

# Treatment and outcomes of pediatric supracondylar humeral fractures in Korle Bu Teaching Hospital

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## Abstract

**Objectives:** Supracondylar humeral fractures (SCHF) are the most common elbow injury in the pediatric population. The treatment, outcome, and health-related quality of life (HRQoL) following these injuries are described.

**Methods:** Patients with SCHF who were treated depending on the fracture type were evaluated. Medical records stored in the REDCap database were reviewed to obtain information on demographics, mechanisms of injury, neurovascular status, infection rates, and postoperative complications. Outcomes were assessed using Flynn's criteria and Pediatric Quality of Life (PedsQL) version 4.0. Follow-up was for 6 months.

**Results:** A total of 101 patients with a mean age of 5.2 years (SD ± 2.3) were seen. Most of the injuries occurred at home (64.3%). The left-arm (nondominant) was the most injured (62%), though 92% of patients were right hand dominant. Ninety-six percent of the fractures were the extension type. A total of 98% had satisfactory outcomes using Flynn's criteria and older patients were likely to sustain Gartland type III SCHF ( $P = .01$ ). There was a significant difference in mean scores of PedsQL (all  $P$  values < .01) at 6 months.

**Conclusions:** In this prospective study, the quality of life of patients following SCHF diminished at the time of the injury and returned to the population normal 6 months after. There was no significant difference in HRQoL scores between patients who presented early and those who presented late. The delayed presentation and management did not also affect the functional outcome and complications. Therefore, surgical management of these injuries after late presentation is still safe.

**Keywords:** Flynn criteria, Ghana, outcome, PedsQL, supracondylar humeral fracture

## 1. Introduction

Supracondylar humeral fractures (SCHF) are the most common pediatric elbow fractures.<sup>[1–3]</sup> The reported incidence is between 50% and 70% of elbow fractures<sup>[4]</sup> and about 13% of all

pediatric fractures.<sup>[5]</sup> The peak incidence is between the ages of 5 to 7 years with a male-to-female ratio of 2:1.<sup>[6,7]</sup> Some authors, however, have found no variations among the sexes whereas others found higher incidence among girls.<sup>[7,8]</sup> The left hand (which usually is the nondominant hand) is mostly affected in most studies.<sup>[7–9]</sup> These fractures are classified using the Gartland classification, which also serves as a treatment guide.<sup>[10]</sup> Gartland types 1 and IIa fractures may be managed nonoperatively whereas types IIb and III are treated operatively.<sup>[11–13]</sup> Closed reduction and percutaneous (CRPP) fixation using Kirschner wires (K-wires) is the operative treatment of choice.<sup>[5,14]</sup>

Some studies that have evaluated outcomes and complications with respect to timing found no difference in the infection rate, neurovascular injury, length of hospital stay, or conversion to open reduction.<sup>[15–18]</sup> Others, however, recommended urgent fixation as any delays made the subsequent surgery difficult and raised the chances of complications.<sup>[19,20]</sup> In Ghana and most of the subregion, aside from patients with SCHF presenting late, others are taking to traditional bonesetters for management leading to permanent disability, and life and limb-threatening complications. This is as a result of what we term “bonesetter's limb or gangrene.”<sup>[21]</sup>

This study sought to evaluate the treatment and outcomes as well as quality of life in children who presented to our emergency unit with SCHF.

## 2. Patients and methods

This was a prospective cohort study done at the orthopedic unit of Korle Bu Teaching hospital (with a bed capacity of over 2000)

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The study was reviewed and approved by the institutional review board of the School of Medicine and Dentistry, University of Ghana.

Informed consent was obtained from the parents/guardians of all participants in this study.

The authors have no conflicts of interest to disclose.

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from January 2014 to January 2015. The follow-up was for 6 months. The study was approved by the institutional review board of the University of Ghana Medical School (PIN MS-Et/M.2-P3.1/2014–2015).

**2.1. Inclusion and exclusion criteria**

The inclusion criteria for this study were children up to the age of 13 years. Children who had SCHF that were over 3 weeks old were excluded.

