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Original article

Predictive factors determining outcomes in pulseless limb in paediatric supracondylar fractures of humerus

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ABSTRACT

Introduction: Amongst all the complications associated with paediatric supracondylar humerus fractures, significant vascular injury is reported in only 1% cases, of which, less than 1% develop Volkmann's ischemic contracture. This study evaluates factors, like delay in presentation of the injury, limb perfusion and pulse, in determining functional outcome in a supracondylar humerus fractures with pulseless limb.
Materials & methods: Twenty-one paediatric patients with a pulseless supracondylar humerus fracture presenting from 2012 to 2014 were included. The patients were divided into 3 groups with Group A (pulse returned post-reduction, n = 13), Group B (pink pulseless hand, n = 7) and Group C (white pulseless hand, n = 1). 11 patients in group A and 4 patients in Group B presented within 6 h. of injury while the remaining patients presented after 6 h. The primary outcome was vascular status as indicated by radial pulse and perfusion, and secondary outcomes included functional parameters assessed with Mayo Elbow Performance Score and Flynn criteria.
Results: Mean peripheral SpO2 in Group A patients was higher than Group B and Group C had a non-recordable oxygen saturation. Mean capillary refill time was more in Group A than Group B whereas in Group C patient had blanching and no capillary refill was seen. Mean Mayo Elbow Performance Score of Group A patients was highest as compared to Group B and Group C. Patients presenting within 6 h. of injury had a higher mean Mayo Elbow Performance score as compared to the patients presenting after 6 h of injury. Functional outcome as measured by Flynn Criteria was excellent in 13 patients. 6 patients had a good, 2 had fair outcome. A moderate negative corrélation (R = −0.5798) was seen between the time elapsed from the injury and the Mayo Elbow Performance score.
Conclusion: Duration to presentation since injury, limb perfusion and presence of peripheral pulses seem to be important predictive factors determining the outcomes in pulseless supracondylar fracture humerus.

1. Introduction

Supracondylar fracture of humerus is the most common elbow fracture in children.[1,2,3] This fracture pattern is common in the 1st decade of life[4,5] due to various causes, of which main is ligament laxity and anatomical structure of humerus tube (shaft) to flat transformation at the lower end of humerus. Of all the complications associated with supracondylar fractures, nerve injury ranks highest. Nerve injury in supracondylar fracture humerus occurs in 7% cases and significant vascular injury is seen in 1% cases,[6] of which less than 1% develop Volkmann's ischemic contracture. It is necessary to have a high index of suspicion, to avoid missing an impending compartment syndrome, especially in cases with a concomitant median nerve injury or a forearm fracture, as these may mask symptoms of compartment syndrome.

An absent radial pulse is no indication for surgery in the presence of good capillary circulation. Patients with vascular compromise may present with a peripheral pulselessness which often recovers after fracture reduction. Immediate angiography is not indicated for a pulseless limb, as it delays fracture reduction, which usually corrects the vascular problem.[7] This results in either a return of the pulse or a “pink pulseless hand” with an absent peripheral pulse but good perfusion. Patients in which the pulse doesn't return and have a poor perfusion, result in a “white pulseless hand”. Peripheral perfusion of the limb can be assessed

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by comparing the hand colour, capillary refill time and peripheral SpO_2, with the normal side.

Patients with the return of the peripheral pulses post-reduction of the fracture, have excellent prognosis and are treated with a standard post-operative protocol as defined for patients with supracondylar humeral fractures without any neurovascular deficit. Patients with a perfused or pink pulseless hand also have a very good prognosis and generally require a strict postoperative monitoring. A white pulseless hand requires an intraoperative duplex ultrasound or a vascular consult or an urgent but not an emergent exploration.

Several factors are thought to predict and determine the immediate, and long term outcomes in patients with a pulseless limb in supracondylar fracture humerus but with an inconclusive evidence. This study evaluates the predictive factors, like duration to presentation of injury, limb perfusion and peripheral pulselessness in determining outcomes in a pulseless limb in supracondylar fractures of humerus in children.

2. Materials & methods

Twenty-one patients, between the ages of 5–14 years, with a closed pulseless supracondylar humerus fracture presenting to the emergency services and outpatient department of a tertiary care center in Jaipur during the period from January 2012 to January 2015 were included in this study.

