

## RESEARCH ARTICLE

# Epidemiological Characteristics of Pediatric Supracondylar of Humerus Fractures in a Tertiary Hospital in Iran

Mohammad Reza Bahaeddini, MD; Mohammad Hosein Senemari, MD; Meysam Salehi Beromi, MD; Amir Aminian, MD; Pouria Tabrizian, MD; Elham Mohammadyahya, MD; Hamed Tayyebi, MD

Research performed at Shafa Orthopedic Hospital, Iran University of Medical Sciences

Received: 8 July 2023

Accepted: 24 January 2024

## Abstract

**Objectives:** Supracondylar humerus fracture (SHF) is the most common fracture observed in children. The present study aimed to assess the characteristic parameters in one of the most extensive available pediatric SHF series referred to a tertiary hospital in Iran.

**Methods:** The medical profiles of the SHF patients who were referred to our tertiary hospital between January 2017 and January 2022 were retrospectively reviewed. The inclusion criteria entailed age < 14 years and a radiographically confirmed diagnosis of SHF. The collected data included age, gender, side of injury, mechanism of injury, season of the injury, concurrent complications, type of fracture, and treatment.

**Results:** A total of 1,309 patients with a mean age of  $7.7 \pm 2.7$  years were included in this study. The incidence of SHF was 1.8-fold higher in males, while the mean age of incidence was significantly lower in female patients (7.2 vs. 8 years;  $P < 0.001$ ). Falling was the most frequent mechanism of injury (97%). Gartland type I was the most prevalent type of injury ( $n=482$ ; 36.8%). Moreover, the majority of fractures were extension-type ( $n=1,249$ ; 95.4%). Most patients were managed conservatively ( $n=785$ ; 60%). Concurrent fractures as well as neuralgic, vascular, and muscular complications were present in 3%, 1.45%, 1.22%, and 0.5% of patients, respectively.

**Conclusion:** As evidenced by the results of this study, SHF is prevalent among the Iranian pediatric population. Therefore, greater awareness is required regarding the high incidence of this fracture in this population and its adequate management with respect to concurrent complications, particularly neurovascular compromise.

**Level of evidence: IV**

**Keywords:** Epidemiology, Iran, Pediatrics, Supracondylar humerus fracture

## Introduction

Supracondylar humeral fracture (SHF) is the most common fracture observed in children, mostly affecting 5-7-year-old children.<sup>1,2</sup> The SHF accounts for up to 18% of pediatric fractures<sup>3</sup> and is generally the result of a fall with an extended elbow, leading to the displacement of distal fragments in the posteromedial direction.<sup>4</sup> It is often combined with distal radius fracture or distal ulna.<sup>5</sup> Non-displaced and minimal displacement SHF may be treated conservatively. Nonetheless, displaced SHF is generally severe and needs to be stabilized surgically. Neurological injuries are among the most

common immediate complications, accounting for almost 18% of displaced SHFs.<sup>6</sup>

A concurrent forearm fracture or median nerve injury may mask the symptoms of compartment syndrome. Therefore, a high index of suspicion is required to avoid missing an impending compartment syndrome in such cases.<sup>2</sup> Insufficient knowledge may result in an increased risk of complications due to a delayed diagnosis and treatment.<sup>7</sup> In light of the aforementioned issues, the present study aimed to assess the characteristic parameters in one of the most extensive available pediatric SHF series referred to a

**Corresponding Author:** Hamed Tayyebi, Shafa Yahyaiean Orthopedic Hospital, Baharestan Square, Tehran, Iran

**Email:** hamedtayyebi65@gmail.com



THE ONLINE VERSION OF THIS ARTICLE  
ABJS.MUMS.AC.IR



tertiary hospital in Iran.

### Materials and Methods

This descriptive study was approved by the review board of our institute under the code IR.IUMS.FMD.REC.1401.283. The medical profiles of the SHF patients who were referred to our tertiary hospital between January 2017 and January 2022 were retrospectively reviewed. The inclusion criteria entailed age < 14 years and a radiographically confirmed diagnosis of SHF. The required data were extracted from the patient's clinical and radiologic profiles and recorded on the picture archiving and communication system. The collected data included age, gender, side of injury, mechanism of injury, and the presence of any concurrent complications, such as neurovascular compromise. The season of the injury (during term-time or holidays) was also accessed to evaluate the impact of holidays on the incidence rate of SHF.

