Original Research

FUNCTIONAL OUTCOMES OF CONSERVATIVE VERSUS SURGICAL TREATMENT IN DISTAL RADIUS FRACTURES: A PROSPECTIVE INTERVENTIONAL STUDY

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ABSTRACT

Background: Distal radius fractures (DRFs) are among the most common orthopaedic injuries, with management strategies ranging from closed reduction and casting to open reduction and internal fixation (ORIF). Optimal management remains debated, particularly in mixed-age populations with varying fracture morphologies.

Aim: To compare functional outcomes of conservative and surgical interventions in the management of distal radius fractures.

Methods: This prospective interventional study was conducted in the Department of Orthopaedics, Rohilkhand Medical College & Hospital, Bareilly, over one year. Seventy-four patients aged ≥18 years with extra- or intra-articular distal radius fractures were allocated to two groups of 37 each. Group A received closed reduction and below-elbow plaster cast immobilization for six weeks, while Group B underwent ORIF with a volar locking plate or Joshi's External Stabilising System (JESS) fixator. Patients were followed at 2, 6, 8 and 24 weeks. Outcomes were assessed using the Visual Analogue Scale (VAS), Mayo Wrist Score, range of motion (ROM), grip strength, radiological union, complications, hospital stay and return to activity.

Results: The mean Mayo Wrist Score at 24 weeks was significantly higher in the surgical group (88.2 ± 8.1) than in the conservative group (78.4 ± 9.2) ($p < 0.001$). Excellent-to-good outcomes were achieved in 83.7% of surgical patients versus 54.0% of conservative patients. Surgical patients had lower VAS scores (1.1 ± 0.4 vs 1.8 ± 0.6), greater wrist flexion (74.1° vs 65.2°), better grip strength (88.3% vs 78.5% of normal side), faster radiological union (8.4 vs 9.8 weeks) and earlier return to activities (7.3 vs 10.4 weeks). Overall complication rate was lower in the surgical group (16.2% vs 27.0%), although the surgical group required longer hospitalisation (7.4 vs 2.8 days).

Conclusion: Surgical fixation provides superior functional and radiological outcomes compared with conservative management in distal radius fractures, with earlier pain relief, better wrist mechanics and lower mechanical complication rates. Conservative management remains appropriate for stable extra- articular fractures and elderly patients with low functional demands.

Keywords: Distal Radius Fracture,Volar Locking Plate, Jess Fixator, Conservative Management, Mayo Wrist Score, Functional Outcome.

INTRODUCTION

Distal radius fractures (DRFs) are among the most frequently encountered injuries in orthopaedic practice, accounting for approximately 17% of all fractures treated in emergency departments.[1,2] These fractures display a characteristic bimodal age distribution, occurring predominantly in young adults following high-energy trauma such as road traffic accidents, and in elderly individuals after low-energy falls on an outstretched hand.[3,4] The increasing global incidence, particularly among the

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ageing population with osteoporotic bone, has rendered DRFs a substantial public-health and economic burden.[5]

The optimal management of DRFs remains a matter of considerable debate. Treatment options range from closed reduction and cast immobilisation to a spectrum of operative techniques including percutaneous Kirschner-wire (K-wire) fixation, external fixation, and open reduction and internal fixation (ORIF) with volar locking plates.[6–8] The introduction of fixed-angle volar locking plates over the last two decades has revolutionised operative management by allowing stable fixation even in osteoporotic bone, facilitating early mobilisation and rehabilitation.[9,10]

Conservative management with closed reduction and below-elbow casting remains a viable, low-cost option for stable, extra-articular fractures, particularly in elderly patients with low functional demands or significant comorbidities.[11] However, this approach carries the risk of redisplacement, malunion, joint stiffness and complex regional pain syndrome (CRPS), particularly in unstable or intra-articular fractures.[12,13] Conversely, surgical fixation provides superior anatomical restoration but is associated with operative risks, hardware-related complications and increased healthcare cost.[14,15]

The AO/OTA classification, which categorises DRFs into Type A (extra-articular), Type B (partial articular) and Type C (complete articular) fractures, is the most widely used system to guide treatment decisions.[16] Restoration of radiographic parameters—radial height (11–14 mm), radial inclination (21°– 25°), volar tilt (~11°) and articular step-off less than 2 mm—is considered essential for optimal functional recovery.[17,18] Functional outcome is assessed using validated tools such as the Mayo Wrist Score, Disabilities of the Arm, Shoulder and Hand (DASH) score, and Patient-Rated Wrist Evaluation (PRWE).[19,20]

