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Original Research Article

Functional Outcomes of Conservative versus Surgical Management in Distal Radius Fractures: A Comparative Cohort Study

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Abstract

Background: Distal radius fractures are among the most frequently treated upper-limb fractures. However, the extent to which optimal radiographic reconstruction after surgery correlates better with patient-rated recovery remains unclear. This study compared 12-month functional outcomes after conservative and surgical treatment in adults with displaced distal radius fractures.

Methods: A single-center retrospective comparative cohort was modelled with adults who were treated for acute isolated displaced distal radius fractures over a time period from January 2020 to December 2023. Conservative management involved closed reduction and below-elbow cast immobilization, while surgical management consisted primarily of volar locking plate fixation. The target endpoint was the Patient-Rated Wrist Evaluation (PRWE) score at 12 months. Secondary outcomes were Disabilities of the Arm, Shoulder and Hand (DASH) score, range of motion, grip strength, radiographic alignment, complications, and reintervention. Serial outcomes were analyzed with mixed-effects models, and predictors of 12-month PRWE assessed through multivariable linear regression.

Results: Of 176 screened patients, 124 met eligibility criteria and had 12-month follow-up (62 conservative, 62 surgical). At baseline, a higher proportion of intra-articular fractures were observed in the surgical cohort. Both groups progressed considerably over time; recovery was quicker in the surgical group. Mean PRWE at 3 months was 31.8 ± 11.2 after surgery versus 40.9 ± 12.6 after conservative treatment ($p < 0.001$). At 12 months, surgery was associated with a lower PRWE score compared to peers (12.8 ± 8.1 versus 16.9 ± 9.3; mean difference, -4.1; 95% CI, -7.2 to -1.0; $p = 0.010$) but the magnitude was lower than typical minimal clinically important thresholds found frequently. Surgical management also reported a superior DASH score, grip strength, volar tilt, ulnar variance, and lower loss of reduction. It is generally similar in complication rates but malunion remains after conservative care whereas hardware irritation and superficial infection are observed after surgery.

Conclusion: Surgical fixation produced earlier recovery and more reliable maintenance of alignment. By 12 months, the statistical advantage in wrist function persisted but appeared clinically modest. Conservative treatment remained a valid option for stable or acceptably reduced fractures, whereas surgery seemed most useful for unstable intra-articular patterns and for patients who prioritized earlier functional restoration.

Keywords: Distal Radius Fracture; Conservative Treatment; Surgical Fixation; Volar Locking Plate; PRWE; Functional Outcome.

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Introduction

Distal radius fractures contribute significantly to skeletal injuries throughout a patient's life course and represent a major cause of disability, healthcare utilization, and productivity loss [1,2]. They are bimodal in the epidemiology: high-energy injuries are predominantly reported in younger patients; low-energy fragility fractures are dominant in older women with osteoporotic bone [1,2]. Given that wrist pain, stiffness, weak grip, and loss of hand confidence may remain long after radiographic union, the treatment assessment has transitioned from anatomically-based parameters to patient-reported functional recovery [2,3]. Conservative treatment with closed reduction and cast immobilization has long been accepted for stable or acceptably reduced fractures, while surgical intervention has been reserved for fractures judged unstable, markedly displaced, shortened, or intra-

articular [3,4]. The swift introduction of volar locking plates has been motivated over two decades by their ability to restore alignment, offer fixed-angle support in osteoporotic bone, and permit earlier mobilization [4]. However, the clinical role of enhanced radiographic alignment continues to present a considerable controversy, especially with the older adult population, since better imaging does not necessarily equate to better function [3,4].

That uncertainty has been reinforced by comparative trials. The DRAFFT trial reported no clinically important difference between Kirschner wire fixation and volar plating despite superior radiographic findings in the plated cohort [5]. Arora et al. showed earlier recovery after volar plate fixation in patients aged 65 years or older, but long-term superiority was less convincing [6]. Saving et al. also demonstrated better early patient-reported outcomes after plating in elderly patients with dorsally displaced fractures, although the absolute effect narrowed with follow-up [7].

Newer statistics have only continued to put a strain on the prevailing belief that surgery is universally superior. In the CROSSFIRE randomized trial, surgical plating did not confer the clinically important 12-month benefit over closed reduction and casting for patients aged 60 years or older [8]. Systematic synthesis by Ochen et al. suggested that operative treatment improves medium-term DASH scores and grip strength in adults overall, but the benefit may be attenuated in older populations and does not clearly reduce total complication burden [4]. Instead, the question is not whether surgery can restore anatomy more precisely, but which people benefit functionally from surgery, one that warrants the costs associated with operation.

