant
Department of Orthopaedics
Inlaks and Budhrani Hospital
7-9, Koregaon Park, Pune,
Maharashtra, India

Dr. Arjun G Viegas
Senior Consultant Department of
Orthopaedics Inlaks and
Budhrani Hospital 7-9,
Koregaon Park, Pune,
Maharashtra, India

Dr. Baldev Dudani
Senior Consultant, Department
of Orthopaedics Inlaks and
Budhrani Hospital 7-9,
Koregaon Park, Pune,
Maharashtra, India

Corresponding Author:
Dr. Ghanshyam C Jagani
Department of Orthopaedics
Inlaks and Budhrani Hospital
7-9, Koregaon Park, Pune,
Maharashtra, India

Clinical, functional and radiological outcomes of volar locked plating of distal radius fracture: A prospective study

Dr. Ghanshyam C Jagani, Dr. Jagdeesh B Panse, Dr. Arjun G Viegas and Dr. Baldev Dudani

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Abstract

Background: The fracture of lower end radius is the most common fracture of the upper extremity encountered in practice and constitutes 10 to 20% of all the fractures and 75% of all forearm fractures. In spite of various new advances, closed reduction and cast immobilization has been the mainstay of treatment of these fractures, but malunion of fracture and subluxation /dislocation of distal radioulnar joint resulting in poor functional and cosmetic results is the usual outcome. Recently, the volar locked plate osteosynthesis is considered as the “gold standard” in treatment of ‘unstable’ distal radius fractures. The present study proposed to evaluate the role of volar locking plate fixation in the management of intra-articular and extra-articular volar fractures of distal end radius and to evaluate the clinical, functional and radiological outcomes.

Aim and Objectives: To study the improvement in clinical, functional and radiological outcomes of volar locked plate fixation in a distal end radius fracture.

Materials and Methods: A prospective study was undertaken in a Tertiary Hospital from September 2016 to September 2018, 30 patients (age >20 yrs) with volar fracture of lower end of radius i.e. AO types A 2.3, B 3.1, B 3.2, B 3.3 operated with volar locked plating. The patients were followed up at 2nd, 6th, 12th and 24th postoperative weeks. Radiological & clinical, functional outcomes were assessed by using Stewart score & PRWE (Patient-rated wrist evaluation questionnaire) score respectively. Data collected of these 30 patients were statistically analysed using ANOVA chi – square test.

Results: Clinical and Functional outcome by Patient Rated Wrist Evaluation scoring system shows maximum no. of patients come in Good and Excellent grading i.e. 17(56.7%) and 8(26.7%) out of 30 patients, along with this 1(3.3%) Fair and 4(13.3%) Poor result. Radiological outcome by Stewart I scoring system is Maximum no. of cases shows Good and Excellent results i.e. 20(66.7%) and 6(20%) out of 30 patients. With this 1(3.3%) Fair and 3(10%) Poor result.

Conclusion: Open reduction and internal fixation with volar locked plating has satisfactory functional and radiological outcome with minimal complications and thus it is an excellent modality to treat volar fractures of distal end radius.

Keywords: Distal end radius fracture, Volar locked plating, Stewart I score, Patient Rated Wrist Evaluation (PRWE) score

Introduction

The fracture of lower end radius is the most common fracture of the upper extremity encountered in practice and constitutes 10 to 20% of all the fractures and 75% of all forearm fractures [1, 2]. Volar displaced fracture of the distal end of radius includes both intra-articular and extra-articular fracture i.e. Volar-Barton’s and Smith’s fracture. The distal end of radius fractures continue to pose a therapeutic challenge. Intra-articular and extra-articular malalignment can lead to various complications such as post traumatic osteoarthritis, decreased grip strength and endurance, as well as limited motion, and carpal instability.[3]

In spite of various new advances, closed reduction and cast immobilization has been the mainstay of treatment of these fractures, but malunion of fracture and subluxation /dislocation of distal radioulnar joint resulting in poor functional and cosmetic results is the usual outcome [4]. Recently, the volar locked plate osteosynthesis is considered as the “gold standard” in treatment of ‘unstable’ distal radius fractures [5].

