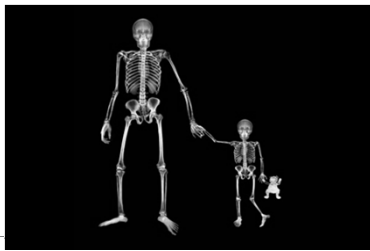


IMAGE GENTLY- INDICATIONS FOR IMAGING



André du Plessis

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Overview

- Paediatric radiation safety
- General guidelines
- Protocols

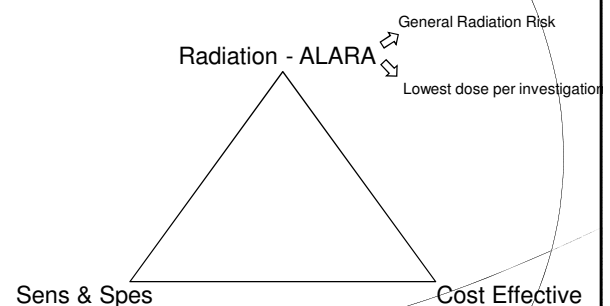
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Paediatric Radiation Safety

- Paediatric patients are unique
- Children are more susceptible to radiation induced cancer than adults
- Younger children are more sensitive
- Girls more than boys (breast / thyroid)

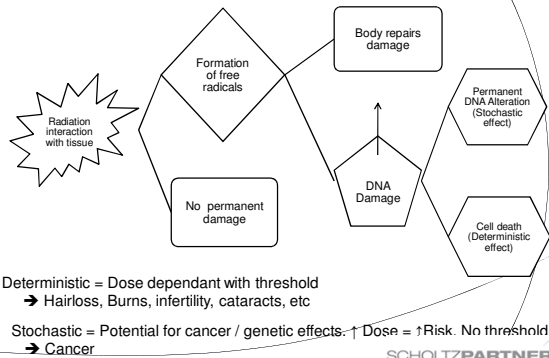
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Imaging Indications



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Radiation effects



Deterministic = Dose dependant with threshold
→ Hairloss, Burns, infertility, cataracts, etc

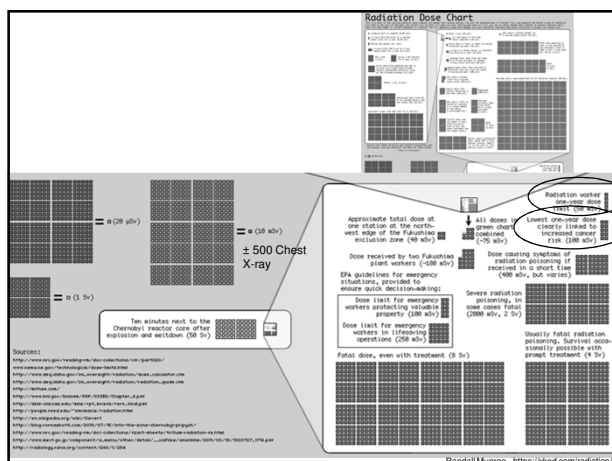
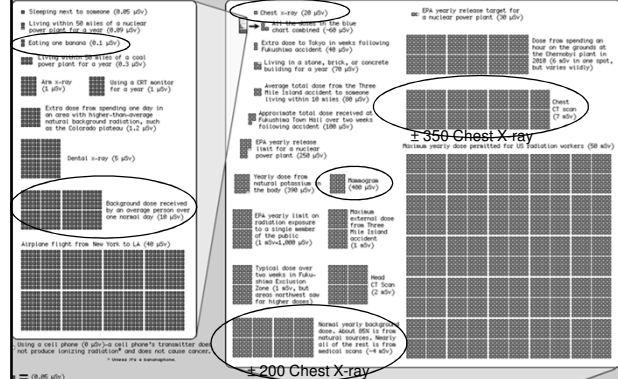
Stochastic = Potential for cancer / genetic effects. ↑ Dose = ↑ Risk. No threshold
→ Cancer

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Radiation Dose Chart

RADIATION DOSE CHART

This is a chart of the ionizing radiation dose a person can absorb from various sources. The unit for absorbed dose is "sievert" (Sv), and measures the effect a dose of radiation will have on the cells of the body. One sievert (all at once) will make you sick, and too many more will kill you, but we safely absorb small amounts of natural radiation daily. Most the dose number of sieverts absorbed in a shorter time will generally cause more damage, than your cumulative long-term dose plays a big role in things like cancer risk.



