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### Conservative treatment in children with vascular injury in supracondylar humerus fractures: a clinical trial

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#### ABSTRACT

##### Introduction

Supracondylar humerus fracture is one of the most important and common fractures in children of 3-10 years old. In this fracture, there is a risk of Injury to the brachial artery, which is considered as an emergency surgery situation in children. The aim of this study was to provide a clinical approach in the treatment of children with supracondylar humerus fractures with coexisting vascular injury and to investigate the effect of conservative treatment in pink pulseless hand with good blood perfusion.

##### Method

During a clinical trial, a group of children with complaint of extension-type supraclavicular humerus fracture following a blunt trauma were investigated. Investigation was performed following the admission of these children in the emergency room of Trauma Center of Shahid Rajaei Hospital, Qazvin University of Medical Sciences, Iran between 1392/01/01 until 1397/06/01. The maximum age for inclusion in the study was 10 years. In all patients, the perfusion and circulatory condition of damaged organ were carefully examined by checking the capillary refill and radial pulse in the emergency room.

All patients underwent fracture reduction during the first 24 hours after admission. Radial pulse was evaluated during and after the reduction in the emergency room. Patients were under observation up to two weeks after the reduction.

##### Findings

Out of 26 patients, 17 patients (65.4%) were male and 9 patients (34.6%) were female. The average age was 5 years. Six patients (23.1%) had radial pulse on admission, and 20 patients (76.9%) did not have radial pulse on admission. Average interval between injury and admission to hospital was 4.57 hours. 16 patients (61.5%) underwent open reduction and 10 patients (38.5%) underwent closed reduction.

Radial pulse returned immediately after the reduction in 6 patients (23.1%). In all patients, radial pulse was checked during two weeks after the reduction. Vascular refill status on admission was poor in 7 patients (26.9%) and good in 19 patients (73.1%). After the reduction, the capillary refill was good in all patients.

### Conclusion

The results of our study demonstrated that there is no need for surgical exploration of artery in treating of pink pulseless arms with sufficient blood perfusion. After a closed reduction, radial pulse will be detected and collateral vessels will maintain the vital function of the organ and therefore arterial surgical exploration imposes complications and unnecessary cost and time.

**Keywords:** Supracondylar Hummers Fractures, Pediatrics, Arterial Damage (Vascular Injuries), Clinical Trial, Conservative Therapy

## INTRODUCTION

Young children are considerably exposed to traumatic injuries resulting in mortality and morbidity. About 70% of fractures in children affect the upper extremities [1, 2]. Trauma to upper extremity in children younger than 19 years old account for about \$ 8 billion of health system costs [3].

Among the upper limb fractures, humerus is the second most common site of fracture after the forearm fractures [4]. Distal radius fractures account for more than 85% of total humerus fractures in children [5]. About 55-75% of these fractures are associated with supracondylar humerus which represent about 3% of all fractures in children [6-9]. This is an extra-articular fracture in the distal radius and is common in children aged 5-7 [1, 10, 11]. The incidence of this fracture is higher in males [10, 12], and affects the non-dominant hand about 1.5 times more than the dominant hand [12]. Its incidence rate has been reported as 177.3 per 100,000 cases [13]. This fracture is divided into two types of flexor and extensor [14]. The most common type is extension type which represents 97% of cases [15] and occurs because of falls onto an outstretched hand when elbow joint is in extension [16]. Other one is flexion type fracture which is observed in 1-3% of cases [17] and occurs because of direct trauma to the elbow joint in flexion or falls onto the flexed elbow [18]. In injuries subsequent to hyperextension, the distal part moves backward causing damage to the brachial artery and median nerve [19]. Vascular injury has been reported in 10-20% of fractures associated with displacement [20]. This situation conventionally requires an emergency surgery but the requirement for an emergency surgery has recently been disputed [18].

Thus, a careful neurovascular examination must be performed on these patients in the emergency room and results needs to be recorded [21]. Color Doppler Ultrasound and Pulse Oximetry can be used to check the arterial blood flow, pulse rate and capillary refill but vascular angiography is the gold standard method [22].

Due to the presence of more collateral vessels in the upper limbs than lower limbs, the obstruction of the brachial artery is bypassed and therefore is less likely to result in gangrene and amputation. Consequently, maintaining sufficient oxygenation keeps the hand pink and pulseless [23, 24].

There is no disagreement over the surgical exploration in vascular injury of supraclavicular fractures with decreased blood flow, which is associated with symptoms such as pain on a passive stretch of the wrist, capillary refill, impaired oxygen saturation and low temperature of hand (pulseless, pale and cold hand) [23, 25].

However, treatment of pink pulseless hands with sufficient blood supply is controversial [26-29]. Some studies recommended the emergency exploration of brachial artery [30, 31]. While, others suggested the conservative treatment [29, 32].

The aim of this study was to provide a clinical approach in the treatment of children with supracondylar humerus fractures with coexisting vascular injury and to investigate the effect of conservative treatment in pink pulseless hands with sufficient blood supply.

### Patients and methods

During a clinical trial, after the consent of Ethics Committee, a group of children with complaint of clavicular humerus fracture who were admitted in the emergency room of Trauma Center

of Shahid Rajaei Hospital, Qazvin University of Medical Sciences, Iran between 1392/01/01 until 1397/06/01 were investigated.

