EXTERNAL FIXATOR AND K-WIRE FIXATION VERSUS LOCKING COMPRESSION PLATE IN MANAGEMENT OF DISTAL - END RADIUS FRACTURES FRYKMANN'S TYPE VII AND VIII A RANDOMISED CONTROLLED TRIAL

Original Article
Orthopaedics

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Abstract:

Introduction: Distal end radial fractures represent approximately one-sixth of all fractures treated in emergency department. The goal of treatment is to restore congruity to the radiocarpal and distal radioulnar joint surfaces and to restore and maintain the length of the radius.

Discussion: In each of the subsets of patients the need for operative stabilization may arise. The high-energy fractures frequently have articular comminution and displacement that require open means to reduce. A percentage of some of the comminuted, osteoporotic low-energy fractures may be unstable injuries that require operative stabilization. The need for operative fixation of distal radius fractures in the elderly is becoming more common as the life expectancy in society increases and the elderly population stays more active and physiologically healthier.

Conclusion: In our series static external fixator was used to treat 15 patients with intra-articular distal end of radius fractures. Most of the cases in our series were of Frykman type VIII .

The locking compression plate was applied after adequate reduction of the articular step-off, radial alignment under guidance of c-arm. We inserted the locking plate with good soft tissue coverage over the plate. The operative time was more as compared to the external fixator group. The range of motion gained was earlier than the external fixator group, even though the range of movements was not clinically significant.

Key words: *External Fixator, K wire, Locking compression plate, distal end radius fractures*

Introduction

Distal end radial fractures represent approximately one-sixth of all fractures treated in emergency department.[1] The goal of treatment is to restore congruity to the radiocarpal and distal radioulnar joint surfaces and to restore and maintain the length of the radius. In current opinion in orthopaedics, a study concludes that external fixation appears to have benefits that outweigh associated complications and as such, make it an attractive treatment option for fractures of the distal radius that require surgical treatment. Both its ease of use and successful track record make it an extremely versatile tool for the treatment of these injuries.[2]A study conducted in hongkong concludes that application of a locking compression plate for displaced distal radial fracture is a safe alternative. It provides stable fixation with excellent radiographic and functional results and minimal complications.[3] The goal of the current study is to assess the efficacy of anatomical and functional outcome in patients treated with external fixator and k-wire fixation or locking compression plate. Frykmann established the homogenous classification system, which specifies the intra articular or extra-articular nature of the fracture, the individual participation of radiocarpal radioulnar joints, in combination with the existence or not of ulna's styloid process. External fixator is based on ligamentotaxis, in which the fracture fragments are moulded by traction forces across the ligaments. Despite acceptable healing and adequate anatomic results with external fixation but a high complication rate resulting from injury or treatment, with a significant correlation between complications and poor functional outcome. In addition, external fixation is unable to prevent dorsal collapse of the radius or maintain the normal palmar tilt of the radiocarpal joint surface. This complication may predispose to posttraumatic wrist instability and arthritis. The problems with external fixation have prompted a search for a better treatment option. An internal fixator placed through limited incisions on the dorsal aspect of the radius and spanning the fracture site can, in theory, provide the benefits of external fixation without the associated morbidity, In addition, these internal devices theoretically act as a mechanical dorsal buttress that prevents dorsal collapse and loss of palmar tilt in a manner analogous to volar buttress plate. An internal fixator is a reasonable alternative to external fixation if it is biomechanically equivalent in maintaining distraction and withstanding applied loads. The use of precontoured angular stable plate fixation is characterized by higher stability even in osteopenic bone and in altered bone architecture as it is seen in osteoporosis. These implants afford osseous fixation that allows early motion and rehabilitation. Also their precontoured shape maintains desirable patterns of alignment, congruency and inclination of the distal radius after corrective osteotomy because of their ability to ensure angular and axial stability. These properties reduce the probabilities of screw loosening and consequent loss of reduction.[4] Locking compression plate (LCP) is a new screw – plate system developed by combining the traditional plating techniques with the principles of AO internal fixator. The distal radius is the foundation of the wrist joint and an indispensable part of ligamentous support, reconstruction of articular congruity and stable fixation reduces the incidence of post-traumatic osteoarthritis and allows early Functional rehabilitation.[5] LCP omits pre – bending, large area of exposure of fracture site, minimises soft tissue damage, significantly reduces non – union, infection and implant failure.