In the early 1950s, James Ellis from England started using a specially designed T-plate to buttress the small marginal fragment in Volar Barton's fractures. In 1970s, the AO group designed plates specifically for the treatment of distal radius fractures. There are two types of plates for fractures of the distal radius: (a) Conventional plates and (b) fixed angle locking compression plates. With conventional plates and screws, stability is achieved by compression of the plate to a bone by bicortical 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.

A Fixed angle construct provides additional strength to fixation by constructing a scaffold under the distal radial articular surface. Volar fixed angle locking plates are an effective treatment for unstable extra-articular distal radius fractures allowing early postoperative rehabilitation [6]. Because of angular stability of locking compression plate's reduction can be maintained over time so that secondary displacement is no longer a problem [7].

The Primary stability is achieved with locking screw in a plate prevents secondary displacement irrespective of the bone quality, enabling good results in both patients with osteoporotic bones and in young patients. The development of fixed angular stable fixation techniques theoretically improves stability to maintain the reduction of fractures in osteoporotic bones and fractures considered to be unstable.

As open reduction and volar plating ensures more consistent correction of displacement and maintenance of reduction, the present study proposed to evaluate the role of volar locking plate fixation in the management of intra-articular and extra-articular volar fractures of distal end radius.

Aim and Objectives

1. To treat volar fractures of the Distal end radius using locking plate system.
2. To evaluate clinical, functional and radiographic results of the patients treated by this method.
3. To arrive at a consensus about the status of using locking plates in treating volar fractures of Distal end radius.

Materials and Methods

A prospective interventional study was done in the Department of Orthopaedics in Inlaks and Budhrani Hospital,

Pune, Maharashtra between 26/09/2017 to 25/09/2019, 30 cases of distal end radius fracture classified as AO types A 2.3, B 3.1, B 3.2, B 3.3 and treated with volar locked plate fixation and were included in the study after obtaining informed, written consent. Clearance from the institutional ethics committee was obtained before starting of the study.

Inclusion criteria

1. Age > 20 years
2. Both sexes; Males and Females
3. Fresh simple volar fracture presenting within a week of injury
4. All volar fractures of lower end radius i.e. AO types A 2.3, B 3.1, B 3.2, B 3.3
5. Patients willingness to participate and follow up.

Exclusion criteria

1. Age < 20 years
2. Pathological fractures
3. Patients medically unfit for surgery.

Methodology

Patients were admitted those suspected of wrist injury. All the necessary clinical details were recorded in the proforma prepared for this study and splinting of affected limb was done. Standard posteroanterior and lateral view x-rays were taken to assess fracture pattern. On the posteroanterior film radial height, radial inclination, articular step-off and gap were noted. On lateral film palmar tilt angle noted. Fractures were classified according to AO classification. Patients operated after proper counselling and informed consent. All surgeries were performed under regional anaesthesia (supraclavicular or axillary block) and were approached by Standard Henry approach with extension on the wrist if required & fixed with 2.7mm fixed angle Volar locking plate. (Fig 1) Hand was elevated for 24 hours with a monitoring of neurovascular status. Early motion of digits, elbow and shoulder was encouraged from very next day. Intravenous antibiotics were given just before anaesthesia, continued for 48 hours. Post operatively and then oral antibiotics were given for 1 week. Patients was discharged at appropriate time. Patient was followed up at the end of first, second & six week, 3, 6 month. (Fig 2 & 3)

Fig 1. Intraoperative pictures



Fig 1A: Incision for volar approach 1B. Flexor carpi radialis tendon exposure 1C. Pronator quadratus exposure 1D. Fracture reduced and fixed with volar locked plate.

