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FUNCTIONAL OUTCOME OF CLOSE REDUCTION AND PERCUTANEOUS PINNING IN COLLES FRACTURE UNDER IMAGE INTENSIFIER

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ABSTRACT

Background: Colles' fractures are common distal radius fractures that may result in pain, restricted wrist motion, reduced grip strength and impaired hand function when satisfactory alignment is not achieved or maintained. Closed reduction and percutaneous pinning (CRPP) under image-intensifier guidance provides a minimally invasive method of maintaining reduction in appropriately selected unstable fractures. However, functional recovery remains an important endpoint because radiographic restoration does not always translate directly into functional recovery. Local evidence regarding functional outcomes following CRPP for Colles' fracture remains limited.

Objective: To determine the frequency of excellent, good and fair functional outcomes at six months postoperatively among patients with Colles' fracture treated with closed reduction and percutaneous pinning under image-intensifier guidance, using the Modified Cooney Wrist Score.

Methods: A descriptive longitudinal study was conducted in the Department of Orthopaedics, Ayub Teaching Hospital, Abbottabad, Khyber Pakhtunkhwa, Pakistan, from 5 December 2025 to 5 June 2026. A total of 149 adult patients aged 20–70 years with unilateral Frykman type I or II Colles' fractures presenting within seven days of injury and undergoing CRPP under image-intensifier guidance were included through non-probability consecutive sampling. Closed reduction was performed with longitudinal traction followed by palmar flexion and ulnar deviation, and fixation was achieved using two or three 1.8-mm Kirschner wires according to fracture stability. Functional outcome was assessed at six months using the Modified Cooney Wrist Score, which evaluates pain, functional status, range of motion and grip strength, with a total score of 100. Outcomes were categorized as excellent (90–100), good (80–89) or fair (65–79). Data were analyzed using IBM SPSS Statistics version 26. Associations between functional outcome and demographic or fracture-related variables were assessed using the chi-square test or Fisher's exact test, as appropriate, with $p \leq 0.05$ considered statistically significant.

Results: The mean age of the study participants was 52.0±11.0 years, with a median age of 53 years (IQR 44–60). Female patients comprised 86 (57.7%) of the study population, while 63 (42.3%) were male. Right-sided fractures were present in 79 (53.0%) patients and left-sided fractures in 70 (47.0%). Frykman type I fractures accounted for 85 (57.0%) cases and type II fractures for 64 (43.0%). At six months, 78 (52.3%) patients achieved an excellent functional outcome, 60 (40.3%) had a good outcome and 11 (7.4%) had a fair outcome. The mean Modified Cooney Wrist Score was 88.9±9.0, with a median of 90 (IQR 84–95). The mean scores for pain, functional status, range of motion and grip strength were 22.5±3.4, 22.0±3.5, 22.1±3.2 and 22.3±3.4, respectively. No statistically significant association was observed between functional outcome and age, gender, BMI, side of involvement, Frykman classification, socioeconomic status, educational level or residential status ($p > 0.05$ for all comparisons).

Conclusion: In this selected cohort of adults with unilateral Frykman type I and II Colles' fractures, closed reduction and percutaneous pinning under image-intensifier guidance was associated with predominantly favorable functional outcomes at six months. More than half of the patients achieved an excellent Modified Cooney Wrist Score and a further substantial proportion achieved a good outcome. The findings support CRPP as a practical treatment option for appropriately selected Colles' fractures in which satisfactory closed reduction can be achieved and maintained. Comparative studies involving other fixation methods and longer follow-up are needed to further evaluate functional recovery.

KEYWORDS: Colles' fracture; distal radius fracture; closed reduction; percutaneous pinning; Kirschner wire; image intensifier; Modified Cooney Wrist Score; functional outcome.

INTRODUCTION

Distal radius fractures are among the most frequently encountered fractures in adult orthopaedic practice and represent a substantial proportion of upper-extremity trauma. Their incidence increases with age, particularly in patients with reduced bone quality, although high-energy trauma may produce similar injuries in younger adults.[1,2]

The functional importance of these fractures extends beyond fracture union because the distal radius contributes substantially to wrist stability, forearm rotation and load transmission across the wrist. Restoration of radial height, inclination and sagittal alignment is therefore an important component of treatment, particularly when displacement is likely to compromise wrist mechanics.[3] Colles' fracture is the classic extra-articular, dorsally displaced fracture of the distal radius, traditionally described as occurring within approximately 2.5 cm of the wrist joint. It is commonly produced by a fall on an outstretched hand and is particularly frequent among older women, although it also occurs in younger adults following higher-energy trauma.[1,2] Displacement may result in loss of radial height, increased dorsal tilt and alteration of radial inclination. If satisfactory alignment is not achieved or subsequently maintained, patients may develop persistent pain, reduced wrist motion and grip strength, and difficulty with activities requiring normal wrist function. The relationship between radiographic alignment and long-term function is not, however, uniform across all patient groups, and functional recovery remains an important endpoint when evaluating treatment.[4] Management of displaced distal radius fractures depends on fracture stability, displacement, patient age, functional requirements, bone quality and associated injuries. Options include closed reduction and cast immobilisation, external fixation, percutaneous pinning and open reduction with internal fixation. Current evidence does not establish a single fixation method as universally superior, and treatment decisions should be individualized according to fracture characteristics and patient factors.[5] In unstable dorsally displaced fractures, closed reduction followed by percutaneous Kirschner-wire (K-wire) fixation provides a means of maintaining reduction without extensive soft-tissue dissection. The technique is relatively straightforward and uses fluoroscopic guidance to confirm reduction and guide wire placement.[6] Closed reduction and percutaneous pinning (CRPP) is particularly relevant where stable extra-articular reduction can be achieved by manipulation. The technique aims to restore the normal relationship of the distal radius and maintain the reduction during fracture healing while limiting surgical exposure. Evidence from comparative studies suggests that K-wire fixation remains a viable surgical option for distal radius fractures, although differences in early recovery and complications have been reported when it is compared with volar plate fixation.[6,7] The Cochrane review of percutaneous pinning also highlights that the available evidence is heterogeneous and that the benefits of pinning should be interpreted in relation to fracture stability and the specific fixation technique used.[6] Functional assessment is therefore important when determining the effectiveness of CRPP. A prospective study specifically evaluating displaced Colles' fractures treated with closed reduction and percutaneous pinning reported predominantly good-to-excellent functional results at six months, with outcomes assessed using the modified Cooney wrist scoring system.[8] The score incorporates pain, functional status, range of motion and grip strength, thereby providing a clinically relevant assessment beyond radiographic union alone. More recent evidence also indicates that radiographic restoration does not always translate directly into superior functional recovery, reinforcing the importance of assessing patient function after treatment.[7]

Despite the widespread use of CRPP for appropriately selected displaced Colles' fractures, functional outcomes may vary according to patient characteristics, fracture pattern and the quality of reduction and fixation. Local evidence is also important because treatment practices, patient demographics, presentation patterns and access to postoperative rehabilitation may differ between healthcare settings. Studies from Pakistan have reported functional outcomes following K-wire fixation of distal radius fractures, but these studies have involved different fracture patterns, treatment comparisons and outcome measures.[9,10] Evidence specifically evaluating a defined cohort of patients with Colles' fractures treated with CRPP under image intensifier guidance at a tertiary-care teaching hospital in Khyber Pakhtunkhwa remains limited.

Therefore, this study was undertaken at the Orthopaedics Department of Ayub Teaching Hospital, Abbottabad, to determine the functional outcome of patients with Colles' fracture treated with closed reduction and percutaneous pinning under image-intensifier guidance, using the Modified Cooney Wrist Score at six months after surgery. Conducting this study will help determine the efficacy of CRPP in achieving satisfactory functional recovery among local patients. The results will contribute to improved clinical decision-making, development of standardized treatment protocols, and enhancement of overall patient outcomes following displaced distal radius fractures.

Aims and Objectives

Aim

To evaluate the functional outcome of patients with Colles' fracture treated with closed reduction and percutaneous pinning under image-intensifier guidance.

Objective

To determine the frequency of functional outcomes, categorized as excellent, good, or fair, at 6 months postoperatively among patients with Colles' fracture treated with closed reduction and percutaneous pinning under image intensifier, using the Modified Cooney Wrist Score.

MATERIALS AND METHODS

Study design and setting

This descriptive longitudinal study was conducted in the Department of Orthopaedics, Ayub Teaching Hospital, Abbottabad, Khyber Pakhtunkhwa, Pakistan. The study period was from 5 December 2025 to 5 June 2026. The study evaluated the functional outcome of patients with Colles' fracture treated with closed reduction and percutaneous pinning (CRPP) under image-intensifier guidance.

