Radiation Exposure in Pediatric Trauma

*J Trauma 44:147-152, 1983.*

The use of radiographic imaging in trauma patients has exploded over the past decade. A growing amount of research is looking at adult patients, but what about children?

Johns Hopkins did a one year retrospective review of radiographic imaging in kids age 14 and below. The studies performed and the estimated radiation dose was calculated for each child. A total of 719 children were studied and they underwent a total of 4603 studies:

- CT scans - 1457 (32%)
- Plain radiographs - 3097 (67%)
- Fluoroscopy - 49 (1%)

CT accounted for only 32% of studies but delivered 91% of the total radiation dose. Children involved in car crashes received the highest dose of radiation (18mSv) versus burned children, who had the lowest dose (1.2 mSv). Radiation exposure increased as the injury severity increased. The average age was 8 years, which means that these children have a long time until possible side-effects emerge.

What to do? First, **seriously weigh the risks and benefits of every radiographic study before you order it.** If CT is not essential, do something else. The ALARA concept is key (as low as reasonably achievable):

- Use weight-based CT protocols in order to deliver the minimum amount of radiation needed to get decent images
- Shield all sensitive areas that are not being imaged
- Use focused studies
- Avoid repeat exams
- Become knowledgeable about the effects of radiation exposure
- Ask yourself: “What if this were my child?”

**TRAUMA CALENDAR OF EVENTS**

**U OF M PEDIATRIC TRAUMA SUMMIT**

PLACE: CROWNE PLAZA ST. PAUL RIVERFRONT HOTEL
DATE: SEPTEMBER 22-23, 2011

**EMERGENCY MEDICINE & TRAUMA UPDATE**

PLACE: DOUBLETREE BY HILTON, BLOOMINGTON
DATE: NOVEMBER 17, 2011

**QUICK TIP**

**WHO IS A PEDIATRIC TRAUMA PATIENT ACCORDING TO THE AMERICAN COLLEGE OF SURGEONS?**

*A pediatric patient is a child who is less than 15 years old.*

If your hospital admits more than 100 pediatric trauma patients per year, your adult trauma surgeons must be credentialed for pediatric trauma care, there must be a designated or preferred pediatric resuscitation area in the ED, a pediatric ICU area, pediatric resuscitation equipment in appropriate areas of the hospital, and a separate pediatric PIPS program.
The FAST Exam in Children

FAST is a helpful adjunct to the initial evaluation of adult trauma patients. Unfortunately, due to small numbers the usefulness is not as clear in children. In part, this is due to the fact that many children (particularly small children < 10 years old) have a small amount of fluid in the abdomen at baseline. This makes interpreting a FAST exam after trauma more difficult.

Despite this, use of FAST in children is widespread. A survey of 124 US trauma hospitals in 2007 showed an interesting pattern of ultrasound usage. In adult-only institutions 96% use FAST, and at hospitals that see both adults and kids, 85% use it. Most of these centers that use FAST have no lower age limit, and the physician most commonly performing the exam was a surgeon. However, only 15% of children’s hospitals do FAST exams, and they were usually done by nonsurgeons! The reasons for this are not clear. It appears that the pediatric surgeons have not embraced this technology as much as their adult counterparts.

What about that confusing bit of fluid found in kids? Several groups have looked at this (retrospectively). Fluid in the pelvis alone appears to be okay, but fluid anywhere else is a good predictor of solid organ injury. Fluid seen outside the pelvis had a 90% sensitivity and 97% specificity for injury, and positive and negative predictive values were 87% and 97% respectively.

Bottom line: FAST exam is useful in pediatric victims of blunt abdominal trauma. Fluid in the pelvis alone is normal in most children, but fluid seen anywhere else indicates a high probability of solid organ injury.

References:


Sonography In Place of CT For Pediatric Abdominal Trauma


Pediatric blunt abdominal trauma is not common, but if present it has the potential to cause significant morbidity or mortality. Evaluation of the abdomen at the trauma center is crucial, and most trauma professionals are aware of the trade-offs in the use of CT scan in children (radiation exposure, need for sedation).

Ultrasound is widely available and allows for imaging of most areas of concern in the abdomen. Could sonography be used in place of CT in specific cases? Pediatric surgeons in Germany (who have been using ultrasound far longer than the US has) published a paper last year looking at their experience with children who were diagnosed with an intra-abdominal organ injury after blunt trauma. Their 7 year experience only produced 35 such children, and they were evaluated with examination and one or more serial FAST ultrasound exams. Equivocal results were scanned with CT.

They found that ultrasound was effective in diagnosing abdominal injury 97% of the time. Although 11 of the 35 children had subsequent CT scanning, it only changed management in one case.

Bottom line: Obviously, this is a very small retrospective series, but it is provocative. The German pediatric surgeons go above and beyond the typical FAST exam in the US, using it for diagnostic purposes as well. Could a complete diagnostic ultrasound take the place of CT in select children in the US? Probably so, as they are very sensitive in detecting free fluid and solid organ injury. But what about blunt intestinal injury?

