

## Epidemiology of Supracondylar Fractures of the Humerus in Children

*Epidemiologia das Fraturas Supracondilianas do Úmero em Crianças*

*Epidemiología de las Fracturas Supracondíleas del Húmero en Niños*

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### Abstract

Background: Supracondylar fracture of the humerus are the second most common fracture in pediatric patients. There are few studies concerning their epidemiology in Brazil. This study aims to assess the clinical and epidemiological characteristics of supracondylar fractures of the humerus in children managed at a tertiary-level hospital within the Brazilian Unified Health System (translation for SUS - Sistema Público de Saúde). Methods: This retrospective study included patients younger than 13 years diagnosed with supracondylar fracture of the humerus assisted at an urgent and emergency referral unit of the Unified Health System from June 2022 to July 2023. The statistical analysis used R software version 4.0.4 with a significance level set at 0.05 using descriptive and inferential statistics. Results: 197 children with mean age of 5.4 years ( $\pm 2.4$ ) were diagnosed with a supracondylar fracture of the humerus. The highest temporal incidence occurred in December, being 56.9% male patients, 81.3% identified as African American, and 51.8% had a fracture on the left side. The most prevalent cause for the fracture was a fall from standing height on the outstretched hand. At least 95% of the patients had extension fractures, and the distribution by Gartland classification was: I, 36.7%; II, 26.2%; III, 30.9%; and IV, 6.3%. Three patients had a neurological injury. All patients with III and IV fractures, as well as those with flexion fractures, underwent surgery. However, of the 50 patients with grade II fractures, 11 underwent surgery, and 39 managed with nonoperative methods. We observed an association between the fracture severity, and fall height, neurological impairment, and management received. Conclusion: Targeted education efforts and interventions can prevent the occurrence of supracondylar fractures in our region at the northeast side of the country.

**Descriptors:** Humeral Fractures; Elbow Joint; Child.

### Resumo

As fraturas supracondilianas do úmero são a segunda fratura mais comum em pacientes pediátricos. Existem poucos estudos sobre sua epidemiologia no Brasil. Este estudo tem como objetivo avaliar as características clínicas e epidemiológicas das fraturas supracondilianas do úmero em crianças atendidas em um hospital de nível terciário do Sistema Único de Saúde (SUS). Métodos: Este estudo retrospectivo incluiu pacientes menores de 13 anos com diagnóstico de fratura supracondiliana de úmero atendidos em uma unidade de referência de urgência e emergência do Sistema Único de Saúde no período de junho de 2022 a julho de 2023. A análise estatística utilizou o software R versão 4.0.4 com um nível de significância fixado em 0,05 por meio de estatística descritiva e inferencial. Resultados: 197 crianças com idade média de 5,4 anos ( $\pm 2,4$ ) foram diagnosticadas com fratura supracondiliana do úmero. A maior incidência temporal ocorreu em dezembro, sendo 56,9% pacientes do sexo masculino, 81,3% identificados como afro-americanos e 51,8% tiveram fratura no lado esquerdo. A causa mais prevalente para a fratura foi queda da própria altura com a mão estendida. Pelo menos 95% dos pacientes apresentavam fraturas de extensão e a distribuição pela classificação de Gartland foi: I, 36,7%; II, 26,2%; III, 30,9%; e IV, 6,3%. Três pacientes tiveram lesão neurológica. Todos os pacientes com fraturas III e IV, bem como aqueles com fraturas em flexão, foram operados. Entretanto, dos 50 pacientes com fraturas grau II, 11 foram submetidos à cirurgia e 39 tratados com métodos não operatórios. Observamos associação entre gravidade da fratura, altura da queda, comprometimento neurológico e manejo recebido. Conclusão: Esforços e intervenções educacionais direcionadas podem prevenir a ocorrência de fraturas supracondilianas em nossa região, no nordeste do país.