Relative radiation dose

Source	Estimated Dose	Equivalent to background
Natural background	3 mSv/year	
Airline passenger cross country	0.04 mSv	
Chest x-ray (single view)	0.01-0.15 mSv	1 day of background radiation
Chest x-ray (2 view)	0.1-0.15 mSv	
Head CT (adjusted)	Up to 2 mSv	8 months of background / About 150 chest x-rays
Head CT (adult settings)	(30 – 60 mSv if a neonate)	
Chest CT (adjusted)	Up to 3 mSv	About 150 chest x-rays
Chest CT (adult settings)	Up to 5 mSv	
Abdominal CT (adjusted)	Up to 5 mSv	20 months background / About 250 chest x-rays
Abdominal CT (adult settings)	Up to 25 mSv	

Modality	Background equivalent
CT	8 months +
Interventional	1 – 6months +
Fluoroscopy	10 days +
Nuclear medicine	1 day +
Radiographs	1 day +
Ultrasound / MR	None



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COMMERCIAL STRATEGISTS

Relative Risk

Activity	Death (per million/year)
Being a person age 55 years (all causes)	10,000
Smoking a pack of cigarettes daily (all causes)	3,500
Rock climbing for 2 h (accident)	500
Canoeing for 20 h (accident)	200
Motorcycling for 1,000 miles (accident)	200
Travelling 1,500 miles by car (accident)	40
Being a pedestrian (accident)	40
Working 1 week as a fire-fighter (accident)	15
Working 1 week in agriculture (accident)	10
Fishing (drowning)	10
Eating (choking on aspirated food)	8
Skating for 10 h (accident)	8
Working 1 month in a typical factory (accident)	5
Travelling 5,000 miles by air (accident)	5
Having a chest radiograph (radiation-induced cancer)	1
Visiting Denver for 2 months (cancer from cosmic rays)	1
Living in the vicinity of a nuclear power plant (radiation-induced cancer)	<0.1

<https://www.cdc.gov/nceh/ehp/content/pediatrics/radiationradiation.htm>

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AAPM Mission Statement

- Discussion of risks related to radiation dose from medical imaging procedures should be accompanied by acknowledgement of the benefits of the procedures.
- Risks of medical imaging at effective doses below 50 mSv for single procedures or 100 mSv for multiple procedures over short time periods are too low to be detectable and may be nonexistent

<http://www.aapm.org/bm/policies/details.asp?id=318&type=PP¤t=true>

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How do we reduce radiation?

- Image appropriately!
 - Best investigation for question
- “Child-size” the amount of radiation used
 - Technical stuff your Radiologist need to know about
- If we CT- Scan
 - Only when necessary
 - Only indicated region
 - Only once

image
gently®



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Who is responsible for reducing radiation?

- | | | |
|--|--|--|
| <ul style="list-style-type: none"> • Radiologist <ul style="list-style-type: none"> • Offer appropriate service • Reduce radiation (technical) • Offer affordable service | | <ul style="list-style-type: none"> • Referring clinician <ul style="list-style-type: none"> • Understand modern imaging • Imaging “educated” • Cautious of radiation exposure |
|--|--|--|

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Working together

- ◉ Image Gently
 - The Alliance goal is to change practice: to raise awareness of the opportunities to lower radiation dose in the imaging of children
- ◉ SASPI
 - South African Society of Paediatric Imaging
- ◉ ACR
 - American College of Radiology
 - ACR Appropriateness Criteria

