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Research Paper

Clinical characteristics, management approaches, and treatment outcomes of pediatric supracondylar humerus fractures: a descriptive study

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ABSTRACT

Supracondylar fractures of the humerus are common among children and can be managed using various treatment methods depending on fracture type. A prospective cross-sectional observational study was conducted over six months at a selected medical hospital. Patients meeting the inclusion and exclusion criteria were enrolled. Data were collected using a pretested semi-structured questionnaire after obtaining informed consent from legal guardians. Confidentiality was maintained, and participants could withdraw at any time. Data were analyzed using SPSS version 25.0. The study included patients aged 4–12 years, with a mean (± SD) age of 7.6 ± 2.2 years. Most patients were male (31, 73.8%), and fractures were primarily caused by falls (27, 64.3%). A significant proportion (30, 71.4%) attended the hospital on the day of injury. Most fractures were non-rotational (34, 81%) and managed with closed reduction and percutaneous pinning (37, 88.1%). The majority of patients (31, 73.8%) achieved excellent functional outcomes. Overall, supracondylar fractures are common in male Muslim children, usually resulting from falls and less frequently from RTA. Most cases are non-rotational and successfully treated with closed reduction and percutaneous pinning, while a few require open reduction. Physiotherapy is often unnecessary, and outcomes are generally excellent.

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1. INTRODUCTION

Supracondylar fracture is one of the most common fractures seen in children, particularly involving the distal humerus around the elbow joint. It usually occurs as a result of an indirect impact, most often from a fall on an outstretched hand, which transmits force to the elbow and causes a fracture with displacement and extra-articular involvement. Supracondylar fracture of the humerus can be broadly classified into flexion type and extension type. Among those types, the extension type is more commonly observed, caused by numerous reasons [1].

This fracture can occur at any age, but is more commonly seen among children. A recent study found that children around the age of 7 are more vulnerable to having a supracondylar fracture. Children are more commonly have the fractures because of the fragility of the bone and high physical activity. Dabis J. and team in their study found that supracondylar fractures account for around 12% to 17% of all pediatric fractures and contribute to approximately 60% of all elbow fractures among children. Among the different patterns, extension-type injuries are by far the most common, responsible for nearly 95% of supracondylar fractures, while flexion-type injuries are relatively rare [2].

Closed reduction with percutaneous Kirschner wire (K-wire) fixation is the established treatment for Gartland type II and III supracondylar fractures in children. The use of K-wire is too common to treat supracondylar fractures, but still the optimal configuration for K-wire use in case of supracondylar fracture has an ongoing debate. Among different configurations of K-wire use, the Cross K-wire is more commonly preferred because of the strong mechanical stability provided by it but it imposes a significant risk of iatrogenic ulnar nerve injury. To avoid such risk of nerve injury, a significant number of surgeons use lateral entry of K-wire, which can be either parallel or through divergent entry. Various studies revealed that divergent placement of K-wire can provide strong resistance to torsional, varus and extension forces, while cross K-wire can provide and maintain good reduction.

The British Orthopaedic Association Standards for Trauma also supported that cross-wire fixation gives stability, and lateral wire reduces the risk of ulnar nerve injury. KC KM., in their study, mentioned that two lateral K-wires and a single medical K-wire are more suitable for multiplanar stability; if required medical K-wire can be removed if there is ulnar nerve injury through maintaining stability [3]. Supracondylar fracture of the humerus can also be classified depending on the degree of displacement. Type I denote a supracondylar fracture without displacement.

Type II fracture represents a fracture which is displaced, but still the posterior cortex remains intact, while type III fracture indicates complete displacement without periosteal stripping, and type IV fracture means complete displacement of the fractured fragment with associated periosteal stripping [4].

Supracondylar fracture can be treated by either surgical management or conservatively, depending upon the fracture type and associated injury. Surgeons often go for surgical management when closed reduction fails, fracture-associated neurovascular injury or if there is an open fracture. These types of events are summoned for invasive management to achieve an optimal post-reduction outcome and to prevent the possible risk of long-term complications.

