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Arch Basic Clin Res 2026;8(2):206-211
DOI: 10.4274/ABCR.2026.26444

Research Article

Balancing Function and Cost: Kirschner Wire Fixation Versus Volar Plating in Intra-Articular Distal Radius Fractures

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Cite this article as: Şenocak E, Çelik M, Dağ İ, Karabak B, Kaşali K. Balancing function and cost: Kirschner wire fixation versus volar plating in ıntra-articular distal radius fractures. *Arch Basic Clin Res.* 2026;8(2):206-211.

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ABSTRACT

Objective: To comparatively evaluate the clinical, functional, radiological, and cost related outcomes of Kirschner wire fixation versus volar locking plate osteosynthesis in the management of intra-articular distal radius fractures.

Methods: A retrospective comparative study was conducted in 133 patients who had Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association type C distal radius fractures and who underwent surgical treatment between 2017 and 2023. Patients were allocated to two groups based on fixation technique: Kirschner wire fixation (n=67) and volar locking plate fixation (n=66). Functional outcomes were assessed using the disabilities of the arm, shoulder and hand (DASH) questionnaire and the Mayo Wrist Score at the 1st, 3rd, and 6th postoperative months. Additionally, Wrist range of motion, perioperative variables, and total treatment costs were analyzed. Longitudinal and intergroup comparisons were performed to determine temporal recovery patterns and treatment-related differences.

Results: Kirschner wire fixation was associated with significantly shorter operative duration, reduced intraoperative blood loss, shorter hospitalization, and substantially lower overall treatment cost compared with volar plating (all $P < 0.001$). Conversely, patients treated with volar plate osteosynthesis demonstrated significantly superior functional recovery and greater wrist range of motion during the early postoperative period ($P < 0.001$). Although both groups exhibited progressive and significant improvement over time ($P < 0.001$), intergroup differences diminished by the sixth postoperative month. Notably, DASH scores at 6 months indicated slightly better patient-reported outcomes, suggesting comparable mid-term patient-reported functional outcomes with the less invasive technique despite inferior early recovery.

Conclusion: Volar locking plate fixation provides enhanced early postoperative functional recovery and wrist mobility in intra-articular distal radius fractures. However, Kirschner wire fixation remains a cost-effective and surgically efficient alternative with comparable mid-term clinical outcomes. These findings support an individualized treatment strategy based on fracture characteristics, patient expectations, surgeon experience, and healthcare resource considerations.

Keywords: Distal radius fracture, Kirschner wire fixation, volar locking plate, ORIF, functional outcomes, cost-effectiveness analysis

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Received: May 21, 2026
Revision Requested: June 26, 2026 **Accepted:** June 29, 2026 **Publication Date:** July, 14, 2026

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INTRODUCTION

Distal radius fractures (DRFs) are among the most common reasons for emergency department visits, accounting for approximately 1.5% of all such visits in the United States.[1] Furthermore, they constitute nearly 18% of orthopedic trauma admissions.[2] DRFs demonstrate a bimodal age distribution, with increasing incidence in two distinct age groups. Their frequency increases secondary to high-energy trauma among young males whereas in elderly women the incidence increases primarily due to osteoporosis.[3] As average life expectancy increases, the incidence of osteoporotic DRFs is expected to rise further.[4]

Current treatment strategies for DRFs encompass a wide range of modalities, including nonoperative management with closed reduction and casting and surgical options such as volar and dorsal plate-and-screw fixation, external fixation, and closed reduction with percutaneous Kirschner wire fixation.[5] The primary objective of all treatment methods is to restore fracture alignment and joint congruity, thereby enabling early mobilization and recovery of wrist function. Failure to achieve proper alignment may result in wrist osteoarthritis, restricted range of motion, and diminished grip strength.[6]

In this retrospective study, we aimed to comparatively evaluate the clinical, functional, radiological, and cost-related outcomes of Kirschner wire fixation versus volar locking plate osteosynthesis in the management of intra-articular DRFs.

MATERIALS and METHODS

This retrospective comparative study was approved by the Institutional Ethics Committee of Atatürk University Faculty of Medicine (decision no: B.30.2.ATA.0.01.00/292, date: 29.04.2026). Between January 2017 and January 2023, patients admitted to our clinic with a diagnosis of DRF were retrospectively reviewed. The study included patients who met the inclusion criteria and underwent either volar plate (VP)-and-screw fixation or Kirschner-wire fixation.

