CT Imaging in Pediatric Trauma?

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Objectives

- Review literature regarding indications for CT imaging in pediatric trauma
- Review some common patterns of injury in major pediatric trauma

Conventional (ATLS) Imaging

- AP CXR
- AP Pelvic X-ray
- Lat. C-Spine X-ray
- +/- FAST
- Selected CT scans
- Additional X-rays

Objectives of CT Imaging in Trauma

- Identify and aid in treatment or prevention of serious injuries
- NOT a treatment modality
- To be used only if potentially aids/does not block access to definitive care

Questions?

- What criteria is used to select CT scans to be done?
- How do I identify the patient who needs to be transported for CT imaging?

Disclosures

- I have no conflicts to disclose
Cases to be discussed here

Why discuss this at all?
- Rate of missed injuries in pediatrics likely similar to adults (9-26%)
- Skeletal injuries predominate
- Rate increases with complexity of trauma, altered LOC and possibly decreasing age
- Goal is to quickly identify injuries that change outcomes/require intervention


Why discuss this at all?
- Possible evidence suggesting that whole body CT Scan (PAN SCAN) is better than other modalities INCLUDING physical exam for identifying injuries

PanScan may be better...or at least faster
- No mortality difference.
- Faster time to movement out of the ED

PanScan?
  - Multicentre European and North American, adult study of conventional approach (plain x-rays and targeted CT scans) vs whole body scan in adult major trauma patients
  - Completion date March 2014

SCAN ‘EM ALL!
- For a 3 year old girl, 1 in 166 mean lifetime cancer risk for a whole body CT scan
- 1 in 333 for a 3 year old boy
- 1 in 250 for a 15 year old girl and 1 in 500 for a boy
- 1 in 1500 for an adult

Please, can’t I just do a little scanning?

- For a 1-year-old child, estimated lifetime cancer mortality risk to be 0.18% for an abdominal CT and 0.07% for a head CT


So Who Should I Scan?

Head Imaging!!

Kupperman et al. Lancet Sept 2009

Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study

Osmond et al. CMAJ March 2010

PECARN STUDY - Lancet 2009

Age Less Than 2 Years:

CT YES (4.4% risk of cTBI)
- GCS 14
- Altered LOC
- Palpable skull fracture

CT MAYBE (0.9% risk of cTBI)
- Occipital, temporal or parietal hematoma
- LOC greater than 5 seconds
- Not acting normal as per parent
- Severe mechanism of injury

NPV and Sensitivity of 100%
PECARN STUDY - Lancet 2009

- Age greater than 2 years
- CT YES (4.3% risk of ciTBI)
  - GCS 14
  - Altered LOC
  - Signs of basilar skull fracture
- CT Maybe (0.9% risk of ciTBI)
  - History of LOC
  - History of vomiting
  - Severe mechanism
  - Severe headache
- NPV and Sensitivity of 99.95% and 96.8%

PECARN STUDY - Lancet 2009

- Based recommendation of scan yes or no on whether risk of ciTBI was higher than risk of CT induced malignancy
- Still recommends yes or possible scan for 50% of kids with head injury

CATCH Study - CMAJ 2010

- Multicentre cohort study of 3866 patients
- 4.1% rate of TBI on CT scan
- 0.6% rate of neurosurgical intervention
- Defined criteria for who DOES need a CT scan
  - High risk and Medium risk criteria

CATCH Study - CMAJ 2010

- High Risk:
  - GCS <15 2 hours or more post injury
  - Suspected open or depressed fracture
  - Worsening headache
  - Irritability on exam
- Medium Risk:
  - Any sign of basal skull II
  - Large boggy hematoma
  - Dangerous mechanism
  - (MVA, fall >3feet, 5 stairs, fall off bicycle no helmet)

CATCH Study - CMAJ 2010

- Would scan 30% of kids due to high risk criteria
- Would scan 50% of kids due to medium risk criteria
- Sensitivity good (98-100%)
- Specificity moderate (50-70%)

Head Injuries Summary

- ciTBI rare in kids (less than 5%)
- Need for neurosurgical intervention less than 1%
- 2 guidelines for who needs/doesn’t need a head CT
- Lots of room still for clinical judgement
TAC C-Spine Guidelines

- Poll of all Canadian Pediatric Hospitals:
  - Responders (12/15)
    - Halifax, Montreal Children’s, Ottawa, Toronto, St. John’s, London, Winnipeg, Saskatchewan, Edmonton, Calgary, Victoria
  - 8 out of 12 use C-Spine Clearance algorithm
  - None are the same

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Canadian C-Spine Rules

**High risk factors** that require imaging:
- Age ≥ 65 yo
- Dangerous mechanism of injury
  - Fall from 1m (5 stairs)
  - Axial load to the head (e.g. Diving)
  - MVA - high speed (>100mph, rollover, ejection)
  - Motorised recreational vehicles
  - Paraesthesia in extremities

