

# Does Re-Reduction Improve Outcomes in Fifth Metacarpal Neck Fracture? A Matched Cohort Study

✉ Bekir Karagöz<sup>1</sup>, ✉ Hünkar Çağdaş Bayrak<sup>2</sup>

<sup>1</sup>Clinic of Orthopedics and Traumatology, University of Health Sciences Türkiye, Eskişehir City Hospital, Eskişehir, Türkiye

<sup>2</sup>Clinic of Orthopedics and Traumatology, Çekirge State Hospital, Bursa, Türkiye

## Abstract

**BACKGROUND/AIMS:** To evaluate the radiological and functional effectiveness of repeated closed reduction in patients who developed early loss of reduction at the 48-hour follow-up after an initially successful closed reduction for fifth metacarpal neck fractures, and to examine its association with surgical treatment decisions.

**MATERIALS AND METHODS:** This retrospective matched cohort study included 200 adult patients with isolated, closed fifth metacarpal neck fractures who underwent closed reduction at a tertiary orthopedic center between January 2023 and December 2024. Patients were divided into two equal groups: the (single reduction group, n=100) and the [re-reduction group (RRG), n=100], based on whether they underwent a second closed reduction due to early loss of initially acceptable radiographic alignment detected at the 48-hour follow-up. Matching was performed 1:1 on the basis of age and sex. Radiological parameters-including dorsal angulation and metacarpal shortening-were measured at six time points during follow-up. Functional outcomes were assessed using Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) scores, grip strength, and joint range of motion. Surgical conversion rates were analyzed, and multivariate logistic regression was used to identify independent predictors of surgical intervention.

**RESULTS:** Initial angulation and shortening were comparable between the groups. However, the RRG exhibited significantly greater deformity at the 4<sup>th</sup> and 6<sup>th</sup> weeks, with higher angulation ( $p=0.007$  and  $p<0.001$ , respectively) and more pronounced shortening ( $p=0.001$  and  $p=0.009$ , respectively). At 6 weeks, QuickDASH scores were significantly worse in the RRG ( $p=0.002$ ), though this difference was no longer statistically significant by 6 months. Flexion and extension angles were consistently more restricted in the RRG. Importantly, multivariable firth-penalized logistic regression identified initial shortening as the only independent predictor of surgical intervention, while angulation parameters did not retain statistical significance after adjustment.

**CONCLUSION:** Repeated closed reductions for early loss of alignment do not consistently improve outcomes and may be associated with delayed union. Longitudinal evaluation of angulation and shortening provides better clinical guidance than single-time-point assessments; however, among these parameters, initial shortening appears to be the most reliable independent predictor of eventual surgical intervention.

**Keywords:** Metacarpal neck fracture, closed reduction, re-reduction, treatment strategy, angulation, shortening

**To cite this article:** Karagöz B, Bayrak HÇ. Does re-reduction improve outcomes in fifth metacarpal neck fracture? A matched cohort study. Cyprus J Med Sci. 2026;11(3):188-196

**ORCID IDs of the authors:** B.K. 0000-0002-7447-452X; H.Ç.B. 0009-0003-4963-9980.



**Corresponding author:** Bekir Karagöz  
**E-mail:** drbkr71@gmail.com  
**ORCID ID:** orcid.org/0000-0002-7447-452X

**Received:** 21.11.2025  
**Accepted:** 23.04.2026  
**Publication Date:** 25.06.2026



Copyright© 2026 The Author(s). Published by Galenos Publishing House on behalf of Cyprus Turkish Medical Association.  
This is an open access article under the Creative Commons AttributionNonCommercial 4.0 International (CC BY-NC 4.0) License.

## INTRODUCTION

Fractures of the fifth metacarpal neck account for a substantial portion of hand injuries and represent the most common type of metacarpal fracture, particularly among young and active individuals.<sup>1,2</sup> These injuries usually result from direct trauma and most frequently affect the non-dominant hand.<sup>3</sup> Although they often present with mild angulation and shortening, they may, in some cases, lead to significant deformity, functional limitations, and cosmetic concerns.<sup>2,4</sup> Therefore, treatment decisions should be based not only on radiographic findings but also on patient-specific factors such as age, occupation, and functional demands.

Closed reduction followed by immobilization is often the first-line treatment option.<sup>4,6</sup> However, maintaining the alignment achieved after reduction can be challenging. Loss of reduction, which refers to the gradual displacement of the fracture during follow-up, has been reported in 20% to 30% of cases in the literature.<sup>2</sup> Studies have shown that increased angulation or shortening after reduction can negatively affect functional outcomes. In particular, angulations exceeding 30 degrees have been associated with reduced grip strength, while shortening greater than 2 millimeters may limit finger mobility.<sup>2,7,8</sup> This highlights the importance of ensuring the stability of the fracture position throughout the follow-up period, not just immediately after the initial reduction.

In cases of loss of reduction, repeated attempts at closed reduction are often performed to correct the deformity and avoid surgical intervention.<sup>9,11</sup> However, the actual functional benefit of these additional procedures and their contribution to fracture healing remain uncertain. Existing studies on this topic are limited in number and often involve small, heterogeneous patient populations.<sup>4,6,10</sup> Furthermore, the progression of angulation and shortening over time and their implications for clinical decision-making have not been clearly defined.<sup>8,12</sup> This uncertainty makes it difficult to determine whether follow-up decisions are consistently supported by objective evidence.

This study aims to evaluate the radiographic and functional effectiveness of repeated attempts at closed reduction in patients with loss of reduction following fifth metacarpal neck fractures. It also seeks to analyze the relationship between these interventions and the decision to proceed with surgical treatment.

