

Displaced Distal Radius Fracture in Children, Single vs Double K-Wire Fixation

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ABSTRACT

Introduction: Distal radius fracture in pediatric population is the most common sustained injury¹. Treatment often is guided by the amount of displacement, with un-displaced fractures requiring only full cast and displaced fractures requiring fixation following reduction with Kirchner Wire (K-wire). Use of a single or double K-wire fixation technique is mostly dependent on the stability of the fracture as well as surgeon preference. Our study aims to evaluate both the Single vs. double K-wire fixation technique for the fixation of Displaced distal radius fracture in children in terms of time of surgery, fracture re-displacement, functional outcome and rate of complications.

Materials & Methods: This was a prospective study conducted at The Children Hospital and Institute of Child Health, Lahore between February 1st, 2020 and July 30th 2021. Following approval from the Institutional Ethical committee, 54 pediatric patients presenting to the Emergency and outpatient department with trauma to affected wrist with Displaced Fracture of Distal Radius were admitted and divided into two equal groups. Closed Surgical Fixation following manipulation under anesthesia (MUA) with single and double cross K-wires was performed in each group and Full Cast below elbow was applied for 4 to 6 weeks. Mean radial shortening, angulation and displacement was measured on radiograph pre-operatively, immediate post operatively and at the time of removal of k-wires. Functional outcome was measured post k-wire removal follow up in terms of normal, mildly reduced, moderately reduced and severely reduced.

Results: A total of 54 patients were included in the study with the mean age of 9.61(6-14) years, mean time of surgery was 17.26±3.75 minutes for single k-wire and 23.22±3.48 minutes for double k-wire fixation which was significant ($p \leq 0.05$). Mean Follow-up was 6.70±0.76 weeks for single k-wire and 6.19±0.48 weeks for double k-wire fixation. There was a statistically significant increase in mean dorsal angulation immediate post-operatively and at the time of k-wire removal ($p \leq 0.05$). There was no statistical difference in mean dorsal angulation between the two groups at the time of k-wire removal ($p = 0.55$). Seven (29.12%) patients of single k-wire developed complications including 3 (11.11%) pin site infection, 1 (1.85%) loss of reduction and 2 (7.41%) wire migration. In contrast to single k-wire fixation, 13 (48.15%) patients developed complications in double k-wire fixation including 7 (29.12%) pin site infection, 1 (1.85%) loss of reduction, 2 (7.41%) neuropraxia and 2 (7.41%) wire migration. In the single k-wire group, 22 (81.48%) patients had normal, 5 (18.52%) had mildly reduced and none had moderately reduced outcome. In double k-wire group, 21 (77.78%) had normal, 5 (.52%) had mildly reduced and 1 (3.70%) had moderately reduced outcome.

Conclusion: We concluded that although functional outcome is similar in both groups, single k wire fixation is superior to double k-wire fixation technique in terms of reduced time of surgery and less post-operative complications specially the pin site infection.

Key words: Displaced, Distal radius Fracture, K-wire fixation

INTRODUCTION

Fracture of the distal radius is among the most common fracture in the pediatric population¹ and account for about 19.9-35.8% of the fractures in pediatric age group². Most often they are managed by reduction under anesthesia and cast immobilization with or without kirschner wire (k-wire fixation). Displaced distal radius fractures managed by cast immobilization following reduction alone tends to re-displace after two weeks in 21-34% of the cases³⁻⁶. To prevent the re-displacement of the displaced distal radius fracture following reduction, percutaneous fixation with k-wire is used before applying the plaster cast. The number of k-wires used for fixation has not been clearly defined in the past literature. Where additional k-wires can add to stability of the fracture, it can deem the patient to complications such as pin site infection or neuropraxia^{7,8}.

The use of k-wires in fractures with high initial translation and imperfect reduction has shown reduced risk of re-displacement^{9,10}.

