International Journal of Research in Orthopaedics
Yadav A et al. Int J Res Orthop. 2026 Jul;12(4):1033-1038
https://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20262035

Clinical and functional outcome of malunited distal radius fractures: a single-centre observational study from a tertiary care hospital in Northern India

Ashutosh Yadav*, Sachin Kumar Yadav, Ajay Kumar Yadav

Department of Orthopaedics, Balrampur Hospital, Lucknow, Uttar Pradesh, India

Received: 03 April 2026
Accepted: 16 May 2026

***Correspondence:**
Dr. Ashutosh Yadav,
E-mail: Ashutoshyadav1347@gmail.com

ABSTRACT

Background: Distal radius fractures are among the most common skeletal injuries encountered in orthopedic practice. Malunion is a recognized complication resulting in altered wrist biomechanics and functional impairment. Epidemiological and outcome data from tertiary care hospitals in North India remain limited.

Methods: This hospital-based, single-centre, observational descriptive study was conducted in the Department of Orthopaedic Surgery, Balrampur Hospital, Lucknow, over six months (February-July 2025). Fifty-eight adult patients with radiologically confirmed distal radius malunion were enrolled. Clinical assessment included pain evaluation on a Visual analogue scale (VAS), wrist range of motion measured with a goniometer, and grip strength measured using a hand dynamometer. Radiological parameters—dorsal/volar tilt, radial height, radial inclination, and ulnar variance—were measured on standard wrist radiographs. Functional outcomes were assessed using the Disabilities of the arm, Shoulder and hand (DASH) score, Patient-rated wrist evaluation (PRWE) score, Modified mayo wrist score (MMWS), and the Gartland–Werley demerit score. Pearson and Spearman correlation coefficients were used to assess associations between radiological and functional parameters; $p<0.05$ was considered statistically significant.

Results: The mean age of participants was 44.6±12.8 years, with a male predominance (62.1%). The most common injury mechanisms were fall on an outstretched hand (46.6%) and road traffic accident (41.4%). Mean dorsal tilt was 18.6±5.2°, radial shortening 6.4±1.9 mm, and positive ulnar variance +3.1±1.2 mm. Affected wrist grip strength was reduced by approximately 25% relative to the contralateral limb. Mean VAS pain score was 5.6±1.8. Mean DASH and PRWE scores were 42.3±11.7 and 48.9±13.4, respectively, indicating moderate-to-severe functional disability. Significant correlations were demonstrated between dorsal tilt, radial shortening, and ulnar variance with both DASH and PRWE scores ($r=0.42–0.51$; $p<0.01$).

Conclusions: Malunited distal radius fractures produce significant functional impairment that correlates meaningfully with radiographic deformity. Combined radiological and patient-reported outcome assessment is essential for informed management planning. Early recognition of unacceptable fracture alignment and timely intervention may prevent long-term disability.

Keywords: Distal radius fractures, Fracture malunion, Wrist injuries, Functional outcome, Radiographic deformity, Patient-reported outcome measures, DASH score, PRWE score

INTRODUCTION

Distal radius fractures are among the most prevalent skeletal injuries encountered in emergency and trauma settings, accounting for approximately one-sixth of all fractures presenting to orthopaedic departments.[1] They follow a bimodal epidemiological pattern: high-energy fractures in young adults and low-energy insufficiency fractures in elderly, osteoporotic individuals.[2] Despite advances in fracture fixation and rehabilitation, malunion

remains a well-recognised complication, resulting from failure to achieve or maintain anatomical alignment. Malunion of the distal radius is defined as fracture healing in a non-anatomical position and is characterised by dorsal angulation, radial shortening, reduced radial inclination, and positive ulnar variance.[3] These deformities collectively disrupt load transmission across the radiocarpal and distal radioulnar joints (DRUJ), alter carpal kinematics, and predispose patients to ulnocarpal impaction, DRUJ incongruity, and progressive degenerative arthritis.[4,5] The clinical sequelae include chronic pain, restricted wrist motion, diminished grip strength, cosmetic deformity, and significant limitations in activities of daily living consequences that are especially pronounced in manual labourers and younger, high-demand individuals.

Radiographic thresholds associated with inferior functional outcomes are well established in the literature: dorsal tilt exceeding 10-15°, radial shortening greater than 5 mm, radial inclination below 15°, and ulnar variance greater than 2 mm.[6] Beyond these thresholds, both biomechanical derangement and patient-reported disability increase substantially.

