International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

# Analysis of Functional Outcome of Intrarticular Lower End Radius Fractures Treated by Closed Reduction with JESS Fixator with K-Wires versus Plating: A Comparative Study

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**Abstract:** ***Purpose:*** *The purpose of this study was to compare the functional outcome in distal radius articular fractures treated by closed reduction through JESS fixator with k-wires versus volar-locking plating.* ***Methods:*** *This study included patients with comminuted intra-articular distal radius fractures treated at SMIMER Surat. 54 patients treated with either modality of treatment were analysed, who had been followed up for an average of was 8.9 months, (range: 3 months to 24 months). Prospective and retrospective data were gathered on patients, of which 30 were treated with JESS fixator with k-wire and 24 were treated with volar LCP. The 2 groups were compared for range of motion (ROM), strength, and functional outcome as measured by the Mayo wrist score. Sarmiento's modification of Lindstorm's criteria was used to compare the radiological outcome in both the groups.* ***Results:*** *The mean passive wrist ROM at the final follow-up evaluation in ext fixation patients was 55 degrees extension and 67 degrees flexion, compared with 69 degrees extension and 77 degrees flexion in patients treated with volar LCP group. Whereas mean passive wrist ROM at the final follow-up evaluation in JESS fixation patients was 58 degrees supination and 46 degrees pronation, compared with 76 degrees supination and 64 degrees pronation in patients treated with volar LCP group. Final radiographic measurements for the JESS fixation group averaged 2.9 degrees volar tilt and 14.2 mm degrees radial inclination, with 5mm radial length. The Volar LCP group averaged 7.3 degrees volar tilt, 16.9 degrees radial inclination, with 9.75mm radial length. Radial length and volar tilt were significantly greater for the ORIF group when compared with the radial length. There was significant difference in the radiological and functional outcome of AO Muller type C fractures treated by volar LCP with respect to the JESS fixator group ( p value 0.009 and 0.026 respectively ). There was no significant difference in the radiological and functional outcome of AO Muller type B fractures treated by volar LCP with respect to the JESS fixator group (p value 0.706 and 0.707 respectively).* ***Conclusion:*** *The use of ORIF with a volar fixed-angle implant resulted in stable fixation of the unstable (dorsally or volarly displaced intraarticular) distal articular fragments, allowing early postsurgical wrist motion (functional outcome) and having excellent to good radiological outcome; as compared with JESS fixator with K – wires. However in type B (partial intraarticular fractures) fractures, Volar LCP and K- wire JESS fixator provide equivocal results and none is proved superior. Ligamentotaxis by JESS fixation provided favourable results in younger age group and in partial intra- articular type of distal radius fractures and requires atleast 4 cortical purchases on each side for effective stability. However long term follow-up is required to confirm our findings.*

**Keywords:** distal radius, intraarticular fractures, JESS fixator

## 1. Introduction

Distal radius fractures are most common fractures of upper limb presenting at emergency rooms, compromising of more than 16% of all fractures. Distal radial fractures have a bimodal type of age distribution with high-energy trauma contributing in younger and low energy trauma in elderly population. Females are more liable to distal radius fractures when compared with males [1] mainly because of more severe osteoporosis and a higher liability of elderly women to falls[2] compared to the age – matched men.

The metaphyseal widening of the distal radius is a zone predisposed to fractures because of a lower amount of strong cortical bone and higher amount of weaker cancellous bone. The major risk factors are low bone mineral density (BMD) and a tendency to fall. Consequently, a fracture of the distal radius is typically the result of a fall on the outstretched arm in a postmenopausal woman, where a functionally active person suffers a trauma on an osteoporotic bone. Until about 60 years ago, it was general notion that most distal radial fractures could be treated conservatively with satisfactory results. Only recently, it was clinically proved that intra-articular step-off and radial shortening corrected by surgery had improved patient outcome [3,4]. These issues don't affect elderly people and low-demand patients probably due to low functional and physical demand. In general anatomic reduction should be pursued in younger and high-demand elderly patients (because of longer healing time and to initiate early mobilization) with extra-articular fracture or intra-articular fractures. Low-demand elders with severely displaced intraarticular fracture or median nerve compression require surgical management but otherwise the prime focus in this group should be on joint movement [3;4]. Non-displaced or reducible but stable extra and intra-articular fractures can also be treated with casting. Unstable reducible extra-articular fractures are commonly treated with reduction and often supplemented with extra- or intra-focal pinning. Extra-articular fractures that are irreducible, intraarticular fractures and fractures for demanding patients who require early mobilization, are commonly treated with plating (more often with palmar plating), intramedullary fixation, external fixation or pinning [5;6;7;8]. Close reduction and cast immobilization has been the principal

