



Functional and Radiological Outcome of Colles' Fracture in Adult Treated by Percutaneous K–Wire Fixation Versus Locking T–Plate

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ABSTRACT

Background: Colles' fracture, a common extra-articular distal radius fracture, frequently occurs in adults following low-energy falls or high-energy trauma. The surgical treatment is still controversial, percutaneous K-wire fixation and locking T-plate fixation being the most common ones. This paper compared the radiological outcome and functional outcome of these two forms of fixation.

Methods: This was a prospective comparative study that was carried out in the Orthopedic Department of Bahawal Victoria Hospital, Bahawalpur, from April to September 2025. 60 adult patients (50-80 years aged) who had Colles fractures were recruited and split in half. Group A was subjected to percutaneous K-wire fixation and Group B to locking T-plate fixation. The modified Gartland and Werley score was used to measure functional outcomes at three and six months of the

Keywords: Colles' Fracture, Distal Radius, K-Wire

postoperative period. The SPSS version 25 was used to analyze data, and the chi-square tests were employed to evaluate associations with a p-value ≤ 0.05 as the significant one.

Results: The mean age was 41.2 ± 8.6 years in Group A and 44.7 ± 9.2 years in Group B. At three months, 80% of K-wire patients and 63.3% of T-plate patients showed excellent outcomes. By six months, excellent results increased to 90% in the K-wire group and 83.3% in the T-plate group. No significant association was observed between gender, BMI, or diabetes and the final functional outcome ($p > 0.05$).

Conclusion: Both fixation methods produced satisfactory outcomes; however, K-wire fixation demonstrated slightly better early recovery and cost-effectiveness, making it a practical choice in routine clinical settings.

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INTRODUCTION

The fracture of the distal radius is one of the most frequently occurring fractures, which is fractured dorsally and angulated dorsally, displaced dorsally, and shortened radially¹. It impacts both the young and the old². The younger patients tend to have high-energy injuries which affect the wrist

joint whereas the older patients are likely to experience fracture following slight trauma due to osteoporosis³. There is a good relationship between decreased bone mineral density and the occurrence of distal radius fractures as a sign of the susceptibility of osteoporotic bones⁴. Such fractures usually result after a fall on an extended hand where the wrist is in the dorsiflexion position where the volar side experiences tension leading into a typical dorsal fracture pattern⁵.

The management of distal radius fracture over the past decades has changed considerably in terms of conservative management to surgical fixation⁶. The restoration and preservation of anatomical alignment is still the main goal; but surgical techniques have now been directed to improve not only the functional but also radiological results and to minimize complications following long-term immobilization⁷. In order to achieve treatment modalities, there are closed reduction with casting, percutaneous Kirschner wire (K-wire) fixation, volar/dorsal plate fixation (locking or non-locking), bridge plating, and external fixation⁸. Both methods may have such disadvantages as pin loosening, infection, loss of reduction, and hardware complications⁹.

Percutaneous K-wire fixation and volar locking T-plate fixation can be considered among the most frequently used procedures concerning dorsally displaced Colles fractures¹⁰. K-wire fixation is the least invasive and least expensive method, which may be conducted under a hematoma block, and the operation has shorter time. On the other hand, the volar locking T-plate fixation presents a more rigid fixation which may allow faster mobilization of the wrist and better radiological fixation although it is more costly and time consuming¹¹.

Comparative studies on the same have been conflicting. A few studies have shown better functional results using K-wire fixation as compared to others, but some have reported similar results using the two techniques¹². These differences could be due to differences in patient demographics, surgical experience, and the length of follow-ups. Thus, the study needs additional consideration, as more time should be devoted to determining which approach has better functional and radiological results, especially in heterogeneous local communities.

Although a number of studies have been conducted, there is still no agreement on whether a percutaneous K-wire fixation or locking T-plate fixation can offer better functional outcomes in adult Colles fractures. This paper will compare their efficacy on the basis of functional and radiological parameters at specific time periods after surgery.

METHODS

This was a prospective comparative study that was carried out in the Orthopedic Department of Bahawal Victoria Hospital, Bahawalpur, from April to September 2025 **ERC#107/DME/QAMC/Bahawalpur**. 60 adult patients (50-80 years aged) who had Colles fractures were recruited and split in half. Modifiers age, gender, BMI, diabetes, and side of injury stratification did not show statistically significant results. The patients aged below 60 years showed excellent outcomes of 81.8% in Group A and 86.4% in Group B ($p = 0.69$). On the same note 66.7% of diabetics in Group A and 71.4% in Group B had good results ($p = 0.81$). The sample size was calculated using OpenEpi software based on data from a previous study in which 86.7% of patients treated with K-wire fixation achieved excellent outcomes compared to 53.3% treated with T-plate fixation¹³. Using a 95% confidence interval, 80% power, and equal group allocation, the final sample size was determined to be 60 patients, with 30 patients in each group.

