International Journal of Research in Orthopaedics
Talukdar MAR et al. Int J Res Orthop. 2025 Nov;11(6):1401-1406
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20253414

Clinical profile and surgical outcomes of displaced supracondylar humeral fractures in children

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Received: 27 July 2025
Accepted: 18 September 2025

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ABSTRACT

Background: Supracondylar humeral fractures are the most common elbow injuries in children, frequently resulting from low-energy trauma such as falls on an outstretched hand. Displaced fractures often require surgical intervention due to risks of neurovascular compromise and functional impairment. Understanding patient demographics, fracture types and treatment outcomes is essential for optimizing care. The aim of this study was to assess the clinical profile and surgical outcomes of displaced supracondylar humeral fractures in children.
Methods: This cross-sectional observational study was conducted at the Department of Orthopaedics, Shaheed Ziaur Rahman Medical College Hospital and Ibn Sina Diagnostic Centre, Bogura, Bangladesh from February 2025 to July 2025. Total 64 pediatric patients diagnosed with displaced supracondylar humeral fractures were enrolled in the study.
Results: In this study, mean (±SD) age was 9.2±3.5 years and majority patients (65.6%) were male. Most injuries were sustained from falls on an outstretched hand (84.4%) and 62.5% were classified as Gartland type III fractures. Closed reduction with percutaneous pinning (CRPP) was performed in 81.3% of cases, while 18.7% underwent open reduction. According to Flynn's criteria, 59.4% achieved excellent outcomes, 28.1% good, 9.4% fair and 3.1% poor. Complications were minimal, with only 15.6% experiencing issues such as pin tract infections, nerve palsy or malunion.
Conclusions: Displaced supracondylar humeral fractures in children can be effectively managed with timely surgical intervention, particularly using CRPP. Most patients regain excellent to good elbow function, with a low rate of complications, reinforcing the safety and efficacy of current surgical protocols.

Keywords: Clinical profile, Children, Displaced supracondylar humeral fractures, Surgical outcomes

INTRODUCTION

Supracondylar humeral fractures (SCHFs) are the most common elbow fractures in children, being found in approximately 50–70% of all elbow fractures and 15% of all fractures in children.[1,2] These fractures are most common in children aged between 3 and 8 years, with the highest incidence in the age group 5–7 years and a significant male predilection secondary to greater physical activity and risk-taking behavior.[3,4] The mechanism is most commonly a fall on an extended elbow on an outstretched hand, which imposes axial loading and valgus stress to the distal humerus and there is fracture just proximal to the level of the olecranon fossa. The

extension-type pattern accounts for 97–99% of all supracondylar fractures and flexion-type fractures remain rare.[5] Gartland classification system remains the most widely utilized system for evaluating SCHFs based on the degree of displacement and cortical continuity. Type I is non-displaced, type II has angulation with intact posterior cortex and type III is completely displaced with loss of cortical contact.

Others take this classification even further to encompass type IV fractures, which are characterized by being multidirectional unstable on fluoroscopy.[6,7] The degree of displacement not only aids in classification but is also significant in guiding the treatment and the outcome. Displaced SCHFs, particularly Gartland type II and III, can need surgery due to associated risks such as neurovascular compromise, compartment syndrome and late complications including malunion and cubitus varus deformity.[8,9]

The preferred surgical technique is evolving, with closed reduction and percutaneous pinning (CRPP) remaining the gold standard for most displaced fractures due to its minimally invasive technique and worldwide excellent results. Open reduction and internal fixation (ORIF) are reserved for failed closed reduction or open injury, but elastic stable intramedullary nailing (ESIN) is limited and typically reserved for elderly children with metaphyseal-diaphyseal extension.[2,10] Functional and cosmetic outcomes following surgery are typically evaluated with Flynn's criteria, quantifying elbow range of motion and carrying angle and are often supplemented by Mayo Elbow Performance Score (MEPS) or Disabilities of the Arm, Shoulder and Hand (DASH) score for overall functional assessment.[5,7] Radiologic assessment is typically measurement of Baumann's angle to assess alignment and provide predictions about possible deformity.

