

## What Lies Beneath and Beyond? A Case Series on Management of Intra Articular Distal Radius Fractures with Ellis Plate

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### Abstract:

**Background:** Volar plating is the workhorse technique employed for management of unstable intra articular fractures of distal radius. Surgical management is associated with high complication rates. There is no clear consensus regarding choice of treatment modality for managing these fractures. We here report a case series of unstable intra articular fractures of distal radius managed surgically with Ellis plate.

**Patients and Method:** A prospective study was conducted on 50 patients with unstable distal radius intra articular fractures classified according to Frykman's Classification, treated with volar Ellis plate applied through volar Henry's approach. Patients were followed up for a minimum of one year period and the anatomical and functional outcomes were measured using the Lidstrom's criteria.

**Results:** Excellent results were observed in 44% of patients, good in 28%, fair in 24% and poor results in the remaining 4% of patients. Functional results observed were similar to the anatomical results.

**Conclusion:** Volar Ellis plating technique can be relied upon as a reasonably good option for unstable distal radius fractures, provided proper care is ensured regarding placement of plate and screws under fluoroscopic guidance.

**Keywords:** Complex regional pain syndrome (CRPS), Distal radio ulnar joint (DRUJ), Ellis plate, Fragment specific fixation, Frykman's Classification, Henry's approach, Lidstrom's criteria, Three column concept.

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### Introduction

The incidence of distal radius fractures is on the rise and parallels that of increasing life expectancy with more population belonging to the high-risk group [1]. Intra-articular and extra-articular misalignments are known to cause posttraumatic osteoarthritis, reduction of hand grip, strength and endurance with restricted mobility, impaired wrist and hand function due to shortening and carpal instability [2,3]. American Academy of Orthopaedic Surgeons recommend surgical management of distal radius fractures with radial shortening >3 mm, dorsal tilt >10 degrees, or intra-articular displacement or step-off >2 mm [4]. Percutaneous pinning with Kirschner wire, volar plating and external fixation are some of the employed fixation modes for distal radius [5].

Unstable distal radius fractures and those with articular incongruity with failed reduction and manipulation and ligamentotaxis attempts need open reduction and internal fixation, if adequate bone stock is present to allow early range of motion [6]. Chhabra AB et al has describes volar plating as the workhorse of distal radius fracture management [7]. Complication rates associated with surgical management are also high.

Optimal treatment of these fractures is controversial and unclear. We here report a case series of intra articular distal radius fractures managed surgically with volar plating using Ellis plate to provide an analysis of the functional outcome and the role of radius plating.

## Patients and Method

A prospective study was carried out on 50 patients with intra articular distal radius fractures admitted to our institute between November 2019 to July 2023. All patients were managed surgically with volar Ellis plating technique. Patients aged above 20 years of age, classified as intra articular fractures as per Frykman's Classification were included in the study after taking their informed written consent for participation in the study. Pathological fractures, poly trauma patients, fractures more than two weeks old and those patients who were medically unfit for surgery were excluded from the study. Following admission for

surgery thorough evaluation for other injuries was done. An initial below elbow slab was applied until surgery to support the fracture. Plain radiograph of the wrist joint including forearm antero-posterior (AP) and lateral view was obtained to classify the fracture type (Fig 1). Investigations necessary for pre anaesthetic clearance were done. These included blood investigations like CBC, Blood urea, Serum creatinine, Blood sugars, HIV I & II, HBsAg, HCV, liver function tests, Bleeding Time, Clotting Time. Nasal swab and HRCT was performed to rule out covid. Chest radiograph and Electro cardiogram were the other investigation performed routinely.



**Figure: 1: Pre-operative plane radiograph of the wrist joint including the forearm antero-posterior and lateral view showing intra articular fracture of distal radius**

Patients were operated in supine position, under C-arm image guidance, either under ultra sound guided brachial plexus block or under general anaesthesia. Pneumatic tourniquet was used routinely in all patients to minimise blood loss and provide clear field of vision during surgery.

Volar Henry's approach was employed to expose the fracture site. Pronator quadratus was lifted off subperiosteally from distal radius. Preliminary reduction was achieved through manual traction and counter traction. A standard 3.5mm volar Ellis plate was used to stabilize the fracture. Reduction, plate and screw position were confirmed under image guidance.