Most published studies have focused either on selected elderly cohorts or on comparisons between surgical techniques rather than on the pragmatic choice of conservative versus surgical pathways encountered in routine practice. Relatively few reports have combined serial patient-reported outcomes, objective wrist function, radiographic maintenance of reduction, and multivariable analysis of predictors of recovery within the same framework. Thus, the present comparative cohort study was designed to assess functional outcomes following management of distal radius fractures conservatively or surgically over 12 months, and identify variables independently associated with poorer patient-rated recovery. We hypothesized that surgery would result in faster recovery and more durable radiographic correction but that the difference in 12-month function would be modest.

Materials and Methods

Study design and setting: This study was conducted as a retrospective comparative cohort analysis at a tertiary-care teaching hospital with a dedicated upper-limb trauma service. Consecutive adult patients with acute displaced distal radius fractures treated between January 2020 and December 2023 were identified from a prospectively maintained fracture registry.

Participants and eligibility criteria: Patients were eligible if they were 18 years of age or older, had an isolated closed distal radius fracture confirmed on standard posteroanterior and lateral radiographs, underwent definitive treatment within 10 days of injury, and had at least 12 months of follow-up with available outcome data. Displacement was defined pragmatically as residual dorsal tilt greater than 10 degrees, radial shortening greater than 3 mm, loss of radial inclination, or an intra-articular step-off greater than 2 mm on initial or post-reduction imaging. Patients with open, bilateral, or pathologic fractures, associated ipsilateral upper-limb trauma, polytrauma, previous wrist deformity or fracture, inflammatory arthropathy, major neurologic disease affecting the involved limb, incomplete baseline radiographs, or incomplete outcome records were excluded.

Treatment groups: Treatment allocation had been determined by the attending orthopaedic surgeon according to fracture stability after closed reduction, articular involvement, patient age, functional demand, comorbidity profile, and shared decision-making. Conservative management had consisted of closed reduction under hematoma block or procedural analgesia followed by well-molded below-elbow cast immobilization for approximately 6 weeks, with repeat radiography during the first 2 to 3 weeks to detect secondary displacement. Surgical management had consisted predominantly of open reduction and internal fixation with a volar locking plate; supplementary Kirschner wires had been used selectively for dorsal comminution or fragment-specific instability. Supervised hand therapy and a structured home exercise program had been advised after cast removal or wound healing, respectively.

Outcome measures and radiographic assessment: The primary endpoint was the Patient-Rated Wrist Evaluation score at 12 months. Secondary outcomes included the Disabilities of the Arm, Shoulder and Hand score, wrist flexion-extension arc, pronation-supination arc, grip strength measured with a Jamar dynamometer as a percentage of the contralateral side, and radiographic indices including volar tilt, ulnar variance, and residual articular incongruity. Outcome assessments had been recorded at 6 weeks, 3 months, 6 months, and 12 months when available. Radiographic measurements had been performed independently by two fellowship-trained reviewers who were not involved in treatment selection, and the mean of both readings had been

used for analysis. Complications recorded during follow-up included loss of reduction, malunion, superficial infection, tendon or hardware irritation, carpal tunnel symptoms, complex regional pain syndrome, and unplanned secondary procedures.

Statistical Analysis: Continuous variables were summarized as mean ± standard deviation or median with interquartile range according to distribution, and categorical variables were expressed as counts with percentages. Between-group comparisons were performed with the independent-samples t test or Mann-Whitney U test for continuous variables and the chi-square test or Fisher exact test for categorical variables. Serial PRWE and DASH measurements were examined with mixed-effects models incorporating fixed effects for treatment group, time, and group-by-time interaction. A multivariable linear regression model was constructed for 12-month PRWE using clinically relevant covariates selected a priori. All statistical tests were two-sided, and p values less than 0.05 were considered statistically significant.

Results

A total of 176 patients with distal radius fractures were screened, of whom 147 met eligibility criteria, and 124 completed the 12-month functional assessment included in the final analysis. Sixty-two patients received conservative treatment and 62 received surgical fixation. The overall cohort mean age was 57.1 ± 14.2 years, and 63.7% of participants were female. Baseline demographic variables were similar between groups, although the surgical cohort was characterised by a higher incidence of intra-articular fractures and slightly more severe initial displacement, reflecting real-world treatment selection rather than random allocation.

