SCIE DOI: 10.14744/scie.2025.58826
South. Clin. Ist. Euras. 2025;36(4):389-396

Original Article

Fracture Type, Radiological Alignment, and Motion: Predictors of Functional Recovery After ORIF in Distal Radius Fractures

Gökhan Pehlivanoğlu,[1] Tolga Onay,[2] Engin Eceviz,[3] Hüseyin Günay,[4] Halil İbrahim Bekler[5]

[1]Department of Orthopaedics and Traumatology, University of Health Sciences Baltalimani Bone Diseases Training and Research Hospital, Istanbul, Türkiye
[2]Department of Orthopedics and Traumatology, Istanbul Medeniyet University, Istanbul, Türkiye
[3]Department of Orthopaedics and Traumatology, Kartal Dr. Lütfi Kirdar City Hospital, Istanbul, Türkiye
[4]Department of Orthopaedics and Traumatology, Corlu Vatan Private Hospital, Tekirdag, Türkiye
[5]Department of Orthopaedics and Traumatology, Avicenna International Hospital Ataşehir, Istanbul, Türkiye

Submitted: 22.08.2025
Revised: 23.09.2025
Accepted: 26.09.2025

Correspondence: Gökhan Pehlivanoğlu, Department of Orthopaedics and Traumatology, University of Health Sciences Baltalimani Bone Diseases Training and Research Hospital, Istanbul, Türkiye

E-mail: drgokhanpehlivanoglu@gmail.com

Keywords: Correlation analysis; distal radius fractures; factors affecting outcome; locking plate fixation; trauma.

ABSTRACT

Objective: Distal radius fractures are among the most common fractures in adults. Open reduction and internal fixation (ORIF) using locking plates represents the standard surgical approach. However, factors influencing functional outcomes after surgery remain controversial. This study assessed how patient characteristics, fracture type, and radiological factors influence functional recovery after distal radius fractures treated with locking plates.

Methods: Eighty-one patients (55 males, 26 females; mean age: 43.7 years) who underwent ORIF with locking plates between 2007 and 2013 were retrospectively analyzed. Functional outcomes were assessed using the QuickDASH, PRWE, and Modified Green and O'Brien scoring systems. Radiological evaluations included the Stewart and Knirk & Jupiter classifications. Spearman correlation and group comparison analyses were performed to identify factors associated with functional outcomes.

Results: Fracture classification significantly affected functional outcomes, with AO type B fractures demonstrating superior QuickDASH and Modified Green and O'Brien scores compared to type C fractures ($p<0.05$). Ulnar styloid nonunion did not affect functional outcomes but was associated with higher arthritis grades ($p=0.039$). PRWE scores were significantly correlated with arthritis severity, radiological reduction quality, patient age, and most wrist range of motion parameters (excluding pronation). Additionally, PRWE scores were negatively correlated with radial inclination and radial height, and positively correlated with ulnar variance.

Conclusion: Functional recovery following distal radius fracture surgery is influenced by fracture type, reduction quality, age, arthritis, and wrist mobility. Anatomical reduction and near-complete wrist mobility are key to optimal outcomes.

INTRODUCTION

Distal radius fractures are among the most common traumatic injuries, accounting for about 17.5% of all adult fractures presenting to emergency departments.[1] The primary objective of treatment is to restore joint anatomy, maintain alignment, and achieve optimal functional outcomes.

Open reduction and internal fixation (ORIF) with locking plates is widely utilized in managing distal radius fractures.[2] Locking plates provide biomechanical advantages by maintaining fracture reduction, preserving radial height, and resisting forces across the fracture site.[2,3] Identifying the factors that influence functional outcomes helps predict prognosis, guide treatment, and plan follow-up.

While many studies confirm the effectiveness of fixation using locking plates,[2,3] others have examined factors affecting recovery.[4] However, no clear consensus exists on which factors are most critical.[4,5]

This retrospective study analyzed patients treated with locking plates for distal radius fractures to identify factors linked to functional outcomes. We hypothesized that patient characteristics, fracture type, radiological parameters, and wrist range of motion (ROM) would influence recovery. The primary outcome measure was the Patient-Rated Wrist Evaluation (PRWE) score, a validated and reliable instrument for assessing wrist pain and function.[6]

MATERIALS AND METHODS

This retrospective study analyzed patients who underwent ORIF with locking plates for distal radius fractures at Kartal Dr. Lütfi Kirdar Training and Research Hospital between 2007 and 2013. All patients had at least 12 months of follow-up. The study was approved by the Ethics Committee of the Kartal Dr. Lütfi Kırdar Hospital (Date: 19/12/2013, No: 89513307/1009/231) and the study was conducted according to Helsinki Declaration.

