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**ORIGINAL ARTICLE**

# K-Wiring Versus Plating: A Comparative Study on the Outcomes in Distal Radius Fractures

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## ABSTRACT

**Background:** Distal radius fractures are among the most common orthopedic injuries, yet the optimal surgical management remains a topic of debate. This study compares the functional outcomes of two prevalent techniques: K-wire fixation and volar locking plate.

**Methods:** A prospective randomized controlled trial was conducted from January to December 2022. Sixty eligible patients with closed AO type A or B DRFs were randomly allocated to either K-wire fixation (Group A, n=30) or volar plating (Group B, n=30). The primary outcome was the QuickDASH score at six months. Secondary outcomes included radiological parameters and complication rates (infection, malunion, hardware irritation, reoperation). Data were analyzed using SPSS version 25 independent t-tests and chi-square tests. P-value <0.05 considered significant.

**Results:** The mean age of participants was 37.92 ± 10.07 years, with a male predominance (76.7%). The volar plating group demonstrated a statistically significant superior functional outcome, with a mean QuickDASH score of 13.01 ± 4.60 compared to 20.66 ± 4.96 in the K-wire group ($p < .001$). This functional advantage was consistent across most subgroups, particularly in younger and male patients. While overall complication rates were not significantly different, distinct trends were observed: the K-wire group had higher incidences of malunion (23.3% vs. 10.0%) and hardware irritation (40.0% vs. 26.7%), whereas the volar plating group had a higher reoperation rate (23.3% vs. 13.3%).

**Conclusion:** Volar locking plate fixation for distal radius fractures results in significantly better functional outcomes at six months compared to K-wire fixation. However, there was no significant difference in the complications of both techniques.

**Keywords:** Distal Radius Fracture, K-wire, Volar Locking Plate, Functional Outcome, Randomized Controlled Trial.

## INTRODUCTION

One of the most frequent skeletal injuries seen in orthopaedic treatment is distal radius fractures (DRFs), which have a bimodal distribution that affects both young people after high-energy trauma and the elderly after low-energy accidents[1]. Restoring functional and anatomical integrity is the main objective of treatment in order to avoid long-term issues including discomfort, stiffness, and post-traumatic arthritis[2]. While stable, non-displaced fractures of upper extremities can be managed conservatively, unstable or intra-articular fractures with displacement often necessitate surgical intervention to maintain a stable reduction[3,4].

The optimal surgical management for unstable DRFs, however, remains a subject of considerable debate. Among the various modalities, percutaneous Kirschner wire (K-wire) fixation and open reduction and internal fixation with volar locking plates are two of the most frequently employed techniques. K-wire fixation offers the advantages of being a minimally invasive, cost-effective, and relatively simple procedure. Its drawbacks, however, include a lack of rigid stability, which can lead to loss of reduction, and the risk of pin-tract infections. In contrast, volar locking plates provide angular stability, allowing for anatomical restoration and early postoperative mobilization, which is theorized to facilitate a quicker functional recovery. This comes at the cost of a more extensive surgical dissection, higher implant expense, and potential risks such as tendon irritation or rupture[5,6].

Despite numerous comparative studies, the evidence regarding the superiority of one technique over the other is conflicting. Some studies report significantly better functional and radiological outcomes with volar plating, while others, including a large randomized controlled trial, found no significant difference in functional outcomes at one year, despite better radiological parameters with plates[7,8,9,10].

Ongoing controversy regarding superior functional outcomes as well as postoperative complication following K-wire fixation and volar plating underscores the need for further well-designed studies to guide evidence-based surgical decision-making. Based on the past evidence, we hypothesize that there is a difference in functional outcomes as well as complications between the two treatment groups. This study, therefore, aims to contribute to this discourse by conducting a prospective randomized controlled trial to compare the functional outcomes and complication profiles of K-wire fixation versus volar plating in the management of distal radius fractures in the local population presenting to the tertiary care hospital of Islamabad.