The inclusion criteria were as follows: patients with Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association type C DRFs involving the articular surface; patients with closed fractures or Gustilo-Anderson type I open fractures; patients aged 18-80 years; and patients presenting within 10 days of injury.

MAIN POINTS

- Volar locking plate fixation provided superior early postoperative functional recovery and greater wrist range of motion compared with Kirschner wire fixation in intra-articular distal radius fractures.
- Despite the early functional advantages of volar plating, both fixation methods achieved comparable functional outcomes by the sixth postoperative month.
- Treatment selection for intra-articular distal radius fractures should be individualized by considering functional expectations, surgical burden, fracture characteristics, and healthcare resource utilization.

The exclusion criteria included patients with Gustilo-Anderson type II and III open fractures; those younger than 18 years or older than 80 years; those with pathological fractures; those with less than one year of follow-up; and those with a history of DRF.

A retrospective evaluation of the hospital automation system identified 247 patients who underwent surgery for DRFs. Of these, 32 patients with type A fractures were excluded. In addition, routine follow-up was considered inadequate in 33 patients treated with Kirschner wire fixation and 41 patients treated with plate-and-screw fixation. In the plate-and-screw fixation group, 5 patients required implant removal and revision to external fixation due to infection. In the Kirschner wire fixation group, fixation failure occurred in 3 patients, necessitating revision surgery with plate-and-screw fixation. Ultimately, 67 patients treated with Kirschner wire fixation and 66 patients treated with plate-and-screw osteosynthesis, all of whom met the inclusion criteria and had a minimum follow-up of one year, were included in the study.

According to patients' records, disabilities of the arm, shoulder and hand (DASH) scores obtained at postoperative months 1, 3, and 6, Mayo Wrist Scores, wrist flexion-extension range of motion, and forearm pronation-supination range of motion were evaluated and compared between the two surgical groups.

Fracture union time, operative duration, intraoperative blood loss, and length of hospital stay were assessed. A comprehensive cost analysis was performed using data obtained from the hospital billing and administrative records. The total treatment cost included implant costs, operating room costs, costs related to operative duration, hospitalization costs, perioperative medication costs, laboratory and radiological examination costs, postoperative follow-up costs, and costs associated with additional interventions when required. All costs were initially calculated in Turkish Lira (TRY) according to the hospital reimbursement system in effect during the study period and subsequently converted to U.S. Dollars (USD) using the official exchange rates for the period when the treatment was performed. The total treatment costs were then recorded and analyzed statistically.

Surgical Technique

All surgical procedures were performed under standard regional or general anesthesia by a surgical team with at least five years' operative experience, with the patient in the supine position on a radiolucent hand table and with C-arm fluoroscopic guidance.

In the Kirschner wire fixation group, following gentle reduction, percutaneous fixation was achieved under fluoroscopic guidance with two or three 2-mm Kirschner wires inserted in a crossed configuration from the distal radius toward the proximal radial shaft. Perioperative blood loss, operative time, and intraoperative complications were recorded during the procedure.

In the VP group, the affected extremity was approached through a longitudinal volar incision under pneumatic tourniquet control. After dissection through the tissue planes, the fracture site was exposed, while the radial artery and median nerve

were carefully protected. Fixation was subsequently performed using an anatomically contoured VP and an appropriate number of screws. Operative time, intraoperative blood loss, and perioperative complications were recorded during surgery.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics v20. Data were presented as mean and standard deviation, median (minimum-maximum), and as percentages and frequencies. The normality of continuous variables was assessed using the Shapiro-Wilk test.

For comparisons between two independent groups, the Independent samples t-test was used when the assumption of normality was met, and the Mann-Whitney U test when it was not. For comparisons of more than two dependent groups, Repeated Measures ANOVA was used when normality was met, and the Friedman test when it was not; post-hoc comparisons were performed using the Tukey test or Tamhane's T2 test according to the homogeneity of variances.

For categorical variables, the Pearson chi-square test, Yates' continuity correction chi-square test, Fisher's exact test, or the Fisher-Freeman-Halton test were used depending on expected frequencies. A P value < 0.05 was considered statistically significant.

RESULTS

A total of 133 patients were included in the study. Analysis of the age distribution demonstrated that the study population had a mean age of 41 ± 18 years, with a median age of 39 years (range: 17-77 years), indicating a broad age spectrum. In terms of sex distribution, males constituted the majority of the cohort (80.5%, n=107), while females represented 19.5% (n=26). This distribution is consistent with the known sex-related epidemiology of DRFs. Clinical variables were compared (Table 1).