Objectives

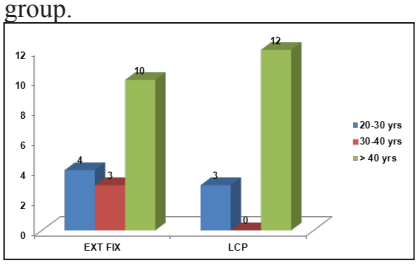
1. To study the efficacy of external fixator and k-wire fixation versus locking compression plate in treatment of distal end radial fractures.
2. To study the anatomical outcome by radiographs.
3. To study the functional outcome in terms of pain, disability, range of movements.

Results

Table No. 1: Age Distribution

Group	20-30 yrs	30-40 yrs	> 40 yrs
EXT FIX	4	3	10
LCP	3	0	12

There were four in second three in third and ten in above fourth decade in external fixator group, three in second, twelve in above fourth decade in LCP group.

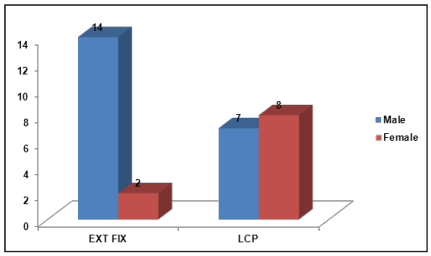


Graph No. 1: Age Distribution

Table No. 2: Sex Distribution

Group	Male	Female
EXT FIX	13	2
LCP	7	8

There are thirteen male and two female in external fixator group , seven male and eight female in LCP group.

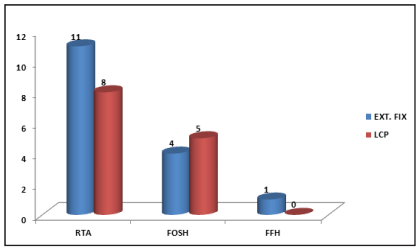


Graph No. 2 : Sex Distribution

Table No. 3: Mechanism of Injury

Group	RTA	FOSH	FFH
EXT. FIX	11	4	1
LCP	8	5	0

There are eleven road traffic accident, six fall on outstretched hand and one fall from height in external fixator group, eight road traffic accident, five fall on outstretched hand in LCP group.

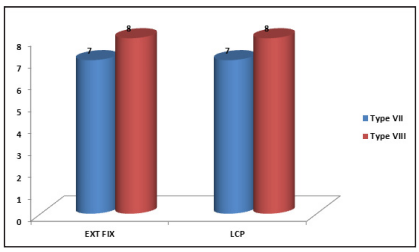


Graph No. 3: Mechanism of Injury

Table No. 4: Frykmann Type

Group	Frykmann	
	Type VII	Type VIII
EXT FIX	7	8
LCP	7	8

There were seven Frykmann type VII and eight Frykmann type VIII in both external fixator and LCP group.

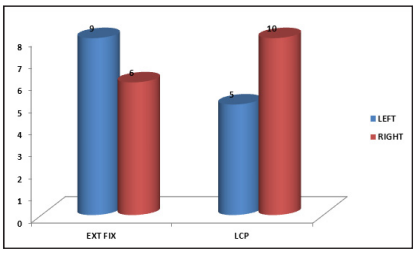


Graph No. 4: Frykmann Type

Table No. 5: Laterality

Group	Left	Right
EXT FIX	9	6
LCP	5	10

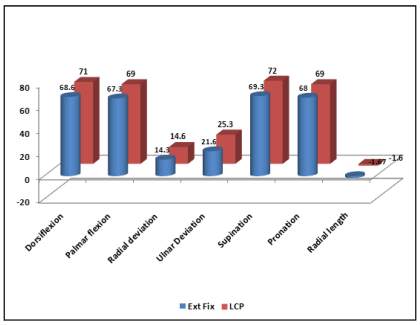
There were nine left and six right wrist affected in external fixator group, five left and ten right wrist affected in LCP group.