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Practical Points

- ◉ Extremities
 - Comparative views
- ◉ Head and Neck
 - Skull X-rays
 - Convulsions
 - Sinus X-rays
- ◉ Chest
 - Lateral chest X-rays
- ◉ Abdomen
 - Reflux / GORD
 - HPS
 - Intussusception
 - Appendicitis
- ◉ Pelvis
 - DDH
- ◉ Urinary System
 - Urinary tract infection



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Comparative views

- ◉ Generally not indicated
- ◉ Only on request for subtle or confusing appearances
- ◉ Exceptions
 - Skeletal survey
 - Measurements for Orthopods

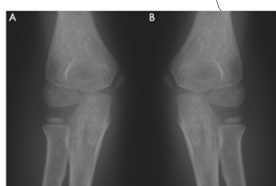
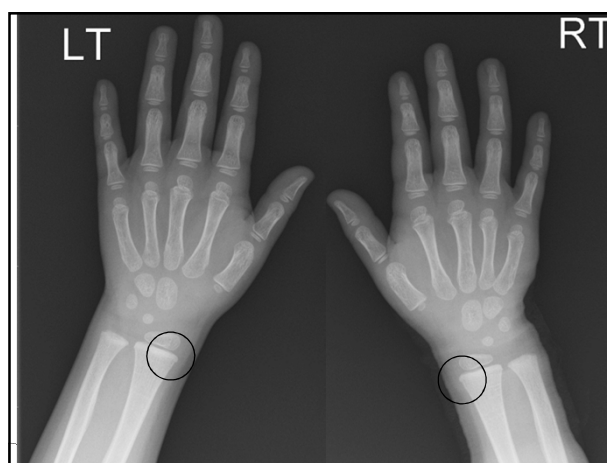


Fig. 1 a and b. Comparative views of the right elbow. The ossification centres have a 'predictable' age at which they appear, with the capitulum appearing first.

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Head injury / Skull X-rays

- Not indicated at institutions with CT facilities
 - If no CT available, may be used in mild head injury → visualised fracture = indication for CT
- May be done as part of skeletal survey in suspected NAI (Leave if doing CT) & surgical follow-up for device implantation
- CT preferred for head shape abnormalities / craniosynostosis.



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SASPI

ii. Imaging protocol for head injuries

- No role for skull x-rays
- Currently no role for cranial ultrasound
- CT head – low threshold for imaging except in resource-limited setting, then employ the following guidelines for CT referral:
 - GCS ≤ 14 on assessment at hospital after adequate resuscitation
 - Abnormal drowsiness
 - Focal signs
 - Penetrating injury
 - Suspected base of skull fracture
 - Clinical suspicion of occipital / suboccipital fracture
 - NAI
 - Post-traumatic seizure
 - Vomiting > 3 times or > 2 hours post injury

ACR

American College of Radiology
ACR Appropriateness Criteria[®]

Clinical Condition: Head Trauma — Child
Variant 1: Minor head injury (GCS ≥13) ≥2 years of age without neurologic signs or high risk factors (eg. altered mental status, clinical evidence of basilar skull fracture). Excluding nonaccidental trauma.

Radiologic Procedure	Rating	Comments	REL [*]
CT head without contrast	3	This is a known low-yield procedure.	***
MRI head without contrast	2		0
X-ray head	1		0
CT head without and with contrast	1		****
CT head with contrast	1		****
CTA head with contrast	1		****
MRI head without and with contrast	1		0
MRA head without contrast	1		0
MRA head without and with contrast	1		0
Arteriography cerebral	1		****
US head	1		0
FDG-PET/CT head	1		****
Tc-99m HMPAO SPECT head	1		****

