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Original Research Article

Comparison of External Fixation and Supplementary Kirschner-Wires Fixation with Volar Locking Plate for the Treatment of Intra-Articular Distal End Radius Fractures

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ABSTRACT:

Introduction: There are controversies regarding the benefit of open reduction and internal fixation with volar locking plates over closed reduction and external fixation along with supplementary Kirschner wires fixation for intra-articular distal end radius fracture.Therefore, this study aimed to compare the outcomes between external fixation along with supplementary Kirschner wires with volar locking plate in the treatment of intra-articular distal end radius fractures. **Methods:** This prospective, observational and analytical study was conducted over one and a half years. Forty-seven adults with displaced intra-articular distal end radius fracture were included in the study. Twenty-one cases were treated with closed reduction and external fixation along with supplementary Kirschner wires, whereas 26 patients were treated with open reduction and volar locking plate fixation. **Results**: At the end of three months, as per the Green and O'Brien scoring, the mean functional outcome score in the volar plate group was significantly better 80.77(±11.46) than the external fixation group 70.24(±10.66) (p=0.002). However, at the end of six months, the mean score in the volar plate group 86.15(±7.39) was not significantly different from the external fixation group 81.43(±9.63) (p= 0.63). Fracture reduction was achieved and maintained better in the volar locking plate group. **Conclusion**: Functional outcome of closed reduction and external fixation along with supplementary Kirschner wires is comparable with open reduction and internal fixation by volar locking plate in treatment of displaced intra-articular distal radius fractures. Radiological correction is achieved and maintained better with volar locking plates.

Keywords: External fixation; Functional outcomes; Green and O'Brien score; Intra-articular distal radius fracture; Volar locking plate

INTRODUCTION:

There are controversies regarding the management of distal end radius fracture.[1]There are various treatment options available for the distal radius fractures, which range from closed reduction and cast application, percutaneous Kirschner (K) wire fixation, open reduction and internal fixation with volar or dorsal plates (locking or nonlocking), bridge plating, use of an external fixator along with supplementary K-wires or a combination of these techniques. The best choice depends on the age and demand of patients.[2,3]

For intra-articular distal end radius fractures, commonly performed procedures are open reduction and internal fixation with volar locking plates and

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closed reduction and external fixation along with supplementary K-wires fixation. According to literature, there is no consistent benefit of one method over another.[1,2,3,4] Therefore, this study aimed to compare outcomes between external fixation along with additional K-wires with a volar locking plate for intra-articular distal radius fractures.

METHODS:

This prospective, observational, and analytical study was conducted at the Department of Orthopedics, Lumbini Medical College, and Teaching Hospital (LMCTH), Nepal from March 2019 to August 2020. A convenient sampling technique was used; sample size calculation was done. Reference values for sample size calculations were taken from the study by Pradhan R L et al.[5] Radial inclination was taken for reference values and calculation was done at a confidence level of 90% and power of 80%.

$n = (Z_{1-\alpha/2}+Z_{1-\beta})^2 \times (\sigma_1^2 +\sigma_2^2/r)/ (\mu_1- \mu_2)^2$

n=sample size 14.2 at 10% drop out =15.53, 16 patients in each group.

This study was approved by the Institutional Review Committee (IRC -LMC 015-A/019) of LMCTH. Informed consent was taken from each participant. Patients of 18 years and above with displaced intra-articular distal end radius fracture of AO type C1, C2, or C3 were included in the study. Patients with pathological fractures, compound fractures, fractures with distal neurological deficits, and delayed presentation of more than two weeks were excluded from the study. X-rays in anteroposterior (AP) and lateral views of the injured wrist was taken. An AP view of the uninjured side was taken for comparison. CT scan of the wrist was done in every case. Selection of procedure, open reduction, and internal fixation with volar locking plates or closed reduction, external fixation and K-wire fixation was the surgeon's decision.

Procedure

External fixation and K-wire insertion: Standard techniques and principles of external fixation were followed. Two Schanz pins of 2.5mm were inserted in the second metacarpal and two 3.5 mm pins in the radius proximal to the abductor pollicis longus muscle belly. The pins were interconnected with connecting rod and universal clamps. The reduction of fracture was done with traction and counter traction technique and direct manipulation of fragments if necessary. The reduction was checked in the C-arm in AP and lateral views and an external fixator was tightened. Two additional K-wires 1.5 to 1.8 mm were inserted, one from the radial styloid and another from the dorso-ulnar side in all cases. Final reduction was checked under C-arm. **Volar locking plate technique**: A 2.7 mm Two-Column Volar Distal Radius plate or 2.7 mm Volar Rim Distal Radius Plate was used to fix the fracture. The fracture was approached through modified Henry's approach. Fracture fragments were reduced by direct manipulation, verified under C-arm and temporary fixation was done with K-wires. The plate was placed on the volar surface of the radius. The position of the plate was verified under C-arm and locking screws were inserted. After the closure of the wound, the fracture was immobilized in the below-elbow dorsal slab.