Although several randomised controlled trials and meta-analyses have compared conservative and surgical treatment for DRFs, results remain heterogeneous. Some studies report superior functional outcomes with surgery, particularly in the short term,[21–23] while others demonstrate equivalent long- term function between the two modalities, especially in elderly patients.[24,25] Furthermore, data from Indian tertiary centres comparing both approaches across mixed-age cohorts and varied fracture morphologies remain limited.[26]

The present study was undertaken to provide a comprehensive comparative analysis of functional outcomes between conservative and surgical management of DRFs in a North Indian tertiary care setting, using standardised clinical, radiological and functional assessment tools.

MATERIALS AND METHODS

Study design and setting

This prospective interventional study was conducted in the Department of Orthopaedics, Rohilkhand Medical College & Hospital, Bareilly, Uttar Pradesh, over a period of one year, after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment, in accordance with the Declaration of Helsinki.[27]

Participants

The sample size was calculated using the Power and Sample Size Program with $\alpha = 5\%$, power = 70%, P0 = 8% and P1 = 98%, yielding a target of 74 patients (37 per group). Inclusion criteria comprised patients aged 18 years and above presenting with extra-articular or intra-articular DRFs and no history of previous wrist injury.[28] Patients with multiple traumatic injuries, previous wrist injuries or pathological fractures were excluded. Allocation to conservative (Group A, n = 37) or surgical (Group B, n = 37) management was based on fracture morphology, displacement, AO type, patient age, comorbidities and informed patient preference.

Clinical and radiological assessment

All patients underwent detailed history-taking and clinical examination at admission. Socioeconomic status was recorded using the Modified Kuppuswamy Scale.[29] Standard antero-posterior and lateral wrist radiographs were obtained, and fractures were classified according to the AO/OTA system.[16] Pre- treatment pain was recorded on the Visual Analogue Scale (VAS, 0–10).

Conservative management (Group A)

Following local anaesthesia, closed reduction was performed under the supervision of an orthopaedic surgeon. The affected limb was immobilised in a below-elbow plaster slab, converted to a complete cast after 48 hours. A check radiograph was obtained immediately post-reduction and at 2 weeks. The cast was retained for 6 weeks. Supervised physiotherapy was initiated immediately after cast removal and continued throughout follow-up.

Surgical management (Group B)

Surgery was performed under regional anaesthesia. For ORIF with volar locking plate, a modified Henry approach was used.[30] A longitudinal incision was made along the flexor carpi radialis (FCR) tendon, followed by careful retraction of the radial artery and FCR. The pronator quadratus was incised in an L-shaped manner and reflected to expose the fracture. After reduction and provisional K-wire fixation, an appropriately sized volar locking compression plate was applied, and definitive fixation was achieved with cortical and locking screws. Reduction, screw length and plate position were verified under C-arm fluoroscopy, and the pronator quadratus was repaired over the plate where possible.

In selected cases of severe comminution or compromised soft tissue envelope, JESS external fixation was applied.[31] After closed reduction under

fluoroscopic guidance, two Schanz pins were inserted into the proximal and distal radial fragments, and two additional pins into the second metacarpal base and shaft. The pins were connected externally with rods and clamps to construct a stable distraction-based fixator.

Postoperative care and follow-up

Postoperative radiographs were obtained on days 2 and 4. Patients were typically discharged on postoperative day 5 if clinically stable. Suture removal was performed at day 14, and follow-up was scheduled at 6, 8 and 24 weeks. Supervised physiotherapy emphasising early range-of-motion and progressive strengthening exercises was instituted in both groups after the immobilisation period.

Outcome measures

The primary outcome was the Mayo Wrist Score at 24 weeks, categorised as Excellent (90–100), Good (80–89), Fair (65–79) or Poor (<65).[19] Secondary outcomes included VAS pain scores, wrist range of motion (flexion, extension, pronation, supination), grip strength as a percentage of the contralateral side measured using a Jamar dynamometer, radiological union time, hospital stay, return to normal daily activities and complications.

