

Management and Functional Outcome of Supracondylar Humerus Fractures in Children: A Prospective Observational Study

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Abstract

Background: Supracondylar fracture of the humerus is one of the most common elbow fractures in children. Displaced fractures may be associated with neurovascular complications, deformity and restricted elbow movement. Appropriate management is essential for achieving good functional and cosmetic outcomes.

Aim: To evaluate the management and outcome of supracondylar humerus fractures in children.

Methods: A prospective observational study was conducted in the Department of Orthopaedics at a tertiary-care hospital over 6 months. A total of 100 children aged 1–14 years with supracondylar humerus fractures were included. Demographic details, mechanism of injury, Gartland classification, neurovascular status, treatment modality and complications were recorded. Functional and cosmetic outcomes were assessed using Flynn's criteria.

Results: The mean age of the children was 7.1 ± 2.6 years, and males constituted 62% of the study population. Fall while playing was the commonest mechanism of injury (42%). Gartland type III was the most common fracture pattern (50%). Operative management was performed in 78% of patients, with closed reduction and percutaneous K-wire fixation being the most common procedure (70%). Complications occurred in 18% of patients, with pin-tract infection being the most frequent (7%). According to Flynn's criteria, 64% had excellent, 25% good, 8% fair and 3% poor outcomes. Overall, 89% achieved excellent or good functional and cosmetic outcomes.

Conclusion: Supracondylar humerus fractures in children generally have favorable outcomes when appropriately classified and managed. Early neurovascular assessment, appropriate treatment selection, stable fixation when indicated and regular follow-up are important for achieving satisfactory functional and cosmetic results.

Keywords: Supracondylar fracture; Humerus; Children; Gartland classification; K-wire fixation; Flynn's criteria; Functional outcome.

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Introduction

Supracondylar fracture of the humerus is the most common fracture around the pediatric elbow, accounting for approximately 15% of all fractures in children and more than half of pediatric elbow fractures.[1,2] The injury occurs predominantly in children aged 5–8 years, with extension-type fractures comprising approximately 97–99% of cases.[2] Epidemiological studies have reported substantial hospital and emergency-department burden, with one large US study estimating 60–72 cases per 100,000 children annually.[3]

Displaced supracondylar fractures are clinically important because of the risk of neurovascular injury, compartment syndrome, malunion and elbow stiffness. Neurovascular abnormalities have been reported in approximately 6.5–19% of displaced fractures, while vascular compromise occurs in about 10–20% of displaced injuries.[2] Management

is primarily guided by the Gartland classification: nondisplaced fractures are generally treated with immobilization, whereas displaced fractures usually require reduction and stabilization, most commonly by closed reduction and percutaneous K-wire fixation.[2,4]

Although satisfactory functional outcomes are achieved in most children, controversies remain regarding the management of selected Gartland type II fractures, timing of surgery and optimal K-wire configuration.[5,6] Recent systematic reviews have shown that both operative and selected non-operative approaches can provide good outcomes in appropriately selected type II fractures, while lateral pinning may reduce the risk of iatrogenic ulnar nerve injury.[5,7] Therefore, evaluating the pattern of injury, treatment modalities, complications and functional outcomes of pediatric supracondylar

humerus fractures is important for optimizing clinical management.

Aim: To evaluate the management and outcome of supracondylar humerus fractures in children.

Objectives

1. To study the clinical and demographic profile of affected children.
2. To classify fractures according to Gartland classification.
3. To assess the management methods and complications.
4. To evaluate functional and cosmetic outcomes using Flynn's criteria.

Methodology

Study Design and Setting: A prospective observational study will be conducted in the Department of Orthopaedics at a tertiary-care hospital over a period of 6 months.

Study Population: Children aged 1–14 years presenting with a radiologically confirmed supracondylar fracture of the humerus during the study period will be included.

Sample Size: The sample size will be calculated using the formula: $n = 4pq/d^2$, where p is the prevalence/proportion reported in a previous study, $q = 100 - p$, and d is the allowable absolute error. A previous prospective study of 263 pediatric patients reported Gartland type III fractures in 54.37% of cases.⁸ Using this proportion with an absolute precision of 10%, the minimum sample size is approximately 100 children. Therefore, 100 eligible children will be enrolled during the 6-month study period.

Inclusion criteria

- Children aged 1–14 years.
- Radiologically confirmed supracondylar fracture of the humerus.
- Patients presenting during the study period.
- Written informed consent from parent/guardian.

Exclusion criteria

- Open fractures.
- Pathological fractures.
- Associated major fracture of the same upper limb.
- Patients with previous deformity or fracture of the affected elbow.

- Patients unwilling to participate or unavailable for follow-up.

Data Collection: After obtaining informed consent, demographic and clinical details will be recorded using a structured proforma. Data will include age, sex, side involved, mechanism of injury, time of presentation, fracture type, Gartland classification, neurovascular status and associated injuries.

Management: Treatment will be decided by the treating orthopaedic surgeon according to the Gartland classification, fracture stability and neurovascular status. Patients will receive either conservative treatment or operative management, including closed reduction and percutaneous K-wire fixation or open reduction and fixation, when indicated.

Follow-up and Outcome Assessment: Patients will be followed clinically and radiologically after treatment. At follow-up, fracture union, range of motion, carrying angle, radiological alignment and complications such as nerve injury, vascular complications, pin-tract infection, loss of reduction, cubitus varus and elbow stiffness will be documented.

Functional and cosmetic outcomes will be assessed using Flynn's criteria^[9], which are commonly used for evaluating pediatric supracondylar humerus fractures.