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## MATERIALS AND METHODS

A prospective randomized controlled experiment was executed in the Department of Orthopedics, Federal Government Polyclinic, Islamabad, from January 2022 to December 2022. The research acquired ethical clearance from the institution's review board (Ref. No. FGPC.1/12/2023/Ethical Committee), and informed permission was secured from all participants before their registration. Patients of both genders, having age between 18 and 70 years, presenting to the emergency and outpatient departments with closed distal radius fractures were enrolled following assessment for eligibility (i.e. a radiologically confirmed closed distal radius fracture (AO classification types A or B and presentation within 7 days of injury). Patients were excluded if they had open fractures; associated ipsilateral upper limb fractures; pathological fractures; or a history of previous surgery on the affected wrist. The sample size was determined with the WHO sample size calculator, based upon the functional outcome scores documented by Habib et al. [11] in which score of 72.3 (SD 19.5) was seen in the K-wire group, while the plating group had a mean score of 60.1 (SD 12.1). With a power of 90% and a significance level of 10%, a minimum of 27 patients per group was necessary. The sample size was determined to be 30 patients in each group to accommodate anticipated dropouts, yielding a total of 60 participants. Eligible patients were randomly assigned to one of two therapy groups.

Group A (K-wire Fixation) patients underwent closed reduction and percutaneous fixation using Kirschner wires (K-wires) under image intensifier guidance. The fracture was stabilized using multiple wires in a configuration determined by the operating surgeon based on the fracture pattern. The wires were

left protruding through the skin and a below-elbow plaster slab was applied for immobilization. On the other hand, open reduction and internal fixation using a volar locking plate technique was used for group B (Volar Plating) patients. A standard volar approach was utilized. After fracture reduction under direct vision, a pre-contoured volar locking plate was applied. The pronator quadratus was repaired where possible. Postoperatively, a bulky dressing or futura splint was applied. All surgical procedures were performed by experienced consultant orthopedic surgeons under regional or general anesthesia. A standardized perioperative protocol, including prophylactic intravenous antibiotics, was followed for all patients. Postoperative rehabilitation was standardized for both groups. Active finger, elbow, and shoulder movements were encouraged from the first postoperative day. In the K-wire group, the plaster slab and K-wires were removed at 6 weeks, followed by active and assisted wrist mobilization. In the volar plating group, supervised physiotherapy for active wrist range of motion was initiated after suture removal at 2 weeks. Patients were followed up clinically and radiologically at 2 weeks, 6 weeks, 12 weeks, and 6 months postoperatively.

The primary outcome measure was the functional status, assessed using the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) questionnaire at the 6-month follow-up. The QuickDASH score ranges from 0 (no disability) to 100 (severe disability).Secondary outcome measures included 1) Radiological Parameters**:** Assessed on standard anteroposterior and lateral radiographs at each follow-up, including radial inclination, volar tilt, and radial length. 2) Complication Rates: Documented throughout the study period, including infection, malunion, hardware irritation, and the need for reoperation.

SPSS version 25.0 version was used for data entry and analysis. Mean ± standard deviation (SD) was calculated for quantitative variables and compared between groups using the independent Student t-test. Qualitative variables were expressed as frequencies and percentages and compared using the Chi-square test. A p-value of ≤ 0.05 was considered statistically significant for all analyses.

## RESULTS

A total of 60 patients with distal radius fractures were randomized equally into two groups: K-wire fixation (Group A, n=30) and volar plating (Group B, n=30). The mean age of the study population was 37.9±10.1 years, with the majority (60.0%) aged 18–40 years. Group A had a slightly younger mean age (36.0±10.0) compared to Group B (39.8±9.9). Males constituted 76.7% (n=46) of the study population, with a higher male predominance in the K-wire group (90.0%) than in the volar plating group (63.3%). The overall mean BMI was 27.4 ± 3.9 kg/m², placing the cohort in the overweight category. Half of the participants were overweight, while obesity was more frequent in Group B (30.0%) compared to Group A (13.3%). The baseline demographic and anthropometric characteristics of the participants are summarized in Table 1.