Bone grafting was used to augment fracture site in patients with severe comminution or bone loss. Distal radio ulnar joint stability was assessed with ballottement test. If found unstable, radio ulnar K wire was passed through DRUJ and the pin was retained for a minimum of four weeks.

A short below elbow plaster of Paris slab was applied until suture removal to provide additional support to the wrist. Intra venous antibiotics were started on the day of surgery and continued for at

least three days. Post-operative radiograph was taken to evaluate the reduction and quality of fixation (Fig 2). Suture removal was done on the tenth post-operative day.

Post-operative rehabilitation included day one initiation of wrist and finger movements as pain permitted. Forearm movements were restricted until four weeks in patients with distal radio ulnar joint (DRUJ) K-wire fixation. Strenuous activities like heavy weight lifting were prohibited up to 12 weeks after surgery.

Serial radiographs were taken at frequent intervals to observe the progress of union. Radiological union was defined as visible bridging callus formation on both AP and Lateral views on follow-up radiographs. Patients were followed for a minimum of one year post surgery.

Functional and anatomical outcomes were evaluated based on Lidstrom's criteria. The objective evaluation was based on following ranges of motion, as being minimum range required for normal function – 45° of dorsiflexion, 30° palmar flexion, 15° radial deviations, 50° pronation and 50° supination.



**Figure 2: Immediate post-operative radiograph of the forearm with wrist joint included showing well reduced fracture of distal radius stabilized with properly positioned Ellis plate supported by adequate screw lengths.**

## Results

A prospective study on surgical management with Ellis plating technique was carried out on 50 patients with intra articular fractures of distal radius. Patients were followed up for a minimum of one year and the anatomical and functional results were analysed using Lidstrom's criteria.

Average age of the patients included in the study was 35.6 years with a range of 20 to 60 years. 76% of the patients were females and 24% were males. Left side was involved in 60% of patients. Fall on out stretched hand was the most common mode of injury in elderly population while road traffic accidents (RTA) were the most common mode in younger population. Of the 50 patients, 12% were of Frykman's Type III, 28% of Type IV, 20% of Type V, 32% of Type VI, 4% of Type VII and 4% of Type VIII.

Patients were operated within two to seven days following admission. Mean intra operative time required was 56.56 minutes with a range of 45 to 70 minutes. The overall mean time of union was 8.84 weeks with range of 6 to 18 weeks. Based on Lidstrom's anatomical and functional criteria, excellent result was observed in 44% patients, good in 28%, fair in 24% and poor result in remaining 4% of patients. Functional results observed were similar to the anatomical results. Wound infection was noticed in three patients, stiffness of wrists in 4 patients, mal-union and residual pain in one patient each. CRPS was observed in 2 patients. Five patients developed loss of hand grip. No patient in the present reported of tendon irritation and rupture or carpal tunnel syndrome.

## Discussion

Distal radius fractures are common in elderly population with osteoporotic bone but are also on a

rise in working population [8]. Reasons for instability of distal radius fractures are older age, gross displacement, severe comminution, intra articular extension, excess angulation or axial compression [9]. There is no universal agreement on what is the best course of action for the management of distal radius fractures. The congruency of reduction has a direct bearing on the functional outcome [10]. In unstable intra articular fractures closed manipulation may not regain the wrist intra-articular integrity and the radial length.

Distal end radial fracture was greater in the second to fourth decade in present study. Majority of intra-articular, comminuted, and unstable fractures requiring operational management occurred in young people and were associated with high-energy trauma similar to the studies by Willson. J et al. [11] and Anakwe RE et al. [12]. Majority of the patients in the present study were females. Most of the studies reported a female preponderance, due to their increased risk of fractures secondary to osteoporotic nature of bone. The most common encountered fracture in the present study was Frykman's type IV to VIII fractures similar to the study done by Gill SPS et al. [13].

Open reduction with internal plate fixation is the mostly commonly employed technique for management of intra articular distal radius fractures. Open reduction offers the advantage of direct visualization and manipulation of fracture [14]. Volar plating emerged as an optimal option for unstable intra articular fractures of distal radius [15]. Ellis plates are preferred over traditional plates [16]. These plates are recommended in osteoporotic bones. Advantages of plating include proper fracture intra articular alignment, sustained stable reduction, early mobilization of nearby joints and regain of muscle strength through physiotherapy.