## MATERIALS AND METHODS

### Study Design and Patient Selection

This retrospective, comparative cohort study was conducted at a tertiary orthopedic referral center characterized by high patient turnover and a substantial trauma workload. Approval was obtained Eskişehir City Hospital Institutional Review Board Ethics Committee (approval no: ESH/BAEK 2025/114, date: 20.02.2025). All patients aged 18 years and older who presented to the emergency department with isolated, closed fifth metacarpal neck fractures and underwent closed reduction between January 2023 and December 2024 were retrospectively reviewed using the hospital's electronic medical records. Inclusion criteria were as follows: age over 18 years, diagnosis of an isolated, closed fracture of the fifth metacarpal neck, and initial management with closed reduction in the emergency department. Exclusion criteria included age under 18, open fractures, intra-articular extension of the fracture, associated traumatic injuries in the same upper extremity,

prior fractures or surgical interventions in the same hand, and insufficient clinical or radiographic data before or after the reduction. After excluding cases that met any of these criteria, 200 patients were included in the final analysis. Patients were divided into two groups based on their reduction strategy: those who underwent a single closed reduction were assigned to the "single reduction group (SRG)," while those who achieved acceptable alignment after the initial closed reduction but demonstrated early loss of reduction at the 48-hour follow-up and therefore underwent a second closed reduction were assigned to the "re-reduction group (RRG)". Each group consisted of 100 patients. One-to-one matching was performed based on age and sex to ensure comparability between groups. In cases with multiple eligible matches, the SRG patient whose reduction date was closest to that of the RRG patient was selected. This matching strategy was used to minimize the influence of potential confounders such as age and sex, thereby enhancing the internal validity of the comparative analyses. In addition to age and sex, baseline fracture characteristics, considered proxies for fracture severity and instability, were recorded for all patients. These included initial dorsal angulation, initial metacarpal shortening, rotational deformity, dominant-hand involvement, and mechanism of injury. These variables were used to assess baseline comparability between groups and to account for potential confounding by indication in subsequent analyses. Data collected retrospectively from the hospital's digital records included age, sex, duration of follow-up, time to union, hand dominance, mechanism of injury, conversion to surgical treatment, and complications.

### Treatment and Follow-Up Protocol

All reduction procedures were performed in the emergency department by attending orthopedic specialists, using flexion, ulnar deviation, and dorsal pressure maneuvers.<sup>4</sup> Following reduction, a splint was applied to immobilize the wrist and metacarpals, with the wrist placed in slight extension and the metacarpophalangeal (MCP) joints at 90 degrees of flexion. Immediately after the initial reduction, post-reduction radiographs were obtained to confirm acceptable alignment. For clarity, radiographic time points were defined as follows: "initial" referred to the pre-reduction radiograph obtained at first presentation; "post-reduction" referred to the immediate radiograph obtained after the first closed reduction; and "48-hour" referred to the reassessment radiograph obtained approximately 48 hours after the first reduction. Post-reduction radiographs were assessed for residual angulation, metacarpal shortening, and rotational deformity at the neck of the fifth metacarpal. All patients were re-evaluated within 48 hours after the initial reduction. Radiographic and clinical findings at this time were assessed according to predefined objective criteria. Early loss of acceptable alignment at the 48-hour follow-up was defined by any of the following: dorsal angulation greater than 30° on lateral radiographs, metacarpal shortening exceeding 3 mm at the fracture site, or clinically observed rotational deformity identified by digit misalignment during fist formation.<sup>6,10</sup> Patients demonstrating early loss of reduction based on these criteria underwent a second closed reduction (re-reduction) within 48 hours of the initial procedure. Subsequently, all patients were followed up at the orthopedic outpatient clinic at 1, 4, and 6 weeks and at 6 months. Clinical follow-up assessed pain, swelling, range of motion (ROM), and cast tolerance, whereas radiographic follow-up monitored angulation and metacarpal length. Surgical intervention was considered if follow-up findings exceeded predefined anatomical thresholds. These included dorsal angulation over 30° on lateral radiographs, shortening greater than 3 mm, persistent rotational deformity, significant range-of-

motion limitation, or ongoing pain resulting in functional impairment.<sup>4,6</sup> Decisions to proceed with surgery were based on standardized criteria and were not influenced by individual physician preference. Surgical treatment options included intramedullary pin fixation or internal fixation with miniplates and screws.

### Radiological and Clinical Assessment

Standard posteroanterior and lateral hand radiographs were obtained at five time points: within the first 48 hours after reduction and at follow-up visits scheduled for week 1, week 4, week 6, and month 6. On lateral radiographs, the degree of dorsal angular deformity and metacarpal shortening were measured using digital radiographic analysis software. Dorsal angulation was defined as the angle between the longitudinal axis of the fifth metacarpal shaft and the axis of the distal fracture fragment on true lateral radiographs.<sup>1</sup> Metacarpal shortening was measured on posteroanterior radiographs as the linear distance between the distal articular surface of the fractured fifth metacarpal and that of the adjacent fourth metacarpal, expressed in millimeters.<sup>4</sup> All radiological measurements were performed independently by two orthopedic surgeons who were blinded to group allocation and unaware of the study protocol. In cases of discrepancy between the two observers, the relevant images were re-evaluated by a third orthopedic specialist, whose assessment was accepted as final. Radiographs obtained after surgical fixation were not included in the longitudinal radiographic analyses of angulation and metacarpal shortening. Surgical intervention was treated as a censoring event for longitudinal radiographic outcomes; only preoperative follow-up radiographs were analyzed. Accordingly, longitudinal radiographic analyses were conducted using a per-protocol rather than an intention-to-treat approach, as postoperative imaging reflects a different treatment pathway and is not biologically comparable to non-operative follow-up.

ROM was assessed at the 6-week and 6-month follow-up visits. Measurements were based on patients' active motion and included flexion and extension angles of the fifth MCP and proximal interphalangeal (PIP) joints. All ROM measurements were performed using a standard plastic goniometer, with patients seated and hands positioned neutrally on a flat surface. Each joint angle was measured three times, and the mean value was used for analysis.