The primary functional outcome, assessed by the DASH score, showed a statistically significant improvement in the volar plating group compared to the K-wire fixation group (mean 13.01±4.60 VS 20.66±4.96; $p < .001$). On the other hand, no statistically significant difference was noticed for complications rate among both groups. However, post-operative infection, malunion and hardware irritation was more frequently occurred in K-wire patients; while, reoperation rates were higher in the volar group. Study outcomes are illustrated in detail in table 2.

Stratification analysis for functional outcome reflected that the volar plating had significantly superior functional outcomes compared to K-wire fixation across most subgroups. The benefit was more pronounced in younger patients (mean difference 9.69, $p < .001$) than older ones (6.82, $p < .001$), and was significant in males (8.08, $p < .001$) but not in females. Across BMI categories, volar plating consistently outperformed K-wire, with the greatest improvement seen in normal and obese patients (table 3). Complication rates were largely comparable between groups, except for malunion in older patients, which occurred in 27.3% of the K-wire group but in none with volar plating ($p = .044$). Hardware irritation was more frequent with K-wires, particularly in overweight patients (61.1% vs. 25.0%, $p = .052$), while reoperation was more common after volar plating, though not statistically significant. Detailed stratification analysis of complications among both groups is presented in table 4.

Table 1: Baseline Characteristics of the Study Population

| Characteristic | Total (n=60) | Group A: K-wire (n=30) | Group B: Volar Plating (n=30) |
|---|---|---|---|
| Age (Years) | | | |
| Mean (SD) | 37.92 (10.07) | 36.03 (10.01) | 39.80 (9.93) |
| 18-40, n (%) | 36 (60.0%) | 19 (63.3%) | 17 (56.7%) |
| 41-60, n (%) | 24 (40.0%) | 11 (36.7%) | 13 (43.3%) |
| BMI (kg/m²) | | | |
| Mean (SD) | 27.35 (3.86) | 26.57 (3.56) | 28.13 (4.04) |
| Normal, n (%) | 17 (28.3%) | 8 (26.7%) | 9 (30.0%) |
| Overweight, n (%) | 30 (50.0%) | 18 (60.0%) | 12 (40.0%) |
| Obese, n (%) | 13 (21.7%) | 4 (13.3%) | 9 (30.0%) |
| Gender | | | |
| Male, n (%) | 46 (76.7%) | 27 (90.0%) | 19 (63.3%) |
| Female, n (%) | 14 (23.3%) | 3 (10.0%) | 11 (36.7%) |
| Abbreviations: SD, Standard Deviation; BMI, Body Mass Index | | | |

Table 2: Comparison of Primary and Secondary Outcomes Between Study Groups

| Outcome Measure | Group A: K-wire (n=30) | Group B: Volar Plating (n=30) | p-value |
|---|---|---|---|
| Primary Outcome | | | |
| DASH Score, Mean ± SD | 20.66 ± 4.96 | 13.01 ± 4.60 | < .001 |
| Secondary Outcomes | | | |
| Infection, n (%) | 7 (23.3%) | 5 (16.7%) | 0.519 |
| Malunion, n (%) | 7 (23.3%) | 3 (10.0%) | 0.166 |
| Hardware Irritation, n (%) | 12 (40.0%) | 8 (26.7%) | 0.273 |
| Reoperation, n (%) | 4 (13.3%) | 7 (23.3%) | 0.317 |
| Abbreviations: SD, Standard Deviation; DASH, Disabilities of the Arm, Shoulder, and Hand. | | | |

Table 3: Stratified Analysis of Functional Outcome (DASH Score) on the basis of effect modifiers (age, gender and BMI)

| Stratification Variable | Group A: K-wire (Mean ± SD) | Group B: Volar Plating (Mean ± SD) | Mean Difference | p-value |
|---|---|---|---|---|
| Age | | | | |
| 18-40 Years (n=24) | 24.66 ± 4.16 (n=11) | 14.97 ± 4.81 (n=13) | 9.69 | < .001 |
| 41-60 Years (n=36) | 18.34 ± 3.81 (n=19) | 11.52 ± 3.94 (n=17) | 6.82 | < .001 |
| Gender | | | | |
| Male (n=46) | 21.17 ± 4.67 (n=27) | 13.09 ± 4.37 (n=19) | 8.08 | < .001 |