If the patient has significant swelling, it is essential to take appropriate measures to reduce the swelling. Regarding post-operative complications, it was evident that compartment syndrome and vascular compromise are among the early signs, for which healthcare professionals need to pay attention. However, appropriate postoperative analgesics need to be used to minimise the pain so that the early clinical symptoms of different complications, like vascular insufficiency, can be detected and adequate measures can be taken [5]. Both Flexion and extension types of supracondylar fractures need to be managed optimally. Appropriate anatomical reduction can provide expected functional outcomes as well as patient satisfaction. To evaluate the outcome of the supracondylar fractures, Flynn's criteria are the most acceptable worldwide.

This scoring system is based on the carrying angle of the elbow and the range of motion. Ultimately, Flynn's criteria evaluate the functional and cosmetic outcome of the patients who are treated for supracondylar fractures [6]. According to the guidelines of the American Academy of Orthopaedic Surgeons, which were provided in 2012 opined that closed reduction and pin fixation is the most appropriate method to treat displaced Gartland types II and III supracondylar fractures [7].

2. RELATED WORK

Supracondylar fractures mainly occur among children of 2 to 12 years, but the average age for this type of fracture is 7 years. Among the flexion and extension types of fracture, Alagesan S *l,* revealed that around 93% of the supracondylar fractures are extension, while the flexion type of fractures was less frequently observed. Among the patients who were treated, complications like severe infection or septic arthritis were less likely. However, minor deformities like cubitus rectus were reported among around 8% of patients, but usually those deformities do not cause a significant impact on functional outcome among the patients. Overall, these findings highlight the prevalence of extension-type fractures in children and indicate that, with proper management, favourable clinical and functional outcomes can typically be achieved [8].

Another current study revealed that 57% of patients with supracondylar fracture were male and another 43% were female, evident the male predominance. This may be because male children were comparatively more active and usually engaged in outdoor games. A recent study found that, among the patients with supracondylar fracture, 38.29% had right elbow fracture and the majority 61.71% had fracture in the left elbow [9]. Kitta MI reported that among children with supracondylar fractures, 16.7% were aged 3–4 years, 36.7% were 5–6 years, 30% were 7–8 years, and 16.7% were 9–10 years. Regarding sex distribution, 63.3% were male and 36.7% were female. The author also found that around 63.3% of fractures involved the left side, and around 70% of the patients had the fracture in the non-dominant side. In their study, around 40% of the patients were treated by closed reduction with percutaneous pinning (CRPP) and a significant number of patients were treated by open reduction and internal fixation (ORIF) [10].

Another research work reported that around 4% patients with supracondylar fractures had type I fracture, while 38% had type II fractures, and around 58% had type III fractures. In their study, all the type III fractures were managed by K-wire fixation. Falls onto an outstretched hand were found to be the commonest cause causing supracondylar fracture, which is around 92%, while road traffic accident is the 2nd most contributing factor causing supracondylar fracture, which is around 8% of all fractures [11]. Pediatric supracondylar fractures are among the most common elbow injuries in children and frequently result from falls. Studies report that affected children are usually between 2 and 12 years of age, with a mean age of 7.15 years. Kitta MI. found that 16.7% of patients were aged 3–4 years, 36.7% were 5–6 years, 30% were 7–8 years, and 16.7% were 9–10 years. Among these, 63.3% were male and 36.7% were female. The left side was involved in 63.3% of cases, and nearly 70% of injuries affected the non-dominant hand.