**Descritores:** Fraturas do Úmero; Articulação do Cotovelo; Criança.

### Resumen

Antecedentes: las fracturas supracondíleas del húmero son la segunda fractura más común en pacientes pediátricos. Existen pocos estudios sobre su epidemiología en Brasil. Este estudio tiene como objetivo evaluar las características clínicas y epidemiológicas de las fracturas supracondíleas del húmero en niños atendidos en un hospital de tercer nivel del Sistema Único de Salud de Brasil (traducción para SUS - Sistema Público de Saúde). Métodos: Este estudio retrospectivo incluyó pacientes menores de 13 años con diagnóstico de fractura supracondílea de húmero atendidos en una unidad de derivación de urgencia y emergencia del Sistema Único de Salud desde junio de 2022 hasta julio de 2023. El análisis estadístico utilizó el software R versión 4.0.4 con un nivel de significancia establecido en 0,05 utilizando estadística descriptiva e inferencial. Resultados: 197 niños con edad media de 5,4 años ( $\pm 2,4$ ) fueron diagnosticados con fractura supracondílea de húmero. La mayor incidencia temporal se presentó en diciembre, siendo el 56,9% pacientes masculinos, el 81,3% identificados como afroamericanos y el 51,8% presentaron fractura del lado izquierdo. La causa más frecuente de la fractura fue una caída desde una altura elevada con la mano extendida. Al menos el 95% de los pacientes presentaron fracturas en extensión y la distribución según la clasificación de Gartland fue: I, 36,7%; II, 26,2%; III, 30,9%; y IV, 6,3%. Tres pacientes sufrieron una lesión neurológica. Todos los pacientes con fracturas III y IV, así como aquellos con fracturas en flexión, fueron sometidos a cirugía. Sin embargo, de los 50 pacientes con fracturas de grado II, 11 fueron sometidos a cirugía y 39 fueron tratados con métodos no quirúrgicos. Observamos una asociación entre la gravedad de la fractura y la altura de la caída, el deterioro neurológico y el manejo recibido. Conclusión: Los esfuerzos e intervenciones educativas específicas pueden prevenir la aparición de fracturas supracondíleas en nuestra región del noreste del país.

**Descriptores:** Fraturas do Húmero; Articulação do Codo; Niño.

### INTRODUCTION

Supracondylar fracture of the humerus is common in the immature skeleton, ranking as the

second most common childhood fracture, second only to fractures of the distal radius end. Its peak incidence is at 5 years and 3 months of age<sup>1</sup>.

However, it is the most prevalent fracture among children aged 4–7 years<sup>2</sup>. Over recent decades, there has been an approximately 7% increase in the incidence of this fracture type<sup>3</sup>.

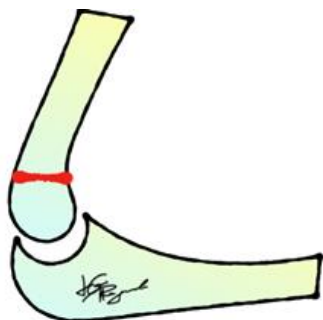
Supracondylar fractures predominantly occur in boys<sup>3-7</sup> and are more common on the left or non-dominant limb<sup>5</sup>. They can result from both low-energy impacts, such as falls from standing height, or high-energy traumas, such as those associated with sports activities.

These fractures can manifest as flexion or extension displacement, with the latter accounting for approximately 98% of cases<sup>7</sup>. The degree of displacement is determined by the direction and magnitude of the deforming force and the limb's position at the time of trauma<sup>8-9</sup>.

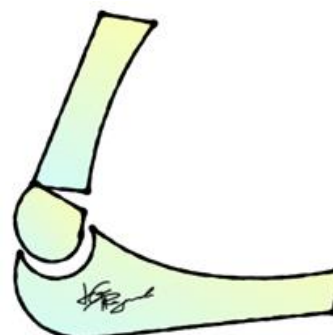
Gartland classified extension fractures into three types based on the degree of displacement observed on elbow radiographs: type I, no or minimal displacement with an intact humeral line; type II, slight displacement but retaining fragment contact at the posterior cortex; and type III, complete separation of the fragments with injury to the posterior cortex<sup>10</sup>. In 2006, type IV was introduced, characterized by multidirectional instability, and diagnosed during the intraoperative period<sup>11</sup>. Figures 1-4 show the Gartland classification modified by Leitch et al.<sup>11</sup>.

Gartland I fractures are usually treated conservatively. In contrast, displaced type II fractures and types III and IV fractures are typically treated with closed reduction and percutaneous fixation with Kirshner wires<sup>11-12</sup>. However, consensus is lacking regarding the optimal positioning of the Kirschner wires (whether lateral or crossed), with various studies aiming to determine the ideal fixation method<sup>13</sup>.