Study population
The study population comprised adult patients presenting to the Orthopaedics Department with a unilateral Colles' fracture who met the predefined eligibility criteria and underwent closed reduction and percutaneous pinning under image-intensifier guidance.
Sample size and sampling technique
A total sample of 149 patients was included. The sample size was calculated using the WHO sample size calculator, considering a 95% confidence level, a 4% margin of error and an anticipated frequency of fair functional outcome of 6.67%, based on a previously published study of patients with displaced Colles' fractures treated with closed reduction and percutaneous pinning.[1]
Patients were selected using non-probability consecutive sampling, with all eligible patients presenting during the study period being considered for inclusion until the required sample size was achieved.
Eligibility criteria
Patients were eligible for inclusion if they fulfilled all of the following criteria:
Age 20–70 years.
Either gender.
Unilateral Colles' fracture meeting the predefined clinical and radiological criteria.
Planned treatment with closed reduction and percutaneous pinning under image-intensifier guidance.
Presentation within 7 days of the traumatic event.
Frykman type I or II fracture.
Patients were excluded if they had an open fracture, a history or evidence of neurovascular injury, a comminuted or pathological fracture, an associated injury involving the same limb such as a carpal, metacarpal or ulnar shaft fracture, previous wrist surgery, or pre-existing wrist deformity or arthritis.
Operational Definitions:
Colles' fracture: It will be defined as an extra-articular transverse fracture of the distal radius occurring within 2.5 cm of the articular surface of the wrist. Clinically, it will be characterized by any two of the following findings such as pain intensity ≥5 on the VAS, localized swelling and tenderness over the distal radius, "dinner fork" deformity or restriction of wrist movements (dorsiflexion <30°, palmar flexion <40°, pronation <50° and supination <60°). Radiologically, it will be confirmed on X-ray showing at least two of the following findings, dorsal angulation >10°, loss of radial height >5 mm, radial inclination <15° and positive ulnar variance of > 3 mm.
Functional outcome: It will be in terms of Modified Cooney Wrist Score, which evaluates four parameters: pain (25 points), functional status (25 points), range of motion (25 points) and grip strength (25 points), giving a total of 100 points (Annexure-III).….
Excellent outcome: It will be defined as a total Cooney Wrist Score of 90–100 points at 6 months postoperatively.
Good outcome: It will be defined as a total Cooney Wrist Score of 80–89 points at 6 months postoperatively.
Fair outcome: It will be defined as a total Cooney Wrist Score of 65–79 points at 6 months postoperatively.
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Preoperative assessment and data collection
After obtaining ethical approval from the institutional review board ofayub teaching hospital abbottabad, eligible patients were enrolled following informed consent. Baseline demographic and clinical information was recorded using a structured data collection proforma. Variables included age, gender, body mass index (BMI), side of involvement, Frykman fracture classification, socioeconomic status, educational level and residential status.
Surgical technique
All patients underwent closed reduction and percutaneous pinning under regional or general anaesthesia. The patient was positioned supine on the operating table, with the affected upper limb supported on a radiolucent hand table. Following routine sterile preparation and draping, closed reduction was performed using longitudinal traction with countertraction over the arm, followed by palmar flexion and ulnar deviation to restore the alignment of the distal radius.
The adequacy of reduction was assessed using an image intensifier in anteroposterior and lateral views. Once satisfactory reduction had been achieved, percutaneous fixation was performed using two or three 1.8-mm Kirschner wires (K-wires) according to the stability of the reduced fracture.
The first K-wire was introduced from the radial styloid and directed obliquely across the fracture to engage the opposite/proximal cortex. A second K-wire was introduced from the dorsoulnar aspect and directed obliquely across the fracture to provide additional rotational stability. A third wire was used when additional stabilization was considered necessary. Wire placement was performed under real-time fluoroscopic guidance, with care taken to avoid intra-articular penetration.
Following fixation, the reduction was rechecked fluoroscopically, with assessment of restoration of the radial height, radial inclination and volar tilt. The target values described in the study protocol were approximately 11–12 mm for radial height, 22–23° for radial inclination and 11° for volar tilt. The K-wires were then bent and cut, with the ends left accessible for subsequent removal.
Postoperative care and follow-up
After fixation, a below-elbow plaster splint was applied with the wrist maintained in moderate palmar flexion and ulnar deviation. Patients were monitored postoperatively for neurovascular compromise and received analgesia

for pain control. Elevation of the affected limb was advised to reduce swelling. Postoperative anteroposterior and lateral radiographs were obtained to verify maintenance of reduction and appropriate K-wire position.
The pin sites and wound were inspected during follow-up, and patients were provided instructions regarding pin-site care and limb elevation. At approximately 2 weeks, patients were reviewed for wound assessment and removal of sutures where required. At 4–6 weeks, repeat radiographs were obtained to assess fracture healing. K-wire removal was performed once adequate healing, evidenced by bridging trabeculae, was present. Following K-wire removal, wrist mobilization exercises were initiated to restore range of motion and strength, with physiotherapy supervision where required.

Assessment of functional outcome

The primary outcome was functional status at 6 months postoperatively, assessed using the Modified Cooney Wrist Score. The score evaluates four domains: pain, functional status, range of motion and grip strength, with each domain contributing 25 points to a total score of 100.
Functional outcomes were categorized as follows:
Excellent: 90–100 points
Good: 80–89 points
Fair: 65–79 points
The final Modified Cooney Wrist Score was recorded on the study proforma, and each patient was classified into one of the three predefined outcome categories.
Statistical analysis
Data were entered and analyzed using IBM SPSS Statistics version 26. Qualitative variables, including gender, side of involvement, socioeconomic status, educational level, residential status, Frykman classification and functional outcome categories, were summarized using frequencies and percentages.
Quantitative variables, including age and BMI, were assessed for distribution using the Shapiro–Wilk test and presented as mean ± standard deviation for normally distributed data or median with interquartile range (IQR) where appropriate.
Functional outcome categories were subsequently stratified according to age, gender, BMI, side of involvement, Frykman classification, socioeconomic status, educational level and residential status. Associations between categorical variables were assessed using the chi-square test or Fisher's exact test, as appropriate. A p-value ≤ 0.05 was considered statistically significant.

Ethical considerations

The study was conducted after approval from the relevant institutional ethical review authority of Ayub Teaching Hospital. Informed consent was obtained from participants before enrolment. Participation was voluntary, and confidentiality of patient information was maintained throughout the study.

RESULTS

A total of 149 patients fulfilling the predefined eligibility criteria were included in the study. All patients underwent closed reduction and percutaneous pinning under image-intensifier guidance and were assessed for functional outcome at six months using the Modified Cooney Wrist Score. The study population consisted of adults aged 20–70 years with unilateral Frykman type I or II Colles' fractures presenting within seven days of injury, in accordance with the study protocol.

Table 1. Demographic characteristics of patients (n=149)

Variable	Category	n (%)
Age (years)	20–29	8 (5.4)
	30–39	18 (12.1)
	40–49	31 (20.8)
	50–59	51 (34.2)
	60–70	41 (27.5)
Gender	Male	63 (42.3)
	Female	86 (57.7)
Side involved	Right	79 (53.0)

Variable	Category	n (%)
	Left	70 (47.0)
BMI (kg/m²)	<18.5	5 (3.4)
	18.5–24.9	63 (42.3)
	25.0–29.9	59 (39.6)
	≥30.0	22 (14.8)
Socioeconomic status	Low	47 (31.5)
	Middle	78 (52.3)
	High	24 (16.1)
Educational level	No formal education	39 (26.2)
	Primary	32 (21.5)
	Secondary	51 (34.2)
	Graduate or above	27 (18.1)
Residential status	Urban	92 (61.7)
	Rural	57 (38.3)

The mean age of the study population was approximately 52 years, with patients aged 50–59 years comprising the largest age group. Female patients were slightly more frequent than males. Right-sided fractures were observed somewhat more frequently than left-sided fractures. The majority of patients had a BMI between 18.5 and 29.9 kg/m² and belonged to the middle socioeconomic category.

Table 2. Age and BMI of patients

Variable	Mean ± SD	Median (IQR)	Range
Age (years)	52.0 ± 11.0	53 (44–60)	20–70
BMI (kg/m²)	25.8 ± 3.5	25.5 (23.4–28.0)	17.9–34.8

Table 3. Fracture characteristics of patients (n=149)

Variable	Category	n (%)
Frykman classification	Type I	85 (57.0)
	Type II	64 (43.0)
Laterality	Right	79 (53.0)
	Left	70 (47.0)
Time from injury to presentation	0–2 days	71 (47.7)

Variable	Category	n (%)
	3–4 days	52 (34.9)
	5–7 days	26 (17.4)

Frykman type I fractures constituted a little over half of the study population, while type II fractures accounted for the remainder. Most patients presented within the first four days following injury.