All the previous studies available so far have used one or two k-wires through the radial styloid or the lister's tubercle, but it has not been clearly documented whether single or double k-wire fixation has a better outcome in terms of re-displacement of fracture, functional range of motion of wrist joint and complications associated with the procedure. More so, such study has not been conducted in our population and in our institute where there is a large referral of pediatric trauma from all over the country. We aim to evaluate both the Single vs. double K-wire fixation technique for the fixation of Displaced distal radius fracture in children in terms of time of surgery, fracture re-displacement, functional outcome and rate of complications.

MATERIAL AND METHODS:

This prospective study was conducted over six months between February 1st, 2020 and July 30th 2021 at the Children Hospital and Institute of Child Health, Lahore. After approval from the Institutional Ethical committee, 54 pediatric patients aged between 6-14 years presenting to the Emergency and outpatient department with trauma to affected wrist with Displaced Fracture of Distal Radius were admitted and divided into two equal groups. After taking written informed consent from the parents/ guardian, demographic details were noted. Detailed history and examination were performed and radiographs of the affected wrist, Anteroposterior and lateral view was taken. Closed Surgical Fixation following manipulation under anesthesia (MUA) with single and double cross K-wires was performed in each group and Full Cast below elbow was applied. Mean radial shortening, angulation and displacement was measured on radiograph pre-operatively, immediate post operatively and at the time of removal of k-wires. The patients were called for follow-up at 1 week and then at 4 weeks for removal of k-wires following which physiotherapy was advised. Time for surgery, total follow-up time and complication if any were noted. Functional outcome was measured post k-wire removal follow up in terms of normal, mildly reduced, moderately reduced and severely reduced. Normal function was defined as no restriction in forearm rotation as compared to the opposite side, Mildly reduced as <10° restriction of forearm rotation as compared to opposite limb and spontaneous resolution, moderately reduced as >10° restriction in forearm rotation as compared to contralateral side which resolved following physiotherapy and Severely reduced as >30° restriction in forearm rotation in contrast to opposite limb which did not improve following physiotherapy and required further intervention.

Statistics: All the statistical analysis was performed using the IBM SPSS version 25. For non-binary variables i.e age, fracture displacement and angulation, mean and interquartile ranges were used. Independent samples T-test was used to compare the difference between the two groups in terms of Fracture angulation, displacement, time for surgery, outcome, follow-up and complications. A p ≤ 0.05 was considered as statistically significant.

RESULTS

A total of 54 patients were included in the study with the mean age of 9.61(6-14) years, 19(21.30%) patients presented following direct trauma to wrist, 31 (34.80%) patients presented following fall on outstretched hand and 4 (4.50%) patients presented as case of polytrauma. Mean time of surgery was 17.26±3.75 minutes for single k-wire and 23.22±3.48 minutes for double k-wire fixation which was significant (p ≤ 0.05). Mean Follow-up was 6.70±0.76 weeks for single k-wire and 6.19±0.48 weeks for double k-wire fixation. There was a statistically significant increase in mean dorsal angulation immediate post-operatively and at the time of k-wire removal (p ≤ 0.05). There was no statistical difference in mean dorsal angulation between the two groups at the time of k-wire removal (p= 0.55). Seven (29.12%) patients of single k-wire developed complications

including 3 (11.11%) pin site infection, 1 (1.85%) loss of reduction and 2 (7.41%) wire migration. In contrast to single k-wire fixation, 13 (48.15%) patients developed complications in double k-wire fixation including 7 (29.12%) pin site infection, 1 (1.85%) loss of reduction, 2 (7.41%) neuropraxia and 2 (7.41%) wire migration. In the single k-wire group, 22 (81.48%) patients had normal, 5 (18.52%) had mildly reduced and none had moderately reduced outcome. In double k-wire group, 21 (77.78%) had normal, 5 (.52%) had mildly reduced and 1 (3.70%) had moderately reduced outcome.