Fracture union time, operative duration, blood loss, length of hospital stay, and costs differed significantly between the Kirschner wire (KIRSC) and open reduction and internal fixation (ORIF) groups (P < 0.001). No statistically significant difference was observed between the two groups with respect to age (Z = -1.045, P = 0.296).

In the intergroup comparison, a statistically significant difference favoring the KIRSC group was observed for the DASH score at postoperative month 6 (Z = -3.564, P < 0.001) and for the Mayo score at postoperative months 1 and 3 (Z = -9.882 and Z = -6.260, respectively; P < 0.001). However, no significant intergroup differences were found in DASH scores at postoperative months 1 and 3 or in the Mayo score at postoperative month 6.

Wrist flexion-extension values were consistently higher in the ORIF group across all follow-up periods, and these differences were statistically significant (P < 0.001). Forearm supination-pronation demonstrated a significant between-group difference only at postoperative month 1 (Z = -7.354, P < 0.001), whereas no significant intergroup differences were detected at postoperative months 3 and 6 (P > 0.05).

In the intragroup repeated-measures analysis, DASH and Mayo scores, wrist flexion-extension, and forearm supination-pronation values showed statistically significant changes across postoperative months 1, 3, and 6 in both groups (Friedman test, P < 0.001). Post-hoc analyses revealed statistically significant differences between all pairwise time periods. Table 2 compares demographic and clinical characteristics.

No statistically significant differences were observed between the KIRSC and ORIF groups with respect to sex, side involvement, hand dominance, mechanism of trauma, or associated injuries (P > 0.05). These findings indicate that the two groups had similar distributions of the evaluated demographic and clinical characteristics and were therefore comparable.

Functional scores and range of motion parameters improved significantly over time in both treatment groups (Friedman test, P < 0.001). Intergroup comparisons demonstrated significantly higher Mayo Wrist Scores at postoperative months 1 and 3 and greater wrist flexion-extension values at all follow-up periods in the ORIF group. In contrast, DASH scores at postoperative month 6 were significantly lower in the KIRSC group. No significant differences were observed between groups regarding forearm supination-pronation at postoperative months 3 and 6. Detailed results are presented in Figure 1 and Table 2.

Table 1. Comparison of the KIRSC and ORIF Groups According to Clinical Variables

	KIRSC		ORIF			
Variable	**Mean ± SD**	**Med (min-max)**	**Mean ± SD**	**Med (min-max)**	**Z**	***P***
Age (year)	42 ± 19	41 (17-77)	39 ± 18	35 (18-74)	-1.045	0.296
Union time (week)	6 ± 2	5 (4-11)	9 ± 2	9 (5-13)	- 7.019	**< 0.001**
Surgery duration (minute)	19 ± 8	16 (10-45)	56 ± 12	55 (35-80)	-9.701	**< 0.001**
Blood loss (mL)	8 ± 7	5 (5-50)	96 ± 27	90 (45-200)	-10.189	**< 0.001**
Hospitalisation time (day)	1 ± 1	1 (0-6)	3 ± 2	3 (1-7)	-8.387	**< 0.001**
Cost (USD)	221 ± 116	210 (100-720)	1321 ± 1206	1075 (600-10000)	-9.857	**< 0.001**

Table 2. Comparison of the KIRSC and ORIF Groups in Terms of Demographic and Clinical Characteristics

		KIRSC	ORIF		*P*
		n (%)	n (%)	Test ist.	
Sex	Male	54 (80.6%)	53 (80.3%)	0.002	0.966[a]
	Female	13 (19.4%)	13 (19.7%)		
Side	Right	45 (67.2%)	45 (68.2%)	0.016	0.900[a]
	Left	22 (32.8%)	21 (31.8%)		
Dominence	Right	62 (92.5%)	63 (95.5%)		0.718[b]
	Left	5 (7.5%)	3 (4.5%)		
Etiology	Simple fall	50 (74.6%)	44 (66.7%)	6.651	0.132[c]
	Out-of-vehicle traffic accident	7 (10.4%)	4 (6.1%)		
	Fall from height	2 (3.0%)	0 (0.0%)		
	Skiing accident	6 (9.0%)	12 (18.2%)		
	Motorcycle accident	2 (3.0%)	6 (9.1%)		
Concomitant injury	No concomitant injury	56 (83.6%)	56 (84.8%)	0.040	0.841[a]
	Presence of concomitant injury	11 (16.4%)	10 (15.2%)		

