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Treatment of Pink Hand Syndrome (Pulsless Hand) Post Supracondylar Humeral Fractures in Pediatrics

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Abstract **Original Research Article**

Objectives: To review and present our experience at King Hussein Medical Centre, in the management of pink pulseless hand syndrome (PPHS), and to analyse the results and outcome of the conservative watchful approach in the paediatric age group of patient presenting with PPHS, following Gartland type III humeral supracondylar fracture closed reduction and percutaneous pinning fixation (CRPP). ***Methods:*** This is a retrospective study, conducted at King Hussein Medical Centre, on patients aged 14 years and below (Paediatric age group) who sustained grade III Gartland supracondylar fracture of humerus (SCFH) and developed pulseless hands post fracture fixation, between the period of January 2016 and December 2021. ***Results:*** Among 533 patients with the age group of 14 years and below presented to the emergency department with SCFH, 196 patients had type III Gartland SCFH. Post CRPP, 125 (63.8%) had normal vascularity with intact pulses, 45 (22.9%) patients were found to have absent pulses with cold pale poorly perfused hands. Twenty six patients (13.3%) had absent pulses, but well perfused well perfused pink hands. During the admission, only two patients (6.7%) among the 24 patients experienced worsening of the perfusion in the involved extremity and underwent emergency exploration of the brachial artery restoration of hand perfusion successfully post operation. Twenty four (92.3%) patients had well perfused hands within 48 hours of in hospital admission period and were successfully discharged. ***Conclusion:*** Patients presenting with pink pulseless hand syndrome post fracture reduction and stabilization can be safely observed with in hospital admission and strict monitoring of perfusion of the involved hand with no significant sequel and with successful results.

Key words: Supracondylar fracture, pink hand, pulseless, conservative, brachial artery.

INTRODUCTION

Supracondylar fracture of humerus bone (SCFH) is considered one of the most common fractures in the paediatric age group accounting up to 16% of fractures affecting children [1, 2]. It is often associated with devastating neurovascular injuries in up to 20% of the cases, with the incidence of co-existing isolated brachial artery injury ranging between 8-10% of cases, leading to devastating consequences [1, 2].

SCFH is often classified using Gartland classification system into three grades, with grade III being an extension type fracture that is usually associated with complete displacement of distal humerus, and it is the grade most likely associated with vascular injuries. The mechanism is usually falling down onto outstretched hands with the elbow in full extension [2, 3].

Following Closed reduction and percutaneous pinning (CRPP) of Gartland type III SCFH, the involved upper extremity is assessed for vascularity and perfusion. Pale pulseless ischemic hands often require emergency operative brachial artery exploration and management according to the type of vascular injury [1-

4]. Controversy and debate exist in the management of Pink well perfused pulseless hands post fracture stabilization. Treatment options include: immediate vascular exploration versus watchful conservative inpatient management unless any deterioration of perfusion occurs meanwhile which mandates surgical exploration [1-4].

The aim of this study is to review our experience at King Hussein Medical Centre, regarding the management of pink pulseless hand syndrome (PPHS), and to analyse the results and outcome of the conservative watchful waiting approach in the paediatric age group patients, who present with PPHS following Gartland type III SCFH stabilization and fixation.

METHODS AND PATIENTS

A retrospective study was conducted on patients aged 14 years and below, at king Hussein Medical Centre, who sustained grade III Gartland SCFH, between the period of January 2016 and December 2021, in our vascular surgery and orthopaedic departments. During this time period, 533 patients with this age group presented with SCFH to the emergency department. Patients with open fractures were not included in our study group. Clinical and radiological evaluation using Anteroposterior and lateral x rays views, demonstrated that 196 patients had extension displaced type III Gartland SCFH. Vascular perfusion assessment was based on clinical examination including capillary filling, temperature, colour of hand and fingers. Pulses and oxygen saturation were evaluated, in addition to the use of hand-held doppler examination of the affected upper limb in order to evaluate the arterial flow to the extremity. All patients were assessed for vascular compromise before any intervention and following fracture stabilization. Patients were immediately hospitalized and operated under the orthopaedic surgery team using closed reduction and stabilization of the fracture by means of percutaneous pinning k wires both at lateral and medial aspects. Data were obtained from patient's medical hospital records and electronic patient's data base in king Hussein Medical Centre.

