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Complication rates, fluoroscopy exposure time, and functional outcomes of the two K-wire fixation methods for distal radius fractures in pediatric patients; mini-incision as a feasible surgical option

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ABSTRACT

Objectives. In this study, we aimed to compare complication rates and fluoroscopy exposure time, as well as to analyze the functional results of percutaneous K-wire fixation and K-wire fixation with mini-open techniques in pediatric distal radius fractures. *Materials and Methods*. In this retrospective design study, one-hundred patients with completely displaced fracture of the distal radius were evaluated in terms of demographic data, radiological and functional evaluations, fluoroscopy exposure time, and complications. In Group 1, 50 patients were treated by closed reduction and percutaneous K wire application. In Group 2, 50 patients were treated with close reduction and K-wire fixation using a mini-incision. *Results*. There were no statistically significant differences between the two groups in terms of age, fracture degree, reduction degree, and follow-up duration. We found the fluoroscopy time and redisplacement rate were significantly lower in group 2. We did not notice tendon irritation and neuropraxia complications in any of the patients in group 2. We observed good functional results and no malalignment in both groups. *Conclusions*. The mini-open incision technique had lower complication rates and fluoroscopy durations. Based on the results of this study, K-wire fixation with the mini-open technique may be recommended as an alternative method for pediatric distal radius fractures.

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Introduction

The distal radius is the most common site of the pediatric fracture, accounting for 20–30% of all fractures [1]. The choice of treatment for distal radius fractures is based on the instability of the fracture and consequently on the risk of re-displacement. Most of these pediatric fractures have been treated by a good closed anatomical reduction and immobilization in a cast [2,3], but re-displacement following conservative treatment of displaced distal radius fractures has been reported at high rates [2,4]. Because of the significant risk for re-displacement in completely displaced pediatric distal radius fractures, K-wire placement is advocated as an effective method [2,3,5-9].

Although good results have been reported with K-wire fixation, superficial infection, neuropraxia, tendon irritation, pull out of wire, subcutaneous K-wires, and prominent scars have been reported as complications after pinning [9-11]. We looked for an option that eliminates all these problems. In this study, we aimed to compare the complication rates, and fluoroscopy exposure time, and observe the functional and radiological results of percutaneous K-wire fixation and K-wire fixation with mini-open techniques in pediatric distal radius fractures.

Materials and Methods

The local ethics committee approved the study protocol (protocol number 48670771-514.10) and the study was carried out according to the principles of the Declaration of Helsinki (2013). Written informed consent was obtained from the parents. In this retrospective consecutive case series, we enrolled 117 patients who were treated by surgery between March 2016- January 2019 for completely displaced fractures of the distal radius.

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We excluded seventeen patients who had an open fracture, a pathological fracture, a concomitant fracture, definite physis damage, elbow injury at the initial trauma site, and lost for follow-up from the study. Thus 100 patients were evaluated in terms of demographic data, radiological and functional evaluations, fluoroscopic exposure time, and complications.

In Group 1, 50 patients were treated by closed reduction and percutaneous K wire application. In Group 2, 50 patients were treated with closed reduction and K-wire fixation using mini-incision. There were 36 (72%) boys, 14 (28%) girls in Group 1, and 38 (76%) boys, 12 (24%) girls in Group 2. The mean ages were 11.95±1.34 years and 11.75±1.25 years in Groups 1 and 2, respectively. We performed the preoperative radiology evaluation by measuring the angulation angles on the AP and Lateral X-rays.

All the operations were performed by the same surgical team who had ≥10 years of experience. We performed operations using general anesthesia and the patient in a supine position with the arm placed on a hand-and-arm table. Under fluoroscopic guidance with AP and lateral images, we performed the reduction with traction and closed manipulation. In Group 1, two 1.6 mm K-wires were applied retrograde from 2 cm proximal to the radial styloid, parallel to each other in the direction of crossing the fracture line. The ends of the K-wires were bent, then cut and leftover the skin.

In Group 2 following manipulation, a 10 mm transverse skin incision was made over 2 cm proximally from the radial styloid, and blunt dissection was made by observing the superficial branch of the radial nerve and vascular structures, then two K-wires were applied as described for the patients in Group 1 (Figures 1-2). We applied short cast immobilization for 4 weeks in both groups.