At 1.5,3,6, month follow up, PA and lateral X-rays were taken compared with opposite wrist radiogram (control) and patients were instructed about the exercise of the elbow, digits and shoulder. At the end of the first week, the splints were replaced by dynamic splint which allow movements of wrists and hand freely. At end of sixth week, radiographs were taken and active motion of the wrists consisting of wrist

movements, supination, pronation, finger grip were started. Patients were assessed, which include the subjective impression of the patient, objective grading of function and deformity. A detailed questionnaire was completed with each patients to evaluate subjective factors such as pain, functional limitation and occupational considerations. The outcome of each fracture was graded as excellent, good, fair or poor.

Radiological & clinical, functional outcomes were assessed by using Stewart I score [8, 9] (Table 1) & PRWE (Patient-rated wrist evaluation questionnaire) score [9-11] respectively. The results were analyzed using the ANOVA Chi-square test, the mean follow-up was 6 months (range 0 to 12months) for outcome measurement of volar locking plate fixation.

Results

Out of 30 patients, 16 (53.3%) were males and 14 (46.7%) were females. The youngest patient in the series was of 28 years and the oldest was of 83 years. In this study 43.3% of the total patient had a fracture involving their right hand (dominant). Majority of the injuries (50%) were due to fall on outstretched hand, followed by those due to road traffic accident (40%), and the remaining (10%) due to fall from the height. Out of the 30 patients maximum number of patients (13) had been classified in B3.2 by the AO classification. Maximum number of patients stayed for duration of 1 to 3 days in the hospital i.e. 15 out of 30 patients. The average results of movements after 6 months in the present study were 67.5° palmar flexion, 69.1° dorsiflexion, 18.3° radial deviation, 32° ulnar deviation, 74.1° pronation and 76.6° supination (Table 2). The complications observed were postoperative stiffness in 2 (6.6%) patients and regional pain syndrome in 1 (3.3%) patient. Union occurred in all cases.

Radiological outcome by Stewart I scoring system showed good (66.6%) to excellent (20%) results. Fair and poor results were seen in 3.3% and 10% of the patients respectively (Table 3). Functional outcome by patient rated wrist evaluation scoring system showed good and excellent grading in a majority of patients i.e. in 56.7% and 27.7% respectively, along with fair and poor results in 3.3% and 13.3% of the patients, respectively (Table 4). The final radiological and functional end results were 86.7% (26) satisfactory (good and excellent) and 13.3% (4) unsatisfactory (fair and poor). (Table 5)

Discussion

The main objective of volar fracture treatment is the re-establishment of anatomic integrity and functioning. In unstable intra-articular and extra-articular fractures, re-establishment of inter-articular integrity of the wrist and or maintaining the radial length are often not possible with closed methods.

Volar locking plates have gained popularity over the last several years. The potential advantages of the volar fixed angle implants included a decreased rate of complications when compared with dorsal plating or external fixation, subchondral support and initiation of early wrist motion exercises.

Present study included 30 patients (16 males, 14 females; mean age 50 years; range 28 to 83 years). Out of our 30 cases majority that is 9(30%) patients lie in the age group of 51 to 60 years of age group. The male to female ratio is 16(53.3%):14(46.7%). Ayhan Kilic [12] (2009) the study included 27 patients (15 males, 12 females; mean age 45 years; range 18 to 77 years) who were treated with volar locking plate fixation for unstable distal radius fractures. The P value (ANOVA) was insignificant (0.2196). In our study 43.3% (13 cases) involving the right side and 56.7% (17 cases) involving the left side. K. Murakami [13] in his series had 55% of the patients with fractures involving the right side. The P value was insignificant (0.5843). Out of 30 cases maximum no. of patients have injury due to fall (on outstretched hand & from height) and Road traffic accident;