RESULTS

Among the 196 patients of the targeted age group, extremities with Gartland type III SCFH underwent vascular assessment to evaluate the perfusion status prior to the CRPP stabilization of the fracture.

Refer to Picture 1, 2

Mean age was 8.3 years (range 2-14 years old). Seventy of them (35.7%) were females and 126 (64.3%) were males. Following vascular assessment 90 (46%) patients had intact vascularity in the involved upper extremity with palpable pulses while 106 (54%) patients had absent distal pulses before fracture stabilization. Post CRPP, 125 (63.8%) had normal vascularity with intact pulses in the affected limb. However, 45 (22.9%) patients were found to have absent pulses with cold pale poorly perfused upper limb and delayed capillary filling of the hand. This group of patients had emergency brachial artery exploration and operative intervention accordingly.

Twenty six patients (13.3%) had absent pulses, but well perfused pulseless pink hands with good capillary filling and intact motor and sensory functions (pink hand syndrome) post CRPP using kirshner wires of Gartland type III SCFH performed under general anaesthesia. These patients were admitted to hospital and observed as inpatient for 48 hours, with an arterial duplex ultrasound scan of the involved upper limb, being performed to confirm that the brachial artery continuity was intact. Strict monitoring of the involved hand perfusion using clinical assessment and pulse oximetry was applied, on top of hand held Doppler evaluation of distal arterial signals. They were started on unfractionated heparin using a bolus dose of (75 IU /KG given intravenously over 10 minutes) followed by maintenance dose of 20 IU/Kg/hour, with dose adjustment to maintain aPTT of 60 to 85 seconds.

During the admission, only two patients (6.7%) experienced worsening of the perfusion in the involved extremity detected by clinical assessment. These underwent emergency exploration of the brachial artery. Operative findings included brachial artery adventitial hematoma and thrombosis with arterial spasm and managed successfully with simple thromboembolectomy of the artery resulting in good distal triphasic signals and perfused hands with restoration of hand perfusion fruitfully post procedure. Twenty four (92.3%) patients had well perfused hands within 48 hours of In-hospital admission period and were successfully discharged.

About 70% (17 patients) of them had their pulses back in two days whereas the remaining 7 patients had palpable pulses detected within two weeks, being checked during their follow up visit after 14 days of hospital discharge. While no other vascular complications were encountered during this period.

Refer to Figure 1

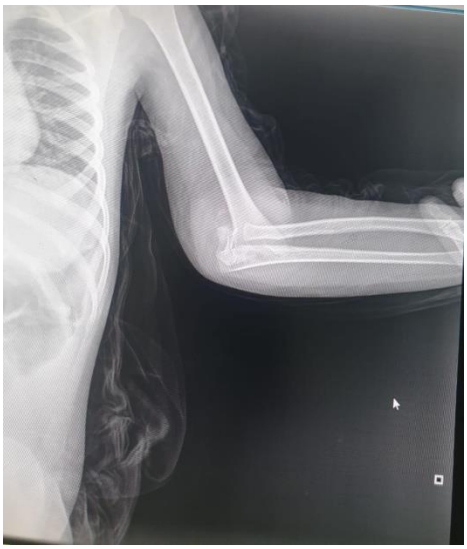

Fig-1x ray views of a 10 years old child persented with gartland type iii supracondylar farcture