Figure 1. Preoperative anterior–posterior (AP) and lateral (L) wrist radiographs of a 10-year-old male patient treated with the K-wire pinning using the mini-open technique.

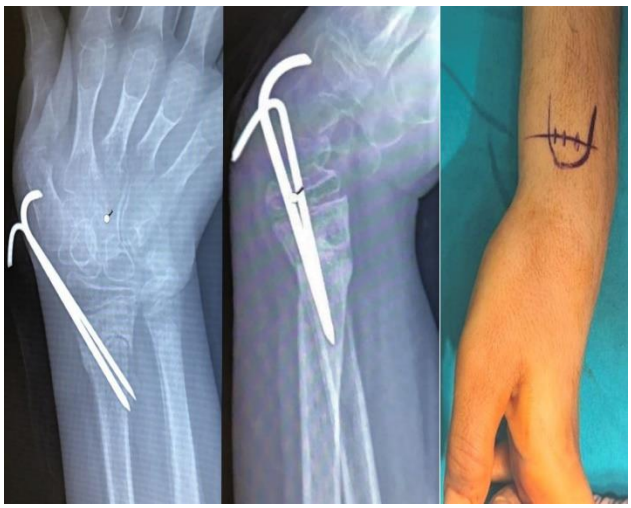

Figure 2. Image of intraoperative marking of the transverse mini-incision. Early postoperative AP and L radiographs

We used the same fluoroscopy imaging unit by the same radiology technician in all cases.

The patient underwent clinical evaluation at the 2nd, 4th, and 6th weeks and 3rd, 6th, 12th, and 18th months after the initial trauma. We applied the same postoperative follow-up protocol in both groups. We planned antero-posterior and lateral radiographs during follow-up visits. We evaluated redisplacement and union time in the early follow-ups and malalignment in the final follow-up. The casts were removed in the 4th week. Finally, we removed the K wires in the outpatient clinic after 6 weeks. Active exercises were initiated after K-wire removal. We permitted the patients to resume their routine daily activities. No formal physical therapy was prescribed.

Patients were called in for finally functional and radiological evaluation at the 18th month. We assessed the wrist range of motion (ROM) with a goniometer and compared it with that of the contralateral wrist. Physical appearance and patient satisfaction with the forearm were assessed using a 10-cm visual analog scale score (VAS) cosmetics, with the maximum score for the similar appearance of the fractured and the non-fractured arm, to evaluate forearm alignment and scars [5]. Fracture line angulations were evaluated radiologically on AP and lateral radiographs. Angles over 15° were considered as malalignment on the lateral radiographic evaluation [3].

Patients were also evaluated in terms of complications during follow-up. As early complications; pin site infection, tendon irritation, neuropraxia, redisplacement, and pin migration were evaluated. Patients with redisplacement underwent secondary surgery. We evaluated the patients in terms of malalignment and functional results in late follow-up.

Statistical Analysis

The normality of variables was tested by the Shapiro–Wilk test. Numerical variables reflecting normal

distribution were stated as mean ± standard deviation (SD) and those not reflecting normal distribution as median (minimum-maximum) values. Categorical variables were stated as number (n) and percentage (%). As there were two groups, differences between the groups in numerical variables not showing normal distribution were evaluated with the Mann–Whitney U test, and relationships between categorical variables were determined with the Pearson chi-square test and the Fisher Exact test. P <0.05 was considered statistically significant.

Results

There were no statistically significant differences between the two groups in terms of age, gender and follow-up duration (p>0.005) (Table 1).

Table 1. Patient demographics and follow-up data (Group 1: Percutan K-wire fixation; Group 2: K-wire fixation with a mini-incision)

	Group 1	Group 2	P value
Age	11,95±1,34	11,75±1,25	0,458
Fracture Degree	20,62±4,65	19,55±4,98	0,267
Reduction Degree	2,60±1,42	2,51±1,53	0,762
Follow-up Duration (Month)	18,12±4,73	18,02±4,80	0,592
Fluoroscopy time (seconds)	28,6 ±7,1	15,4±5,3	0.002*
VAS (VAS 2-3)	3 (6%)	2 (4%)	0.86
ROM Limitations (Pronation/ Supination)	4 (<10°)	3 (<10°)	0.99

*ROM: range of motion; VAS: visual analog scale score Pearson Chi-Square Test (Monte Carlo), *p<0.05 considered as significant*

There were no also statistically significant differences in terms of fracture and reduction degrees. We didn't observe malalignment in radiological evaluation in both groups at the final follow-up (Figure 3).