Statistical analysis

Data were entered into Microsoft Excel and analysed using SPSS version 23.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation and compared using the independent-samples Student t-test, while categorical variables were compared using the Chi-square test or Fisher's exact test as appropriate. A two-tailed p value < 0.05 was considered statistically significant.

RESULTS

Demographic and baseline characteristics

A total of 74 patients were enrolled, with 37 in each group. The mean age was 51.6 ± 18.2 years in the conservative group and 50.4 ± 19.7 years in the surgical group. Most patients (29.7%) were aged 31– 45 years, followed by 46–60 years (25.7%), 18–30 years (24.3%) and >60 years (20.3%). Males predominated (56.8%), and the right side was more frequently involved (54.1%). Road traffic accidents (51.3%) were the leading mechanism, followed by falls on outstretched hand (41.9%) and sports/occupational injuries (6.8%). Baseline demographic and fracture characteristics were comparable between the groups (Table 1).

Table 1. Demographic and baseline characteristics of the study population (n = 74)

Variable	Conservative (n=37)	Surgical (n=37)	Total (n=74)
Age 18–30 years	8 (21.6%)	10 (27.0%)	18 (24.3%)
Age 31–45 years	10 (27.0%)	12 (32.4%)	22 (29.7%)
Age 46–60 years	11 (29.7%)	8 (21.6%)	19 (25.7%)
Age >60 years	8 (21.6%)	7 (18.9%)	15 (20.3%)
Male	22 (59.5%)	20 (54.1%)	42 (56.8%)
Female	15 (40.5%)	17 (45.9%)	32 (43.2%)
Right side involvement	21 (56.8%)	19 (51.3%)	40 (54.1%)
Road traffic accident	18 (48.6%)	20 (54.1%)	38 (51.3%)
Fall on outstretched hand	16 (43.2%)	15 (40.5%)	31 (41.9%)
Sports / occupational	3 (8.2%)	2 (5.4%)	5 (6.8%)
AO Type A (extra-articular)	16 (43.2%)	10 (27.0%)	26 (35.1%)
AO Type B (partial articular)	11 (29.7%)	12 (32.4%)	23 (31.1%)
AO Type C (complete articular)	10 (27.0%)	15 (40.6%)	25 (33.8%)

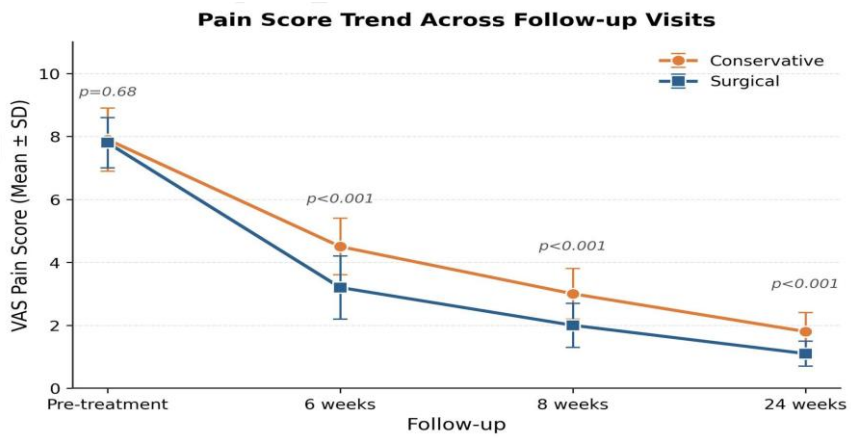

Figure 1. Trend of Visual Analogue Scale (VAS) pain scores across follow-up visits

AO Type C (complete articular) fractures were more common in the surgical group (40.6% vs 27.0%), reflecting the principle of reserving operative fixation for complex, intra-articular and unstable fracture patterns.

Pain and functional outcomes

Pre-treatment VAS scores were comparable between groups (7.9 ± 1.0 vs 7.8 ± 0.8; p = 0.68). Pain reduction was significantly faster in the surgical group at all subsequent follow-up points, with mean VAS scores at 24 weeks of 1.1 ± 0.4 in the surgical group versus 1.8 ± 0.6 in the conservative group (p < 0.001) (Figure 1, Table 2).