Acceptable criteria for fracture reduction: The reduction of fracture was considered satisfactory when the following radiological parameters were met.[3,6]

1. The radial inclination of $>15^0$.

2. Radial shortening of <5 mm compared to the contralateral side.

3. The sagittal tilt between 15^0 dorsal and 20^0 volar tilt.

4. Intra-articular step-off of <2 mm.

Postoperative protocol: Follow up was done at two weeks, six weeks, three months, and six months. In the volar plating group, suture and slab removal was done at two weeks. Physiotherapy of the wrist was started following the removal of the slab. In the external fixator group, pin site inspection and the dressings were done at two weeks. External fixator and K –wires were removed at six weeks following which physiotherapy was started.

Functional evaluation was done at three months and six months and comparison was done between groups. Functional evaluation was done according to the Green and O'Brien scoring system. [7] This includes pain, activity status, grip strength, and wrist range of motion (ROM): flexion and extension (both grip strength and ROM measured as a percentage of the normal wrist). Points in each range from 0-25 with a maximum score of 100. Scores

<65 were considered poor, and scores between 65 and 79, between 80 and 89, and between 90 and 100 were considered fair, good and excellent, respectively. At six weeks and six months follow-up, AP and lateral views X-rays of the affected wrist was done for radiological evaluation. Radiological measurements (dorsal tilt, radial inclination, and radial length) were done for comparison between two groups.

Data were recorded in the proforma. The data were then coded and entry was done in the Statistical Package for Social Sciences (SPSS™) version 16.0. The data were processed and analyzed. The mean values of continuous outcome characteristics between the two techniques were compared by the Student t-test. Ordinal outcomes were compared using Fisher exact test or Chi-square test as appropriate. All tests were two-sided and p-values <0.05 were considered significant.

RESULTS:

A total of 47 patients were included in the study. Twenty-one patients were treated by closed reduction and external fixation along with supplementary K-wires. Twenty-six patients were treated by open reduction and internal fixation with a volar locking plate. Fractures united within six months in all patients. The demographic characteristics of patients are shown in table 1.

At the end of three months, as per the Green and O'Brien score, the mean functional outcome score in the volar plate group was significantly better 80.77(±11.46) compared to the external fixation group 70.24(±10.66)(p=0.002). However, at the end of six months, the mean score in the volar plate group 86.15(±7.39) was not significantly different from that in the external fixation group 81.43(±9.63) (p= 0.63). Functional outcomes at three months and six months are shown in table 2. At the end of three months, 18 (69.23%) cases were good to excellent in the volar plate group compared to the external fixator group where 8 (38.09%) cases had good to excellent outcomes (p=0.033). At the end of six months, 21 (80.76%) cases had good to excellent in the volar plate group compared to 16 (76.19%) cases in the external fixation group (p=0.703)

Table 1. Demographic characteristics of patients (N=47).

Patients characteristics	External fixation group (n=21)	Volar plate group (n=26)
Age in years Mean ± SD (range)	37.48 ± 11.65 (18-60)	34 ± 10.45 (18-55)
Male to female ratio	2:1	1.6:1
C1	6	12
C2	6	10
C3	9	4
Dominant side involved	61.90%	57.7%

The results of the radiological evaluation are shown in table 3. An analysis of radiographs at six weeks showed that correction of the anatomical parameters; radial length, radial inclination, and dorsal tilt were achieved better with a volar locking plate than external fixation, mainly volar tilt correction which was statistically significant (p=0.040). At six months evaluation radial length, radial inclination, and dorsal tilt were maintained better in the volar locking plate group in comparison to external fixation (p=0.005, 0.001 and 0.007 respectively). All fractures united within the acceptable radiological limit except in four cases, where articular step-off of more than two (2-3) millimeters was seen, step-off was seen in three (14.28%) cases in the external fixation group, and one (3.84%) case in the volar plate group (p=0.311). There were four (19.04%) cases of complications in the external fixator group in the form of pin tract infection which improved with regular dressing and oral antibiotics as per the culture and sensitivity report. In the volar plate group, there was one (3.84%) complication as postoperative hematoma which improved after wound care.

Table 2. Functional outcomes as per the Green and O'Brien scoring at 3 months and 6 months.