The SHFs were categorized according to the Gartland classification. Therefore, the fractures were classified into four types: Type I (undisplaced or minimally displaced), Type II (displaced with intact cortex), Type III (completely displaced), and Type IV (displaced, with periosteal disruption, which was unstable in flexion and extension).<sup>8</sup> The treatment strategy was based on the Gartland type. In this respect, type I SHF and type II SHFs that did not require a reduction were managed conservatively. Type II SHF requiring a closed reduction was managed with or without percutaneous fixation using Kirschner pins, and type III fractures were managed with closed reduction and percutaneous pinning. Moreover, type IV fractures were treated by open reduction and internal fixation with pins.

### Statistical analyses

Data were analyzed using SPSS software (version 16). Quantitative variables were expressed as mean  $\pm$  standard deviation (SD), and qualitative variables as numbers with percentages. A comparison of mean values between the two groups was made with an independent t-test. A p-value of less than 0.05 was considered statistically significant.

### Results

The study population consisted of 1,309 SHF patients, including 851 (65%) males and 458 (35%) females. The mean age of the patients was  $7.7 \pm 2.7$  years (range of 1-14). The mean age of male and female patients was reported as  $8 \pm 2.8$  and  $7.2 \pm 2.6$  years, respectively. This difference was statistically significant ( $P < 0.001$ ). The fracture was in the right hand in 531 (40.7%) patients and in the left hand in 778 (59.3%) patients. Falling was the most frequent mechanism of fracture ( $n=1,270$ ; 97%). The majority of patients were referred in the summer and spring ( $n=809$ ; 61.8%). Gartland type I was the most frequent SHF class in the present study ( $n=482$ ; 36.8%). According to the preoperative radiographs, extension-type (posterior displacement of the distal fragment) and flexion-type (anterior displacement of the distal fragment) were detected in 1,249 (95.4%) and 60 (4.6%) patients, respectively. The clinical, demographic, radiographic, and surgical characteristics of the patients are provided in [Table 1].

**Table 1. Characteristics of the pediatric patients with a supracondylar humerus fracture requiring a surgery**

Variable	Mean $\pm$ SD or n (%)
<b>Age (year)</b>	7.7 $\pm$ 2.7
<b>Gender</b>	
• Male	851 (65)
• Female	458 (35)
<b>Laterality</b>	
• Right	531 (40.7)
• Left	773 (59.3)
<b>Mechanism of injury</b>	
• Falling	1,270 (97)
• Direct trauma	22 (1.7)
• Motor-vehicle accident	17 (1.3)
<b>Season of referral</b>	
• Spring	402 (30.7)
• Summer	407 (31.3)
• Autumn	262 (20)
• Winter	238 (18)
<b>Fracture</b>	
• Open	2 (0.15)
• Close	1,307 (99.85)
<b>Gartland classification</b>	
• I	482 (36.8)
• II	368 (28.1)
• III	330 (25.2)
• IV	129 (9.9)
<b>Fracture type</b>	
• Flexion	60 (4.6)
• Extension	1,249 (95.4)
<b>Treatment</b>	
• Conservative	785 (60)
• Close reduction	344 (26.2)
• Open reduction	180 (13.8)

The fracture was managed conservatively in most patients ( $n=785$ , 60%), and 19 (1.45%) cases were referred with a neurologic complication. The information regarding the types of neurologic complications is presented in [Table 2]. As reported, 17 (1.22%) patients were referred with vascular complications. The data about the types of vascular complications are summarized in [Table 3]. Moreover, 42 (3%) cases were presented with a concomitant fracture. The types of concurrent fractures are demonstrated in [Table 4]. In addition, 7 (0.5%) patients had muscular complications [Table 5].