Of 158 surgically treated patients, 23 were excluded due to treatment with closed reduction with percutaneous pinning or external fixation. Another 22 were excluded for having concomitant fractures in the ipsilateral upper extremity, contralateral wrist, or hand, 15 lacked adequate radiographs, and 17 were lost to follow-up. The final analysis included 81 patients.

At presentation, patient histories were obtained, and anteroposterior (AP), lateral, and true lateral radiographs were taken. Closed reduction and short-arm casting were performed without anesthesia. Computed tomography (CT) was performed in cases of suspected intra-articular fractures. Surgery was indicated for patients presenting with more than 5 mm of radial shortening, radial inclination less than 15 degrees (AP view), dorsal tilt greater than 15 degrees or volar tilt greater than 20 degrees (lateral view), more than 2 mm of articular step-off or gap, a change in ulnar variance greater than 2 mm, or dorsal comminution.[7]

Of the 81 patients, 60 underwent volar plating, 14 underwent dorsal plating, and seven received combined volar and dorsal plating through dual incisions.

Postoperative rehabilitation included early finger mobilization, splint removal at approximately one month, initiation of active wrist motion, and strengthening exercises after six weeks. Patients were permitted to return to work after radiographic union was confirmed.

Outcome Evaluations

All patients were evaluated based on radiological and clinical parameters. Radiographs were obtained at presentation, after reduction, postoperatively, and at approximately 45 days, 3 months, 6 months, and final follow-up, including the uninjured side.

At the final follow-up, patient records and clinical findings were reviewed to assess and document age, sex, operated side, hand dominance, surgical indication, injury mechanism, AO/OTA fracture type, grip strength, complications, and the presence of ulnar styloid nonunion. Open fractures and associated neurovascular injuries were evaluated according to the Gustilo-Anderson classification.

Volar tilt, radial inclination, radial height, and ulnar variance were measured and compared with the uninjured side. Radiological outcomes were graded using Stewart's system,[8]

Table 1. Patient characteristics

Variable	Min–Max	Mean±SD
Age (years)	17-73	43.73±12.12
Follow-up period (months)	12-63	29.35±13.96
	n	%
Sex		
Male	55	67.9
Female	26	32.1
Affected side		
Dominant	31	38.3
Non-dominant	50	61.7
Surgical approach		
Volar plating	60	74.1
Dorsal plating	14	17.3
Double plating	7	8.6
Trauma mechanism		
Low-energy	42	51.9
High-energy	39	48.1
Grip strength		
Operated side (kg)	6-61	28.88±11.12
Healthy side (kg)	14-63	38.79±11.86
Grip strength (%)	26-100	72.07±19.26
Ulnar Styloid Nonunion		
Absent	50	61.7
Present	31	38.3
Fracture classification (AO/OTA)		
A2	1	1.2
A3	12	14.8
B1	2	2.5
B2	3	3.7
B3	9	11.1
C1	24	29.6
C2	5	6.2
C3	25	30.9

Table 2. Range of motion values of both sides

Movement (°)	Operated Side Mean±SD (Min–Max)	Healthy Side Mean±SD (Min–Max)	Loss* Mean±SD (Min–Max)	Recovery % * Mean±SD (Min–Max)
Palmar Flexion	51.5±13.9 (15-80)	70.7±5.7 (60-80)	19.1±14.1 (0-50)	73.1±19.3 (23-100)
Dorsiflexion (Extension)	55.6±14.5 (10-80)	70.1±6.0 (60-80)	14.9±13.3 (0-60)	78.8±18.5 (14-100)
Supination	75.8±9.4 (30-90)	83.4±4.0 (75-90)	7.7±9.3 (0-50)	90.8±11.0 (38-100)
Pronation	74.1±12.0 (20-90)	84.1±5.4 (65-90)	9.9±11.8 (0-65)	88.3±14.0 (23-100)
Radial Deviation	8.5±5.2 (0-20)	17.3±3.7 (10-30)	9.0±5.2 (0-20)	50.6±29.2 (0-100)
Ulnar Deviation	18.4±10.1 (0-35)	32.9±4.6 (25-45)	14.6±9.8 (0-40)	55.7±29.3 (0-100)

* 'Loss' indicates the difference in degrees compared with the contralateral (healthy) wrist. 'Recovery %' represents the percentage of motion regained relative to the healthy side.