Functional outcomes were evaluated using the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) score, which was recorded at both the 6-week and 6-month follow-up visits.<sup>13</sup> This allowed comparison between early post-reduction function and mid- to long-term outcomes. In addition, grip strength was assessed as part of the functional evaluation at the 6-month follow-up. Measurements were obtained with patients seated, shoulders in neutral rotation, elbows at 90° flexion, forearms in neutral rotation, and wrists positioned between 0-30° of extension and 0-15° of ulnar deviation. A calibrated digital hand dynamometer (Baseline® Digital Dynamometer, Fabrication Enterprises Inc., White Plains, NY, USA) was used. Only the injured hand was evaluated; three consecutive trials were performed, and the highest value was used for analysis.

Complications that occurred during the follow-up period were assessed retrospectively through medical records and outpatient documentation. Stiffness was defined as a total active flexion arc <180° or a persistent extension deficit >20° at the MCP and/or PIP joints at the 6-month follow-up.<sup>2,12</sup> Malunion was defined as persistent deformity at 6 months-

specifically, ≥30° of dorsal angulation or ≥3 mm of metacarpal shortening-when compared to the 6-week radiographic findings.<sup>2</sup> Nonunion was defined as the absence of radiographic continuity at the fracture site and persistent tenderness on palpation at 12 weeks post-injury.<sup>2</sup>

### Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY) and R software (version 4.3.2; R Foundation for Statistical Computing, Vienna, Austria). Before data collection, an a priori power analysis was performed using G\*Power software based on the mean and standard deviation values reported in comparable studies. This analysis demonstrated that a total sample size of 200 participants would provide sufficient statistical power to detect clinically relevant differences between study groups.

Because the distribution of continuous variables was predominantly nonparametric, between-group comparisons were conducted using the Mann-Whitney U test. At the same time, within-group paired evaluations were performed using the Wilcoxon signed-rank test. For repeated measurements involving more than two time points, the Friedman test was applied, followed by Bonferroni-corrected post-hoc pairwise comparisons. Categorical variables were assessed using chi-square or Fisher's exact tests, as appropriate. Interobserver reliability of radiological measurements was evaluated using intraclass correlation coefficients (ICCs).<sup>14</sup>

Following completion of the study, post hoc effect size calculations were performed for variables that showed statistically significant between-group differences. Effect sizes (*r*) derived from Mann-Whitney U test results averaged 0.245, corresponding to a Cohen's *d* value of approximately 0.52. Based on this effect size, the study's statistical power exceeded 90%, supporting the robustness of the observed differences.

Multivariable modeling was used to adjust for proxies for baseline fracture severity, alongside re-reduction status, to account for potential confounding by indication. For regression modeling, all candidate predictors were initially screened by univariable logistic regression. In accordance with established purposeful selection strategies, variables with univariable *p*-values <0.25 were considered for multivariable modeling, depending on the selection methods. Because the number of surgical events led to an events-per-variable below the recommended threshold of 10, conventional logistic regression was considered suboptimal because of the risk of overfitting. Therefore, a fifth-penalized logistic regression model was applied using the *logistf* package in R to reduce small-sample bias and obtain reliable coefficient estimates. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) were reported, and a *p*-value <0.05 was considered statistically significant.

## RESULTS

Demographic and general clinical characteristics of the study groups are summarized in Table 1. The groups were statistically comparable in terms of age, sex, hand dominance, mechanism of injury, final treatment decisions, and complication rates. However, both the overall follow-up duration and time to fracture union were significantly longer in the RRG (*p*=0.018 and *p*<0.001, respectively).

Functional and clinical outcome measures are presented in Table 2. At the 6-month follow-up, there was no significant difference in grip strength between the groups. Regarding QuickDASH scores, patients in

the RRG had significantly higher values at 6 weeks ( $p=0.002$ ), indicating worse function; however, the magnitude of this early difference was slightly below the distribution-based estimate of the minimal clinically important difference (Table 3) and should therefore be interpreted as having limited clinical relevance. This difference was not statistically significant at 6 months ( $p=0.075$ ). In terms of joint ROM, both flexion and extension angles were significantly more restricted in the RRG at both 6 weeks and 6 months ( $p<0.001$ ,  $p=0.023$ ,  $p=0.045$ , and  $p<0.001$ , respectively).

Radiological assessments using conventional between-group comparisons demonstrated that initial post-traumatic and immediate post-reduction angulation values were comparable between groups

(Table 4). However, during follow-up, angulation values were significantly higher in the RRG at the 4- and 6-week time points ( $p=0.007$  and  $p<0.001$ , respectively). Similarly, metacarpal shortening measurements at weeks 1, 4, and 6 were significantly greater in the RRG ( $p=0.001$ ,  $p<0.001$ , and  $p=0.009$ , respectively). At the 6-month follow-up, no significant differences were observed between groups in angulation or shortening.

To formally evaluate whether radiological trajectories differed between groups over time, a linear mixed-effects model (LMM) was applied. The model included group, follow-up time, and their interaction as fixed effects, with a random intercept for each patient to account for within-subject correlation across repeated measurements.

The LMM revealed a significant group $\times$ time interaction for angulation [ $F(5, 155.3)=3.31$ ,  $p=0.007$ ], indicating that the temporal evolution of angulation differed between the two groups. Although early post-reduction angulation values were similar, the RRG demonstrated a steeper increase during early follow-up, with the greatest divergence observed around the 4-week assessment (Figure 1a). In addition, significant main effects of group ( $p=0.037$ ) and time ( $p<0.001$ ) were observed.

Likewise, the LMM demonstrated a significant group $\times$ time interaction for metacarpal shortening [ $F(5, 21.5)=4.40$ ,  $p=0.007$ ], indicating that shortening trajectories differed between groups. While immediate post-reduction values were comparable, the RRG exhibited greater shortening during the early follow-up period, particularly at the 1-week and 4-week time points (Figure 1b). Significant main effects of group ( $p=0.044$ ) and time ( $p<0.001$ ) were also identified.