Delayed Diagnosis of Blunt Intestinal Injury in Children


Let’s look at a recent study that examined the consequences of delayed laparotomy for blunt intestinal injury. The American Pediatric Surgical Association conducted an 18-center study of the management of intestinal injuries in children less than 16 years of age. They were stratified by time to treatment. There were 214 continued on page 3
patients with complete data records for review.

The majority of the patients were involved in a motor vehicle crash or a bicycle accident. Demographics were similar in all time to treatment groups. Half were resuscitated at a referring hospital and then transferred to a pediatric trauma center, on average after 6 hours.

Key points:

- The only deaths occurred in the 0-6hr and 6-12hr groups. The average Injury Severity Score of the children who died was significantly higher than survivors.
- Children operated on in the 0-6hr group had significantly higher ISS as well.
- There was no difference in early or late complications across all groups.
- Time to beginning oral intake and time in hospital were the same in all groups.
- The authors concluded that observation and serial exam rather than urgent exploration or repeated CT scans is appropriate.

**Bottom line:** If you combine this study with the ultrasound study above, it seems appropriate to modify the usual (read: adult) way of evaluating blunt trauma to the abdomen. In place of automatically getting a CT scan of the abdomen in children, obtain a complete abdominal ultrasound to detect solid organ injury or free fluid. This will determine the degree of monitoring needed (e.g. ICU for higher grade liver or spleen injuries).

Follow this with serial abdominal exam. If the child becomes symptomatic, it’s probably time to proceed to the OR. Note: I generally do not make children npo during the observation phase. They need to eat, and if they don’t want to, that tells you something.

**How Do I Clear The Pediatric Cervical Spine?**

There is quite a bit of controversy surrounding clearing the cervical spine in children. The trauma and emergency medicine literature have few high quality studies to base recommendations on. However, a few very good studies have been carried out that did include children, and they are the basis for this suggested method for clearance.

There are a few key concepts that must be understood before approaching spine clearance in this patient group.

- **Clinical clearance is key!** The majority of children’s cervical spines can be cleared clinically
- **Limit routine radiographic evaluation, especially by CT.** The head and neck is packed with glandular tissue that is sensitive to radiation, especially in early childhood.
- **If radiographs are required, be sure to have them read by a radiologist who routinely reads pediatric images.** There are many nuances in ossification and bony positioning that may falsely lead to injury diagnoses.
- **Memorize the NEXUS criteria.** This study included enough children to allow treatment recommendations to be validated. They are:
  - Midline cervical tenderness
  - Focal neurologic deficit
  - Altered level of consciousness
  - Evidence of intoxication
  - Painful distracting injury

The first step is to determine whether the child is eligible to be clinically cleared. They must be able to verbalize and cooperate with your exam. They may not have a developmental delay, since this may interfere their ability to cooperate with your exam. Frequently, younger children are apprehensive around doctors, and I recommend that you have a parent perform appropriate parts of the exam under your verbal guidance.

Next, evaluate to see if any of the NEXUS criteria are met. The distracting injury criterion is the most difficult to assess. This is a judgment call, but if the child is aware of multiple potentially painful areas, then a distracting injury is probably not present.

If no NEXUS criteria are met, the spine is cleared and should be documented as such. If any are present, a lateral cervical spine xray should be ordered. If the child is >8 years old, a plain odontoid xray should also be obtained. If all are normal, the spine is cleared and should be documented. Children 8 or younger do not have an odontoid that visualizes well. In such cases, a CT from occiput to the base of C2 should be obtained, with appropriate shielding in place.

If, at any point, an abnormality is encountered, expert consultation must be sought in order to safely clear the cervical spine and remove any stabilization.
Alfred I. DuPont Children’s Hospital has condensed their clearance technique into a relatively simple algorithm that can be used in conjunction with the tips in the previous section.

Some notes on this algorithm:

- Can be performed only by attending physicians or a trauma resident in consultation with the attending trauma surgeon
- Clinical clearance alone may be carried out in select cases
- If radiographs are required, cross-table lateral, anterior/posterior, and odontoid views should be obtained (age 8 and above, non-intubated)
- Flexion / extension views should only be ordered in consultation with neurosurgery

What’s This?
Scan this using a QR Code App for your Smartphone or tablet to load a copy of the algorithm from the Web. Type the bit.ly address in your browser to download the file
Regions Hospital
Pediatric Blunt Trauma
Abdominal Imaging Protocol

Abdominal evaluation required
Hemodynamically stable

Complete Abdominal Ultrasound

Normal
Routine monitoring (ward)

Abnormal
High level monitoring (ICU, stepdown, trauma unit)

Abnormal High Risk
Example: seat belt sign
OR

http://bit.ly/qBmFbw