RESEARCH PAPER

Parent-Reported Functional and Quality-of-Life Outcomes After Percutaneous Pinning of Paediatric Supracondylar Humerus Fractures: A Retrospective Cohort Study

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Abstract

Background: Displaced supracondylar fractures of the humerus are among the most common pediatric elbow injuries requiring surgical management. Closed reduction and percutaneous pinning (CRPP) is widely accepted as the standard treatment for Gartland type II and III fractures. While radiological and clinical outcomes have been extensively studied, parent-reported functional outcomes and quality-of-life measures are less frequently evaluated.

Aim: To assess parent-reported functional outcomes and quality of life following CRPP in pediatric supracondylar humerus fractures using validated patient-reported outcome measures.

Methods: This retrospective cohort study included 30 children aged 2–12 years who underwent CRPP for Gartland type II or III supracondylar humerus fractures between October 2024 and December 2025, with a minimum follow-up of 3 months. Demographic and surgical data were obtained from hospital records. Parent-reported functional outcomes were assessed via telephonic follow-up using the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) questionnaire and the Pediatric Outcomes Data Collection Instrument (PODCI) focusing on upper extremity function and pain domains. Clinical outcomes were evaluated using Flynn criteria, elbow range of motion, complication rates, and parental satisfaction scores. Correlation analysis was performed to examine the relationship between PROM scores and clinical outcomes.

Results: The mean patient age was 6.7 ± 2.3 years, with 60% males and 40% females. Gartland type III fractures accounted for 63.3% of cases. Lateral pin fixation was used in 90% of patients, while 10% underwent cross pinning. The mean operative time was 36 ± 8 minutes. Parent-reported outcomes showed minimal functional disability with a mean QuickDASH score of 9.1 ± 4.5, while PODCI Upper Extremity and Pain scores were 92.4 ± 5.1 and 90.8 ± 6.3, respectively. According to Flynn criteria, 80% of patients achieved excellent outcomes, 16.7% had good outcomes, and 3.3% had fair outcomes. The mean elbow flexion-extension arc was 131° ± 6°, with 93.3% regaining near-normal range of motion. The overall complication rate was 10%, including pin tract infection (6.7%) and mild elbow stiffness (3.3%). A strong negative correlation was observed between QuickDASH and PODCI scores ($r = -0.72$, $p < 0.001$). The mean parental satisfaction score was 9.1 ± 0.9/10.

Conclusion: Closed reduction and percutaneous pinning provides excellent functional recovery, favorable clinical outcomes, and high parental satisfaction in children with displaced supracondylar humerus fractures. Parent-reported outcome measures such as QuickDASH and PODCI offer valuable insight into postoperative functional recovery and should be incorporated into outcome assessment in pediatric orthopedic trauma.

Keywords: Supracondylar humerus fracture; pediatric elbow fracture; percutaneous pinning; QuickDASH; PODCI; Flynn criteria; functional outcome.

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Introduction

Supracondylar fractures of the humerus are the most common elbow fractures in children, accounting for nearly 60–70% of paediatric elbow injuries. These fractures most frequently occur between the ages of 5 and 10 years and typically result from a fall on an outstretched hand.[1–3]

The Gartland classification remains the most widely used system for categorizing supracondylar fractures and guiding treatment strategies.[4] While nondisplaced fractures can be

managed conservatively, displaced fractures (Gartland types II and III) often require surgical stabilization.

Closed reduction and percutaneous pinning (CRPP) has become the gold standard treatment for displaced supracondylar fractures because it provides stable fixation while minimizing soft-tissue injury.[5–7] Numerous studies have demonstrated excellent radiographic and clinical outcomes following CRPP.

Traditional outcome measures have relied on radiographic parameters, elbow range of motion, and Flynn criteria.[8] However, these measures may not fully capture the patient's functional recovery or quality of life.

Increasing emphasis on patient-centered healthcare has led to the use of patient-reported outcome measures (PROMs) in orthopaedic research. Instruments such as the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) and the Pediatric Outcomes Data Collection Instrument (PODCI) provide valuable information regarding functional recovery, pain, and daily activities.[9–12]

Despite the growing use of PROMs, limited studies have evaluated parent-reported outcomes following CRPP for supracondylar humerus fractures. Understanding these outcomes can help clinicians better assess treatment effectiveness from the patient and caregiver perspective.