**Table 2. Types of neurologic complications in pediatric patients with a supracondylar humerus fracture requiring a surgery**

Neurologic complications	Frequency (%)
<b>Median nerve injury</b>	10 (0.76)
<b>Ulnar nerve injury</b>	8 (0.61)
<b>Median and ulnar nerve injury</b>	1 (0.08)
<b>Total</b>	19 (1.45)

**Table 3. Types of vascular complications in pediatric patients with a supracondylar humerus fracture**

Vascular complications	Frequency (%)
Entrapment of brachial artery and vein	5 (0.37)
Entrapment of brachial artery	9 (0.7)
Brachial artery spasm	2 (0.15)
<b>Total</b>	<b>16 (1.22)</b>

**Table 4. Types of concomitant fracture in pediatric patients with a supracondylar humerus fracture**

Fracture	Frequency (%)
Monteggia fracture	5 (0.37)
Distal radius fracture	23 (1.75)
Both bone fracture	12 (0.9)
<b>Total</b>	<b>40 (3)</b>

**Table 5. Types of other muscular complications in pediatric patients with a supracondylar humerus fracture**

Muscular complications	Frequency (%)
Entrapment of brachialis muscle	5 (0.4)
Rupture of brachialis muscle	1 (0.08)
Rupture of biceps and brachioradialis muscle	1 (0.08)
<b>Total</b>	<b>7 (0.5)</b>

## Discussion

The present study assessed the characteristic features of SHF in a large pediatric SHF series referred to a tertiary hospital in Iran. The incidence of SHF was 1.8-fold greater in males, while the mean age of incidence was significantly smaller in female patients. Falling was the most frequent mechanism of injury. Gartland I was found to be the most frequent type of injury. Moreover, the majority of fractures were extension-type. Conservative management was the most frequently adopted method of treatment. In patients who underwent surgery, the most common type of treatment was closed reduction percutaneous pinning. Concurrent fracture, neuralgic, vascular, and muscular complications were present in 3.3%, 1.5%, 1.3%, and 0.5% of patients, respectively. Distal radius fracture was the most prevalent type of concomitant fracture. Median nerve injury was the most common type of neurologic complication. The entrapment of the brachial artery was the most frequent type of vascular injury, while the entrapment of the brachialis muscle was the most common type of muscular injury.

Epidemiological, clinical, radiographic, and surgical characteristics of SHF have also been reported in several earlier studies. Khoshbin and Leroux, in one of the most extensive evaluable reports (n=3,235), evaluated the epidemiology of pediatric SHF. The median age of patients was six years. The incidence density rate varied significantly by season and age.<sup>9</sup> Barr reported the epidemiology, mechanisms, and incidence of pediatric SHF during school holidays over 3 years (n=159). Regarding gender, 53% of patients were male. Falling was the most frequent mechanism of injury (37%). The weekly incidence was

significantly higher during school holidays.<sup>10</sup> In a study by Anjum et al., the mean age of patients was 7.9 years and 59.7% of cases were male. In a similar vein, falling was the most prevalent mechanism of injury.<sup>7</sup>

Martinez et al. reported the epidemiologic characteristics of pediatric SHF in 140 patients with an average age of 5 years and 3 months. In the stated study, 49.6% of patients were male. Falling in the park was the most frequent mechanism of injury, and 70.7% of fractures were recorded on weekends.<sup>4</sup> The mean age of patients was six years in a study by Pilla et al., with a higher incidence in males (42 vs. 33). All fractures were the result of falling. Summer, spring, autumn, and winter had the highest incidence in order.<sup>11</sup> The mean age of patients was six years in a study by Cheng et al., with a male dominance (253 vs. 150).<sup>1</sup> Similar results were also reported by other authors.<sup>12-15</sup> In agreement with the results of earlier studies, we observed a higher incidence in the male population and during the holidays. Falling was also the most frequent mechanism of injury in our patients. Moreover, the mean age of incidence was 7.7 years in the present study, which was in line with that reported in earlier studies.

