Title: Entrapment of the Brachial Artery Following Supracondylar Fracture Reduction: A Case Report

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Abstract:

Background: Supracondylar fractures of the humerus are common elbow fractures in children. Supracondylar fractures have two subtypes: flexion, which makes up less than 2 percent of all such fractures, and extension, which makes up more than 98 percent of supracondylar fracture of the humerus. Supracondylar fractures of the humerus can develop vascular and neurological complications—either following the fracture itself due to the detached pieces of bone, or after reduction or k-wire fixation used as treatment. The most common complication is damage to the brachial artery.

Case report: The patient is a healthy seven-year-old right dominant boy who sustained a Gartland type 3 fracture following a fall and was admitted to the emergency ward. At first, a weak pulse was detected in the distal part of the right upper extremity, and the following reduction using 2 K-wires the distal pulse of the limb became undetectable. Vascular examination unveiled that the adventitia of the brachial artery was trapped between the condyle parts. The artery was later released and the distal pulse returned.

Conclusion: This case’s examination shows that while entrapment and pulling of the adventitia of the brachial artery between the condyles of the humerus following a supracondylar fracture is a rare occurrence in this type of fracture and also happens, due to reduction using K-wires percutaneously it nevertheless necessitates a neurovascular examination in all cases of supracondylar fractures. In supracondylar fractures in cases of pink pulseless limbs, immediate arterial exploration can achieve a markedly better outcome in comparison to simply monitoring.

Keywords: Supracondylar fracture, Brachial artery, Entrapment.
Introduction

Supracondylar fractures are one of the most common bone fractures in children,(1) making up to 60 percent of fractures in the elbow, and two-third of all the related hospitalizations to elbow belongs that, 3 percent of all fractures in children.(2-4) These fractures usually manifest through a discernable displacement of the distal section of the humerus. The peak occurrence for this type of fracture is from the ages of 4 to 7, more commonly occurring in boys than girls.(5, 6) The occurrence rate for this type of fracture in children is 177 in 10000,(7) most of which take place as a result of suffering a fall on their hand- and the non-dominant hand at that.(8, 9)

This type of fracture can be divided into two categories: extension-which makes approximately 97 to 99 percent of all supracondylar humeral fractures and occur due to falling on an outstretched hand with the full extension elbow, and flexion- which comprise 2 percent of all cases and occur due to directly falling on a flexed limb.(10) This type of fracture is categorized using the GARTLAND method which mainly uses lateral radiography to discern the severity of the fracture.(11) This method of categorization was modified in 1984 by Wilkins and categorized fractures into 4 distinct groups. In this method, surgical reduction is the recommended method of treatment for types 3 and 4.(12, 13) The reduction can be performed in closed and open surgery methods.(14, 15) Lately, closed reduction using k-wires is the preferred method of treatment for GARTLAND type 3 fractures.(16) There have been few reports of complications from this method of treatment.(17) Although this type of fracture is rarely life-threatening, it can increase morbidity and DALY (disability-adjusted life years) in children.(18) Several immediate and latent complications have been detected for supracondylar fractures. The immediate complications can be more dangerous, and are usually neurovascular while the latent complication of this type of fracture affects the functional condition of the limb.(19, 20) These complications can either be a result of the initial injury and the fractured sections or iatrogenic and as a result of our usage of k-wires for reduction.(21, 22) The most well-known complication due to this type of fracture is vascular injuries, so much so that up to 10 percent of these fractures are accompanied by injury to the brachial artery.(23) Ischemia is another complication for this type of fracture and the reports indicate that 10 percent of these fractures are also accompanied by distal ischemia of the limb.(24) Volkmann ischemia is yet another complication that can occur following injury to the brachial artery.(25) In addition to vascular complications and perfusion disruptions, this type of fracture can also cause several neurological injuries,(26) such as iatrogenic injury to the ulnar nerve.(27) Injury to the median nerve is the most common neurological complication caused by this type of injury.(28) Cubitus Varus deformity
is one of the delayed complications proposed by some authors as a result of unequal growth in the distal part of the humerus, Cubitus Varus has cosmetic aspects too, loss of reduction and infection of the surgical site although is too rare but reported in some cases as immediate complications of supracondylar fracture.(29)

In this report, we intend to present a case of brachial artery entrapment following a supracondylar fracture and pulling of the adventitia of the brachial artery accompanied by a post-reduction hematoma.

**Case presentation**

The patient is a seven-year-old right dominant boy who presented to the emergency department after a parallel fall on his right outstretched hand. He was suffering from an inability to move limb extremities, laceration, and pain in his right elbow. Primary examination shows that the patient could move the fingers on his right hand. distal pulse was reported as weak but palpable. The color of the extremity was reported as pale.

The patient was a healthy boy without past medical history including any underlying disease or musculoskeletal and bone disorder, the parents of the boy report no history of drugs or food usage or any allergic reactions during his life.

Due to the patient’s irritability and complaints from the pain, a complete neurovascular examination was not performed. The patient shows clinical symptoms of extension supracondylar fracture and the diagnosis was later confirmed radiographically(figure1) as type 3 of extension supracondylar fracture. The patient was moved to the operation room and after general anesthesia, he was treated with closed reduction and k-wire fixation. Following reduction, in less than 20 minutes the right-hand color returned to normal but after 45 minutes’ distal pulse was no longer palpable but no neural disorders were found. Following this occurrence, he was referred to our surgery department.