**2.2. Study procedure**

Patients with Gartland type I (Fig. 1) fractures did not need any form of manipulation, whereas those with type IIa fractures had manipulation under anesthesia. The limb was then put in a well-padded long-arm splint with 60° to 70° of elbow flexion for 3 weeks. X-rays were obtained weekly to ensure the fracture remains reduced. The higher energy types are usually associated with gross deformity of the elbow (Fig. 2A and B). All cases of Gartland type IIb and type III (Figs. 3 and 4 respectively) were done using CRPP with the aid of an image intensifier. The limb was then splinted for 3 weeks after which time the k-wires were removed. The cross-pinning technique was mostly used for this study (Fig. 5). None of these injuries needed open reduction and pinning and none of those managed nonsurgically redislocated.

The range of motion and carrying angle and PedsQL were the outcome instrument used in this study. These were administered by one of our senior Orthopedic surgeons at 3 weeks and final follow up at 6 months.

**2.3. Data handling and statistics**

Study data were collected and stored in REDCap electronic data capture tools hosted at University of California, San Fran-



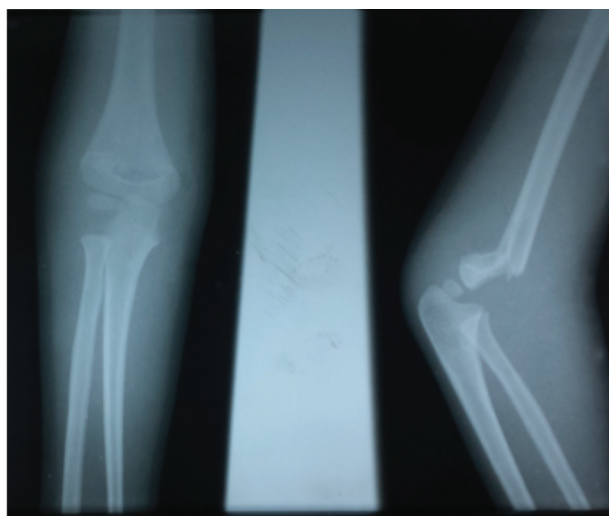
**Figure 2.** (A, B) Clinical appearance of type III supracondylar fracture in a 6-year-old boy. The AP and lateral views show an S-shaped deformity of the elbow due to complete displacement of the distal fragment.

cisco.<sup>[22,23]</sup> Statistical analyses were done using SAS version 9.4 Software (SAS Institute Inc, Cary, NC, 2004). Continuous variables were reported as means and standard deviations while categorical variables were reported as percentages. Chi-square and Fisher exact tests were used to test for relationships between categorical variables such as time of injury to the time of presentation to hospital, marital status of parents, and time of presentation to the hospital and educational levels of parents and time of presentation to the hospital.

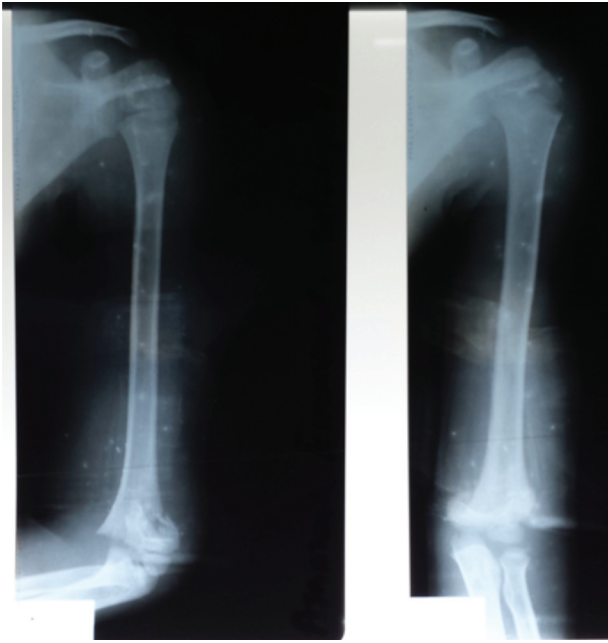
Flynn’s criteria grouped as satisfactory (excellent and good) and unsatisfactory (fair and poor) were used for evaluating the physical outcomes of management. Measurement of the health-related quality-of-life scores using the pediatric quality-of-life assessment form was done at 3 weeks and 6 months posttreatment respectively using a paired sample *t* test.



**Figure 1.** Lateral x-ray of a patient with Gartland type I supracondylar humeral fracture (SCHF). This fracture may be difficult to see on plain radiograph. The presence of an anterior and/or posterior fat pad sign (blue arrow) on the lateral view indicates the likelihood of a type I fracture.