Table 2. Visual Analogue Scale (VAS) pain scores at follow-up

Follow-up	Conservative (Mean ± SD)	Surgical(Mean ± SD)	p-value
Pre-treatment	7.9 ± 1.0	7.8 ± 0.8	0.68
6 weeks	4.5 ± 0.9	3.2 ± 1.0	<0.001
8 weeks	3.0 ± 0.8	2.0 ± 0.7	<0.001
24 weeks	1.8 ± 0.6	1.1 ± 0.4	<0.001

At 24 weeks, the mean Mayo Wrist Score was significantly higher in the surgical group (88.2 ± 8.1) than the conservative group (78.4 ± 9.2; p < 0.001). Excellent outcomes were observed in 48.6% of surgical patients compared with 21.6% of conservative patients, while poor outcomes were found in only 2.8% of the surgical group versus 18.9% of the conservative group (Figure 2, Table 3). Cumulatively, 83.7% of surgical patients achieved excellent or good outcomes compared to 54.0% of conservative patients.

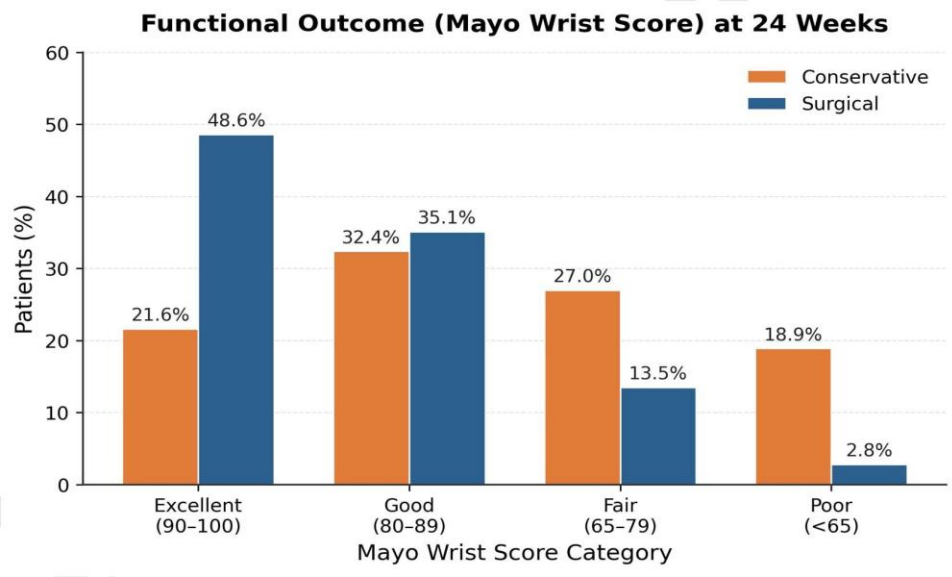

Figure 2. Distribution of Mayo Wrist Score categories at 24 weeks.

Table 3. Mayo Wrist Score categorical and mean outcomes at 24 weeks

Score Category	Conservative (n=37)	Surgical (n=37)
Excellent (90–100)	8 (21.6%)	18 (48.6%)
Good (80–89)	12 (32.4%)	13 (35.1%)
Fair (65–79)	10 (27.0%)	5 (13.5%)
Poor (<65)	7 (18.9%)	1 (2.8%)
Mean ± SD	78.4 ± 9.2	88.2 ± 8.1 (p<0.001)

Range of motion and grip strength

The surgical group demonstrated significantly greater range of motion across all directions at 24 weeks (Table 4, Figure 3). Mean wrist flexion was 74.1° versus 65.2° (p < 0.001), and extension 67.5° versus 58.4° (p < 0.001). Pronation and supination also favoured the surgical group. Grip strength, expressed as a percentage of the uninvolved side, was 88.3 ± 6.8% in the surgical group compared with 78.5 ± 7.2% in the conservative group (p < 0.001) (Figure 4).