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

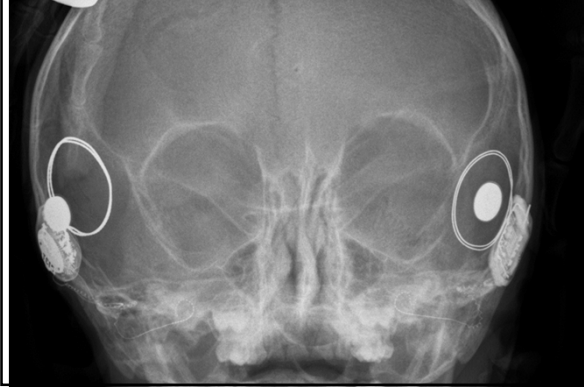
*Relative Radiation Level

ACR Head injury

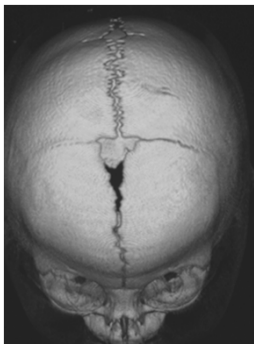
- ◉ Minor injury - GCS > 13, \emptyset Risk Fx
 - ➔ No imaging
- ◉ Moderate / Severe – GCS < 13, \pm Risk Fx
 - ➔ CT brain pre-contrast (? MRI pre)
- ◉ NAI
 - ➔ CT brain pre-contrast / MRI Brain DAI
- ◉ Subacute HI with Neuro Sx
 - ➔ MRI brain pre / CT brain pre

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Cochlear implant – Surgical Cx



Craniosynostosis



Andronikou, S. AND Dekker, G. "Paediatric radiology: what's hot and what's not". Continuing Medical Education [Online]. Volume 24 Number 6 (23 January 2008)

Sinus / Adenoids X-rays

- ◉ Very limited value!
- ◉ Sinus complaints should receive empirical treatment without imaging except
 - Features of complication
 - Surgical planning
 - ➔ CT is then indicated



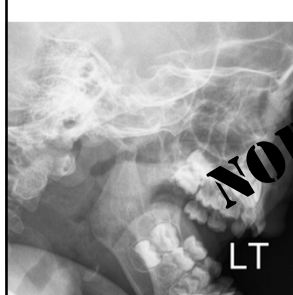
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Adenoid hypertrophy



3yr 5m

Adenoid hypertrophy ?



Sinuses



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SASPI – CT Sinuses

PARANASAL SINUSES CT

Indication	(A) Only after trial of therapy if planning endoscopic surgery	
	(B) Complicated Sinusitis – Orbital Cellulitis /Intracranial extension?	
	(C) No role for plain radiographs	
	(D) Do NOT image children under 4 years, particularly not under 2 years	
➡ (A) After trial of therapy prior to surgery	(B) Complicated Sinusitis – Orbital Cellulitis /Intracranial extension? ➡	
Contrast	Non C	Post C ONLY
		2 ml/kg
		No Delay

ACR Sinusitis

- Uncomplicated acute sinusitis
→ NO IMAGING
- Persistent, recurrent or chronic sinusitis
→ CT Sinuses pre-contrast
- Complicated sinusitis (Orbital / Intracranial)
→ CT brain and sinuses with contrast (? MRI with contrast)

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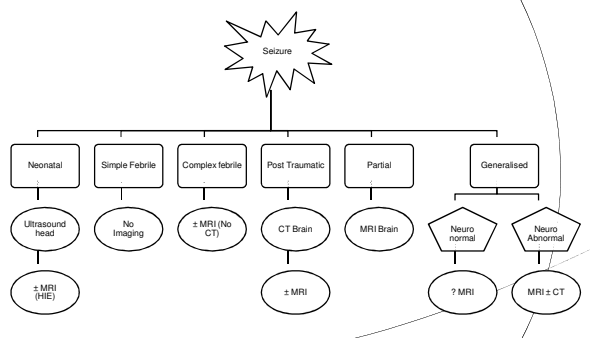
Convulsions

- Modality differs between ages
- Correlating clinical history of vital importance.