Another study reported that 4% of children had type I fractures, 38% had type II fractures, and approximately 58% had type III fractures, with all type III fractures treated by closed reduction and K-wire fixation. Falls on an outstretched arm were the most common cause (92%), while motor vehicle accidents accounted for 8% of injuries. In addition, 9% of patients had associated fractures, 9% experienced nerve injuries, 5% had vascular injuries, and 12% presented with a pucker sign, with no cases of compartment syndrome reported. Regarding the place of injury, 47% occurred at home, 40% on school playgrounds, and 5% in gymnasiums. Detailed analysis of fall mechanisms revealed that 39% of injuries occurred from playground equipment, 13% from furniture, 8% during sports activities, 4% from stairs, and another 4% while riding a bicycle [12]. Regarding management, 88.3% of patients were treated with closed reduction and casting, 9.1% underwent open reduction with cross pinning, and 2.6% were managed by closed reduction with percutaneous pinning [13]. According to Flynn's criteria, 24 patients (80%) achieved an excellent outcome, 5 patients (16.7%) had a good outcome, and 1 patient (3.3%) had a fair outcome. None of the patients had a poor result [14].

3. METHODOLOGY

3.1 Study Design

A prospective cross-sectional observational study was conducted over a period of 6 months.

3.2 Study Place

The study was conducted at a selected medical college in Dhaka, Bangladesh.

3.3 Study Population

Patients with supracondylar humerus fractures were admitted to a selected medical college in Dhaka, Bangladesh.

3.4 Sampling Technique

A consecutive sampling method was used to select the respondents. For the selection of medical colleges, a convenience sampling method will be employed. After the colleges are selected.

3.5 Data Collection Instrument

Data were collected using an interviewer-administered, semi-structured questionnaire covering all relevant study variables. The questionnaire was initially developed in English and then translated into Bangla. To ensure clarity, relevance and appropriateness, pretesting was conducted in a similar geographical location. Pre-tested questionnaire was used for data collection.

3.6 Data Collection Procedure

Data collection began with a detailed explanation of the study's purpose to each patient's guardian, emphasising the importance of their participation. The data were collected by the principal investigator and co-investigators. Informed consent was obtained from the legal guardians of the patients. The participation in the study was voluntary, and the confidentiality of the patients was assured to be maintained. Each completed questionnaire was reviewed for completeness to ensure accuracy of the data.

3.7 Quality Control

To ensure the accuracy and reliability of the data, strict quality control measures were taken. The questionnaire was pretested to ensure the clarity of the questions. The questionnaire was coded to facilitate data entry. After completion of each questionnaire, it was checked for completeness and consistency of the data.

3.8 Data Management and Statistical Analysis

After data collection, the questionnaires were checked for completeness and marked with unique identification numbers. The data were entered, coded and analysed by using SPSS. Data were presented in tables and figures according to their nature.

4. RESULTS AND DISCUSSION

4.1 Results

A total of 42 patients were included in this study who fulfilled the inclusion and exclusion criteria. The age of the patients ranged from 4 to 12 years, with a mean (± SD) age of 7.6 ± 2.2 years, indicating that the majority of cases occurred in the early school-age group. As shown in Figure 1, out of the total, 31 (73.8%) were male and 11 (26.2%) were female, reflecting a clear male predominance.

With respect to religion, most respondents were Muslims 37(88.1%), while only 5 (11.9%) were Hindus.

Analysis of the cause of injury documented in Tab Table *1* revealed that falls were the most frequent mechanism, accounting for 27 cases (64.3%). Injuries sustained during play in playgrounds were reported in 10 patients (23.8%), while road traffic accidents (RTA) contributed to 5 cases (11.9%).