In the study by Barr, out of 159 patients, extension-type injuries were recorded in 155 cases. Gartland Type I was the most common type of SHF (46%), and 41% of patients were treated surgically.<sup>10</sup> In the study by Martinez et al., Gartland Types I and III were the most frequent SHF types, and the majority of patients were managed surgically (54.3%).<sup>4</sup> In a study by Cheng et al., Gartland type III fractures were the most prevalent type of SHF (45%), while only 20% of fractures required open reduction.<sup>1</sup> In a study by Barrón-Torres et al., 44 (78.6%) cases required surgical intervention in the form of open reduction in 26 (59.1%) patients.<sup>12</sup> In a study by Gaudeuille et al., out of 119 patients, the mechanism of fracture was extension-type in 115 cases, most of which (68.1%) were severe fractures (Lagrange Grade 3 and 4). Gartland type III and extension-type were the most frequent SHF in a study by Babalola et al. (78.8% and 98.1%, respectively).<sup>15</sup> In the study by Anjum et al., Gartland Type III was the most common type of SHF (54.4%). Contrary to the majority of studies, the flexion-type mechanism was observed in 98.1% of patients.<sup>7</sup> In the present study, Gartland Type I was the most frequent SHF injury.

Immediate neuralgic complications have been reported, with an incidence of 12%-20% in pediatric SHF.<sup>16</sup> The incidence of vascular injuries associated with pediatric SHF has been reported as 3.2%-14.3%.<sup>17</sup> Open fractures have also been reported to be present in up to 30% of cases.<sup>18</sup> In the present study, neurologic and vascular complications were recorded in 1.45% and 1.22% of patients, respectively. The open fracture was recorded only in 2 patients (0.15%). The surgical repair of nerve and vascular injury was not necessary in any patients. Moreover, no compartment syndrome was detected in our patients. The lower rate of concomitant complications in the present series could also be attributed to the nature of our hospital, which is a single specialty orthopedic hospital; therefore, patients with multiple trauma injuries are less likely to be referred to our hospital.

The results of the present study, in line with the findings of earlier studies, confirmed the high incidence of SHF in the pediatric population aged around seven years, highlighting the importance of concurrent complications, such as neurovascular injuries. Nonetheless, this study was not without limitations. The main limitation of the study was related to its retrospective design. In addition, our hospital was a single specialty orthopedic hospital. Therefore, the results of this study may not be generalizable to general hospitals with several specialties.

### Conclusion

As evidenced by the obtained results, SHF has the highest incidence at the age of almost seven years. The incidence of SHF is higher in males, whereas the mean age of incidence is significantly smaller in female patients. Falling is the most frequent mechanism of injury. Gartland Type I and extension-type mechanisms are the most common types of injury. Accordingly, most patients can be managed non-operatively. The majority of patients who require a surgical intervention can undergo treatment with closed reduction and percutaneous pinning. Concurrent fractures as well as neuralgic, vascular, and muscular complications may be

present and should be managed adequately to prevent their devastating consequences.

### Acknowledgement

Not applicable

**Conflict of interest:** None

**Funding:** None

Mohammad Reza Bahaeddini MD <sup>1</sup>

Mohammad Hosein Senemari MD <sup>1</sup>

Meysam Salehi Beromi MD <sup>1</sup>

Amir Aminian MD <sup>1</sup>

Pouria Tabrizian MD <sup>1</sup>

Elham Mohammadyahya MD <sup>1</sup>

Hamed Tayyebi MD <sup>1</sup>

1 Bone and Joint Reconstruction Research Center, Department of Orthopedic Surgery, School of Medicine, Iran University of Medical Sciences, Tehran, Iran