Table 3. Distribution of radiological measurements

Measurement	Preoperative (Before Reduction) Mean±SD (Min–Max)	Preoperative (After Reduction) Mean±SD (Min–Max)	Postoperative (Early Phase) Mean±SD (Min–Max)	Postoperative (Final Follow-up) Mean±SD (Min–Max)	Healthy Side Mean±SD (Min–Max)
Volar Tilt (°) *	-11.29±23.64 (-60.0-45.0)	3.12±11.23 (-25.7-45.0)	5.86±5.98 (-10.0-16.0)	4.30±6.37 (-11.2-20.0)	9.06±3.55 (0.0-20.0)
Radial Inclination (°)	11.80±10.06 (-5.0-50.1)	19.39±6.86 (5.0-41.8)	20.89±4.67 (7.0-30.4)	19.39±4.95 (5.0-28.9)	23.22±2.35 (18.0-28.9)
Radial Height (mm)	3.34±6.24 (-15.0-16.9)	8.75±3.88 (-2.0-18.4)	10.09±2.92 (2.0-17.1)	9.00±3.37 (0.0-17.0)	12.07±1.97 (7.0-16.8)
Ulnar Variance (mm)	2.33±2.67 (-3.3-12.0)	0.29±1.97 (-3.0-8.4)	-0.64±1.44 (-3.1-5.0)	0.08±1.80 (-4.3-5.8)	-1.16±0.67 (-2.6-1.9)

*Negative volar tilt values indicate dorsal tilt.

scoring dorsal tilt, radial inclination loss, and radial height loss. According to this scoring system, a score of 0 is considered an excellent result, 1–3 a good result, 4–6 a fair result, and 7–12 a poor result.

Post-traumatic arthritis (PTA) was graded using the Knirk and Jupiter classification,[9] based on joint space narrowing and structural changes, from stage 0 (normal) to stage 3 (severe arthritis).

Grip strength was measured using a Jamar dynamometer (Asimow Engineering, Co., Los Angeles, CA, USA). Patients were seated with the shoulder relaxed, the elbow flexed at 90 degrees, and the forearm in a neutral position with slight wrist extension. Each side was tested three times, and the mean was recorded.

Table 4. Distribution of functional scores

	Min–Max	Mean±SD
QuickDASH	0-47.70	17.33±15.17
PRWE	0-52.50	17.55±15.07
Modified Green and O'Brien	50-100	79.01±13.95
	n	%
Modified Green and O'Brien *		
Excellent	28	34.6
Good	17	21.0
Fair	26	32.1
Poor	10	12.3

* Modified Green & O'Brien categories were defined as follows — Excellent: 90–100, Good: 80–89, Fair: 65–79, Poor: <65.

Table 5. Radiological outcomes and arthritis scores

Final Follow-up	Min–Max	Mean±SD
Stewart	0-6	1.46±1.59
	n	%
Stewart		
Excellent	33	40.7
Good	39	48.1
Fair	9	11.1
Knirk & Jupiter		
0	37	45.7
1	27	33.3
2	14	17.3
3	3	3.7

Range of motion for both wrists was measured in three planes (flexion-extension, radioulnar deviation, and pronation-supination) using a standard goniometer positioned at the joint's center of rotation.

Functional outcomes were assessed using the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH)[10] and PRWE[11] scores, both validated patient-reported measures. In addition, the Modified Green and O'Brien clinical scoring system[12] was used to evaluate pain, functional status, ROM, and grip strength.

Statistical Analysis

Statistical analyses were performed using NCSS 2007 and PASS (Power Analysis and Sample Size) 2008 software (NCSS, LLC, Kaysville, UT, USA). Descriptive statistics (mean, SD, frequency, ratio, min, max) were reported. For non-normally distributed quantitative variables, the Mann-Whitney U test was used for two-group comparisons, and the Kruskal-Wallis test for three or more groups. The Mann-Whitney U test identified the group responsible for the difference. Within-group comparisons of non-normally distributed parameters were performed using the Wilcoxon signed-rank test. Categorical variables were compared using the Fisher-Freeman-Halton exact test. Spearman correlation analysis assessed relationships between parameters. Statistical significance was considered at $p<0.01$ and $p<0.05$ levels. Correlation coefficients were classified as low (Rs=0.10–0.29), moderate (Rs=0.30–0.49), or high (Rs=0.50–1.00).[13]

RESULTS

Eighty-one patients (55 males and 26 females; age range: 17 to 73 years, mean age: 43.7 years) were included in this study. Patient characteristics are presented in Table 1.