mode of management of distal radius fractures but it often lead to fracture malunion and subluxation /dislocation of distal radioulnar joint, hence resulting in poor functional, radiographic and cosmetic results[9]. The residual worse deformity of wrist adversely affected wrist motion and hand function, thereby interfering with the mechanical advantage of the extrinsic hand musculature [10].It also causes pain, limitation of forearm motion, and decreased grip strength as a result of arthrosis of the radiocarpal and distal radioulnar joints [11].

Open reduction and volar plating was designed to ensure more consistent correction of displacement and maintenance of reduction. Metaphyseal defects can also be grafted, although not generally advocated in fresh fractures and good bone quality [12].

**Aims and Objectives**

To analyze and compare the functional outcome in distal radius articular fractures of 54 patients treated by closed reduction through JESS fixator with K-wires and volar-locking plating done in our Institute over a period of 2 years and 2 months. We evaluated the efficiency of the fixation with volar locking compression plate with JESS -fixator optionally with k-wires for distal radius articular fractures by

1) Radiographic assessment of post- operative fixation
2) Functional assessment of post- operative fixation
3) Evaluation of treatment related complications

## 2. Materials and Methods

**Inclusion Criteria**

1) Age more than 18 years.
2) Muller's type B (partial intra-articular ) and type C ( complete intraarticular)
3) Intra-articular fractures extending less than 5 cm from joint line
4) Closed fractures.

**Exclusion Criteria**

1) Age less than 18 years.
2) Undisplaced fracture.
3) All open fractures.
4) Neglected fractures more than 4 weeks.
5) Severe co-morbidities.
6) H/O previous wrist pathology or malunited distal radius fracture. Patients of both sexes were recruited in the study according to the devised inclusion and exclusion criteria.

**Patient Evaluation**

Patients presenting in the Emergency department and the Outpatient department were admitted for thorough evaluation. Detailed history was taken to rule out other systemic injury, ascertain the duration of injury, mode of injury, co morbid illness, and history of previous surgeries and for ruling out other major system involvement as a part of trauma screening. The involved limb is evaluated for the injuries pertaining to skin in the form of abrasions, contusion, lacerations, punctured wounds etc. Diagnosis of fracture was done clinically with the help of tenderness, swelling, deformity and abnormal mobility (rarely). Vascular examination of the distal forearm, hand and palpation of radial artery and ulnar artery pulses ( by Allen test) in particular were done. Allen test is used to detect patency of radial, ulnar and digital arteries. Neurological examination of all peripheral nerves is done with particular attention to median nerve considering its propensity to get injured because of its anatomical position. Careful evaluation of the features of impending or established compartment syndrome was done for ruling out those fractures from the study. Specialist opinion to rule out other injuries was got. All eligible patients fulfilling our inclusion criteria were subjected to further radiological Evaluation.

**Preoperative Assessment:** The limb was stabilized in a below - Elbow slab temporarily and Limb elevated to reduce the pain and swelling. Further investigations were done for anaesthetist opinion and assessment obtained. All patients included in the study were subjected to the described surgical procedure, after surgical fitness was obtained.

**Surgical Procedure:** The fractures were treated with internal fixation or external fixation for the distal radius intraarticular fractures. The patients were randomized alternatively into 2 groups and were operated by internal or external fixation.

**Preoperative Planning:** The choice of a particular procedure for each case depended on the Fracture pattern, reducibility and stability and quality of bone. The range of armamentorium for distal radius is 2-column volar Locking compression plate to external fixator optionally augmented with Kirschner wires.

**Patient Positioning:** Patient was positioned supine on the radiolucent table with side arm-board. Image intensifier was positioned under the arm-board so as to visualise the distal radius, distal ulna and the articular surface in AP and lateral views.

