Flexion-Type Supracondylar Humeral Fracture with Ulnar Nerve Injury in Children: Two Case Reports and Review of the Literature

Authors' Contribution:
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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
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Case series
Patients: **Female, 7-year-old • Male, 6-year-old**
Final Diagnosis: **Flexion-type supracondylar humeral fracture**
Symptoms: **Pain**
Medication: **—**
Clinical Procedure: **—**
Specialty: **Orthopedics and Traumatology**

Objective: **Rare co-existance of disease or pathology**
Background: Supracondylar humeral fracture is a common fracture in the pediatric population. Although extension-type is the most common fracture pattern (97% to 98%), flexion-type supracondylar fractures are rarely encountered (2% to 3%). The combination of a flexion-type supracondylar humeral fracture with an ulnar nerve injury represents a real challenge for an orthopaedic surgeon.
Case Reports: We report 2 cases of flexion-type supracondylar humeral fracture with ulnar nerve injury that open reduction and fixation was necessary because closed reduction could not achieve an acceptable result. An anterior approach to the elbow joint was chosen to explore whether any neurovascular structures were entrapped between the fragments. The ulnar nerve was not found to be compressed in the fracture site. After anatomic reduction, cross K-wire fixation of the fracture was performed. At 6-month follow-up, ulnar nerve injuries (in both patients) were resolved.
Conclusions: These case reports enhance the existing literature that flexion-type supracondylar fractures with ulnar nerve injury are associated with higher rates of open reduction. Orthopaedic surgeons should be aware, and family members of those patients should be informed, that the likelihood of an open reduction in these types of injuries is extremely high. Open reduction is needed not only to achieve an anatomic reduction of the fracture but to make sure that the ulnar nerve is not entrapped between the proximal and distal fragment.

MeSH Keywords: **Accessory Nerve Injuries • Child • Fracture Fixation, Internal • Humeral Fractures • Ulnar Nerve**

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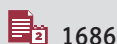
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Background

Supracondylar humeral fracture (SHF) is considered the second most common fracture (after distal radius fracture) in childhood, accounting for approximately 15% of all pediatric fractures [1]. Among SHFs, the majority are extension-type (97% to 98%) and only 2% to 3% are flexion-type, with nerve injuries occurring in 10% to 20% of all supracondylar fractures [2]. Flexion-type SHF combined with ulnar nerve palsy is an even rarer clinical situation and a recent study concluded that the presence of ulnar nerve palsy in a flexion-type SHF can be predictive of open reduction [3].

Flexion-type SHF occurs mainly by directly falling on the elbow rather than falling on an outstretched hand [4]. Treatment of flexion-type fractures can be either closed reduction and casting, closed reduction and percutaneous pinning, or open reduction and pinning depending on the degree of displacement [4,5]. Nevertheless, they are considered more severe injuries with more complications than extension-type SHFs [6].

Although in the current orthopedic literature there are many case reports with extension-type SHFs, the reports of flexion-type SHFs with ulnar nerve palsy are few. The purpose of this report was to present 2 cases of a flexion-type SHF with ulnar nerve injury where open reduction and fixation of the fracture was required, indicating that for these injuries, clinicians should have a high index of suspicion that open reduction will be needed.

Case Reports

We present a case of a 7-year-old girl and a case of a 6-year-old boy suffering from a flexion-type SHF with ulnar nerve injury; we discuss the attempts of closed reduction and the surgical management of open reduction.

Case 1

A 7-year-old girl presented in our emergency department with a history of falling on her right elbow. The mechanism of injury was a fall from a trampoline while playing in the playground. With inspection, it was obvious that the elbow was significantly swollen supported by the other hand.

Case 2

A 6-year-old boy presented to the emergency department after a direct fall on his right elbow. A more thorough history, regarding the exact mechanism of injury, could not be obtained. Figure 1 shows the swelling of the elbow of the boy.
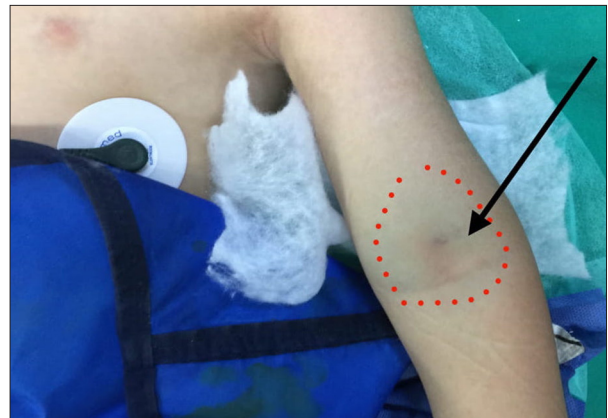
Figure 1. Significant swelling of the elbow joint after a flexion-type supracondylar humeral fracture. The red dotted circle shows the area of swelling and the black arrow shows that an ecchymosis starts to appear.