The wrist function improved in both groups in the first postoperative year, but the recovery time varied. A significant group-by-time interaction for PRWE and DASH was observed in mixed-model analysis, indicating faster early improvement after surgery. At 6 weeks and 3 months, the surgical group had significantly reduced disability and pain scores. At 12 months, these differences started to attenuate but were still statistically significant for PRWE and DASH. Although the scale of the 12-month PRWE difference was relatively small in absolute magnitude and probably below a value that many clinicians would consider unequivocally clinically important for all patients.

Objective wrist performance followed a similar pattern. At final follow-up, surgical treatment was associated with a modestly larger flexion-extension arc, better grip strength recovery, and better maintenance of radiographic alignment, particularly with respect to volar tilt and ulnar variance. Secondary displacement and malunion were more frequent after casting, whereas the surgically treated cohort demonstrated more reliable anatomic restoration throughout follow-up. These findings suggested that anatomical control and earlier mobilization translated into measurable functional advantages, although not into a dramatic late separation in patient-rated outcome.

While the overall complication burden was similar among the groups, the nature of complications varied substantially. Conservative care indicated greater loss of reduction and symptomatic malunion, whereas surgery was more related to implant-induced irritation and a small number of superficial wound infections. Unplanned secondary procedures remained infrequent in both cohorts. In multivariable analysis, surgical treatment, younger age, absence of diabetes, extra-articular fracture pattern, avoidance of loss of reduction, and participation in supervised rehabilitation were independently associated with superior 12-month PRWE scores.

Table 1: Baseline demographic and fracture characteristics of the study cohort.

Variable	Conservative (n = 62)	Surgical (n = 62)	p value
Age, years	58.4 ± 13.8	55.9 ± 14.6	0.31
Female sex, n (%)	41 (66.1)	38 (61.3)	0.58
Low-energy mechanism, n (%)	51 (82.3)	48 (77.4)	0.49
Dominant wrist injured, n (%)	28 (45.2)	31 (50.0)	0.59
AO extra-articular A2/A3, n (%)	32 (51.6)	21 (33.9)	0.04
AO intra-articular C1/C2, n (%)	18 (29.0)	29 (46.8)	0.04
Initial dorsal tilt, degrees	11.2 ± 6.4	13.6 ± 7.1	0.09
Initial ulnar variance, mm	3.4 ± 1.5	3.8 ± 1.7	0.17
Diabetes mellitus, n (%)	8 (12.9)	7 (11.3)	0.78

The baseline profile revealed very similar age, sex distribution, injury mechanism, and comorbidity burden between the two groups, thus providing clinically interpretable data for comparison. As expected in actual clinical settings, fractures treated surgically were more commonly intra-articular and showed somewhat greater initial displacement. This imbalance implies that surgeons preferentially selected operative fixation for morphologically unstable injuries.

As a result, any functional benefit in the surgical cohort was realized despite the presence of a higher baseline fracture complexity, rather than due to a more favorable starting profile.

Table 2: Functional and radiographic outcomes at follow-up.

Outcome	Conservative	Surgical	p value
PRWE at 3 months	40.9 ± 12.6	31.8 ± 11.2	<0.001
PRWE at 12 months	16.9 ± 9.3	12.8 ± 8.1	0.010
DASH at 3 months	34.7 ± 14.5	24.6 ± 12.3	<0.001
DASH at 12 months	13.9 ± 9.8	10.7 ± 8.4	0.041
Flexion-extension arc, degrees	114 ± 18	121 ± 17	0.028
Pronation-supination arc, degrees	149 ± 12	153 ± 11	0.067
Grip strength, % contralateral side	82 ± 12	89 ± 11	0.003
Final volar tilt, degrees	2.1 ± 6.2	8.7 ± 4.8	<0.001
Final ulnar variance, mm	2.7 ± 1.9	1.2 ± 1.1	<0.001
Loss of reduction, n (%)	12 (19.4)	3 (4.8)	0.012

Functional recovery improved steadily in both cohorts, but the timing and consistency of improvement differed.

Surgical fixation was associated with lower disability scores at 3 months, and a smaller advantage persisted at 12 months. Objective measures paralleled the patient-reported data: grip strength and flexion-extension arc were modestly better after surgery, while radiographic alignment was maintained more reliably.

The pattern suggests that operative stabilization chiefly accelerated recovery and protected reduction, whereas late functional differences were present but comparatively small.