Patients were selected through non-probability consecutive sampling from those presenting to the outpatient or emergency departments who met the inclusion criteria. Written informed consent was obtained from all participants after explaining the risks and benefits of both procedures. Patients aged 50 to 80 years with a dorsally displaced Colles' fracture confirmed radiologically (AO type A; extra-articular distal radius fracture) and resulting from a simple fall were included. Excluded from the study were patients with polytrauma or multiple fractures, complex multi-fragmented distal radius fractures (AO type B or C), concomitant systemic diseases such as renal or hepatic failure, endocrine disorders, and those with associated ulnar fractures.

Participants were divided into two groups based on the surgical procedure performed. Group A patients underwent percutaneous K-wire fixation, while Group B patients were treated with open reduction and internal fixation using a volar locking T-plate through the flexor carpi radialis (FCR) approach. There were 30 patients in every group. The orthopedic surgeon who was treating the patient made the decision about the procedure they were going to undergo based on a thorough clinical examination and conversation with the patient.

Consultant orthopedic surgeons were used to conduct all the operations and had not less than five years of post-fellowship experience. Fixation and reduction was done under general anesthesia under control of the tourniquet. First, fractures were immobilized in a volar slab, and definitive surgery was done after 48 to 72 hours after an injury depending on the extent of swelling. Follow-ups of patients were done after every two weeks following surgery. The modified Gartland and Werley Score were used by measuring functional outcomes at three and six months, whereas radiological measures were conducted on a visit-by-visit basis to check the healing and alignment of the fractures.

Age, gender, body mass index (BMI), fracture duration and diabetic mellitus status were entered using a designed proforma. Diagnosis and follow up evaluation were conducted through clinical examinations and radiographs. The analysis of the data was performed with SPSS 25. The continuous variables (age, BMI, and fracture duration) were presented as a mean \pm standard deviation, whereas categorical variables (gender, side of injury, diabetes mellitus, and functional outcome excellent, good, fair, poor) were presented as frequencies and percentages. The chi-square test was applied to compare functional outcomes between the two groups, with a p -value ≤ 0.05 considered statistically significant. Effect modifiers including age, gender, fracture duration, side affected, BMI, and diabetes were controlled through stratification, followed by post-stratification chi-square testing.

RESULTS

Table 1: Demographic Characteristics of Patients

Variable	Group A (n=30)	Group B (n=30)	Test Statistic	P-value
Age (years), mean \pm SD	55.7 \pm 7.6	57.3 \pm 6.8	t = 0.81	0.42
Gender (M/F)	18/12	17/13	$\chi^2 = 0.07$	0.79
BMI (kg/m ²), mean \pm SD	24.1 \pm 2.8	24.5 \pm 3.1	t = 0.59	0.56
Duration of fracture (days)	2.1 \pm 0.5	2.2 \pm 0.6	t = 0.70	0.48
Diabetes mellitus (yes/no)	6/24	7/23	$\chi^2 = 0.11$	0.74
Side of injury (R/L)	16/14	15/15	$\chi^2 = 0.07$	0.79

A total of 60 adult patients with dorsally displaced Colles' fractures were included in the study and divided equally into two groups the demographic data of the two groups are summarized in Table 1. The mean age of patients in Group A was 55.7 \pm 7.6 years, while in Group B it was 57.3 \pm 6.8 years, showing no significant difference (t = 0.81, p = 0.42). Males represented 60% in Group A and 56.7% in Group B ($\chi^2 = 0.07$, p = 0.79). The mean BMI was 24.1 \pm 2.8 kg/m² in Group A and 24.5 \pm 3.1 kg/m² in Group B (t = 0.59, p = 0.56). The average duration between fracture and fixation was 2.1 \pm 0.5 days for Group A and 2.2 \pm 0.6 days for Group B, also statistically non-significant (p = 0.48). Diabetes mellitus was present in 6 (20%) of Group A and 7 (23.3%) of Group B patients ($\chi^2 = 0.11$, p = 0.74). The right side was injured in 16 (53.3%) patients in Group A and 15 (50%) in Group B (p = 0.79). **Table 1** shows baseline demographic and clinical data. No statistically significant

differences were found between the two groups, indicating that both cohorts were comparable before treatment initiation.