18(60%) and 12(40%) respectively. AK Aggarwal [14] (2004) In his study out of 16 cases the injury was caused by motor vehicle accidents in 13(81%) cases and by a fall in 3(19%). The P value is significant (0.0122). In this study out of 30 patients maximum no. of patients have been classified in B3.2 by AO classification; 13(43.3%). AK Aggarwal [14] (2004) From January 1997 to July 2003, a total of 19 cases of volar Barton's fracture were operated, records of 16 cases were available for study. All cases were type-B3 fractures: 10 were of the B3.3 subtype, 4 of the B3.2 subtype, and 2 of the B3.1 subtype. Ayhan Kilic [12] (2009) Among those 27 patients, Three fractures were B2 (11.1%), two were B3 (7.4%), two were C1 (7.4%), fourteen were C2 (51.9%) and six were C3 (22.2%), in reference to AO classification. The P value is insignificant (0.4591). In our study average hospital stay for maximum patients; 15(50%) is 1-3 days. Delayed stay like 1 patient in our study is due to associated injuries. Michele Rampoldi [15] (2007) In his study the time between initial injury and operation ranged from 1 to 9 days (mean, 2.3 days). Stewart scoring was based on a radiograph of the normal wrist (the control film) and serial radiographs of the injured wrist. In present study, we had a Mean volar angle of 9.13 degrees, loss of radial length is 1.83 mm and loss of radial angle of 1.53 degrees, at the end of 6 month, comparing with control film (Normal wrist). Stewart HD [8] (1984) in their comparative study (plaster cast group), the mean volar or dorsal angle of 9.9 degrees, loss of radial length is 1.8 mm and loss of radial angle of 1.7 degree, at the end of the study. Ayhan Kilic [12] (2009) in his study of Volar Locking plate for unstable distal radius fracture, the mean radial tilting angle was 6.2° towards volar direction (range dorsal 1° - volar 14°) on the healthy side and 3° towards volar direction (range dorsal 10°- volar 18°) on the operated side, the mean loss of radial length on the operated side was 1.3 mm (range 0-5 mm), the mean radial angle for the healthy side was 26.8° (range 22°-30°) while the mean radial angle for the operated side was 24.8° (range 20°-28°), so mean loss is 2°. The results of movements after 6 months in present study are comparable to the measure of above series ; the average results in the present studies are as follows à 67.5 degree palmar flexion, 69.1 degree dorsiflexion 18.3 degree radial deviation , 32 degree ulnar deviation, 74.1 degree pronation and 76.6 degree supination. Ayhan Kilic [12] (2009), and others in their prospective study of volar locking plating for unstable fractures of distal radius got the following functional results of the patients at the end-point visit were as follows: Mean flexion angle was 55°(range 0°-70°), mean extension angle was 40° (range 35°-70°), mean radial deviation was 18° (range 10°- 26°), mean pronation was 86° (range 0°-90°) and the mean supination angle was 83° (range 0°-90°). Kasapinova K [9] (2011) In his study Outcome evaluation at end of 6 month in patients with Radius fracture of had an average movement of 53.5 palmar flexion degree, 61.7 degree dorsiflexion, 30.6 degree radial deviation, 38.8 degree ulnar deviation, 87.7 degree pronation and 67 degree supination. Murakami K. [13] (2007) and others in their study had an average movements of 55 degree palmar flexion, 61 degree dorsiflexion and 23 degree radial deviation, 35 degree ulnar deviation, 87 degree pronation and 87 degree supination. The complications observed were mild radiocarpal Osteoarthritis in 2 patient and Regional pain syndrome in 1 patient.Total 3(10%) patients. Ayhan Kilic [12] (2009) In his study two patients (7.4%), joint alignment deficiency due to insufficient fixation was observed while having one patient (3.7%) with complaints about surrounding tissue disturbances related to

screws in the early phase, in total of 3(11.1%) patients. Agarwal AK ^[14] (2004) in his study mild radiocarpal osteoarthrosis, seen in 2 patients, did not affect their functional outcome. One case of Sudeck's atrophy (in a non-cooperative patient) did affect the functional result (which was graded as fair) total of 3(18.75%) cases. The P value is insignificant (0.671). According to Stewart Score in this study 26(86.7%) cases showed satisfactory anatomical results (Good and excellent), hence volar locking plate fixation for volar fracture of distal radius is associated with satisfactory anatomical end result. The P value is insignificant (0.2172). Functional Outcome by PRWE Scoring System: (Pain Scoring (A) and Functional Scoring (B) Combined) 25 patients shows satisfactory functional results (Good and