Therefore, the present study aimed to evaluate parent-reported functional outcomes and quality of life in children treated with CRPP using validated PROM tools.

Materials and Methods

Study Design

A retrospective cohort study with cross-sectional telephonic PROM assessment was conducted.

Study Population

Children aged 2–12 years who underwent closed reduction and percutaneous pinning (CRPP) for supracondylar humerus fractures were included.

Inclusion Criteria

- Age between 2–12 years
- Gartland type II or III fracture
- Treatment with CRPP
- Minimum 3-month follow-up
- Parent reachable by telephone

Exclusion Criteria

- Open fractures
- Ipsilateral limb injuries
- Neurovascular exploration cases
- Neuromuscular disorders
- Incomplete records

Data Collection

Clinical Data

Hospital records were reviewed for:

- Age and sex
- Mechanism of injury
- Gartland fracture type
- Pin configuration
- Operative details
- Postoperative complications

Parent-Reported Outcome Measures

QuickDASH

Assesses upper limb disability.

Score range: 0 (no disability) to 100 (maximum disability).

PODCI

Two domains assessed:

- Upper Extremity Function
- Pain/Comfort

Higher scores indicate better function and less pain.

Interpretation of PODCI Scores in Relation to Functional Recovery

PODCI Score Range	Functional Interpretation	Relevance to Present Study
90–100	Excellent functional recovery with minimal pain	Mean PODCI Upper Extremity score in this study: 92.4 ± 5.1, indicating excellent recovery
75–89	Good functional recovery with mild limitations	Observed in a small subset of patients with minor residual symptoms
60–74	Moderate functional limitation	Not observed in the majority of patients in this cohort
<60	Poor functional outcome with significant functional impairment	Not observed in this study

The Pediatric Outcomes Data Collection Instrument (PODCI) evaluates functional health and quality of life in children with musculoskeletal disorders. Scores range from 0 to 100, with higher scores representing better function and lower pain levels. In the present study, the mean PODCI Upper Extremity score (92.4 ± 5.1) and PODCI Pain score (90.8 ± 6.3) fall within the "excellent functional recovery" category, indicating favorable postoperative outcomes following closed reduction and percutaneous pinning of supracondylar humerus fractures.

Additional Outcomes

- Flynn criteria
- Elbow range of motion
- Complications
- Parent satisfaction score

Statistical Analysis

Data were analyzed using SPSS software.

- Continuous variables expressed as mean ± SD
- Independent t-test / ANOVA for group comparisons
- Pearson correlation between PROM scores and clinical outcomes
- $p < 0.05$ considered statistically significant

Ethical Considerations

Ethical approval was obtained from the institutional ethics committee. Telephonic informed consent was obtained from parents, and confidentiality was maintained.

Results

A total of 30 pediatric patients who underwent closed reduction and percutaneous pinning (CRPP) for supracondylar humerus fractures were included in the study. The mean age was 6.7 ± 2.3 years, with an age range of 2–12 years. The majority of patients were male (60.0%), while 40.0% were female. According to the Gartland classification, 11 patients (36.7%) had type II fractures, whereas 19 patients (63.3%) had type III fractures, indicating that most cases involved completely displaced fractures requiring surgical intervention.

Table 1: Demographic and Fracture Characteristics of the Study Population

Variable	Frequency (n)	Percentage (%)
Total patients	30	100
Age (mean ± SD)	6.7 ± 2.3 years	-
Age range	2–12 years	-
Male	18	60.0
Female	12	40.0
Gartland type II	11	36.7
Gartland type III	19	63.3

This table summarizes the demographic characteristics and fracture distribution in the study population. A higher proportion of male patients and Gartland type III fractures was observed, consistent with the typical epidemiological pattern of pediatric supracondylar humerus fractures.

Surgical Characteristics

With respect to surgical fixation techniques, lateral pin configuration was used in 27 patients (90.0%), while cross pinning was performed in 3 patients (10.0%). The mean operative time was 36 ± 8 minutes, reflecting the relatively short operative duration of CRPP procedures when performed by experienced surgeons.