Table 4. Functional outcome at 6 months according to Modified Cooney Wrist Score (n=149)

Functional outcome	Modified Cooney Wrist Score	n (%)
Excellent	90–100	78 (52.3)
Good	80–89	60 (40.3)
Fair	65–79	11 (7.4)
Total	—	149 (100.0)

At six months, 78 (52.3%) patients had an excellent functional outcome, 60 (40.3%) had a good outcome, and 11 (7.4%) had a fair outcome. Thus, the large majority of patients fell within the excellent or good functional categories.

Table 5. Modified Cooney Wrist Score and its component domains at 6 months

Parameter	Mean ± SD	Median (IQR)	Possible score
Pain	22.5 ± 3.4	23 (21–25)	0–25
Functional status	22.0 ± 3.5	23 (20–25)	0–25
Range of motion	22.1 ± 3.2	22 (20–25)	0–25
Grip strength	22.3 ± 3.4	23 (20–25)	0–25
Total Modified Cooney Wrist Score	88.9 ± 9.0	90 (84–95)	0–100

The overall Modified Cooney Wrist Score demonstrated generally favourable functional recovery at six months. Among the individual domains, pain, functional status, range of motion and grip strength showed comparable contributions to the total score. The score incorporated the four predefined domains, each contributing 25 points.

Table 6. Functional outcome according to age group

Age group (years)	Excellent n (%)	Good n (%)	Fair n (%)	Total
20–29	6 (75.0)	2 (25.0)	0 (0.0)	8
30–39	11 (61.1)	7 (38.9)	0 (0.0)	18
40–49	19 (61.3)	11 (35.5)	1 (3.2)	31
50–59	25 (49.0)	21 (41.2)	5 (9.8)	51
60–70	17 (41.5)	19 (46.3)	5 (12.2)	41

Age group (years)	Excellent n (%)	Good n (%)	Fair n (%)	Total
Total	78 (52.3)	60 (40.3)	11 (7.4)	149
p-value				0.441

Although the proportion of excellent outcomes tended to decrease across the older age groups, while fair outcomes were somewhat more frequent among older patients, the association between age group and functional outcome did not reach statistical significance.

Table 7. Functional outcome according to gender

Gender	Excellent n (%)	Good n (%)	Fair n (%)	Total
Male	34 (54.0)	25 (39.7)	4 (6.3)	63
Female	44 (51.2)	35 (40.7)	7 (8.1)	86
Total	78 (52.3)	60 (40.3)	11 (7.4)	149
p-value				0.895

The distribution of functional outcomes was broadly comparable between male and female patients, with no statistically significant association between gender and the six-month functional outcome.

Table 8. Functional outcome according to BMI

BMI category (kg/m²)	Excellent n (%)	Good n (%)	Fair n (%)	Total
<18.5	4 (80.0)	1 (20.0)	0 (0.0)	5
18.5–24.9	33 (52.4)	27 (42.9)	3 (4.8)	63
25.0–29.9	30 (50.8)	24 (40.7)	5 (8.5)	59
≥30.0	11 (50.0)	8 (36.4)	3 (13.6)	22
Total	78 (52.3)	60 (40.3)	11 (7.4)	149
p-value				0.718

No statistically significant association was observed between BMI category and functional outcome at six months.

Table 9. Functional outcome according to side of involvement

Side	Excellent n (%)	Good n (%)	Fair n (%)	Total
Right	41 (51.9)	31 (39.2)	7 (8.9)	79
Left	37 (52.9)	29 (41.4)	4 (5.7)	70
Total	78 (52.3)	60 (40.3)	11 (7.4)	149
p-value				0.983

Functional outcome was similarly distributed between right- and left-sided fractures, with no statistically significant difference.

Table 10. Functional outcome according to Frykman classification

Frykman type	Excellent n (%)	Good n (%)	Fair n (%)	Total
Type I	45 (52.9)	34 (40.0)	6 (7.1)	85
Type II	33 (51.6)	26 (40.6)	5 (7.8)	64
Total	78 (52.3)	60 (40.3)	11 (7.4)	149
p-value				0.978

The functional outcome distribution was similar for Frykman type I and type II fractures, and no statistically significant association was found.

Table 11. Functional outcome according to socioeconomic status

Socioeconomic status	Excellent n (%)	Good n (%)	Fair n (%)	Total
Low	24 (51.1)	19 (40.4)	4 (8.5)	47
Middle	40 (51.3)	32 (41.0)	6 (7.7)	78
High	14 (58.3)	9 (37.5)	1 (4.2)	24
Total	78 (52.3)	60 (40.3)	11 (7.4)	149
p-value				0.954

The functional outcome categories were not significantly associated with socioeconomic status.

Table 12. Functional outcome according to educational level

Educational level	Excellent n (%)	Good n (%)	Fair n (%)	Total
No formal education	20 (51.3)	15 (38.5)	4 (10.3)	39
Primary	17 (53.1)	12 (37.5)	3 (9.4)	32
Secondary	26 (51.0)	21 (41.2)	4 (7.8)	51
Graduate or above	15 (55.6)	12 (44.4)	0 (0.0)	27
Total	78 (52.3)	60 (40.3)	11 (7.4)	149
p-value				0.819

No significant association was observed between educational level and functional outcome.

Table 13. Functional outcome according to residential status

Residential status	Excellent n (%)	Good n (%)	Fair n (%)	Total
Urban	48 (52.2)	34 (37.0)	10 (10.9)	92
Rural	30 (52.6)	26 (45.6)	1 (1.8)	57
Total	78 (52.3)	60 (40.3)	11 (7.4)	149

Residential status	Excellent n (%)	Good n (%)	Fair n (%)	Total
p-value				0.488

There was no statistically significant association between residential status and functional outcome at six months. Overall, the functional results at six months were predominantly within the excellent and good categories. More than half of the patients achieved an excellent Modified Cooney Wrist Score, while approximately two-fifths had a good outcome. Fair functional recovery was observed in a relatively small proportion of patients. None of the examined demographic or fracture-related variables demonstrated a statistically significant association with functional outcome at the predefined significance level of $p \leq 0.05$.

Figures

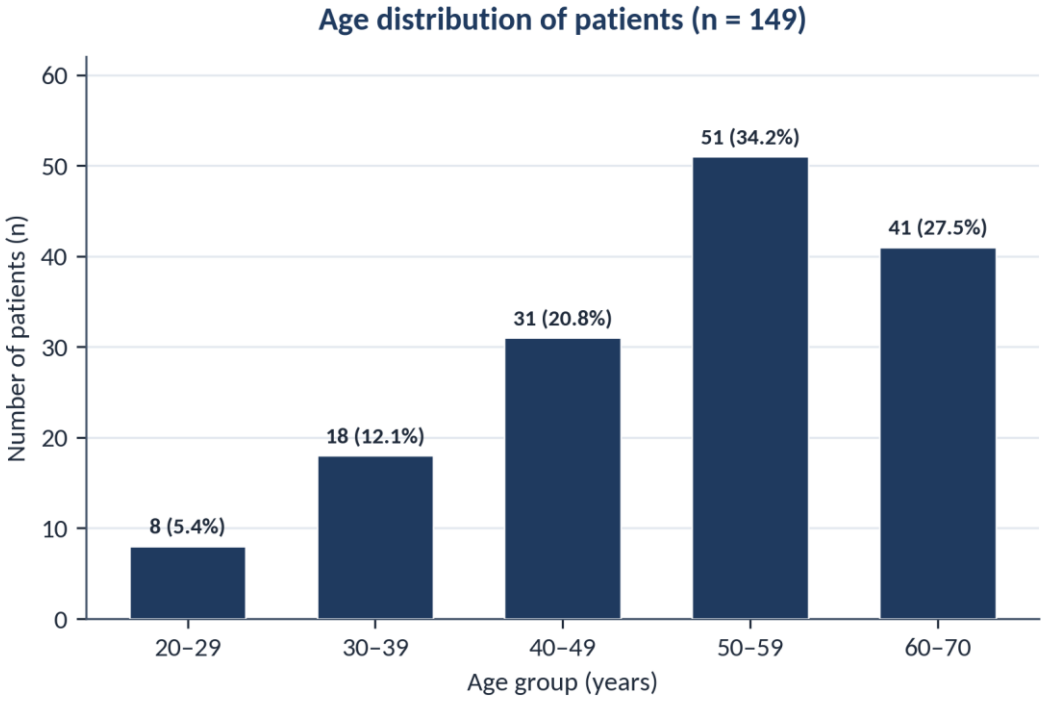


Figure 1. Age distribution of patients (n = 149).
Bars show number of patients (n) with percentage of total in parentheses.