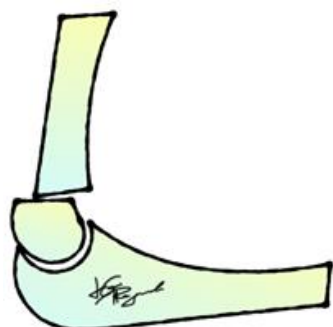
Despite the increasing incidence over recent decades, the epidemiology of these fractures has not been evaluated in the northeast region of Brazil. Therefore, this study aimed to evaluate the clinical and epidemiological profile of supracondylar fractures of the humerus in children treated at a tertiary-level hospital within the Unified Health System.



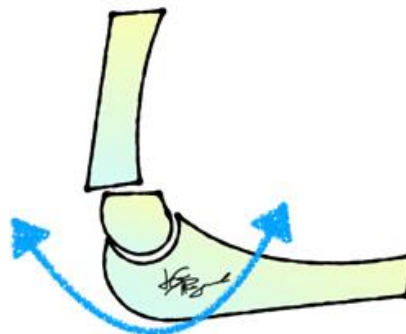
**Figure 1:** Gartland Supracondylar Humerus Fractures classification modified by Leitch et al.<sup>11</sup>, Type I: Non-displaced fractures. Illustration by Luis Guilherme Rosifini Alves Rezende.



**Figure 2:** Gartland Supracondylar Humerus Fractures classification modified by Leitch et al.<sup>11</sup>. Type 2: Displaced fracture, posterior cortex intact. Illustration by Luis Guilherme Rosifini Alves Rezende.



**Figure 3:** Gartland Supracondylar Humerus Fractures classification modified by Leitch et al.<sup>11</sup>. Type 3: Displaced fracture (complete), posterior cortex without contact. Illustration by Luis Guilherme Rosifini Alves Rezende.

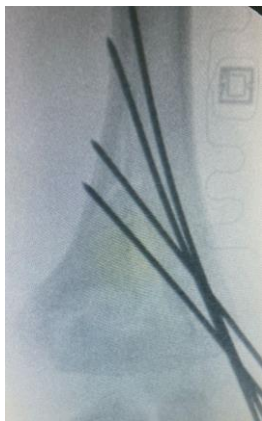


**Figure 4:** Gartland Supracondylar Humerus Fractures classification modified by Leitch et al.<sup>11</sup>. Type 4: Displaced fracture complete periosteal disruption, multidirectional instability (anterior and posterior). Illustration by Luis Guilherme Rosifini Alves Rezende.

Figures 5-7 show a comminuted supracondylar humerus fracture managed operatively with multiple K-wires.



**Figure 5:** Comminuted Supracondylar Humerus Fracture: preoperative anteroposterior view. Courtesy of Luis Guilherme Rosifini Alves Rezende



**Figure 6:** Cominutive Supracondylar Humerus Fracture: intraoperative anteroposterior view with Kirschner wires. Courtesy of Luis Guilherme Rosifini Alves Rezende.



**Figure 7:** Cominutive Supracondylar Humerus Fracture: intraoperative lateral view with Kirschner wires. Courtesy of Luis Guilherme Rosifini Alves Rezende.

**MATERIAL AND METHOD**

This retrospective observational study examined patient data from a tertiary-level emergency and urgent care unit of the Unified Health System from June 2022 to July 2023. The study included patients younger than 13 years who were diagnosed with a supracondylar fracture of the humerus. The study was approved by the Research Ethics Committee (reference no. 6.257.920, CAAE 69892023.1.0000.0217).

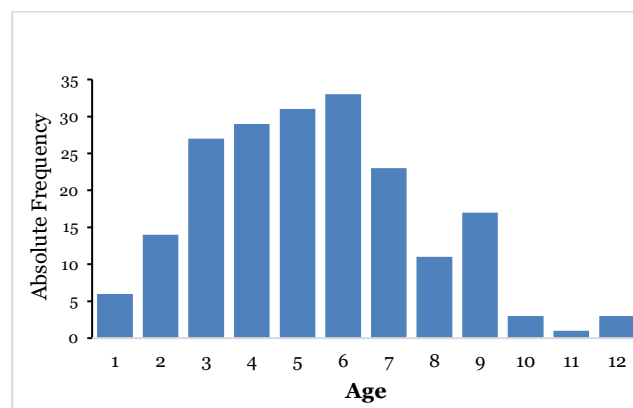
The initial treatment involved a thorough evaluation of the circulatory conditions of their limbs and potential neurological injuries. For every patient, anteroposterior (AP) and lateral (L) elbow radiographs were taken to confirm the diagnosis and classification using the Gartland system. After excluding cases for which data were missing in the electronic system, 197 children diagnosed with supracondylar fractures of the humerus were analyzed.

