

Issues Related to Imaging – 2007

Especially of the Abdomen and Pelvis

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Outline of Talk

- Which different imaging tests are available and what are their advantages and disadvantages?
- How should the imaging tests be done?
 - *CT: Why give intravenous contrast material and are there any concerns related to its use?*
 - *CT: Can we drink something besides barium (i.e. water or milk)?*
 - *MRI: Do we need to use contrast material for MRI, and, if so, what are the risks?*
- Opportunity for questions to be answered throughout my talk

What do I do?

- I work in a large department which is divided into many subspecialty areas
- I do abdominal imaging
 - *Conventional x-rays: IVPs and cystograms*
 - *Computed tomography*
 - *GI exams (uppers and lowers)*
 - *Some exposure to ultrasound and MRI (of abdomen and pelvis only)*

What do I do?

- My academic interest lies in the subspecialty of genitourinary radiology...within this area my interest lies primarily in
 - *X-ray dyes (contrast media) used for CT and MRI*
 - *Imaging of the urinary tract for detection of tumors*
 - *The retroperitoneum*

What kinds of things do we look for in imaging studies on patients with hereditary syndromes?

- New or growing masses in the kidneys (cancers)
- Masses in the adrenal glands
- Masses in the pancreas
- Other incidental findings

How can we look?

- Conventional radiography
- Ultrasonography
- Computed tomography
- Magnetic resonance imaging
- Positron emission tomography

Ultrasonography

- Advantages
 - Cheap, no x-rays
 - Easily performed
- Disadvantages
 - Ultrasound waves do not penetrate all the way through the body (eg. intestinal gas and bone)
 - Ultrasound quality dependent upon skills of person doing the exam

Ultrasonography

- Generally not used to screen high risk patients for cancer
- In the abdomen, best for gallbladder, female pelvic organs, and sometimes to look for abdominal wall hernias

Computed Tomography (CT)

- Advantages
 - Uses x-rays, which are not blocked by bone or bowel gas
 - Images obtained with current scanners are exceptionally detailed and accurate

Computed Tomography (CT)

- Advantages
 - Also, unlike ultrasound, you can tell by looking at the images whether or not a good quality study was obtained
 - Images are reproducible from one study to the next (not technologist dependent)

How should CT be performed?

CT Technique

- + IV contrast media
(requires that an IV line be placed)
- + Oral contrast media
(requires drinking a great deal of fluid before the procedure)

CT Technique

- If looking for renal masses, it is ideal to obtain CT images prior to and following administration of intravenous contrast material...so that we can tell if any masses contain blood vessels
- In the kidney, this is the major way that we can tell cysts apart from solid masses/cancers...(CM makes tumors whiter/brighter, but doesn't change the appearance of cysts)

Timing of CT after CM Injection

- Delayed enhanced images are preferred (at 100 or more rather than 70 sec)
- Otherwise, renal/kidney cancers may be missed or misdiagnosed as cysts
- Some renal cancers do not demonstrate that they contain blood vessels until about 100 seconds or more after the injection of contrast material begins
- Also, at first, the kidneys don't take up the contrast homogeneously and some cancers can be difficult to see in this setting

Dose of CT IV Contrast Media

- Standard dose: 100-150 ml (20-30 teaspoons)

IV Contrast Media for CT

- Problems with its use
 - There are rare reactions to the contrast material --- how rare - 1:30 have a mild reaction, 1:2,500 a severe reaction, and < 1:170,000 will die...note that fatality rate is lower than that for penicillins and...

Remember, in life there are always risks...