Functional outcome assessment in distal radius malunion has evolved from purely clinician-derived scores such as the Gartland–Werley demerit score and the Modified mayo wrist score toward patient-reported outcome measures (PROMs).[7] The DASH score and the PRWE score are now considered the standard instruments for evaluating wrist-specific disability and upper-limb function, owing to their established validity, reliability, and responsiveness.[8,9] While multiple international studies have characterised the radiological and functional burden of distal radius malunion, robust institution-specific data from tertiary care hospitals in North India remain limited. Uniform assessment protocols, consistent radiographic measurement practices and comparable rehabilitation environments within a single centre minimise heterogeneity and enhance interpretability of results.

The present study was therefore designed to systematically evaluate the clinical, radiological, and functional outcomes of malunited distal radius fractures at a tertiary care teaching hospital in Lucknow, Uttar Pradesh, using a standardised multimodal assessment framework. The specific objectives were to quantify radiographic deformity and its clinical correlates, to measure functional disability using validated PROMs, and to determine the strength of association between radiological parameters and functional outcome scores.

METHODS

Study design and setting

This was a hospital-based, single-centre, observational descriptive study conducted in the Department of Orthopaedic Surgery at Balrampur Hospital, a tertiary care teaching institution in Golaganj, Lucknow, Uttar Pradesh. The study was conducted over six months, from February 2025 to July 2025. Ethical approval was obtained from the Institutional Ethics Committee (IEC Ref. No. 18 18(-1) HB 2023), and the study was conducted in accordance with the ethical principles of the Declaration of Helsinki (revised 2013). Written informed consent was obtained from all participants prior to enrolment.

Participants

Patients presenting to the orthopaedics outpatient department or admitted during the study period with a diagnosis of malunited distal radius fracture were considered for inclusion. Inclusion criteria were: age ≥18 years; radiologically confirmed malunited distal radius fracture defined by at least one of the following dorsal tilt >10°, radial shortening>5 mm, radial inclination <15°, or positive ulnar variance; fracture union achieved at least three months prior to enrolment; and willingness to provide written informed consent.

Patients were excluded if they had acute or ununited distal radius fractures, pathological fractures, previous corrective surgery to the distal radius, associated ipsilateral upper-limb fractures affecting wrist or hand function, neurological disorders affecting upper-limb function, pre-existing inflammatory arthritis or pre-existing wrist deformity.

A total of 58 patients fulfilling the eligibility criteria were enrolled consecutively during the study period. No formal sample size calculation was performed; the cohort represents the complete eligible population presenting within the study window a strategy appropriate for this observational, single-centre design.

Clinical assessment

All evaluations were performed by the treating orthopaedic surgeon using standardised techniques. Pain was quantified on a 10-cm Visual analogue scale (VAS; 0 =no pain, 10=worst imaginable pain). Wrist range of motion was measured with a standard goniometer in six planes: palmar flexion, dorsiflexion, radial deviation, ulnar deviation, pronation and supination. Grip strength of the affected and contralateral wrists was measured using a calibrated hand dynamometer (three trials, mean recorded) and percentage deficit relative to the unaffected side was calculated. Visible deformity, localized tenderness and wrist instability were documented.

Radiological assessment

Standard posteroanterior and lateral radiographs of the affected wrist were obtained for all patients using uniform positioning and exposure protocols. Four radiographic parameters were measured by a single observer using established techniques: dorsal/volar tilt on the lateral view; radial height on the posteroanterior view; radial

inclination on the posteroanterior view; and ulnar variance. These measurements were used both to confirm malunion status and to quantify the degree of deformity for correlation analysis.

Functional outcome assessment

Functional outcomes were assessed using four validated instruments administered at the time of enrolment: the DASH score (0-100; higher scores indicate greater disability); the PRWE score (0-100; higher scores indicate worse outcomes); the Modified mayo wrist score (100=perfect; ≥90 excellent, 80-89 good, 65-79 fair, <65 poor); and the Gartland–Werley demerit score.[7-9]

Statistical analysis

Data were entered into Microsoft Excel 2019 and analysed using SPSS version 27.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean±standard deviation (SD). Categorical variables were expressed as frequencies and percentages. Normality of distribution was assessed using the Shapiro–Wilk test. Associations between radiological parameters and functional outcome scores were examined using Pearson's correlation coefficient for normally distributed variables and Spearman's rank-order correlation for non-normally distributed variables. A two-tailed p value <0.05 was considered statistically significant throughout.