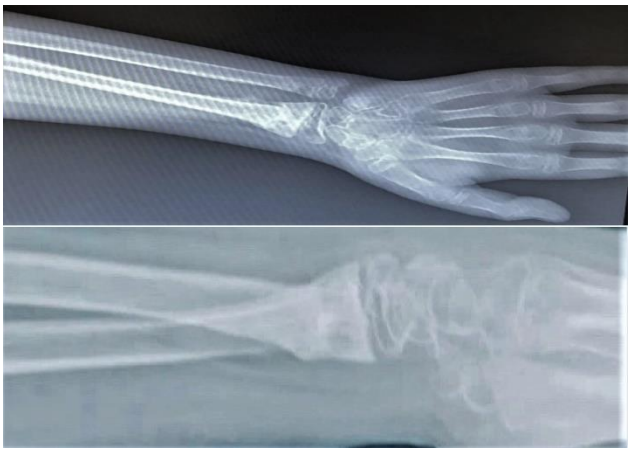

Figure 3. AP and L radiographs at 18th month.

Four patients in Group 1 and 3 patients in Group 2 had observed <10° pronation-supination ROM restriction, total ROM was >120° and none of these patients was aware of the restriction. There was no ROM restriction in other directions. No statistically significant difference was determined between the groups in terms of VAS cosmetic scores (p>0.005) (Table 1, Figure 4).

Figure 4. Functional outcome at 6th week follow-up

The mean fluoroscopy time was 28.6 ±7.1 seconds in Group 1 while, 15.4±5.3 seconds in Group 2. The fluoroscopy time was significantly low in Group 2 (p=0.002). Re-displacement rates were 20% in Group1 and 4% in Group 2 and it was significantly lower in the mini-open group (p=0.026). Patients with redisplacement underwent secondary surgery. Ten (20%) patients in Group 1 and 3 (6%) patients in Group 2 developed superficial pin-site infections (p=0.037); all patients recovered with oral antibiotics and daily dressings. The K-wire had advanced subcutaneously because of pin migration in 7 patients (14%) in Group 1, and 1 patient (2%) in Group 2 (p=0.027). In Group 1 transient neuropraxia and tendon irritation was developed in 4 (8%) and 5 (%10) patients respectively. None of the patients in Group 2 had tendon irritation or transient neuropraxia. We found significantly lower complication rates in the mini-open technique group than in the percutaneous K-wire fixation group (p<0.005). The complications were summarized in Table 2.

Table 2. Complications of the patients

	Group 1 (n/%)	Group 2 (n/%)	P value
Re-Displacement	10 (20%)	2 (4%)	0,026*
Pin track Infection	10 (20%)	3 (6%)	0,037*
Subcutaneous K wire	7 (14%)	1 (2%)	0,027*
Failed Insertion	4 (8%)	0 (0%)	0,041*
Pull out of K wire	2 (4%)	0 (0%)	0,153*
Angulation	6 (12%)	0 (0%)	0,012*
Transient Neuropaxia	4 (8%)	0 (0%)	0,041*
Tendon Irritation	5 (10%)	0 (0%)	0,022*

*Pearson Chi-Square Test (Monte Carlo), f Fisher Exact test (Monte Carlo), OR Odds Ratio (95% Confidence interval) * p<0.05 considered as significant*

Discussion

The distal radius is the most common site of the pediatric fracture, accounting for 20–30% of all fractures [1]. The choice of treatment for distal radius fractures is based on the instability of the fracture and consequently on the risk of re-displacement. Most of these pediatric fractures have been treated by a good closed anatomical reduction and immobilization in a cast [2,3], but re-displacement following conservative treatment of displaced distal radius fractures has been reported at high rates [2,4]. Because of the significant risk for re-displacement in completely displaced pediatric distal radius fractures, K-wire placement is advocated as an effective method [2,3,5-9]. In a systematic review, the mean re-displacement rate was reported at 40% in the casting group and 3.6% in the pinning group [9].