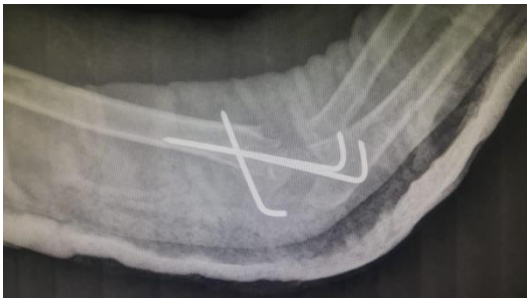

Fig-2: X Ray View Post Closed Reduction And Percutaneous Pinning Fixation

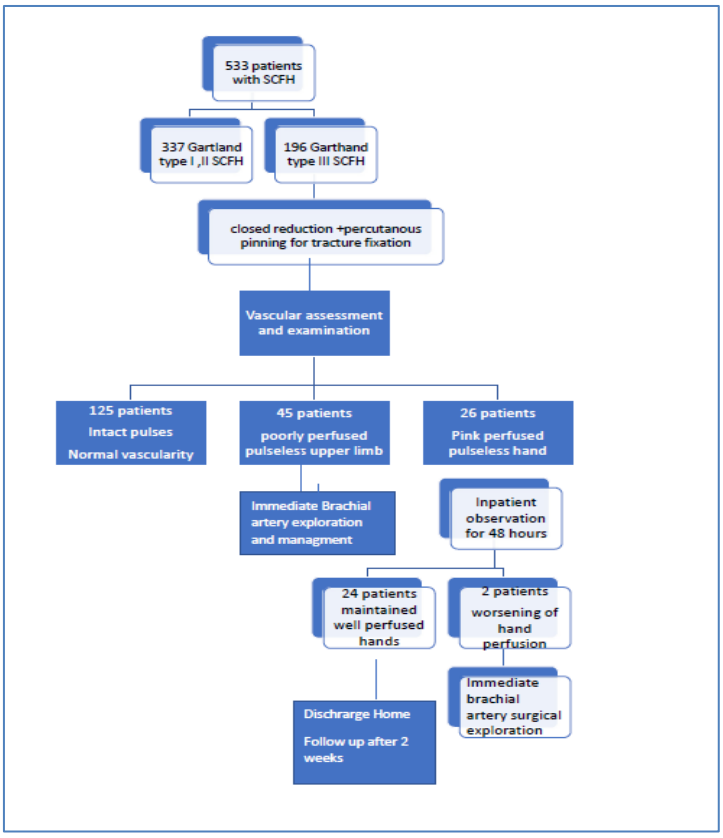

Fig-3: Flow chart representing the managment scheme of our patients groups, SCFH: Supra Condylar Fracture of Humerus

DISCUSSION

The SCFH in Paediatric group is considered as one of the most frequent fractures in this age group. It accounts for up to 60% of elbow injuries with the incidence of coexisting vascular compromise being reported to be as high as 10% [1, 5, 6]. Brachial artery injuries represent a potential challenging issue in the management of these patients. The mechanism of injury consists of a wide range of spectrum including: arterial spasm, kinking, compression, dissection, partial or complete transection, thrombosis and entrapment, resulting in vascular compromise of a varying severity. Patients, who present with pale, cold and pulseless hand following the reduction and stabilization of fracture, require immediate surgical exploration owing to poor perfusion that endangers the viability of the limb [1-6]. A group of patients present with perfused pink hand but with absent pulses post fracture reduction and stabilization, the so called pink hand pulseless syndrome, in which the hand receives oxygenated blood from the rich arterial collateralization around the elbow sufficient to maintain good perfusion [3-6].

Several approaches have been suggested in literature for the management of this group of patients, with lots of controversy have been observed in treatment protocols [3-6].