**Surgical Technique**:

All procedures were performed under general or regional anaesthesia (supraclavicular or interscalene block). Our standard practice was performed under sterile aseptic precautions of local parts preparation and draping. Routinely preoperative prophylactic intravenous cefotaxime was administered for all patients.

Tourniquet was used in 14 patients and hemostasis was achieved in all patients before closing the surgical wound. All the patients were approached by standard volar approach for distal radius except for 6, where closed reduction was done and external fixator was applied and augmented with Kirschner wire or screws. The standard modified Henry's volar approach was undertaken to fix the fragments of the distal radius.

The reduction of both the distal radius were confirmed with the image intensifier during the fixation and ensured before closure of the surgical site. Drain was used in all of our Volar LCP internally fixed patients

**Postop Protocol:**

All patients were given I.V third generation cephalosporin during induction which was continued for 3-5 days post

operatively. The hand and forearm was initially placed in a compressive dressing extending from hand to below elbow and elevated for forty-eight to seventy-two hours to reduce swelling. Drain was removed on the 2nd postoperative day. All patients operated with Volar LCP were encouraged to begin an early active range of motion of thewrist and hand as tolerated. The patients fixed with Kirschner wire augmented External fixator were immobilized for four to six weeks based on the fracture pattern, reduction and stability, with active finger mobilization. Thereafter gradual wrist mobilization was initiated only. Sutures were removed on the twelfth post-operative day. Patients were not allowed to lift heavy weight for twelveto sixteen weeks. Mobilization of the wrist and the hand were initiated from the 2ndpostoperative day as tolerated by the patient except for those fixed with External fixator or Kirschner wires alone. Those patients fixed with K wires were initially given below elbow cast and was mobilized by 3-6 weeks, after the removal of the cast.

## 3. Results

The following observations were made in the study.

**Age Incidence:**
Patients' age ranged from 18 to 70 years. Average: 47.18 years

**Sex Incidence:**
In our series, Males predominated with the ratio of 2.3:1

**Side of Injury**
In our study 30 patients had Left sided injury accounting for 55.5% of the total patients.

**Mode of Injury**
In our series **RTA** was the predominant mode of injury. Only 16 of the 54 patients presented with significant co-morbid illness in the form of Diabetes Mellitus or Systemic Hypertension which were adequately controlled prior to surgery.

All patients belonged to lower to middle socioeconomic strata of the society with moderate built and nourishment. 24 patients had associated skeletal injuries which were treated appropriately. None of the patients had any other major organ involvement. Neurovascular status was intact in all the patients under study. The average delay in surgery in our study was 5.3 days and the range was 12 hours to 28 days In the modality of treatment, 24 patients were treated with volar locking compression plate and 30 patients were treated with external fixation augmented by K-wires.

The mean follow up was 8.9 months, ranging from 3 months to 24 months. All 54 patients had regular follow-up.

**Union:**
All the patients had good union. The mean time of union was 14 weeks with a range of 10 to 18 weeks with a 32 cases healing by 12 weeks. Rest of the 22 cases took a longer duration. 2 cases of delayed union was reported in the external fixator group when the external fixator was removed and a cast was applied for a further 2 months till union was complete . Longer duration to union is noted in patients of older age with relatively poor bone quality.

**Malunion:** 12 patients of the kirschner wire augmented External fixator had malunion with significant dorsal angulation with negative palmar tilt.

**Radiological Outcome:** Sarmiento's modification of Lindstorm's criteria:

**External Fixator Group in AO Type B ( Partial Intraarticular) Fractures**

| Result | Deformity | Palmar Tilt | Radial Shortening | Radial Inclination | Mean |
|---|---|---|---|---|---|
| Excellent | 6 | 6 | 8 | 4 | 6 ( 50% ) |
| Good | 4 | 4 | 2 | 6 | 4(34 %) |
| Fair | 2 | 2 | 2 | 2 | 2( 17%) |
| Poor | 0 | 0 | 0 | 0 | 0 |

**External Fixator Group in AO Type C (Complete Intraarticular) Fractures**

| Result | Deformity | Palmar Tilt | Radial Shortening | Radial Inclination | Mean |
|---|---|---|---|---|---|
| Excellent | 0 | 0 | 0 | 0 | 0 |
| Good | 4 | 2 | 6 | 6 | 4( 22%) |
| Fair | 8 | 8 | 6 | 10 | 8( 45%) |
| Poor | 6 | 8 | 6 | 4 | 6 (33%) |