Although the advantages of K-wires are known, there are some complications related to K-wires which were reported in literatures [9,10]. In some studies, pining complication rates were varying from 0-38% (median 8.3%) [3]. The complications were loss of reduction, prominent scar, infection, pin migration, tendon irritation, transient neuropraxia, failed insertion, subcutaneous K-wires [10-13]. The reported complications were all classed as minor nevertheless there are technical challenges in the pining of these fractures such as the presence of the physis, the small size of the bone, and the required obliquity of the wire [11].

McLauchlan et al. stated 2.8% pain, 5.7% prominent scar, and 2,8% pin migration after percutaneous K-wire stabilization in their study population [14]. In another study, Miller et al. reported K-wire complications included pin migration 12.5%, pin-site infection 12.5%, transient neuropraxia of radial nerve 6.2%, and tendon irritation 6.2% after treatment with percutaneous pin fixation [15]. Finally, in the report of Colaris et al, complications were subcutaneous K-wires 11,4%, re-fractures 4,9%, superficial infections 3.2%, transient neuropraxia 1.6%, failed insertion K- wires 1.6% in the treatment of 61 patients by K-wire stabilization [12].

There have been many studies comparing closed reduction with cast immobilization or percutaneous pinning in pediatric distal radius fractures. However, a study comparing the application of K-wires using percutaneous and mini-incision has not been found in the literature.

In this study, we emphasize using mini-incision in the course of applying K-wire to limit the technical problems and to avoid the complications which could be irritative for the pediatric population. We found significantly lower redisplacement, pin-track infection, subcutaneous wire rates in K-wire fixation using by mini-incision group. And also, we didn't observe potentially serious complications such as neuropraxia, tendon irritation and failed insertion of K-wires, angulation, and pull out of wire in this group.

The function is important because it can affect the quality of children. In our study, we observed good functional results in both groups after 18-month follow-up period.

The use of fluoroscopy in closed fixation methods increases the exposure to radiation with its associated risks; therefore, modifying the treatment method when possible has been recommended to minimize exposure [16-19]. In our study, we observed that the fluoroscopy exposure time was significantly shorter in the group in which we used incision during the application of the K-wires. This is considered an important gain in terms of reducing the radiation exposure of the patient and especially the surgeon.

Some limitations of the present study need to be addressed. First of all, our study's retrospective design and the relatively low number of patients. Secondly, we could not arrange homogenous gender distribution because of our study design.

Conclusions

A comparison of percutaneous K-wire fixation and K-wire fixation with mini-open technique in similar pediatric patient groups showed similar functional results. The mini-open incision technique had lower complication rates and fluoroscopy durations. Based on the results of this study, K-wire fixation with the mini-open technique can be recommended as an alternative method for pediatric distal radius fractures.

Conflict of interest disclosure

There are no known conflicts of interest in the publication of this article. The manuscript was read and approved by all authors.

Compliance with ethical standards

Any aspect of the work covered in this manuscript has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

References

1. Cheng JC, Shen WY. Limb fracture pattern in different pediatric age groups: a study of 3,350 children. *J Orthop Trauma*. 1993;7(1):15-22. doi: 10.1097/00005131-199302000-00004
2. Pretell Mazzini J, Rodriguez Martin J. Paediatric forearm and distal radius fractures: risk factors and re-displacement--role of casting indices. *Int Orthop*. 2010 Mar;34(3):407-12. doi: 10.1007/s00264-009-0904-0