| | | | | |
|---|---|---|---|---|
| Female (n=14) | 16.03 ± 6.14 (n=3) | 12.87 ± 5.20 (n=11) | 3.16 | 0.384 |
| BMI Category | | | | |
| Normal (n=17) | 21.17 ± 5.84 (n=8) | 11.02 ± 4.69 (n=9) | 10.15 | 0.001 |
| Overweight (n=30) | 19.73 ± 3.61 (n=18) | 14.19 ± 2.63 (n=12) | 5.54 | < .001 |
| Obese (n=13) | 23.80 ± 8.09 (n=4) | 13.43 ± 6.20 (n=9) | 10.37 | 0.027 |
| Abbreviations: SD, Standard Deviation; Statistically significant (p < .05) | | | | |

Table 4: Stratified Analysis of Complication Rates by Confounders

| Complication | Variable | Category | Group A: K-wire | Group B: Volar Plating | p-value |
|---|---|---|---|---|---|
| Infection | Age (Years) | 18-40 | 5/19 (26.3%) | 2/17 (11.8%) | 0.271 |
| | | 41-60 | 2/11 (18.2%) | 3/13 (23.1%) | 0.769 |
| | Gender | Male | 7/27 (25.9%) | 5/19 (26.3%) | 0.976 |
| | | Female | 0/3 (0.0%) | 0/11 (0.0%) | *** |
| | BMI | Normal | 2/8 (25.0%) | 0/9 (0.0%) | .110 |
| | | Overweight | 4/18 (22.2%) | 3/12 (25.0%) | .860 |
| | | Obese | 1/4 (25.0%) | 2/9 (22.2%) | .913 |
| Malunion | Age | 18-40 | 4/19 (21.1%) | 3/17 (17.6%) | .797 |
| | | 41-60 | 3/11 (27.3%) | 0/13 (0.0%) | .044 |
| | Gender | Male | 6/27 (22.2%) | 2/19 (10.5%) | .303 |
| | | Female | 1/3 (33.3%) | 1/11 (9.1%) | .287 |
| | BMI | Normal | 2/8 (25.0%) | 1/9 (11.1%) | .453 |
| | | Overweight | 5/18 (27.8%) | 2/12 (16.7%) | .481 |
| | | Obese | 0/4 (0.0%) | 0/9 (0.0%) | N/C |
| Hardware Irritation | Age | 18-40 | 9/19 (47.4%) | 4/17 (23.5%) | .137 |
| | | 41-60 | 3/11 (27.3%) | 4/13 (30.8%) | .851 |
| | Gender | Male | 12/27 (44.4%) | 6/19 (31.6%) | .379 |
| | | Female | 0/3 (0.0%) | 2/11 (18.2%) | .425 |
| | BMI | Normal | 0/8 (0.0%) | 3/9 (33.3%) | .072 |
| | | Overweight | 11/18 (61.1%) | 3/12 (25.0%) | .052 |
| | | Obese | 1/4 (25.0%) | 2/9 (22.2%) | .913 |
| Reoperation | Age | 18-40 | 3/19 (15.8%) | 5/17 (29.4%) | .326 |
| | | 41-60 | 1/11 (9.1%) | 2/13 (15.4%) | .642 |
| | Gender | Male | 3/27 (11.1%) | 3/19 (15.8%) | .643 |
| | | Female | 1/3 (33.3%) | 4/11 (36.4%) | .923 |
| | BMI | Normal | 2/8 (25.0%) | 2/9 (22.2%) | .893 |
| | | Obese | 0/4 (0.0%) | 3/9 (33.3%) | .188 |
| | | Overweight | 2/18 (11.1%) | 2/12 (16.7%) | .661 |
| Abbreviations: N/C, Not Computable (no variation in outcome). Statistically significant (p < .05) | | | | | |