Conservative watchful approach has been suggested with frequent monitoring and clinical evaluation for 48 hours. Proponents of this conservative approach stated that the long term outcome depends on the perfusion rather than the presence or absence of pulses [5-7]. In a study performed by Choi *et al*. in 2010 on 33 patients, 24 of his patients had PPHS following fracture stabilization and were managed successfully with observation and conservative protocols allowing them to be discharged with good distal pulses after 24 hours of observation period [1, 5, 8]. Xie *et al*. published a study in 2021 on 13 patients who presented with PPHS following closed reduction and percutaneous pinning of SCFH, and they have concluded that close observation was acceptable approach in the management especially if accompanied by colour flow duplex scan to assess the status of the brachial artery [9]. Similarly, Grabuz *et al*. had demonstrated in their study, which included 5 patients with perfused pulseless hands, that none of them developed vascular compromise and had good results following fracture stabilization and close observation [1, 4, 10]. Likewise, Louahem *et al*. have supported in his study the conservative approach. They concluded that strict monitoring and closed observation with conservative measures remains mandatory if the hand remains well perfused and pulseless following fracture stabilization .Two of the patients among the 26 patients had pink hand pulseless syndrome who were observed closely with pulses reappearing back in 6 days [1-4, 11, 12].

These good results have been similarly described in many other studies, and accordingly, have justified the expectant management protocol [11-14].

On the other hand, immediate vascular exploration with or without arterial reconstruction has been advocated by other group of authors for the management of PPHS. They recommend a more aggressive approach because the collateral circulation around the elbow is unreliable and variable, in addition to the high success rate results of brachial artery reconstruction in children [15, 16].

In a metanalysis performed by White *el al*., they systematically reviewed a group of published articles on perfused pulseless hands post supracondylar fractures of the humerus. They showed that vascular injuries have been associated in up to 70% of the involved limbs post SCFH, following the surgical exploration of 90% of the 157 limbs in the review, and the author recommended the aggressive approach in management of such cases, thereby questioning the conservative approach [16].

Similarly, in a study performed by Schoenecker *et al*., [7] patients who presented with pink hand pulseless syndrome had successful brachial artery exploration with restoration of pulses with a follow up period up to 30 months , the author recommended that immediate vascular exploration of brachial artery is mandatory if the extremity remains pulseless [1, 2, 3, 9, 12-17].

Blakey *et al*. reported their results on 26 children who presented with pulseless pink hands following SCFH, and who were treated conservatively. After a mean follow up period of three months, 23 of the 26 patients presented with ischemic Volkmann's contracture, for that reason, the authors recommended again immediate vascular exploration in this group of patients [2, 3, 4, 9, 12, 13, 14, 18].

On the other hand, Delniotis *et al*. performed a systemic review in 2019 comparing the results of conservative watchful approach with the exploration of brachial artery, and they highly recommended the watchful approach for pink pulseless hands post closed reduction and percutaneous pinning of humeral supracondylar fractures as long as the hand remains well perfused .However, for pale pulseless hands, if there is no return of pulses following reduction and stabilization of fracture, then surgical exploration is mandatory [9, 19].

The British Society for Children's Orthopaedic Surgery also recommends watchful conservative approach for pink pulseless hands, relying on collateral circulation for perfusion of the involved extremity, showing that only 16 % of their members would adopt the surgical exploration of the brachial artery as an

approach for PPHS following closed reduction and percutaneous pinning of fracture [20].

In our study, 26 patients in the paediatric age group, presented with PPHS post closed reduction and percutaneous pinning fixation of SCFH. We have adopted the watchful conservative approach in our treatment protocol, with patient admission for 48 hours in hospital and strict monitoring of the involved hand perfusion.

During in-hospital admission, only two patients experienced worsening of the perfusion in the involved extremity detected by clinical assessment, for which they underwent emergency exploration of the brachial artery with successful results and no complications being encountered. Twenty four patients had well perfused hands within 48 hours of in hospital admission period and were successfully discharged without any significant sequel. 17 of them had pulses returned back in two days and the remaining 7 patients had palpable pulses detected within two weeks, being checked during their follow up visit .This demonstrate the safety of the watchful conservative approach for the management of PPHS if accompanied by strict monitoring of distal perfusion of the involved hand.

CONCLUSION

Brachial artery injuries following Gartland III SCFH remains a devastating complication that should be addressed carefully [1, 2].

Patients presenting with PPHS post fracture reduction and stabilization can be safely observed with in-hospital admission and strict monitoring of perfusion of the involved hand with no significant sequel and with successful results.

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