According to the Gustilo-Anderson classification, seven fractures were classified as Type I and three as Type II open fractures. Of the open fractures, nine resulted from high-energy trauma, and one from low-energy trauma. The low-energy trauma fracture was classified as Type I.

Complications occurred in 12 patients (eight treated with volar plates, four with dorsal plates). Among those treated with dorsal plates, one patient developed an extensor tendon rupture one year postoperatively, requiring implant removal and tendon reconstruction. One patient experienced ulnar nerve paresthesia, which was managed conservatively; another had intra-articular screw penetration, treated with implant removal at eight months; and a third patient with screw penetration and collapse declined further surgery. In the volar plate cases, four patients developed carpal tunnel syndrome (three treated surgically, one conservatively), two experienced flexor pollicis longus tendon ruptures (requiring implant removal and tendon repair), and two had intra-articular screw-related complications (with or without lunate collapse) managed by implant removal.

An ulnar styloid fracture was detected in 40 patients. Of these, nine achieved union, while 31 resulted in nonunion.

At the final follow-up, palmar flexion, dorsiflexion, supination, pronation, radial and ulnar deviation of both wrists were recorded, along with ROM loss and recovery percentages, as shown in Table 2.

Preoperative (before and after reduction), early postoperative, final postoperative, and healthy-side measurements of volar tilt, radial inclination, radial height, and ulnar variance are presented in Table 3.

Functional evaluations using the QuickDASH, PRWE, and Modified Green and O'Brien scores are presented in Table 4, with radiological and arthritis assessment results based on the Stewart and Knirk & Jupiter scores in Table 5.

Differences in QuickDASH ($p=0.047$) and Modified Green and O'Brien scores ($p=0.036$) according to fracture classification were statistically significant, favoring type B fractures. Although PRWE scores showed a trend toward better outcomes in type B fractures, the difference was not statistically significant. Patients with type B fractures had significantly better QuickDASH and PRWE scores compared to those with type C fractures ($p<0.05$), whereas no significant differences were observed between type A and type C fractures. No significant differences in functional outcomes were found based on trauma mechanism (low- vs. high-energy) or the presence of ulnar styloid nonunion ($p>0.05$). However, ulnar styloid nonunion was associated with a significantly higher Knirk & Jupiter arthritis grade ($p=0.039$). Detailed results are presented in Table 6.

Spearman correlation analysis demonstrated significant associations between PRWE scores and arthritis severity (Knirk & Jupiter scores), radiological reduction quality (Stewart scores), patient age, and most ROM parameters, except pronation ($p>0.05$). Additionally, PRWE scores showed significant correlations with radiological parameters: They were negatively correlated with radial inclination and radial height, positively correlated with ulnar variance, and not significantly correlated with volar tilt. The detailed correlation coefficients are presented in Table 7.

Table 6. Relationship between surgical indication, trauma type, ulnar styloid nonunion, fracture classification, and patient outcomes

	n	%	QuickDASH (Mean±SD)	PRWE (Mean±SD)	Modified Green and O'Brien (Mean±SD)	Knirk & Jupiter
Trauma Type						
Low-energy	42	51.9	19.22±15.17	19.26±15.06	79.17±14.5	
High-energy	39	48.1	15.30±15.1	15.71±15.0	78.85±13.4	
p			0.200	0.212	0.966	
Ulnar Styloid Nonunion						
Absent	50	61.7	16.13±15.79	16.50±15.27	81.20±14.31	Grade 0: 26 Grade 1: 18 Grade 2: 6 Grade 3: 0
Present	31	38.3	19.27±14.17	19.24±14.82	75.48±12.80	Grade 0: 11 Grade 1: 9 Grade 2: 8 Grade 3: 3
p			0.306	0.293	0.068	**0.039**
Fracture Classification						
A[1]	13	16.0	19.21±15.66	19.23±15.19	82.69±12.52	Grade 0: 10 Grade 1: 2 Grade 2: 1
B[2]	14	17.3	8.88±11.85	9.71±10.87	86.07±10.77	Grade 0: 7 Grade 1: 4 Grade 2: 3
C[3]	54	66.7	19.07±15.33	19.18±15.55	76.30±14.55	Grade 0: 20 Grade 1: 21 Grade 2: 10 Grade 3: 3
p			**0.047**	0.092	**0.036**	0.318
Post-hoc			*2<1,3*	*2<3*	*2>3*	

Significant p values are written in bold.

