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Original Article

Comparison of Function Outcome of External Fixation with Orthofix Versus External Fixation with Orthifix Supplemented by K-Wires in Distal Radius Intra-Articular Comminuted Fractures (23c3)

Ali Raza, Muhammad Rashid, Majid Rasheed, Rana Danish Iftikhar

Department of Orthopedic, Sahiwal Teaching Hospital, Sahiwal Pakistan

ABSTRACT

Objective: To compare functional and anatomical outcomes of closed reduction external fixation with Orthofix alone versus Orthofix supplemented by K-wires in distal radius comminuted intra-articular fractures.

Study Design: Quasi experimental study.

Place and Duration of Study: Department of Orthopedic Surgery, Sahiwal Teaching Hospital, Sahiwal, Pakistan from Jan 2025 to Apr 2025.

Methodology: Total 62 patients with closed distal radius comminuted intra-articular fractures (AO type 23-C3) were allocated into two groups with treating physician choice; Group-A external fixator plus K-wires, and Group-B external fixator alone. Functional outcome was assessed using Modified Mayo Wrist Score, while anatomical outcome was measured by radial length, radial angle, and volar tilt at 12 weeks postoperatively. Data were analyzed using SPSS 24. Independent sample t-test and Chi-square/Fisher's exact test were applied, with *p*-value <0.05 considered significant.

Results: The mean MMWS at 12 weeks was significantly higher in Group-A (86.77±4.97) vs Group-B (83.54±7.34; *p*=0.047). At 6th-week postoperative assessment, volar tilt was significantly better in Group-A (11.80 ± 0.80°) versus Group-B (10.99 ± 0.86°; p<0.001), while no significant differences were observed in radial length (p=0.248) and radial angle (*p*=0.083). Functional outcomes were also more favorable in Group-A across most age groups, among females and in fall or sports-related injuries, though differences in RTA-related injuries were less marked.

Conclusion: The addition of K-wires to external fixation provides superior functional recovery and improved anatomical alignment particularly in terms of volar tilt, compared to external fixation alone in the management of distal radius comminuted intra-articular fractures.

Keywords: Comminuted; Fracture Fixation, External; Intra-Articular; Kirschner Wires; Orthopedic Fixation Devices, Radius Fractures.

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INTRODUCTION

Distal radius intra-articular comminuted fractures (DRIFs) are among the most frequent orthopedic injuries, commonly resulting from high-impact trauma/falls, and often requiring surgical management.[1] Treatment strategies range from conservative splinting to surgical reduction with internal/external fixation.[2] Over the last two decades, there has been growing interest in improving outcomes of unstable intra-articular fractures, as intra-articular mal-union is strongly associated with loss of function and patient dissatisfaction.[3] Achieving proper alignment and articular congruity is therefore critical but technically demanding.[4] External fixations, particularly with Orthofix system, is widely used for comminuted fractures as it provides stability with minimal dissection and allows early mobilization. However, functional benefits of external fixation remain controversial, with mixed evidence on its superiority over other methods.[5,6]

Several studies have evaluated the role of K-wire augmentation with external fixation and reported outcomes vary with no clear consensus on added benefit. A local study reported excellent functional outcome among 60% patients, 15% had good, 20% had fair and 5% had poor outcome with the use of external fixator with K-wires for treating distal radius fracture.[7] One comparative study found no significant difference between external fixation alone and fixation supplemented with K-wires in terms of volar tilt (EF: 9.6±0.3 vs. EFK: 9.2±0.3, p-value=0.289), radial length (EF: 11.2±0.3 vs. EFK:10.4±0.4, *p*-value=0.123), or radial inclination (EF:20.4±0.4 vs. EFK:20.1±0.3, *p*-value=0.574).[8] Despite this, supplementary fixation with K-wires is thought to enhance fragment stability, particularly in intra-articular or highly comminuted

Correspondence: Dr Ali Raza, Department of Orthopedic, Sahiwal Teaching Hospital, Sahiwal Pakistan

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fractures, by securing smaller fragments and reducing the risk of malunion.[9]

Studies have reported variables results for functional outcome regarding addition of KL-wire with orthofix and using orthofix alone for treating distal radius comminuted intra articular fractures. This study therefore aims to compare the functional and anatomical outcomes of closed reduction external fixation with Orthofix alone versus Orthofix supplemented by K-wires in treating distal radius intra-articular comminuted fractures.

