Pediatric Brachial Artery Injury from Supracondylar Fractures of The Humerus: Aggressive Revascularization is Sometimes Necessary: Indications, Technical Tips, & Results

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Objectives

1. Report the management and outcomes of five cases of brachial artery injury in children with supracondylar humerus fractures at our institution

2. Emphasize the importance of close observation and low threshold for surgical exploration in these cases

Classification

• Supracondylar Humerus Fractures (SCH)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Non-displaced</td>
</tr>
<tr>
<td>Type 2</td>
<td>Angulated/displaced fracture with intact posterior cortex</td>
</tr>
<tr>
<td>Type 3</td>
<td>Complete displacement with no contact between fragments</td>
</tr>
</tbody>
</table>

Introduction

• Supracondylar humerus fractures make up 60-70% of elbow fractures in children
• Displacement and deformity can injure the median nerve and brachial artery
• Up to 20% of children will present with an abnormal vascular exam due to injury versus a severe spasm
• Ischemic hand:
  - Exploration of the brachial artery is mandatory
• Perfused, pulseless hand:
  - Currently no clear consensus on management
  - If not managed appropriately, the following complications can occur:
    - Delayed ischemia/thrombosis
    - Compartment syndrome
    - Neuropathy
    - Pseudo-aneurysms
    - Growth retardation/limb length discrepancy
    - Ischemic contracture

Neuro – Vascular Exam Mandatory

• Elbow fractures in children:
  - Physical Exam:
    - Neuro-motor exam
    - Thumb extension – EPL (radial – PIN branch)
    - Thumb flexion – FPL (median – AIN branch)
    - Cross fingers – Adduction (ulnar)
  - Signs of compartment syndrome
• Thorough documentation of all findings is important
• A simple record of "neurovascular status is intact" is unacceptable

Disclosures

• I have no disclosures.
Introduction

• The ‘Pink, Pulseless’ Hand:
  – Robust collateral circulation allows the distal extremity to remain viable despite brachial artery disruption

  \[\text{Diagram: Illustration of vessels and nerves.}\]

  \[\text{Text:} \quad \text{Robust collateral circulation allows the distal extremity to remain viable despite brachial artery disruption.}\]

• AIN or median nerve palsy = ‘red flag’
  – Anatomical proximity:
  \[\text{Text:} \quad \text{Concern for both vessel and nerve entrapment.}\]
  \[\text{Pink, pulseless hand + AIN or median nerve palsy = open exploration (Mangat et al., 2009).}\]

• Mechanism of Injury:
  – Neurovascular Compromise
  – When proximal fragment displaces anteromedially
  – Brachial artery and median nerve are at risk for injury

Tethering of Artery Between Fx Fragments

\[\text{Diagram: Illustration of tethering between fractures.}\]

High Probability for Vascular Compromise

• Brachialis Sign: Proximal fragment buttonholed through brachialis

\[\text{Image: Photograph of brachialis sign.}\]

Exploration for Neuro-vascular Compromise

• Supracondylar Humerus Fractures:
  – Indication for Open Reduction
  – Inadequate reduction with closed methods
  – Vascular injury
  – Open fractures

\[\text{Image: Photograph of supracondylar fracture.}\]

Case Report - Methods

• Retrospective chart review from 2009-2016
• Single Institution in Northern Virginia
• Patients who underwent surgical exploration for brachial artery injury due to supracondylar fracture of the humerus
• Age <18 years old

• Identified 5 patients:
  – 4 male and 1 female
  – Mean age 5.4 years old
• Clinical examination on presentation, surgical treatment, and follow-up exam were reviewed
  – Acute follow-up during initial hospital stay and subsequently every 6 months
Case Report - Results

<table>
<thead>
<tr>
<th>Case</th>
<th>Perfusion</th>
<th>Exam</th>
<th>Initial Management</th>
<th>Outcome</th>
<th>Intravenous Findings &amp; Procedure</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No</td>
<td>No</td>
<td>Compartment syndrome</td>
<td>No</td>
<td>Normal function at 3 years</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>No</td>
<td>Perfused, pulse Doppler signal</td>
<td>No</td>
<td>Treated with radial artery release</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>No</td>
<td>No</td>
<td>Observation</td>
<td>Transverse artery, vein, injury</td>
<td>Normal function, mild contractures at 1 year</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>No</td>
<td>No</td>
<td>Immediate exploration</td>
<td>Transverse artery + vein laceration + injury</td>
<td>Normal function, mild contractures at 3 months</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>No</td>
<td>No</td>
<td>Observation</td>
<td>Transverse artery + vein laceration + injury</td>
<td>Normal function, mild contractures at 3 months</td>
<td></td>
</tr>
</tbody>
</table>

Pulse Oximetry

- There is value in pulse oximetry to supplement a duplex ultrasound
  - Good waveform on pulse oximeter:
  - Poor waveform on pulse oximeter:

Conclusions

- Immediate surgical exploration is mandated for the ischemic hand
- Recommended close observation after reduction despite return of palpable pulse or Doppler signal due to risk of delayed ischemia or compartment syndrome – especially in younger children
- Based on our experience, the perfused pulseless hand is a consequence of arterial injury/spasm
- Recommend routine use of Duplex ultrasound of brachial artery to help guide decision making for the perfused pulseless hand. 3 of the 5 cases presented may have had expedited care with this approach.
- Recommend immediate surgical exploration after reduction if no return of radial signal or if diminished flow on DUS
- Early recognition of ischemia and compartment syndrome is paramount and patients should be closely observed even after return of normal perfusion

References