Original article

Evaluating the surgical outcomes of distal radius fractures treated with locking plate fixation at Hue University of Medicine and Pharmacy Hospital

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Abstract

Background: Distal radius fractures are among the most common fractures, particularly in older adults following a fall onto an outstretched hand, and are associated with impaired wrist function and reduced quality of life. Open reduction and internal fixation using locking plates provides stable fixation, limits secondary displacement, and facilitates earlier functional recovery.

Objective: To evaluate the surgical outcomes of distal radius fractures treated with locking plate fixation at Hue University of Medicine and Pharmacy Hospital.

Materials and Methods: This prospective longitudinal study included 42 patients who underwent surgical fixation of distal radius fractures using locking plates at Hue University of Medicine and Pharmacy Hospital between March 2023 and June 2025.

Results: Most patients were older than 60 years, and females accounted for 71.4% of the cohort. The predominant injury mechanism was low-energy domestic falls, with AO/OTA fracture types B3 and C2 being the most common. Radiographic parameters assessed using the Scheck criteria showed significant postoperative improvement. At 6 months, functional outcomes assessed by the Green and O'Brien score were rated as good or excellent in 97.6% of patients. According to the QuickDASH score, the majority of patients had returned to normal function at 6 months (88.1%). No major postoperative complications were recorded. However, neither upper extremity functional recovery (QuickDASH or Green & O'Brien scores) nor postoperative anatomical restoration on radiographs differed significantly among fracture types classified according to the AO system.

Conclusion: Surgical treatment of distal radius fractures using locking plate fixation yields favorable functional outcomes with a low complication rate.

Keywords: *Distal radius fracture; locking plate fixation; surgical treatment.*

1. INTRODUCTION

Distal radius fractures are among the most common fractures encountered in adult orthopedic trauma practice [1]. The typical mechanism in older adults is a fall onto an outstretched hand, whereas in younger patients these injuries more often result from high-energy trauma. Such fractures can lead to impaired wrist function, reduced work capacity, and diminished quality of life [2]. They account for a substantial proportion of admissions to emergency and orthopedic trauma departments, thereby requiring considerable healthcare resources for treatment and rehabilitation [3].

Conservative management with closed reduction and cast immobilization remains a treatment option for many patients; however, the risks of secondary displacement, malunion, and joint stiffness are considerable, particularly in unstable fracture patterns [4,5]. Locking plate fixation offers distinct biomechanical advantages, including stable fracture fixation, resistance to articular surface collapse, prevention of secondary displacement, and facilitation of early mobilization [6].

In recent years, minimally invasive plate osteosynthesis (MIPO) techniques using volar locking plates under fluoroscopic (C-arm) guidance have gained increasing attention. These approaches involve one or two small incisions for submuscular plate insertion, followed by indirect fracture reduction and percutaneous screw fixation. Potential advantages include reduced soft tissue disruption, preservation of periosteal blood supply, and enhanced early postoperative recovery. However, these techniques require advanced surgical expertise and careful patient selection, and their clinical superiority over conventional open approaches remains under

ongoing investigation [3,7].

Numerous randomized controlled trials and meta-analyses have demonstrated that surgical treatment—especially open reduction and internal fixation with volar locking plates—results in better early functional outcomes (as measured by DASH/PRWE scores and grip strength) and improved radiographic parameters compared with conservative treatment during the initial months following injury [8]. Nevertheless, in older patients (≥60 years), these advantages tend to diminish over time; at mid-term and long-term follow-up, functional scores and quality of life are often not significantly different among treatment modalities, while complication rates are comparable [9,10]. This body of evidence underscores the importance of focusing on early follow-up intervals (1, 3, and 6 months) to accurately reflect the benefits of early functional recovery associated with locking plate fixation in distal radius fractures.

In Vietnam in general, and at Hue University of Medicine and Pharmacy Hospital in particular, studies evaluating the outcomes of surgical treatment of closed distal radius fractures using locking plates remain limited. Therefore, we conducted this study to supplement existing data and clinical experience, with the primary objective of evaluating the surgical outcomes of distal radius fractures treated with locking plate fixation.