Whereas there is general consensus regarding the overall management strategy, considerable debate continues on the effect of specific factors on outcome. Numerous studies have determined that there is little effect on functional outcomes and no increase in complications with delayed surgery, discrediting the long-held urgency surrounding these injuries.[11,12]

Although there have been a number of studies that have investigated individual variables such as pin configuration, reduction technique and measures of outcome, few have systematically investigated these variables together with clinical profiles and fracture patterns, especially in selected regional or population-based groups. This is a critical knowledge gap in the literature because such combined analyses are necessary to create locally relevant, evidence-based treatment protocols. The present study is aimed to evaluate the clinical profile, fracture pattern and operative outcomes in children with operatively managed displaced supracondylar humeral fractures in our tertiary care hospital.

Objectives

To assess the clinical profile and surgical outcomes of displaced supracondylar humeral fractures in children.

METHODS

This cross-sectional observational study was conducted at the Department of Orthopaedics, Shaheed Ziaur Rahman Medical College Hospital and Ibn Sina Diagnostic Centre, Bogura, Bangladesh from February 2025 to July 2025. Total 64 pediatric patients diagnosed with displaced supracondylar humeral fractures were enrolled in the study.

Inclusion criteria comprised children aged up to 14 years presenting with Gartland type II and III supracondylar humeral fractures who underwent surgical treatment. Exclusion criteria included patients with open fractures, pathological fractures, associated neurovascular injuries requiring repair or prior deformity of the involved limb. Detailed clinical history and examination findings were recorded for each case. Fractures were classified radiologically according to the modified Gartland classification. We used a Gartland classification for extension-type supracondylar fractures. It is based primarily on the degree of displacement divided into three types. Type I- undisplaced, type II – displaced with intact posterior cortex and type III – displaced with no cortical contact. All patients underwent either CRPP or ORIF, depending on fracture characteristics and intraoperative findings. Standard surgical protocols and pinning techniques were followed. Post-operatively, patients were followed up at regular intervals to assess radiological union and functional outcomes. Functional results were evaluated using Flynn's criteria, which considers both the cosmetic (carrying angle) and functional (range of motion) aspects.

Additional outcome parameters included any post-operative complications such as nerve injury, infection, pin migration or malunion. Ethical approval for the study was obtained from the institutional ethical review board prior to commencement. Written informed consent was taken from the legal guardians of all participating children. All collected data were recorded systematically and analysed using SPSS software version 26.

RESULTS

Table 1 illustrates the baseline characteristics of the 64 pediatric patients included in this study. The majority of the patients (50.0%) were between the ages of 5 and 7 years, followed by 23.4% in the 8–10-year group, 15.6% aged 0–4 years and 10.9% aged 11–14 years. Mean (±SD) age was 9.2±3.5 years. There was a marked male predominance, with 42 patients (65.6%) being male and 22 (34.4%) females. Regarding the side of injury, the right elbow was affected in 59.4% of cases, while the left was involved in 40.6%. According to the Gartland

classification, 62.5% of the fractures were classified as type III (completely displaced), whereas 37.5% were type II (partially displaced).

Figure 1 depicts the mechanism of injury in the study population. A fall on an outstretched hand was the predominant cause, accounting for 84.4% of all cases. Falls from height, such as from beds or trees, were responsible for 10.9% of injuries, while only 4.7% resulted from road traffic accidents. This distribution highlights the commonality of low-energy trauma in pediatric supracondylar humeral fractures.

Table 2 presents the surgical outcomes. Most patients (81.3%) were treated with CRPP, reinforcing its role as the preferred surgical technique. Open reduction and internal fixation using K-wires ORIF was required in 18.7% of cases. With regard to the time interval between injury and surgery, 53.1% underwent surgery within 12–24 hours, 28.1% within 12 hours and the remaining 18.8% after 24 hours post-injury.

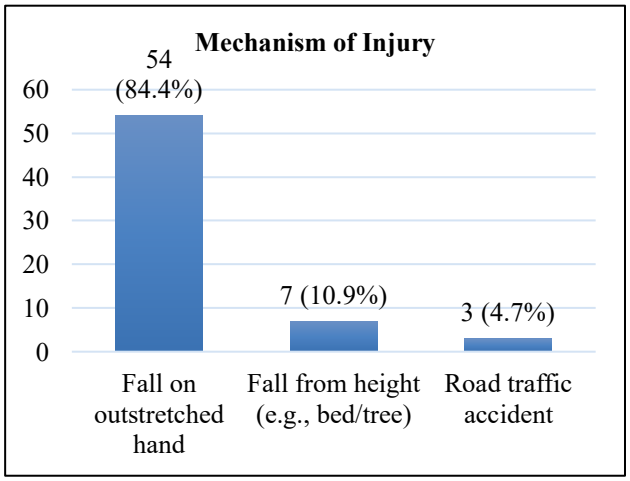

Figure 1: Mechanism of injury (N=64).