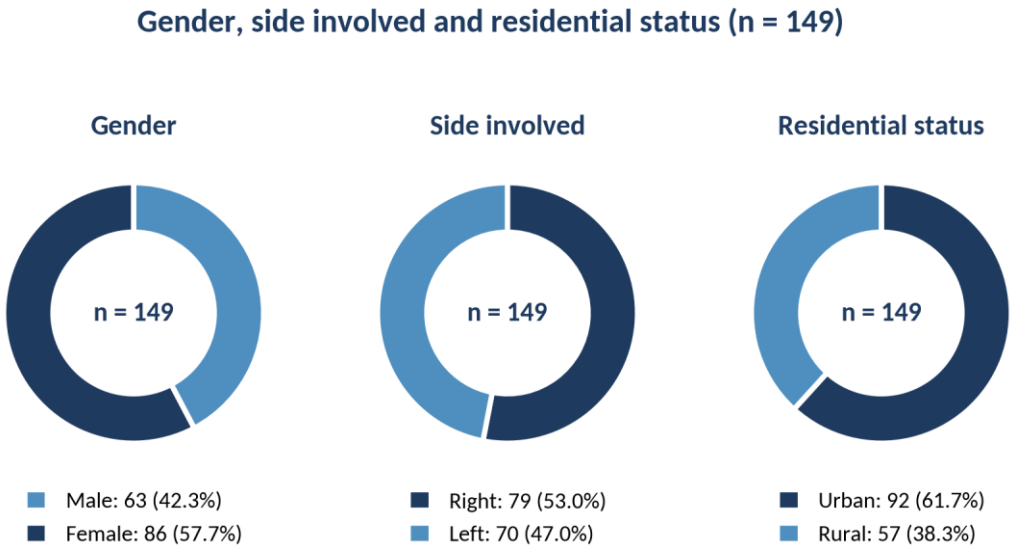


Figure 2. Distribution of patients by gender, side involved and residential status (n = 149).
Values shown as n (%).

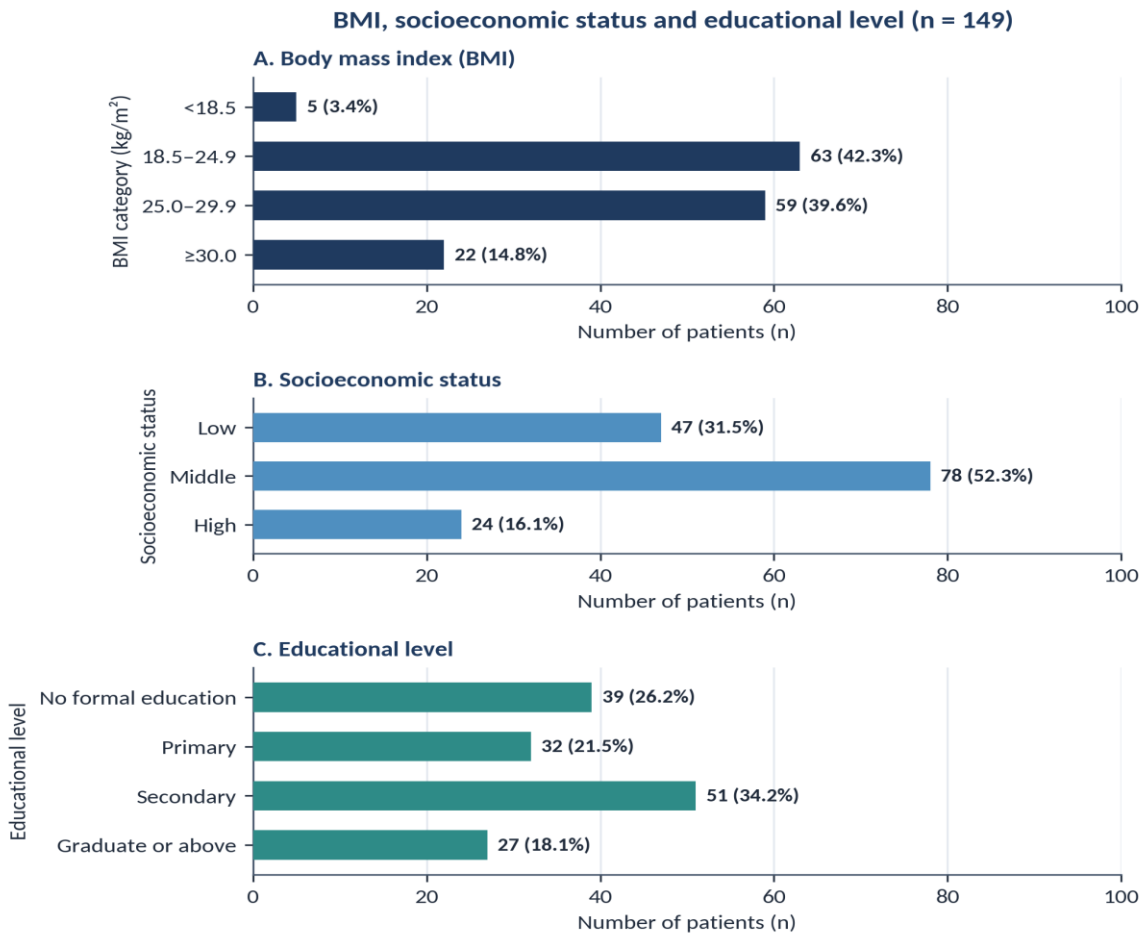


Figure 3. Distribution of patients by body mass index category, socioeconomic status and educational level (n = 149).

Bars show number of patients (n); percentage of total in parentheses.

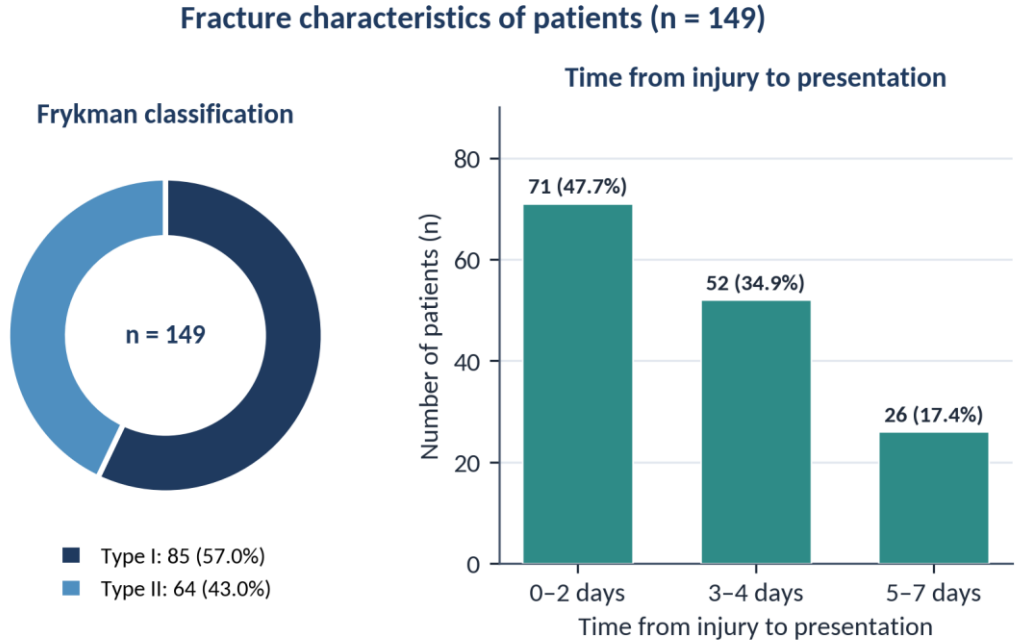


Figure 4. Fracture characteristics of patients: Frykman classification and time from injury to presentation (n = 149).

Values shown as n (%).

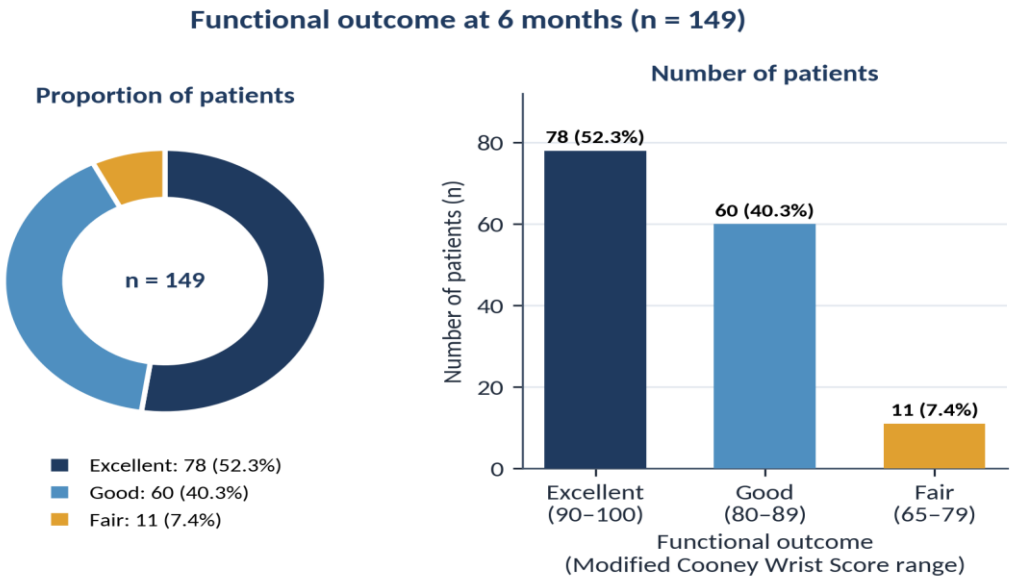


Figure 5. Functional outcome at 6 months according to the Modified Cooney Wrist Score (n = 149). Excellent = 90–100, Good = 80–89, Fair = 65–79. Values shown as n (%).