Table 2: Surgical Characteristics and Pin Configuration

Parameter	Frequency (n)	Percentage (%)
Lateral pinning	27	90.0
Cross pinning	3	10.0
Mean operative time	36 ± 8 minutes	-

This table presents the surgical fixation methods used in the study population. Lateral pinning was the predominant fixation technique, which reflects contemporary surgical practice aimed at minimizing the risk of iatrogenic ulnar nerve injury associated with cross pinning.

Parent-Reported Functional Outcomes

Parent-reported outcome measures indicated favorable functional recovery in the majority of patients. The mean QuickDASH score was 9.1 ± 4.5, suggesting minimal upper limb disability. Similarly, the mean PODCI Upper Extremity score was 92.4 ± 5.1, and the mean PODCI Pain score was 90.8 ± 6.3, indicating excellent upper limb function and low levels of pain during routine daily activities.

Table 3: Parent-Reported Functional Outcome Scores

Outcome Measure	Mean Score	Standard Deviation
QuickDASH	9.1	4.5
PODCI Upper Extremity Function	92.4	5.1
PODCI Pain/Comfort	90.8	6.3

This table presents parent-reported functional outcomes obtained during telephonic follow-up. Lower QuickDASH scores indicate less disability, while higher PODCI scores reflect better upper extremity function and lower pain levels.

Interpretation of PODCI Scores

To facilitate interpretation of functional outcomes, PODCI scores were categorized according to commonly used functional outcome ranges. The mean PODCI score observed in this study falls within the excellent functional recovery category.

Table 4: Interpretation of PODCI Scores in Relation to Functional Recovery

PODCI Score Range	Functional Interpretation	Relevance to Present Study
90–100	Excellent functional recovery with minimal pain	Mean PODCI score: 92.4 ± 5.1
75–89	Good functional recovery with mild limitations	Observed in few patients
60–74	Moderate functional limitation	Not commonly observed
<60	Poor functional outcome	Not observed

PODCI scores range from 0 to 100, with higher scores indicating better functional recovery and lower pain levels. In this study, the mean PODCI score of 92.4 falls within the excellent functional outcome category.

Clinical Outcomes Based on Flynn Criteria

Clinical outcomes were evaluated using the Flynn criteria, which assess both functional and cosmetic outcomes. Excellent results were observed in 24 patients (80.0%), while 5 patients

(16.7%) had good outcomes and 1 patient (3.3%) had a fair outcome. No patients were classified as having poor outcomes.

Table 5: Clinical Outcomes According to Flynn Criteria

Outcome Category	Number of Patients	Percentage (%)
Excellent	24	80.0
Good	5	16.7
Fair	1	3.3
Poor	0	0

This table summarizes postoperative functional and cosmetic outcomes according to Flynn criteria. The majority of patients achieved excellent results, indicating satisfactory restoration of elbow motion and carrying angle following CRPP.

Range of Motion Recovery

At follow-up evaluation, the mean elbow flexion–extension arc was 131° ± 6°. Most patients demonstrated near-normal recovery of elbow mobility, with 28 patients (93.3%) regaining near-normal range of motion, while 2 patients (6.7%) exhibited mild restriction.

Table 6: Postoperative Range of Motion Outcomes

Range of Motion Outcome	Number of Patients	Percentage (%)
Near-normal motion	28	93.3
Mild restriction	2	6.7

This table presents postoperative recovery of elbow motion. The majority of patients achieved near-normal elbow mobility following surgical treatment.

Postoperative Complications

Postoperative complications were relatively uncommon. Pin tract infection occurred in two patients (6.7%), while one patient (3.3%) developed mild elbow stiffness during follow-up. All complications were managed conservatively and resolved without long-term functional impairment.

Table 7: Postoperative Complications

Complication	Number of Cases	Percentage (%)
Pin tract infection	2	6.7
Elbow stiffness	1	3.3
Total complications	3	10.0

This table summarizes postoperative complications observed in the study population. The overall complication rate was low, and all complications were managed successfully without permanent deficits.

Parent Satisfaction

Parental satisfaction was assessed using a 10-point satisfaction scale during telephonic follow-up. The mean satisfaction score was 9.1 ± 0.9, indicating a high level of parental satisfaction with the surgical outcome.