Figure 2: Preoperative X-ray of left elbow showing extension-type supracondylar humerus fracture in a 16 years old female patient.

Figure 3: Preoperative anteroposterior and lateral views of left elbow showing displaced supracondylar fracture in a paediatric patient.

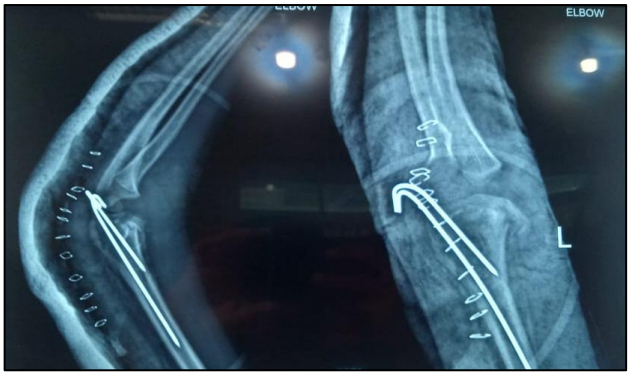

Figure 4: Postoperative X-ray of left elbow in a patient showing intramedullary K-wire fixation with tension band wiring.

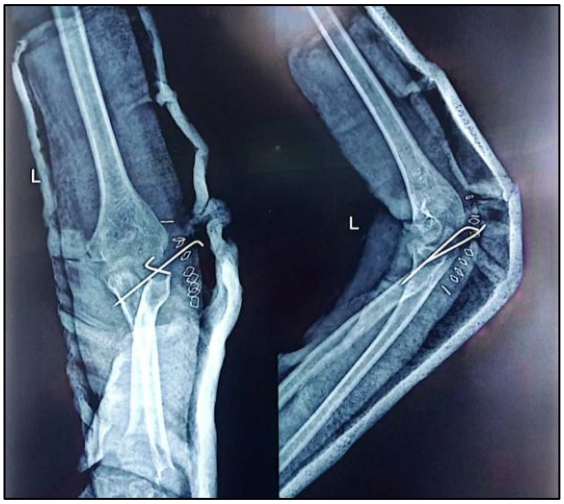

Figure 5: Postoperative X-ray of left elbow showing crossed K-wire fixation for displaced supracondylar fracture in a paediatric patient.

Table 3 outlines the functional outcomes as per Flynn's criteria. An excellent result, defined by <5º loss in both carrying angle and elbow motion, was achieved in 38 patients (59.4%). A good outcome (5–10º loss) was seen

in 18 patients (28.1%), while fair (10–15° loss) and poor (>15º loss) outcomes were observed in 6 (9.4%) and 2 (3.1%) patients, respectively. These results suggest that the majority of patients regained near-normal elbow function and alignment following surgical intervention. Table 4 details the post-operative complications. Most patients (84.4%) experienced no complications. However, 4 patients (6.3%) developed superficial pin tract infections, 2 patients (3.1%) had iatrogenic ulnar nerve palsy and 3 patients (4.7%) experienced malunion resulting in cubitus varus deformity. Only 1 patient (1.6%) had loss of fixation. These findings reflect a relatively low complication rate, reinforcing the safety and efficacy of the surgical techniques employed. Figure 2-5 demonstrates the pre-operative and post-operative radiographs of the study patients.

Table 1: Baseline characteristic of the study patients (n=64).

Characteristics	Category	Number of patients	%
Age group (in years)	0–4	10	15.60
	5–7	32	50.00
	8–10	15	23.40
	11–14	7	10.90
	Mean±SD	9.2±3.5	
Sex	Male	42	65.60
	Female	22	34.40
Side involved	Right	38	59.40
	Left	26	40.60
Gartland type	Type II	24	37.50
	Type III	40	62.50

Table 2: Surgical outcome of the study patients (n=64).

Surgical outcome	Number of patients	%
Surgical method		
Closed reduction+CRPP	52	81.30
Open reduction+K-wire fixation (ORIF)	12	18.70
Time from injury to surgery		
≤12 hours	18	28.10
12–24 hours	34	53.10
>24 hours	12	18.80

Table 3: Functional outcome based on Flynn's criteria (n=64).

