ORIGINAL ARTICLE

THE EFFECTIVENESS OF CLOSED REDUCTION OF SUPRACONDYLAR FRACTURE OF THE HUMERUS WITH NEUROVASCULAR INJURY IN TERMS OF THE NEED FOR EXPLORATION IN CHILDREN

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ABSTRACT

Objective: To determine the effectiveness of closed reduction of supracondylar fracture of the humerus in children with neurovascular injury in terms of the need for exploration.

Material and Methods: This prospective observational study was conducted at the department of Orthopedic Khyber Teaching Hospital Peshawar from July 2020 till July 2021. Children with supracondylar fracture (Gartland type II and III) of the humerus were included irrespective of neurovascular injury. Data was analyzed using SPSS. Mean and standard deviation was used for quantitative data. Frequency and percentages were used for qualitative data. Shapiro Wilk's test was done to find the normality of the data.

Results: The mean age of the 65 children with Gartland type 3 closed fractures was 7 years (± 1.5) years. The male to female ratio was 1:0.4 with 45 males and 20 female patients. The right side was involved in 28 (43%) while left sides in 37(57%) patients. At presentation, 40 patients (61%) had no signs of neurovascular involvement while 25 patients (39%) had signs and symptoms of various nerve injuries and 6 patients had absent radial pulse but with well perfused, pink hand. Of these 25 patients, only 2 patients had combined neurovascular compromise not responding to closed reduction and needed urgent exploration while the remaining 23 were managed conservatively with closed reduction

Conclusion: This study concludes that closed reduction should be done in patients with isolated nerve injury or vascular injury with pink hand and adequate capillary refill while in case of combined nerve and vascular injury not responding to closed reduction, urgent exploration should be considered.

Key Words: Supracondylar fracture of the humerus, Neurovascular injuries, Median nerve, Ulnar nerve, Radial nerve, Gartland classification.

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INTRODUCTION

The neurological and vascular injury in displaced supracondylar fracture of humerus in children is reported in 10 to 20% of cases.[1, 2] The Early recognition of ischemic injury is a matter of great concern for the reversibility of damage, depending upon the duration of the ischemia.[3] The vascularity of the limb in Gartland Type-III injury needs due attention for its survival.[4] The brachial artery injury has been reported in approximately 11% of cases of supracondylar fractures.[5, 6]

There is no dispute in urgent exploration in the case of vascular comprise in supracondylar fracture with pulseless, cool, and white hand.[7] However, the controversy remains there when there is pulseless and pink hand in displaced supracondylar fracture of humerus and several authors have suggested a conservative approach or delayed surgery.[8] Most of the surgeons initially manage such types of injuries with urgent close reduction and K-wire fixation. Mostly, the radial pulse will return immediately.[9] In a study of the British Society of Orthopedic surgery, 60%

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favored observation if the hand remains pulseless after k-wire fixation, whereas 16% favored exploring the vessel immediately and the remainder would call for a vascular surgeon opinion.[10] The neurological injuries may coexist with vascular injuries. The median and anterior interosseous nerves are commonly injured in extension type of supracondylar fracture especially when the distal fragment is displaced posteriorly and laterally.[11, 12] In some studies, radial nerve injuries are reported as the most common nerve injuries followed by median and ulnar nerve.[13] In most of the studies, complete recovery of the nerve function has been reported without the need for exploration which shows that the injury may be partial (neuropraxia).[11, 12] In case of coexisting vascular and median nerve injury, the chances of nerve recovery would be unlikely with conservative treatment, so in such a situation early exploration is required from an anteromedial approach to see kinking or rupture of the vessel and median nerve.[14] The radial pulse will return if the vessel is in spasm or completely obstructed by thrombosis / intimal tear or is trapped at the fracture site. In these cases, the return of radial pulse is due to dilatation of collateral circulation around the elbow.[5]

Table 1: Basic Demographics of the study

Mean Age of patients	**7 years ± 1.5 years**
Distribution with respect to Gender	
Male	45
Female	20
Male to female ratio	1:0.44
Distribution with respect to side involvement	
Right Side	**28**
Left Side	**37**
Distribution with respect to neurovascular compromise	
Present	**25**
Absent	**40**

The local literature seems to be deficient with no appropriate recommendations for dealing with neurovascular compromise in supracondylar humeral fracture. This study aimed to determine the role of closed reduction and its outcomes in supracondylar humeral fracture with neurovascular compromise in terms of the need for exploration in children.