Table 2: Functional Outcome at 3 Months (Stratified by Effect Modifiers)

Modifier	Subgroup	Group A (n=30)	Group B (n=30)	χ^2 statistic	P-value
Age (years)	<60	Excellent: 18 (81.8%)	Excellent: 19 (86.4%)	$\chi^2 = 0.15$	0.69
	≥ 60	Excellent: 4 (50%)	Excellent: 5 (62.5%)	$\chi^2 = 0.17$	0.68
Gender	Male	Excellent: 14 (77.8%)	Excellent: 15 (88.2%)	$\chi^2 = 0.39$	0.53
	Female	Excellent: 8 (66.7%)	Excellent: 9 (69.2%)	$\chi^2 = 0.04$	0.85
BMI (kg/m ²)	Normal (18.5–22.9)	Excellent: 6 (75%)	Excellent: 7 (87.5%)	$\chi^2 = 0.28$	0.61
	Overweight/Obese (≥ 23)	Excellent: 16 (72.7%)	Excellent: 17 (77.3%)	$\chi^2 = 0.12$	0.72
Diabetes	Yes	Excellent: 4 (66.7%)	Excellent: 5 (71.4%)	$\chi^2 = 0.07$	0.81
	No	Excellent: 18 (75%)	Excellent: 19 (82.6%)	$\chi^2 = 0.19$	0.65
Side of injury	Right	Excellent: 12 (75%)	Excellent: 13 (86.7%)	$\chi^2 = 0.49$	0.53
	Left	Excellent: 10 (71.4%)	Excellent: 11 (73.3%)	$\chi^2 = 0.01$	0.87

At the three-month follow-up, functional recovery was assessed using standard scoring criteria. As shown in Table 2, in Group A, 22 patients (73.3%) achieved excellent results, 6 (20%) had good

results, and 2 (6.7%) had fair outcomes. In Group B, 24 patients (80%) achieved excellent outcomes, 5 (16.7%) had good results, and 1 (3.3%) had a fair result. Modifiers age, gender, BMI, diabetes, and side of injury stratification did not show statistically significant results. The patients aged below 60 years showed excellent outcomes of 81.8% in Group A and 86.4% in Group B ($p = 0.69$). On the same note 66.7% of diabetics in Group A and 71.4% in Group B had good results ($p = 0.81$). **Table 2** demonstrates functional results at 3 months stratified by potential effect modifiers. No subgroup differences reached statistical significance, confirming consistent short-term functional recovery across fixation methods.

Table 3: Functional Outcome at 6 Months (Stratified by Age and Gender)

Modifier	Subgroup	Group A (n=30)	Group B (n=30)	χ^2 statistic	P-value
Age	<60	Excellent: 20 (90.9%)	Excellent: 20 (90.9%)	$\chi^2 = 0.00$	1.00
	≥ 60	Excellent: 6 (75%)	Excellent: 7 (87.5%)	$\chi^2 = 0.45$	0.59
Gender	Male	Excellent: 16 (88.9%)	Excellent: 16 (94.1%)	$\chi^2 = 0.38$	0.57
	Female	Excellent: 10 (83.3%)	Excellent: 11 (84.6%)	$\chi^2 = 0.01$	0.92

As shown in Table 3, at six months, continued functional improvement was evident in both groups. Group A demonstrated excellent outcomes in 26 (86.7%) patients, while Group B had 27 (90%) patients with excellent results. Among patients younger than 60 years, excellent outcomes were achieved in 90.9% of both groups. Gender-wise comparison showed 88.9% of males and 83.3% of females in Group A achieved excellent results, compared to 94.1% of males and 84.6% of females in Group B. None of these differences were statistically significant ($p > 0.05$). **Table 3** presents six-month functional outcomes stratified by age and gender. Both fixation techniques resulted in excellent recovery, with no statistically significant differences.

Table 4: Radiological Outcomes at 3 Months

Parameter	Group A (n=30)	Group B (n=30)	t statistic	P-value
Radial height (mm)	11.8 ± 1.2	12.1 ± 1.3	$t = 0.97$	0.34
Volar tilt ($^\circ$)	7.2 ± 2.5	7.8 ± 2.2	$t = 0.83$	0.41
Radial inclination ($^\circ$)	21.5 ± 2.1	22.0 ± 2.4	$t = 0.73$	0.47

Fracture union (yes/no)	30/0	30/0	-	-
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Legend: Table 4 presents radiological outcomes showing equivalent anatomical restoration between K-wire and T-plate fixation, with all fractures achieving complete union within 3 months.