## DISCUSSION

Our study findings demonstrated a clear and statistically significant superiority of volar plating in terms of functional recovery, as measured by the DASH score at six months. However, this functional advantage comes with a distinct and more nuanced complication profile, where each technique carries its own set of risks. The patients treated with volar plating achieved significantly better functional outcomes which is consistent with the biomechanical principles of each method. Volar locking plates provide rigid internal fixation, allowing for immediate post-operative mobilization and early rehabilitation, which is crucial for restoring range of motion and function in the wrist and hand[11]. In contrast, K-wire fixation, while effective in maintaining fracture reduction, offers less rigid stability, often necessitates a period of prolonged immobilization with a cast, and may lead to stiffness and a slower return to function[12]. This explanation is strongly supported by our stratified analysis, which confirmed the benefit of plating across nearly all subgroups, including different age and BMI categories. The magnitude of this benefit was most pronounced in younger patients (≤40 years), a demographic for whom rapid return to work and physical activity is often a priority, underscoring the clinical relevance of our findings.

When contextualized within the existing body of literature, the findings of our study, which demonstrate superior functional outcomes with volar plating, contribute to a nuanced and ongoing debate. Our results align with several studies that reported better radiological parameters and early-to-midterm functional scores with plating. For instance, Habib et al. and Yetkin et al. found significantly better functional outcomes (modified Mayo and Gartland-Werley scores, respectively) in their plating groups, corroborating our primary finding[13,14]. Similarly, Davis et al. reported 95% excellent-to-good results with plating versus 75% with K-wires using the Gartland-Werley score, a trend consistent with our data[15]. However, this apparent advantage of plating is not universally established. Our study contrasts with the work of Hull et al. and Brennan et al., who, despite finding superior radiological outcomes with volar plates, found no significant difference in functional outcomes (DASH and PRWE scores) at longer-term follow-up of 1-2 years[16,17]. This suggests that while plating may accelerate functional recovery, the long-term functional disparity between the two methods may diminish over time. Furthermore, the conclusion of Khan et al., which favored K-wires over non-locking T-plates, highlights the critical influence of implant design, as the modern locking plates used in our study offer biomechanical advantages that older implants lack[18]. The comparable results found between external fixation and plating in complex fractures by Ali et al. further underscore that the optimal surgical choice may be fracture-specific and resource-dependent rather than absolute[19].

The analysis of complications reveals a critical trade-off that must be considered in surgical decision-making. While no single complication rate was significantly different in the overall study population, distinct trends emerged. The K-wire group exhibited higher rates of infection, malunion, and hardware irritation[20]. The higher rate of hardware irritation with K-wires is a well-documented drawback, often necessiating wire removal after fracture union[21]. More notably, our stratification analysis uncovered a significant finding: among patients aged 41-60 years, malunion occurred exclusively in the K-wire group (27.3% vs. 0%, p=0.044). This suggests that in this age group, which may have compromised bone quality, the superior stability of a locking plate is critical in preventing loss of reduction[22,23]. Conversely, the volar plating group, despite its functional advantages, showed a higher rate of reoperations (23.3% vs. 13.3%), although this was not statistically significant. This trend is often attributed to complications such as tendon irritation or rupture, or the elective removal of symptomatic

hardware, which are known risks associated with plate fixation[24]. This underscores that the choice of implant is a balance between achieving excellent function and accepting a different profile of potential complications.

The findings of this study have direct implications for clinical practice and shared decision-making with patients such as for the majority of patients, particularly younger, active individuals and those across all BMI categories, volar plating should be considered the preferred option when the primary goal is maximizing the speed and extent of functional recovery. K-wire fixation remains a valuable technique, particularly in resource-limited settings due to its lower cost. It may also be preferred in specific cases, such as in non-obese patients where hardware irritation is a major concern, or when the fracture pattern is amenable to a less invasive approach. Surgeons should be cognizant of the age-related risk of malunion with K-wires. In patients over 40, the use of K-wires requires careful consideration and perhaps closer radiological monitoring. Patients opting for volar plating should be counseled about the possibility of a secondary procedure for hardware removal.

