Management of cold and pulseless hand after closed reduction and percutaneous pinning of pediatric humerus supracondylar fracture: Is it really necessary to explore brachial artery?

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ABSTRACT

Introduction: Vascular and neurologic complications are common following pediatric humerus supracondylar fractures. Vascular injuries always require urgent surgical intervention and are responsible for major complications, such as Volkman’s ischemic contracture and amputation. When a patient suffers from a cold and pulseless extremity following a fracture, brachial arterial exploration is generally needed. The aim of the current study is to report our experience in six patients having cold and pulseless hands after closed reduction who were managed by conservative methods.

Patients and Methods: Six patients were included in the study. The mean patient age was 3.2 years (range of 1-6 years). Before the operation, all patients underwent a doppler examination, as all of them had non-palpable radial arteries. Doppler examinations revealed monophasic flow in the brachial and radial arteries. Therefore, patients were immediately operated upon and closed reductions with percutaneous pinning were performed.

Results: We verified anatomical reduction using plain radiographs. However, all patients had cold and pulseless hands. Therefore, papaverine was injected subcutaneously and the operated extremities were warmed and elevated for at least 1 hour. During this period, serial doppler examinations were performed. After a mean period of 30 minutes (range of 15 to 90 minutes), we detected brachial and radial arterial flow upon doppler examination, along with warm hands. Patients were followed for at least two days in the clinic and all of the patients healed without any complications.

Conclusions: We advise initial conservative management of cold and pale hands after reduction of a supracondylar fracture, including warming, elevation and papaverine-HCL injection within at least 30 minutes following surgery. If this treatment fails, emergency arterial exploration is needed. Additionally, if the patient has a cold and pale hand before the operation, arterial exploration is needed along with reduction.

Key words: Humerus supracondylar fracture, arterial lesion, conservative management

Introduction

Arterial and neurologic complications following pediatric supracondylar fractures are common and are associated with high morbidity rates. Most neurologic lesions are temporary, because they are generally neurapraxial in nature, with most of the lesions healing completely within 3 months [1]. In addition, previous studies have agreed on the management of the vascular lesions after these fractures [2, 3]. Vascular injuries always require urgent surgical intervention and are responsible for major complications, such as Volkman’s ischemic contracture and amputation, when overlooked. When a patient has a cold, pale and pulseless extremity after the fracture, brachial artery exploration
Arterial lesion in humerus supracondylar fracture

is generally needed [4]. However, warm, pink hands after the fracture can be managed conservatively by close follow-up following surgical treatment of the injury [2-4]. The aim of the current study is to report our experience in the management, using conservative methods, of six patients who had cold and pulseless hands following closed percutaneous pinning of humerus supracondylar fractures.

Materials and methods

Six patients (6 elbows), between the years of 2012 and 2014, who suffered from Gartland type 3 fractures caused by falling onto an outstretched hand, were enrolled in the study. All patients were first admitted to the emergency department. After standard A-P and lateral X-rays, a posterior long-arm splint was applied. Before the operation, all patients underwent doppler examination, as all of them had non-palpable radial arteries with warm, pink hands. Doppler examination revealed monophasic flows in the brachial and radial arteries. Patients were operated upon immediately and closed reductions with percutaneous pinning were performed under general anesthesia. The vascular status following the operation was evaluated by doppler examination in the operating room. When cases of cold and pulseless extremities after reduction and fixation were found, the cardiovascular department was consulted. None of the patients underwent arterial exploration and all of them were managed using conservative methods in the operating room during general anesthesia, which involved extremity elevation, warming, application of papaverine-HCL, and i.v. administration of Dextran and heparine. During the warming procedure, the patient’s upper extremity was monitored with pulse oximetry and doppler ultrasound. A maximum waiting time of 90 minutes was chosen to terminate conservative treatment. After the operation, patients were closely followed for at least 2 days in the clinic and serial plain radiographies were taken weekly for monitoring the reduction.

Results

The mean patient age was 3.2 years (range of 1-6 years). The study included two girls and four boys. All of the patients had severely displaced Gartland type 3 fractures with edema and ecchymosis of their wrists (Figure 1). Two patients had anterior interosseous nerve injuries that resolved within 2 months. The average time to surgery after the initial trauma was 4.8 hours (range of 2-7 hours). After the operation, we verified anatomical reduction using plain radiographs. The average operation time for successful reduction was 38 minutes (range of 25-44 minutes). However, all patients had cold, pale and pulseless hands after reduction. Moreover, on postoperative doppler examination, there was no sign of blood flow, even in brachial, ulnar and radial arteries. Immediately, 1.5 mg/kg papaverine-HCL was injected i.m. and the patient’s extremity was elevated and warmed with the elbow slightly in the extended position. After a mean period of 30 minutes (range of 15 to 90 minutes), we detected brachial and radial arterial flow upon doppler examination, along with warm hands. Next, a 10 ml/kg bolus dose of dextran, with a molecular weight of 40,000 (Rheomacrodex, Eczacibasi-Baxter, Turkey), was started and maintained with a dose of 10 ml/kg thereafter. Heparin (10 U/kg) every four hours was given during the two-day