**Volar LCP Group in AO Type B (Partial Intraarticular ) Fractures**

| Result | Deformity | Palmar Tilt | Radial Shortening | Radial Inclination | Mean |
|---|---|---|---|---|---|
| Excellent | 8 | 4 | 4 | 8 | 6(37.5%) |
| Good | 6 | 8 | 4 | 6 | 6 (37.5%) |
| Fair | 2 | 4 | 8 | 2 | 4 (25%) |
| Poor | 0 | 0 | 0 | 0 | 0 |

**Volar LCP Group in AO Type C (Complete Intraarticular) Fractures**

| Result | Deformity | Palmar Tilt | Radial Shortening | Radial Inclination | Mean |
|---|---|---|---|---|---|
| Excellent | 4 | 4 | 2 | 6 | 4 (50%) |
| Good | 2 | 2 | 6 | 2 | 3(37.5%) |
| Fair | 0 | 0 | 0 | 0 | 0 |
| Poor | 2 | 2 | 0 | 0 | 1 (12.5%) |

**Functional Score for AO Type B (Partial Intraarticular) Fractures**

| | Ext fixator with K-wire group | Volar LCP group |
|---|---|---|
| Excellent | 6 | 6 |
| Good | 4 | 6 |
| Fair | 2 | 4 |
| Poor | 0 | 0 |

**Functional Score for AO Type C ( Complete Intraarticular) Fractures**

| | Ext fixator with K-wire group | Volar LCP group |
|---|---|---|
| Excellent | 0 | 4 |
| Good | 4 | 4 |
| Fair | 8 | 0 |
| Poor | 6 | 0 |

**Complications:**
4 of our patients had malunion. 8 of our patients had prominent wires that were felt subcutaneously onthe ulnar

side. None of the four had any functional disturbance or pain because of the same. 2of our patients had superficial infection which warranted early removal of K-wire leading to malunion. The infection was controlled by removal of K-wire and antibiotics. Stiffness of the wrist joint and the hand was noted in 8 patients who were reluctant in mobilizing and attending physiotherapy sessions. In the Volar LCP group, two patients who were immobilized in cast postoperatively had transient stiffness whichwas overcome with aggressive physiotherapy resulting in good range of motion thereafter. None of the patients in the present study presented with iatrogenic neurovascular injury or implant breakage during the period of follow-up.

**Functional Outcome:**

Subjective Evaluation of Patients by Mayo Score

| | Ext fixator with K-wire group | Volar LCP group |
|---|---|---|
| Very Good ( 90 – 100 ) | 8 | 8 |
| Good ( 80- 89 ) | 2 | 4 |
| Satisfactory ( 65 – 79 ) | 2 | 4 |
| Bad ( less than 65 ) | 0 | 0 |

**Mayo Score for AO Type B (Partial Intraarticular) Fractures**

This was no significant difference in the functional outcome of modality of fixation of distal radius partial intraarticular fractures by Volar LCP and External Fixator.

**Mayo Score for AO type C (Complete Intraarticular) Fractures**

| | Ext fixator with K-wire group | Volar LCP group |
|---|---|---|
| Very Good ( 90 – 100 ) | 0 | 2 |
| Good ( 80- 89 ) | 6 | 6 |
| Satisfactory ( 65 – 79 ) | 6 | 0 |
| Bad ( less than 65 ) | 6 | 0 |

This denotes that there was no significant difference in the functional outcome of modality of fixation of distal radius complete intraarticular fractures by Volar LCP and External fixator.

## 4. Discussion

The rise of intra articular distal radius fractures and its various presentations of complexity in even younger individuals are predominantly due to high energy trauma especially road traffic accidents.

In our study, around 55.5% of patients are due to RTA and presented with polytrauma at the emergency ward. The exact incidence and demography of distal radius intra-articular fractures have not been cited in the literature. In our study 26of 54 cases (48%) are type C distal radius fractures.