**Strengths and Limitations:** The strengths of this study include its prospective randomized controlled design, which minimizes selection bias, and the pre-calculation of sample size ensuring adequate statistical power. The use of a validated functional outcome score (DASH) and a comprehensive analysis of complications, including stratification for key confounders, adds to the validity and depth of our findings. However, certain limitations must be acknowledged. First, the study was not blinded, which could introduce performance or assessment bias. Second, the follow-up period of six months, while sufficient to capture short-to-midterm functional outcomes and early complications, is inadequate to assess long-term outcomes such as post-traumatic arthritis or the long-term durability of the fixation. Third, the significant gender imbalance between the groups, with a much smaller number of females in the K-wire group, limits the generalizability of the gender-stratified results, particularly the non-significant finding in females. Finally, the study was conducted at a single center, and the procedures were performed by experienced surgeons, which may affect the generalizability of the complication rates to other settings.

## CONCLUSION

This trial demonstrates that volar locking plate fixation provides statistically and clinically superior functional outcomes compared to K-wire fixation for closed distal radius fractures, as evidenced by significantly lower DASH scores at six months. The functional benefit of plating was pronounced across most patient subgroups. However, this advantage is counterbalanced by a distinct complication profile for each technique. K-wire fixation was associated with a higher tendency for malunion and hardware irritation, particularly in older patients, while volar plating carried a greater likelihood of requiring a procedure. The findings advocate for an individualized, patient-centric approach to surgical decision-making, where the choice between volar plating and K-wire fixation is guided by a careful consideration of the age of the patient, functional expectations, and the specific risks associated with each implant.

