

SURGICAL MANAGEMENT OF FRACTURES OF DISTAL END OF RADIUS WITH LOCKING COMPRESSION PLATE

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ABSTRACT: BACKGROUND AND OBJECTIVE: The Irish surgeon Abraham Colles described DRFs (distal radial fractures) in the 1814 volume of the Edinburgh Medical Surgical Journal. Although his description was based on clinical examination alone (because radiography had not yet been invented), it is quite accurate, and it is Colles's name that is most often associated with this fracture in the English-speaking world. Colles stated, "One consolation only remains, that the limb will at some remote period again enjoy perfect freedom in all of its motions and be completely exempt from pain." This claim that all DRFs, despite displacement, will fare well has been a source of criticism. 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. A recent trend in internal fixation has been a move towards locking screw implants which can rigidly stabilize cancellous fragmented bone that is normally not amenable to screw fixation. **RESULT:** The study comprised of 15 male and 5 female patients aged from 22 to 70 years with mean age of 42.82 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 50% excellent 40% good, 10% fair and 0 poor results. **INTERPRETATION AND CONCLUSION:** Open reduction and internal fixation of distal radius fracture with volar locking compression plate provides stable fixation, can restore articular congruity and results in good to excellent functional outcome with minimal complication.

KEYWORDS: Distal radius; Comminuted; Intra articular; Open reduction; internal fixation; Locking compression plate, Osteoporosis.

INTRODUCTION: Cooney W.P. et al. (1980) studied the complications of Colles fractures in 565 patients treated from 1968 – 1975 and divided the complications into 9 groups of which the largest were the neuropathies and the next common was post-traumatic arthrosis.¹

Schütz M, Kolbeck S (2003) published his first clinical experiences of Palmar plating with the locking compression plate for dorsally displaced fractures of the distal radius. He stated that the preliminary results demonstrate the option of early functional treatment using the locking compression plate. Most of the patients had a good to excellent range of motion of the injured wrist which resulted in an early return to former activity. There were few intra- and postoperative complications. No irritation of the median nerve, no infection was observed. In one case a screw which was placed intraarticularly was removed prematurely. The palmar locking compression plate has been proven as a safe and effective implant for the treatment of dorsally displaced fractures of the distal radius.² Othman, Ahmed Y(2009) evaluated early functional and radiologic outcomes of

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using distal radius volar locking plate for unstable dorsally displaced distal radius fractures. Consecutive fractures in 16 patients with unstable dorsally displaced distal radius fractures were included in the study.

The functional and radiologic outcomes were rated using three scoring systems; the Disability of the Arm, Shoulder, and Hand scoring system, the Gartland and Werley score, and the Scoring system of Jakim et al. More than 80% percent of the fractures were rated as good or excellent according to all the scoring systems. This report supported the view of using volar plating for the unstable dorsally displaced distal radius fractures.³ Fractures of distal end of radius continue to pose a therapeutic challenge. Intra articular and extra articular malalignment can lead to various complications like post traumatic osteoarthritis, decreased grip strength and endurance, as well as limited motion and carpal instability.⁴ Distal radius fractures are the commonest upper limb fractures occurring in the elderly.⁵ Treatment options range from closed methods and cast immobilisation to percutaneous K wires, external fixator or open reduction and internal fixation via either a dorsal or volar approach. There is no consensus with regards to the optimal management of these fractures.⁶

Internal fixation for metaphyseal fractures has become increasingly popular, primarily to (a) maintain physiologic palmar tilt, (b) prevent collapse with external fixation, and (c) avoid bridging the radiocarpal joint. 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, as 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.⁷

Volar fixed angle locking plates are an effective treatment for unstable extra articular distal radius fractures allowing early post-operative rehabilitation.⁸ Because of angular stability of locking compression plates reduction can be maintained over times so that secondary displacement is no longer a problem.⁹

MATERIALS AND METHODS: 20 patients with fractures of distal radius were selected who were admitted in hospital, during July 2012 to July 2014. Patients were treated with open reduction and internal fixation with locking compression plate through a volar approach and followed up till functional recovery and assessed clinico radiologically.

INCLUSION CRITERIA:

1. Adults (Aged over 18years), both male and female with unstable, comminuted or intra articular fractures of distal end radius.
2. Patients willing for treatment and given-informed written consent.

EXCLUSION CRITERIA:

1. Patients aged below 18 years.
2. Patients medically unfit for surgery.
3. Compound fractures associated with vascular injuries.
4. Patients not willing for surgery.