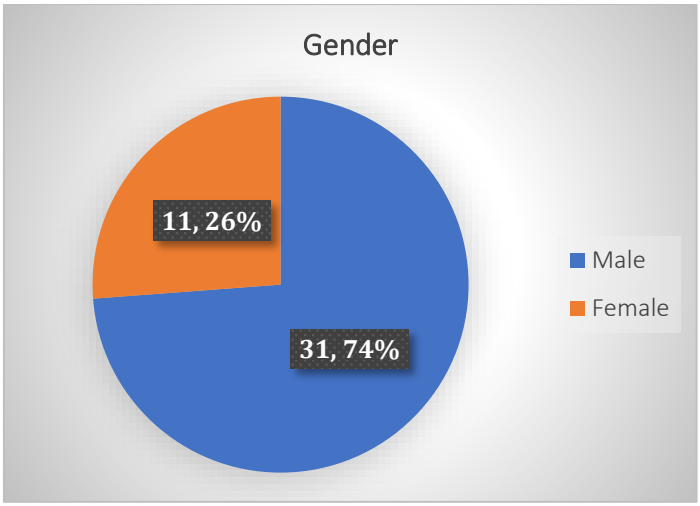

Figure 1. Distribution of Respondents by Gender

Table 1. Distribution of Respondents by Causes of Injury

Causes	Frequency	Percentage
Fall	27	64.3
Playground	10	23.8
RTA	5	11.9

Of the respondents, 28(66.7) had a supracondylar fracture on the left side and only 14((33.3%) had a fracture in the right side. In terms of health-seeking behavior which is displayed in Figure 2, the majority of patients 30(71.4%) presented to the hospital on the same day of injury. Another 8 patients (19.0%) reported within 1–2 days, whereas 4 patients (9.6%) sought treatment after 3 or more days of sustaining the fracture.

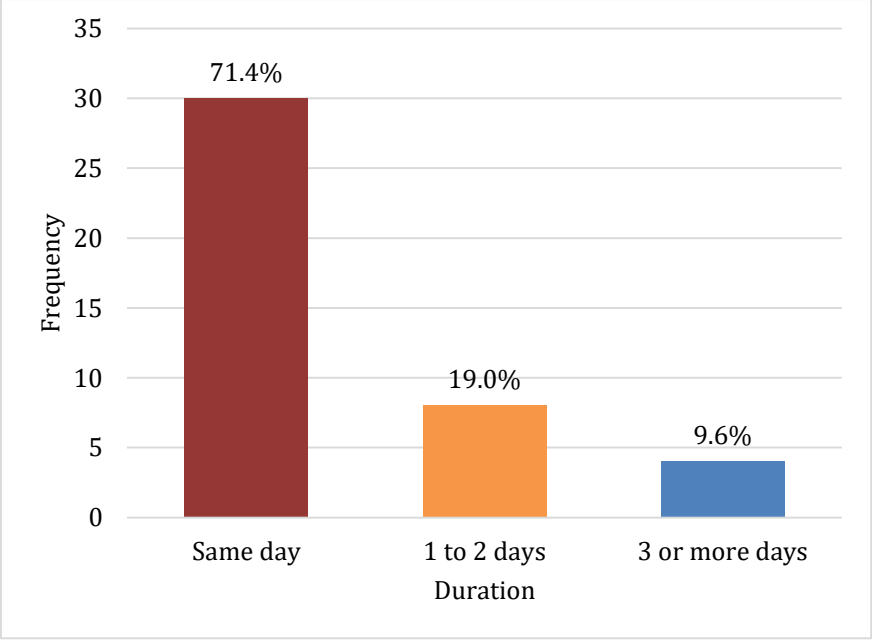

Figure 2. Respondents by Duration to take Treatment after the Injury

Regarding the fracture pattern, as mentioned in
Table 2, non-rotation injuries were more common and observed in 34 patients (81.0%), whereas rotation injuries were identified in 8 patients (19.0%).

Table 2. Distribution of Respondents by Causes of Injury

Fracture Pattern	Frequency	Percentage
Non-rotation	34	81
Rotation	8	19

With respect to treatment modalities, closed reduction and percutaneous pinning (CRPP) was the mainstay of management and was performed in 37 patients (88.1%). A case illustration is shown in Figure 3. A smaller proportion, 5 patients (11.9%), required open reduction and internal fixation (ORIF). Post-treatment rehabilitation showed that 36 patients (85.7%) did not require physiotherapy, while only 6 patients (14.3%) needed structured therapy for functional recovery.