## REFERENCES


1. Meena S, Sharma P, Sambharia AK, Dawar A. Fractures of distal radius: an overview. J Family Med Prim Care. 2014 Oct-Dec;3(4):325-32. doi: 10.4103/2249-4863.148101.
2. Jia Z, Wang S, Jiang W, Li C, Lin J, Liu Q, et al. The treatment of complex intra-articular distal radius fractures with turning radius and distal volaris radius plate fixation. Eur J Med Res. 2020 Dec 7;25(1):66. doi: 10.1186/s40001-020-00470-x.
3. Kraus R, Wessel L. The treatment of upper limb fractures in children and adolescents. Dtsch Arztebl Int. 2010 Dec;107(51-52):903-10. doi: 10.3238/arztebl.2010.0903.
4. Yen WW, Cloud GW, Wasserburg JR, Penny GS, Day LM, Pascal SC, et al. A Systematic Review of the Management of Upper Extremity Orthopaedic Injuries in Epileptic Patients. Arch Bone Jt Surg. 2022 Apr;10(4):301-310. doi: 10.22038/ABJS.2021.56488.2803.
5. Franceschi F, Franceschetti E, Paciotti M, Cancilleri F, Maffulli N, Denaro V. Volar locking plates versus K-wire/pin fixation for the treatment of distal radial fractures: a systematic review and quantitative synthesis. Br Med Bull. 2015 Sep;115(1):91-110. doi: 10.1093/bmb/ldv015.
6. Chaudhry H, Kleinlugtenbelt YV, Mundi R, Ristevski B, Goslings JC, Bhandari M. Are Volar Locking Plates Superior to Percutaneous K-wires for Distal Radius Fractures? A Meta-analysis. Clin Orthop Relat Res. 2015 Sep;473(9):3017-27. doi: 10.1007/s11999-015-4347-1.
7. Costa ML, Achten J, Parsons NR, Rangan A, Griffin D, Tubeuf S, et al. Percutaneous fixation with Kirschner wires versus volar locking plate fixation in adults with dorsally displaced fracture of distal radius: randomised controlled trial. BMJ. 2014 Aug 5;349:g4807. doi: 10.1136/bmj.g4807.
8. Costa ML, Achten J, Rangan A, Lamb SE, Parsons NR. Percutaneous fixation with Kirschner wires versus volar locking-plate fixation in adults with dorsally displaced fracture of distal radius: five-year follow-up of a randomized controlled trial. Bone Joint J. 2019 Aug;101-B(8):978-983. doi: 10.1302/0301-620X.101B8.BJJ-2018-1285.R1.
9. Lee JK, Yoon BH, Kim B, Ha C, Kil M, Shon JI, Lee HI. Is early mobilization after volar locking plate fixation in distal radius fractures really beneficial? A meta-analysis of prospective randomized studies. J Hand Ther. 2023 Jan-Mar;36(1):196-207. doi: 10.1016/j.jht.2021.10.003.
10. Sahu RL, Ranjan R. Fracture union in percutaneous Kirschner wire fixation in paediatric tibial shaft fractures. Chin J Traumatol. 2016 Dec 1;19(6):353-357. doi: 10.1016/j.cjtee.2016.08.003.
11. Habib Z, Uddin S, Niazi RQ, Rehman MU, Qadir A, Lateef A, et al. Comparison of Outcome of two different Methods for the treatment of intra-articular fracture of Distal Radius. Ann Pak Inst Med Sci. 2020;17(1):66-70. DOI: 10.48036/apims.v17i1.500
12. Yetkin H, Altay T, Ozan F, Kayalı C, Koyuncu Ş. Comparison of open reduction volar locking plate fixation and closed reduction percutaneous K-wire fixation in the treatment of AO type C1 distal radius fractures. Int J Clin Exp Med. 2017;10(1):1139-44.
13. Davis D, Raffic M, Joseph S. A Comparison between Volar Plating and K-wire Fixation of Distal End Radius Fractures. Kerala Journal of Orthopaedics. 2018;31(1):2-5.
14. Hull P, Baraza N, Gohil M, Whalley H, Mauffrey C, Brewster M, et al. Volar Locking Plates Versus K-Wire Fixation of Dorsally Displaced Distal Radius Fractures—A Functional Outcome Study. J Trauma. 2011;70(6):E125-E8. DOI: 10.1097/TA.0b013e3181e32714
15. Brennan SA, Kiernan C, Beecher S, O'Reilly RT, Devitt BM, Kearns SR, et al. Volar plate versus k-wire fixation of distal radius fractures. Injury. 2016;47(2):372-6. DOI: 10.1016/j.injury.2015.08.040
16. Khan JI, Hussain FN, Mehmood T, Adil O. A comparative study of functional outcome of treatment of intra articular fractures of distal radius fixed with percutaneous Kirschner's wires vs T-plate. Pak J Med Sci. 2017;33(3):709-13. DOI: 10.12669/pjms.333.11421
17. Ali R, Ilyas A, Riaz H, Faheem U, Khan J, Ahmed N, et al. Outcome of the distal radius fractures managed with across wrist external fixator vs buttress plate. J Ayub Med Coll Abbottabad. 2023;35(1):32-6. DOI: 10.55519/JAMC-01-10605
18. Sharma H, Taylor GR, Clarke NM. A review of K-wire related complications in the emergency management of paediatric upper extremity trauma. Ann R Coll Surg Engl. 2007 Apr;89(3):252-8. doi: 10.1308/003588407X155482.
19. Ma X, Wang L, Zhang X, Zhang Z, Xu Y, Lv L, Shao X. Comparative study of K-wire combined with screw vs. K-wire in the treatment of AO type B3.1 phalangeal fractures. BMC Musculoskelet Disord. 2023 Jul 19;24(1):591. doi: 10.1186/s12891-023-06731-0.
20. Clark D, Nakamura M, Miclau T, Marcucio R. Effects of Aging on Fracture Healing. Curr Osteoporos Rep. 2017 Dec;15(6):601-608. doi: 10.1007/s11914-017-0413-9.
21. Hollevoet N. Effect of patient age on malunion of operatively treated distal radius fractures. Acta Orthop Belg. 2010 Dec;76(6):743-50.
22. DeGeorge BR Jr, Brogan DM, Becker HA, Shin AY. Incidence of Complications following Volar Locking Plate Fixation of Distal Radius Fractures: An Analysis of 647 Cases. Plast Reconstr Surg. 2020 Apr;145(4):969-976. doi: 10.1097/PRS.0000000000006636.


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