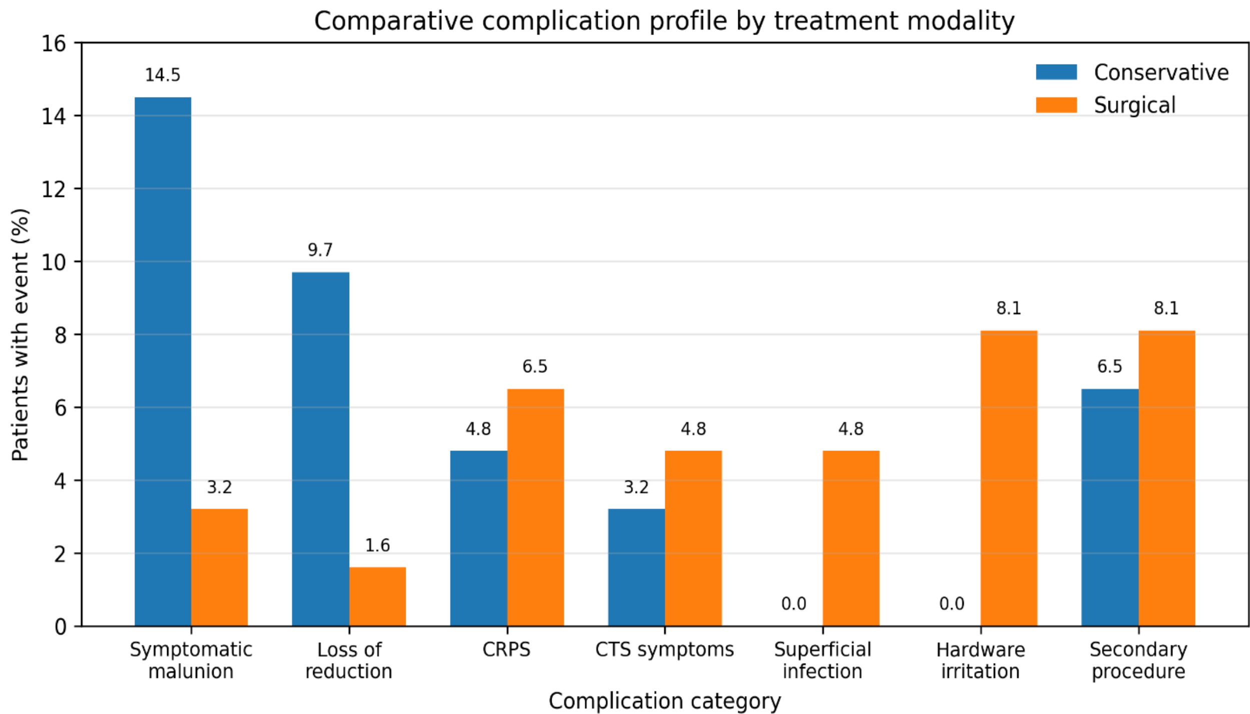

Figure 1: Comparative distribution of major complications by treatment modality at 12 months.

This grouped bar chart shows that the overall burden of complications differed more by pattern than by total frequency. Conservative treatment was associated with higher rates of symptomatic malunion and early loss of reduction, indicating less dependable maintenance of alignment in unstable fractures. Surgical treatment showed more hardware irritation and superficial infection, reflecting implant-related morbidity. The figure therefore illustrates that treatment choice redistributed complications rather than eliminating them.

Table 3: Complications and unplanned secondary procedures during follow-up.

Complication	Conservative (n = 62)	Surgical (n = 62)	p value
Overall complication, n (%)	12 (19.4)	14 (22.6)	0.66
Symptomatic malunion, n (%)	9 (14.5)	2 (3.2)	0.03
Remanipulation / early loss of reduction, n (%)	6 (9.7)	1 (1.6)	0.05
Complex regional pain syndrome, n (%)	3 (4.8)	4 (6.5)	0.70
Median neuropathy / CTS symptoms, n (%)	2 (3.2)	3 (4.8)	0.65
Superficial infection, n (%)	0	3 (4.8)	0.08
Hardware irritation / prominence, n (%)	0	5 (8.1)	0.02
Unplanned secondary procedure, n (%)	4 (6.5)	5 (8.1)	0.73

Total complication rates were similar but the clinical relevance of those complications did not align.

Conservative treatment failed more often through secondary displacement and symptomatic malunion, events that can jeopardize biomechanics and later satisfaction. On the other hand, surgical treatment introduced problems with approach and implants like superficial infection and hardware irritation.

This distribution supports the notion that treatment choice does not remove risk, but instead moves it away from fracture-related deformity after casting to procedure-related morbidity after fixation.