2. MATERIALS AND METHODS

2.1. Study population

This study was conducted on 42 patients who were diagnosed with distal radius fractures and treated surgically with locking plate fixation at the Department of Trauma–Orthopedic and Thoracic Surgery, Hue University of Medicine and Pharmacy Hospital, from March 2023 to June 2025.

Inclusion criteria: Patients aged ≥18 years who were diagnosed with distal radius fractures according to the AO classification and had indications for surgical treatment. Eligible patients had complete medical records, including preoperative and postoperative radiographs, scheduled follow-up radiographs, and provided informed consent to participate in the study.

Exclusion criteria: Open fractures, severe polytrauma, patients with conditions affecting wrist function (such as rheumatoid arthritis or neurological injuries), and patients who were unable or unwilling to comply with follow-up assessments.

2.2. Study design and methods

Study design: A prospective, longitudinal, non-comparative study.

Sampling method: Convenience sampling was applied, enrolling patients with distal radius fractures who met the inclusion and exclusion criteria and were treated during the study period from March 2023 to June 2025.

2.3. Study variables and outcome measures

Baseline characteristics included age, sex, medical and surgical history, mechanism of injury, length of hospital stay, and fracture classification according to the AO/OTA 2018 system [11].

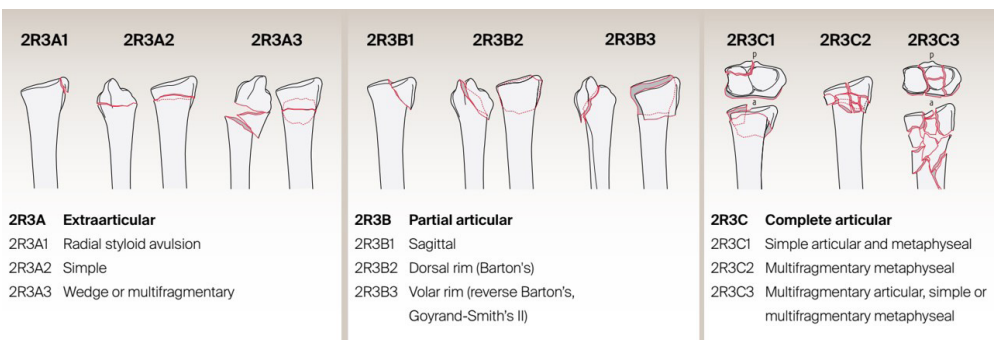

Figure 1. The 2018 AO/OTA classification system for distal radius fractures.

Treatment outcomes: Radiographic outcomes were evaluated using the Scheck scoring system at postoperative baseline and at 1, 3, and 6 months. The Scheck criteria are based on radial styloid length, radial inclination, and dorsal tilt, and outcomes were classified as excellent, good, or poor [12]. Wrist and hand function were assessed at 1, 3, and 6 months postoperatively using the Green and O'Brien scoring system [13], with total scores categorized as follows: excellent (90 - 100), good (80 - 89), fair (65 - 79), and poor (< 65).

Upper extremity function was further evaluated at 1, 3, and 6 months using the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) questionnaire [14].

2.4. Statistical analysis

Data analysis was performed using SPSS software version 26.0. Descriptive statistics were applied, with categorical variables presented as frequencies and percentages, and continuous variables expressed as means and standard deviations. A significance level of $\alpha = 0.05$ was used throughout the analyses.

2.5. Ethical considerations

The study protocol was reviewed and approved by the Institutional Review Board/Ethics Committee in Biomedical Research of Hue University of Medicine and Pharmacy, Hue University (approval code: H2025/595).

3. RESULTS

3.1. General Characteristics

Table 1. General characteristics of the study population (n = 42)

Characteristics	Categories	n (%)
Age group (years)	< 30	7 (16.7)
	30 - 40	5 (11.9)
	41 - 50	2 (4.8)
	51 - 60	14 (33.3)
	> 60	14 (33.3)
Gender	Male	12 (28.6)
	Female	30 (71.4)
Cause of injury	Traffic accident	12 (28.6)
	Occupational accident	4 (9.5)
	Domestic fall	26 (61.9)

Among the 42 patients, the age groups > 60 years and 51 - 60 years were the most prevalent (each accounting for 33.3%), followed by patients younger than 30 years (16.7%). Females predominated (71.4%), whereas males accounted for 28.6%. Regarding injury mechanisms, domestic falls were the most common cause (61.9%), followed by traffic accidents (28.6%) and occupational accidents (9.5%).

