Thank you to Monica Epelman, MD for her contribution to this presentation
Disclaimer

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We certify that all individuals who qualify as authors have been listed; each has participated in the conception and design of this work, the writing of this presentation, and the approval of the submission of this version; that this presentation represents valid work; that if we used information derived from another course, we obtained all necessary approvals to use it and made appropriate acknowledgements; and that each takes public responsibility for it.
Traumatic injury is the leading cause of death in children older than 1 year.

Vascular injury well studied in adult population, but not in children
- Uncommon (0.6% all pediatric trauma patients)

Management of most pediatric injuries often similar to adult strategies.
Background

- Differences between adults and children
  - Children less severely injured than adults
  - Significant injuries more difficult to detect
    - Asymptomatic
    - Associated with spasm
    - Other more severe injuries take priority
  - Small vessel size
    - Technical challenges in diagnosis and treatment
Imaging Evaluation

- Clinical presentation varies depending on anatomic location and type of injury.
Imaging Evaluation

- Prompt diagnosis important
  - Good outcome
    - *64/66 (97%) with initial correct diagnosis*
    - *19/23 (83%) with delayed diagnosis*
  - Poor results most likely in arteries adjacent to elbow and knee

Consider liberal use of angiography in child with involvement of elbow or knee

Imaging Evaluation – Which Modality?

- Duplex Ultrasound
  - Noninvasive, no radiation burden, portable
  - Limited evaluation of many structures

- CT angiography (CTA) or Conventional Angiography (CA)
  - Both have potential risks of radiation exposure and contrast reactions

Although CA still the gold standard, CTA is largely replacing it for vascular injuries
# CT Angiogram vs. Conventional Angiography in Pediatric Population

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<th><strong>CTA</strong></th>
<th><strong>CA</strong></th>
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<td>• Noninvasive, widely available, rapidly obtained&lt;br&gt; • Limited studies diagnostic in pediatric population&lt;br&gt; • Neck and Extremity -95% sensitive; 97% specific*</td>
<td>• Gold standard&lt;br&gt; • Invasive but safe&lt;br&gt; • Low complication rate in pediatric population**&lt;br&gt; • May perform thrombolysis or embolization</td>
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Vascular Injuries in Children

- Iatrogenic Vascular Injuries
  - Most etiologies of pediatric vascular injury

- Extremity Vascular Injuries
  - High incidence of isolated upper extremity injuries

- Truncal Vascular Injuries
  - Additional major injuries common
    - Most commonly with abdominal trauma
Iatrogenic Vascular Injuries

- Significant proportion of pediatric vascular trauma (33-100%)
  - Diagnostic catheterization
  - Cannulation for ECMO or cardiopulmonary bypass
  - Placement of Arterial Lines
  - Arterial puncture/Venopuncture
  - Postoperative
Extremity Vascular Injuries

- Non-iatrogenic injury increases with age
  - \( \frac{1}{2} \) - \( \frac{3}{4} \) penetrating injury
- Children more likely to develop collaterals
  - Amputation rate still up to 50% after major vascular compromise
Extremity Vascular Injuries - Management

**Soft Signs**

Arterial Pressure Index (API) with Doppler

**Hard Signs**

(absence of distal pulses, active external hemorrhage, signs of ischemia, pulsatile bruit or thrill)

**Intervention**

- API > 0.90
  - 99% NPV*

- API < 0.90
  - 95% Sensitivity for Major Arterial Injury*

Angiographic Signs of Extremity Trauma

- Active contrast extravasation
- Loss of opacification or occlusion of an arterial segment
- Intraluminal filling defect
- Early venous opacification
- Abnormal change in vessel caliber, course, or contour
Truncal Vascular Injuries

- Includes thoracic, abdominal, and cervical vascular injuries
  - Outcomes/intervention based on hemodynamic stability of patient
Thoracic Injury - Diagnostic

- Blunt injury
  - Thoracic aorta, innominate artery, pulmonary veins, vena cava
- Little data on imaging evaluation of children
  - Chest Radiograph
  - CTA/CA
  - TEE
Thoracic Injury

- OPEN repair standard of care
- Endovascular interventions common in adults, but limited in children
  - Existing stent grafts too large for children
  - Delivery systems too large or too short
  - Vessel growth lead to migration
Abdominal Injury

- Renal, mesenteric, iliac, aorta
- Management driven by hemodynamic stability
  - Penetrating trauma (90-95% vascular injury)
  - Blunt trauma - more likely solid organ injury
Abdominal Injury: Children vs. Adults

- Children more prone to abdominal solid organ injury
  - Abdominal organs relatively larger
  - Abdominal musculature less mature
  - Abdominal organs and wall have less fat
  - Compliant ribcage
Cervical Vascular Injury

- Penetrating injuries less frequent than blunt trauma
  - Arterial injury 25x higher with penetrating injury
- Morbidity mostly related to stroke
Mechanisms of Injury

- Penetrating vascular trauma
  - Along the injury tract
    - Direct contact with vessel wall
    - Energy imparted to the vessel by projectile
- Blunt vascular trauma (carotid artery)
  - Direct blow to the anterior neck
  - Blow to the side of the head with stretching of vessel
  - Fracture of the skull base
  - Intra-oral
    - Falling on toothbrush or lollipop in mouth
Management of Cervical Vascular Injury

- Immediate exploration
  - Hemodynamically unstable
  - Hard Signs
    - Rapidly expanding hematoma
    - Pulsatile bleeding
    - Air bubbles in the wound
- Imaging for all others
  - Most often CT angiography
Conclusion

- Pediatric vascular trauma is rare
  - Most injuries iatrogenic or isolated extremity
- Diagnostic evaluation and management based on adult strategies

But remember that children have unique anatomic and physiologic consideration so adult management should be approached with caution
Conclusion

- Conventional angiography remains the gold standard to evaluate vascular trauma, but CT angiography is often replacing it
  - Noninvasive, widely available, rapidly obtained

Although studies limited, CTA has been successful in the evaluation of pediatric vascular injury
References

References

13. Schroeder JW, Baskaran V, Aygun N. Imaging of traumatic arterial injuries in the neck with an emphasis on CTA. Emerg Radiol