Mehling et al observed that a stable construct with higher stiffness under axial compression and highest load to failure was offered when all three screws were placed in distal plate holes within 3mm of the subchondral bone. They suggested at least four screws in the distal fragment with at least two of them in the distal row of the plate [17]. Beck et al noted that volar plate failure was likely when less than 15mm of volar cortex was available for fixation [18]. As a counter measure, more distal placement of plate crossing the watershed line (transverse ridge proximal to articular surface) would lead to tendon irritation and rupture. Further improper seating of screws leaving their head prominent can irritate the tendons [19]. Proper placement of plate with completely flush screws and use of unicortical screws may help to deal with tendon irritation and rupture. Imaging should be used appropriately to confirm screw and plate position.

Rhee et al proposed a treatment algorithm based on the three-column theory of wrist by Rikli and Regazzoni [20,21]. It provides guidance on the order of fixation of columns [22,23]. Radiological parameters like radial height, radial inclination, volar tilt, ulnar variance, and the teardrop angle, intra-articular extension, articular step-off, dorsal comminution, and associated ulnar fracture should guide the management [24]. With advances like improved imaging, better understanding of the fracture pattern and factors that add to instability of fracture is possible. Various criteria concerning radiological parameters have been proposed like those by Lafontaine et al, AAOS criteria with no clear consensus agreement among surgeons for treatment guidance. Elderly population regardless of the loss in reduction and mal alignment seem to have acceptable functional outcome [25]. This urged DeGeorge et al to propose that this cohort may need a different treatment algorithm for fracture management [26].

Distal radius fracture following cast application has a tendency for displacement with resultant loss of reduction and higher incidence of mal union [27]. Closed manipulation and K wire fixation is useful to secure a good reduction but it fails overtime to retain the reduction secured intra operatively [28]. Rajeev Shukla et al. in their study found out that low pain and high range of motion were associated with volar plating group compared to ex fix group [29]. Kiernan C et al in their study on comparison of volar plating with K wire fixation and ex fix observed that, volar plate fared well compared to other treatment options in management of intra articular distal radius fractures [30].

Meta-analysis by Peng F et al stated that percutaneous pinning had higher incidence of pin track infection and CRPS with low functional scores [31]. External fixators are useful to maintain

length in severe comminution but have only a small effect on fracture reduction (Chabra B et al). Wolfe et al noted that use of an adjuvant K wire markedly increased the rigidity of the external fixator device [32]. There is no consensus on the position (volar/dorsal) of plate and surgical approach. Dorsal plating though technically apt due to the placement of plate on tension has not gained popularity. This was due to the associated tendon irritation and volar collapse of fracture [33]. DRUJ instability does not seem to affect the outcome as evident by the lack of difference in the result of patients when ulnar styloid was fixed or not [34]. Landgren et al stated that fragment specific fixation which is technically demanding and makes use of low-profile plates is associated with higher complication rates than volar plates [35].

Complications like mal union and deformity are prevalent even after the availability of best fixation devices [36]. Superficial wound infection was observed in three patients in the current study, all of whom were treated with regular dressings and culture sensitivity guided antibiotic coverage. Wounds healed well in all these patients and none of them needed a second surgery. Complex regional pain syndrome (CRPS) was observed in two patients who improved with regular uninterrupted physiotherapy. One patient developed mal union due to loss of screw purchase which can be attributed to reduced bone density with increasing age. The anatomical and functional results assessed as per Lindstrom's criteria were similar to the study by Kim JK et al [37]. Clinic based physiotherapy under direct vision is useful for patients with post-operative complications like CRPS, finger stiffness and carpal tunnel syndrome [38].

The main limitations of this study are lack of comparison group, single centre nature of the study, relatively short follow up period and small sample size. A randomized controlled trial with large sample and comparator arm is essential to draw valid conclusions to authorize the superiority of the treatment option.

## Conclusion

Surgical management provides better regain of radiological parameters over conservative management for unstable distal radius fractures. Articular congruency needs to be taken care of to attain acceptable functional status. Open reduction and internal fixation with volar Ellis plate is a valuable treatment option when properly applied. Use of fluoroscopy helps in proper placement of plate and screws which is crucial to good functional outcome. Surgical technique coupled with care of implantation reduces the incidence of complications and ensure satisfactory outcome.