METHODOLOGY

This quasi experimental study was conducted in the Department of Orthopedic Surgery, Sahiwal Teaching Hospital, Sahiwal Pakistan, from January 2025 to April 2025. Ethical approval was obtained (S. No-341--/IRBSLMC/SWL) from Institutional Review board (IRB) before starting the study. The sample size was calculated with a 5% level of significance and 90% power, based on the expected proportion of excellent functional outcomes with external fixator plus K-wire (41%),[10] versus external fixator alone (6.66%).[11]

Inclusion Criteria: Patients aged 18–60 years of either gender with closed distal radius comminuted intra-articular fractures type 23-C3 (dorsal angulation >20°) were included.

Exclusion Criteria: Patients with neurovascular injury, non-displaced or pathological fractures, open fractures with severe soft tissue loss, immature skeleton, pre-existing impairment of the same limb, distal radius fractures extending to the shaft or concomitant fractures, or multiple injuries were excluded.

Patients were included in the study using non-probability convenient sampling and assigned into two groups of 31 each via treating physician choice.

Written and verbal informed consent was obtained after explaining the study protocol, risks, and benefits. Demographic and clinical data were recorded, and a comprehensive examination was performed to assess pain, tenderness, swelling, deformity, and neurovascular status. Fractures were classified according to the AO/OTA system. Treatment allocation was based on surgeon choice and treatment was divided into two Groups (Figure-1). Group-A received treatment with external fixator supplemented by percutaneous K-wires, while Group-B was treated with external fixator alone. Under proximal tourniquet (250 mmHg), stab incisions were made dorsoradially, superior to the extensor pollicis longus tendon, and laterally over the second metacarpal. Two 4-mm pins were inserted proximally and two distally at different trajectory angles and connected to the external fixator bar using clamps. Traction was applied under fluoroscopic guidance until satisfactory radiologic parameters, including radial inclination, volar tilt, and radial length, were achieved. In Group-A, articular fragments were reduced percutaneously using pointed reduction forceps, followed by 0.45-in K-wire insertion under fluoroscopy through the radial styloid and/or intermediate column before external fixator application. Prophylactic antibiotics were administered preoperatively and continued for 3–5 days postoperatively. Active and passive range-of-motion exercises for the digits and elbow were initiated on the second postoperative day under physiotherapist supervision. Wounds were dressed daily, K-wires were removed at six weeks, and the external fixator was removed two weeks later. Anatomical outcomes (radial length, radial angle, volar tilt) and functional outcomes (Modified Mayo Wrist Score) were assessed at 12 weeks postoperatively.

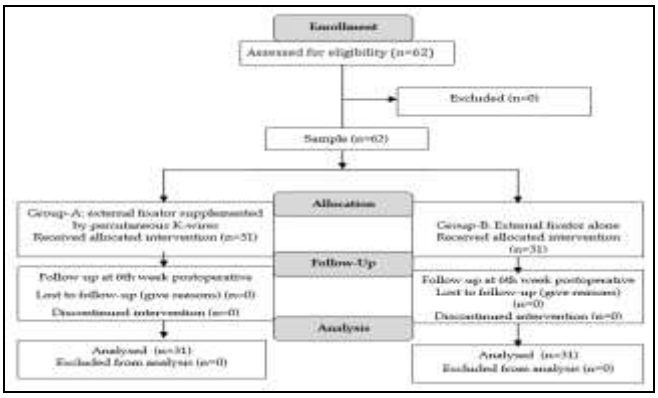

Figure-1: Patient flow Diagram for Functional Outcomes of Orthofix vs Orthofix + K-Wires in Distal Radius 23C3 Fractures (n=62)

Statistical analysis was conducted using Statistical Package for social sciences (SPSS) version 24. Quantitative variables (age, injury to treatment duration, Modified Mayo score, radial length, radial angle and volar tilt) were presented with Mean±SD and qualitative variables (Gender, mode of injury, effected side, functional outcome) were presented with frequency and percentage. Normality assessment of quantitative variables was carried out with Shapiro wilk test. Functional (Modified Mayo score) and anatomical outcome (radial length, radial angle and

volar tilt) outcome was compared between groups with independent sample t-test. Chi square/Fisher exact test was applied to compared functional outcome (Excellent, Good, Fair and poor as assessed with modified Mayo score) between groups at 6th week postoperative. Effect modifiers (age, gender mode of injury and effected side) were controlled through stratification. Post stratification Chi square test was applied to see the impact of effect modifiers on functional outcome.Mann Whitney U test was for non normally distributed variables, *p*-value ≤0.05 was considered statistically significant.

RESULTS

In this study we enrolled 62 patients (31 patients in each group). Both groups were comparable in terms of age, gender distribution, injury-to-treatment duration, etiology, and affected side ($p>0.05$). The mean Modified Mayo Wrist Score at 12 weeks was significantly higher in Group-A (86.77 ± 4.97) compared to Group-B (83.54 ± 7.34), indicating better functional recovery in the K-wire supplemented group (*p*-value= 0.047) (Table-I).