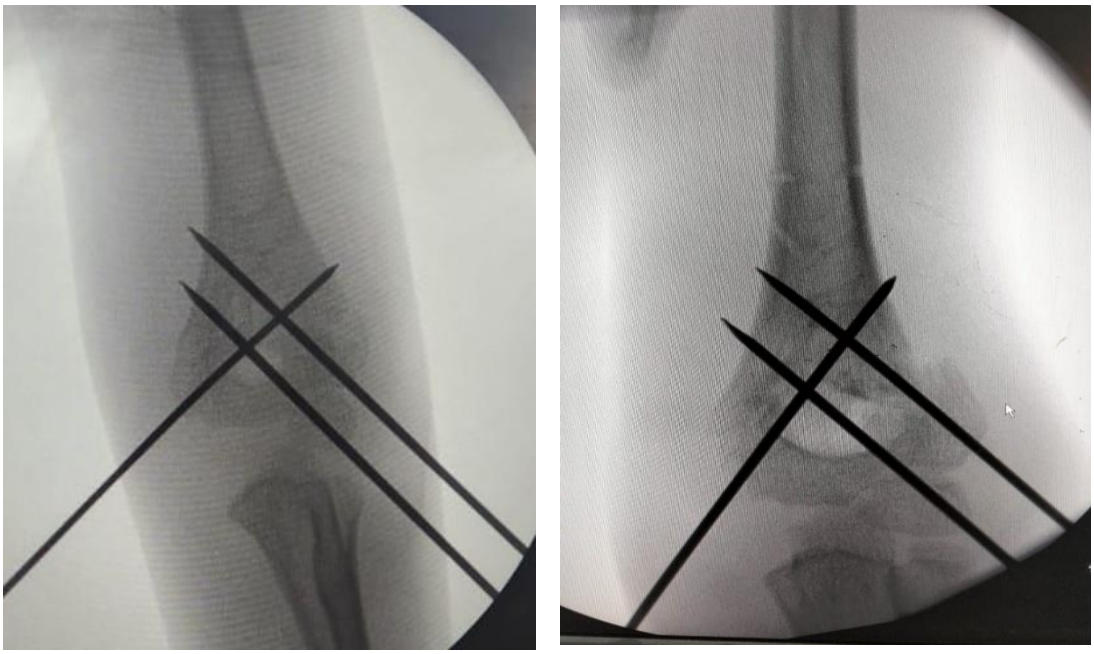

Figure 3. Showing the Postoperative Radiograph (C-Arm) after CRPP

The overall treatment outcome was favourable, as mentioned in detail in Table 3. Regarding Flynn's criteria, excellent results were achieved in 31 patients (73.8%), good outcomes in 8 patients (19.0%), and fair outcomes in 3 patients (7.2%). No poor outcome was reported among the study respondents.

Table 3. Outcome of SCHF According to Flynn's Criteria

Results	Rating	Loss of Carrying Angle	Loss of Motion	Frequency	Percentage
Satisfied	Excellent	0°–5°	0°–5°	31	73.8%
	Good	5°–10°	5°–10°	8	19%
	Fair	10°–15°	10°–15°	2	7.2%
Unsatisfied	Poor	>15°	>15°	00	00%

4.2 Discussion

In the present study, the age of patients ranged from 4 to 12 years, with a mean (± SD) age of 7.6 ± 2.2 years. This finding is consistent with the results of a recent study, where the age of respondents ranged from 2 to 12 years, with a mean age of 7.15 years. The similarity between the two studies indicates that supracondylar fractures of the humerus are most common in early school-age children, a period during which increased physical activity and underdeveloped protective reflexes may predispose them to falls and

related injuries [15]. In the present study, out of 42 respondents, 31 (73.8%) were male and 11 (26.2%) were female, showing a clear male predominance.