Variables associated with surgical referral in the univariable analysis are presented in Table 5. Initial shortening and all angulation parameters, measured immediately after reduction and during follow-up (weeks 1, 4, and 6), showed statistically significant associations with surgical intervention in univariable models (all  $p<0.05$ ). In accordance with the purposeful selection strategy, variables with a univariable  $p$ -value  $<0.25$  were included in the multivariable model. In addition, shortening at 1 week ( $p=0.261$ ) was retained because of its borderline statistical significance and clinical relevance. In the multivariable Firth-penalized logistic regression model, initial shortening was the only independent predictor of surgical intervention (OR) =1.253; 95% (CI): 1.014-1.446;  $p=0.036$ . None of the angulation parameters-including initial, post-reduction, and measurements at weeks 1, 4, or 6-remained significant after adjustment (all  $p>0.05$ ). Similarly, postoperative shortening parameters (post-reduction and weeks 1, 4, and 6) did not independently predict surgical referral in the adjusted model (all  $p>0.05$ ). Dominant-hand involvement approached statistical significance (OR =0.490;  $p=0.076$ ), but did not reach the threshold for independent association. Overall, initial shortening emerged as the sole radiological factor independently associated with the decision to proceed with surgery.

Receiver operating characteristic analysis demonstrated that initial shortening had a modest but statistically significant ability to discriminate patients who required surgical intervention (AUC =0.645, 95% CI: 0.558-0.732,  $p=0.004$ ) (Figure 2). A cutoff value of approximately 2.5 mm provided a more balanced sensitivity (65.1%) and specificity (55.4%), suggesting potential clinical utility for risk stratification rather than definitive decision-making.

**Table 1. Baseline demographic and clinical characteristics of the groups**

Parameters	SRG (n=100)	RRG (n=100)	p-value
Age (years)	29.02 $\pm$ 8.23	29.71 $\pm$ 8.31	0.541*
Follow-up duration (weeks)	10.48 $\pm$ 3.14	11.45 $\pm$ 2.76	0.018*
Union time (weeks)	7.55 $\pm$ 2.13	9.19 $\pm$ 1.91	<0.001*
Gender			0.721**
- Male, n (%)	79 (79%)	82 (82%)	
- Female, n (%)	21 (21%)	18 (18%)	
Dominant hand, n (%)	76 (76%)	71 (71%)	0.423**
Final treatment			0.491**
- Surgery, n (%)	19 (19%)	24 (24%)	
- Conservative, n (%)	81 (81%)	76 (76%)	
Mechanism of injury:			0.604***
- Fall, n (%)	23 (23%)	19 (19%)	
- Traffic accident, n (%)	9 (9%)	6 (6%)	
- Sportive activity, n (%)	10 (10%)	8 (8%)	
- Punch, n (%)	58 (58%)	67 (67%)	
Complications:			0.601***
- Stiffness, n (%)	7 (7%)	9 (9%)	
- Malunion, n (%)	7 (7%)	12 (12%)	
- Nonunion, n (%)	1 (1%)	1 (1%)	

\*Mann-Whitney U test, \*\*Chi-square test, \*\*\*Monte Carlo chi-square test. SRG: Single reduction group, RRG: Re-reduction group.

**Table 2. Functional and clinical outcomes**

Parameters	SRG (n=100)	RRG (n=100)	p-value
Grip strength (kg)	44.14 $\pm$ 8.60	43.49 $\pm$ 7.85	0.324*
QuickDASH, 6 <sup>th</sup> week	31.52 $\pm$ 6.99	34.84 $\pm$ 7.11	0.002*
QuickDASH, 6 <sup>th</sup> month	6.83 $\pm$ 4.65	7.73 $\pm$ 4.28	0.075*
p-value intergroup	0.001**	0.001**	
Flexion (°), 6 <sup>th</sup> week	69.05 $\pm$ 10.07	62.60 $\pm$ 10.16	<0.001*
Flexion (°), 6 <sup>th</sup> month	86.80 $\pm$ 6.22	85.05 $\pm$ 5.75	0.023*
p-value intergroup	0.001**	0.001**	
Extension (°), 6 <sup>th</sup> week	6.35 $\pm$ 4.54	5.10 $\pm$ 4.02	0.045*
Extension (°), 6 <sup>th</sup> month	9.17 $\pm$ 4.15	4.95 $\pm$ 4.47	<0.001*
p-value intergroup	0.001**	0.001**	

\*Mann-Whitney U test, \*\*Wilcoxon test. SRG: Single reduction group, RRG: Re-reduction group, QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand.