**Low risk factors** that allow safe assessment of range of motion:
- Sitting position in the emergency department
- Simple rear end MVA
- Ambulatory at any one time
- Delayed onset of neck pain
- Absence of midline C-spine tenderness

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TAC Guidelines (Clinical)

- National X-Radiography Utilization Study (NEXUS):
  - No posterior midline cervical tenderness
  - No evidence of intoxication
  - Normal LOC
  - No focal neurological deficit
  - No painful, distracting injury

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TAC Guidelines Key Points

- Use Nexus +/- CCS for clinical clearance
  - Consider mechanism and look for pain free movement
  - Use caution in kids under 2 years
- Use AP and Lateral films
- Odontoid view in older kids (5 years and above)
**TAC Guidelines Key Points**

- No evidence yet to proceed to CT for everyone
- For kids less than age 8 years, consider CT neck C1-C3 if head CT
- Flexion/Extension views of unclear benefit
- If neuro findings, obtain MRI
- If no reliable clinical exam for >24 hours consider CT/MRI

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**CHEST IMAGING**

*Ju Jo, Y. et al (2011) Aortic Dissection and Rupture in a Child*  
*Korean Circ J. 2011 March; 41(3): 156–159*

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**ATLS**

- Life threatening chest injuries
  - Airway obstruction
  - Tension/massive hemothorax
  - Tension pneumothorax
  - Flail chest with pulmonary contusion
  - Open pneumothorax
  - Cardiac tamponade

  *(Hopefully, diagnosis not made in CT…..)*

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**ATLS**

- Potentially life threatening injuries
  - Thoracic aortic disruption
  - Tracheobronchial injury
  - Blunt myocardial injury
  - Diaphragm disruption
  - Esophageal injury
  - Pulmonary contusion

  *(Varying efficacy for CT in diagnosis)*

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**Chest – Blunt Vascular Injuries**

- Truncal vascular injuries are rare in children  
  (<0.5% of trauma patients)
- High overall mortality (30-50%)
  - Especially with hemodynamic instability (75-100%)
- Associated with high rate of other injuries, MVC’s and high ISS score (25+)
- Chance # associated with abdominal Ao injury


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**Chest - Traumatic Diaphragm Rupture**

- TDR rare in children
  - Large study of 20 500 patients showed rate of <0.07%
- Associated with high ISS (30+)
- Reports of missed injuries identified years later
- Can be missed on CT scan

*Pediatr Surg Int 15:601–604*

Chest Summary

- Pulmonary contusion in children rarely requires intubation or intervention
- Major vessel disruption/diaphragm rare and associated with extensive trauma
- CXR should be used as a screening tool for chest injuries, not CT


Abdominal Imaging

2012 CAR Level B evidence for contrast CT of the abdomen in “pediatric blunt trauma patients with high risk mechanism or clinical examination consistent with visceral injury.”

Lack of guidelines for imaging in pediatrics

- FAST alone as a screening tool shows sensitivity of approx. 50%
- Liver>spleen>kidney
- Uncommon:
  - Bowel
  - Pancreas
  - Bladder


Abdomen - Children

- Decision rule for low risk of IAI:
  - Low age-adjusted SBP
  - Abdominal tenderness
  - Femur fracture
  - Increased liver enzyme levels
  - Microscopic hematuria
  - Initial hematocrit less than 30%

- Sensitivity 94.9%
- Specificity 37.1%


Abdomen - Children

- Select pediatric patient populations have a high rate of intra abdominal injuries
  - Intubated patients (27%)
  - Severely head injured patients (23%)
  - High ISS
  - Mechanism
    - MVC
    - Falls
    - Handlebars
  - Associated injuries
    - Femur #
    - Pelvic #

Abdomen

- Traditionally, CT suggested for all microscopic hematuria in children
- Application of more conservative adult guidelines may be appropriate


Pelvic Imaging

- Pelvic x-ray has a low sensitivity for fracture identification (49-54%)
- Low incidence in pediatric trauma
  - 2.4-7.5% of trauma admissions
- Mortality of 2-12%


EAST

- If fractures are identified, CT should be done to examine for arterial contrast extravasation (if patient is stable) (Level 1)
- Hemodynamically unstable patients should be considered for angiography once non-pelvic sources of bleeding ruled out (Level 1)
- Fracture pattern does not predict arterial bleeding/need for angiography (Level 2)


Pelvic Imaging

- Small, single centre, retrospective studies have been done to identify patients at low risk of pelvic fracture
- Currently, ATLS guidelines as standard


Pelvic Imaging

- EAST
- T and L Spine Imaging

- Minimal literature to guide imaging in pediatrics
- Most guidelines extrapolated from adults
  - Mechanism and exam findings
- Multiple levels of fracture not uncommon
- Pediatric patterns of injury
  - Eg Chance #
  - NAI

And the answer is……..?

• Not yet clear.

• Use of pediatric modulation of scans and ALARA protocols required
  (as low as reasonably achievable)

• Children are not little adults in trauma
  • Adults break, children bounce
  • More pediatric research needed to help guide clinicians

Revisit cases and discussion

THANK YOU