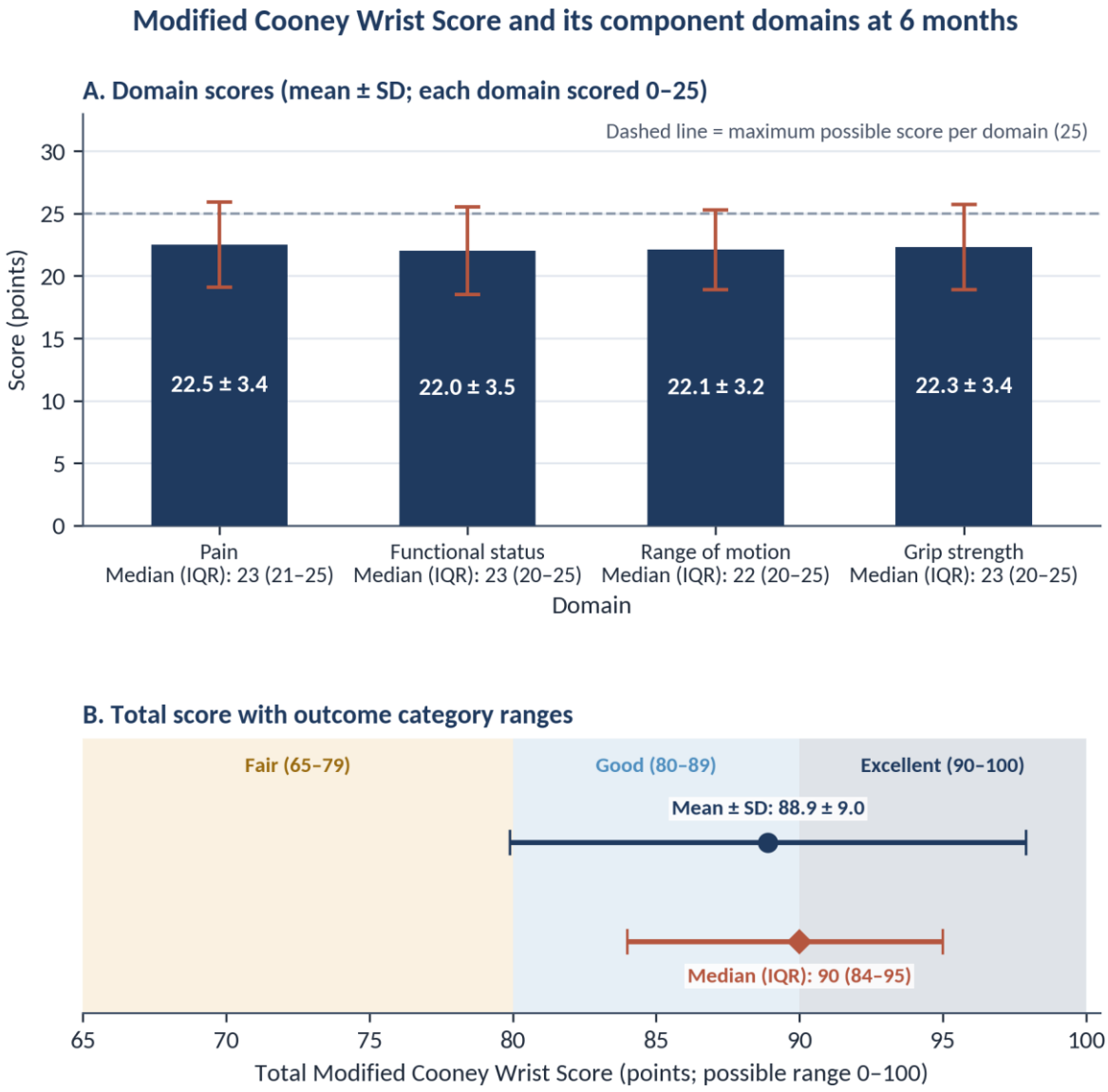


Figure 6. Modified Cooney Wrist Score and its component domains at 6 months.
(A) Mean ± SD for each domain (possible score 0–25) with median (IQR) below each domain. (B) Total score (possible score 0–100): mean ± SD and median (IQR) shown against the outcome category ranges.

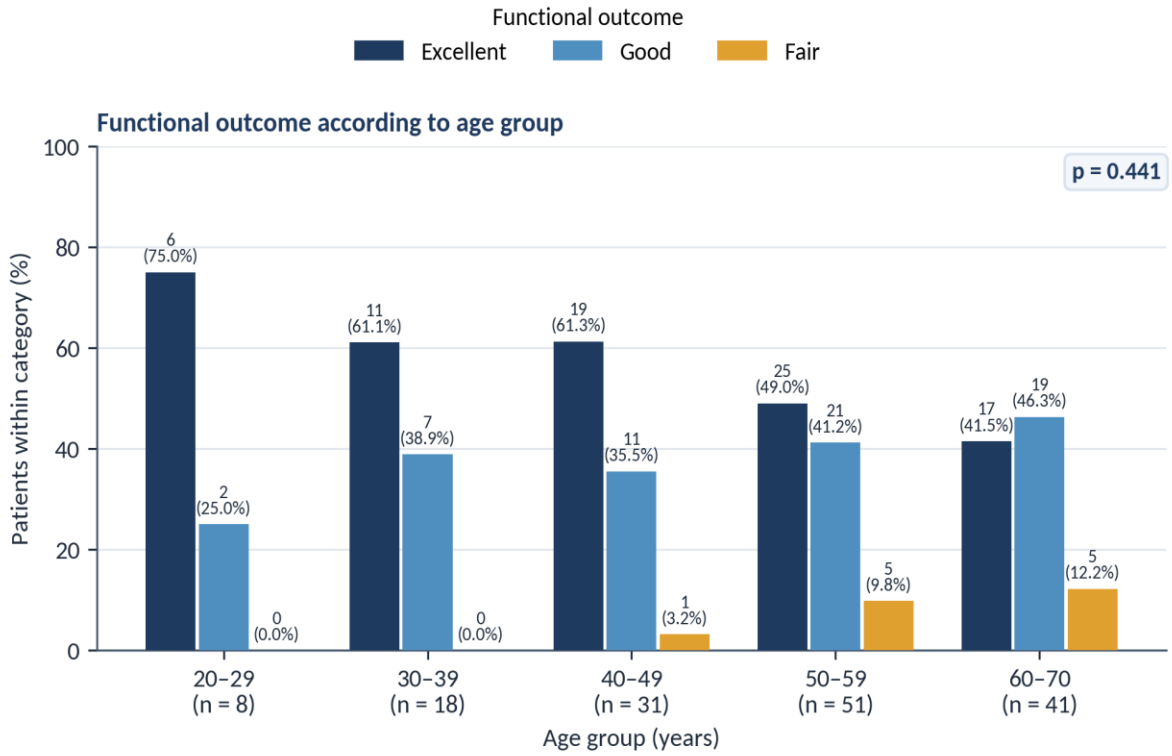


Figure 7. Functional outcome at 6 months according to age group.
Bars show percentage of patients within each age group; labels show n (%). p = 0.441.