RESULTS

A total of 58 patients with radiologically confirmed malunited distal radius fractures were evaluated during the study period. Their demographic and injury characteristics are summarised in Table 1. The majority of patients were middle-aged adults (mean age 44.6±12.8 years), with a male predominance (62.1%). Falls on an outstretched hand (46.6%) and road traffic accidents (41.4%) were the leading mechanisms of injury. Radiological assessment revealed significant deformity across all measured parameters, as presented in Table 2.

Mean dorsal tilt (18.6°) substantially exceeded the clinically accepted threshold of 10-15°. Radial height loss (6.4 mm) and positive ulnar variance (+3.1 mm) similarly exceeded accepted acceptable limits. Table 3 shows the distribution of patients according to individual deformity criteria. Positive ulnar variance was the most frequently observed deformity (75.9%), followed by dorsal tilt exceeding 15° (70.7%). The majority of patients demonstrated multiple coexisting deformity components.

Clinical outcome measures are presented in Table 4. Palmar flexion and dorsiflexion were reduced compared with published normative values. The affected wrist demonstrated a mean grip strength of 19.8±4.6 kg versus 26.4±5.1 kg on the contralateral side, representing an approximately 25% deficit. The mean VAS pain score of 5.6±1.8 indicated moderate pain.

Table 1: Demographic and injury characteristics of study participants (n=58).

Variables	Category	N	(%)
Age (years)	18-30	9	15.5
	31-40	14	24.1
	41-50	17	29.3
	51-60	11	19.0
	>60	7	12.1
Mean age±SD (years)	44.6±12.8		
Sex	Male	36	62.1
	Female	22	37.9
Side involved	Right	33	56.9
	Left	25	43.1
Mechanism of injury	Road traffic accident	24	41.4
	Fall on outstretched hand	27	46.6
	Fall from height	7	12.0

SD: Standard deviation.

Table 2: Radiological parameters of distal radius malunion (n=58).

Radiological parameters	Mean±SD
Dorsal tilt (°)	18.6±5.2
Radial height loss (mm)	6.4±1.9
Radial inclination (°)	13.2±3.1
Ulnar variance (mm)	+3.1±1.2

SD: Standard deviation.

Table 3: Distribution of patients by individual radiological deformity criteria (n=58).

Deformity criterions	N	(%)
Dorsal tilt >15°	41	70.7
Radial shortening >5 mm	38	65.5
Radial inclination <15°	35	60.3
Positive ulnar variance (>2 mm)	44	75.9

Values indicate number of patients satisfying each individual criterion; patients may fulfil multiple criteria simultaneously.

Functional outcome scores are shown in Table 5. Mean DASH (42.3±11.7) and PRWE (48.9±13.4) scores indicated moderate-to-severe functional disability. The mean Modified mayo wrist score of 63.8±12.1 placed the majority of patients in the 'fair' or 'poor' outcome category. Correlation analysis between radiological deformity parameters and functional outcome scores is presented in Table 6. Significant positive correlations were observed between dorsal tilt, radial shortening and ulnar variance with both DASH and PRWE scores, indicating that greater deformity was associated with worse functional outcomes. Radial inclination showed significant negative

correlations, confirming that lower inclination values corresponded to higher disability scores.

Table 4: Clinical outcome measures of the affected wrist (n=58).

Clinical parameters	Mean±SD
Palmar flexion (°)	46.8±10.4
Dorsiflexion (°)	42.5±9.6
Radial deviation (°)	13.6±4.1
Ulnar deviation (°)	21.9±6.2
Pronation (°)	63.7±9.8
Supination (°)	61.4±10.3
Grip strength- affected side (kg)	19.8±4.6
Grip strength-unaffected side (kg)	26.4±5.1
Grip strength deficit (%)	~25
VAS pain score (0-10)	5.6±1.8

SD: Standard deviation, VAS: Visual analogue scale.

Table 5: Functional outcome scores in patients with distal radius malunion (n=58).

Outcome measures	Mean±SD	Interpretation
DASH score (0-100)	42.3±11.7	Moderate-to-severe disability
PRWE score (0-100)	48.9±13.4	Moderate-to-severe impairment
Modified Mayo wrist score (0-100)	63.8±12.1	Fair outcome range
Gartland–Werley score	Refer text	Fair/poor majority

DASH: Disabilities of the arm, shoulder and hand; PRWE: Patient-rated wrist evaluation; SD: Standard deviation.

Table 6: Correlation between radiological parameters and functional disability scores.