Graph No. 5: Laterality

Table No. 6: Range of movements and radial length

	Ext Fix	LCP
DF	68.6±11.09	71 ± 8.90
PF	67.3 ± 10.99	69 ± 10.55
RD	14.3 ± 1.76	14.6 ±1.29
UD	21.6 ± 7.71	25.3 ±6.39
SUP	69.3 ± 7.53	72± 8.41
PRON	68± 8.41	69 ± 9.48
RAD Length	-1.67 ± 0.89	-1.6 ± 8.2



Graph No. 6: Range of movements and radial length

Discussion

Distal radius fractures are extremely common injuries and tend to occur in a bimodal age distribution. They are seen most frequently in young adults and again later in life in elderly, osteopenic women. These fractures are frequently articular injuries resulting in disruption of both the radiocarpal and distal radio ulnar joints. Most distal radius fractures are low-energy fractures, the result of a fall, and may be treated nonoperatively with some form of closed immobilization. High-energy distal radius fractures are more common in younger adults. In each of these subsets of patients the need for operative stabilization may arise. The high-energy fractures frequently have articular comminution and displacement that require open means to reduce. A percentage of some of the comminuted, osteoporotic low-energy fractures may be unstable injuries that require operative stabilization. The need for operative fixation of distal radius fractures in the elderly is becoming more common as the life expectancy in society increases and the elderly population stays more active and physiologically healthier.

External Fixation

The use of external fixators in the treatment of distal radius fractures is common. External fixation can be used for various injuries about the wrist and in combination with other fixation methods. Currently the trend is toward open reduction and internal fixation (ORIF) and away from external fixation. However, we believe the external fixator is still a valuable tool for fracture treatment and through this review we will show its effectiveness.

Fractures of the distal end of radius continues to be one of the most common skeletal injuries of the upper limb.

In our series the majority of the cases of intra – articular fractures of distal end of radius were seen in the younger age group of patients with road traffic accidents [Fall from Motor bike] being the most common.

Several authors[61,62] have stressed that a good functional outcome usually

accompanies a good anatomical result. In comparative studies, bridging external fixator consistently achieved better anatomical results than remanipulation and cast management. The application of cast in these patients would lead to loss of reduction and a poor functional outcome. In displaced intra articular fractures of distal radius, reduction is easy to achieve but difficult to maintain, due to intraosseous crushing, there is a void at the fracture site which can heal only after collapse, this collapse can be prevented by stabilizing either by packing cortico-cancellous bone graft in the void or by using metal to hold the fracture in place eg. External fixator. External pins through metacarpals rigidly fixed by distractor to distal part of radius probably provides the best stabilization for lower end radius fracture. This produces traction effect on comminuted distal radius, this effect has been named ligamentotaxis. Fixed traction with ligamentotaxis minimizes the shortening that may result from resorption of bone at fracture site. The tensile distraction of radius helps healing of comminuted dorsal fragment of radius to occur without displacement. External fixation also provides for retention of an anatomical reduction of the volar cortex obtained by traction with gentle manipulation. The distal fragments therefore are stabilized volarly, dorsal displacement is prevented and so is angulation. For an optional outcome selection of the patients is very important. Unreliable and poorly motivated patients are not the ideal candidates for external fixation.

Augmented External Fixation:

Distal radius fractures often require additional fixation methods after placement of the external fixator. The addition of K-wires to an external fixation construct has been proven in the lab to have increased rigidity.[63] This may be required if fracture reduction cannot be obtained by ligamentotaxis with the fixator alone, or if an excessive, nonphysiologic position of the wrist is needed for fracture reduction. In this latter case the fixator can be used as a provisional reduction tool. Often the fracture requires hyperflexion, ulnar deviation, and significant palmar translation. After this is achieved the reduction can be held with crossed K-wires (0.062"or 0.054"), one or two placed in the radial styloid and an additional pin placed in the ulnar corner of the radius. Augmented fixation also can be beneficial during the postoperative course. With the presence of dual fixation, either the fixator or K-wires can be removed earlier if they become problematic. This can be especially helpful in the presence of a pin tract infection or to initiate early ROM therapy. The fixator can be removed early if there is pin irritation or infection and some of the smooth pins can be left in place as early motion is begun (Fig 4). Augmented external fixation avoids open exposures to the distal radius and becomes an attractive option for unstable distal radius fractures. The ability of augmented external fixation to obtain good results has been well documented in the literature.[17,55,33] Zanotti and Louis[7] prospectively studied the subjective, functional and radiographic outcomes of 20 patients with unstable distal radius fractures treated with external fixation alone or in combination with percutaneous pins. Outcomes were rated as excellent in one patient, good in 15 patients, fair in four patients, and poor in none. When analyzed by mechanism, patients who sustained a high-energy injury were more likely to require supplemental fixation (percutaneous pins). The authors concluded external fixation with supplemental K-wires is a viable treatment option for high-energy distal radius fractures. In our results, all the younger patients have had good & excellent results while the older patients (i.e. 50 – 65 years) have developed the complications. One patient (Female) developed pin loosening on the 4th week. Even the remaining elderly patients had only fair to poor results. Hence in our study the external fixators proved to be effective in younger patients but not very effective in elderly patients.