Table-I: Comparison of Patients Characteristics (n=62)

		Group-A	Group-B	*p*-value
		31	31	
Age (Years)		**41.12±11.94**	**42.09±12.32**	**0.755(t)**
Median Injury to treatment Duration (days)		2(1.0)	2(2.0)	0.900(ζ)
Gender	Male	19(61.3%)	20(64.5%)	0.793(c)
	Female	12(38.7%)	11(35.5%)	
Etiology	Fall	14(45.2%)	21(67.7%)	0.148(f)
	RTA	12(38.7%)	6(19.4%)	
	Sports Injury	5(16.1%)	4(12.9%)	
Effected Side	Right	15(48.4%)	20(64.5%)	0.073(c)
	Left	16(51.6%)	11(35.5%)	
Modified Mayo Wrist Score		86.77±4.97	83.54±7.34	0.047(t)

Note: RTA: Road Traffic Accident (t) Independent sample t-test, (ζ) Mann Whitney U test (c) Chi Square test

Table-II: Comparison of Anatomical Outcome Between Groups (n=62)

	Baseline		6th Week Postoperative		*p*-value(t)	
	Group-A	Group-B	Group-A	Group-B	Baseline	6th Week
	n=31	n=31	n=31	n=31		
Radial Length	7.10±1.88	7.85±1.89	9.75±.83	9.09±2.54	0.121	0.248
Radial Angle	14.46±3.74	14.08±3.13	21.81±1.81	20.90±2.25	0.663	0.083
Volar Tilt	-7.76±6.18	-8.36±3.64	11.80±0.80	10.99±0.86	0.150	<0.001*

Note: (t) Independent sample t-test, (*) p-value<0.05

Baseline anatomical parameters, including radial length, radial angle, and volar tilt, were similar between the groups (*p*-value > 0.05). At the 6th-week postoperative assessment, both groups showed improvement; however, volar tilt was significantly better in Group-A (11.80 ± 0.80°) compared to Group-B (10.99 ± 0.86°, *p*-value< 0.001), while differences in radial length and radial angle were not statistically significant (*p*-value= 0.248 and *p*-value=0.083, respectively). (Table-II)

Figure-2 shows that function outcome of patients was significantly better in Group-A patients as compared to Group-B patients. i.e. (*p*-value=0.048).

In patients aged 19–35 years, 80% in Group-A achieved a "Good" outcome compared to 45.5% in Group-B. For 36–50 years and >50 years, the proportion of patients with "Excellent" outcomes was higher in Group-A (46.2% and 50%, respectively) than in Group-B (20% and 10%). Among males, 35% in Group-A versus 21.1% in Group-B achieved "Excellent" results. Among females, 45.5% in Group-A achieved "Excellent" outcomes compared to 8.3% in Group-B, indicating a trend favoring K-wire supplementation, though *p*-value=0.055. Patients with fall or sports-related injuries showed higher rates of Excellent" and "Good" outcomes in Group-A compared to Group-B, whereas differences in RTA-related injuries were less pronounced. Patients with fall or sports-related injuries showed higher rates of Excellent" and "Good" outcomes in Group-A compared to Group-B, whereas differences in RTA-related injuries were less pronounced. (Table-III)

DISCUSSION

In current study, mean Modified Mayo Wrist Score at 12 weeks was significantly higher in Group-A (86.77 ± 4.97) compared to Group-B (83.54 ± 7.34); *p*-value=0.047. Similarly, Shen *et al.*, indicated that

combination of external fixation and K-wires yields superior MMWS compared to external fixation alone.[12] Ermutlu *et al*., in contrast, suggested that while K-wire supplementation may improve certain outcomes, differences in MMWS may not be clinically significant in all cases, indicating that choice of treatment should be tailored to individual patient needs and fracture characteristics.[13]

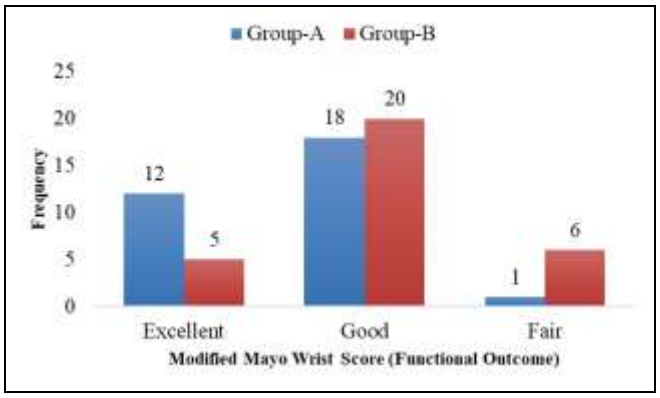

Figure-2: Comparison of Functional Outcome at 12th week Postoperative

Table-III: Association of Functional Outcome in Relation to Patients Characteristics(n=62)