3.2. Clinical and preoperative radiographic characteristics

Table 2. Clinical features of distal radius ractures (n = 42)

Clinical Symptoms	n (%)
Pain	42 (100.0)
Swelling	29 (69.0)
Deformity	15 (35.7)
Limited wrist motion	37 (88.1)
Late ecchymosis	5 (11.9)
Associated distal ulna fracture	3 (7.1)
Total	**42 (100.0)**

Pain was present in all patients (100%), followed by limited wrist motion (88.1%) and swelling (69.0%). Deformity was observed in 35.7% of cases, late ecchymosis in 11.9%, and associated distal ulna fractures in 7.1%.

Table 3. AO/OTA classification of distal radius fractures (n = 42)

Fracture Type (AO/OTA classification)		n (%)	Group Total n (%)
A	A2	9 (21.4)	10 (23.8)
	A3	1 (2.4)	
B	B1	3 (7.1)	16 (38.1)
	B2	1 (2.4)	
	B3	12 (28.6)	
C	C1	4 (9.5)	16 (38.1)
	C2	11 (26.2)	
	C3	1 (2.4)	
Total		**42 (100.0)**	**42 (100.0)**

The most frequent fracture patterns were B3 (28.6%) and C2 (26.2%), followed by A2 (21.4%). Complex fractures (types B and C) were more common than extra-articular fractures (type A).

3.3. Postoperative outcomes

Table 4. Radiographic outcomes according to the Scheck criteria (n = 42)

Radiographic parameters (Scheck)	Preoperative (Mean ± SD)	Postoperative (Mean ± SD)	*p*
Radial styloid length (mm)	7.7 ± 3.8	9.5 ± 3.2	0.011
Radial inclination (°)	14.8 ± 6.3	18.3 ± 5.1	0.005
Dorsal tilt (°)	7.9 ± 13.4	7.5 ± 4.1	0.840
Ulnar variance (mm)	3.5 ± 4.1	−1.1 ± 2.4	<0.001

Postoperatively, most radiographic parameters showed significant improvement. Radial styloid length and radial inclination increased significantly ($p = 0.011$ and $p = 0.005$, respectively). Ulnar variance decreased markedly after surgery ($p < 0.001$). In contrast, dorsal tilt did not differ significantly between preoperative and postoperative measurements ($p = 0.840$).