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There were 15 (75%) males and 5(25%) females between the age group of 22 to 70 years with mean of 42.82 years. 14 (70%) patients had right side involvement (dominant wrist) and 6(30%) had left side involvement. Of the 20 cases, injury occurred due to road traffic accident in 11 (55%) patients and fall on the out stretched hand in 9(45%) patients.

PRE-OPERATIVE EVALUATION:

Immediate Management: 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.

All patients presented with the involved elbow flexed and the wrist supported by the other hand. Careful inspection of the deformity, swelling and ecchymosis were done. Clinically tenderness, bony irregularity, crepitus and the relative position of radial and ulnar styloid process were elicited. Movements of the wrist and forearm were checked and found to be painful and limited. Distal vascularity was assessed by radial artery pulsations, capillary filling, pallor and paraesthesia over finger tips. The involved forearm was immobilized in a below elbow POP slab and kept elevated. Pain and inflammation were managed using analgesics like aceclofenac 100mg twice daily.

Pre-operative Planning: Routine examination of blood was done for hemoglobin percentage, total and differential WBC counts, fasting blood sugar, blood urea, serum creatinine, bleeding and clotting time, HIV and HbsAg. Examination of urine was done for presence of albumin and sugar. Blood pressure and ECG were recorded in all patients. Preparation of the part was done on the day of surgery. Tetanus toxoid injection and intravenous antibiotic were given to all patients pre-operatively. Physician fitness was obtained for all patients. Consent for surgery was taken and patients were operated after a pre-anaesthetic checkup.

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 radiocarpal 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 2.3 5days).

Anaesthesia: The operations were performed under brachial block in all the cases.

PROCEDURE: All cases are treated with a volar locking compression plate using a volar Henry approach.

INSTRUMENTS AND IMPLANTS USED:

- Locking compression plates of varying length.
- 3.5mm LCP drill bit and sleeve system.
- Hand drill / power drill.

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- Tap for 3.5mm cortical screws and 3.5mm depth gauge.
- Hexagonal screw driver for 3.5mm cortical screws and locking screw driver.
- General instruments like retractors, periosteal elevators, reduction clamps, bone levers etc.
- Pneumatic tourniquet.

Technique: The incision for volar fixation of the distal radius is typically performed through the distal extent of the Henry approach. An incision is made between the flexor carpi radialis (FCR) tendon and the radial artery. This interval is developed, revealing the flexor pollicis longus (FPL) muscle at the proximal extent of the wound and the pronator quadratus muscle more distally. The radial artery is carefully retracted radially, while the tendons of the FCR and FPL are retracted ulnarly. The pronator quadratus is divided at its most radial aspect, leaving a small cuff of muscle for later reattachment. Any elevation of the muscle of the FPL should be performed at its most radial aspect, as it receives its innervation from the anterior interosseous nerve on its ulnar side. After the pronator quadratus has been divided and elevated, the fracture is readily visualized, and reduction maneuvers can be accomplished under direct vision. After exposure and debridement of the fracture site, the fracture is reduced and provisionally fixed under fluoroscopy with K-wires, reduction forceps or suture fixation. Reduction aids should be placed so as not to interfere with placement of the plate. The appropriate plate is selected following fracture reduction. 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 fragment with subchondral locking screws, radial length was gained, when necessary, by pushing the plate distally.

The first standard screw can be either left in situ or exchanged with another locking screw; the oval hole is a combination hole designed for locking head screw placement at the distal end and standard screw placement at the proximal end of the same hole. 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 distal screws can be of either monocortical or bicortical engagement. More volar tilt can be achieved during distal screw placement when the wrist is volarly 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 guide. 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. Once stable fixation was achieved and hemostasis secured, the wound was closed in layers and sterile compression dressing was applied. The tourniquet was removed and capillary refilling was checked in the fingers. The operated limb was supported with an anterior below elbow POP slab with the wrist in neutral position.

RESULTS: The present study consists of 20 cases of closed distal radius fracture treated at Basaveswara Hospital Gulbarga, treated between July 2012 to July 2014.