Table 4. Range of motion (degrees) at 24 weeks

Movement	Conservative (Mean ± SD)	Surgical (Mean ± SD)	p-value
Flexion	65.2 ± 7.8	74.1 ± 6.9	<0.001
Extension	58.4 ± 8.1	67.5 ± 7.2	<0.001
Pronation	78.1 ± 6.3	82.3 ± 5.8	0.021
Supination	73.5 ± 6.0	80.2 ± 5.9	<0.001

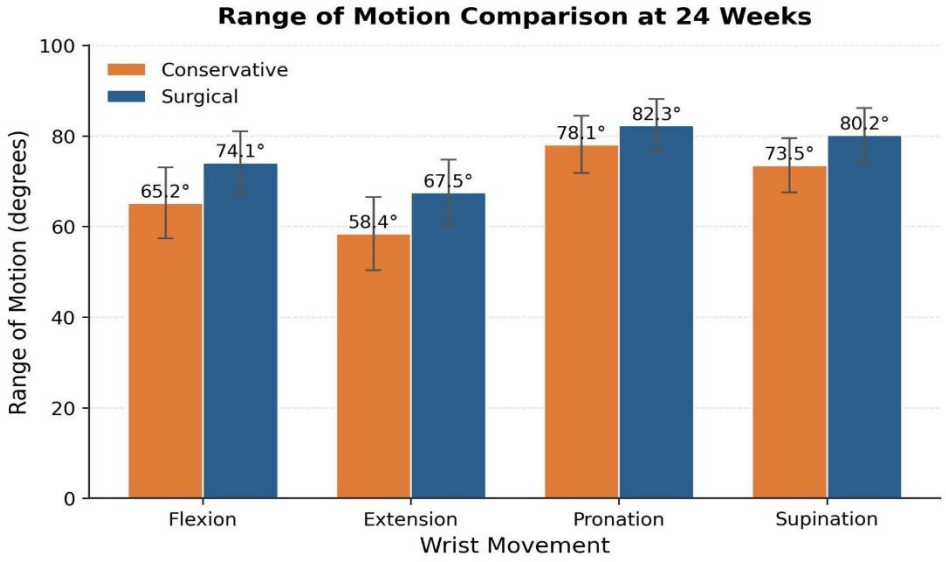

Figure 3. Range of motion comparison at 24 weeks

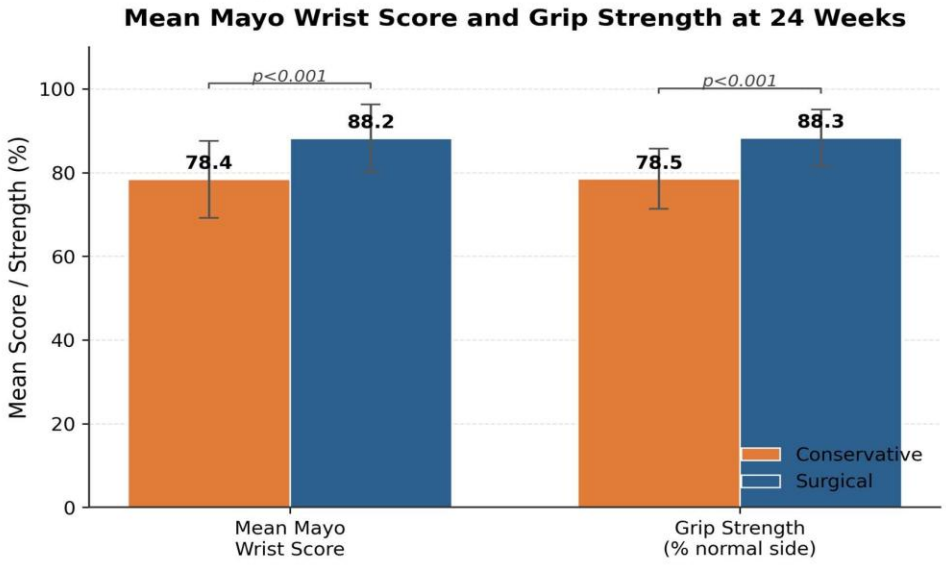

Figure 4. Mean Mayo Wrist Score and grip strength at 24 weeks

Radiological union, hospital stay and return to activity

Radiological union occurred earlier in the surgical group (8.4 ± 1.3 weeks) than the conservative group (9.8 ± 1.5 weeks; p = 0.002). Patients in the surgical group resumed normal daily activities significantly earlier (7.3 ± 1.8 vs 10.4 ± 1.9 weeks; p < 0.001), although hospital stay was longer in the surgical group (7.4 ± 1.8 vs 2.8 ± 0.9 days; p < 0.001) (Table 5).