## Initial examination and management (both patients)

Immediate vascular and neurological clinical examination was performed. Radial and ulnar pulses were present, and the hands were pink and warm. The neurological examination included radial, median, anterior interosseous and ulnar nerve assessment. Through neurological examination a report of tingling in the small finger in both patients made us highly suspect a possible ulnar nerve injury.

After radiological examination, x-rays revealed a significantly displaced flexion-type SHF, in both our patients. Figure 2A shows the fracture of the elbow in Patient Case 1, the 7-year-old girl, and Figure 2B shows the fracture of the elbow, in Patient Case 2, the 6-year-old boy. In both cases, the fractures were stabilized temporarily with a long arm cast with the elbow flexed in 20° of flexion; both patients were transferred to the operating room for closed reduction and percutaneous pinning.

Before general anesthesia, the patients were re-evaluated for possible ulnar nerve injury. A better clinical examination was possible because the fracture was stabilized, and the patients were not in severe pain. Our neurological examination confirmed an ulnar nerve injury.

Intra-operative findings and management (both patients)

Two attempts of closed reduction and percutaneous pinning with K-wires under general anesthesia and fluoroscopy were unsuccessful. The decision for an open reduction was made. An anterior lazy-S incision was performed because we wanted to make sure that all neurovascular bundles (ulnar, median, radial nerve, and brachial artery) were free and not entrapped between the fragments. Figure 3A and 3B show our incision-approach and the fragment under direct vision. No neurovascular bundles
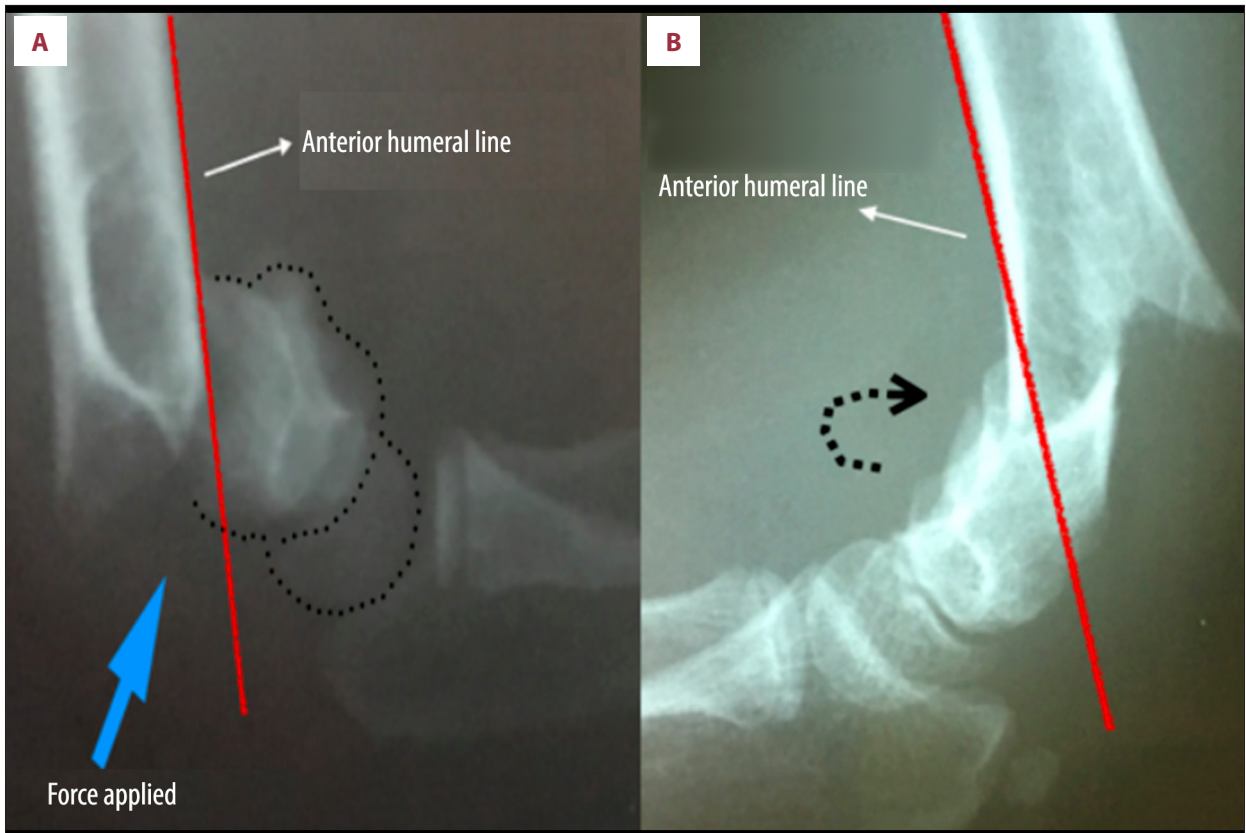
Figure 2. (**A**) A totally displaced (Gartland III) flexion-type supracondylar humeral fracture (SHF). The blue arrow shows the direction of the force that should be applied to cause a flexion SHF. The black dotted outline shows the displacement of the distal fragment. (**B**) Flexion-type SHF with rotation. The black arrow shows the direction of the rotation of the distal fragment. The red straight line demonstrates the "anterior humeral line" that normally should cross the middle 1/3 of the capitellum.
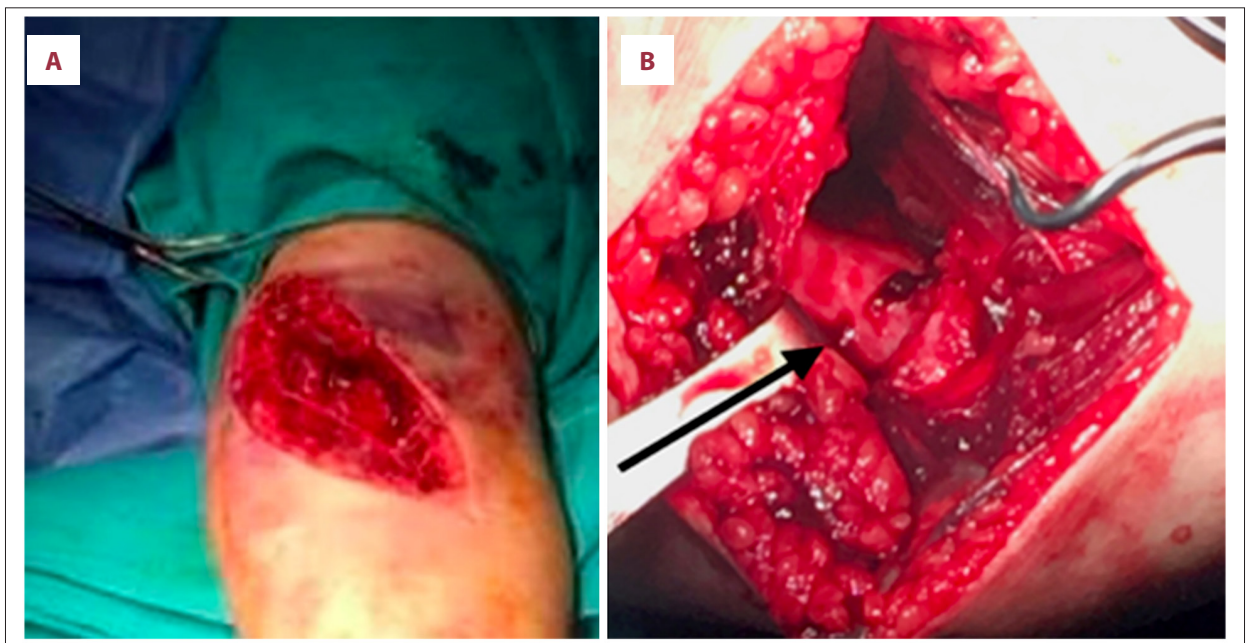
Figure 3. (**A**) Anterior lazy-S approach to elbow joint. (**B**) The black arrow demonstrates an anterior hinge intact and shows the supracondylar fracture under direct vision after reduction.
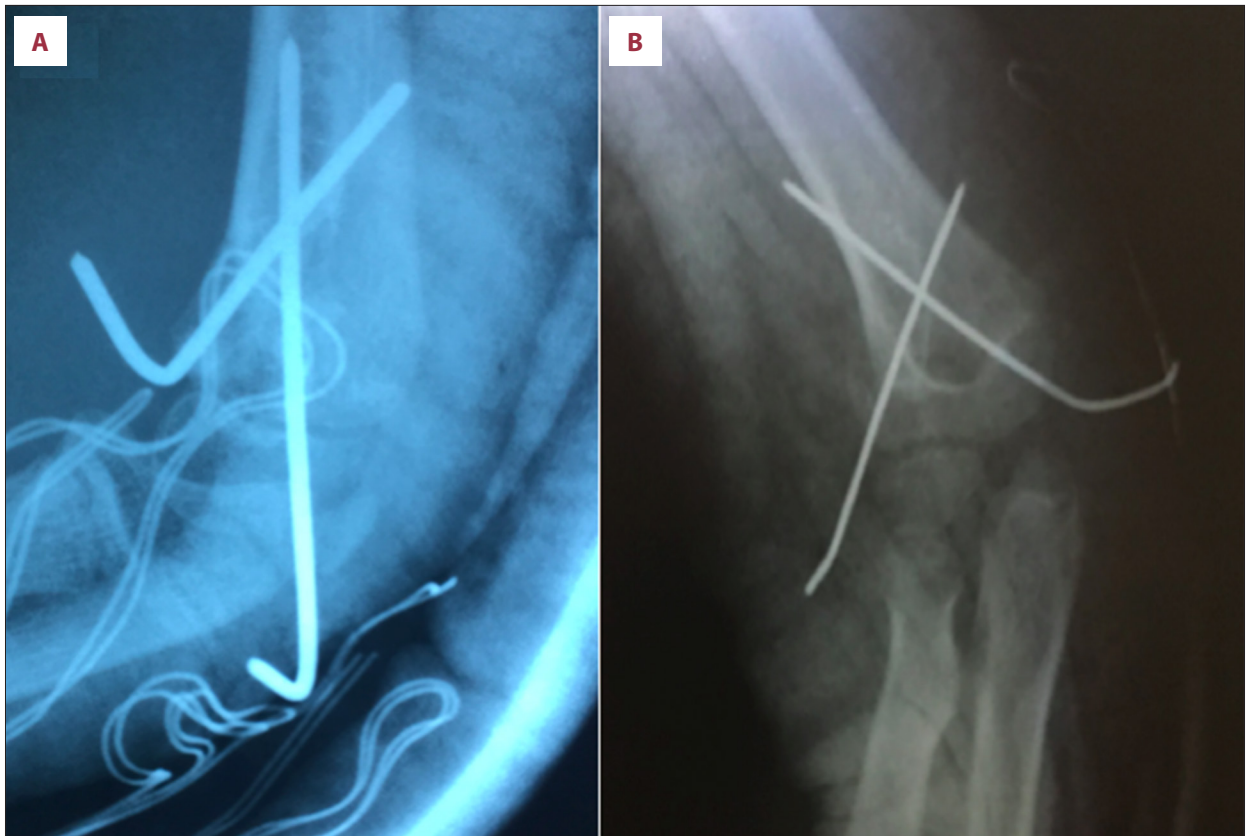
Figure 4. Profile+anteroposterior view. K-wire fixation of our flexion-type supracondylar humeral fracture. (**A**) Profile view: the fixation of the fracture of the 7-year-old female 3 days after surgery. (**B**) Anteroposterior view: stabilization of the fracture of the 8-year-old male patient 4 weeks after surgery. For both patients cross K-wire configuration was chosen after open reduction under direct vision.