Table 8: Parent Satisfaction Scores

Satisfaction Level	Number of Parents	Percentage (%)
Highly satisfied	25	83.3
Moderately satisfied	4	13.3
Neutral	1	3.3
Dissatisfied	0	0

This table presents parental satisfaction levels following treatment. Most parents reported high satisfaction with their child's recovery and functional outcome.

Table 9: Correlation Between Functional Outcome Measures

Variables Compared	Correlation Coefficient (r)	p-value	Interpretation
QuickDASH vs PODCI Upper Extremity	-0.72	<0.001	Strong negative correlation
QuickDASH vs PODCI Pain Score	-0.65	0.002	Moderate negative correlation
QuickDASH vs Flynn Criteria Score*	0.58	0.004	Moderate positive correlation
PODCI Upper Extremity vs Flynn Criteria Score*	-0.61	0.003	Moderate negative correlation

Pearson correlation analysis was performed to evaluate the relationship between patient-reported functional scores and clinical outcomes. A significant negative correlation was observed between QuickDASH and PODCI scores, indicating that lower disability scores were associated with better upper extremity function. Flynn criteria scores also demonstrated a moderate correlation with PROM measures. *For correlation analysis, Flynn criteria outcomes were coded numerically (Excellent = 1, Good = 2, Fair = 3, Poor = 4).

Table 10: Statistical Significance of Functional Outcome Measures

Outcome Measure	Mean ± SD	Test Used	p-value
QuickDASH Score	9.1 ± 4.5	One-sample t-test	<0.001
PODCI Upper Extremity	92.4 ± 5.1	One-sample t-test	<0.001

PODCI Pain Score	90.8 ± 6.3	One-sample t-test	<0.001
Flynn Criteria Distribution	—	Chi-square test	0.012

Statistical analysis demonstrated that functional outcome scores were significantly associated with favorable postoperative recovery. QuickDASH scores indicated minimal disability, while PODCI scores reflected excellent upper extremity function and low pain levels. The distribution of Flynn criteria outcomes also showed statistically significant predominance of excellent results.

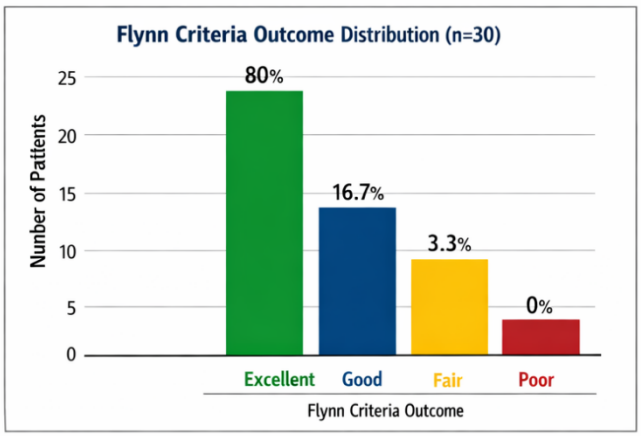

Figure 1: Distribution of Clinical Outcomes According to Flynn Criteria

Discussion

The present study evaluated parent-reported functional outcomes and quality of life in children who underwent closed reduction and percutaneous pinning (CRPP) for supracondylar humerus fractures. The findings demonstrated excellent functional recovery, minimal upper limb disability, and high parental satisfaction following surgical treatment. These results support the effectiveness of CRPP as a reliable treatment modality for displaced supracondylar fractures in the pediatric population.

In our cohort, the majority of patients were male and most fractures were classified as Gartland type III, reflecting a predominance of displaced injuries requiring operative management. This distribution is consistent with previous epidemiological studies reporting a higher incidence of supracondylar fractures in boys and a greater likelihood of surgical intervention in displaced fractures.[1–3] The predominance of type III fractures in our series may also reflect the referral pattern to tertiary care centers, where more severe or unstable injuries are often treated. The Gartland classification system, which remains the standard framework for guiding treatment decisions in pediatric supracondylar fractures, played an important role in determining the need for surgical stabilization in our study population.[4]