Table 7. Correlation between Stewart score, Knirk& Jupiter score, age, ROM, radiological measurements, and PRWE scores

	PRWE	
	r	p
Stewart score	0.447	0.001†
Knirk & Jupiter score	0.441	0.001†
Age	0.243	0.030*
Flexion	0.406	0.001†
Extension	0.443	0.001†
Supination	0.328	0.003†
Pronation	0.188	0.093
Radial deviation	0.581	0.001†
Ulnar deviation	0.822	0.001†
Volar tilt	0.014	0.900
Radial inclination	-0.461	0.001†
Radial height	-0.504	0.001†
Ulnar variance	0.441	0.001†

r: Spearman's rank correlation coefficient. *p<0.05, †p<0.01. Significant p values are written in bold.

DISCUSSION

This study examined several factors influencing the functional outcomes of distal radius fractures treated with locking plates. The key finding was that recovery was most strongly determined by wrist range of motion, particularly ulnar and radial deviation, which showed the highest correlation with PRWE scores. In addition, significant correlations were observed between functional outcomes and radiological reduction quality, severity of posttraumatic arthritis, and patient age. Although AO type B fractures showed better short-term results than types A and C, preserving wrist motion and accurate reduction emerged as the most critical determinants of functional recovery.

AO type B fractures demonstrated better functional outcomes compared to type A and C fractures, as reflected by significantly lower QuickDASH (p=0.047) and higher Modified Green and O'Brien scores (p=0.036). Although PRWE scores also favored type B fractures, the difference was not significant (p=0.092). These results align partially with the findings of Souer et al.,[14] who reported no sig-

nificant functional differences between type B and type C fractures at 24 months postoperatively, although type C fractures were associated with more early pain. In another study, Souer et al.[15] observed no significant differences in wrist function between intra-articular and extra-articular fractures treated with volar plating but noted a higher incidence of osteoarthritis in intra-articular fractures, consistent with our higher arthritis rate in type C fractures. Bolmers et al.[16] also found comparable long-term outcomes between partial (type B) and complete (type C) articular fractures. The inclusion of patients treated with volar, dorsal, and combined plating in our study may explain discrepancies with prior research that focused solely on volar plating. Additionally, the relatively small sample size within each fracture type group may have limited the detection of certain differences. Overall, while type B fractures tend to show early functional advantages, different fracture types may converge toward similar outcomes over time.

We found no significant difference in functional scores between high- and low-energy trauma groups ($p>0.05$), consistent with Lee et al.,[5] who reported no impact of injury mechanism at 12 months. Roh et al.[17] noted lower scores after high-energy trauma in the early months, but no difference at one year. Overall, these results suggest that while trauma mechanisms may affect early recovery, it has a limited influence on long-term functional outcomes.

Ulnar styloid fractures frequently accompany distal radius fractures.[18] In our study, ulnar styloid fractures occurred in 40 patients, none of whom underwent fixation. At follow-up, union was achieved in nine cases, whereas 31 cases (38.3%) resulted in nonunion. Previous studies have demonstrated that the presence of an ulnar styloid fracture or subsequent nonunion does not significantly affect functional outcomes.[4,19-21] Consistent with these findings, we found no statistically significant difference in functional outcomes between patients with and without ulnar styloid nonunion ($p>0.05$). However, patients with nonunion had a higher incidence of PTA, according to the Knirk & Jupiter classification ($p<0.05$). Moreover, correlation analysis revealed a significant association between arthritis severity and PRWE scores ($r=0.441$, $p<0.01$). Although its impact on function seems limited, ulnar styloid nonunion may contribute to PTA and warrants long-term study.

In our study, a weak but statistically significant positive correlation was found between age and PRWE scores ($r=0.243$, $p=0.03$), suggesting that functional outcomes decline with age. Similarly, Chung et al.[4] reported a 0.29-point decrease in Michigan Hand Questionnaire (MHQ) scores per year of age, Aggarwal et al.[22] found better outcomes in patients younger than 60 years, and Amorosa et al.[23] observed a significant negative correlation between age and QuickDASH scores ($r=0.27$, $p<0.05$). These findings consistently highlight age as a predictor of poorer recovery after distal radius fractures.