On admission, primary steps of ABS were performed in the emergency room and supraclavicular humerus fracture was confirmed with a simple x-ray graphs and then the type of fracture was determined. Only children with extension fractures following a blunt trauma were included in the study. Maximum age for inclusion in the study was 10 years. Accordingly, 26 children were included in the study. Demographic data including age and sex was also recorded. After stabilization of general condition and perfusion and circulatory status of the damaged organ, all patients were carefully examined by checking the capillary refill, radial pulse, and sensory and motor nerves status in the emergency room. Vascular injury is defined as the absence of radial pulse or prolonged capillary refill time of greater than 2 second.

All patients were transferred into operating room within the first 24 hours for reduction and then were operated by orthopedic and vascular surgeons. Pulse status was evaluated in the operating room during and after the operation. Clinical examination was used to check the distal pulse and capillary refill. Patients were monitored for up to two weeks after the reduction. During this period, patient were provided with required training and symptoms of ischemic and were instructed to immediately refer to this hospital emergency department in case of having symptoms. Statistical tests were used for statistical analysis.

### Findings

A total of 26 patients were evaluated. 17 patients (65.4%) were male and 9 patients (34.6%) were female. The average age of patients was 5 years. Patients aged between 3-10 years.

**Table1. Frequency distribution of patients by age**

Age/year	Frequency	Percent
3	4	15.4
4	7	26.9
5	7	26.9
6	4	15.4
7	1	3.8
8	1	3.8
9	1	3.8
10	1	3.8
Total	26	100

Right-hand and left-hand fracture was observed in 15 patients (57.7%) and 11 patients (42.3%), respectively. 6 out of 26 Patients (23.1%) had a radial pulse on admission. Radial pulse disappeared before and after the reduction in 2 and 4 patients, respectively. 20 patients (76.9%) did not have radial pulse on admission. Average interval between injury and admission to hospital was 4.57

hours. 16 patients (61.5%) underwent open reduction and 10 patients (38.5%) underwent closed reduction. Radial pulse returned immediately after the reduction in 6 patients (23.1%). In all patients, radial pulse was checked during two weeks after the reduction. In this study, average time of the pulse return was 4 hours.

**Table2. Frequency distribution of patients by the time required for the pulse return after the reduction**

Pulse return time/hour	Frequency	Percent
0	6	23.1
1	2	7.7
2	3	11.5
3	1	3.8
4	4	15.4

6	1	3.8
10	1	3.8
24	1	3.8
48	1	3.8
72	2	7.7
120	1	3.8
168	1	3.8
336	2	7.7
Total	26	100

Capillary refill status on admission was poor in 7 patients (26.9%) and good in 19 patients (73.1%). Following the reduction, the refill status was good in all patients.

## DISCUSSION

Supraclavicular fracture is the most common fracture in elbow region [7, 33, 34]. In this study, the average age of children was 5 years, which is in line with previous studies [1, 10, 11]. Previous studies [10, 12] argued that this fracture is more common in males. In our study, 65.4% of the patients were also male.

Most pediatric orthopedists normally choose the closed reduction and percutaneous pinning [35-37], but in the present study 61.5% of patients underwent open reduction which can be attributed to the level-3 trauma of this medical center and referral of cases with more severe mechanisms. In this study, we found that there is no need for arterial vascular exploration and radial pulse and vascular refill status is good after the reduction and conservative treatment. In a study conducted by Matuszewski et al., It was concluded that there is no need for surgical exploration of brachial artery after the closed reduction of supraclavicular fractures in pulseless hand with good perfusion and conservative treatment is enough unless organ's blood flow does not return after a closed reduction [38]. Wegmann et al. also demonstrated that in cases with no peripheral pulse and vascular refill, watchful waiting treatment can be a good alternative for arterial surgical exploration. [39]. In a review study, Griffin et al. suggested that children with a pink pulseless hand following a supraclavicular fracture can be treated by watchful waiting unless there is vascular damage [40]. The results of studies by Ramesh [41], Malviya et al. [42] were also consistent with our results.

Some studies believe that absence of pulse, even in the case of sufficient organ perfusion, is a

sign of vascular damage and requires arterial surgical exploration, a finding that is inconsistent with our results [30, 31, 43]. Libeling et al. found that arterial surgical exploration is mandatory in cases of neurovascular injuries following fracture, a result which is inconsistent with our findings [44].

In this study and other previous studies [45, 46], it was concluded that in a pink pulseless hand, using clinical symptoms including pulse detection and capillary refill is satisfactory and radiologic evaluations will not be necessary and require extra cost and time.

While Luria et al. suggested that, in cases where radial pulse fails to return, surgical exploration is only recommended after the conduction of angiographic evaluation of the brachial artery. They argued that angiography is an appropriate helpful procedure to avoid the unnecessary surgical exploration of brachial arteries [47].

Limitations of this study were low number of patients and unicentric performance of the study (only in one center). We therefore recommend that more multi-centric studies be conducted with larger sample size in order to confirm the results of our study as well as to provide a treatment algorithm and approach.

## CONCLUSION

The results of our study suggest that surgical exploration is not needed in the treatment of a pink pulseless hand (absent peripheral pulse and good peripheral capillary refill time) following supraclavicular fractures and radial pulse will be detected after the closed reduction and collateral vessels maintain vital function of the organ and therefore arterial surgical exploration imposes complications and unnecessary cost and time. Thus, it is suggested that more studies have been conducted with larger number of patients in order to provide a definitive treatment for children with supracondylar humerus fractures with lower costs and less complications.

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