Figure 1. A six-year old boy suffering from a right humerus supracondylar fracture presenting preoperatively with a non-palpable radial pulse. Note the significant displacement of the proximal bone fragment.
follow-up period. After the operation, a long-arm posterior splint was applied and the patient was followed up at least two days in the clinic. The posterior splint was removed three weeks later and active-passive ROM (range of motion) exercises were initiated. K-wires were removed 1.5 months later. The average follow-up time was 7.2 months (range of 6-13 months) after the operation. In all of the patients, the fractures healed completely and none of them exhibited any ischemic complications during the follow-up period.

**Discussion**

Distal humerus fractures are common in all age groups [5]. In pediatric humerus supracondylar fractures, the major of morbidities are strongly related to neuro-vascular complications [6]. The mechanism and nature of the fracture generally expose the brachial artery to trauma. The brachialis muscle protects the brachial artery and provides a good barrier between the bone and the artery. When the displacement of the fracture is great, the proximal fragment directly ruptures the brachial muscle, which makes a great impact on the neurovascular bundle [3]. This trauma may even be seen in reduction of the fracture, as the brachial artery may be entrapped between fracture fragments. Thus, it is necessary to reduce the fracture anatomically and confirm the integrity of vascular structure. The vascular status of the extremity is determined by assessing radial pulse, color of the skin, temperature of the extremity, amount of pain and function of the arm. When there is a large amount of collateral circulation around the elbow joint that provides sufficient flow to the forearm, even in the case of significant brachial arterial damage [3, 4, 7, 8]. Therefore, the absence of a radial pulse on palpation is not an absolute indication for arterial exploration [9]. In fact, the radial pulse may be absent because of spasms, and generally returns after fracture reduction. Loss of the pulse during reduction may be caused by obstruction from elbow flexion or arterial entrapment between fracture fragments. In the literature, many authors agree that arterial exploration is indicated in cases of an absent radial pulse with palpation and if it is confirmed by doppler examination. Campbell et al. assessed 59 children with supracondylar fractures and reported a higher incidence (19%) of vascular lesions than previous reports. In their study, 6 patients underwent arterial exploration. Three of the 6 patients had arterial spasms that resolved after exploration. The other three patients had major vascular lesions, such as ruptures and intimal tears. They recommended vascular exploration if the radial pulse was absent after reduction of the fracture [1]. Similarly, Copley et al. [10] advised arterial exploration if the pulse was absent (i.e., not palpable and not detectable by doppler) after fracture reduction. Schoenecker and coworkers agreed with the other authors in recommending arterial exploration in the absence of a doppler-detectable radial pulse [11]. Garbuz and associates reviewed 326 patients with supracondylar fractures of the distal end of the humerus and found 22 patients with an absence of a radial pulse on examination. They recommended that patients with an absent radial pulse but good circulation to the hand only need observation after fracture reduction because the collateral circulation around the elbow is excellent and will provide the arm and hand with excellent blood flow. They have recommended arterial exploration in cases of absent radial pulses with dysvascular hands [12].

In our study, all six patients had absent radial pulses with palpation but showed monophasic flow on doppler examination before the operation. In all patients, distal circulation was normal except for distal pulses with warm, pink hands. After reduction, all patients had cold and pale upper extremities that would have warranted arterial exploration if we followed the principles described in the literature. However, we did not routinely explore the brachial artery but chose instead conservative methods, such as warming the upper extremity, papaverine-HCL injection and elevation during general anesthesia. Finally, all of the patients had normal circulations after a mean period of 30 minutes. We think that this condition was due to arterial spasms that were aggravated with forced elbow flexion during fracture reduction. Severely displaced fracture fragments first traumatize the brachial artery and forced flexion of the edematous elbow contemporarily disrupts the arterial flow. Using this approach with the indicated techniques, we think that unnecessary operations, such as arterial exploration, can be prevented. As
previously discussed, Campbell et al. [1] found arterial spasms in 3 of 6 cases in which brachial arterial exploration was performed for ischemia of the upper extremity after reduction of humerus supracondylar fractures. This literature finding thus supports our hypothesis.

In conclusion, we recommend an initially conservative management of patients showing symptoms of cold and pale hands after reduction of supracondylar fractures, including warming, extremity elevation and papaverine-HCL injection within at least 30 minutes following surgery. If this treatment fails, then emergency arterial exploration is needed. Additionally, if the patient has cold and pale hands before the operation, arterial exploration is needed along with reduction.

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