3. Van Leemput W, De Ridder K. Distal metaphyseal radius fractures in children: reduction with or without pinning. *Acta Orthop Belg*. 2009 Jun;75(3):306-9.
4. Schneider J, Staubli G, Kubat S, Altermatt S. Treating Displaced Distal Forearm Fractures in Children. *Eur J Trauma Emerg Surg*. 2007 Dec;33(6):619-25. doi: 10.1007/s00068-007-6204-8
5. Alemdaroğlu KB, Iltar S, Cimen O, Uysal M, Alagöz E, Atlihan D. Risk factors in redisplacement of distal radial fractures in children. *J Bone Joint Surg Am*. 2008 Jun;90(6):1224-30. doi: 10.2106/JBJS.G.00624
6. Sankar WN, Beck NA, Brewer JM, Baldwin KD, Pretell JA. Isolated distal radial metaphyseal fractures with an intact ulna: risk factors for loss of reduction. *J Child Orthop*. 2011 Dec;5(6):459-64. doi: 10.1007/s11832-011-0373-z
7. Zamzam MM, Khoshhal KI. Displaced fracture of the distal radius in children: factors responsible for redisplacement after closed reduction. *J Bone Joint Surg Br*. 2005 Jun;87(6):841-3. doi: 10.1302/0301-620X.87B6.15648
8. Choi KY, Chan WS, Lam TP, Cheng JC. Percutaneous Kirschner-wire pinning for severely displaced distal radial fractures in children. A report of 157 cases. *J Bone Joint Surg Br*. 1995 Sep;77(5):797-801.
9. Zeng ZK, Liang WD, Sun YQ, Jiang PP, Li D, Shen Z, Yuan LM, Huang F. Is percutaneous pinning needed for the treatment of displaced distal radius metaphyseal fractures in children?: A systematic review. *Medicine (Baltimore)*. 2018;97(36):e12142. doi: 10.1097/MD.0000000000012142
10. Khandekar S, Tolessa E, Jones S. Displaced distal end radius fractures in children treated with Kirschner wires - A systematic review. *Acta Orthop Belg*. 2016 Dec;82(4):681-689.
11. Luscombe KL, Chaudhry S, Dwyer JS, Shanmugam C, Maffulli N. Selective Kirschner wiring for displaced distal radial fractures in children. *Acta Orthop Traumatol Turc*. 2010;44(2):117-23. doi: 10.3944/AOTT.2010.2133
12. Colaris JW, Allema JH, Biter LU, de Vries MR, van de Ven CP, Bloem RM, Kerver AJ, Reijman M, Verhaar JA. Re-displacement of stable distal both-bone forearm fractures in children: a randomised controlled multicentre trial. *Injury*. 2013 Apr;44(4):498-503. doi: 10.1016/j.injury.2012.11.001
13. van Egmond PW, Schipper IB, van Luijt PA. Displaced distal forearm fractures in children with an indication for reduction under general anesthesia should be percutaneously fixated. *Eur J Orthop Surg Traumatol*. 2012;22(3):201-207. doi: 10.1007/s00590-011-0826-6
14. McLauchlan GJ, Cowan B, Annan IH, Robb JE. Management of completely displaced metaphyseal fractures of the distal radius in children. A prospective, randomised controlled trial. *J Bone Joint Surg Br*. 2002 Apr;84(3):413-7. doi: 10.1302/0301-620x.84b3.11432
15. Miller BS, Taylor B, Widmann RF, Bae DS, Snyder BD, Waters PM. Cast immobilization versus percutaneous pin fixation of displaced distal radius fractures in children: a prospective, randomized study. *J Pediatr Orthop*. 2005 Jul-Aug;25(4):490-4. doi: 10.1097/01.bpo.0000158780.52849.39
16. Madan S, Blakeway C. Radiation exposure to surgeon and patient in intramedullary nailing of the lower limb. *Injury*. 2002 Oct;33(8):723-7. doi: 10.1016/s0020-1383(02)00042-6
17. Kraus R, Joeris A, Castellani C, Weinberg A, Slongo T, Schnettler R. Intraoperative radiation exposure in displaced supracondylar humeral fractures: a comparison of surgical methods. *J Pediatr Orthop B*. 2007 Jan;16(1): 44-7. doi: 10.1097/01.bpb.0000236238.87763.cf
18. Coskun HS, Usta MB, Say F, Yildirim AM. Factors affecting post-traumatic stress disorder in children with orthopedic injury. *J Clin Investig Surg*. 2020; 5(1): 24-28. doi: 10.25083/2559.5555/5.1/24.28
19. Mastrangelo G, Fedeli U, Fadda E, Giovanazzi A, Scoizzato L, Saia B. Increased cancer risk among surgeons in an orthopaedic hospital. *Occup Med (Lond)*. 2005 Sep;55(6):498-500. doi: 10.1093/occmed/kqi048