Patients coming with closed supracondylar fracture of humerus without any pulse were included in this study. Patients who did not give any consent, open fractures, concomitant injuries, any nerve injury and patients not willing for follow up for the desired period were excluded from the study. After an informed consent all the patients were assessed clinically with special reference to the neurovascular status of the involved limb. Post-traumatic swelling and any visible deformity at the elbow was carefully assessed. All peripheral pulses were palpated, preferably radial pulse. Hand colour, peripheral SpO_2 and capillary refill time, were compared to the normal side to determine the perfusion of the limb. These modalities were assessed by the third author to avoid any bias or any variation. SpO2 was measured by the pulse oximeter and the capillary filling time was assessed by seeing the blanching of the nail bed and measuring the time. Antero-posterior and lateral view skiagrams of the affected elbow were taken. The X-Rays were assessed regarding the type of fracture and the degree of displacement based on Gartland classification.[8]

Treatment was done according to the following protocol (Fig. 1). An immediate closed reduction and percutaneous cross pinning was done followed by an above elbow slab in 30° less than full extension. Following 20 min' post-reduction, peripheral pulse was again checked and hand colour, peripheral SpO2 and capillary refill time, was compared to the normal side, for dividing the patients into 3 groups. Group A (pulse returned post-reduction, n = 13), Group B (pink pulseless hand, n = 7) and Group C (white pulseless hand, n = 1). Group A patients were given standard post-operative care. Group B patients were carefully monitored for the next 48 h in the post-operative ICU while in Group C patient, arterial patency was assessed on duplex ultrasound and surgical exploration was done. On exploration, brachial artery was found entrapped between the fractured ends which was subsequently released and was strictly monitored postoperatively. 11 patients in group A and 4 patients in Group B presented within 6 h. of injury while the remaining patients presented after 6 h. of injury. The reduction, surgery and the assessment of the vascular status was done by the same doctor.

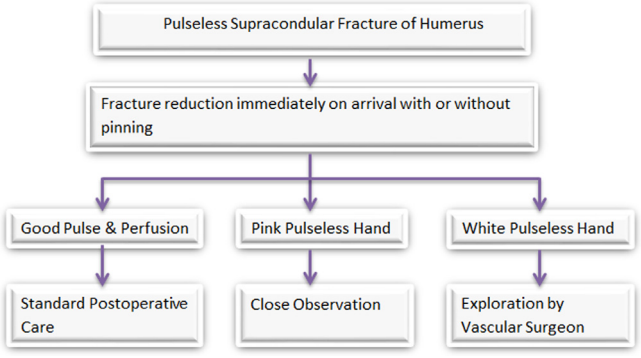

Fig. 1. Treatment protocol followed in the management of pulseless supracondylar fracture [19].

Group A and Group B patients were discharged after 4–5 days and Group C patient was discharged after 7 days, after a post-operative clinical examination for swelling, arterial injury, finger movements and nerve injury and review of the radiographs with instructions on cast care and elevation. The reason for a comparatively longer hospital stay was precautionary as we did not want the children to travel since our hospital was quite far from the city. The child's parents were advised to watch out for any swelling, discoloration of fingers and report immediately, if any, did occur.

Follow Up

2nd week:	2 weeks after the operation, the child was clinically examined for swelling, pulse, peripheral perfusion, infection, loosening of pins, finger movements and status of the nerves.
4th week:	Four weeks after the operation, the above elbow slab and pins were removed and clinical and radiological assessment of the fracture was done. The patients were encouraged to begin with gentle active mobilization of the elbow and strictly advised against any massage, heat or forced passive mobilization. Lifting of heavy weight was not allowed.
6th week:	AP and lateral X-rays were taken to verify progress of union and range of motion of elbow was assessed. Group C patient was subjected to active and assisted physiotherapy to prevent elbow adhesions and fibrosis.
12th week:	Evaluation of range of motion and any deformity.
24th week:	At the final follow-up, clinical assessment of change in carrying angle (Flynn's Criteria) was done along with range of flexion-extension and pronation-supination. AP and lateral view X-Rays of the affected as well as the normal elbow were taken and assessed regarding union, carrying angle, Baumanns angle and Metaphyseal-diaphyseal angle. The Mayo Elbow Performance Score was calculated in all the cases.

The primary outcome was measured in terms of vascular status of the limb both immediate and long term as indicated by radial pulse and perfusion, and secondary outcomes included functional parameters assessed with Mayo Elbow Performance Score[9] and Flynn criteria[10].

3. Results

In this study, of all the 21 patients presenting with paediatric supracondylar fracture humerus, 16 were males and 5 were females. The mean age at presentation was 7.6 years. 66.7% patients presenting with pulseless limb had fractured their non-dominant extremity. The most common mode of trauma was fall from height accounting for 81% of the patients. Group C patient suffered a road traffic accident. Post-reduction of the fracture, a return of peripheral pulse was seen in 13 patients. 7 patients presented with a perfused pulseless hand and only 1 patient presented with a white pulseless hand. All the patients suffered from Gartland Type III supracondylar fracture extension type.

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