**Figure 3.** AP and lateral views of a 4-year-old boy with type II SCHF. The AP view shows a fracture line through the metaphyseal region of the distal humerus on either side of the olecranon fossa. Lateral view shows posterior angulation of the distal fragment associated with an intact posterior cortex and periosteal hinge.



**Figure 4.** Lateral and AP views of a 5-year-old girl showing completely displaced Gartland type III fracture.

### 3. Results

A total of 101 patients with SCHF were seen within the study period, of which 56 had closed reduction and percutaneous pinning. The mean age was 5.2 years ( $SD \pm 2.3$ ) and the highest incidence was between 5 and 7 years. Of the number, 31.7% (32/



**Figure 5.** Postoperative AP and lateral x-rays showing reduction and cross-pinning of the fracture.

101) were Gartland type I, 24.7% (25/101) type II, and 43.6% (44/101) type III fractures. Of the type II fractures, 13 were IIa and 12 being type IIb. In all, 56 patients were managed using CRPP. The left elbow was the most injured (62.4%) though 92.1% of the patients were right hand dominant. Ninety-six percent had an extension type of supracondylar fracture as a result of a fall on the outstretched hand. A total of 70.4% of the patients were seen within 24 hours of the injury (Table 1). Of the 29.6% that presented after 24 hours, 55.6% were initially sent to traditional bonesetters, 14.8% downplayed the injury severity, 11.1% were transferred from another health facility, and 3.7% could not get a means of transportation to the hospital. Only 33 patients were managed within the first 24 hours of injury and these were mainly types I and IIa. About 56.4% of the patients were treated after 3 days. This delay was due mainly to factors such as unavailability of theater, waiting for C-arm which may not be functioning or waiting for the patient to pay for the cost of surgery. Table 1 summarizes the characteristics of patients as well as Gartland type, time from injury to admission, and time from injury to definitive management.

Cumulatively 98% of patients had satisfactory outcomes. The 2% with poor outcomes had a loss of range of motion between  $10^\circ$  and  $20^\circ$  and carrying angle between  $10^\circ$  and  $15^\circ$ . A patient had cubitus varus of  $5^\circ$ , which did not require reoperation at follow-up. Of the type III fractures (44/100), 42 as well as all the types I and II SCHF had satisfactory outcomes.

There was a significant association between patients' age and Gartland type ( $X^2$  (2,  $N=101$ )=8.76,  $P=.01$ ). There were however no association between gender and Gartland type ( $X^2$  (2,  $N=101$ )=2.69,  $P=.26$ ). There was also no significant association ( $P>.05$ ) between variables such as age, distance traveled, time of day, type (extension vs. flexion), injury to admission, and Gartland type with functional and cosmetic outcomes.

Children who were admitted for SCHF suffered significant decline in physical, emotional, school and social well-being during the first 3 weeks after the injury; they however recovered by 6 months postinjury (all  $P<.01$ ). Table 2 shows the results from the paired sample *t* test of the PedsQL mean scores at 3 weeks and 6 months posttreatment. The observed complications from the study are shown in Table 3.

### 4. Discussion

Supracondylar humeral fractures of the distal humerus are the commonest fracture around the pediatric elbow.<sup>[24]</sup> And despite this and the numerous studies on this topic, only a few relate these injuries with outcomes and health-related quality of life.<sup>[25]</sup> This study found a satisfactory outcome of 98% using Flynn's criteria in the patients seen over the 6 months. Though Gartland III fractures are caused by high-energy trauma and are generally inherently unstable and for which reason one expects a poor outcome, 95.5% of the patients in this study had satisfactory outcome. This confirms the assertion that the outcomes are excellent once they are managed aggressively by surgical fixation.<sup>[26]</sup> Though benign and with satisfactory outcomes, the long-term complications of type I fractures such as the mean range of elbow extension compared with the uninjured elbow, however, may be as high as 30%.<sup>[26]</sup>

The type II fractures in our series, whether managed surgically or nonsurgically, all resulted in satisfactory outcomes. This was because we applied the right treatment protocols depending on the fracture type (manipulation and splinting for type IIa and CRPP for type IIb). Miranda et al<sup>[27]</sup> made the same observations

