Case Report:
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% of all such fractures, and extension, which makes up more than 98% 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 therapy. The most common complication is damage to the brachial artery.

Case Presentation: Our patient is a healthy 7-year-old right dominant boy who sustained a Gartland type III 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. After the reduction using 2 K-wires, the distal pulse of the limb became undetectable. Vascular examination revealed that the adventitia of the brachial artery was trapped between the condyle parts. The artery was then released, and the distal pulse returned.

Conclusions: This case shows that although entrapment and pulling of the adventitia of the brachial artery between the condyles of the humerus following a supracondylar fracture is a rare occurrence, it can happen in this type of fracture. After reduction using K-wires percutaneously, a neurovascular examination in all cases of supracondylar fractures is necessary. In supracondylar fractures with pink pulseless limbs, immediate arterial exploration can achieve a markedly better outcome than simply monitoring.

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1. Introduction

Supracondylar fractures are the most common bone fractures in children [1], accounting for up to 60% of fractures in the elbow, two-thirds of all the related-elbow hospitalizations, and 3% 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 of this fracture is seen in children 4 to 7 years, more commonly occurring in boys [5, 6]. The prevalence of this fracture in children is 177 in 10000 [7], most of which occur due to falling on both hands and the non-dominant hand [8, 9].

This type of fracture can be divided into two categories: extension, which makes approximately 97% to 99% of all supracondylar humeral fractures and occurs due to falling on an outstretched hand with the full extension elbow, and flexion, which comprise 2% 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 III and IV [12, 13]. The reduction can be performed in closed and open surgery methods [14, 15]. Lately, closed reduction using K-wires is the preferred treatment method for Gartland type III fractures [16]. There have been few reports of complications after this method of treatment [17]. Although this type of fracture is rarely life-threatening, it can increase morbidity and disability-adjusted life years in children [18]. Several immediate and latent complications have been reported for supracondylar fractures.

The immediate complications can be more dangerous and are usually neurovascular, while the latent complications affect the functional condition of the limb [19, 20]. These complications can either result from the initial injury and the fractured sections, iatrogenic, or usage of K-wires for reduction [21, 22]. The most well-known complication due to this type of fracture is vascular injuries, and up to 10% of these fractures are accompanied by injury to the brachial artery [23]. Ischemia is another complication, and the reports indicate that 10% of these fractures are also accompanied by distal ischemia of the limb [24]. Volkmann ischemia is another complication that can occur following injury to the brachial artery [25]. In addition to vascular complications and perfusion disruptions, this fracture can 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 due to 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 it is rare but were reported in some cases as immediate complications of supracondylar fracture [29].

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

2.Case Presentation

Our case is a 7-year-old right dominant boy who presented to the Emergency Department after a parallel fall on his outstretched right hand. He was suffering from an inability to move limb extremities, laceration, and pain in his right elbow. Primary examination showed 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.

Because of 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 by X-ray (Figure 1) as type III 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 the reduction, in less than 20 minutes, the right-hand color returned to normal, but after 45 minutes, the distal pulse was no longer palpable without any neural disorders.

Following this occurrence, he was referred to our surgery department. A vascular surgeon visited the patient. After a complete neurovascular examination, including evaluation of 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 per-

Table 1. Laboratory findings before and after surgery

Variables	Before Surgery	After Surgery
Cr	0.5	
Urea	26	
Bs	130	
HGB	9.9	
PLT	317000	
WBC	130000	
PT	14.6	12
PTT	100	25
INR	1.4	1

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formed 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, 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. In the first step, K-wires were removed by an orthopedic surgeon. The vessel did not contain thrombosis. The trapped section of the artery was freed, the adventitia returned to normal, and continuity of the vessel was re-established.

Forty-five minutes later, the distal pulse of the limb was palpable, the temperature of the limb returned to normal and capillary filling was restored. Afterward, re-reduction of fracture and re-fixation of K-wire were performed. The incision was sutured, and a splint was set in place (Figure 2).

The patient was admitted to the surgical ward after vascular exploration. Three days later, after no unusual presentation, the boy was discharged from the hospital. Later radiographic imaging showed the complete right humerus bone healing after removing the K-wires (Figure 3). Postoperative examination showed no further complications. Laboratory findings before and after vascular surgery (Table 1) showed that 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 without vascular or neural complication.

3. 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 around 6 to 7 years of age, most of the neurovascular structures like median, radial, and ulnar nerves, brachial artery of upper limb pass through the supracondylar region or have close relationships with it [30, 31]. The weakness of bone and these critical components in this region made the supracondylar area an appropriate place for fracture in the elbow joint. Complications following a supracondylar fracture or its treatment can be seen like all the other fractures and orthopedic therapy. Although new advancements in surgical and nonsurgical treatment in this type of fracture reduce complications, its adverse effects are still a huge concern in children [32].