This is in line with the study conducted by Mubarak FS.., found that around 70.9% were male and only 29.1% were female who had a supracondylar fracture. This reveals the male predominance in the supracondylar fracture, which may be due to comparative overactivity by male children and being involved in more outdoor games [16]. Regarding the causes of supracondylar fracture, it was found that 27(64.3%) had fractures due to a fall, 10(23.8%) had the fracture due to injury in the playground, and another 5(11.9%) had it due to a road traffic accident. This is consistent with the study conducted by Abbott MD and team, where they found that 46.8% had the fracture due to fall, 35.4% incidence took place in playground, 8.4% occurred because of road traffic accident, 4.4% had supracondylar fracture due to sports related injury, 2% had fracture from trampolines, 1.3% results from blunt trauma and rest of the percentage patients had the fracture due to other several reasons [17].

Among the current study respondents, a significant number 30(71.4%) attended the hospital on the same day of injury, while 8 (19.0%) were admitted within 1–2 days after injury, and only 4 (9.6%) received treatment after 3 or more days following injury. A recent study conducted on the supracondylar fracture of the humerus by Sheikdon AA., found that around 14.29% of the patients attended the hospital on the same day, 27.27% careseekers got admission within 1–2 days, and a significant number, 58.44%, presented after 3 days of having a supracondylar fracture. This is not consistent with current study findings that might be attributed to the small sample size, and purposive selection of study group, sampling units, as well as the study area [13]. Regarding the rotation of the fractured fragment, the majority 34(81.0%) patients had non-rotation injuries, while only 8 (19.0%) suffered from rotation injuries. This distribution is consistent with the findings of another study, where 79.6% of patients had non-rotation injuries and 20.4% had rotation injuries.

The similarity between the two studies highlights that non-rotation injuries are far more common in supracondylar fractures, which may be related to the typical mechanism of injury, such as falling on an outstretched hand, that usually produces extension-type rather than rotation-type displacement [18]. Among the current study respondents, more than four-fifths 37(88.1%) patients were treated by closed reduction and percutaneous pinning (CRPP) and only 5 (11.9%) required open reduction and internal fixation (ORIF). This is in contrast with the study conducted by Kitta MI and colleagues, where they found that 40% of the patients were treated by closed reduction and percutaneous pinning and 60% were by open reduction and internal fixation [10]. This is also supported by the study findings conducted by numerous authors, where preferred closed reduction followed by percutaneous pinning and demonstrated the advantage of using K-wire fixation [19], [20], [21], [22]. Of the current study respondents, a significant number 36(85.7%) patients, required no physiotherapy and only 6(14.3%) patients required additional therapy after management. This is also vindicated by the study findings of Flierl MA and team, where they found that only 13.9% of patients required physical or occupational therapy following management of the supracondylar fracture [18]. In the present study, 31 patients (73.8%) achieved excellent outcomes, 8 (19.0%) had good outcomes, and only 3 (7.1%) had fair outcomes. These results are comparable to those of another study, where approximately 80% of patients had excellent outcomes, 16.7% had good outcomes, and 3.3% had fair outcomes [14]. Furthermore, Numerous studies conducted in different nations found that the post-operative outcome following the supracondylar fracture of the humerus was satisfactory [23], [24], [25], [26].

5. CONCLUSION

Supracondylar fractures are predominantly observed in male Muslim children. The majority of these injuries result from falls during play, with a smaller proportion caused by road traffic accidents (RTA). In most instances, parents seek medical care for their children on the day of injury. These fractures are typically non-rotational. A significant number of cases are managed with closed reduction and percutaneous pinning, whereas open reduction and internal fixation are reserved for selected cases. Most patients do not require physiotherapy post-treatment and achieve excellent functional outcomes.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Dr. Md. Asadullah Ripon	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
Dr. Md. Monir Us Saleheen		✓				✓		✓				✓		
Dr. Mohammad Osman Goni			✓			✓			✓		✓		✓	
Dr. Mohammad Rezaul Haque		✓			✓					✓				
Muhammad Imamuzzaman	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

No actual or potential conflicts of interest with respect to the research.

Informed Consent

Informed consent was secured from all participants' guardians. Participant confidentiality and anonymity were rigorously maintained throughout the study.

Ethical Approval

The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and approved by the relevant institutional authorities.

Data Availability

Data are available on request.

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