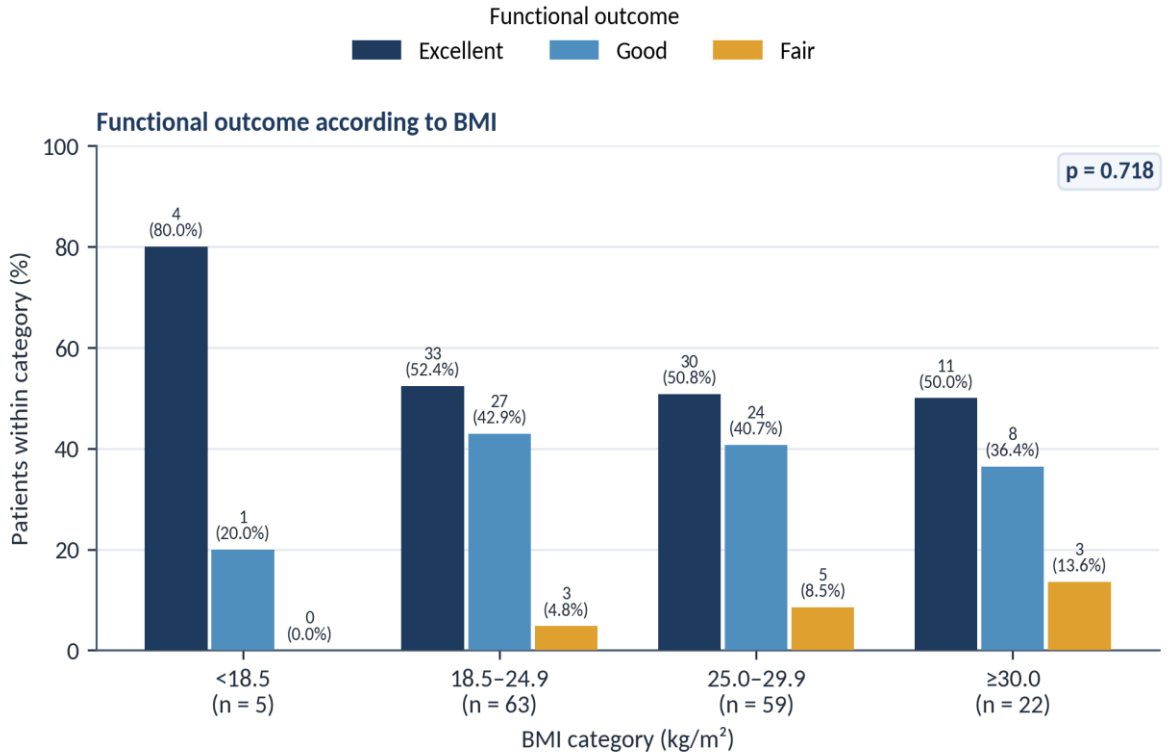


Figure 8. Functional outcome at 6 months according to BMI category.
Bars show percentage of patients within each BMI category; labels show n (%). p = 0.718.

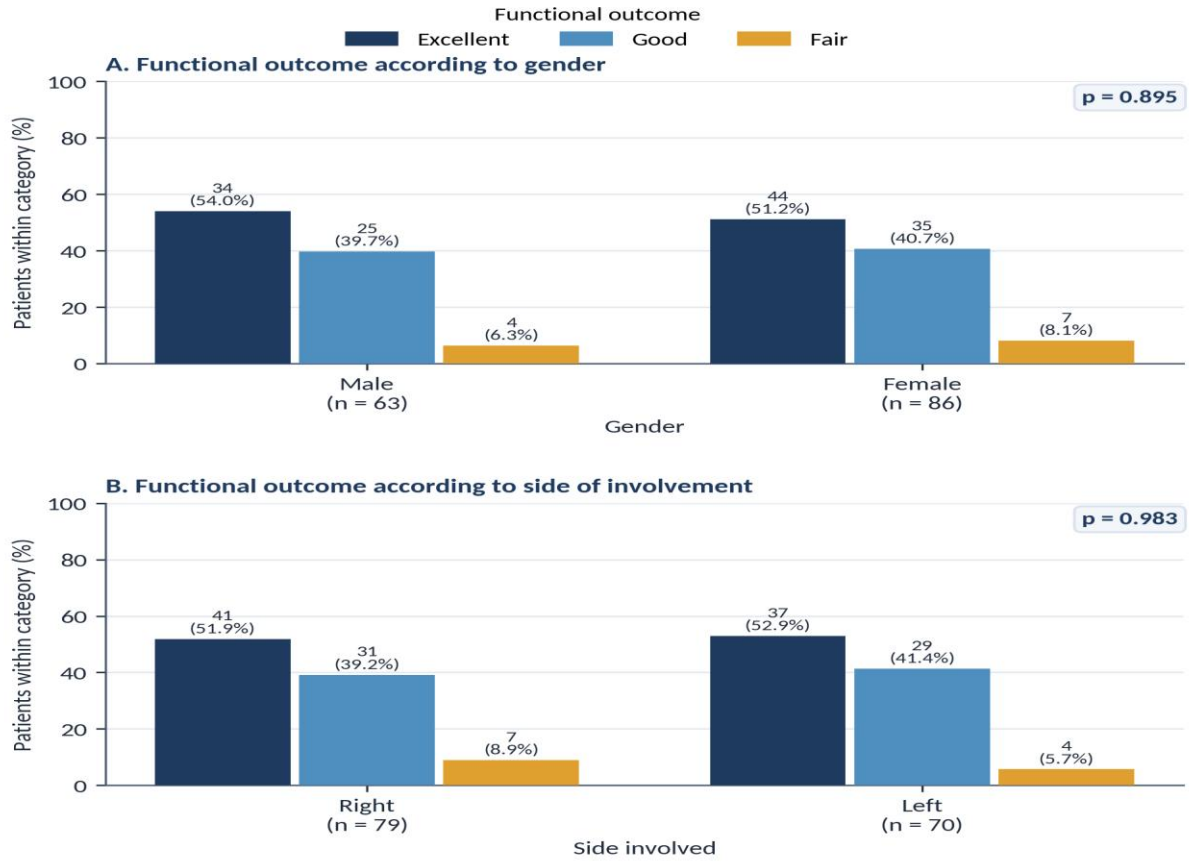


Figure 9. Functional outcome at 6 months according to (A) gender and (B) side of involvement. Bars show percentage of patients within each category; labels show n (%).

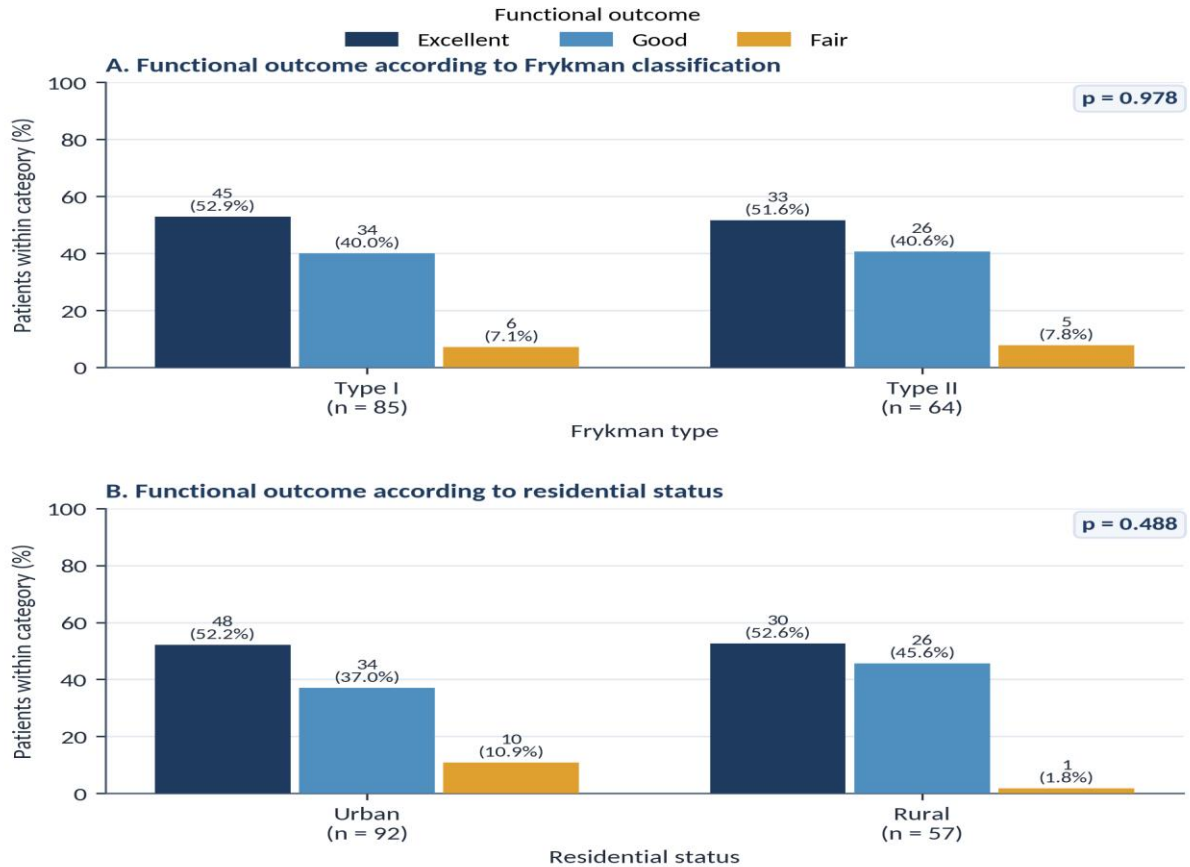


Figure 10. Functional outcome at 6 months according to (A) Frykman classification and (B) residential status. Bars show percentage of patients within each category; labels show n (%).