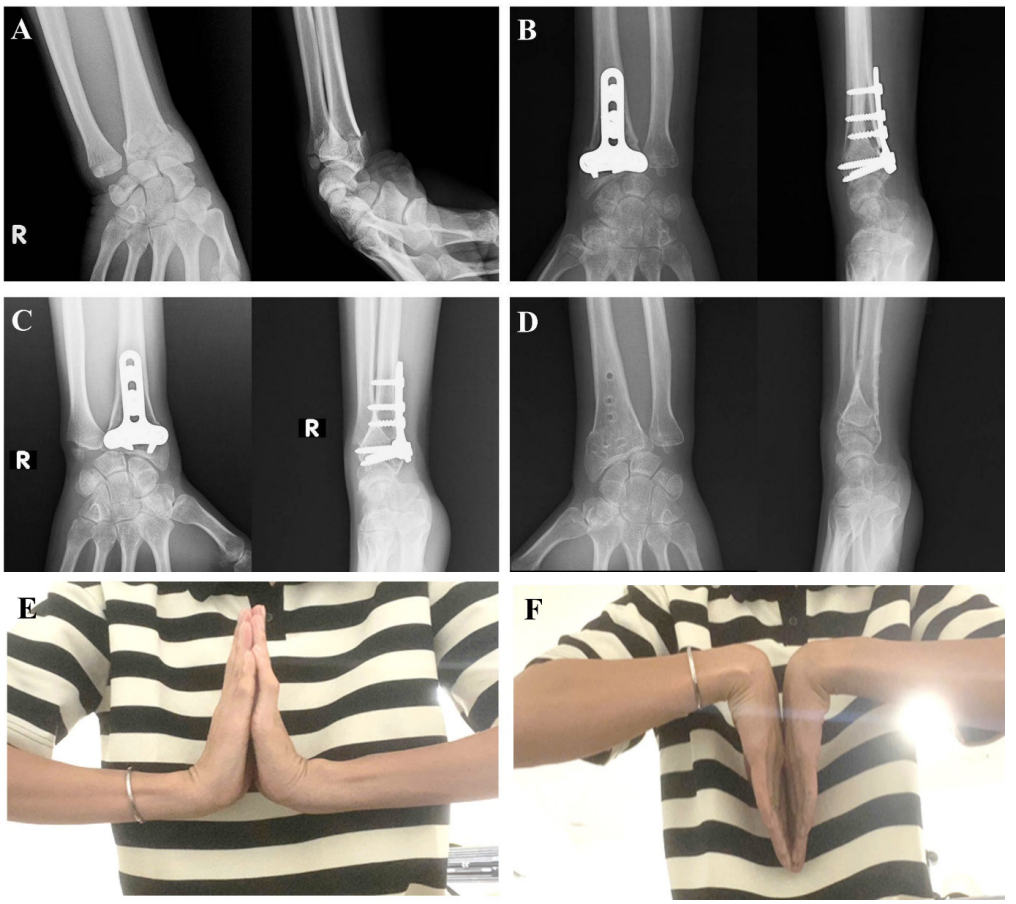

Figure 2. A 32-year-old male patient with an intra-articular distal radius fracture (2R3C1, AO/OTA 2018) treated with open reduction and internal fixation using a volar locking plate.

A. Preoperative anteroposterior and lateral radiographs.

B. Immediate postoperative radiographs.

C. Radiographs at 1-year follow-up.

D. Radiographs after hardware removal.

E, F. Clinical photographs at 1-year follow-up demonstrating restoration of normal wrist flexion and extension range of motion.

Table 5. Upper extremity function assessed by the QuickDASH score at follow-up (n = 42)

Disability Level	Number of patients n (%)		
	1 month	3 months	6 months
Normal (0 - 20)	5 (11.9%)	17 (40.4%)	37 (88.1%)
Mild (21 - 40)	21 (50.0%)	23 (54.7%)	4 (9.5%)
Moderate (41 - 60)	15 (35.7%)	2 (4.7%)	1 (2.3%)
Severe (61 - 80)	1 (2.3%)	0 (0)	0 (0)
Total	**42 (100.0)**	**42 (100.0)**	**42 (100.0)**

At 1 month postoperatively, the majority of patients exhibited mild (50.0%) or moderate disability (35.7%), with only 11.9% regaining normal function. By 3 months, functional recovery progressed substantially, as the proportion of patients with normal function increased to 40.4%, and no cases of severe disability were observed. At 6 months, most patients achieved near-complete functional recovery: 88.1% were classified as having normal function according to the QuickDASH, with a mean score of 11.0 ± 6.7, reflecting a marked reduction in moderate and severe disability.

Table 6. Functional outcomes according to the Green and O'Brien score at follow-up (n = 42)

Grading	Number of patients n (%)		
	1 month	3 months	6 months
Excellent	3 (7.1%)	6 (14.3%)	16 (38.1%)
Good	5 (11.9%)	27 (64.3%)	25 (59.5%)
Fair	25 (59.5%)	9 (21.4%)	1 (2.4%)
Poor	9 (21.4%)	0 (0)	0 (0)
Total	42 (100.0)	42 (100.0)	42 (100.0)

At 1 month, most patients achieved fair outcomes (59.5%), while good and excellent outcomes accounted for only 19.0%. By 3 months, 64.3% of patients achieved good results and 14.3% excellent results, with no poor outcomes. At 6 months, 97.6% of patients achieved good or excellent outcomes, demonstrating a clear improvement over time, with a mean Green & O'Brien score of 92.3 ± 7.3.