**Table 3. Distribution-based MCID context for QuickDASH between-group differences**

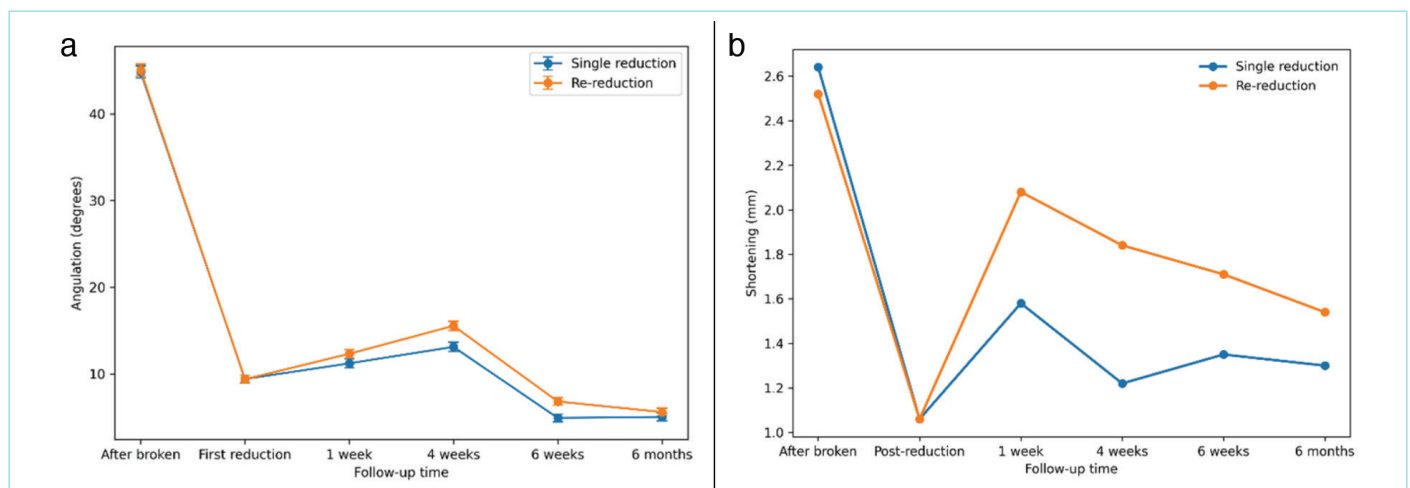
Parameters	SRG (n=100)	RRG (n=100)	Between-group difference	MCID_est (0.5× SD_pooled)	Interpretation vs. MCID
6 <sup>th</sup> week	31.52±6.99	34.84±7.11	+3.32	3.53	Borderline
6 <sup>th</sup> month	6.83±4.65	7.73±4.28	+0.90	2.23	Below

MCID was evaluated only for the QuickDASH using a distribution-based approach (MCID\_est = 0.5 × SD\_pooled). This provides an estimate of clinical meaningfulness and should be interpreted as a supportive context rather than a definitive threshold.  
 SRG: Single reduction group, RRG: Re-reduction group, MCID: Minimal clinically important difference, QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, SD: Standard deviation.

**Table 4. Evolution of angulation and shortening across follow-up in both groups**

Parameters	SRG (n=100)	RRG (n=100)	p-value
1. Angulation (°), initial	44.83±9.00	45.03±7.86	0.773*
2. Angulation (°), post-reduction	9.42±3.62	9.39±3.22	0.813*
3. Angulation (°), 1 <sup>st</sup> week	11.22±4.38	12.32±4.76	0.212*
4. Angulation (°), 4 <sup>th</sup> week	13.12±5.34	15.55±5.72	0.007*
5. Angulation (°), 6 <sup>th</sup> week	4.93±3.69	6.83±3.46	<0.001*
6. Angulation (°), 6 <sup>th</sup> month	5.04±3.68	5.60±2.87	0.125*
Intragroup comparison in different time intervals.	p=0.583** (5-6) p<0.05**, other comparisons	p<0.05** for all comparisons	
1. Shortening (mm), initial	2.64±1.85	2.52±1.53	0.702*
2. Shortening (mm), post-reduction	1.06±0.79	1.06±0.72	0.969*
3. Shortening (mm), 1 <sup>st</sup> week	1.58±1.02	2.08±0.97	<0.001*
4. Shortening (mm), 4 <sup>th</sup> week	1.22±1.01	1.84±1.08	<0.001*
5. Shortening (mm), 6 <sup>th</sup> week	1.35±1.12	1.71±1.05	0.009*
6. Shortening (mm), 6 <sup>th</sup> month	1.30±1.19	1.54±1.11	0.101*
Intragroup comparison in different time intervals.	p=0.314** (4-5) p=0.683** (5-6) p<0.05**, other comparisons	p=0.130** (2-3) p=0.276** (4-5) p=0.219** (5-6) p<0.05**, other comparisons	

\*Mann-Whitney U test, \*\*Friedman test with post-hoc Bonferroni-corrected comparisons.  
 SRG: Single reduction group, RRG: Re-reduction group.



**Figure 1.** Estimated marginal means of radiological parameters over time according to treatment group, derived from the linear mixed-effects model. (a) Temporal changes in angulation. Although early post-reduction angulation values were comparable between groups, the re-reduction group demonstrated a greater increase during early follow-up, with the most pronounced difference observed at 4 weeks. (b) Temporal changes in metacarpal shortening. While early post-reduction shortening values were similar between groups, the re-reduction group exhibited greater shortening during the early follow-up period, particularly at the 1-week and 4-week assessments. Error bars represent standard errors.

Table 5. Univariate and firth penalized regression analysis of variables associated with surgical intervention				
Predictor	OR [Exp(B)]	p-value	95% CI (lower)	95% CI (upper)
<b>Univariable logistic regression for surgical intervention</b>				
Group (re-reduction vs. no re-reduction)	0.743	0.390	0.377	1.464
Age (years)	0.983	0.432	0.942	1.026
Sex (male vs. female)	0.760	0.548	0.309	1.864
Dominant hand (yes vs. no)	0.596	0.162	0.288	1.232
Mechanism (1 vs. ref)	0.903	0.813	0.387	2.104
Mechanism (2 vs. ref)	0.509	0.392	0.109	2.389
Mechanism (3 vs. ref)	0.662	0.536	0.179	2.447
Initial shortening	1.380	0.003	1.117	1.704
Post-reduction shortening	1.408	0.144	0.890	2.227
Shortening at 1 week	0.825	0.261	0.591	1.153
Shortening at 4 weeks	0.794	0.166	0.573	1.100
Shortening at 6 weeks	0.778	0.126	0.564	1.073
Initial angulation	0.967	0.108	0.928	1.007
Post-reduction angulation	0.872	0.008	0.788	0.965
Angulation at 1 week	0.882	0.002	0.813	0.955
Angulation at 4 weeks	0.920	0.012	0.862	0.982
Angulation at 6 weeks	0.862	0.004	0.779	0.954
<b>Multivariable firth penalized logistic regression</b>				
Dominant hand (yes vs. no)	0.490	0.076	0.224	1.080
Initial shortening	1.253	0.036	1.014	1.446
Post-reduction shortening	1.321	0.311	0.772	2.296
Shortening at 1 week	0.821	0.331	0.543	1.198
Shortening at 4 weeks	0.973	0.882	0.709	1.400
Shortening at 6 weeks	0.938	0.717	0.658	1.324
Initial angulation	0.979	0.345	0.938	1.022
Post-reduction angulation	0.956	0.482	0.841	1.086
Angulation at 1 week	0.935	0.187	0.843	1.033
Angulation at 4 weeks	1.007	0.865	0.925	1.093
Angulation at 6 weeks	0.902	0.063	0.804	1.006
OR: Odds ratio, CI: Confidence intervals.				