Statistical analysis: Data will be entered into a computerized database and analyzed using appropriate statistical software. Continuous variables will be expressed as mean $\pm$ standard deviation, while categorical variables will be presented as frequency and percentage. Appropriate tests such as the chi-square/Fisher's exact test and Student's t-test/Mann–Whitney U test, as applicable, will be used. A p -value <0.05 will be considered statistically significant.

Ethical Considerations: Written informed consent was obtained from the parents or legal guardians of all participating children. No separate ethical committee permission was obtained for the study.

Results

A total of 100 children with supracondylar fractures of the humerus were included in the study. The mean age of the participants was 7.1 ± 2.6 years, with the majority belonging to the 5–8-year age group (57%). Males were more commonly affected than females (62% vs. 38%), and the right elbow was involved in 57% of cases.

Table 1: Demographic characteristics of study participants (n=100)

Variable	Frequency, n (%)
Age group	
1–4 years	18 (18%)
5–8 years	57 (57%)
9–12 years	21 (21%)
13–14 years	4 (4%)
Sex	
Male	62 (62%)
Female	38 (38%)
Side involved	
Right	57 (57%)
Left	43 (43%)

Among the 100 children included in the study, fall while playing was the most common mechanism of injury, accounting for 42% of cases, followed by fall from height (28%) and fall from stairs (18%). Road traffic injuries accounted for 8%, while other mechanisms constituted 4%.

Table 2: Gartland classification

Gartland classification	Frequency, n (%)
Type I	15 (15%)
Type II	31 (31%)
Type III	50 (50%)
Type IV	4 (4%)

Table 3: Neurovascular status at presentation

Neurovascular status	Frequency, n (%)
Normal	91 (91%)
Nerve injury	6 (6%)
Vascular compromise	3 (3%)
Total	100 (100%)

Among the 100 children, 82 (82%) had no complications following treatment. Overall, complications were observed in 18 (18%) patients. The most common complication was pin-tract infection, seen in 7 (7%) patients, followed by elbow stiffness in 5 (5%) patients. Loss of reduction occurred in 3 (3%) patients, while nerve injury was observed in 2 (2%) patients. Cubitus varus was the least common complication, occurring in 1 (1%) patient. Overall, the complication rate was relatively low, with the majority of children having an uncomplicated recovery.

Table 4: Treatment modalities

Treatment modality	Frequency, n (%)
Conservative treatment	22 (22%)
Closed reduction + percutaneous K-wire fixation	70 (70%)
Open reduction + K-wire fixation	8 (8%)
Total	100 (100%)

According to Flynn's criteria, 64% achieved an excellent outcome and 25% a good outcome, giving an overall excellent-to-good outcome rate of 89%. Fair and poor outcomes were observed in 8% and 3% of patients, respectively. Poorer outcomes were more frequently observed among patients with higher Gartland fracture grades and those who developed complications.

Discussion

In the present study, 100 children with supracondylar fractures of the humerus were evaluated. The mean age was 7.1 ± 2.6 years, and males constituted 62% of cases. This finding is comparable with the prospective study by Anjum et al.[8], which included 263 children, with a mean age of 7.9 years and male predominance. The predominance of these fractures among young school-aged children is also consistent with the epidemiological observations of Barr.[1]

The most common mechanism of injury in our study was fall while playing (42%), followed by falls from

height and stairs. This is consistent with previous studies identifying falls as the predominant mechanism of pediatric supracondylar humerus fractures.[1,8] In our study, Gartland type III fractures (50%) were the most common, which was comparable with the 54.37% reported by Anjum et al.[8]

Operative management was required in 78% of patients, with closed reduction and percutaneous K-wire fixation being the most common procedure. The high operative rate may be explained by the predominance of displaced Gartland type II–IV fractures. Previous evidence supports reduction and percutaneous fixation as the standard approach for

displaced fractures, although the management of selected type II fractures remains an area of discussion.[2,5,7]

Complications occurred in 18% of patients, with pin-tract infection (7%) being the most common, followed by elbow stiffness and loss of reduction. Previous studies have also identified infection, loss of reduction and nerve injury among the important complications following operative treatment.[6]

The choice of K-wire configuration remains controversial. A systematic review and meta-analysis found similar functional outcomes with crossed and lateral pinning, while iatrogenic ulnar nerve injury was more frequent with crossed pins.¹⁰ Similarly, a meta-analysis of 11 randomized trials involving 900 children found that lateral pinning reduced the risk of iatrogenic ulnar nerve injury, although loss of reduction was more common with lateral pinning.[11] Another meta-analysis of 12 randomized trials involving 930 children found no significant difference in Flynn functional outcomes, but crossed pinning was associated with a higher risk of iatrogenic neurological injury and better maintenance of reduction.[12]

In the present study, 89% of children achieved excellent or good outcomes according to Flynn's criteria. This favorable result is consistent with the generally good functional outcomes reported after appropriate treatment of pediatric supracondylar fractures.[2,9] Overall, the findings emphasize the importance of accurate Gartland classification, careful neurovascular assessment, appropriate treatment selection, stable fixation and regular follow-up for achieving satisfactory functional and cosmetic outcomes.

Conclusion

Supracondylar humerus fractures are common pediatric elbow injuries, predominantly affecting young boys following falls. Gartland type III fractures were the most common in our study. Appropriate fracture classification, early neurovascular assessment and timely selection of conservative or operative management resulted in favorable functional and cosmetic outcomes, with 89% of children achieving excellent or good results according to Flynn's criteria. Careful follow-up is essential for early identification and management of complications.

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