[a]chi-square test, [b]Fisher exact test, [c]Fisher freman halton test

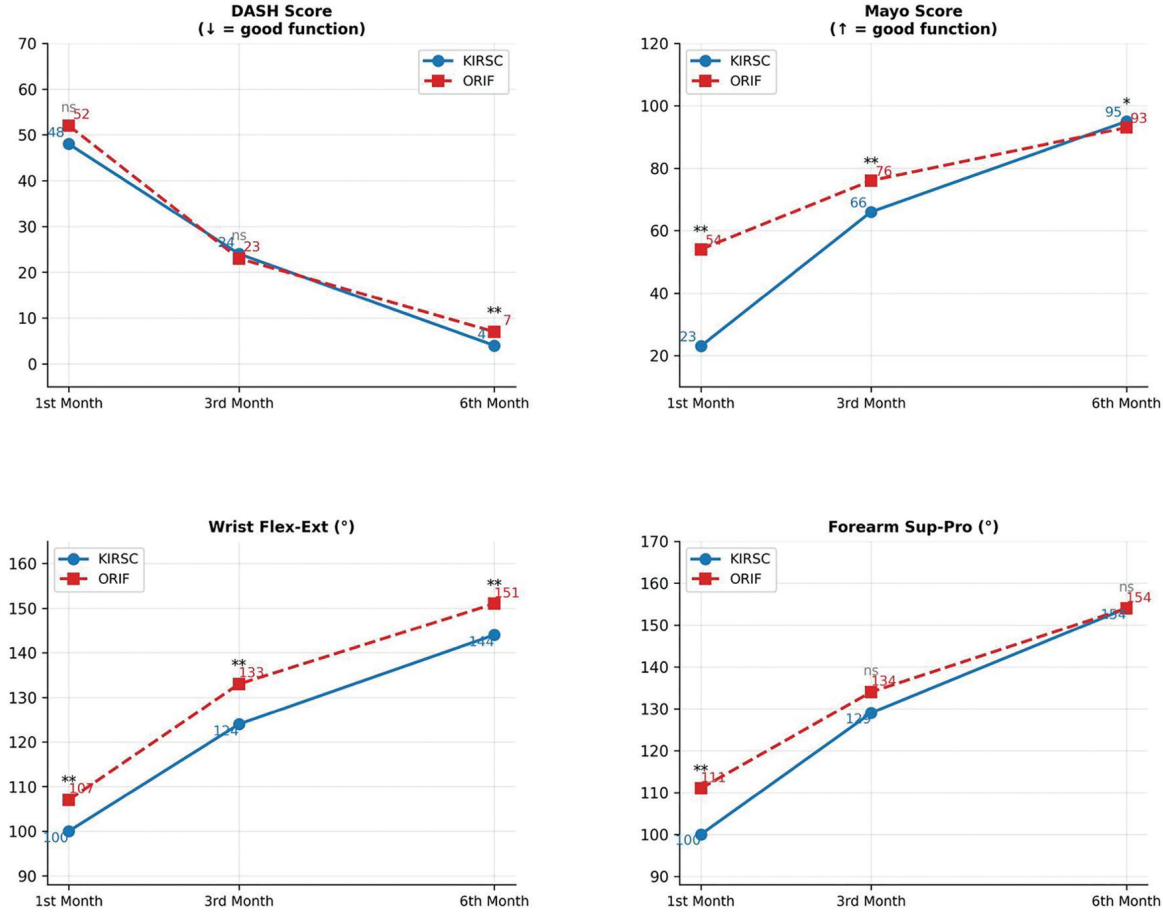


Figure 1. Changes in functional scores and range of motion over time. The lines represent median values at postoperative months 1, 3, and 6. Inter-period *P* values are indicated as follows: **$P < 0.001$, *$P < 0.05$, ns = not significant. Within-group changes in both groups were statistically significant according to the Friedman test ($P < 0.001$).

DISCUSSION

In the present study, we performed a comprehensive comparison of Kirschner wire fixation and VP osteosynthesis for intra-articular DRFs and demonstrated that, whereas volar plating provides superior early functional recovery and range of motion, Kirschner wire fixation offers significant advantages in operative efficiency and cost while achieving comparable mid-term functional outcomes.