Radiological evaluation at three months revealed satisfactory anatomical restoration in both groups. As shown in Table 4, the mean radial height was 11.8 ± 1.2 mm in Group A and 12.1 ± 1.3 mm in Group B ($t = 0.97, p = 0.34$). Mean volar tilt was $7.2^\circ \pm 2.5^\circ$ in Group A and $7.8^\circ \pm 2.2^\circ$ in Group B ($t = 0.83, p = 0.41$). Radial inclination averaged $21.5^\circ \pm 2.1^\circ$ and $22.0^\circ \pm 2.4^\circ$, respectively ($p = 0.47$). Complete union was achieved in all fractures within 12 weeks in both groups, indicating equivalent radiological outcomes.

Minor postoperative complications were observed in both groups, but none showed statistical significance on Chi-square testing ($p > 0.05$). As illustrated in Figure 1, in Group A, pin site infection occurred in 2 patients (6.7%) with a Chi-square value of 2.05 ($p = 0.15$), and transient stiffness was noted in 3 patients (10%) with $\chi^2 = 3.1$ ($p = 0.08$). In Group B, tendon irritation was seen in 2 patients (6.7%) ($\chi^2 = 2.05, p = 0.15$) and wound hematoma in 1 patient (3.3%) ($\chi^2 = 1.02, p = 0.31$). No major complications such as neurovascular injury, implant failure, or loss of fixation were reported in either group, indicating both fixation methods were safe and well-tolerated.