Statistical analysis was conducted using

R software version 4.0.4 with a significance level of 0.05. Both descriptive and inferential statistics were used. The relationship between qualitative variables was assessed using the Chi-squared test ( $\chi^2$ ), and when the observed frequency was less than 5, Fisher's exact test was used.

**RESULTS**

A total of 197 children aged 1–12 years (mean, 5.4 [ $\pm 2.4$ ]) were evaluated. Figure 8 shows the frequency distribution of cases by age.



**Figure 8:** Frequency distribution of supracondylar fractures of the humerus by age. Data from the author's research.

Of the 197 evaluated patients, 112 (56.9%) were male, and the majority (135 [81.3%]) were brown. In December, coinciding with school holidays and summer in the southern hemisphere, the highest number of supracondylar fractures, followed by February, May, and July.

Table 1 shows the epidemiological profile of the study participants. None of the patients had vascular injuries, and there were no cases of open fractures.

**Table 1.** Epidemiological profile of the evaluated children over the study period

Variable/Category	Frequency	Percentage
<b>Mechanism</b>		
Fall from standing height	104	58.8
Fall from bed	17	9.6
Fall from sofa	12	6.8
Fall from bike	11	6.2
Others	33	18.6
<b>Side</b>		
Right	95	48.2
Left	102	51.8
<b>Displacement Pattern (Flexion/Extension)</b>		
Extension	115	95.0
Flexion	6	5.0
<b>Displacement Pattern (Medial/Lateral)</b>		
Lateral	28	36.8
Medial	48	63.2
<b>Gartland Classification</b>		
I	70	36.7
II	50	26.2
III	59	30.9
IV	12	6.3
<b>Neurological Impairment</b>		
No	194	98.5
Yes	3	1.5
<b>Which?</b>		
Median	2	66.7
Radial	1	33.3
<b>Treatment</b>		
Surgical	88	44.7
Conservative	109	55.3

<1 m, less than 1 m; >1 m, greater than 1 m

All patients with grade III and IV extension fractures or with flexion fractures were treated



surgically. However, of the 50 patients with grade II extension fractures, 11 underwent surgical treatment and 39 were treated conservatively. The three patients with neurological injury had grade III or IV extension fractures.

Table 2 shows the correlation between the Gartland classification, sex, fall height, neurological impairment, and type of treatment used.

**Table 2.** Association between Gartland classification and other variables

Variable/Category	Gartland Classification				P value
	I	II	III	IV	
<b>Sex</b>					
Female	29 (35,8%)	19 (23,5%)	26 (32,1%)	7 (8,6%)	*p>0.05
Male	41 (37,3)	31 (28,2)	33 (30)	5 (4,5)	
<b>Fall</b>					
<1 m	47 (45,6%)	25 (24,3%)	28 (27,2%)	3 (2,9%)	*p<0.05
>1 m	20 (28,6)	20 (28,6)	22 (31,4)	8 (11,4)	
<b>Neurological Impairment</b>					
No	70 (37,2)	50 (26,6)	58 (30,9)	10 (5,3)	*p<0.05
Yes	0 (0)	0 (0)	1 (33,3)	2 (66,7)	
<b>Treatment</b>					
Surgical	0 (0,0)	11 (13,4)	59 (72)	12 (14,6)	*p<0.05
Conservative	70 (64,2)	39 (35,8)	0 (0,0)	0 (0,0)	

<1 m, less than 1 m; >1 m, greater than 1 m

## DISCUSSION

Given the increasing incidence of supracondylar fractures of the humerus in children in recent years<sup>3,14</sup>, it is crucial to understand the epidemiological profile of these fractures across different regions of Brazil. With this aim, the present study undertook an epidemiological analysis of patients treated at a referral pediatric hospital in northeastern Brazil.

Previous studies reported an average age of patients with supracondylar humerus fractures of 5–7 years<sup>1,3,4,13</sup>. This aligns with our study findings of an average age of 5.4 (±2.4) years. The peak incidence was 6 years of age, with 72.1% of patients aged 3–7 years.