DRFs represent a substantial proportion of orthopedic trauma, with a well-established bimodal distribution and increasing incidence due to aging populations and osteoporosis.[1-4] Despite advances in surgical techniques, the optimal treatment strategy for intra-articular fractures remains controversial, particularly regarding the balance between anatomical restoration and minimally invasive approaches.[5-7]

The significantly shorter operative time, reduced blood loss, and shorter hospitalization, observed in the Kirschner wire group in our study, are consistent with the minimally invasive nature of percutaneous fixation techniques. Ribeiro et al.[7] emphasized that less invasive methods may reduce perioperative morbidity, although functional superiority remains uncertain. Similarly, Wei et al.[8] reported that external fixation and less invasive approaches are associated with lower surgical burden compared to plate fixation. In contrast to some studies in the literature, Yılmaz found no clinical or radiological differences between VP fixation and EF fixation in the surgical treatment of intra-articular DRFs.[9]

In contrast, the superior early functional outcomes and greater wrist range of motion observed in the ORIF group can be attributed to the biomechanical stability provided by volar locking plates. Malisorn[10] highlighted the advantages of volar fixation in maintaining reduction and enabling early mobilization. Furthermore, Che Daud et al.,[11] in a multicenter prospective study, demonstrated that locking plate fixation provides stable construct integrity, facilitating early rehabilitation and improved early functional outcomes. Our findings are in strong agreement with these reports, particularly regarding early postoperative recovery.

A key finding of our study is that the early advantages of ORIF diminish over time, with both techniques yielding comparable functional outcomes at six months. This observation is consistent with the randomized trial by Wei et al.[11] and the meta-analysis by Margaliot et al.,[12] both of which reported no significant long-term functional superiority of plate fixation over alternative methods. Importantly, our finding that DASH scores favored the Kirschner group at mid-term follow-up supports the notion proposed by Samal et al.[13] that patient-reported outcomes may not directly correlate with radiological or biomechanical parameters.

From a biomechanical perspective, the persistent superiority of ORIF in wrist flexion-extension range of motion throughout the follow-up period may be explained by improved anatomical restoration and stable fixation, which allow for controlled early mobilization.[14] However, in our study the absence of long-term differences in forearm rotation suggests that rotational recovery is primarily dependent on fracture healing rather than fixation method.

A key strength and novel aspect of this study is the simultaneous and integrated evaluation of functional outcomes, range of motion parameters, and costs in patients with intra-articular DRFs treated with two commonly used fixation techniques. While previous studies have predominantly focused on either radiological or functional outcomes, cost-effectiveness has rarely been evaluated in conjunction with longitudinal functional recovery.[15] Our study provides a more comprehensive perspective by combining clinical efficacy and economic burden, which is particularly relevant for healthcare systems with constrained resources. Furthermore, the demonstration that mid-term functional outcomes converge despite the early biomechanical advantages of ORIF provides important evidence in the ongoing debate over optimal treatment selection.

The strengths of this study include a relatively large and homogeneous patient cohort, standardized follow-up intervals, and the simultaneous assessment of multiple clinically relevant outcome measures. Moreover, the comparable baseline characteristics between groups enhance the internal validity of the findings. However, several limitations should be acknowledged. First, the retrospective single-center design may limit the generalizability of our findings and introduce the potential for selection bias. Second, treatment allocation was based on surgeon preference and clinical judgment rather than on randomization, and this may have influenced the observed outcomes. Third, postoperative rehabilitation protocols were not fully standardized across patients, and variations in these protocols may have affected functional recovery. Fourth, radiological parameters were not comprehensively analyzed, limiting the ability to assess the correlation between anatomical and functional outcomes. Fifth, the absence of multivariate regression analysis precludes adjustment for potential confounders. Although all patients were followed for a minimum of one year, the relatively short follow-up period limits the assessment of long-term functional outcomes, late complications, and treatment durability.

In conclusion, both volar locking plate fixation and Kirschner wire fixation are effective treatment options for intra-articular DRFs. Volar locking plate fixation provides enhanced early postoperative functional recovery and improved wrist mobility, likely due to its superior biomechanical stability and facilitation of early mobilization. However, these advantages diminish over time, as Kirschner wire fixation demonstrates comparable mid-term clinical outcomes while offering significant benefits in terms of operative efficiency, reduced surgical burden, and cost-effectiveness. These findings support an individualized treatment strategy that considers not only fracture characteristics and patient expectations but also surgeon experience and healthcare resource utilization. Prospective, randomized, multicenter studies with standardized rehabilitation protocols and longer follow-up periods are warranted to further optimize treatment selection for intra-articular DRFs.

Ethics

Ethics Committee Approval: This retrospective comparative study was approved by the Institutional Ethics Committee of Atatürk University Faculty of Medicine (decision no.: B.30.2.ATA.0.01.00/292, date: 29.04.2026).