were entrapped between the proximal and the distal fragment. The fractures were reduced and percutaneous pinning with 2 cross K-wires were performed. No additional surgical exploration of the ulnar nerve was performed. The elbows were positioned at 60° of flexion in a long arm cast and the patients were transferred to their room in the clinic.

Follow-up

Follow-up and re-examination of the patients were performed at 1-month, 3-months, and 6-months after surgery. Figure 4A shows the lateral x-ray of the girl's elbow 3 days after open reduction and fixation of the fracture. Figure 4B shows the anteroposterior x-ray of the boy's elbow 1 month after fixation. At the 1-month follow-up, ulnar nerve sensory disturbances were improved compared to the initial examination but not to the point of the normal contralateral hand. We did not perform electromyography (EMG), as we decided to wait for a full recovery. The K-wires were also removed at 1-month follow-up in the clinic, without anesthesia. The long arm cast was held in place for 4 weeks. After K-wire and cast removal, gentle motion of the elbow joint was encouraged. The muscle strength

of the muscles innervated by the ulnar nerve and the range of motion of the elbow joint were gradually increased and by 3-months, the ulnar nerve neurological examination in both patients was normal. At the 6-month follow-up, both patients were able to return to their pre-injury activities without any problems. No malunion or nonunion of the fracture was noticed.