excellent) considering pain and functional activities, 5 cases shows unsatisfactory results (fair and poor) with the help of Patient Rated Wrist Evaluation Scoring. The P value is insignificant (0.3811). Observing the Stewart scoring and the PRWE scoring system, the final outcome of the treatment was graded as excellent, good, fair and poor. The maximum no. of patients came out with Good and excellent (Satisfactory) results thus confirming the Volar Locking Plate treatment to be the best for volar fracture of the Distal end Radius Fractures. The overall results obtained in this study were comparable with above series i.e Kasapinova K. (2011), Kamiloski V. (2006), Ayhan Kilic (2009), K. Murakami (2007), AK Aggarwal (2004), Stewart HD (1984).

Table 1: Stewart I Scoring System Assessment of anatomical result (modified from Sarmiento *et al.* 1980)

Final volar angle (degrees)	Loss of radial length (mm)	Loss of radial angle(degrees)	Score for each measurement
Neutral	Under 3	0-4	0
1-10	3-6	5-9	1
11-14	7-11	10-14	2
≥15	≥12	≥15	4

Anatomical grade obtained by addition of the three scores for each result: excellent 0; good 1-3; fair 4-6; and poor 7-12

Table 2: Range of Movement (6 Month Post Operatively)

Movements	Normal Range In Degrees	Average Result After 6 Months In Degrees
Palmar Flexion	35 – 75	67.5
Dorsal Flexion	45 – 85	69.1
Radial Deviation	15 – 30	18.3
Ulnar Deviation	20 – 50	32
Pronation	70 – 90	74.1
Supination	75 – 90	76.6

Table 3: Radiological Outcome (Stewart Score I)

Range of Score	Grading	No. of Patients	Percentage%
0	Excellent	6	20.0
1 – 3	Good	20	66.7
4 – 6	Fair	1	3.3
7 – 12	Poor	3	10.0
Total		30	100

Table 4: Functional Outcome by PRWE Scoring System. (Pain Scoring (A) and Functional Scoring (B) Combined)

Range of Score	Grading	No. of Patients	Percentage%
0 – 20	Excellent	8	26.7
21 - 40	Good	17	56.7
41 - 60	Fair	1	3.3
61 – 80	Poor	4	13.3
81 - 100	Worst	0	0
Total		30	100

Table 5: Final Outcome of the LCP System in Volar Fracture by Stewart I Score and PRWE Scoring System Combined

Final Result	No. of Patients	Percentage%
Excellent	6	20.0
Good	20	66.7
Fair	1	3.3
Poor	3	10.0
Total	30	100



Fig 2A: Pre-op X-ray AP view



2B: Pre-op X-ray Lateral view



2C: Immediate Post-op X-ray PA view



2D: Immediate Post-op X-ray Lateral view



2E: Post-op X-ray PA view after 6 month



2F: Post-op X-ray Lateral view after 6 month

Fig 3: Clinical Picture (06 months)



3A:P Palmar Flexion



3B: Dorsal Flexion



3C: Supination

3D: Pronation



3E: Radial Deviation

3F: Ulnar Deviation

Conclusion

In our shortterm study, we arrived at the following conclusions:

Fracture of the distal end radius with or without involvement of articular surface when treated with volar plate fixation have significantly better outcome in terms of restoration of anatomy and function. This is due to better stabilization of fracture fragments which allows early mobilization of joints around together with muscle strengthening exercises.

By providing sufficient stability without additional bone grafts or bone substitutes, volar plate systems would facilitate healing of Volar distal radius fractures and allow rapid recovery of range of motion without loss by reduction by providing good subchondral support and preventing collapse of fracture.

The open reduction and internal fixation with Volar Locking Plating has excellent functional outcome with minimal complications thus proving that it is the prime modality of treatment for distal radius fractures.

However, a prospective randomized controlled trial and long term follow up is needed to further validate our findings.

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Conflicts of Interest: NIL

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