In the study it is reveals that 3 (15%) patients were between 21-30 years, 4(20%) between 31-40 Years, 8(40%) between 41-50 years and 4 (20%) between 51-60 years. The age of the patients ranged from 22-70 years with an average & standard deviation is 42.82±12.16 years. out of 20 patients 15(75.0%) males and 5(25.0%) females. 11(55.0%) patients with road traffic accidents and

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9 (45.0%) patients fell on their outstretched hand. 3(15%) of the fractures were of Type I Frykman's classification, 3 (15%) of Type II, 7 (35%) of Type III, 3(15%) of Type IV, 1(5%) of Type V and 3(15%) of Type VIII. There were no cases of Type VI and VII fractures. 1(5%) of the fractures were of AO Type A2, 5(25%) of type A3, 1(5%) of type B1, 5(25%) of type B2, 4(20%) of type B3, 3(15%) of type C1, 1(5%) of type C2. There were no cases of AO type A1 and C3 fractures. All were closed type of fractures. 6(30%) of the fractures were of Extra articular Type and 14 (70%) were Intra articular fractures. Surgery was done between 1-5 days in 17(85%) patients as an elective procedure. Surgery was delayed upto the 6th day in 3 (15%). In the present study 15 (75%) patients had union within 2-3 months and 4(20%) patients had union in 3-4 months. There was 1(5%) case of delayed union. Out of 20 (100%) patients had dorsiflexion within the normal functional range (minimum 45°), 20 (100%) had palmar flexion within the Normal functional range (minimum 30°), 20 (100%) had pronation within the normal functional range (minimum 50°), 20 (100%) had supination within the normal functional range (minimum 50°), 16 (80%) had radial deviation within the normal functional range (minimum 15°) and 19 (95%) patients had ulnar deviation within the normal functional range (minimum 15°). 19(95%) patients had grip strength more than 60% compared to the opposite side. 1(5%) had significant loss of grip strength (<60% compared to the opposite side). 1 (5%) patients had pain in the distal radioulnar joint. None of the patients had stiffness of the wrist. Only one case 1 (5%) patient had extensor pollicis longus tendon irritation because of long volar to dorsal screw. None of the patients had median nerve complications.

Evaluation of Results: The assessment of results were made using the demerit score system of Gartland and Werley 10 based on objective and subjective criteria, residual deformity and complications. Using the demerit score system of Gartland and Werley 10, we had 10 (50%) excellent results, 8 (40%) good results, 2 (10%) fair results and no poor results.

Clinical and X-ray Photograph



Preoperative AP and Lateral views



Post-operative AP and Lateral views

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Post-operative Dorsi flexion and palmar flexion with good range of movements



Post-operative pronation and supination with good range of motion



Post-operative radial and ulnar deviation with good range of movements

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. Distal radius fractures are the most frequently seen upper extremity fractures. The main objective of its treatment is the re-establishment of anatomic integrity and functioning. In unstable intra-articular fractures, re-establishment of intra-articular integrity of the wrist and maintaining the radial length are often not possible with closed methods. In such cases, where an open positioning 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. Besides, improvements in fixation materials have provided

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new opportunities. Today, open positioning and plate fixation are the widely recognized surgical methods. Locked plates are in the process of replacing conventional support plates. While facilitating the positioning, those anatomical plates with screw-plate interlocking feature have more biomechanical strength against forces applied on the fracture surfaces. Because of their biomechanical strength, locked plates are preferred in osteoporotic and/or multiple fractures. However, there is no consensus neither about how to approach to distal radius nor the positioning of the plate. 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 locked 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:

Age Distribution: In our study, distal radial fracture was more common in the 3rd to 5th decade with an average of 42.82 years. Most of the intra articular, comminuted and unstable fractures requiring operative management occurred in young individuals are due to high energy trauma such as road traffic accident and fall from tree. Fractures occurring in old individuals are due to trivial fall and usually will be extra articular which in most cases can be treated with closed reduction and cast application. The average age in our study is comparable to the following studies.

Series	Minimum age in years	Maximum age in Years	Average in Years
Ayhan Kilic et al., (2009) ¹¹	18	77	45
Kevin C. Chung et al., (2006) ¹²	18	83	48.9
R. E. Anakwe et al., (2010) ¹³	22	67	48
Arora Rohit et al., (2007) ¹⁴	17	79	57
Present study (2014)	22	70	42

Sex Distribution: Our study had a male preponderance with 15 male patients and 5 female patients and is comparable to the following previous studies mentioned in the table below.

Series	Males	Females
Ayhan Kilic et al., (2009) ¹¹	15	12
Kevin C. Chung et al., (2006) ¹²	37	50
R.E. Anakwe et al., (2010) ¹³	8	13
Arora Rohit et al., (2007) ¹⁴	21	93
Present study	15	5

Increased incidence in males is probably due to their involvement in outdoor activities, riding vehicles and heavy manual labour.

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Involved Side: The right side (dominant wrist) was involved in 14 of the cases in our study.