**Table 1**  
**Characteristics of patients**

Characteristic	Frequency	Percentage (%)
Gender		
Male	73	72.3
Female	28	27.7
Age		
Less than 5 years	58	57.4
More than 5 years	43	42.6
Mode of transport		
Public: (taxi, trotro)	65	64.4
Private cars	27	26.7
Walk-in	8	7.9
Ambulance	1	1.0
Location where the injury occurred		
Home	65	64.4
School	28	27.7
Recreational area	8	7.9
Time injury occurred	66	65.3
Day (morning and afternoon)		
Night (evening and night)	35	34.7
Injury to admission		
Less than 24 hours	71	70.3
24 hours to 72 hours	12	1.9
4 days to 14 days	18	17.8
Injury to theatre		
Less than 24 hours	33	32.7
24 hours to 72 hours	11	10.9
4 days to 14 days	57	56.4

as they reported similar radiological and functional outcomes when closed reduction followed by casting was compared to CRPP of type II fractures. Again, 77% of type II fractures in the series by Hadlow et al<sup>[28]</sup> would have had unnecessary surgery if all of these fractures were surgically treated. Using Flynn's criteria, Parikh et al<sup>[11]</sup> reported a satisfactory outcome (72%) in nonsurgically treated type II fractures, with only 8% (n=2/25) reporting unsatisfactory outcomes. Moraleda et al<sup>[29]</sup> also reported a good outcome (80.4%) in a series of 46 patients managed nonsurgically for type II fractures with a mean follow-up of 6.6 years. Notwithstanding the ongoing discussion, there is an increasing tendency toward surgical fixation of these fractures.<sup>[26]</sup> It is believed that type II fractures are a heterogeneous group with varying degrees of stability and angulation of the anterior cortex.<sup>[26]</sup> For this reason, they have been subclassified into types IIa and IIb depending on rotation and/or displacement in the coronal plane<sup>[30]</sup> and type IIb fractures should be managed surgically while type IIa may be managed by closed reduction and immobilization.<sup>[31]</sup>

Though there are many studies on SCHF due to its common nature, only a few have used validated outcomes measures.<sup>[25,32-</sup>

**Table 3**  
**Complications observed during the study period**

Complication	Frequency
Pin site infection	5/66
Gartland type II	2
Gartland type III	3
Nerve injury	3/101
AIN	2
Ulna nerve	1
Vascular injury	1
Cubitus varus	1
Myositis ossificans	1

AIN, anterior interosseous nerve.

<sup>34]</sup> Available studies mainly looked at patients with lower extremity injury outcomes after treatment.<sup>[35,36]</sup> In this study, which is among the first from Africa to look at the effect of SCHF on the quality of life in children, the PedsQL version 4.0 was used.<sup>[37]</sup> This tool assesses: physical, emotional, social, and school functioning as the key features of quality of life.<sup>[35]</sup> The reliability and internal consistency, as well as construct validity, have been shown to be good.<sup>[35]</sup> Our results suggests that all the components of the PedsQL were affected by the injury initially but improved to near the population normal at 6 months' follow-up. This may be explained by the fact that it took about 3 to 4 weeks for the fracture to heal clinically and subsequent use of the affected limb with full return to activities of daily living.

The average age of 5.2 years from this study confirms results from previous studies.<sup>[38]</sup> According to Michelson et al,<sup>[39]</sup> by ages 5 to 6 years, most children would have enrolled into schools compared with those younger than this age. This age is also associated with increased activity levels, minimal supervision by parents, increased playground activity both at school and home, all of which increases the risk of sustaining fractures.<sup>[40,41]</sup> They also learn new skills and the tendency to experiment with the acquired skills further increases the risk of fractures and this may explain the peak incidence at 5 to 6 years.<sup>[39]</sup> The role of home environment cannot be over-emphasized as 65% of the SCHF in our study occurred at home and this is similar to that found by Mangwani et al.<sup>[42]</sup> This however differs from other studies that found only a small fraction that occurred at home.<sup>[6,7]</sup> This may be because most of the patients from this study were restricted to play at home mostly because of safety reasons or lack of availability of sports facilities in the areas. Of these fractures, 65.4% occurred during the daytime, which unsurprisingly coincides with the period of maximum activity, and less supervision as the parents may not be home or the child may be in school.

