The Trauma Professional's Blog

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CT Contrast Administration Via Intraosseous Catheter

The standard of care in vascular access in trauma patients is the intravenous route. Unfortunately, not all patients have veins that can be quickly accessed by prehospital providers. Introduction of the intraosseous device (IO) has made vascular access in the field much more achievable. And it appears that most fluids and medications can be administered via this route. But what about iodinated contrast agents via IO for CT scanning?

Physicians at Henry Ford Hospital in Detroit published a case report on the use of this route for contrast administration. They treated a pedestrian struck by a car with a lack of IV access sites by IO insertion in the proximal humerus, which took about 30 seconds. They then intubated using rapid sequence induction, with drugs injected through the IO device. They performed full CT scanning using contrast injected through the site using a power injector. Images were excellent, and ultimately the patient received an internal jugular catheter using ultrasound. The IO line was then discontinued.

This paper suggests that the IO line can be used as access for injection of CT contrast if no IV sites are available. Although it is a single human case, a fair amount of studies have been done on animals (goats?). The animal studies show that power injection works adequately with excellent flow rates.

The authors prefer using an IO placement site in the proximal humerus. This does seem to cause a bit more pain, and takes a little practice. A small xylocaine flush can be administered to reduce injection discomfort in awake patients. Additionally, the arm cannot be raised over the head for the torso portion of the scan.

Bottom line: CT contrast can be injected into an intraosseous line (IO) with excellent imaging results. Insert the IO in a site that you are comfortable with. I do not recommend power injection at this time. Although the marrow cavity can support it, the connecting tubing may not. Have your radiologist hand-inject and time the scan accordingly.

Note: long term effects of iodinated contrast in the bone marrow are not known. For this reason, and because of smaller marrow cavities, this technique is not suitable for pediatric patients.

Trauma Calendar of Events

Trauma, Critical Care & Acute Care Surgery
Location: Caesar's Palace, Las Vegas, NV
Date: March 31-April 2, 2014

Society of Trauma Nurses
Location: Sheraton New Orleans, New Orleans, LA
Date: April 2-5, 2014

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Reference: Intraosseous injection of iodinated computed tomography contrast agent in an adult blunt trauma patient. Annals Emerg Med 57(4):382-386, 2011.

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:

1. *Use of focused abdominal sonography for trauma at pediatric and adult trauma centers: a survey. J Pediatric Surgery 44:1746-1749, 2009.*
2. *Minimal pelvic fluid in blunt abdominal trauma in children: the significance of this sonographic finding. J Pediatric Surgery 36(9):1387-1389, 2001.*
3. *Clinical importance of ultrasonographic pelvic fluid in pediatric patients with blunt abdominal trauma. Ulus Travma Acil Cerrahi Derg 16(2):155-159, 2010.*

CT Scanning Before Transfer To A Pediatric Trauma Center

CT scan is essential in diagnosing injury, although concerns for unnecessary radiation exposure are growing. These concerns are even greater in children, who may be more likely to have long-term effects from it. This makes avoiding duplication of CT scanning extremely important.

Unfortunately, there are only about 50 pediatric trauma centers in the US, so the majority of seriously injured children are seen at another hospital before transfer. **Does CT evaluation at the first hospital increase the likelihood that a repeat scan will be needed at the trauma center, increasing radiation exposure and risk?**

Rainbow Babies and Children's Hospital in Cincinnati examined 3 years of transfers of injured children from community hospitals. They then looked at how many of those children had an initial head and/or abdomen scan at the outside hospital, and whether a repeat scan of those areas was performed within 4 hours or arrival at Rainbow.

Numbers were small, but here are the factoids:

- 33 had an outside CT scan, 28 (90%) were repeated
- 6 had an outside abdominal scan, 2 (33%) were repeated
- 55 did not have outside scans, none were repeated at Rainbow. (This is a weird thing to look at. I would hope that the trauma center didn't have to repeat any of their own scans within 4 hours!)

Bottom line: It is critically important for referring hospitals to use radiation wisely! First, if the patient has obvious injuries that require transfer, don't scan, just send. If you need to scan to decide whether you can keep the patient, use the best ALARA* technique you can. And trauma centers, please send a copy of your CT protocols to your

referring hospitals so they can get the best images possible.

**ALARA = As low as reasonably achievable (applied to radiation exposure). Also known as ALARP outside of North America (as low as reasonably practicable).*

Reference: Computed tomography before transfer to a level I pediatric trauma center risks duplication with associated radiation exposure. J Pediatric Surg 43(12): 2268-2272, 2008.