Most of the patients recovered significant movement of the wrist & forearm with 2 weeks of physiotherapy.

In the literature the duration of fixation varies from 4 weeks to 10 weeks. In our series external fixation was maintained for 6 weeks. We had a high rate of excellent to good results and a low rate of complications.

External fixation is used to maintain axial length while reduction is attained by manipulation of fracture fragments with supplemental Kirschner wires and ligamentotaxis in intra-articular and extra-articular fracture patterns.[56,57]

However, external fixation alone is limited by the inability to directly reduce intra-articular fracture fragments in complex unstable fracture patterns. The advantages of open reduction and internal fixation include direct visualization and manipulation of the fracture fragments.[70]

Trumble et al.[80] stated that the degree to which articular step-off, gapping between fragments, and radial shortening can be improved with surgery correlates strongly with improved outcome. Hence, a treatment method that is more likely to achieve these goals will result in better

function.

Locking Compression Plate

A prospective randomised study by David H.Wei et al, compared with both external fixation and locking compression plate, fixation with a locked volar plate led to a more rapid improvement in subjective function.

This advantage over external fixation was evident at the six weeks time point, which may not be relevant because of the delay in initiating therapy when a spanning external fixator is in place. By three months, the patients with a volar plate not only had a higher level of subjective function than the patients treated with the other two techniques, but they also had a mean DASH score comparable with normative values.[87] By six months, all two surgical groups demonstrated excellent subjective functional scores, and at one year, the patients in the volar plate group had significantly better subjective function only when compared with those treated with a external fixation. Thus, the patients who had been treated with a volar plate had the distinct advantage of achieving normal subjective function three months earlier than the patients who had been managed with either external fixation. Fixed angle volar plates for the fixation of distal radius fractures were introduced in the English literature by Orbay and Fernandez in 2002.[78] Volar plating of dorsally angulated distal radius fractures, has become an increasingly common treatment option in more recent years.[81-87] The volar side of the wrist has a large cross-sectional space and the pronator quadratus muscle can be used to cover a volar plate, thereby avoiding direct contact of the plate and screws with the flexor tendons, causing fewer complications and less hardware prominence. Distal locking screws of the fixed angle plate prevent the distal fragments from collapsing dorsally which makes early mobilization possible. Volar fixed angle plates are pre-contoured to the anatomical shape of volar side of the distal radius. The direction of the distal locking screws is either fixed by the plate design or it can be adjusted 5-10 degrees.[67]

Conclusion

In our series static external fixator was used to treat 15 patients with intra-articular distal end of radius fractures. Most of the cases in our series were of Frykman type VIII. Mechanism of injury was road traffic accident in 11cases, fall from height 1 and fall on outstretched hand in 3 cases. Two patients had associated injuries - One Lefort's fracture, another with ipsilateral supracondylar Femur fracture and one ankle bimalleolar fracture. We inserted 2.5 mm Schanz pins, 2 in the proximal radius & two in the metacarpal [2nd & 3rd] involving 4 cortices. Engaging 4 cortices enhances the rigidity of the fixation and supplemental k-wire fixation where required. External fixation was maintained for 6 weeks till the bony union is complete. For an optimal result, good anatomical reduction is necessary. In our series locking compression plate was used to treat 15 patients with intra-articular distal end of radius fractures. Most of the cases were Frykmann type VIII. Mechanism of injury was road traffic accident in 10 cases, and fall on outstretched hand in 5 cases. The locking compression plate was applied after adequate reduction of the articular step-off, radial alignment under guidance of c-arm. We inserted the locking plate with good soft tissue coverage over the plate. The operative time was more as compared to the external fixator group. The range of motion gained was earlier than the external fixator group, even though the range of movements was not clinically significant.