Discussion

Although extension-type SHF are well known in the literature and in clinical practice, most orthopedic surgeons are not familiar with the flexion-type SHF because it is very rare [7]. To indicate how rare this injury is, Garg et al. reported 25 flexion-type fractures out of 1296 supracondylar humeral fractures (2%) [7].

The most common cause of flexion-type SHF in children is a direct fall on the elbow, which results in failure of the posterior cortex and thus anterior angulation of the distal fragment [4]. Flexion-type fractures are classified as extension-type fractures according to Gartland classification system as non-displaced, partially displaced, and completely displaced [8,9].

The treatment of flexion-type fractures can be either: 1) closed reduction under anesthesia by traction, correction of displacement and angulation and stabilization with a long arm cast in 20° of elbow-flexion, 2) closed reduction and percutaneous pinning or 3) open reduction and percutaneous pinning [10]. Many authors support the view that pinning with K-wires should also be performed in partially displaced fractures (type-II) because this can guarantee a better reduction and avoidance of complications [5,10].

Flexion-type supracondylar fractures have been associated with more short-term and long-term complications and a high rate of open reduction [11,12]. According to Kuoppala et al., flexion-type fractures are prone to more displacement; they report only 1 non-displaced flexion-type SHF out of 7 [11]. They concluded that non-displaced flexion-type SHF are uncommon [11]. This displacement might be the reason these fractures are associated with more complications [8,11].

Although extension-type fractures are associated more with brachial artery and anterior interosseous nerve injury, the flexion-type fractures, in contrast, are associated with ulnar nerve injury [3,13]. The ulnar nerve can be injured either 1) because it can become entrapped between the distal and the proximal fragment or 2) because the nerve can become stretched over the posterior spike of the proximal fragment or 3) from the placement of a K-wire on the medial side, near the cubital tunnel [4,14]. Most injuries are neurapraxia rather that axonotmesis or neurotmesis and usually resolve in less than 6 months, approximately 10 weeks. Close follow-up and re-evaluation are needed [15,16].

In our patients, we noticed no ulnar nerve entrapment between the fragments. We hypothesized that ulnar nerve disturbances during the clinical examination were due to stretching of the nerve from the proximal fragment. We followed the strategy of closed observation and re-evaluation of our patients with ulnar nerve injury. Indeed, the sensation in the ulnar 1/5 digits was improved already by week 4, in both patients. Our medial entry point for the K-wire can be justified because the Kirschner was inserted under direct vision after exposure of the fracture. Crossing K-wires was our treatment of choice to stabilize the fracture because the cross-wire configuration of K-wires provides more biomechanical stability (compared with 2 lateral K-wires) [17].

It seems from the literature, that although flexion-type SHFs are associated with a higher rate of open reduction, flexion-type SHFs with an ulnar nerve injury are associated with an even higher rate of open reduction [3,18]. Mahan et al. compared patients with flexion-type and extension-type SHFs and found that patients with flexion-type injuries were more prone to require open reduction (31% compared to 10% with extension-type) [18]. Flynn et al. reported that flexion-type injuries were associated with a 15.4-fold increase in the odds of open reduction, and if in these fractures an ulnar nerve injury was also present, an additional 6.7-fold higher risk of open reduction existed [3]. A direct explanation cannot be given but it seems that ulnar nerve injury is associated with higher energy of fracture, higher displacement of the fracture, and higher soft-tissue injury. These circumstances also make these fractures more unstable and prone to open reduction [8,11,18]. Many authors support the view that family members should be informed in these situations that the likelihood of open reduction is higher [8,11,19]. Novais et al. tried to identify factors predictive of conversion from closed reduction to open reduction and found that flexion-type fractures were significantly more likely to undergo this conversion [19].

In our 2 patients who had a combination of a flexion-type and ulnar nerve injury, although closed reduction was attempted, open reduction was necessary to achieve an anatomic reduction of the fracture. Our primary aim of open reduction was to achieve an anatomic reduction and make sure that the ulnar nerve was not entrapped between the proximal and the distal fragment.

Conclusions

With our 2 case reports, we want to enhance the literature that flexion-type SHFs accompanied with ulnar nerve injury are more prone to require an open reduction to achieve an anatomic or at least an acceptable reduction. Orthopedic surgeons should be aware that the likelihood of an open reduction in these types of injuries is high. Open reduction is needed not only to achieve an anatomic reduction of the fracture but to make sure that the ulnar nerve is not entrapped between the proximal and distal fragment.

Conflicts of interest

None.

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