Table 5. Hospital stay, radiological union and return to activity

Parameter	Conservative (Mean ± SD)	Surgical (Mean ± SD)	p-value
Hospital stay (days)	2.8 ± 0.9	7.4 ± 1.8	<0.001
Radiological union (weeks)	9.8 ± 1.5	8.4 ± 1.3	0.002
Return to activity (weeks)	10.4 ± 1.9	7.3 ± 1.8	<0.001

Complications

Overall, complications were observed in 27.0% of conservatively treated patients and 16.2% of surgical patients. The conservative group had higher rates of stiffness (13.5%) and malunion (10.8%), while the surgical group had a 5.4% incidence of superficial infection. CRPS was observed in one patient in the conservative group (Table 6, Figure 5).

Table 6. Complications in conservative versus surgical groups

Complication	Conservative (n=37)	Surgical (n=37)
Stiffness	5 (13.5%)	3 (8.1%)
Malunion	4 (10.8%)	1 (2.7%)
Superficial infection	0 (0.0%)	2 (5.4%)
Complex regional pain syndrome	1 (2.7%)	0 (0.0%)
Total	10 (27.0%)	6 (16.2%)

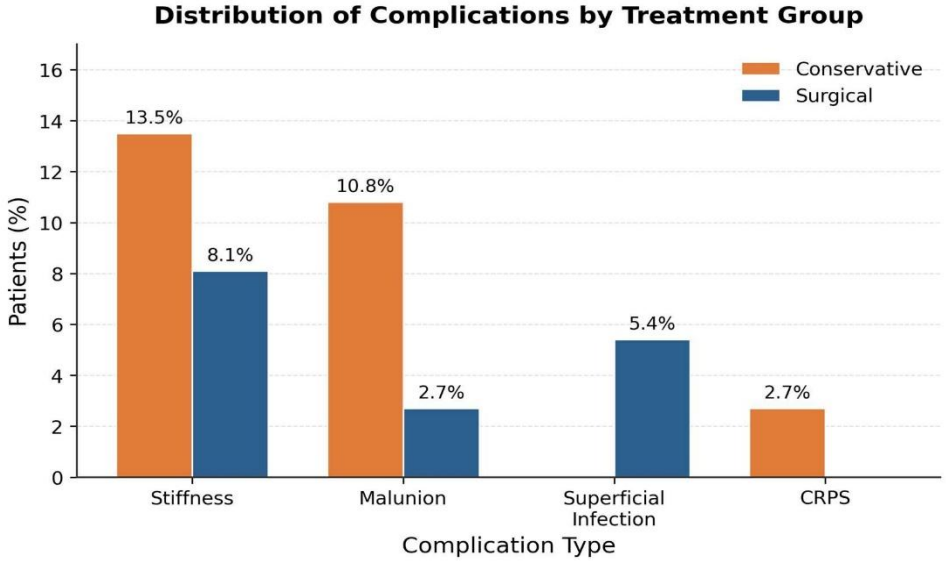

Figure 5. Distribution of complications by treatment group

DISCUSSION

This prospective interventional study comparing conservative and surgical management of distal radius fractures in a North Indian tertiary centre demonstrated that operative fixation was associated with significantly better functional and radiological outcomes at 24 weeks. The mean Mayo Wrist Score was 88.2 in the surgical group versus 78.4 in the conservative group ($p < 0.001$), and excellent-to-good outcomes were achieved in 83.7% of surgical patients compared with 54.0% in the conservative arm. These findings parallel those of Verma et al.[26], who reported excellent or good outcomes in 80% of surgically treated patients versus 33.3% of those treated conservatively, and Singh,[32] who similarly favoured surgical fixation for displaced intra-articular fractures.

Pain reduction was significantly faster in the surgical group at all post-treatment intervals, with VAS scores converging at 24 weeks. This trend has been consistently reported in the literature and is generally attributed to the mechanical stability afforded by internal fixation, more accurate articular reduction and the ability to commence early mobilisation.[33,34] Hammer et al.[35] similarly demonstrated that volar plating allowed earlier mobilisation than augmented external fixation, although long-term function was comparable. The faster anatomical restoration achieved with internal fixation likely contributes to reduced soft tissue irritation and improved patient comfort during recovery.