Outcome category	Carrying angle loss	Motion loss	Frequency (N)	%
Excellent	<5º	<5º	38	59.40
Good	5–10º	5–10º	18	28.10
Fair	10–15º	10–15º	6	9.40
Poor	>15º	>15º	2	3.10

Table 4: Post-operative complications among the study patients (n=64).

Complication type	Number of patients	%
Superficial pin tract infection	4	6.30
Iatrogenic ulnar nerve palsy	2	3.10
Malunion (Cubitus varus)	3	4.70
Loss of fixation	1	1.60
No complications	54	84.40

DISCUSSION

This study presents an observational analysis of pediatric patients with displaced supracondylar humeral fractures treated operatively at a tertiary care center, with emphasis on demographic patterns, surgical modalities, functional outcomes and complications. The demographic profile observed in our cohort reflects trends reported globally,

with the majority of patients (50%) aged between 5 and 7 years, confirming that this age group represents the peak incidence for such injuries.[13] Our findings of a male predominance (65.6%) and right-sided involvement in 59.4% of cases are similarly consistent with previous studies that attribute these trends to higher physical activity levels in boys and a possible correlation with hand dominance and injury biomechanics.[14,15]

In our series, Gartland type III fractures accounted for 62.5% of cases, while type II made up 37.5%, reflecting the surgical threshold wherein most displaced fractures require operative management. These findings are in line with those of Mangwani et al who reported a predominance of type III fractures in surgically treated cohorts.[16] The mechanism of injury analysis showed that a fall on an outstretched hand (FOOSH) was responsible for 84.4% of fractures, underscoring the well-established role of low-energy trauma in pediatric supracondylar injuries.[17] Falls from height contributed to 10.9% of injuries, particularly among children under five years of age, which aligns with literature indicating that low-height falls such as from beds or furniture are common sources of injury in toddlers.[18]

The majority of patients (81.3%) underwent CRPP, while 18.7% required open reduction with K-wire fixation. This distribution strongly supports current consensus that CRPP remains the gold standard for displaced supracondylar humeral fractures, as it offers favorable outcomes with lower complication rates and minimal invasiveness.[7] A study by Wendling-Keim et al, has similarly demonstrated that CRPP yields equivalent or superior outcomes compared to open reduction, particularly for Gartland type II and III injuries.[10] Regarding timing of intervention, 53.1% of surgeries were conducted within 12–24 hours, 28.1% within 12 hours and 18.8% after 24 hours. Importantly, no significant difference in functional outcomes was observed across timing groups, echoing findings from MDPI's prospective cohort study, which reported no association between surgical delay (beyond 12 hours) and postoperative complications or alignment.[19]

Functional outcomes were assessed using Flynn's criteria, revealing excellent or good outcomes in 87.5% of patients. This finding is comparable to those from Cureus and the journal of orthopaedic case reports, where satisfactory outcomes ranged from 79% to 93%.[20,21] Notably, the consistency of favorable outcomes in our study supports the robustness of operative techniques employed and adherence to post-operative rehabilitation protocols.

The overall complication rate in our study was 15.6%, with superficial pin tract infections being the most frequent (6.3%), followed by cubitus varus deformity (4.7%), ulnar nerve palsy (3.1%) and one case of fixation loss (1.6%). These rates are comparable to those reported by Wall et al, who observed a 4.3% pin tract infection rate in a multicenter cohort.[22] Furthermore, the incidence of ulnar nerve palsy in our study mirrors those in studies by Körner et al reinforcing that careful surgical technique can minimize neurovascular complications.[18] The low rate of malunion and fixation failure reflects the efficacy of proper pin configuration and stable reduction strategies advocated in the literature.[23] The findings reaffirm the safety and effectiveness of CRPP as the preferred surgical modality for displaced supracondylar humeral fractures in children.

In the study, there was small sample size and absence of control for comparison. The study was conducted at a short period of time.

CONCLUSION

This study demonstrates that displaced supracondylar humeral fractures in children can be effectively managed with timely surgical intervention. Closed reduction with percutaneous pinning remains the preferred technique, offering excellent functional outcomes and a low complication rate. The majority of patients regained near-normal elbow function, affirming the safety and efficacy of current surgical protocols. Continued adherence to standard operative techniques ensures optimal recovery and minimizes long-term deformities in pediatric elbow fractures.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Talukdar MAR, Hoque ME, Hasan MN, Wahid AHMA, Hossain MM, Hasan MM, et al. Clinical profile and surgical outcomes of displaced supracondylar humeral fractures in children. Int J Res Orthop 2025;11:1401-6.