Role of early rehabilitation cannot be overlooked or undermined. One year follow up of patients treated with volar Ellis plate provides an impression on the quality of long term stability the implant offers.

### References

- Corsino CB, Reeves RA, Sieg RN. Distal radius fractures. Stat Pearls [Internet]. 2022 Aug 8.
- Kumar Nagnur R, Patil AB, Angadi V, Palled GS. Locking compression plate fixation vs external fixator for distal radius fractures. International Journal of Orthopaedics. 2016; 2(3):92-6.
- Schmitt R, Froehner S, Coblenz G, Christopoulos G. Carpal instability. European radiology. 2006 Oct; 16:2161-78.
- Lichtman DM, Bindra RR, Boyer MI, Putnam MD, Ring D, Slutsky DJ, Taras JS, Watters III WC, Goldberg MJ, Keith M, Turkelson CM. Treatment of distal radius fractures. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2010 Mar 1; 18(3):180-9.
- Ermütlu C, Mert M, Kovalak E, Kanay E, Obut A, Öztürkmen Y. Management of distal radius fractures: comparison of three methods. Cureus. 2020 Aug 19; 12(8).
- Bartosh RA, Saldana MJ. Intraarticular fractures of the distal radius: a cadaveric study to determine if ligamentotaxis restores radiopalmar tilt. The Journal of hand surgery. 1990 Jan 1; 15(1):18-21.
- Chhabra AB, Yildirim B. Adult distal radius fracture management. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2021 Nov 15; 29(22): e1105-16.
- Beleckas C, Calfee R. Distal radius fractures in the athlete. Current reviews in musculoskeletal medicine. 2017 Mar; 10:62-71.
- Wadsten MÅ, Sayed-Noor AS, Englund E, Buttazzoni GG, Sjöden GO. Cortical comminution in distal radial fractures can predict the radiological outcome: a cohort multicentre study. The bone & joint journal. 2014 Jul 1; 96(7):978-83.
- Diaz-Garcia RJ, Oda T, Shauver MJ, Chung KC. A systematic review of outcomes and complications of treating unstable distal radius fractures in the elderly. J Hand Surg Am. 2011; 36(5):824-35.
- Wilson J, Viner JJ, Johal KS, Woodruff MJ. Volar Locking Plate Fixations for Displaced Distal Radius Fractures: An Evaluation of Complications and Radiographic Outcomes. Hand (N Y). 2018; 13(4):466-472.
- Anakwe RE, LAK Khan, Cook RE, McEachan JE. Locked volar plating for complex distal radius fractures: Patient reported outcomes and satisfaction J Orthop Surg Res. 2010; 5: 51.
- Gill S, Raj M, Singh S, Rajpoot A, Mittal A, Yadav N. Intra-articular fracture distal end radius external fixation versus locking volar radius plate: A comparative study. J Orthop Traumatol Rehabil 2019; 11:31-43.
- Pattanashetty OB, Bhavi S, Bami M, Daultani D, Mapari Y. Outcome of fracture distal end of radius in adults treated by open reduction and internal fixation with buttress plate. Kerala Journal of Orthopaedics. 2013 Jul 1; 26(2).
- Fok MW, Klausmeyer MA, Fernandez DL, Orbay JL, Bergada AL. Volar plate fixation of intra-articular distal radius fractures: a retrospective study. Journal of wrist surgery. 2013 Aug; 2(03):247-54.
- DJ Fuller 1973 the Journal of Bone and Joint Surgery. Thirty-one patients treated with the Ellis plate for Smith's fracture have been examined.
- Mehling I, Müller LP, Delinsky K, Mehler D, Burkhardt KJ, Rommens PM. Number and locations of screw fixation for volar fixed-angle plating of distal radius fractures: biomechanical study. The Journal of hand surgery. 2010 Jun 1; 35(6):885-91.
- Beck JD, Harness NG, Spencer HT. Volar plate fixation failure for volar shearing distal radius fractures with small lunate facet fragments. The Journal of Hand Surgery. 2014 Apr 1; 39(4):670-8.
- Drobotz H, Kutscha-Lissberg E. Osteosynthesis of distal radial fractures with a volar locking screw plate system. International orthopaedics. 2003 Feb; 27:1-6.
- Rhee PC, Medoff RJ, Shin AY: Complex distal radius fractures: An anatomic algorithm for surgical management. J Am Acad Orthop Surg 2017; 25:77-88.
- Rikli DA, Regazzoni PI. Fractures of the distal end of the radius treated by internal fixation and early function: a preliminary report of 20 cases. The Journal of Bone & Joint Surgery British Volume. 1996 Jul 1; 78(4):588-92.
- Lafontaine M, Hardy D, Delince P: Stability assessment of distal radius fractures. Injury 1989; 20:208-210.
- Hammert WC, Kramer RC, Graham B, Keith MW. AAOS appropriate use criteria: treatment of distal radius fractures. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2013 Aug 1; 21(8):506-9.
- Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. Hand clinics. 2012 May 1; 28(2):113-25.
- Grewal R, MacDermid JC. The risk of adverse outcomes in extra-articular distal radius fractures is increased with malalignment in patients of all ages but mitigated in older patients. The Journal of hand surgery. 2007 Sep 1; 32(7):962-70.
- DeGeorge Jr BR, Van Houten HK, Mwangi R, Sangaralingham LR, Larson AN, Kakar S.