Series	Right	Left
Ayhan Kilic et al., (2009) ¹¹	14	13
Kevin C. Chung et al., (2006) ¹²	50	37
R.E. Anakwe et al., (2010) ¹³	15	6
Arora Rohit et al., (2007) ¹⁴	70	44
Present study	14	6

All the above series had increased involvement of the right wrist in their series which was also the case in our series.

Mode of Injury: In our study 64% of the patients had road traffic accident and 36% had a fall on the out stretched hand.

Series	Road traffic accident	Fall on the out stretched hand	Direct blow
Ayhan Kilic et al., (2009) ¹¹	13	14	-
Kevin C. Chung et al., (2006) ¹²	42	45	-
R. E. Anakwe et al., (2010) ¹³	14	7	-
Arora Rohit et al., (2007) ¹⁴	40	60	14
Present study	11	9	-

Kevin C. Chung et al (2006) and Arora Rohit et al (2007) reported fall on the outstretched hand as the most common mode of injury.

We reported road traffic accident as the more common mode of injury. Ayhan Kilic et al (2009) and R. E. Anakwe et al (2010) also reported similar findings in their series.

Type of Fracture: Based on AO classification, we had 1 (5%) A2 type fractures, 5 (25%) A3, 1 (5%) B1, 5 (25%) B2, 4 (20%) B3, 3 (15%) C1, and 1 (5%) C2 fractures.

Score	Type of fracture (%)								
	A1	AA3 2		B1	B2	B3	C1	C2	C3
Ayhan Kilic et al., (2009) ¹¹	0	0	0	0	3	2	2	14	6
Kevin C. Chung et al., (2006) ¹²	0	15	19	4	0	4	23	5	16
R. E. Anakwe et al., (2010) ¹³	0	0	0	0	0	0	4	8	9
Arora Rohit et al., (2007) ¹⁴	0	39	16	0	0	0	24	30	5
Present study	0	2	4	1	4	4	4	1	0

Ayhan Kilic et al., (2009) reported maximum number of cases of AO C2 type of fractures. Kevin C. Chung et al., (2006) reported maximum number of cases of AO C1 and A3 type of fractures. R.E. Anakwe et al., (2010) reported maximum number of cases of AO C3 and C2 type of fractures. Arora Rohit et al., (2007) reported maximum number of cases of AO A3 and C2 type of fractures. Our series is has maximum number of cases of AO type A3, B2, B3 and C1 type of fractures.

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COMPLICATIONS: We encountered a complication rate of 5%, due to extensor pollicis longus tendon irritation, caused by long volar to dorsal screw. Ayhan Kilic et al., (2009) reported a complication rate of 11.1%, Kevin C. Chung et al., (2006) reported a complication rate of 9.1%, R.E. Anakwe et al., (2010) reported a complication rate of 4.8% and Arora Rohit et al., (2007) reported a complication rate of 57%.

RESULTS: In our series, we had 50% excellent, 40% 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. 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 their 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) who had 44.4% excellent, 44.4% good, 11.2% fair. Kevin C. Chung et al., (2006) 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, lateral pinch strength and mean flexion of the wrist was 86% of normal side. R.E. Anakwe et al., (2010) 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) used modified Green and Obrein score 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 locking compression plate and the following conclusions were drawn. Distal radial fractures are more common in the 3rd 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 locking compression 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 Type III - VIII) and AO type B2, B3, C1 and C3. Locked plates that are widely used 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

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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 95% recovery. We encountered a complications (5%) in our study, which being extensor tendon Injury due to long screws projecting dorsally. Use of locked compression 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.

SUMMARY: The study comprised of twenty cases of distal radial fractures in adults. All patients treated with open reduction and internal fixation with a volar locked compression plate. The follow-up ranged from 9-18 months. The average age was 43 years with the fracture being more common in the 3rd to 5th decades. Males were predominant with right wrist affection more than left. All fractures were either due to road traffic accidents or fall on the outstretched hand, with road traffic accidents being more common of the two. Most of the fractures were of Frykman Type III. The average duration from the date of injury to the date of surgery was 2.95days. Surgery was delayed till the sixth day in 3(15%) cases. All (100%) the patients had their range of motion within the normal functional range. None of the patients had wrist stiffness. Complications were minimal. There was 1(5%) case of extensor pollicis longus tendon irritation which was because of long volar to dorsal screw and the pain subsided once the screw was removed. we had 15 (75%) cases of intra articular fracture, there was no complication of post traumatic arthritis. Long term follow up is needed to assess the arthritic changes.

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