Informed Consent: Retrospective study.

Footnotes

Author Contributions

Concept Design – E.Ş., M.Ç.; Data Collection or Processing – E.Ş., M.Ç., İ.D., B.K., K.K.; Analysis or Interpretation – E.Ş., İ.D., B.K., K.K.; Literature Review – E.Ş., M.Ç.; Writing, Reviewing and üEditing – E.Ş., M.Ç., İ.D., B.K., K.K.

Declaration of Interests: The authors declared no conflicts of interest.

Funding: The authors declare that this study has received no financial support.

REFERENCES

1. Azad A, Kang HP, Alluri RK, Vakhshori V, Kay HF, Ghiassi A. Epidemiological and treatment trends of distal radius fractures across multiple age groups. *J Wrist Surg*. 2019;8(4):305-311. [CrossRef]
2. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. *Injury*. 2006;37(8):691-697. [CrossRef]
3. Gencer B, Ender İbaç S, Teoman Yeni B, Sezer T, Doğan Ö. Surgical treatment of bilateral distal radius fractures: an analysis of epidemiological variables and outcome parameters. *Arch Basic Clin Res*. 2024;6(3):202-208. [CrossRef]
4. Sagerfors M, Jakobsson H, Thórdardóttir Á, Wretenberg P, Möller M. Distal radius fractures in the superelderly: an observational study of 8486 cases from the Swedish fracture register. *BMC Geriatr*. 2022;22(1):140. [CrossRef]
5. Koval KJ, Harrast JJ, Anglen JO, Weinstein JN. Fractures of the distal part of the radius. The evolution of practice over time. Where's the evidence? *J Bone Joint Surg Am*. 2008;90(9):1855-1861. [CrossRef]
6. Arora R, Gabl M, Gschwentner M, Deml C, Krappinger D, Lutz M. A comparative study of clinical and radiologic outcomes of unstable colles type distal radius fractures in patients older than 70 years: nonoperative treatment versus volar locking plating. *J Orthop Trauma*. 2009;23(4):237-242. [CrossRef]
7. Ribeiro E, Campanholi G, Acherboim M, Ruggiero GM. Mini-invasive surgery for distal radius fractures: a double incision under 12 mm. *J Wrist Surg*. 2021;10(2):136-143. [CrossRef]
8. Wei XM, Sun ZZ, Rui YJ, Song XJ, Jiang WM. Minimally invasive percutaneous plate osteosynthesis for distal radius fractures with long-segment metadiaphyseal comminution. *Orthop Traumatol Surg Res*. 2016;102(3):333-338. [CrossRef]
9. Yılmaz M. Comparison of the clinical and radiological results of volar locking plate and external fixation treatment of intra-articular fractures of the distal radius. *Arch Basic Clin Res*. 2023;5(3):378-385. [CrossRef]
10. Malisorn S. Functional outcomes and early complications following volar locking plate fixation of unstable distal radius fractures: a minimum two-year follow-up study. *Cureus*. 2026;18(2):e103133. [CrossRef]
11. Che Daud AZ, Mohd Nayan NA, Ahmad A, Alrashdi M, Kadar M, Mohd Poot EF. Distal radius fracture rehabilitation: a bibliometric and scoping review. *J Hand Ther*. 2026;39(1):120-132. [CrossRef] Epub 2025 Jul 4. Erratum in: *J Hand Ther*. 2025:S0894-1130(25)0019019-5. [CrossRef]
12. Margaliot Z, Haase SC, Kotsis SV, Kim HM, Chung KC. A meta-analysis of outcomes of external fixation versus plate osteosynthesis for unstable distal radius fractures. *J Hand Surg Am*. 2005;30(6):1185-11899. [CrossRef]
13. Samal BP, Pradhan S, Mohanty RR, Chatterjee G, Acharya T, Sahoo BS. Volar plate versus Kirschner-wire fixation in intra-articular fracture of distal radius. *J Pharm Bioallied Sci*. 2025;17(Suppl 3):S2320-S2322. [CrossRef]
14. Kong L, Li C, Bai J, Lu J. Surgical treatment of distal radius fractures: impact on forearm rotation in non-elderly patients. *Sci Rep*. 2024;14(1):2876. [CrossRef]
15. Kumar J, Rahul K, Niraj NK, Mane A, Navaneethan P, Pandey P. An economically feasible solution for distal radius fractures treated with column-specific fixation. *J Orthop Case Rep*. 2026;16(3):338-344. [CrossRef]