Table 7. Comparison of QuickDASH and Green & O'Brien scores at 6 months among AO fracture types

Scores / AO/OTA	A (n=10)	B (n = 16)	C (n=16)	*p*
Quick-DASH	13.5 (5–20)*	9.0 (2–24)	8.0 (2–28)	0.529
Green & O'Brien	95.0 (75–100)	90.0 (80–100)	92.5 (85–100)	0.778

**Values are presented as median (min–max).*

Kruskal–Wallis analysis demonstrated no statistically significant differences in QuickDASH or Green & O'Brien scores at 6 months among the three AO fracture types ($p > 0.05$), indicating comparable functional recovery across fracture patterns.

Table 8. Association between postoperative Scheck radiographic outcomes and AO fracture classification

Scores / AO/OTA	A (n = 10)	B (n = 16)	C (n = 16)	*p*
Poor	1 (2.4%)	2 (4.8%)	2 (4.8%)	
Good	4 (9.5%)	9 (21.4%)	9 (21.4%)	0.460
Excellent	5 (11.9%)	5 (11.9%)	5 (11.9%)	

Postoperative radiographic outcomes according to the Scheck criteria were similarly distributed across AO fracture groups, particularly between types B and C. Linear-by-linear association analysis revealed no significant relationship between AO classification and postoperative radiographic outcomes ($p = 0.460$).

4. DISCUSSION

4.1. Characteristics of the study population

Among the 42 patients with distal radius fractures treated with locking plate fixation, female patients predominated, accounting for 71.4% of the cohort. This finding contrasts with the study by Le Quang Tri and Phan Huu Hung conducted at Military Hospital 7A, where females represented only 29.27% and males accounted for 70.73% [15]. However, our results are consistent with a large epidemiological study from the United States conducted between 2017 and 2022, which reported a higher incidence of distal radius fractures in women, comprising approximately 70% of cases [16].

The age distribution in our study showed that patients aged 51–60 years and over 60 years each accounted for 33.3%, representing the two largest age groups. This pattern can be explained by age-related skeletal changes, particularly reduced bone mineral density and osteoporosis in older adults, which increase susceptibility to fractures even after low-energy trauma. Yusuf Mahmoud et al. similarly reported that patients aged 40–64 years were more likely to require surgical intervention than younger patients aged 18–39 years [16]. Variations in sex and age distribution among studies may reflect differences in population structure, demographic characteristics, and healthcare-seeking behavior across regions.

Regarding injury mechanisms, domestic falls were the most common cause, accounting for 26 of 42 cases, which is consistent with findings from Thai Nguyen Central Hospital [17]. This reflects the epidemiological characteristics of distal radius

fractures in the elderly, where low-energy trauma predominates. In contrast, traffic-related and occupational injuries were less frequent and were more commonly observed in younger patients, typically associated with high-energy trauma.

In our cohort, AO/OTA fracture types B3 and C2 were the most prevalent, accounting for 28.6% and 26.2%, respectively, followed by type A2 (21.4%). Overall, intra-articular fractures (types B and C) comprised 76.2%, markedly higher than extra-articular fractures (23.8%). This distribution may be related to injury mechanisms, osteoporosis in elderly patients, and surgical selection criteria, as unstable intra-articular fractures (types B and C) are more frequently indicated for operative treatment than extra-articular fractures. These findings are consistent with the study by Christian Fang et al. involving 259 patients [18].

4.2. Evaluation of treatment outcomes

Radiographic assessment using the Scheck scoring system in all 42 cases demonstrated significant improvement in most parameters immediately after surgery. This can be attributed to the biomechanical advantages of locking plate fixation, which provides rigid internal stabilization, maintains anatomical reduction, and minimizes secondary collapse. Owing to its high biomechanical stability, this technique effectively restores key radiographic parameters, including radial height, radial inclination, and ulnar variance, while also facilitating early mobilization and improved functional outcomes.