Factors which raise an individual's risk of dying by 1 in 150,000

- Smoking 11 cigarettes
- Living 13 months with a cigarette smoker
- Living for 2 months in a city (vs the country)
- Eating 260 tablespoons of peanut butter
- Traveling 2,000 miles in a car (how far does the average driver travel in a year?)
- Flying 5,760 miles in a plane (less than a round trip trans-Atlantic flight)

IV Contrast Media for CT

- Problems with its use
 - On occasion, IV contrast material can damage kidney function: this is extremely rare in people who start with normal kidney function (people with pre-existing elevated serum creatinine levels are at most risk - especially if they are diabetic)

IV Contrast Media for CT

A Few Other Facts

- We know that some patients are at increased risk for having an allergic reaction to CM (1 in 500 - 800 rather than 1 in 2,500 for a severe reaction)
 - *Previous allergic-like reaction to the same type of contrast material (greatest risk – 5 x)*
 - *Other allergies (to medications or foods, for example) ? especially if multiple or severe (lower risk – 2-3 x)*
 - *Asthmatics (lower risk – 2-3 x)*

IV Contrast Media for CT

A Few Other Facts

- Please note, that even high risk patients are unlikely to have a severe reaction

IV Contrast Media for CT

A Few Other Facts

- There is no independent increased risk from shellfish/seafood or topical iodine

(I WISH THAT EVERYONE WOULD STOP ASKING ABOUT THIS!)

How Can We Reduce The Risk of A Reaction in High Risk Patients

- By giving them a short course of high dose steroids (*usually prednisone*) before they are to receive contrast material
- Steroids work if the first dose is given 12 hours or more before the CT
- This may cut the increased risk approximately in half

How Can We Reduce The Risk of A Reaction in High Risk Patients

- Steroids may not work at all if they are only administered immediately before contrast media is to be injected (within 1-2 hours)
- Many people require that the first dose be given at least 6 hours before injection...but no one really knows what minimum time is needed for them to work

So Who Should Get Steroids

There is no absolute answer for every situation. There is no science to tell us what the right thing is to do!

So Who Should Get Steroids

- Almost all of us would give steroids to anyone with a prior moderate or severe allergic-like reaction to iodinated contrast media (**more than hives, such as breathing problems or low blood pressure**)
- Some of us would also premedicate anyone who had any prior allergic reaction to contrast media, including hives

So Who Should Get Steroids

- Some of us also would premedicate anyone who has many or severe allergies to other agents
- Most of us would NOT premedicate asthmatics unless they were currently symptomatic

IV Contrast Media for CT

- Normal response
 - *Slight metallic taste*
 - *Brief (a few minutes) feeling of warmth*
 - *Mild nausea (sometimes vomiting)*
- Allergic reactions that we see
 - *Hives (most common, by far)*
 - *Tightness in the throat / hoarseness*
 - *Bronchospasm (wheezing)*
 - *Light-headedness*

Computed Tomography (CT)

- Minimizing risks of IV contrast material
 - *Notify your doctor and the radiologist if you are in a higher risk group for a contrast reaction...on some occasions he or she may ask that you take steroids in advance*
 - Previous allergic reaction to contrast material
 - Many or severe food or medication allergies
 - Asthma (primarily, if active)

Computed Tomography (CT)

- Minimizing risks of IV contrast material
 - *Notify your doctor and the radiologist if you know you have an elevated serum creatinine level and diabetes (unusual)*

IV Contrast Material and Pheos A Special Note

- It was previously taught that people with possible pheochromocytomas should not get IV contrast injections for CT, due to the risks of it causing severe hypertension as a result
- This is NO LONGER felt to be an issue with the current generation of IV contrast media (which are called low-osmolality nonionic agents)

Questions

Oral Contrast Media For CT

- Extremely safe
- Adverse reactions are almost, but not quite, unheard of...

Oral Contrast Media For CT

- For years we have asked patients to drink either dilute barium agents or gastrografin / Hypaque
- On CT, these make the stomach and intestines look white, helping us distinguish them from other fluid collections or masses (which are not as white)

Barium Agents

- Not the best tasting stuff
- And you have to drink a great deal (as many of you know)
- University of Michigan protocol
 - 1st dose: 450 ml /16 oz – 90 minutes prior
 - 2nd dose: 450 ml/16 oz – 45 minutes prior
 - 3rd dose: 450 ml/16 oz – just prior

Some Have Recently Asked A Basic Question

(that for some reason hadn't been asked in over 30 years of doing CT)

- Does making the intestines look white on CT really help?
- Do we really need to do this?