Summary

Static external fixators were used in 15 intra – articular fractures of distal end of radius in a prospective study. Fixator was maintained for a duration of 6 -8 weeks. We had 2 excellent, 8 good, 3 fair and 2 poor result in our external fixator group. There was only 2 complications [10 %] one of pin loosening and one of shoulder hand syndrome. We had 3 excellent, 10 good ,1 fair,1 poor outcome in our LCP group. The fair and poor outcome was seen in elderly patients. This series concludes that in LCP group had 20% excellent and 67% good outcomes as compared to external fixator group with 13% excellent and 53% good outcomes In younger age group [<50], external fixation or ORIF locking compression plate consistently results in a favourable outcome in the management of intra-articular distal end of radius fractures.

References:

1. David S. Ruch, Rockwood & Green's,USA, Lippincott : Williams & Wilkins, chapter 26, 910 pp.
2. Reynolds, Paul R., Beredjiklian, Pedro K. Hand and wrist. Volume 12(4), Lippincott USA: Williams & Wilkins, 286-289 pp. August 2001.
3. KK Wong, KW Chan. Volar fixation of dorsally displaced distal radial fracture using locking compression plate. Journal of Orthopaedic Surgery 2005;13(2):153-157 pp.
4. Santiago A, Lozano-Calderon.

New technologies for the treatment of trauma sequelae in elderly patients. The orthopaedic journal at Harvard Medical Sciences 2005; 1: 1-8.
5. Chen Kai, Yang Chang, Wang Qiu-gen, Applied principles and cautions of locking compression plate, Shangai. Journal of clinical rehabilitative tissue engineering research April 2008; 12 : 22.
6. Williams PL, Warwick R, Dyson M, Bannister LH. Gray's Anatomy. 37th ed. Churchil Livingstone ; 1989.
7. Viktor MM, Louis AG. Imaging techniques for distal radius fractures and related injuries. Orthop Clin North Am 1993 ; 24 (2) : 217-27.
8. Szabo RM. Comminuted distal radius fractures. Orthop Clin North Am 1992 ; 23 (1) : 1 – 5.
9. Jupiter JB. Current concepts review, Fractures of the distal end of radius. J Bone Joint Surg [Am] 1991 ; 73 (A) : 461-69.
10. Cooney WP. Fractures of the distal radius. A modern treatment based classification. Orthop Clin North Am 1993 ; 24 : 211-16.
11. Cooney WP, Dobyns JH, Linscheid R. Complications of Colle's Fractures. J Bone Joint Surg [Am] 1980 ; 62-A (4) : 613-19.
12. Cooney WP, Linscheid R, Dobyns JH. External pin fixation for unstable Colle's fractures. J Bone Joint Surg [Am] 1979 ; 61-A : 840.
13. Szabo RM, Weber SC. Comminuted intra articular fractures of the distal radius. Orthop Clin North Am 1988 ; 23 : 39-47.
14. Clyburg TA. Dynamic External fixation for comminuted intra articular fractures of distal end of radius. J Bone Joint Surg [Am] 1987 ; 69 (A) : 248.
15. Howard PW, Steward HD, Hind RE, Burke FD. External Fixation or plaster for severely displaced comminuted Colles Fracture ? A prospective study of anatomical and functional results. J Bone Joint Surg [Am] 1989 ; 71 (B) : 68-73.
16. Dienst M, Wozasek GE, Seligsone D. Dynamic External fixation for distal radius fractures. Clin Orthop 1997 ; 338 : 160-171.
17. Cooney WP. External fixation of distal radius fractures. Clin Orthop 1983 ; 180 : 44 – 49.
18. Grana WA, Kopta JA. The Roger Anderson device in the treatment of fractures of the distal end of radius. J Bone Joint Surg [Am] 1979 ; 61 (A) :1234.
19. Van Der Linden, Ericson R. Colles fractures. How should its displacement be measured and how should it be immobilized ? J Bone Joint Surg [Am] 1981 ; 63 (A) : 1285 – 88.
20. Bassett RL. Displaced intra articular fractures of distal radius. Clin Orthop 1985 ; 214 : 148-52.