The patient was visited by a vascular surgeon and after a complete neurovascular examination including evaluation sense, movement of radial, median and ulnar nerve and pulses of upper limb arteries, vascular involvement was detected. Capillary filling existed and the hand was pink. A Doppler sonography was performed on the patient’s right hand which reported normal and triphasic blood flow in the axillary and brachial artery but no observable flow in the radial and ulnar arteries. The patient underwent arterial exploration. After general anesthesia, then an incision was made in the medial and distal surface of the
arm. After the hematoma was initially drained it was observed that part of the artery’s adventitia was being pulled and trapped by the reduced bone and crossed K-wire out of joint and the artery was completely kinked. as first step K-wires removed by an orthopedic surgeon the vessel did not contain thrombosis. the trapped section of the artery was free and the adventitia returned to normal and continuity of the vessel was reestablished.

Forty-five minutes later, the distal pulse of the limb becomes palpable and the temperature of the limb returned to normal and Capillary filling existed too. Following that re-reduction of fracture and re-fixed of K-wire performed, after suturing was performed, a splint was set in place. (figure2)

The patient was admitted to the surgical ward after vascular exploration for three days and after reassurance, there isn’t an unusual presentation the boy discharged from the hospital. Later radiographic imaging shows the right humerus bone healing completely after removal of the K-wires(figure3), postoperative examination shows no further complications. Laboratory finding before and after vascular surgery presented(Table1) sensation and movement were normal and recuperation was deemed satisfactory in the follow-up visits. Eight months after the surgery limb function, range of motion in flexion and extension returned to normal and saw no vascular or neural complication.

Discussion
The Supracondylar region in children includes the distal part of the humerus that consists of very thin and weak bone located above the condylar part because Remodeling of the supracondylar area completes between 6 to 7 years of age, most of the neurovascular structures like median, radial, and ulnar nerves, brachial artery of upper limb passes through Supracondylar region or have close relationships with that.(30, 31) The weakness of bone and these critical components in this region made the Supracondylar region an appropriate place for fracture in the elbow joint. Complications following Supracondylar fracture or its treatment can be seen like all the other fractures and orthopedic treatment. Although new advancements in surgical and nonsurgical treatment in this type of fracture reduce complications this type of fracture and its adverse effects is still a huge concern in children.(32)

In type 3 supracondylar fractures, the best orthopedic result is achieved through close reduction and percutaneous pinning.(33) Type 2 and 3 supracondylar fractures are often accompanied by vascular and neurological injuries. The frequency of neurological damage following the supracondylar fracture is 10 to 20 percent but this can increase to 49 percent in type 3. in posteromedial supracondylar fractures, injury to the radial nerve is more likely to occur.(20) In posterolateral supracondylar fractures, the
median nerve is more likely to come under harm. Most type of neural involvement is neuropraxia that healing routinely after 2 or 3 months. (34) Vascular injuries usually occur in posterolateral fractures and can include thrombosis, spasms, occlusions, and aneurysms. (14, 24, 25, 35)

In this type of fracture closed reduction and fixation must be attempted immediately after its occurrence regardless of circumstances. The existence of vascular involvement and disruption in the radial pulse usually manifests in 2 forms.

Management of vascular involvement in the supracondylar fracture is a source of controversy yet and there is the debate between orthopedic surgeons for decades and still, there is not a certain opinion. In the first form, the limb becomes pale and cyanotic and the radial pulse becomes impalpable. Most surgeons believe that if closed reduction is attempted and the radial pulse remains impalpable, the extremity must undergo open exploratory vascular surgery, and decompression and vascular repair and reconstruction must be performed. (36) The second form of vascular involvement in supracondylar fractures manifest a pink pulseless appendage. This form requires more research material and at this time, no single united opinion exists about it. In this form, despite the loss of radial pulse, tissue perfusion is retained due to collateral blood flow. The temperature of the hand remains normal and it becomes pink in color. Researchers suggest different opinions from inpatient monitoring accompanied by neurovascular examination to vascular intervention. However, in general, two treatments are suggested. The first of these is watchful waiting which believes that the need for surgical intervention is not immediate and suggests that the patient be monitored for a time instead. (31) The reason for this is that it is believed that most of these cases occur because of a temporary vascular spasm that will eventually regress by itself. (37)

However, monitoring can only last as long as no symptoms of ischemia and a lack of blood flow such as paresthesia manifest. In the case of such symptoms manifesting, immediate intervention is required. (36) The second form of treatment suggested for this type of vascular involvement is to attempt immediate vascular intervention despite the fact is that the limb has sufficient blood flow, which was the route of treatment chosen in this case.

However, the difference was that in this case a weak but palpable pulse was initially detected that vanished following closed reduction. In examining 75 cases of pink pulseless hands in which radial pulse failed to return the following reduction, 70 percent of the cases were observed to have suffered from vascular
injuries, and only 9 percent of the cases were vascular spasms reported in arterial explorations. In a study done by Kumar et al, the results indicated that in cases of warm hands with undetectable pulses, immediate arterial exploration achieves a more desirable outcome in comparison to delayed arterial explorations. On the other hand, if the neurovascular examination is done in a precise and thorough manner both before and after reduction is performed, it can play an influential role in the course of treatment. This examination can also help in watchful waiting patients by predicting the likelihood of the need for vascular intervention and preventing any possible damage from spreading.

**Conclusion**

In supracondylar fractures in cases of pink pulseless limbs, immediate arterial exploration can achieve a markedly better outcome in comparison to simply monitoring the patient’s status or taking surgical measures at a later point. Performing a thorough neurovascular examination before and after attempting orthopedic reduction and Doppler-sonography after reduction can influence the process of treatment and the final outcome.

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**Conflict of interest**

The authors have no Conflict of interest to declare

**Information Consent**

The data for publication were given orally from the patient’s Parents.
References


Figures

**Fig.1.** Supracondylar fracture confirmed radiographically.

**Fig.2.** Re-reduction and percutaneous pin placement using 2 k-wires after two weeks.
Fig. 3. The humerus bone healing after remove 2 k-wires.

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Table 1. Laboratory finding before and after surgery