Supracondylar fractures were predominantly observed in males (56.7%), with a 1.3:1 ratio compared to females, and tended to affect the left arm (51.8%). These findings align with those in the literature. Barr (2014)<sup>14</sup> reported a 53% incidence in males and a 59% incidence on the left side, data that were later supported by Rokaya et al. (2018)<sup>5</sup>, who found a 67.3% incidence in males and a 63.7% incidence on the left side<sup>5,14</sup>.

An analysis of fracture frequency indicated that fractures in children are more common during the summer and school vacation periods<sup>1,14</sup>. Furthermore, a Spanish study identified Friday as the day with the highest frequency of such fractures<sup>1</sup>. Similar results were observed in the present study: Friday had the highest incidence and December had the highest absolute frequency of supracondylar fractures.

Supracondylar fractures can be caused by low- and high-energy mechanisms. In our study, the primary mechanism associated with fractures was a

fall from standing height on the outstretched hand, which is consistent with the findings of Mubarak et al.<sup>6</sup> and Wu et al.<sup>7</sup> However, the exact activity being performed during the fall was not specified. For our analysis, we categorized fractures based on fall height: a short distance or standing height (<1 m) or from a greater height (>1 m). We observed that the more severe fractures were statistically associated with falls from great heights, a finding that is consistent with those of Schuller et al.<sup>3</sup>, who found that type I fractures typically occur during falls from standing height, while the severity of fractures seems to increase with fall height per the Gartland classification<sup>3</sup>.

In 1959, Gartland published an article entitled “*Management of supracondylar fractures of the humerus in children.*” The article aimed to educate the community on the fundamental principles of treatment and provide a straightforward and practical approach to handling various situations involving supracondylar fractures of the humerus. Gartland’s study aim was to specifically target professionals in hospitals that lacked available orthopedic care and supervision and where immediate treatment was administered by individuals lacking adequate training in managing such fractures. The introduction of a systematic and effective approach led to the development of the Gartland system which is now widely used in the orthopedic community<sup>10</sup>.

Supracondylar fractures in children can be categorized into two main types: (1) extension, in which the humerus is pushed backward at the elbow joint (accounting for 98% of cases) and can be classified using the Gartland system; and (2) flexion. Among extension fractures, type I fractures, considered simpler and conservatively treatable, are most common, representing 40–64% of cases depending on the study<sup>1,3,4,6,14,15</sup>. Schuller et al.<sup>3</sup> reported an incidence of 56% for type I, 17.9% for type II, 11.1% for type III, and 14.9% for type IV. Our study identified a lower frequency for Gartland I (36.7%) than other studies. This might be due to the nature of the referral hospital since fewer complex cases are often treated in smaller facilities.

When a dislocation occurs in the coronal plane, it is most commonly associated with a medial dislocation, which characterizes it as a posteromedial dislocation. In the present study, the incidence of posteromedial dislocation was 63.2%, consistent with the previously reported posteromedial dislocation rate of 71.1%<sup>5</sup>.

All type III and IV fractures were treated surgically. A total of 78% of type II fractures were treated conservatively. A significant association was observed between the higher Gartland grades and the need for surgical intervention, underscoring the clinical significance of the classification.

In the literature, the flexion fracture rate was

1–3% and convey a potential longer surgical duration<sup>5,14,16,17</sup> however, Aparicio Martínez et al.<sup>1</sup> reported just one fracture caused by a flexion injury mechanism (0.7% of their sample). In our research, the prevalence of flexion fractures was notably higher (5% of the sample). They also differ from adult humeral patterns of fractures and complications such nerve injury<sup>18,19</sup>.

None of the patients in our sample had vascular injuries, but there were three (1.5%) cases of neurological injuries at the initial assessment: one radial nerve injury and two median nerve injuries. These patients had Gartland classification III and IV fractures. Wu et al.<sup>7</sup> reported 1.6% of nerve injury,<sup>7</sup> but Aparicio Martínez et al.<sup>1</sup> reported a higher frequency (4.9%). However, unlike our study, their study evaluated injuries during the initial assessment and after treatment.

### CONCLUSION

We conclude that the epidemiological data for patients with supracondylar fractures in our region align with the findings in the international literature and targeted education efforts and interventions can be set up to prevent the occurrence of supracondylar fractures. The finding can help produce guidelines for the management of supracondylar fractures in your country.

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#### **CONFLICT OF INTERESTS**

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The authors declare no conflict of interest.

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