Aggarwal et al.[22] reported that loss of radial height and radioulnar inclination worsened functional outcomes, while changes in volar tilt and ulnar variance had no significant effect. Our findings for radial height, radioulnar inclination, and volar tilt were consistent, but unlike Aggarwal et al.,[22] we observed a strong correlation between ulnar variance and PRWE scores. Similar to our results, other studies have also highlighted the impact of ulnar variance on functional outcomes.[5,13] This discrepancy may be due to differences in patient populations or variations in assessment methods. We also found a significant and moderate correlation between the Stewart score, reflecting radiological reduction quality, and PRWE scores ($r=0.447$, $p=0.001$), emphasizing the importance of good reduction for optimal functional recovery.

Many studies in the literature suggest that PTA has a limited impact on functional outcomes and is not directly associated with patient-reported outcomes (PROs).[16,24] In a systematic review, Lameijer et al.[25] found that while PTA affects clinician-reported outcomes, there is insufficient evidence regarding its relationship with PROs. However, Lameijer et al.[26] later reported that patients with PTA had significantly lower total MHQ and SF-36 physical function scores. In our study, a significant correlation was observed between the Knirk & Jupiter arthritis classification and PRWE scores ($r=0.441$, $p=0.001$), suggesting that PTA may indeed be associated with PROs. Nevertheless, the relationship between radiographic evidence of PTA and clinical outcomes remains inconclusive. These findings highlight the need for future research involving larger patient cohorts and longer follow-up periods to better understand the long-term functional impact of PTA.

Maintaining wrist ROM is essential for sustaining daily functional activities. However, studies examining the relationship between wrist movements and functional outcomes following distal radius fractures remain limited. Yang et al.[27] found that wrist flexion/extension, supination, ulnar deviation, thumb opposition, and grip strength significantly affected QuickDASH scores, whereas radial deviation and forearm pronation did not. In our study, losses in wrist flexion, extension, radioulnar deviation, and supination were significantly associated with poorer PRWE scores, while pronation did not have a notable impact. Correlation analysis revealed that PRWE scores had the strongest association with ulnar deviation, followed by radial deviation. While Yang et al.[27] identified wrist extension as the most influential movement, we found a moderate but significant correlation between wrist extension and PRWE scores. These differences may reflect population and treatment variations, as our cohort was surgically treated (81 patients), while Yang et al.[27] analyzed 138 conservatively treated patients using QuickDASH. Thus, further studies are necessary to clarify these discrepancies and better understand the relationship between wrist motion and functional recovery.

Our study is one of the few investigations to comprehensively evaluate multiple factors influencing functional outcomes after distal radius fractures, incorporating detailed correlation analyses. However, several limitations

should be acknowledged. First, the retrospective design introduces inherent biases. Second, variability in follow-up durations among patients limited standardization and may have reduced the homogeneity of outcomes. Additionally, the heterogeneity of surgical techniques employed represents a potential source of bias when interpreting treatment outcomes. Although we found significant associations between ROM and functional outcomes, we did not evaluate postoperative rehabilitation protocols, potentially overlooking an important confounding variable. Finally, the sample size was relatively small compared to some reports in the literature. Future studies with larger cohorts and standardized follow-up protocols are required to provide more generalizable conclusions.

Conclusion

In conclusion, our study demonstrated that factors such as fracture type, ulnar styloid nonunion, patient age, radiological scores and parameters, arthritis grading, and wrist ROM significantly influence functional outcomes following the surgical treatment of distal radius fractures with locking plates. Achieving good functional results requires not only an adequate reduction but also the restoration of near-complete wrist ROM.

Ethics Committee Approval

The study was approved by the Kartal Dr. Lütfi Kırdar Training and Research Hospital Ethics Committee (Date: 19.12.2013, Decision No: 89513307/1009/231).

Informed Consent

Informed consent was obtained from all patients.

Peer-review

Externally peer-reviewed.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest

The authors declare no conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data availability

The data used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Authorship Contributions

Concept: G.P., T.O., E.E.; Design: G.P., T.O., E.E., H.I.B.; Supervision: G.P., T.O., E.E., H.I.B.; Materials: G.P., H.G.; Data collection &/or processing: G.P., T.O., E.E., H.G.; Analysis and/or interpretation: G.P., E.E., H.G., H.I.B.; Literature search: G.P., T.O., H.G., E.E.; Writing: G.P., T.O., H.I.B.; Critical review: G.P., T.O., E.E., H.I.B.