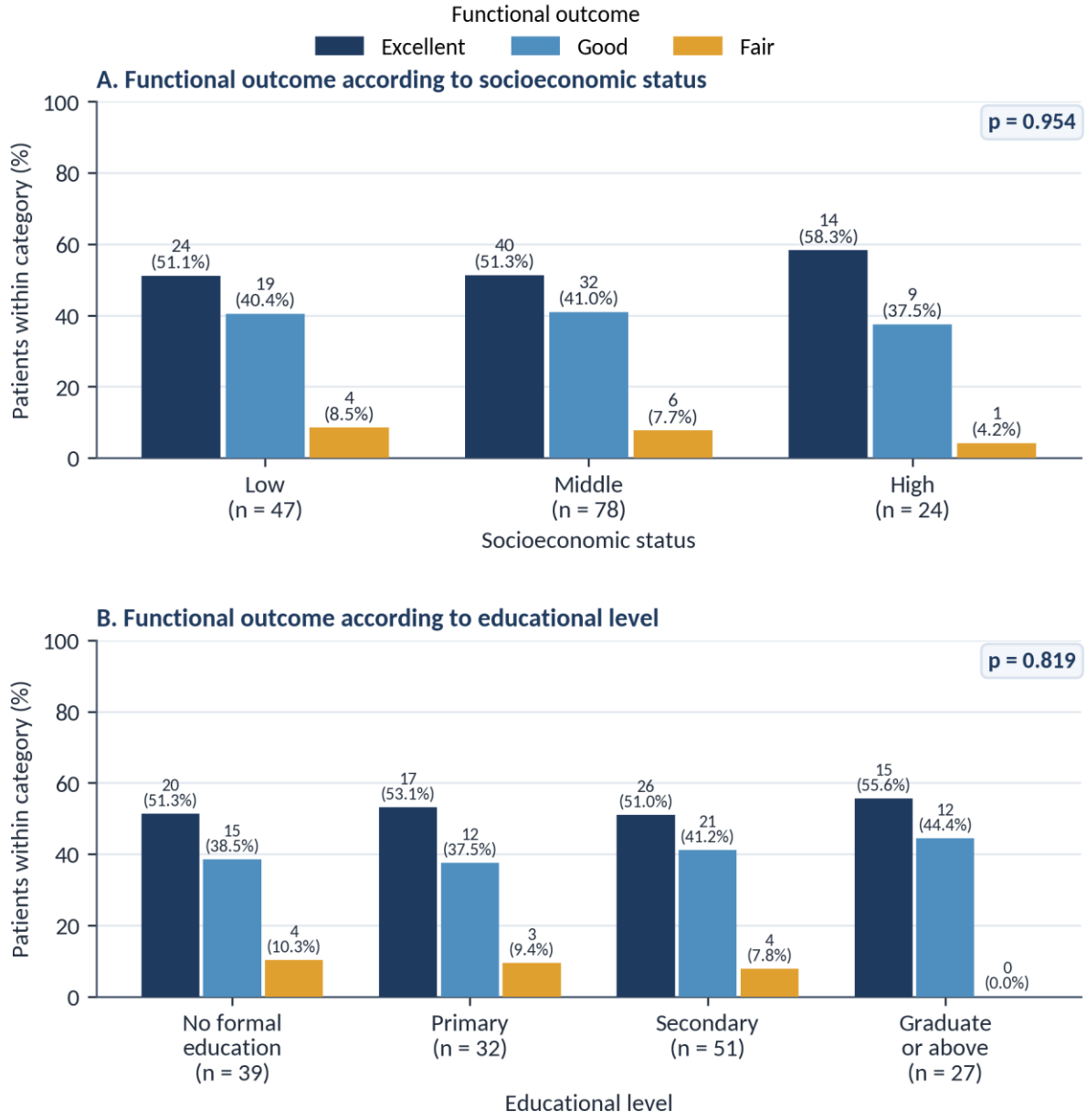


Figure 11. Functional outcome at 6 months according to (A) socioeconomic status and (B) educational level. Bars show percentage of patients within each category; labels show n (%).

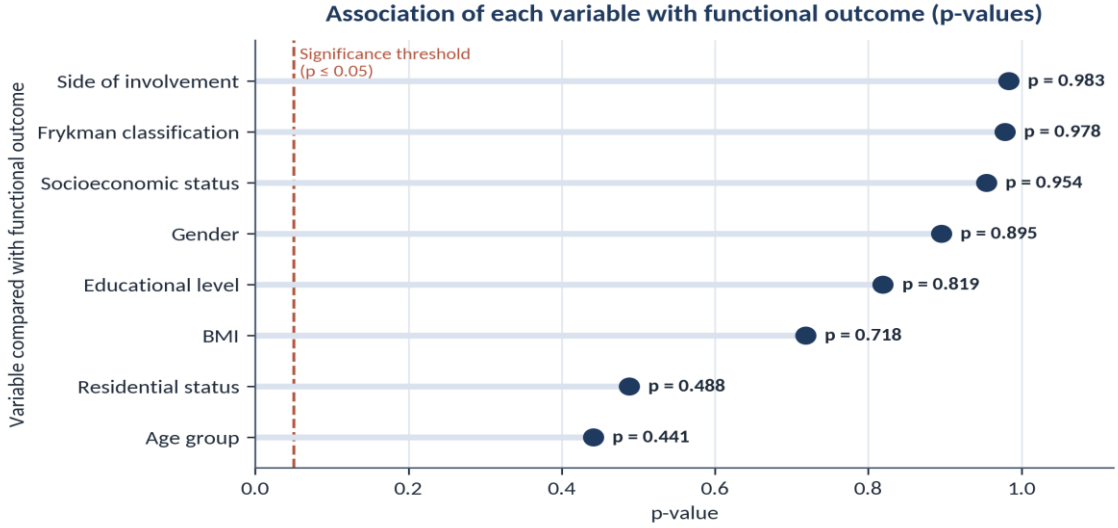


Figure 12. P-values for the association between each variable and functional outcome. Dashed line marks the predefined significance level ($p \leq 0.05$). No variable reached statistical significance.

DISCUSSION

This study evaluated the functional outcome of closed reduction and percutaneous pinning (CRPP) under image-intensifier guidance in 149 adults with unilateral Colles' fracture. The main finding was that functional recovery at six months was generally favorable: 78 (52.3%) patients achieved an excellent outcome, 60 (40.3%) achieved a good outcome, and only 11 (7.4%) had a fair outcome according to the predefined Modified Cooney Wrist Score. These findings support the role of CRPP as a useful method for appropriately selected dorsally displaced, extra-articular distal radius fractures in which satisfactory closed reduction can be obtained and maintained. The study was intentionally limited to Frykman type I and II fractures and therefore represents a relatively defined fracture population rather than the full spectrum of distal radius fractures.

The demographic pattern observed in the study was consistent with the recognized epidemiology of distal radius fractures. The mean age was approximately 52 years, with patients aged 50–59 years forming the largest age group, and women constituted 57.7% of the study population. Distal radius fractures become increasingly common with advancing age, particularly in the presence of reduced bone quality, while younger patients may present after higher-energy trauma.[1,2] The predominance of female patients in the current series is therefore clinically plausible and is also consistent with the demographic pattern reported in previous Colles' fracture studies. In the prospective study by Panthi et al., for example, 60 of 90 patients were female and the mean age was 54.93 years.[8]

The most important observation was the overall functional result at six months. More than half of the patients achieved an excellent score, while a further 40.3% achieved a good score. Only a small proportion had a fair result. This pattern is particularly relevant because the Modified Cooney Wrist Score assesses several clinically meaningful domains, including pain, functional status, range of motion and grip strength, rather than relying on radiographic appearance alone. This multidimensional approach is appropriate when the objective is to determine whether a patient has regained useful wrist function following fracture treatment. Contemporary recommendations for distal radius fracture outcome assessment similarly emphasize standardized measurement of pain, function, performance and other clinically relevant domains.[16]

The functional distribution in the present study is close to that reported by Panthi et al., who found excellent, good and fair outcomes in 53.33%, 40% and 6.67% of patients, respectively, at six months after closed reduction and K-wire fixation of displaced Colles' fractures.[8] The similarity is noteworthy because both studies evaluated a relatively selective Colles' fracture population and used six months as the principal endpoint. However, the numerical results should not be regarded as directly equivalent because the outcome thresholds used in the two studies were not identical. In the present study, excellent, good and fair outcomes were defined as 90–100, 80–89 and 65–79 points, respectively, whereas the Cooney score categories used by Panthi et al. differed.[8] The current findings therefore provide supportive evidence in the same general direction rather than a strict one-to-one comparison.