MATERIALS AND METHODS

This prospective observational study was conducted at the Department of Orthopedic Khyber Teaching Hospital Peshawar from July 2020 till July 2021. The inclusion criteria was displaced (Gartland Type II and III) supracondylar fractures of the humerus in children presented with or without neurovascular injury prior to an attempt of close or open reduction. The exclusion criteria was fracture treated elsewhere and supracondylar fracture with pulseless, cool, and white hand. The fractures were classified according to Gartland classification and proper clinical examination was performed before any sort of treatment to find out any neurovascular compromise. The patients with isolated vascular and nerve injury were treated with closed reduction while patients with combined neurovascular injury underwent surgical exploration. The neurovascular status was assessed upto 3 days of the above-mentioned intervention and then after 3 months.

RESULTS

A total of 65 children with Gartland type 3 closed extension type supracondylar fractures were included in the study, the basic demographics of which are discussed in Table 1.

Out of these 65 patients, only 25 had signs and symptoms of neurovascular compromise which are discussed in Table 2.

Table 2: Details of neurovascular compromise

Parameters	**Number of patients**	**Status at 3rd day**	**Status 3 months**	**Need for exploration**
Only Vascular compromise	6 Absent radial pulse	Pulse reappeared in 2 patients after closed reduction	in 4 patients pulse reappeared after 3 months of closed reduction with normal capillary refill	None
Only Nerve compromise	11 Anterior interosseous nerve 8 Median Nerve 6 Radial Nerve 0 Ulnar Nerve	Neuropraxia in all cases after closed reduction	Normal status after three months of closed reduction	None
Combined neurovascular compromise	2 Radial artery and median nerve involved	Closed reduction failed Radial pulse reappeared at 48 hours after exploration	Closed reduction failed Median nerve function reappeared after 3 months of open reduction	Openly explored

DISCUSSION

The neurovascular injuries in supracondylar fractures of the humerus in children are common in Gartland type III extension type fractures.[15] There is controversy regarding the management of pulseless but perfused hand after close reduction. Some authors opt for conservative management while other favor early exploration.[16]

In the literature, there are different frequencies of various nerve injuries in supracondylar fractures of the humerus in children. In one study, the nerve injuries occurred in 13.3% of patients, with median nerve 58.9% followed by radial 26.4% and ulnar nerve injuries 14.7%, combined nerve and vascular injury occurred in 2.9%. [11] In another study conducted in the U.S.A, nerve injuries were reported in 19 (9.5%) cases out of 200 cases with acute type III extension type Supracondylar fractures.[17] The percentage of nerve injuries in our study was 38%. There was 44% anterior interosseus nerve involment, 32% median nerve while 24% radial nerve and no ulnar nerve. On the other hand, percentage of the vascular injury in our study was 24%. The percentage of combined neurovascular injury was 8%.

We managed six cases with absent pulse by closed reduction and percutaneous pinning without exploring the brachial artery. The logic behind this approach was that in well-perfused pulseless hands the radial pulse usually appears following relaxation from vascular spasm. Likewise, strong collateral circulation also develops around children's elbow. [5] In 2 cases having both an absent radial pulse and median nerve injury, the brachial artery and nerve were explored through an anteromedial approach. The brachial artery and median nerve were found entrapped between fracture fragments, both were released and fracture fixed with cross k-wires. In both cases, pulse reappeared after 72 hours and median nerve started functioning within 3 months.

In our study, we also found that the median nerve is most commonly injured in displaced supracondylar humerus fractured in children followed by radial and ulnar nerve. In other studies, radial nerve injury is most commonly injured followed by median and ulnar nerve. [13]

Moreover, we noted that in supracondylar fractures with posteromedial displacement the radial nerve got injured due to anterolateral pressure of proximal humeral fragment, while the median nerve and brachial artery injuries occurred in posterolaterally displaced fractures due to anteriomedial pressure of proximal fragment as reported by other authors.[11] Diagnosis of fracture displacement pattern provides a clue toward clinical examination for nerve injury assessment. In children, it is very difficult to assess nerve injury but one can get some clue of nerve injury by thumb moments.

Due to the limited number of participants in the study, it is difficult to generalize the results. Further large scale multicenter studies of this kind are needed to improve our understanding and strengthen the guidelines.

CONCLUSION

This study concludes that closed reduction should be performed in children with isolated nerve injury or vascular injury with pink hand and adequate capillary refill while in case of combined nerve and vascular injury not responding to closed reduction, urgent exploration should be seeked.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under

Khan MY: Study design, overall supervision, and approval of the final version.

Khan MS: Manuscript writing, concept, Study Design

Khan MAJ: Data collection, helping in manuscript writing

Sajjad A: Data collection

Khan MK: Study design, overall supervision

Shoaib F: Manuscript writing

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.