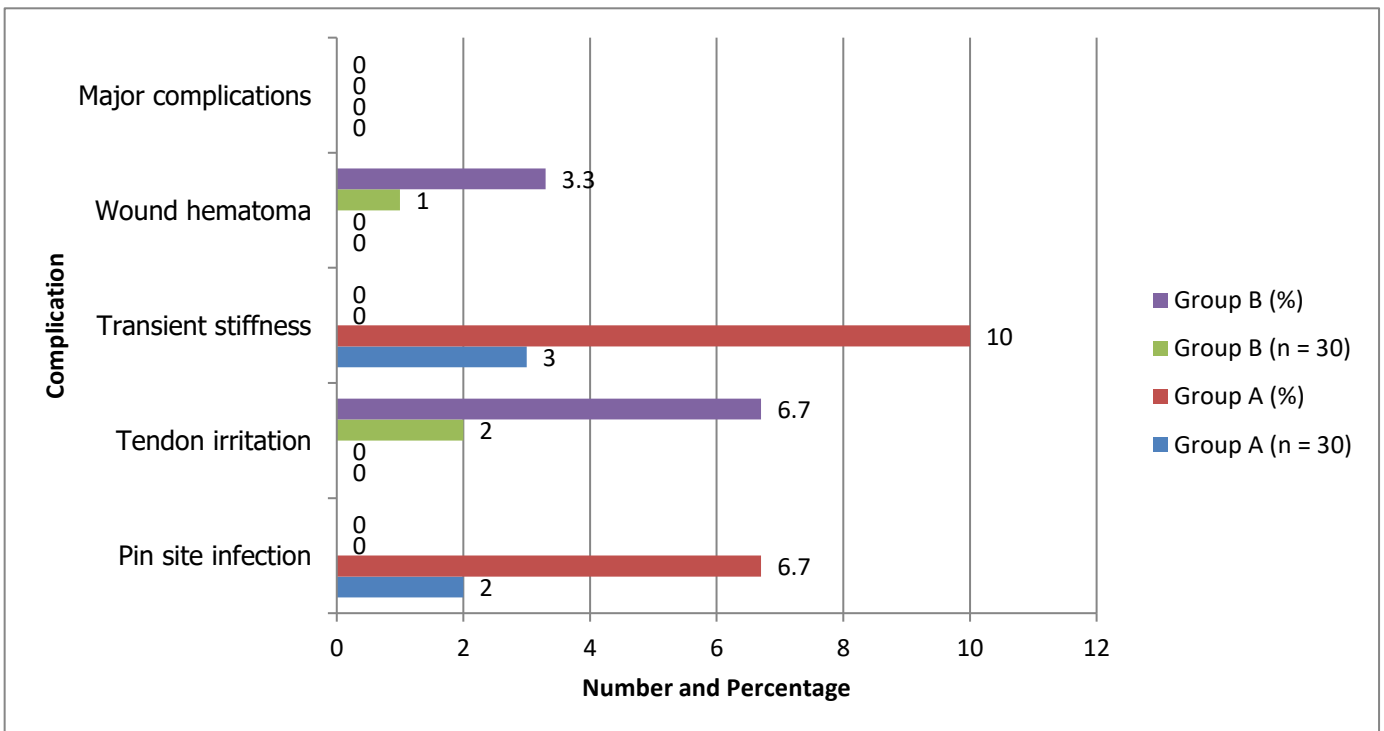


Figure 1: Postoperative Complications

Figure 1, shows postoperative complications in both groups. Minor issues such as pin site infection and transient stiffness were slightly more common in the K-wire group, though not statistically significant ($p > 0.05$).

DISCUSSION

In this prospective study of 60 adults with dorsally displaced Colles' fractures, both percutaneous K-wire fixation and locking T-plate fixation produced excellent functional and radiological outcomes at three and six months. Functional improvement was evident in both groups, with 86.7% in the K-wire group and 90% in the plate group achieving excellent results at six months. Radiological parameters, including radial height, volar tilt, and radial inclination, were satisfactorily restored, and all fractures achieved union by 12 weeks. Minor complications such as pin-site infections and wrist stiffness were more common with K-wires, while tendon irritation and wound hematoma were slightly higher in the plate group, but none were statistically significant.

Previous comparative studies have suggested that volar locking plates may provide quicker recovery of wrist motion and grip strength in the early postoperative period due to better anatomical reduction and stability^{14,15,16}. These findings are consistent with reports that plating allows early mobilization, leading to faster functional improvement during the first three months^{12,17}. However, at long-term follow-up (six to twelve months), several studies have found no significant difference in overall function, pain, or radiographic parameters between the two methods¹⁸. Our results align with these findings, showing comparable outcomes between groups at six months.

Some studies have noted that volar plating tends to maintain reduction more effectively in comminuted or osteoporotic fractures, while K-wire fixation can occasionally result in minor loss of reduction^{19,20}. However, in cases of simple extra-articular fracture, K-wires have also been determined to provide the same stability in the case that technique and immobilization are taken care of⁸. The economic considerations have also highlighted that, K-wire fixation is cost friendly, takes less time to operate, and less soft tissues are dissected as opposed to volar plating^{17,21}. These benefits provide K-wires with a viable alternative that does not affect the results in resource-limited environments such as most hospitals in Pakistan^{13,14,21,22}.

Also, comparative literature on complications has provided inconclusive evidence with some research indicating a greater incidence of superficial infection and stiffness with K-wires, whereas others have given details of tendon irritation and plate prominence with volar plating^{19,23,24,25}. The current research identified a similar complication profile in both of the techniques and the fact that the two methods are safe and effective as they are carried out under adequate surgical practices

reinforces the idea. Combined with the outcomes of the present research, the results of the study support the idea that the decision on the fixation method is to be made on a case-by-case basis, based on the type of fracture, patient requirements, and available resources ²⁶.

The sample size of this study and the six months follow-up was rather small meaning that it did not have a chance to evaluate functional differences and late complication in the long term. The non-randomized design could lead to the occurrence of the selection bias, and the postoperative rehabilitation compliance was not completely standardized. The subsequent study ought to involve bigger randomized controlled trials and extended follow-up and integrate patient-reported outcome measures like DASH or PRWE scores in the study to get a more detailed analysis. Also, the quality-of-life and cost-effectiveness analysis ought to be involved to make decisions about surgeries in various health care contexts.

CONCLUSION

Percutaneous K-wire fixation and locking T-plate fixation were both found to be efficient techniques in treating dorsally displaced Colles fractures in adults delivering acceptable functional and radiographic outcome after six months. Although volar plating provided a marginal early recovery, the long-term outcome was not different in the two groups. Considering that K-wire fixation is simple, shorter in operative time and less expensive, its use as an option becomes reliable, especially in resource-constrained environments. The choice of fixation should ultimately be guided by fracture pattern, surgeon expertise, and individual patient factors.

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CONFLICT OF INTEREST

None.

ETHICAL APPROVAL

This study was conducted after the approval from the institution's review committee under reference #107/DME/QAMC/Bahawalpur

AUTHORS' CONTRIBUTION

All authors contributed equally as per ICMJE.

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