### References

- Cheng JC, Lam TP, Maffulli N. Epidemiological features of supracondylar fractures of the humerus in Chinese children. *J Pediatr Orthop B*. 2001; 10(1):63-7.
- Omid R, Choi PD, Skaggs DL. Supracondylar humeral fractures in children. *J Bone Joint Surg Am*. 2008; 90(5):1121-32. doi:10.2106/jbjs.g.01354.
- Shenoy PM, Islam A, Puri R. Current Management of Paediatric Supracondylar Fractures of the Humerus. *Cureus*. 2020; 12(5):e8137. doi:10.7759/cureus.8137.
- Aparicio Martínez JL, Pino Almero L, Cibrian Ortiz de Anda RM, Guillén Botaya E, García Montolio M, Mínguez Rey MF. Epidemiological study on supracondylar fractures of distal humerus in pediatric patients. *Rev Esp Cir Ortop Traumatol (Engl Ed)*. 2019; 63(6):394-399. doi:10.1016/j.recot.2019.07.001.
- Dhoju D, Shrestha D, Parajuli N, Dhakal G, Shrestha R. Ipsilateral supracondylar fracture and forearm bone injury in children: a retrospective review of thirty one cases. *Kathmandu Univ Med J*. 2011; 9(34):11-6. doi:10.3126/kumj.v9i2.6280.
- Khademolhosseini M, Abd Rashid AH, Ibrahim S. Nerve injuries in supracondylar fractures of the humerus in children: is nerve exploration indicated? *J Pediatr Orthop B*. 2013; 22(2):123-6. doi:10.1097/BPB.0b013e32835b2e14.
- Anjum R, Sharma V, Jindal R, Singh TP, Rathee N. Epidemiologic pattern of paediatric supracondylar fractures of humerus in a teaching hospital of rural India: A prospective study of 263 cases. *Chinese J Traumatol*. 2017; 20(3):158-160. doi:10.1016/j.cjtee.2016.10.007.
- Gartland J. Management of supracondylar fractures of the humerus in children. *Surg Gynecol Obstet*. 1959; 109(2):145-154.
- Khoshbin A, Leroux T, Wasserstein D, et al. The epidemiology of paediatric supracondylar fracture fixation: a population-based study. *Injury*. 2014; 45(4):701-8. doi:10.1016/j.injury.2013.10.004.
- Barr LV. Paediatric supracondylar humeral fractures: epidemiology, mechanisms and incidence during school holidays. *J Child Orthop*. 2014; 8(2):167-70. doi:10.1007/s11832-014-0577-0.
- Pilla NI, Rinaldi J, Hatch M, Hennrikus W. Epidemiological Analysis of Displaced Supracondylar Fractures. *Cureus*. 2020; 12(4):e7734. doi:10.7759/cureus.7734.
- Barrón-Torres EA, Sánchez-Cruz JF, Cruz-Meléndez JR. [Clinical and epidemiological characteristics of humeral supracondylar fractures in pediatric patients in a Regional General Hospital]. *Cirugía y Cirujanos*. 2015; 83(1):29-34. doi:10.1016/j.circir.2015.04.020.
- Gaudeuille A, Douzima PM, Makolati Sanze B, Mandaba JL. [Epidemiology of supracondylar fractures of the humerus in children in Bangui, Central African Republic]. *Med Trop (Mars)*. 1997; 57(1):68-70.
- Matuszewski Ł, Okoński M. Retrospective epidemiological study of supracondylar fractures of the humeral bone in children from urban and rural areas of the Lublin region in eastern Poland. *Ann Agric Environ Med*. 2013; 20(2):401-4.
- Babalola O, Ugwoegbulem O, Izuagba E, Idowu O, Owoola A. Supracondylar humeral fractures in school children: Incidence and aetiology during school terms and holidays. Original Article. *Niger J Orthop Trauma*. 2020; 19(2):69-72. doi:10.4103/njot.njot\_28\_20.
- Ramachandran M, Birch R, Eastwood DM. Clinical outcome of nerve injuries associated with supracondylar fractures of the humerus in children: the experience of a specialist referral centre. *J Bone Joint Surg Br*. 2006; 88(1):90-4. doi:10.1302/0301-620x.88b1.16869.
- Griffin KJ, Walsh SR, Markar S, Tang TY, Boyle JR, Hayes PD. The pink pulseless hand: a review of the literature regarding management of vascular complications of supracondylar humeral fractures in children. *Eur J Vasc Endovasc Surg*. 2008; 36(6):697-702. doi:10.1016/j.ejvs.2008.08.013.
- Fleisher GR, Ludwig S. Textbook of pediatric emergency medicine. Lippincott Williams & Wilkins; 2010.