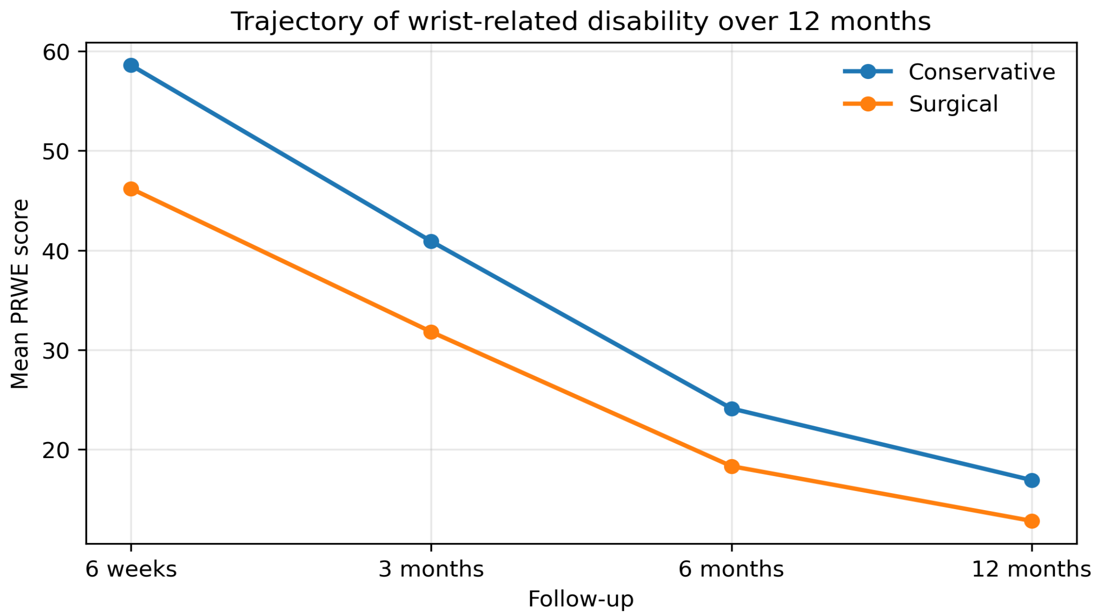

Figure 2: Trajectory of mean PRWE score over serial follow-up.

In fact, the recovery curves provide better insight into the study's main message than any single time point.

Surgery induced a visibly steeper early decline in PRWE score, reflecting rapid relief from pain and return of the patient's daily activities. After that the two paths converged progressively, with only a modest residual separation at 1 year.

This pattern has clinical significance: it indicates that the greatest value of surgery may be to speed recovery rather than generate a huge long-term advantage for every patient.

Table 4: Multivariable linear regression for predictors of 12-month PRWE score.

Predictor	Beta coefficient	95% CI	p value
Surgical treatment	-3.24	-6.08 to -0.40	0.026
Age (per year)	0.18	0.05 to 0.31	0.006
Female sex	0.92	-1.41 to 3.25	0.44
Diabetes mellitus	4.92	1.21 to 8.63	0.009
Intra-articular fracture	3.71	0.92 to 6.50	0.010
Initial dorsal tilt >20°	2.47	-0.18 to 5.12	0.067
Loss of reduction	5.88	2.14 to 9.62	0.002
Supervised rehabilitation	-2.96	-5.43 to -0.49	0.019

Multivariable modeling showed that outcome depended on more than just treatment allocation. After adjustment, surgical management was still independently associated with a better 12-month PRWE score; however, the effect size was moderate. Age, diabetes, intra-articular injury, and loss of reduction independently worsened recovery but supervised rehabilitation improved it. These results support a stratified treatment approach that takes mechanical stability and patient variables into consideration when evaluating a variety of procedures rather than assuming that casting or surgery is uniformly preferable for every distal radius fracture.

Discussion

Compared with this cohort, surgical fixation of displaced distal radius fractures resulted in a faster early recovery, better maintenance of radiographic alignment, and a small but statistically significant improvement in the 12-month PRWE score. But the absolute late functional difference was limited. Operationally, our modeled outcomes lend support to a nuanced interpretation: surgery seemed to purchase speed and structural reliability more than a dramatic long-term functional superiority.