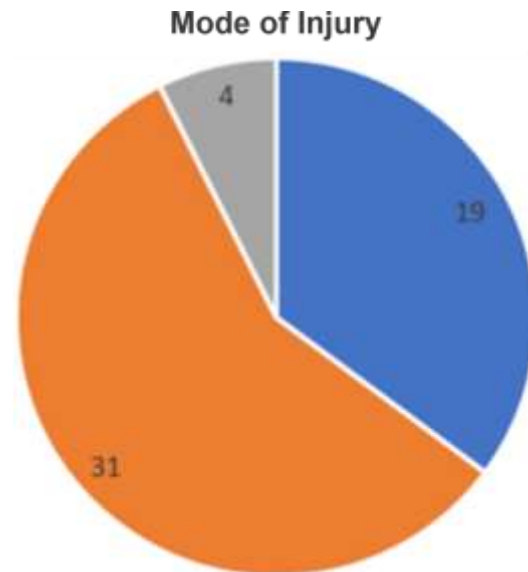


Figure 1: Different modes of injury.

Table 1. Radiological measurements of single K-wire fixation

Fracture characteristic (mm)	Pre-operative	Immediate post-operatively	At the time of k-wire removal
Mean shortening (%)	8.37±3.43	0.56±0.46	1.28±0.92
Mean angulation (°)	24.70±10.21	2.78±1.93	4.85±1.13
Mean displacement (%)	24.70±10.21	5.85±2.81	5.85±2.81

Table 2. Radiological measurements of double K-wire fixation

Fracture characteristic (mm)	Pre-operative	Immediate post-operatively	At the time of k-wire removal
Mean shortening (%)	12.37±2.50	0.10±0.00	0.10±0.00
Mean angulation (°)	18.78±5.06	2.44±1.34	4.29±0.95
Mean displacement (%)	18.78±5.06	5.11±2.24	5.11±2.24

Figure 2. Functional outcome following Single vs. Double k-wire fixation

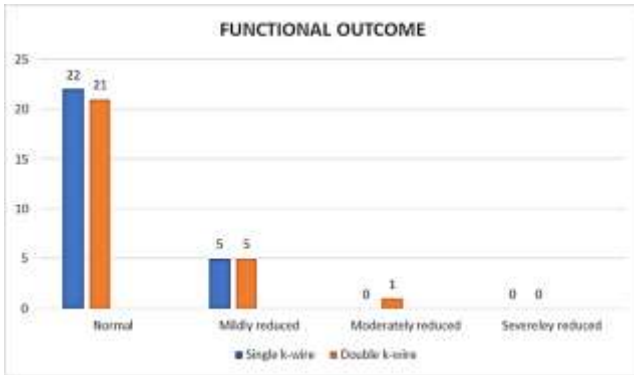


Table 3: Different complications in both single vs double k-wire group

Complication	Single k-wire	Double k-wire
Pin site infection	3 (11.11%)	7 (29.12%)
Wire migration under skin	2 (7.41%)	2 (7.41%)
Loss of reduction	1 (1.85%)	1 (1.85%)
Neuropraxia	0 (0%)	2 (7.41%)
none	21(77.78%)	15 (55.56%)

Complications: As can be seen from table 2, total of 10 (18.51%) patients had pin site infections which resolved after the removal of k-wire and local dressings. None of the patient developed deep infection. Four (7.41%) patients had wire migration under skin which was removed after instilling local anesthetic and using knife blade for nick over the k-wire to remove the wire. Two (3.70%) patients had loss of reduction and had to undergo re-manipulations. 2 (3.70%) developed neuropraxia which spontaneously resolved over time following the removal of k-wires. Thirty-six (66.67%) patients did not develop any complications