Although dorsal tilt did not show a statistically significant improvement, its clinical impact appears to be limited in this cohort, as functional outcomes at 6 months remained favorable. Previous studies have suggested that minor residual dorsal tilt may not significantly affect short- to mid-term wrist function when other radiographic parameters, such as radial height and radial inclination, are adequately restored [19]. In complex intra-articular fractures, achieving optimal correction of dorsal tilt remains technically challenging. Future research may focus on advanced techniques, including variable-angle locking plates, intraoperative three-dimensional imaging, or arthroscopy-assisted reduction, to improve the accuracy of volar tilt restoration.

Functional assessment using the QuickDASH score revealed that at 1 month postoperatively, most patients were classified as having mild (50.0%) or moderate (35.7%) disability, with only 11.9% achieving normal function. This reflects the early postoperative phase, during which pain, joint stiffness, and incomplete fracture healing limit wrist function. By 6 months, 88.1% of patients had regained near-normal upper limb function, with no cases of severe or very severe disability, indicating that functional recovery is time-dependent and reaches optimal levels in the later postoperative period. These results are comparable to those reported by Ingall et al. (2020), who observed functional recovery in approximately 82% of patients within 3–6 months after surgery [20]. Therefore, the QuickDASH score serves as a valuable clinical tool for prognostic counseling, enabling clinicians to reassure patients that substantial functional improvement typically occurs within 3–6 months postoperatively.

Assessment using the Green & O'Brien scoring system showed that at 1 month, most patients achieved only fair outcomes (59.5%), while good and excellent results remained limited (19.0%). Similar to QuickDASH findings, this can be attributed to early postoperative pain, stiffness, and ongoing bone healing. By 3 months, functional outcomes improved markedly, with 64.3% of patients achieving good results and 14.3% achieving excellent results, and no poor outcomes recorded. At 6 months, 97.6% of patients achieved good or excellent outcomes, with only 2.3% remaining in the fair category, demonstrating a clear and progressive improvement over time. These findings are consistent with the study by Vu Truong Thinh et al. involving 44 patients evaluated at 6 months [21]. The Green & O'Brien score thus represents a comprehensive, practical, and clinically meaningful instrument for monitoring recovery and predicting outcomes in distal radius fracture management.

When comparing AO/OTA fracture types A, B, and C, postoperative radiographic outcomes assessed by the Scheck score showed no statistically significant differences among fracture groups. This finding is consistent with the study by Tsang et al., which analyzed 177 patients [22]. Locking plate fixation allows accurate reduction and stable fixation even in complex intra-articular fractures, resulting in consistent radiographic outcomes regardless of fracture complexity.

Similarly, comparison of QuickDASH and Green & O'Brien scores among AO fracture types demonstrated a gradual decrease in disability scores over time in all groups, without statistically significant differences at 6 months. This observation aligns with a Korean study of 73 patients with a mean follow-up of 25.5 months [23]. Collectively, these findings suggest that fracture classification

according to AO/OTA does not substantially influence functional recovery or radiographic outcomes when appropriate surgical indications and techniques are applied. Even complex intra-articular fractures (type C) can achieve outcomes comparable to less complex fracture patterns when managed with timely and proper surgical intervention.

Finally, several limitations of this study should be acknowledged. First, the relatively small sample size may limit the statistical power to detect differences between fracture subgroups. Second, the follow-up duration was insufficient to fully assess late complications and long-term functional outcomes. Additionally, incomplete follow-up or follow-up at other institutions in some patients may have affected data completeness. Therefore, future studies with larger sample sizes and longer follow-up periods are warranted to further validate and strengthen these findings.

5. CONCLUSION

Open reduction and internal fixation with a locking plate for the treatment of closed distal radius fractures provides favorable anatomical restoration and functional recovery, particularly in elderly patients, female patients, and those with complex intra-articular fracture patterns. This technique offers stable fracture fixation, enables early mobilization, shortens the overall recovery period, and reduces complications associated with prolonged immobilization, such as muscle atrophy and joint stiffness. Therefore, locking plate fixation represents a safe and effective treatment option that can be widely applied in clinical practice to improve outcomes in patients with distal radius fractures. However, functional recovery assessed by the QuickDASH and Green & O'Brien scores, as well as postoperative radiographic restoration, did not differ significantly among fracture types classified according to the AO system.

Conflict of Interest Statement

The authors declare no conflicts of interest related to this study.

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