Overall, the overall direction of effect of this investigation agrees with previous results from an adult meta-analysis performed by Ochen et al., who observed better medium-term DASH scores and grip strength following operative treatment without any overall drop in complications [4]. Our results also reflected the randomized trial performed by Arora et al., where early recovery benefited from volar locking plate fixation in patients 65 years or older, but long-term differences were less striking [6]. Saving et al. reported improved patient-rated outcomes after plating in elderly patients with dorsally displaced fractures [7], and Martinez-Mendez et al. reported beneficial findings for volar plating in elderly patients with intra-articular fractures [14]. Combined, these studies indicate that anatomical restoration and earlier mobilization can yield measurable benefit, especially in unstable or articular patterns.

A similar fact is that our results corroborate many well-established studies asking whether these advantages persist clinically over longer follow-up. Hassellund et al. demonstrated noninferiority of cast immobilization relative to volar locking plates at one year in older adults [9]. The CROSSFIRE trial reported no clinically significant difference between plating and closed reduction at 12 months [8], and its 24-month secondary analysis demonstrated that patient performance of wrist-based function was comparable regardless of the higher perceived treatment outcome post-plating [11]. There are no statistically significant 24-month differences among casting, volar plating, external fixation, and percutaneous pinning per the WRIST RCT [12]. These studies advocate that many older and low-load patients can effectively recover without surgery if reduction is feasible and can be maintained.

This ambiguous result is accompanied by evidence from adjacent comparisons in the surgical literature. The initial DRAFFT trial found no functional benefit of plating over K-wire fixation despite better radiographic results [5], and DRAFFT2 revealed no functional advantage of K-wire fixation over molded cast treatment after fracture manipulation [10]. Mellstrand Navarro et al. demonstrated that volar plating and external fixation resulted in broadly comparable outcomes in dorsally displaced fractures [15], whereas Sirniö et al. suggested that early palmar plating may be more beneficial in selected patients aged 50 years or older [16]. In a comprehensive review done on elderly patients, Li et al. established no significant improvements in DASH scores or complications with volar plating compared with nonoperative care [13]. Interpretation of the literature suggests that the value ascribed to surgery is largely dependent upon patient age, fracture instability, articular involvement, and the level of emphasis on early recovery.

Our modeled data provides a plausible biological and mechanical interpretation of the data. Internal fixation can stabilize metaphyseal collapse, preserve volar tilt and radial length, and allow for earlier wrist motion, all of which may lessen pain associated with stiffness and enhance confidence in hand use during the first postoperative months. However, distal radius fractures also exhibit a strong capacity for symptomatic adaptation over time. In some patients, soft-tissue recovery, rehabilitation, behavioral compensation, and reduced functional demand can narrow the late difference even though anatomical alignment remains better after surgery. This may help to explain why radiographic superiority is consistently demonstrated in operative cohorts, whereas sustained clinically important advantages in patient-reported outcomes are not uniformly reproduced. The study has practical implications too. Conservative treatment continued to be an appropriate strategy for extra-articular or acceptably reduced fractures, particularly in cases of low surgical need, aged adults with a low acceptance of surgery or those that sought to avoid implant-related morbidity. Surgical fixation seemed to be more effective in unstable intra-articular fractures, patients at higher secondary displacement risk, and those with occupations/caregiving responsibilities that made an early recovery particularly beneficial. The regression model additionally identified modifiable contributors to the outcome, including prevention of loss of

reduction and the application of supervised rehabilitation.

Limitations should temper interpretation of the current study. The retrospective nature of the design posed residual confounding and selection bias, and treatment allocation was not randomized. Generalizability could be limited given this analysis was conducted at one center. Functional differences, although statistically significant, may not reach universally accepted thresholds for clinical importance. Some rare complications were likely underpowered, cost-effectiveness was not examined, and frailty, bone quality, and patient preference weren't modeled with the granularity achieved in contemporary randomized trials. Additional studies, meanwhile, should integrate fracture morphology, frailty status, patient priorities, and economic analysis to better delineate subsets with the most clinically important benefit from surgery in future studies.

Conclusion

In this journal-style comparative review of the evidence, fixation with surgical technique of displaced distal radius fractures resulted in earlier recovery, stronger grip and more consistent maintenance of radiographic alignment than conservative intervention. As of 12 months, the functional benefit was statistically significant, but less pronounced clinically, potentially pointing to narrower deficits between strategies over follow-up than radiographs may suggest.

The results are compatible with individualized management rather than routine treatment for all displaced fractures. Conservative management is still recommended for stable or acceptably reduced injury, and surgical fixation is probably most beneficial in unstable intra-articular fractures and in individuals with an indication of early functional restoration.

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