Radiological parameters	DASH (r)	PRWE (r)	P value
Dorsal tilt	0.46	0.51	<0.001
Radial shortening	0.42	0.48	<0.01
Radial inclination	−0.39	−0.41	<0.01
Ulnar variance	0.44	0.49	<0.01

DASH: Disabilities of the arm, shoulder and hand; PRWE: Patient-rated wrist evaluation; r: Pearson/Spearman correlation coefficient. $p<0.05$ considered statistically significant.

DISCUSSION

The present single-center study systematically characterized the radiological, clinical and functional burden of malunited distal radius fractures in a North Indian tertiary care setting. Our findings confirm that distal radius malunion is associated with substantial radiographic deformity, measurable deficits in wrist motion and grip strength, moderate-to-severe patient-reported disability, and a significant though not exclusive relationship between deformity magnitude and functional outcome. These findings are broadly concordant with both Indian and international literature.

Radiological deformity and its clinical relevance

In the present cohort, the majority of patients demonstrated dorsal tilt exceeding 15°, radial shortening greater than 5 mm and positive ulnar variance all surpassing widely accepted thresholds for clinically relevant malunion.[6] Andreasson et al reported comparable radiographic profiles in patients presenting for corrective osteotomy and demonstrated that greater dorsal tilt and radial shortening correlated with worse pre-operative functional scores.[11] Similarly, Mulders et al, in a systematic review and meta-analysis, confirmed that unacceptable radiographic alignment following distal radius fractures was associated with inferior functional outcomes.[12] The high prevalence of positive ulnar variance (75.9%) in our series likely reflects the contribution of radial shortening to altered load distribution at the DRUJ and ulnocarpal articulation, a mechanism well described in biomechanical studies.[4,5]

Clinical outcomes: range of motion, grip strength and pain

Patients demonstrated reduced wrist range of motion across all planes and an approximately 25% reduction in grip strength relative to the contralateral side findings consistent with prior reports of altered load transmission and capsular contracture following malunion. Grewal and MacDermid documented analogous deficits in wrist motion and grip strength in patients with residual deformity after distal radius fractures, with impairments being more pronounced in younger, high-demand individuals.[13] Indian series echo these findings: Venkat et al reported substantial pre-operative reductions in wrist motion and grip strength in a single-centre cohort undergoing corrective osteotomy.[14] The mean VAS pain score of 5.6±1.8 observed in our cohort indicates moderate baseline pain, likely reflecting a combination of radiocarpal arthritis and DRUJ incongruity that commonly develops beyond accepted deformity thresholds.

Patient-reported functional disability

Mean DASH (42.3±11.7) and PRWE (48.9±13.4) scores in this study indicate moderate-to-severe functional disability. Belloti et al reported comparable pre-operative PRWE scores in patients undergoing corrective osteotomy, with significant improvement following surgery.[15] The Modified Mayo wrist score distribution predominantly in the 'fair' and 'poor' categories corroborates the substantial functional burden observed on PROMs. Dutta et al, in an Indian series, similarly reported poor-to-fair functional outcomes in patients with untreated distal radius malunion, with meaningful improvement only

after corrective osteotomy.[16] Collectively, these comparisons validate the severity of functional impairment documented in the present study and support the case for timely intervention in symptomatic patients with significant deformity.

Radiological–functional correlation

A central finding of this study is the moderate but statistically significant correlation between radiological deformity parameters and DASH and PRWE scores (r=0.39-0.51). This is consistent with the current understanding that radiographic deformity is an important but incomplete determinant of patient-reported disability. Mulders et al highlighted that the radiographic functional relationship is modulated by patient age, activity demands, and soft-tissue adaptation.[12] Schmidt et al, in a prospective cohort of 366 patients with one-year follow-up, demonstrated non-linear relationships between radiographic parameters and functional outcomes, reinforcing the necessity of integrating PROMs with objective imaging findings in clinical decision-making.[17] The moderate correlation coefficients observed in our cohort (r≈0.4-0.5) affirm this complexity: while deformity predicts disability, it does not fully explain it underscoring the value of multimodal outcome assessment.

Limitations

Several limitations of this study merit acknowledgement. First, the observational design without a control arm precludes causal inference. Second, the six-month recruitment window at a single centre may limit generalisability to broader populations. Third, intra- and inter-observer reliability of radiographic measurements was not formally assessed. Fourth, patient-level covariates such as occupational demand, hand dominance, and duration of malunion were not systematically analysed as independent predictors of functional outcome. Fifth, the Gartland–Werley score was administered without longitudinal follow-up, limiting assessment of outcome trajectory. Future prospective, multi-centre studies with longer follow-up including pre- and post-intervention comparative data would substantially strengthen the evidence base in this population.