Interobserver reliability across all radiological measurements was high, with ICCs ranging from 0.772 to 0.984, indicating methodological consistency and reproducibility of the assessments.

## DISCUSSION

In this study, the effectiveness of repeated closed reduction procedures was evaluated in patients who developed secondary displacement following initial closed reduction for isolated fifth metacarpal neck fractures. The analysis focused on both radiological and functional outcomes. Patients in the RRG had significantly longer follow-up and time to fracture union. Radiographic assessments revealed that angulation values at weeks 4 and 6, as well as shortening at weeks 1, 4, and 6, were significantly higher in RRG. Additionally, the rate of surgical intervention was higher in this group. Initial shortening emerged as the only independent predictor of surgical intervention in the multivariable firth penalized regression analysis. QuickDASH scores at week 6 were significantly worse in the RRG. Furthermore, flexion and extension angles were more restricted in this group at both early and late follow-up assessments, suggesting a lasting impact on joint mobility.

Fractures of the fifth metacarpal neck are frequently encountered, particularly in young males, and are often managed by closed reduction.<sup>6,7,15-17</sup> However, current literature indicates that the stability of closed reduction in this fracture type is limited, and significant deterioration in angulation and shortening can occur during the early post-reduction period.<sup>18-20</sup> For this reason, many studies have emphasized that specific radiographic thresholds, such as angulation exceeding 30 to 40 degrees or shortening exceeding 2 millimeters, serve as useful indicators for surgical decision-making.<sup>18-23</sup> Despite this, these thresholds are generally established based solely on initial post-traumatic radiographs, and there is insufficient data describing how fracture alignment evolves during the follow-up period. In particular, studies focusing on patients who develop secondary displacement and subsequently undergo repeat closed reductions remain scarce and lack systematic, measurement-based analyses.<sup>4,6,10</sup> The clinical impact and effectiveness of a second reduction attempt in this group, both radiologically and functionally, remain poorly defined. Moreover, the influence of changes in angulation and shortening, which can begin in the first weeks after reduction, has not yet been quantitatively

described in relation to treatment decisions. A distinctive aspect of the present study is its approach to angulation and shortening, treating them not as static measurements but as dynamic parameters tracked over time. Although increases in angulation at the fourth and sixth weeks were associated with repeat reduction in univariable analyses, these parameters did not remain independent predictors of surgical intervention in the multivariable model. This represents a valuable contribution to the literature, in which most studies have focused only on initial radiographs. Similarly, the significant association between the degree of initial shortening and later surgical referral supports the interpretation of early radiographs as decision-making tools, rather than passive diagnostic images.

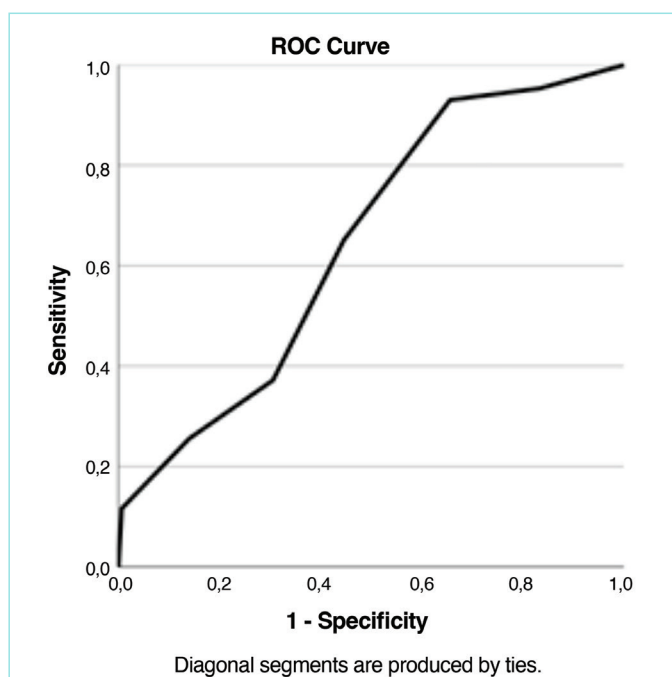
The impact of post-reduction changes in angulation and shortening on the decision for surgical treatment has been evaluated only to a limited extent in previous studies.<sup>19-24</sup> In most cases, the success of reduction is determined solely by immediate post-procedure imaging, while radiological changes observed during follow-up are often overlooked in clinical decision-making. However, the findings of the present study demonstrate that increases in angulation at weeks four and six are associated with surgical intervention in univariable analysis, although these parameters did not remain independent predictors in the multivariable model. This suggests that deformity should be considered a dynamic parameter that evolves over time, rather than a fixed structural outcome. Instead of relying on static threshold values, continuous monitoring of measurements, such as angulation and shortening, throughout the follow-up period may provide more accurate guidance for timely and appropriate interventions. Nevertheless, the effectiveness of repeated closed reductions for patients who experience loss of reduction remains controversial.<sup>25-28</sup> In this study, patients who underwent re-reduction showed longer union times and lower functional scores. These findings indicate that a second reduction

attempt may not offer equal benefit for all patients. The observation that initial shortening was a predictor of surgical intervention further supports the notion that radiographic assessment at the time of initial presentation holds not only diagnostic but also prognostic value. Therefore, decisions regarding repeat reduction should be made by integrating follow-up findings and radiographic parameters, rather than through reflexive or routine approaches. Each intervention should be clinically justified and tailored to the patient's evolving condition.