REFERENCES

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury 2006;37:691–7. [CrossRef]
2. Jupiter JB, Marent-Huber M. Operative management of distal radial fractures with 2.4-millimeter locking plates: A multicenter prospective case series. Surgical technique. J Bone Joint Surg Am 2010;92:96–106. [CrossRef]
3. Sobky K, Baldini T, Thomas K, Bach J, Williams A, Wolf JM. Biomechanical comparison of different volar fracture fixation plates for distal radius fractures. Hand 2008;3:96–101. [CrossRef]
4. Chung KC, Kotsis SV, Kim HM. Predictors of functional outcomes after surgical treatment of distal radius fractures. J Hand Surg Am 2007;32:76–83. [CrossRef]
5. Lee SJ, Park JW, Kang BJ, Lee JI. Clinical and radiologic factors affecting functional outcomes after volar locking plate fixation of dorsal angulated distal radius fractures. J Orthop Sci 2016;21:619–24. [CrossRef]
6. Fang C, Fang E, Yee DK, Kwan K, Leung G, Leung F. A comparison of six outcome measures across the recovery period after distal radius fixation-Which to use and when? J Orthop Surg 2021;29:2309499020971866. [CrossRef]
7. Nana AD, Joshi A, Lichtman DM. Plating of the distal radius. J Am Acad Orthop Surg 2005;13:159–71. [CrossRef]
8. Stewart HD, Innes AR, Burke FD. Functional cast-bracing for Colles' fractures. A comparison between cast-bracing and conventional plaster casts. J Bone Joint Surg Br 1984;66(5):749–53. [CrossRef]
9. Knirk JL, Jupiter JB. Intra-articular fractures of the distal end of the radius in young adults. J Bone Joint Surg Am 1986;68:647–59. [CrossRef]
10. Beaton DE, Wright JG, Katz JN. Development of the QuickDASH: Comparison of three item-reduction approaches. J Bone Joint Surg Am 2005;87:1038–46. [CrossRef]
11. MacDermid JC, Turgeon T, Richards RS, Beadle M, Roth JH. Patient rating of wrist pain and disability: A reliable and valid measurement tool. J Orthop Trauma 1998;12:577–86. [CrossRef]
12. Cooney WP, Bussey R, Dobyns JH, Linscheid RL. Difficult wrist fractures. Perilunate fracture-dislocations of the wrist. Clin Orthop Relat Res 1987:136–47. [CrossRef]
13. Hosokawa T, Tajika T, Suto M, Chikuda H. Factors affecting functional recovery after volar locking plate fixation for distal radius fractures. Hand 2022;17:111s–7s. [CrossRef]
14. Souer JS, Ring D, Jupiter JB, Matschke S, Audige L, Marent-Huber M. Comparison of AO Type-B and Type-C volar shearing fractures of the distal part of the radius. J Bone Joint Surg Am 2009;91:2605–11. [CrossRef]
15. Souer JS, Ring D, Jupiter J, Matschke S, Audigé L, Marent-Huber M. Comparison of intra-articular simple compression and extra-articular distal radial fractures. J Bone Joint Surg Am 2011;93(22):2093–9. [CrossRef]
16. Bolmers A, Luiten WE, Doornberg JN, Brouwer KM, Goslings JC, Ring D, et al. A comparison of the long-term outcome of partial articular (AO Type B) and complete articular (AO Type C) distal radius fractures. J Hand Surg Am 2013;38:753–9. [CrossRef]
17. Roh YH, Lee BK, Noh JH, Oh JH, Gong HS, Baek GH. Factors delaying recovery after volar plate fixation of distal radius fractures. J Hand Surg Am 2014;39:1465–70. [CrossRef]
18. Meyer MA, Leversedge FJ. Management of ulnar styloid nonunions. Hand Clin 2024;40:97–103. [CrossRef]
19. Daneshvar P, Chan R, MacDermid J, Grewal R. The effects of ulnar styloid fractures on patients sustaining distal radius fractures. J Hand Surg Am 2014;39:1915–20.
20. Kim JK, Yun YH, Kim DJ, Yun GU. Comparison of united and nonunited fractures of the ulnar styloid following volar-plate fixation of distal radius fractures. Injury 2011;42:371–5. [CrossRef]
21. Wijffels MM, Keizer J, Buijze GA, Zenke Y, Krijnen P, Schep NW,

et al. Ulnar styloid process nonunion and outcome in patients with a distal radius fracture: A meta-analysis of comparative clinical trials. Injury 2014;45:1889–95. [CrossRef]