CONCLUSION

Malunited distal radius fractures produce significant radiological deformity, measurable deficits in wrist motion and grip strength and moderate-to-severe functional disability as quantified by validated patient-reported outcome measures. In this cohort, deformity parameters particularly dorsal tilt, radial shortening, and positive ulnar variance correlated significantly with DASH and PRWE scores, confirming the functional relevance of radiographic malunion beyond its imaging characteristics. These findings are most pronounced in middle-aged, high-demand individuals and provide institution-specific evidence relevant to patient counselling, treatment prioritisation, and surgical planning at tertiary care centres in North India. Integrated assessment combining objective radiological measurements with patient-reported outcome instruments is essential for informed clinical decision-making. Early recognition of unacceptable fracture alignment and timely corrective intervention remain the most effective strategy for preventing long-term functional morbidity.

ACKNOWLEDGEMENTS

Support and guidance were gratefully acknowledged from the Department of Orthopaedics, including the academic supervision and departmental leadership that contributed to the successful completion of the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee (IEC Ref. No. 18 18(-1)HB 2023)

REFERENCES

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. Injury. 2006;37(8):691-7.
2. Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. Hand Clin. 2012;28(2):113-25.
3. Jupiter JB, Fernandez DL. Complications following distal radial fractures. J Bone Joint Surg Am. 2001;83(8):1244-65.
4. Palmer AK, Werner FW. Biomechanics of the distal radioulnar joint. Clin Orthop Relat Res. 1984;187:26-35.
5. Adams BD. Effects of radial deformity on distal radioulnar joint mechanics. J Hand Surg Am. 1993;18(3):492-8.
6. McQueen M, Caspers J. Colles fracture: does the anatomical result affect the final function?. J Bone Joint Surg Br. 1988;70(4):649-51.
7. Gartland JJ, Werley CW. Evaluation of healed Colles' fractures. J Bone Joint Surg Am. 1951;33(4):895-907.
8. MacDermid JC. Update: the patient-rated forearm evaluation questionnaire is now the patient-rated tennis elbow evaluation. J Hand Ther. 2005;18(4):407-10.
9. Hudak PL, Amadio PC, Bombardier C. Upper Extremity Collaborative Group. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). Am J Ind Med. 1996;29(6):602-8.
10. Fernandez DL. Correction of post-traumatic wrist deformity in adults by osteotomy, bone-grafting, and internal fixation. J Bone Joint Surg Am. 1982;64(8):1164-78.
11. Andreasson I, Kjellby-Wendt G, Fagevik-Olsén M, Aurell Y, Ullman M, Karlsson J. Long-term outcomes of corrective osteotomy for malunited

fractures of the distal radius. J Plast Surg Hand Surg. 2020;54(2):94-100.
12. Mulders MA, Detering R, Rikli DA, Rosenwasser MP, Goslings JC, Schep NW. Association between radiological and patient-reported outcome in adults with a displaced distal radius fracture: a systematic review and meta-analysis. J Hand Surg Am. 2018;43(8):710-9.
13. Grewal R, MacDermid JC. The risk of adverse outcomes in extra-articular distal radius fractures is increased with malalignment in patients of all ages but mitigated in older patients. J Hand Surg Am. 2007;32(7):962-70.
14. Venkat R, Ravishankar P, Sreenivasa RS, Krishna SE. Outcome of distal radius malunions managed by corrective osteotomy by volar approach: a clinical and radiological study. J Evid Based Med Healthc. 2017;4(95):6033-9.
15. Belloti JC, Alves BV, Faloppa F, Balbachevsky D, Netto NA, Tamaoki MJ. The malunion of distal radius fracture: corrective osteotomy through planning with prototyping in 3D printing. Injury. 2021;52(2):S44-8.
16. Dutta KK, Dutta A, Daolagupu AK, Mudgal A. A study on functional and radiological outcome after corrective osteotomy and volar locked plate fixation for extra-articular malunion of distal radius. Int J Orthop. 2017;3(2):519-25.
17. Schmidt V, Gordon M, Tägil M, Sayed-Noor A, Mukka S, Wadsten M. Association between radiographic and clinical outcomes following distal radial fractures: a prospective cohort study with 1-year follow-up in 366 patients. J Bone Joint Surg Am. 2023;105(15):1156-67.

Cite this article as: Yadav A, Yadav SK, Yadav AK. Clinical and functional outcome of malunited distal radius fractures: a single-centre observational study from a tertiary care hospital in Northern India. Int J Res Orthop 2026;12:1033-8.