

Vascular compromise associated with supracondylar fractures in children

*Hussein M. Rabee, FRCSI, MD, Mussaad M. Al-Salman, FRCS, FACS,
Kaisor Iqbal, MS, FRCSI, Hazem Al-Khawashki, FRCSEd.*

ABSTRACT

Objectives: Our aim was to study the significance of persistently absent radial pulse, with monophasic doppler flow after close reduction percutaneous pinning of displaced supracondylar fracture of humerus, and the need of early exploration of brachial artery in such cases.

Methods: Between July 1992 and 1999, 86 children with Grade III supracondylar fracture of humerus were treated at King Khalid University Hospital, Riyadh, Kingdom of Saudi Arabia. The history, physical examination, vascular status of limb before and after close reduction percutaneous pinning of fracture were recorded. All children having persistently absent radial pulse and monophasic flow doppler signals after close reduction percutaneous pinning underwent exploration of brachial artery.

Results: Of the 86 children with Grade III supracondylar fracture of humerus, 6 had persistently absent radial pulse with monophasic flow doppler signals after close reduction

percutaneous pinning. Five children had one warm pink well perfused hand and one cold pale poorly perfused hand. All 6 underwent exploration of brachial artery and were found to have entrapped artery at the fracture site. There was an immediate return of radial pulse with triphasic Doppler flow on release of brachial artery.

Conclusions: Persistently absent radial pulse with objectivity, obtained by doppler ultrasound in the form of absent or monophasic flow in radial artery, is a reliable indicator of vascular compromise. Surgical exploration of brachial artery by a competent surgeon is to be carried out to avoid early and late complication, of pulseless limb in children with displaced supracondylar fracture of humerus.

Keywords: Vascular, supracondylar, fracture, humerus, doppler.

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Around 65%-75% of all fractures in children occur in the upper extremity.¹ Supracondylar fractures of humerus account for 60% of fractures around the elbow.¹⁻³ The most common fracture displacement seen is extension either in the postero-medial or postero-lateral direction.^{1,4,5} The incidence of vascular complication associated with supracondylar fracture in a child has been reported in less than 12% of cases.^{6,7} Brachial artery injury occurred in 38% of cases in the Campbell series.^{4,11} Injury to a main artery is potentially dangerous in a child with supracondylar fracture of humerus. It not only has an

immediate threat to limb viability, but there is also the possibility of long term effects on the growth of the limb and later claudication if the brachial artery flow is not well restored.^{7,8} The goals of treatment of an injury are, to achieve normal function and alignment while avoiding complications.¹¹ Absence of the pulse after limb fracture is a cause for concern. It is generally believed as one of the 'hard' signs of vascular injury which can be diagnosed by physical examination.¹² It is a reliable indicator of ischemia in children with supracondylar fracture of humerus, to base clinical decision and management on.^{5,11}

From the Division of Vascular Surgery, Department of Surgery (Rabee, Al-Salman, Iqbal), and the Department of Orthopedics, (Al-Khawashki), College of Medicine, King Khalid University Hospital, Riyadh, Kingdom of Saudi Arabia.

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Address correspondence and reprint request to: Dr. Hussein M. Rabee, Head, Division of Vascular Surgery, Department of Surgery, College of Medicine, King Khalid University Hospital, PO Box 7808, Riyadh 11472, Kingdom of Saudi Arabia. Tel +966 (1) 467 1589. Fax +966 (1) 467 9493. E-mail: hmrabee@ksu.edu.sa

Doppler ultrasound examination provides a safe, objective evaluation of arterial patency. By grading arterial flow signals and waveform as monophasic, biphasic or triphasic an injured artery can be identified (triphasic-normal flow, biphasic-obstructed flow, monophasic-minimal flow).^{7,12} There are no clear guidelines in the management of children with satisfactory close reduction of a displaced supracondylar fracture of humerus and post reduction persistently absent radial pulse.^{3,4,7,11} The authors present their experience in the management of absent radial pulse with monophasic flow on Doppler studies, in children with displaced supracondylar fracture of humerus. They continue to emphasize on early recognition and management of vascular injury associated with limb fractures.¹²

Methods. Between July 1992 and July 1999, 86 children with displaced extension type supracondylar fracture of humerus (Type III as classified by Gartland and modified by Wilkins)⁸ were treated at King Khalid University Hospital Riyadh, Kingdom of Saudi Arabia (Figure 1). History, physical, radiological examination and treatment were reviewed. Vascular status of limb before and after treatment and findings at exploration were recorded. In children with absent radial pulse after close reduction-percutaneous pinning, a careful repeat vascular status examination was carried out. All the peripheral pulses were examined and dopler ultrasound equipment connected to spectrum analyzer was also used to asses the flow in the brachial artery proximal to the fracture and in the radial artery distally. Both results were compared with that of the contralateral uninjured limb. Children with persistant post reduction absent radial pulse and having monophasic flow doppler signals and waveforms underwent surgical exploration and restoration of brachial artery flow.