Answer

- Maybe not
- It may actually be better sometimes to keep the intestines dark
- Investigators have now shown that this is the case, at least in instances where one wishes to examine the pancreas or the small intestines for subtle abnormalities

Low Density Oral Agents

- Water
- Milk
- VoLumen: very dilute barium (0.1%)
- Others
 - Corn oil emulsion
 - Simethicone-coated cellulose
 - Cellulose, oil, in water emulsion, also containing paraffin (with lemon added to improve taste)
 - Lactulose (< 50% said it tastes good, in one study)
 - Mucofalk: dried ripe plant seeds

Low Density Oral Agents: Water

- Advantages
 - Easier to drink (? easiest to drink)
 - Inexpensive
- Disadvantages
 - It is absorbed, so it does not fill out the last part of the small intestines
 - It does not inhibit peristalsis

My opinion: poor absorption not a big problem if we are concerned primarily with the pancreas, adrenal glands, and kidneys

My opinion: failure to prevent peristalsis is not as big a problem on modern fast CT scanners

Low Density Oral Agents: Milk

- Advantages
 - Inexpensive
 - Better distention of all of the small intestine
 - Slows peristalsis
- Disadvantages
 - Best results only with 4% (not 2% or skim), which has a high fat content
 - Images not that much better than those with water
 - Some people are milk intolerant
 - Some people (like me) will have problems drinking 48 ounces of milk (3 large cups) - in fact I couldn't do it!!

My opinion: not worth it

Low Density Oral Agents: VoLumen

- Advantages
 - ? Best distention of the intestines
 - Slows peristalsis
- Disadvantages
 - Expensive
 - Not as easy to drink
 - Images somewhat better than those with water

My opinion: probably not absolutely necessary when imaging is not specifically concerned with distal small bowel or large intestines...although images will be nicest

Questions

Another Problem With CT

- RADIATION
 - CT scans expose people to radiation
 - There may be a tiny increased risk of inducing a cancer (~0.04% or 1 in 2,500) after each CT ----
 - But remember, the risk of not finding a cancer that may be present is probably much higher in many people – especially if they are in higher risk groups
 - Also, remember that we are all exposed to background radiation every day
 - For example, there is more radiation exposure on a transcontinental airplane flight than from a chest x-ray
 - Standard abdomen CT exams expose people to only about twice the annual radiation that they get just by living in US

Computed Tomography (CT)

- Minimizing risks of radiation
 - Risks are generally so low that you don't need to worry about it
 - Exception- Very young people (especially children), are very radiation sensitive and will live for a long time. In these cases, MRI (which does not expose patients to ionizing radiation) may be preferable to CT

Questions

Magnetic Resonance Imaging (MRI)

- Advantages
 - No ionizing radiation (unlike CT)
 - Provides excellent quality images
 - Better "contrast" than CT
 - Same reconstruction possibilities

MRI Technique

- Many sequences
- + IV contrast material
- - Oral contrast material
- So, you usually get an IV, but you usually don't have to drink anything

MRI IV Contrast Media

Standard dose:
20 ml
(4 teaspoons)

MRI IV Contrast Media

- Completely different substance than is used for CT (no cross-reactivity)
- Very safe in almost all people
- Rate of allergic reactions is even lower than that for the contrast media used for CT
- Types of allergic reactions are similar to that for seen after injection of the contrast material used for CT

MRI IV Contrast Media

- Unlike the contrast media used for CT, with MRI contrast media, when injected at routine doses, there is probably no risk that it will damage our kidneys

Magnetic Resonance Imaging (MRI)