It should also be acknowledged that patients undergoing re-reduction are likely to have fracture patterns with inherent mechanical instability. In this context, the decision to perform re-reduction may be interpreted not as an independent therapeutic intervention, but rather as a clinical marker of early instability or inadequate mechanical control. Therefore, the longer union times and inferior early functional outcomes observed in the RRG may be related primarily to the underlying fracture characteristics rather than to a direct adverse effect of the re-reduction procedure itself. Accordingly, the findings of the present study should be interpreted as associational rather than causal.

### Study Limitations

One of the most significant limitations of this study is its retrospective design, which prevented standardization of treatment decisions. The choice between reduction and surgical intervention may have varied depending on individual physician preferences or institutional practices. Additionally, the technical details of repeat reductions and the quality of the reductions achieved could not be assessed uniformly. The reliability of some functional outcome measures may also be affected by their reliance on patient self-reporting and by the limited mid-term follow-up. Moreover, because the decision to perform re-reduction was not randomly assigned, patients in the RRG may have presented with fracture patterns exhibiting greater inherent mechanical instability. This selection process may have introduced confounding by indication, potentially influencing early functional outcomes and time to union, independent of the re-reduction procedure itself. In addition, the longer follow-up duration observed in the RRG does not necessarily reflect a true biological delay in fracture healing. Patients with fractures that are considered to have a higher risk of instability are more likely to undergo closer clinical surveillance and more frequent radiographic evaluations. This increased monitoring may have contributed to fracture union being documented later, thereby introducing ascertainment bias. Therefore, differences in union time between groups should not be interpreted as solely reflecting a true biological delay, rather but should be considered in the context of differential follow-up intensity. Despite these limitations, the study offers meaningful contributions by systematically evaluating the effectiveness of repeat closed reductions, analyzing time-dependent changes in radiological parameters such as angulation and shortening, and identifying their impact on clinical decision-making through multivariate analysis. The findings suggest a need to shift from rigid threshold-based decision models toward more dynamic approaches that incorporate follow-up observations. Future research using prospective designs and standardized treatment protocols may better clarify the optimal timing and selective application of repeat reduction procedures in relation to both radiological and functional outcomes. In addition, long-term follow-up data will be essential to fully understand the clinical implications of residual deformity and to establish more robust treatment algorithms for this fracture type.



**Figure 2.** Receiver operating characteristic (ROC) curve of initial metacarpal shortening for predicting the need for surgical intervention.

## CONCLUSION

This study demonstrated that radiological changes observed during follow-up after reduction of fifth metacarpal neck fractures may serve as important indicators for the treatment process. Repeated closed reductions performed in patients with secondary displacement did not yield consistent benefits across all cases and were associated with limited improvements in both functional and radiological outcomes. Continuous and dynamic evaluation of parameters such as angulation and shortening throughout the follow-up period may provide valuable guidance, particularly in determining the appropriate timing of clinical interventions. Furthermore, initial shortening emerged as an independent predictor of surgical referral, highlighting the prognostic value of early radiographic assessment.

## MAIN POINTS

- Re-reduction after early loss of alignment in fifth metacarpal neck fractures does not consistently improve radiological or functional outcomes.
- Radiological parameters such as angulation and shortening should be interpreted as dynamic variables evolving over time rather than static measurements.
- Early deterioration in alignment, particularly within the first weeks, reflects underlying fracture instability rather than the effect of re-reduction itself.
- Initial metacarpal shortening emerged as the only independent predictor of subsequent surgical intervention.
- Continuous follow-up assessment provides more clinically relevant guidance than a single time-point radiographic evaluation.

## ETHICS

**Ethics Committee Approval:** Approval was obtained Eskişehir City Hospital Institutional Review Board Ethics Committee (approval no: ESH/BAEK 2025/114, date: 20.02.2025).

**Informed Consent:** This retrospective, comparative cohort study.

## Acknowledgements

We thank you, all the participants, for participating in our study.

## Footnotes

### Authorship Contributions

Surgical and Medical Practices: B.K., H.Ç.B., Concept: B.K., H.Ç.B., Design: B.K., Data Collection and/or Processing: H.Ç.B., Analysis and/or Interpretation: H.Ç.B., Literature Search: B.K., H.Ç.B., Writing: B.K.

## DISCLOSURES

**Conflict of Interest:** No conflict of interest was declared by the authors.

**Financial Disclosure:** The authors declared that this study received no financial support.

**Declaration of Generative AI and AI-assisted Technologies in the Writing Process:** During the preparation of this work, the author(s) used ChatGPT to improve “readability” and “language”. After using this tool/

service, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

## REFERENCES

1. Carreño A, Ansari MT, Malhotra R. Management of metacarpal fractures. *J Clin Orthop Trauma*. 2020; 11(4): 554-61.
2. Kollitz KM, Hammert WC, Vedder NB, Huang JI. Metacarpal fractures: treatment and complications. *Hand (N Y)*. 2014; 9(1): 16-23.
3. Lambi AG, Rowland RJ, Brady NW, Rodriguez DE, Mercer DM. Metacarpal fractures. *J Hand Surg Eur Vol*. 2023; 48(2\_suppl): 42S-50.
4. Popova D, Welman T, Vamadeva SV, Pahal GS. Management of hand fractures. *Br J Hosp Med (Lond)*. 2020; 81(11): 1-11.
5. Taghinia AH, Talbot SG. Phalangeal and metacarpal fractures. *Clin Plast Surg*. 2019; 46(3): 415-23.
6. Suhail D, Ma Y, Chung P, Al-Ani S, Jester A. Management of paediatric fifth metacarpal neck fractures: a systematic review. *Arch Orthop Trauma Surg*. 2024; 144(8): 3865-74.
7. Keller MM, Barnes R, Brandt C, Hepworth LM. Hand rehabilitation programmes for second to fifth metacarpal fractures: a systematic literature review. *S Afr J Physiother*. 2021; 77(1): 1536.
8. Sletten IN, Nordsletten L, Hjorthaug GA, Hellund JC, Holme I, Kvernmo HD. Assessment of volar angulation and shortening in 5th metacarpal neck fractures: an inter- and intra-observer validity and reliability study. *J Hand Surg Eur Vol*. 2013; 38(6): 658-66.
9. Zawam SH, Abdelrazek BH, Elmofty A, Morsy A, Abousayed M. Conservative treatment versus transverse pinning in fifth metacarpal neck fractures in active adults: a randomized controlled trial. *Eur J Trauma Emerg Surg*. 2024; 50(2): 531-42.
10. Luciani MA, Mayers Y, Warnick EP, Udoeyo IF, Klena JC, Grandizio LC. Trends in the management of fifth metacarpal neck fractures. *J Hand Surg Am*. 2024; 49(4): 384.e1-9.
11. Melamed E, Joo L, Lin E, Perretta D, Capo JT. Plate fixation versus percutaneous pinning for unstable metacarpal fractures: a meta-analysis. *J Hand Surg Asian Pac Vol*. 2017; 22(1): 29-34.
12. Vargas A, Chiapas-Gasca K, Hernández-Díaz C, Canoso JJ, Saavedra MÁ, Navarro-Zarza JE, et al. Clinical anatomy of the hand. *Reumatol Clin*. 2012; 8(Suppl 2): 25-32.
13. Franchignoni F, Vercelli S, Giordano A, Sartorio F, Bravini E, Ferriero G. Minimal clinically important difference of the disabilities of the arm, shoulder and hand outcome measure (DASH) and its shortened version (QuickDASH). *J Orthop Sports Phys Ther*. 2014; 44(1): 30-9.
14. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropr Med*. 2016; 15(2): 155-63.
15. Lee SJ, Merrison H, Williams KA, Vuillermin CB, Bauer AS. Closed reduction and immobilization of pediatric fifth metacarpal neck fractures. *Hand (N Y)*. 2022; 17(3): 416-21.
16. Zachary PKD, Parikh HB, Kulber DA, Kuschner SH. Fifth metacarpal neck fractures: less is more. *Plast Reconstr Surg Glob Open*. 2025; 13(4): e6687.
17. Dunn JC, Kusnezov N, Orr JD, Pallis M, Mitchell JS. The boxer's fracture: splint immobilization is not necessary. *Orthopedics*. 2016; 39(3): 188-92.
18. France TJ, Leversedge FJ, Lauder A. Clinical outcomes of severely angulated fifth metacarpal neck fractures treated nonsurgically. *Hand (N Y)*. 2023; 18(4): 604-11.
19. Boeckstyns MEH. Challenging the dogma: severely angulated neck fractures of the fifth metacarpal must be treated surgically. *J Hand Surg Eur Vol*. 2021; 46(1): 30-6.

20. Thomas TL, Kachooei AR, Ilyas AM. Intramedullary k-wires versus alternate techniques for metacarpal shaft and neck fractures: a systematic review and meta-analysis. *J Hand Microsurg.* 2022; 15(5): 376-87.
21. Pellatt R, Fomin I, Pienaar C, Bindra R, Thomas M, Tan E, et al. Is buddy taping as effective as plaster immobilization for adults with an uncomplicated neck of fifth metacarpal fracture? A randomized controlled trial. *Ann Emerg Med.* 2019; 74(1): 88-97.
22. Amsallem L, Pierrart J, Bihel T, Sekri J, Lafosse T, Masmajeun E, et al. Simplified internal fixation of fifth metacarpal neck fractures. *Orthop Traumatol Surg Res.* 2018; 104(2): 257-60.
23. Heckmann N, Dusch MN, Pannell WC, Bauschard M, Alluri RK, Sivasundaram L, et al. The utility of plain films for nonoperative fifth metacarpal fractures: are follow-up radiographs necessary? *Hand (N Y).* 2018; 13(6): 646-51.
24. Lee JK, Cho WM, Lee HI, Ha JW, Cho JW, Kim J, et al. The inter-and intra-observer reliability of volar angulation measurements in a fifth metacarpal neck fracture. *Arch Orthop Trauma Surg.* 2022; 142(7): 1705-13.
25. Maximen J, Rossetti A, Vallée N, DE Geyer A, Dreano T, Ropars M. Fractures of the fifth metacarpal neck treated by syndactyly: functional and quality of life outcomes of a series of 39 patients. *Acta Orthop Belg.* 2023; 89(2): 225-31.
26. Cavalcanti Kussmaul A, Kuehlein T, Langer MF, Ayache A, Unglaub F. The treatment of closed finger and metacarpal fractures. *Dtsch Arztebl Int.* 2023; 120(50): 855-62.
27. Kim DE, Lee TJ, Na Y, Noh YG. Comparative evaluation of the efficacy of combined intramedullary pinning with k-wires pinning in the treatment of fifth metacarpal neck fractures versus conventional techniques-k-wires pinning and intramedullary pinning. *Medicina (Kaunas).* 2023; 59(11): 1944.
28. Kaynak G, Botanlioglu H, Caliskan M, Karaismailoglu B, Ozsahin MK, Kocak S, et al. Comparison of functional metacarpal splint and ulnar gutter splint in the treatment of fifth metacarpal neck fractures: a prospective comparative study. *BMC Musculoskelet Disord.* 2019; 20(1): 169.