DISCUSSION

The objective of our study was to see if usage of additional k-wire fixation for displaced distal radius fracture in pediatric population had any added benefit in contrast to single k-wire fixation. Relatively few studies are available in this aspect in the literature. Our study has showed that both single and double k-wire fixation provided similar stability to the fracture, and similar functional outcome, however the surgery time was greater in double k-wire fixation in contrast to single k-wire fixation, and complications associated with k-wire i.e. pin site infection was statistically significant in double k-wire fixation than single k-wire fixation. In both groups k-wire fixation failed to prevent increased dorsal angulation at the time of k-wire removal, a factor which was significant statistically but not clinically since functional outcome was relatively good in both cases. Various studies are available regarding the management of displaced distal radius fracture in pediatric age group, despite which controversy still exists regarding its management. Some authors have published good functional outcome results when displaced distal radius fractures have been managed conservatively with cast only. Crawford et al. 11 managed 51 patients with displaced distal radius fractures only applying well molded cast to correct angulation. They did not reduce the fracture

and hence did not require any sedation or anesthesia. At 1year follow-up all the fractures united with good functional outcome. They also claim this method to be cheaper than manipulation under anesthesia and k-wire fixation. On the other hand, managing displaced distal radius fractures with cast immobilization alone is found to be associated with higher rates of re-displacement requiring re-manipulation under anesthesia^{12,13}. Recent studies have found certain pre-operative risk factors to be associated with re-displacement of fracture such as >11° angulation, radial shortening, completely displaced fractures and intact ulna as well as adequate initial reduction of fracture¹⁴⁻¹⁶. Well molded plaster cast also has a beneficial role in preventing re-displacement of fracture¹⁷.

Displaced distal radius fractures with risk factors for re-displacement need fixation with k-wires as recommended by some studies^{12, 18}. Jordan found that out of 17 patients with displaced distal radius fracture, none required re-manipulation¹². Despite fixation with k-wires, our result showed a 1.85% re-displacement rate in both single and double k-wire fixation requiring re-manipulation. This finding is consistent with the re-displacement rate of 2% as shown by Ramoutar et al. 1 following k-wire fixation. Therefore, k-wire fixation does not completely prevent re-displacement of fractures following fixation.

The number of k-wires used for fixation of displaced fracture has also been a topic of debate among the scholars. Our results show benefit of using single k-wire fixation in contrast to double k-wire fixation when keeping into account the duration of procedure and the complications involved, although there has been no difference between preventing the re-displacement of the displaced fracture and the final functional outcome. Ramoutar et al. 1 studied the outcome of k-wire fixation in displaced distal radius fracture. Their results showed that the number of k-wires used did not have any affect on the re-angulation, finding in line with our results. The rate of complication associated with the use of k-wire however, increased with the additional k-wire used. Our results revealed 18.00% patients with single k-wire developed k-wire related complications when compared to 40.74% with double k-wire fixation including pin site infection, wire migration under skin and neuropraxia. Previously published data has variable complication rate associated with k-wire fixation. Miller et al.¹⁸ reported k-wire related infection in 6 out of 16 (38.00%) patients in terms of pin site infection and pin migration. Choi et al. 19 found neuropraxia in 2.00% patients and pin tract infection in 5.70% of patients. Ramoutar et al. 1 had 17.00% k-wire complications.

Following k-wire fixation we applied below elbow plaster of paris cast for immobilization. Previous studies have not shown any significant difference between below elbow cast and above elbow cast^{13, 20}. Above elbow cast also immobilizes the elbow joint without having any added benefit to the fracture union and can delay return of normal function of elbow joint. It also hampers the daily activities of the pediatric population and hence early return to normal function²¹.

This study is not without limitations. There is need to conduct this study on a larger population size and for a longer duration as follow-up radiographs after complete recovery of function will show changes until complete

remodeling of the displaced distal segment occurs. Better assessment tools for functional outcome of the wrist function needs to be devised to completely understand the outcome, as the currently available assessment scores mostly evaluate the degree of restriction of movement rather than formally validated measures as these leads to bias.

CONCLUSION

Keeping in mind the complications associated with k-wire fixation and the good remodeling potential of pediatric fractures, single k-wire fixations is superior as it provides similar functional outcomes at the cost of less surgery time and lesser complications when compared to double k-wire fixation.

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