In type III supracondylar fractures, the best orthopedic result is achieved through close reduction and percutaneous pinning [33]. Vascular and neurological injuries often accompany type II and III supracondylar fractures. The frequency of neurological damage following the supracondylar fracture is 10% to 20%, but this number can increase to 49% in type III. 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 neural involvement is neuropraxia that usually heals af-

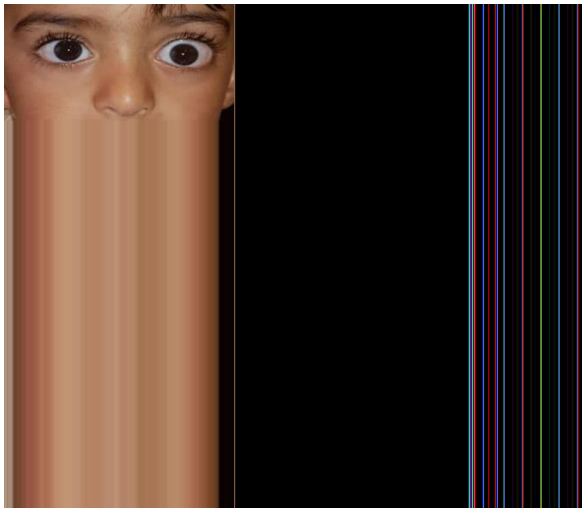

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Figure 1. Supracondylar fracture confirmed radiographically

ter 2 or 3 months [34]. Vascular injuries typically 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. Managing vascular involvement in the supracondylar fracture is still controversial, and there has been a debate between orthopedic surgeons for decades. The existence of vascular involvement and disruption in the radial pulse usually manifests in two forms.

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

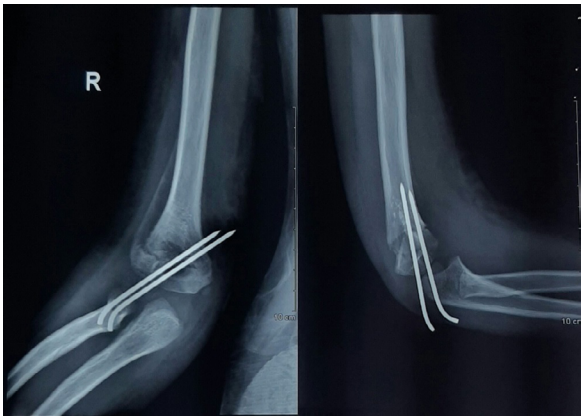

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Figure 2. Re-reduction and percutaneous pin placement using 2 K-wires after two weeks

undergo open exploratory vascular surgery, and decompression and vascular repair and reconstruction must be performed [36]. The second vascular involvement in supracondylar fractures manifests a pink pulseless appendage. This form requires more research, and at this time, no common opinion exists in this regard. In this form, despite the loss of radial pulse, tissue perfusion is retained due to collateral blood flow. The hand's temperature 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 recommended. The first is watchful waiting which believes that surgical intervention is not immediate and suggests that the patient be monitored for a time instead [31]. 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

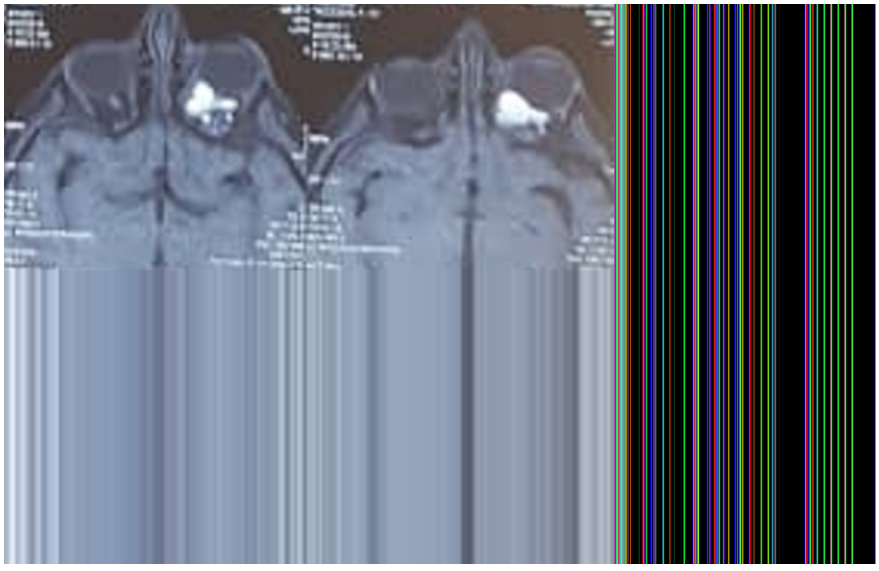

Figure 3. The humerus bone healing after removing 2 K-wires

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as no symptoms of ischemia and a lack of blood flow, such as paresthesia, manifest. In the case of such symptoms, immediate intervention is required [36].

The second form of treatment suggested for this type of vascular involvement is to attempt immediate vascular intervention because the limb has sufficient blood flow, which was the route of therapy chosen in this case. However, a weak but palpable pulse was initially detected in this case that vanished following closed reduction. In examining 75 cases of pink pulseless hands in which radial pulse failed to return the following reduction, 70% of the cases suffered from vascular injuries. Only 9% of the cases were vascular spasms reported in arterial explorations. In the Kumar et al. study [20], the results indicated that in cases of warm hands with undetectable pulses, immediate arterial exploration achieves a more desirable outcome compared to delayed arterial explorations. On the other hand, if the neurovascular examination is done before and after reduction in a precise and thorough manner, it can play an influential role in 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.

4. Conclusion

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

Ethical Considerations

Compliance with ethical guidelines

Oral consent of the patient's parents was obtained for publication of data.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflicts of interest

The authors declared no conflict of interest.

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