Our results indicated that SCHF are common in males (72%) and this may be due to the active nature of boys in this age group.

**Table 2**  
**Descriptive statistics and t test for PedsQL at 3 weeks and 6 months following the injury**

Pediatric quality of life	3-weeks		6-months			95% CI for mean difference	t	df
	M	SD	M	SD	N			
Physical	1.10	0.50	0.0	0.10	101	0.46, 0.61	20.98*	100
Emotional	0.20	0.40	0.0	0.0	101	0.35, 0.47	4.45*	100
Social	0.20	0.40	0.0	0.0	101	0.36, 0.47	6.13*	100
School	1.10	0.80	0.0	0.10	101	0.67, 0.88	14.89*	100

\* P<.01.

Though a slight female predominance has been suggested by some studies,<sup>[7,8]</sup> most authors found higher incidence (ranging from 53% to 64%) in males than females.<sup>[6,7,42,43]</sup> Although only about 8% to 15% of the world population is left hand dominant,<sup>[8]</sup> most of the fractures (62%) in our study population occurred in the left elbow, though 92% were right hand dominant. It has been found that during a fall on the outstretched hand, the commonest mechanism of injury, it is the nondominant hand that hits the ground first as the person tries to break the fall, accounting for this observation.<sup>[8]</sup> It was observed that the older children were most likely to sustain type III injuries. In the pediatric population, bone mineral density and content increases with age<sup>[44,45]</sup> hence greater force is needed to cause a fracture compared to younger children.<sup>[38]</sup>

Of the 101 patients with SCHF, there were 3 documented neurological deficits (Table 3). The ulnar nerve injury was iatrogenic following medial pin placement. The overall incidence of neurological complications (2.97%) was lower than that reported by other authors.<sup>[8,42,46,47]</sup> The nerve injuries however resolved within 3 months which is consistent with the findings from other studies.<sup>[48]</sup> The 9.3% infection rate in this study was within the estimated rates of 0% to 21% reported following surgical management of SCHF,<sup>[19,49]</sup> and these resolved following removal of the pins and administration of antibiotics. Noted by the current authors and not reported previously is that the 5 patients that had the infections were initially seen and treated by traditional healers. Further studies are therefore required to determine the association between herbal treatment and pin site infections.

In this study, we fixed the fractures with 2 crossed pins. The crossing of pins at the fracture site may be associated with secondary displacement of the fracture and this might have accounted for the single incidence of cubitus varus seen. This was not serious enough to warrant surgical correction. Research has shown that cross pinning provides much stability compared with lateral or parallel pinning thereby reducing the incidence of cubitus varus which may result from displacement of the distal fragment or posttreatment loss of reduction.<sup>[50,51]</sup> There was a single case of vascular injury that resolved after CRPP as well as a case of myositis ossificans, which resolved within a year of the injury. There were however no cases of compartment syndrome or Volkmann ischemic contractures, same as reported by other authors.<sup>[52]</sup>

Our study shows that, distance traveled to get to the hospital, time of day patient presented, time from injury to admission or to surgery (all of which led to delay in fracture fixation) did not have any significant effect on the PedsQL or the functional and cosmetic outcomes. It was observed that patients treated within 24 hours and after 24 hours did not differ in terms of outcome or complication rate. Some other authors made similar observations to ours.<sup>[53]</sup> We believe that delayed management of SCHF, without neurological or vascular complications, is safe as it enables the patient to get the optimum perioperative care. And the outcomes appear to be similar to those treated earlier.<sup>[53]</sup> To the best of our knowledge, this is the first study from sub-Saharan Africa to find out the effect of these fractures, on both PedsQL and functional outcomes simultaneously. This study was limited by the small sample size and the fact that it was conducted in a single institution; hence, the findings cannot be generalized. A multicenter or nationwide study therefore is recommended to find out if our findings were due to chance or consistent with other centers. This however enabled us to gather all the important data on each patient as well as follow up on all of them and this

together with the prospective nature were the strength of this study.

## 5. Conclusion

In this prospective study, the quality of life of patients following SCHF diminished at the time of the injury and returned to the population normal 6 months after. There was no significant difference in HRQoL scores between patients who presented early and those who presented late. The delayed presentation and management did not also affect the functional outcome and complications. Therefore, in a lower or lower middle income country such as Ghana, surgical management of these injuries after late presentation is still safe.

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