The improvement in range of motion seen in our surgical cohort—particularly flexion (74.1° vs 65.2°) and extension (67.5° vs 58.4°)—is consistent with several comparative studies. Arora et al.[9], in their landmark prospective randomised trial of 73 elderly patients, found that volar locking plates yielded better early grip strength and DASH scores than non-operative management, although the

differences narrowed over time. Our finding of grip strength averaging 88.3% of the uninvolved side in surgical patients versus 78.5% in conservative patients corroborates these observations and supports the biomechanical rationale that anatomical reduction translates into improved muscular leverage and joint kinematics.

In a comprehensive meta-analysis of over 3,000 patients, Ochen et al.[23] concluded that operative treatment, particularly with volar locking plates, modestly improved short-term function in adults with DRFs. However, the benefit attenuated over longer follow-up. Walenkamp et al.[36] similarly reported equivalence at one year, despite earlier recovery with surgery. The DRIFT trial by Hevonkorpi et al.[37], which specifically targeted patients aged ≥65 with malaligned fractures, demonstrated that surgical fixation produced better functional outcomes when conservative treatment failed to maintain reduction. Conversely, the recent DART trial by Ter Meulen et al.[38] found that casting did not achieve non- inferiority compared with surgery in elderly patients with displaced intra-articular fractures, yet many in the cast group achieved acceptable function. These observations highlight the importance of individualising treatment by considering not just radiographic appearance but also functional demand and physiological age.

Our overall complication rate was lower in the surgical group (16.2% vs 27.0%). The conservative group experienced more mechanical complications (stiffness 13.5%; malunion 10.8%), consistent with the well-recognised risk of redisplacement during cast immobilisation.[39] The surgical group, while spared most mechanical complications, had a 5.4% rate of superficial infection—a finding mirrored in published data showing infection to be the predominant operative complication.[40] Mishra et al.[41] reported similar long-term outcomes in elderly patients treated with K-wires and ORIF, suggesting that complication profiles vary primarily by procedure type rather than absolute superiority of one approach.

Faster radiological union (8.4 vs 9.8 weeks) and earlier return to daily activities (7.3 vs 10.4 weeks) in the surgical group reflect the mechanical advantage of stable internal fixation, which permits early callus formation and rehabilitation. Ermutlu et al.[42] reported similar acceleration of recovery with internal fixation, while Wretö et al.[43] demonstrated comparable long-term outcomes between volar locking plates and percutaneous K-wires, but with shorter rehabilitation following plating. The longer hospital stay observed in our surgical cohort (7.4 vs 2.8 days) represents an important practical consideration, particularly in resource-constrained settings, although Toon et al.[44] have argued that the productivity gains from earlier return to work in working-age adults can offset increased inpatient costs.

Several limitations should be acknowledged. First, the follow-up of 24 weeks may not capture late complications such as post-traumatic arthritis or implant-related issues. Second, the modest sample size limits subgroup analyses by AO type or age stratum. Third, blinding was not feasible given the nature of the interventions. Fourth, the surgical group included both volar plating and JESS fixation, which may differ in long-term outcome and are best evaluated separately in larger cohorts. Finally, while the Mayo Wrist Score is a robust and widely used tool,[19] supplementing it with patient-reported instruments such as PRWE or DASH would have strengthened outcome characterisation.[20]

Despite these limitations, the present study contributes meaningful prospective evidence from an Indian tertiary centre. The findings reinforce that, for displaced, unstable or intra-articular fractures—particularly in younger and active patients—surgical fixation provides a clinically meaningful functional advantage. Conservative management retains its role for stable extra-articular fractures and elderly patients with low functional demands, where the operative risk-benefit balance shifts. Future research should focus on long-term outcomes, head-to-head comparison of surgical techniques, and cost-effectiveness analyses tailored to low- and middle-income contexts.

CONCLUSION

Surgical management of distal radius fractures yields significantly superior functional and radiological outcomes compared with conservative treatment at 24 weeks of follow-up. Patients undergoing open reduction and internal fixation with volar locking plates or JESS fixation experienced earlier pain relief, greater wrist motion, stronger grip, faster radiological union, earlier return to daily activities and lower mechanical complication rates. Conservative management remains a valid option for stable extra- articular fractures and elderly patients with significant comorbidities or low functional demands. Treatment selection should therefore be individualised on the basis of fracture morphology, bone quality, patient age, lifestyle and functional expectations, while ensuring early supervised rehabilitation to optimise recovery in both modalities.

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