- Outcomes and complications in the management of distal radial fractures in the elderly. *JBJS*. 2020 Jan 2; 102(1):37-44.
27. Earnshaw SA, Aladin A, Surendran S, Moran CG. Closed reduction of Colles fractures: comparison of manual manipulation and finger-trap traction: a prospective, randomized study. *JBJS*. 2002 Mar 1; 84(3):354-8.
  28. Cooney 3rd WP, Linscheid RL, Dobyns JH. External pin fixation for unstable Colles' fractures. *JBJS*. 1979 Sep 1; 61(6):840-5.
  29. Shukla R, Jain RK, Sharma NK, Kumar R. External fixation versus volar locking plate for displaced intra-articular distal radius fractures: a prospective randomized comparative study of the functional outcomes. *J Orthop Traumatol*. 2014; 15(4): 265-70.
  30. Kiernan C, Brennan S, McInerney N, Judzan M, Kearns S, Sullivan MO. Volar locking plate versus K-wiring fixation of distal radius fractures in 20–65-year-olds. *Irish Journal of Medical Science*. 2012 Mar 1; 181:236.
  31. Peng F, Liu YX, Wan ZY. Percutaneous pinning versus volar locking plate internal fixation for unstable distal radius fractures: a meta-analysis. *Journal of Hand Surgery (European Volume)*. 2018 Feb; 43(2):158-67.
  32. Wolfe SW, Swigart CR, Grauer J, Slade III JF, Panjabi MM. Augmented external fixation of distal radius fractures: a biomechanical analysis. *The Journal of hand surgery*. 1998 Jan 1; 23(1):127-34.
  33. Wei J, Yang TB, Luo W, Qin JB, Kong FJ. Complications following dorsal versus volar plate fixation of distal radius fracture: a meta-analysis. *Journal of International Medical Research*. 2013 Apr; 41(2):265-75.
  34. Osada D, Viegas SF, Shah MA, Morris RP, Patterson RM. Comparison of different distal radius dorsal and volar fracture fixation plates: a biomechanical study. *The Journal of hand surgery*. 2003 Jan 1; 28(1):94-104.
  35. Landgren M, Abramo A, Geijer M, Kopylov P, Tägil M. Fragment-specific fixation versus volar locking plates in primarily nonreducible or secondarily redisplaced distal radius fractures: a randomized controlled study. *The Journal of hand surgery*. 2017 Mar 1; 42(3):156-65.
  36. Rampoldi M, Marsico S. Complications of volar plating of distal radius fractures. *Acta Orthop Belg*. 2007; 73(6):714-9.
  37. Kim JK, Ju WY, Jeon SH. The effect of acute distal radioulnar joint laxity on the outcome after volar plate fixation of distal radius fractures. *J Orthop Trauma* 2013 Dec 1; 27(12):735-9.
  38. Valdes K, Naughton N, Burke CJ. Therapist-supervised hand therapy versus home therapy with therapist instruction following distal radius fracture. *The Journal of hand surgery*. 2015 Jun 1; 40(6):1110-6.