Radiation Exposure In Pediatric Trauma

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?"**

Reference: Brown, et al. Diagnostic radiation exposure in pediatric trauma patients. J Trauma 2010, ahead of print.

Diagnosing Facial Fractures With CT

Facial fractures are common after major blunt trauma. There are a number of diagnostic tests available for their diagnosis, including head CT, conventional facial imaging and facial CT.

Our preference has been to add a facial CT to the list of diagnostics in any patient with external evidence of facial trauma. Subjectively, it appeared that there were not many injuries being identified, and the vast majority did not require operative management.

A review of the literature shows that head CT alone is sufficient for screening for significant facial fractures. A small retrospective series noted that the accuracy was 92%, with 90% sensitivity and 95% specificity.

Bottom line: A head CT alone ordered for the usual indications is a very good screening test for facial fractures. If none are seen, it is unlikely that there are any fractures that require specific management. If fractures are seen, consultation with a facial surgeon is needed. However, unless the fractures involve critical areas (e.g. temporal bone near the middle ear) or are significantly displaced, the benefit of a facial CT scan is still very low since most will be treated without operation.

Reference: Computed tomography of the head as a screening examination for facial fractures. Marinaro et al. Am J Emerg Med 25, 616-619, 2007.

Double CT Scanning: Don't Do It!

Typical order: "***chest CT with and without contrast***"

A review of Medicare claims from **2008** showed that **5.4% of patients received double CT scans of the chest**. Although the median was about 2% across 3,094 hospitals, 618 hospitals performed double scans on more than 10% of their patients. And 94 did it on more that half! One of the outliers was a small hospital in Michigan that double scanned 89% of Medicare

patients! As expected, there was wide variation from hospital to hospital, and from region to region around the US.

Time for some editorial comment.

This practice is very outdated and shows a lack of understanding of the information provided by CT. Furthermore, it demonstrates a lack of concern for radiation exposure by both the ordering physician and the radiologist, who should know better.

Some officials at hospitals that had high scan rates related that radiologists ordered or okayed the extra scan because they believed that "more information was better." There are two problems with this thinking.

1. **Information for information's sake is worthless.** It is only important if it changes decision making and ultimately makes a difference in outcome.
2. As with every test we do, **there may be false positives**. But we don't know they are false, so we investigate with other tests, most of which have known complications.

The solution is to do only what is clinically necessary and safe. The tests ordered should be **based on the best evidence available**, which demands familiarity with current literature.

In trauma, there are a few instances where repeat scanning of an area is required. Examples include solid organ lesions which may represent an injury **or** a hemangioma, and CT cystogram to exclude bladder trauma. In both cases, only a selected area needs to be re-scanned, not the entire torso.

Bottom line: Physicians and hospitals need to take the lead and rapidly adopt or develop guidelines which are literature-based. State or national benchmarking is essential so that we do not continue to jeopardize our patient's safety and drive up health care costs.

IV Contrast And Trauma

We use CT scanning in trauma care so much that we tend to take it (and its safety) for granted. I've written quite a bit about thoughtful use of radiographic studies to achieve a reasonable patient exposure to xrays. But another thing to think about is the use of IV contrast.

IV contrast is a hyperosmolar solution that contains some substance (usually an iodine compound) that is radiopaque to some degree. It has been shown to have a significant impact on short-term kidney function and in some cases can cause renal failure.

Here are some facts you need to know:

- Contrast nephrotoxicity is defined as a 25% increase in serum creatinine, usually within the first 3 days after administration
- There is usually normal urine output and minimal to no proteinuria
- In most cases, renal function returns to normal after 3-4 days
- Nephrotoxicity almost never occurs in people with normal baseline kidney function
- Large or repeated doses given within 72 hours greatly increase risk for toxicity
- Old age and pre-existing diabetic renal impairment also greatly increase risk

If you must give contrast to a patient who is at risk, make sure they are volume expanded (tough in trauma patients), or consider giving acetylcysteine or using isosmolar contrast (controversial, may still cause toxicity).

Bottom line: If you are considering contrast CT, try to get a history to see if the patient is at risk for nephrotoxicity. Also consider all of the studies that will be needed and try to consolidate your contrast dosing. For example, you can get CT chest/abdomen/pelvis and CT angio of the neck with one contrast bolus. Consider low dose contrast injection if the patient needs formal angiographic studies in the IR suite. Always think about the global needs of your patient and plan accordingly (and safely).

Reference: Contrast media and the kidney. British J Radiol 76:513-518, 2003.