An important aspect of the present study is the evaluation of patient-reported functional outcomes using validated instruments such as QuickDASH and PODCI. The mean QuickDASH score of 9.1 ± 4.5 observed in this study indicates minimal functional disability following treatment. Similarly, the mean PODCI Upper Extremity score of 92.4 ± 5.1 and PODCI Pain score of 90.8 ± 6.3 reflect excellent recovery of upper limb function with minimal residual pain. These findings are comparable with previously published studies that have reported favorable functional outcomes following CRPP in pediatric supracondylar fractures. Previous investigations utilizing PROM tools have demonstrated similarly low disability scores and high functional performance after surgical stabilization of displaced fractures.[9–12] The high PODCI scores in our study suggest that most children were able to resume normal daily activities without significant functional limitation.

Another notable finding in our study was the predominant use of lateral pin fixation (90%). Lateral pinning has gained increasing acceptance among orthopedic surgeons because it reduces the risk of iatrogenic ulnar nerve injury associated with medial pin placement. Several biomechanical and clinical studies have demonstrated that lateral-entry pin constructs provide adequate fracture stability while maintaining a favorable safety profile.[13] [14] Meta-analyses comparing lateral and crossed pin configurations have also suggested that although crossed pins may offer slightly greater mechanical stability, the difference in clinical outcomes is minimal, and lateral pinning remains a safer option in many clinical settings.[18] [19] The high rate of lateral pinning observed in this study likely reflects evolving surgical preferences toward techniques that minimize the risk of nerve injury without compromising fracture stability.

Clinical outcomes in the present study were also evaluated using the Flynn criteria, which assess both functional and cosmetic results based on loss of elbow motion and carrying angle. The majority of patients in our study achieved excellent outcomes (80%), while 16.7% demonstrated good outcomes, and only one patient had a fair result. These findings are consistent with previous reports demonstrating high rates of excellent and good outcomes following CRPP for displaced supracondylar fractures.[8] [13] The favorable Flynn criteria outcomes observed in this study further confirm that percutaneous pinning provides reliable restoration of elbow alignment and motion when appropriate reduction and fixation techniques are used.

Postoperative complications in our cohort were relatively uncommon. The overall complication rate was low, with only a few cases of pin tract infection and mild elbow stiffness observed. These complications were managed conservatively and did not result in long-term functional impairment. Similar complication rates have been reported in previous studies evaluating CRPP for supracondylar fractures.[20] Early identification and appropriate management of minor

complications likely contributed to the favorable functional outcomes observed in this study.

The restoration of elbow range of motion is an important determinant of functional recovery following supracondylar fractures. In our study, the majority of patients regained near-normal elbow mobility at follow-up, which is consistent with previously reported long-term outcomes of surgically treated supracondylar fractures in children.[28] Adequate fracture reduction, stable fixation, and early rehabilitation are key factors contributing to satisfactory recovery of elbow motion.

Another important observation in the present study was the high level of parental satisfaction, with most parents reporting excellent satisfaction with their child's recovery. Parent-reported outcomes provide valuable insight into the functional and psychosocial impact of treatment from the caregiver's perspective. The use of telephonic follow-up for PROM assessment in this study also highlights a practical approach to evaluating postoperative outcomes, particularly in settings where long-term in-person follow-up may be challenging.

Despite these encouraging findings, several limitations should be acknowledged. First, the retrospective design of the study may introduce potential selection bias. Second, the relatively small sample size limits the generalizability of the findings. Additionally, telephonic data collection may introduce recall bias, although the use of validated PROM instruments helps minimize this limitation. Future prospective studies with larger sample sizes and longer follow-up periods would provide more comprehensive insights into long-term functional outcomes and quality of life following surgical treatment of pediatric supracondylar fractures.

Overall, the findings of this study reinforce the effectiveness of closed reduction and percutaneous pinning as a safe and reliable treatment for displaced supracondylar humerus fractures in children, providing excellent functional recovery, low complication rates, and high parental satisfaction.

Conclusion

Closed reduction and percutaneous pinning remain an effective treatment for paediatric supracondylar humerus fractures. Parent-reported outcomes demonstrate excellent functional recovery, minimal disability, and high satisfaction levels. PROM tools such as QuickDASH and PODCI should be incorporated into routine follow-up to better assess patient-centered outcomes.

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