Treatment Groups	Outcomes at 3 months N (%)				Outcomes at 6 months N (%)			
	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
External fixator	2 (9.5%)	6 (28.6%)	9 (42.9%)	4 (19%)	7 (33.3%)	9 (42.9%)	4 (19%)	1 (4.8%)
Volar plate	9 (34.6%)	9 (34.6%)	5 (19.2%)	3 (11.5%)	14 (53.8%)	7 (26.9%)	5 (19.2%)	0

Table 3. Radiological results at 6 weeks and 6 months.

Radiological Parameters		External fixator mean (±SD)	Volar plate mean (±SD)	Statistics
6 weeks	Radial length	10(±0.54)	10.23(±0.765)	t=0.019, df=44.43, p=0.235
	Radial inclination	19.24(±1.44)	19.96(±1.39)	t=0.132, df=45, p=0.089
	Dorsal tilt	2.76(±4.99)	-0.62(±5.79)	t=0.437, df=45, p=0.040
6 months	Radial length	9.14(±0.57)	9.77(±0.86)	t=0.044, df=43.53, p=0.005
	Radial inclination	17.81(±1.07)	18.92(±1.16)	t=0.047, df=44.10, p=0.001
	Dorsal tilt	4.86(±4.45)	0.85(±5.19)	t=0.46, df=44.43, p=0.007

DISCUSSION:

Restoration of anatomy following distal end radius fracture is important to reduce the disability and for better functional outcome.[8,9] Both external fixation and volar plating are accepted procedures with their advantages and disadvantages. External fixation is based on the principles of ligamentotaxis. Easy, quick application, and minimal invasion are the advantages of an external fixator. Pin site infection, difficult care of hardware, and cumbersomeness are the disadvantages.[10,11] With the introduction of volar locking plates, open reduction and internal fixation with volar locking plates have become the preferred method of a surgery over the last decade.[12] Low profile volar locking plates and multi-angle locking head screws allow stable and anatomical reconstruction of multi fragmentary intra-articular fracture of distal end radius and it has been gaining popularity among surgeons.[13,14] But consensus regarding the superiority of volar locking plate over external fixation in the management of distal end radius fracture is uncertain.

In the present study, according to the Green and O'Brien scoring system outcomes were better in the volar locking plate group at three months postoperative period but at six months follow up there was no significant difference in outcomes between the two groups. The radiological correction was achieved better in the volar locking plate group and it was maintained better than the external fixation group till six months follow-up. Results similar to our study have been shown by various other studies. In a recent randomized controlled trial conducted by Sharma et al., results in the volar locking plate and external fixation group were comparable in terms of retaining anatomy and function, however, volar locking plates were superior in providing early recovery similar to present study.[15] Germaine GQ et al., found no significant difference between the results of the external fixator and the volar locking plate with regards to radiological and functional outcomes and complications.[16] A similar study was conducted by Pradhan RL et al., where a similar evaluation tool was used for functional evaluation. The mean functional score was better in the volar locking plate group at three months follow up. But the results were not different at six months and one year which was similar to our study.[5]

In a randomized controlled trial conducted by Jeudy et al. the open reduction and internal fixation (ORIF) group did better than the external fixator group. However, open reduction and volar plating did not yield better subjective results than the external fixator group.[17] They suggested ORIF with a volar locked plate as a better option for young and active individuals. Two recent meta-analyses conducted by Wang et al., and Fu et al., have advocated the use of volar locking plates over external fixators.[18,19] The latest meta-analysis conducted by Gouk et al., concluded there is no difference in functional outcomes, grip strength, and radiographic outcomes between both methods of treatment even though ROM was found better in the ORIF group.[20] In a study by Shukla et al., they found at a year follow–up overall outcome of the external fixator group was better over volar plating.[6]

In this study, we have seen better outcomes during early postoperative periods in the volar locking plate group that could be due to stable fixation provided by locking plate which allows early rehabilitation programs. Perugia et al., in a review article found a stable internal fixation obtained with a plate enables an early movement of wrist that prevents the stiffness of the wrist and improves the capacity of the wrist to perform normal function.[9]

In the present study, irrespective of radiological differences, functional outcomes in both groups are comparable in the later phase of the study. This finding is in agreement with a study conducted by Kasapinova et al.[21] In their study, they found no correlation between the X-ray parameters and quality of life and functional outcomes.

Small sample size, non-randomization, and selection of procedure as per the surgeon's decision, use of two different types of volar locking plates, and shorter duration of follow-up are the limitations of this study.

CONCLUSION:

Radiological correction is achieved and maintained better by volar locking plates. Though functional outcomes are better in volar locking plates at three months, it becomes comparable with the external fixator and supplementary K-wire fixation group at six months follow-up.

Conflict of Interest: The authors declare that no competing interests exist.

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