Results. Eighty-six children with displaced extension type supracondylar fracture of humerus (Type III), were admitted to King Khalid University Hospital, Riyadh, for treatment. Fifty-nine were male and 27 female, the average age was 5.5 years (ranges 1-11 years). Six of them had persistently absent radial pulse with monophasic flow on doppler studies after close reduction-percutaneous pinning (CRPP) and none of them had associated nerve injury. Of these 6 children, 5 had one warm and pink hand, and one had a cold, pale, poorly perfused hand with compartment syndrome. There were 4 boys and 2 girls, the average age was 4.5 years (ranges 2-9 years). All of them underwent exploration of brachial artery under general anesthesia used for close CRPP of displaced fracture and were found to have an entrapped brachial artery at the fracture site with no



Figure 1 - Displaced extension type supracondylar fracture of humerus.

damage to the artery. With careful dissection and release of the entrapped brachial artery, the blood flow was restored to the limb in all cases. In one child who presented with compartment syndrome, fasciotomy was carried out. There was immediate return of radial pulse with triphasic flow pattern on doppler examination in all the cases. No angiogram was carried out in any of the cases. Follow-up revealed good palpable radial pulse in all cases with no late vascular complications.

Discussion. Comparing with other fractures in children, supracondylar fracture of humerus has a high complication rate.² Vascular injury is commonly associated with completely displaced supracondylar fracture.^{5,8} The spectrum of arterial injuries accompanying displaced supracondylar fracture in children ranges from vascular contusion, to intimal damage to brachial artery transection.^{3,13} The most serious complication of supracondylar fracture is Volkman's ischemic contracture due to vascular injury and compartment syndrome.^{3,9,11,13} In order to reduce the incidence of these complication, early detection and prompt treatment of vascular injury is mandatory.¹¹ Careful repeated examination of a child with supracondylar fracture is mandatory to determine improvement or decline in vascular status.¹¹ Arterial spasm may have the same clinical appearances as the true vascular injury with absent or grade 1 pulse (grade 0 = no pulse, grade 1 = barely palpable, grade 2 and 3 = normal, grade 4 = aneurysmal.) We believe as others do that prolonged

arterial spasm without structural damage is rare and persistent absent peripheral pulse in such fractured extremity might indicate a vascular injury.^{9,11-13}

We continue to use, as a routine, preoperative doppler studies in all our patients with absent or weak peripheral pulses and found that this non-invasive tool was simple, easy to use by all in any place or time.¹² Doppler ultrasound in addition to grading of signals, when connected to spectrum analyzer produces objective picture of velocity waveform (triphasic=normal flow, biphasic=obstructed flow, monophasic=minimal flow) which, is compared with the uninjured limb and interpreted as normal or abnormal. Various non-invasive techniques such as pulse volume recording, digital pressure, pulse oximetry, duplex ultrasound are also useful methods for assessment of vascular patency.

Angiography is an invasive procedure, and is used in children with supracondylar fracture of humerus having a pulseless, cold, white hand. They need immediate surgical exploration of the brachial artery, restoration of arterial flow, open reduction and internal fixation of fracture.^{3,4,7,11} The rich collateral circulation around the elbow however may sustain viability of the extremity in a pulseless pink hand, but there may be a potential threat to the viability of the limb with the migration of brachial artery thrombus, development of compartment syndrome and the late sequelae of vascular compromise in a growing child.^{1,3,7,11,13}

It is generally believed that absent peripheral pulses in association with limb fractures is one of the 'hard' signs of vascular injury and indicates a vascular compromise which can be diagnosed by physical examination and angiography can be avoided, as the arterial injury is always located at the fracture site.^{5,11,12} Persistently absent radial pulse with objectivity obtained by Doppler ultrasound studies in the form of absent or monophasic flow in the radial artery after satisfactory close reduction of a displaced supracondylar fracture humerus, is a reliable indicator of vascular compromise.^{5,11,12} It may represent an entrapped or injured artery as seen in this study. We believe as others do that, surgical exploration by a competent surgeon should be carried out immediately with reconstitution of the brachial artery patency in such a situation. In most of our cases studied, the limb was not threatened, we found that early exploration allowed assessment of neurovascular structures, type of injury with the additional advantage of decompression of both the antecubital fossa and flexor compartment syndrome. The fracture can also be reduced directly under vision, avoiding further damage to the neurovascular

bundle. Follow-up of cases revealed good palpable radial pulse in all cases, with no late vascular complications or serious morbidity from surgical exploration and open reduction of the fracture.

In conclusion, in the management of displaced supracondylar fracture of humerus, a careful repeat assessment of improvement or decline in vascular status of limb is mandatory and with emphasis on an aggressive approach, with surgical exploration and reconstitution of arterial flow to avoid the complications in a pulseless limb. A non-invasive tool, such as doppler ultrasound was used in all of our patients and we were able to reach the diagnosis of vascular injury without the need for angiography.

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