Variables	Functional Outcome	Group		*p*-value(c)
		Group-A	Group-B	
19-35 Years	Excellent	2(20%)	2(18.2%)	0.170
	Good	8(80%)	5(45.5%)	
	Fair	0(0%)	4(36.4%)	
36-50 Years	Excellent	6(46.2%)	2(20%)	0.379
	Good	7(53.8%)	8(80%)	
>50 Years	Excellent	4(50%)	1(10%)	0.193
	Good	3(37.5%)	7(70%)	
	Fair	1(12.5%)	2(20%)	
Male	Excellent	7(35%)	4(21.1%)	0.316
	Good	12(60%)	11(57.9%)	
	Fair	1(5%)	4(21.1%)	
Female	Excellent	5(45.5%)	1(8.3%)	0.055
	Good	6(54.5%)	9(75%)	
	Fair	0(0%)	2(16.7%)	
RTA	Excellent	3(25%)	0(0%)	0.168
	Good	9(75%)	4(80%)	
	Fair	0(0%)	1(20%)	
Fall	Excellent	6(42.9%)	5(23.8%)	0.532
	Good	7(50%)	13(61.9%)	
	Fair	1(7.1%)	3(14.3%)	
Sports Injury	Excellent	3(60%)	0(0%)	0.167
	Good	2(50%)	3(60%)	
	Fair	0(0%)	2(40%)	

Note: (c) Chi Square test

Liu *et al*., documented that non-bridging external fixation provides superior functional outcomes compared to bridging fixation, with significantly higher percentage of excellent results at 12 weeks and better wrist joint function, while complication rates were comparable between groups.[14] Similarly, in our study, at 6th-week postoperative assessment, both groups showed improvement; however, volar tilt was significantly better in Group-A (11.80±0.80°) compared to Group-B (10.99±0.86°, *p*-value< 0.001), while differences in radial length and radial angle were not statistically significant (*p*-value= 0.248 and *p*-value=0.083, respectively).

Krustins *et al*., compared arthroscopically assisted volar locking plates with external fixator plus K-wires, revealed no clinically significant differences were found between two treatment methods.[15] Costa *et al*., however, found that surgical fixation using K-wires showed no improvement in wrist function at 1 year follow-up.[16]

In current study, functional outcome of patients was significantly better in Group-A vs Group-B; *p*-value=0.048. Barakat *et al*., demonstrated superior outcomes of ORIF compared to external fixation, with 90% of patients achieving acceptable functional results and 95% attaining favorable radiographic parameters on Sarmiento score. In contrast, external fixation with Kirschner wire yielded 75% acceptable functional outcomes and 85% acceptable radiological parameters.[17] Compared with our study, which evaluated external fixation with and without K-wire supplementation, addition of K-wires improved the proportion of patients achieving "Excellent" and Good" functional outcomes across most age groups and in both genders. While external fixation alone in earlier studies appeared inferior to ORIF, our results suggest that combining K-wires with external fixation enhances stability and functional recovery, thereby narrowing the outcome gap between EF and ORIF. Addition of K-wire contributes to construct stiffening and results in reduced local stress at fracture site. Conversely, increasing the span of fixation lowers stiffness and elevates local stress levels. Notably, when K-wire is inserted across fracture line, axial stiffness improves significantly, thereby enhancing overall stability of the fixation construct.[18,19]

LIMITATION OF STUDY

The present study has certain limitations that should be acknowledged, follow-up period was relatively short, which may not fully capture long-term functional and radiological outcomes, particularly about late complications such as post-traumatic arthritis or implant-related issues. Secondly, complications associated with external fixation and K-wire supplementation, including pin-tract infections, loosening, or delayed union, were not systematically

assessed in our study. Future research with longer follow-up duration and detailed evaluation of complication profiles is warranted to validate and strengthen these findings.

CONCLUSION

Results of this study demonstrate higher treatment efficacy of K-Wire group in terms of functional recovery and restoration of volar tilt. However, no significant difference was seen between groups for radial length and radial angle. These findings highlight that the addition of K-wires enhances construct stability, leading to improved functional recovery and better anatomical alignment.

Conflict of Interest: None.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AR & MR: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

MR & RDI: Data acquisition, data analysis, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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