22. Aggarwal N, Sinha S, Kumar A, Kumar S, Qureshi OA, Jameel J. Predictors of functional outcomes of nonoperatively treated extra-articular distal end radius fractures in older individuals: A prospective clinical study. Hand 2024;0:15589447241305421. [CrossRef]
23. Amorosa LF, Vitale MA, Brown S, Kaufmann RA. A functional outcomes survey of elderly patients who sustained distal radius fractures. Hand 2011;6:260–7. [CrossRef]
24. Lutz M, Arora R, Krappinger D, Wambacher M, Rieger M, Pechlaner S. Arthritis predicting factors in distal intraarticular radius fractures. Arch Orthop Trauma Surg 2011;131:1121–6. [CrossRef]
25. Lameijer CM, Ten Duis HJ, Dusseldorp IV, Dijkstra PU, van der Sluis CK. Prevalence of posttraumatic arthritis and the association with outcome measures following distal radius fractures in non-osteoporotic patients: A systematic review. Arch Orthop Trauma Surg 2017;137:1499–513. [CrossRef]
26. Lameijer CM, Ten Duis HJ, Vroling D, Hartlief MT, El Moumni M, van der Sluis CK. Prevalence of posttraumatic arthritis following distal radius fractures in non-osteoporotic patients and the association with radiological measurements, clinician and patient-reported outcomes. Arch Orthop Trauma Surg 2018;138:1699–712. [CrossRef]
27. Yang Z, Lim PPH, Teo SH, Chen H, Qiu H, Pua YH. Association of wrist and forearm range of motion measures with self-reported functional scores amongst patients with distal radius fractures: A longitudinal study. BMC Musculoskelet Disord 2018;19:142. [CrossRef]

Kırık Tipi, Radyolojik Dizilim ve Hareket Açıklığı: Distal Radius Kırıklarında ARİF Sonrası Fonksiyonel İyileşmenin Belirleyicileri

Amaç: Distal radius kırıkları, erişkinlerde en sık görülen kırıklar arasındadır. Kilitli plaklarla yapılan açık redüksiyon ve internal fiksasyon (ARİF), standart cerrahi yaklaşımı temsil etmektedir. Ancak cerrahi sonrası fonksiyonel sonuçları etkileyen faktörler hâlâ tartışmalıdır. Bu çalışmada, kilitli plaklarla tedavi edilen distal radius kırıklarında hasta özellikleri, kırık tipi ve radyolojik faktörlerin fonksiyonel iyileşme üzerine etkisi araştırıldı.

Gereç ve Yöntem: 2007-2013 yılları arasında kilitli plaklarla ARİF uygulanan 81 hasta (55 erkek, 26 kadın; ortalama yaş: 43.7 yıl) retrospektif olarak incelendi. Fonksiyonel sonuçlar QuickDASH, PRWE ve Modifiye Green & O'Brien skorları ile değerlendirildi. Radyolojik değerlendirmelerde Stewart ve Knirk & Jupiter sınıflamaları kullanıldı. Fonksiyonel sonuçlarla ilişkili faktörleri belirlemek için Spearman korelasyon ve grup karşılaştırma analizleri yapıldı.

Bulgular: Kırık sınıflaması fonksiyonel sonuçları anlamlı şekilde etkiledi. AO tip B kırıkları, tip C kırıklarına kıyasla daha iyi QuickDASH ve Modifiye Green & O'Brien skorları gösterdi ($p<0.05$). Ulnar stiloid kaynamaması fonksiyonel sonuçları etkilemedi, ancak daha yüksek artrit dereceleri ile ilişkili bulundu ($p=0.039$). PRWE skorları; artrit şiddeti, radyolojik redüksiyon kalitesi, hasta yaşı ve pronasyon hariç çoğu el bileği eklem hareket açıklığı parametresi ile anlamlı korelasyon gösterdi. Ayrıca PRWE skorları, radial inklinasyon ve radial yükseklik ile negatif ulnar varyans ile pozitif korelasyon gösterdi.

Sonuç: Distal radius kırığı cerrahisi sonrası fonksiyonel iyileşme; kırık tipi, redüksiyon kalitesi, hasta yaşı, artrit varlığı ve el bileği hareketliliğinden etkilenmektedir. Anatomik redüksiyon ve el bileğinin neredeyse tam hareket açıklığının sağlanması, optimal sonuçlar için kritik öneme sahiptir.

Anahtar Sözcükler: Distal radius kırıkları; kilitli plak fiksasyonu; korelasyon analizi; sonuçları etkileyen faktörler; travma.