The average mean age of our study is comparable to the one by Anakwe and Jupiter who had an average age of 48 and 43 years respectively. Our study had a male predominance with 38 of 54 cases. Our study's male predisposition of 70 % is comparable to Louis Catalano et al which was 67%. The higher incidence among the males could be attributed to a highly active work group with a higher involvement in high energy trauma and high velocity injuries of RTA. In our study left side (non-dominant) was involved in 30 of the 54 study cases.

Our study's non-dominant Left-side predisposition of 55 % is comparable to Louis Catalano et al and Walz et al which was 52%. The relatively more predisposition could be attributed to a less- protective and late defense mechanism when fall on the left side or using left hand. In our study RTA formed the reason of trauma in 30 of the 54 study cases. Our study's RTA trauma predisposition is 55 %. The reason for this nearly same incidence could be an older mean age of case study where a low-energy trauma is more frequent is causing a fracture on the outset of an osteoporotic bone.

All in our study belong to either type B or type C of distal radius fractures and graded the severity accordingly. 28 of Our 54 cases had sustained a complete intra articular( AO type C) fracture. That is Type C Fracture accounted for 52% in our study. The fixed angled 2.4mm locking plates is the relatively newer choice of implant was used in all our patients, with maximum number of screws in the metaphyseal region in the desired direction of anchorage. Recent biomechanical and clinical studies whichwere undertaken for knowing the distal radius fixation revealed placement of locking screws in the metaphyseal bone with as close as 5mm close to the distal subchondral bone without violating its articular surface (59). It became evident that more screw placement in the distal metaphyseal acts as reefing technique.

The clinical assessment of the distal radioulnar joint becomes difficult in the emergency room setting but it can be assessed under anaesthesia after rigid fixation of the distal radius like piano key test. Improved biomechanical understandings of the ligaments of the wrist led to the implementation of reefing technique, placement of plate more distally in volar aspect such that screws in the distal metaphyseal fragment will buttress the fragments well and prevent collapse of the articular comminution. The latest concept among the various researches in distal radius fixation is the introduction of variable angle locking screws which as ply of 15 -20 degrees in all direction and also locks with the plate.

The mean range of radiological evaluation of various studies was comparable with our study. The key aspects of the treatment are distal radius articular surface's anatomical reduction and achieving gooddistal radio ulnar congruity with an early mobilization for early rehabilitation.

In our study we had 27% of external fixator and 42% of Volar LCP associated with very good results based on Mayowrist score and are comparable to other studies. Complications were at least and are comparable with standard studies. We had 8 patients with prominent wires, 2 cases with superficial infection and 6 patients with wrist stiffness and 2 with finger stiffness.

In our study, among 15 external fixator cases, 3 had unstable distal fragments of distal radius , which needed to be augmented with additional K wire fixation and immobilization in above elbow slab for 4 weeks. Later it

was removed and immediate methodical wrist mobilization started. The results of theVLCP subgroup patients were comparable to studies like Bradway et al but a vast majority ( 84 % ) had good to very good functional score and satisfactory movement. Primary internal fixation of the distal radius fixed with variable angle screws of volar locking plate facilitates early mobilization and hence earlier return to activities with good range of movements, especially rotations.

## 5. Conclusion

From our study, we conclude that Conservative management or internal fixation with Kirschner wires alone for partial and complete intra-articular fractures of distal radiusis not sufficient. Early Primary fixation of the distal radius fractures by volar LCP is essential for good functional outcome and to avoid complication of prolonged immobilization, which facilitates early return to regular activities. Patients with unstable, either a dorsally or volarly displaced intraarticular radius fracture had excellent to good radiological outcome when treated with fixed angle volar locking plate. With the above discussion, the fracture fixation with volar plate and screw system in the management of distal radius articular fractures, especially in type C ( Complete intraarticular fractures ) is a superior method to maintain the reduction till union and prevent the collapse of the fracture fragments, even in grossly comminuted , unstable and osteoporotic bones ; as compared with external fixator augmented with K – wires. However in type B ( partial intraarticular fractures ) fractures, Volar LCP and K- wire augmented External fixator provide equivocal results and none is proved superior. Ligamentotaxis by external fixation provided favourable results in younger age group and in partial intra- articular type of distal radius fractures and requires atleast 4 cortical purchases on each side for effective stability. However long term follow-up is required to confirm our findings

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