- Disadvantages
 - *Worse resolution than CT*
 - *More expensive than CT*
 - *Can be harder to schedule (there are fewer MRI scanners in the US)*
 - *Takes longer to perform the exam*
 - *It can be a tight fit in the MRI scanner (for those who are claustrophobic)*
 - *Can't be performed in people with pacemakers*
 - *Rare individuals may have a reaction to the contrast material given for MRI*
 - *NSF*

Nephrogenic Systemic Fibrosis

- Has received an increasing amount of publicity
- This is a bad disease (which produces increasing stiffness of the joints, especially in the legs, leading to immobility in some; it can also affect the internal organs)
- Its onset appears to be associated strongly with administration of MRI contrast media

Nephrogenic Systemic Fibrosis

Why You Shouldn't Worry About This Too Much

- Has been seen almost exclusively in people with moderate or severe renal failure (who have very elevated serum creatinine levels)
- Vast majority of cases have been associated with only ONE of several used MRI contrast agents (Omniscan) and nearly all radiologists now avoid using this agent in high risk patients
- Even so, the risk of NSF in patients with moderate or severe renal failure who get Omniscan is relatively low (5 - 6%, at most)

Questions

Summary

- Recent developments in imaging have led to tremendous improvements in all people, including those with hereditary diseases
- Imagers must be aware of the specific abnormalities for which they are searching, since CT and MRI protocols may have to be tailored to an individual's specific disease (use of delayed CT images, for example)

Summary

- As you can see, there are many issues related to the technique that we use and our desire to perform these procedures safely, that have been thought out to a great extent
- But, that doesn't mean that there isn't room for more improvement in the coming years

Summary

- CT and MRI intravenous and oral contrast media are both very safe, but you should be aware of factors that might place you at an increased risk of having a reaction and what you can do if you are at increased risk

Summary

- The risk of NSF is very low, particularly for those individuals who have normal serum creatinine levels
- NOTE: Having a partial nephrectomy does not result in an elevated serum creatinine level. In fact, even loss of an entire kidney does not result necessarily in an elevated serum creatinine level

Questions

Von Hippel Lindau

Recommended Imaging

- Baseline abdominal & testicular ultrasound (esp if < 18 y)
- Brain MRI (with gadolinium) every 2 years after the age of 12 (children younger than this do not get CNS disease)
- Abdominal CT every 2 – 3 years after age of 18

Von Hippel Lindau

Recommended Imaging

- In families with pheos, get screening MRIs even in childhood (as well as serum catecholamine levels) – as these can be seen earlier

NOTE: pts with partial mutations will have to be imaged earlier!

Birt-Hogg Dubé and HLRCC Recommended Imaging

- Not defined
- Routine imaging of the kidneys is probably warranted at some threshold age

A few Comments on Several Exciting Developments in the Treatment of Hereditary Renal Cancers

- In the old days (and even now), treatment often has been deferred until the masses reach a threshold size of 2.5-3.0 cm
- The 3 cm rule has been relaxed by some

Imaging of patients with von Hippel Lindau and other hereditary diseases

1. Ultrasound
2. The CT scan

Advantages

Great images
New scanners are widely available

Disadvantages

Radiation – but there is a risk for NOT finding disease, too (don't forget that radiation is everywhere)

Nephrotoxicity of contrast material

1. This is a factor in people whose kidney function is compromised
2. We don't know how much of a factor this is in other people
3. Is its importance overstated (lack of control studies)

The more you find out about something, the less you actually know!

Choice of oral contrast material

Bright agents (radiopaque)
Advantages and disadvantages
Neutral agents (water, milk)
Advantages and disadvantages
Low density agents (fat)
Advantages and disadvantages
Which is best?

Why intravenous contrast material

3. MRI

Advantages

Lack of radiation
Superior contrast
Decreased toxicity of contrast material to the kidneys

Disadvantages

Inferior resolution
Potential for NSF in patients with renal failure

Other questions/issues