The favorable functional outcome observed in this study can be considered in the context of the mechanical purpose of CRPP. Closed reduction restores the displaced distal radius without extensive surgical exposure, while percutaneous K-wires provide additional stability and help maintain the reduction during healing. The use of image intensification allows assessment of reduction and wire position during the procedure. This approach is particularly suited to fractures in which satisfactory alignment can be achieved by manipulation and in which the fracture pattern is sufficiently stable after fixation. The current study protocol incorporated fluoroscopic confirmation of reduction and fixation and used two or three 1.8-mm K-wires according to fracture stability. The Cochrane review of percutaneous pinning has emphasized that the evidence surrounding pinning is heterogeneous and that outcomes depend on fracture stability and the specific fixation technique used rather than on the use of K-wires in isolation.[6]

The present findings should not, however, be interpreted as evidence that K-wire fixation is universally superior to volar plating. Comparative evidence remains mixed. An earlier meta-analysis reported some functional advantages of volar plating, particularly for DASH scores, while finding no clear difference in several other clinical outcomes.[11] More recently, a meta-analysis of randomized controlled trials reported better early and one-year DASH scores with volar locking plates, together with some early advantages in grip strength and wrist motion, but also concluded that both techniques are effective and that the overall evidence does not establish unequivocal superiority of one method.[12] The 2025 systematic review already cited in the Introduction similarly concluded that K-wire fixation remains a viable alternative despite marginal functional advantages reported with plating at some time points.[7] These findings are important because the present investigation was not designed as a comparative trial; it was designed to determine the functional outcome achieved with CRPP in a predefined Colles' fracture cohort.

Longer-term comparative evidence also provides useful context. In the multicentre randomized trial by Costa et al., no clinically relevant difference in patient-rated wrist evaluation was identified between K-wire fixation and volar locking-plate fixation during five years of follow-up in adults with dorsally displaced distal radius fractures.[13] This suggests that differences observed between fixation methods during the early recovery period may become less pronounced with time. A similar pattern has been reported in a Pakistani study from Rawalpindi, in which functional differences between volar plating and conventional percutaneous K-wire fixation were present at six weeks but were no longer statistically significant at three and six months.[18] These observations are relevant

to the current study because the principal endpoint was six-month function, when the immediate postoperative advantages of one fixation method over another may be less apparent.

An important feature of the present study was that functional outcome was not significantly associated with age, gender, BMI, side of involvement or Frykman classification. Although the proportion of excellent results tended to be lower in older patients and fair outcomes were somewhat more frequent in the 60–70-year age group, these differences did not reach statistical significance. A similar lack of significant associations was observed for gender, BMI and fracture type. These findings should be interpreted conservatively. The study was designed primarily to describe the frequency of functional outcomes rather than to establish independent predictors, and the relatively small number of patients with fair outcomes limits the precision of subgroup comparisons. In addition, restriction of the sample to Frykman type I and II fractures reduced fracture heterogeneity and may have contributed to the absence of marked differences between fracture subgroups.

The absence of a significant association between radiographic/fracture classification and functional outcome is also consistent with the broader literature showing that radiographic restoration and clinical function are related but not interchangeable outcomes. Radiographic assessment commonly includes radial inclination, radial height, volar or dorsal tilt and ulnar variance, but there is substantial variation in how these measurements are defined and interpreted between studies.[14] A systematic review and meta-analysis found that unacceptable radiological reduction was associated with worse patient-reported outcomes, particularly with respect to dorsal angulation and ulnar variance, but the magnitude of these differences did not consistently reach the threshold for clinical importance.[15] This supports the approach taken in the present study, in which restoration of alignment was an important surgical objective but functional recovery at six months remained the primary endpoint.

The postoperative rehabilitation protocol may also have contributed to the favorable functional recovery observed. In the present study, K-wires were removed after evidence of adequate fracture healing, after which wrist mobilization exercises were initiated, with physiotherapy supervision where required. Recovery of wrist motion and grip strength is dependent not only on fracture fixation but also on restoration of movement following immobilization. However, the evidence concerning the optimal rehabilitation strategy after distal radius fracture remains uncertain; a Cochrane review found considerable heterogeneity among rehabilitation interventions and generally low or very low certainty of evidence for many comparisons.[15] Therefore, the favorable outcome in the current series should be viewed as the result of the complete treatment pathway, including reduction, fixation, immobilization, subsequent mobilization and follow-up, rather than attributed to K-wire fixation alone.

The socioeconomic, educational and residential characteristics recorded in the present study were not significantly associated with six-month functional outcome. These observations are potentially relevant to the local clinical setting because patients attending a tertiary teaching hospital may have considerable variation in educational background, socioeconomic circumstances and place of residence. Nevertheless, these variables should not be interpreted as direct determinants of recovery on the basis of the present findings. The study was not designed to examine the mechanisms through which socioeconomic or educational factors might affect rehabilitation adherence, access to physiotherapy or return to work. Their inclusion was primarily descriptive and exploratory, in keeping with the predefined statistical analysis plan.

The use of a standardized wrist score is another strength of the study. The Cooney-type scoring system incorporates pain, function, range of motion and grip strength, thereby providing a clinically understandable summary of recovery.[17] At the same time, contemporary outcome methodology emphasizes that no single measure fully captures recovery after a distal radius fracture and that patient-reported measures can complement clinical and radiographic assessments.[16] Consequently, future local studies could strengthen the evidence by combining the Modified Cooney Wrist Score with a validated patient-reported measure such as PRWE or DASH/QuickDASH, together with standardized radiographic parameters.

Strengths

This study has several important strengths. First, it included a relatively large sample of 149 patients from a tertiary-care teaching hospital, providing locally relevant evidence regarding the functional recovery of patients with Colles' fracture treated with CRPP. Second, the study population was defined using specific clinical and radiological eligibility criteria and was restricted to unilateral Frykman type I and II fractures, which reduced heterogeneity within the study population.

Another strength was the use of a clearly defined operative technique performed under image-intensifier guidance, with fluoroscopic confirmation of reduction and K-wire placement. The study also incorporated a structured postoperative follow-up pathway, including radiographic assessment, appropriate timing of K-wire removal and subsequent wrist mobilization.

Functional outcome was assessed using the Modified Cooney Wrist Score at a predefined six-month endpoint. The score incorporates pain, functional status, range of motion and grip strength, allowing functional recovery to be assessed from several clinically relevant domains rather than relying solely on radiographic findings.

Finally, the study prospectively recorded a range of demographic and fracture-related variables and used predefined statistical methods to examine their association with functional outcome. This provides a broader description of the patient population and allows the observed functional results to be considered across clinically relevant subgroups.

Limitations

This study has several limitations that should be considered when interpreting the findings. It was conducted at a single tertiary-care teaching hospital using a descriptive longitudinal design and non-probability consecutive sampling; therefore, the findings may not be directly generalizable to all healthcare settings or to patients with other patterns of distal radius fracture.

The study did not include a comparison group treated with cast immobilization, external fixation or volar plate fixation. Consequently, the present findings describe the functional outcome following CRPP but cannot establish whether CRPP provides superior or equivalent results compared with alternative treatment methods. In addition, the study was limited to Frykman type I and II fractures and excluded comminuted, pathological and associated injuries, which further limits extrapolation of the findings to more complex distal radius fractures.

Functional outcome was assessed at six months, providing useful intermediate-term information; however, longer follow-up would be required to evaluate persistent disability, late complications and post-traumatic degenerative changes. Furthermore, the study focused primarily on the Modified Cooney Wrist Score and did not include additional patient-reported outcome measures such as PRWE or DASH. Finally, although demographic and fracture-related variables were examined for association with functional outcome, the observational design does not permit determination of independent causal predictors of recovery.

CONCLUSION

Closed reduction and percutaneous pinning under image-intensifier guidance resulted in predominantly favorable functional outcomes at six months among the selected adults with Colles' fracture included in this study. More than half of the patients achieved an excellent functional outcome, while most of the remaining patients achieved a good outcome according to the Modified Cooney Wrist Score. Fair functional outcomes were observed in only a small proportion of patients.

No statistically significant association was observed between six-month functional outcome and the demographic or fracture-related variables examined in this study. Within the defined population of unilateral Frykman type I and II Colles' fractures, these findings support CRPP as a practical treatment option when satisfactory closed reduction can be achieved and maintained. Further comparative, multicenter studies with longer follow-up are needed to evaluate CRPP in relation to other fixation methods and across a broader range of distal radius fracture patterns.

Additional Information

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Authors contribution

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