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ACR - Convulsions



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Lateral Chest X-ray

- Not routinely used in USA / UK
- Valuable in SA for detecting TB lymph adenopathy
 - CT more accurate, but not feasible to perform in every case of suspected TB



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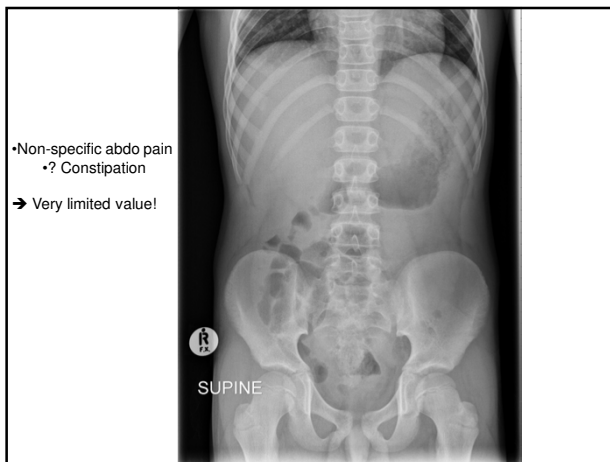
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Bowel imaging

- X-ray evaluation very limited
- Only absolute x-ray indication
 - Obstruction / Perforation
 - Positioning of lines



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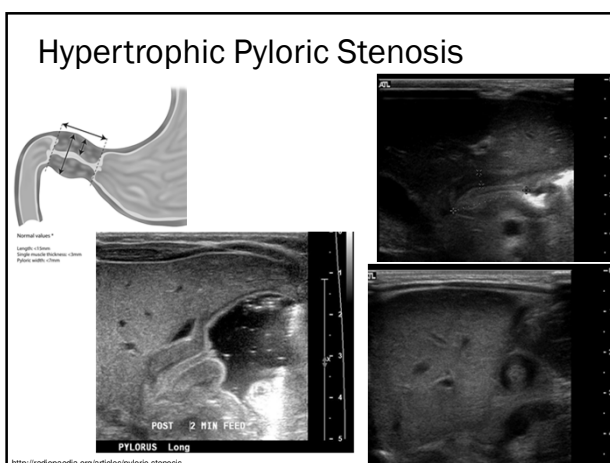


Bowel imaging

- ◉ Reflux / GORD
 - Barium swallow limited value early
 - → Physiological reflux / ? When abnormal
- ◉ Hypertrophic pylorus stenosis
 - Ultrasound first line
 - Barium studies only in difficult / equivocal cases



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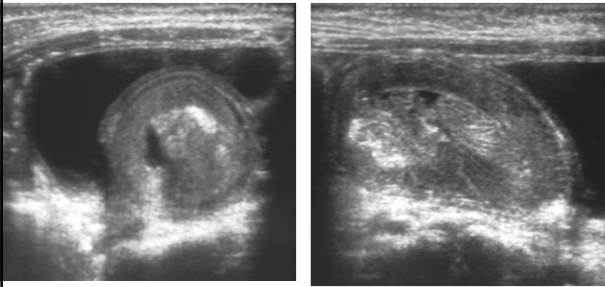
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Intussusception



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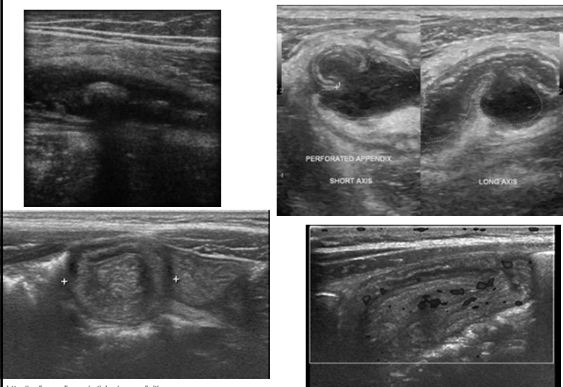
Bowel Imaging - Appendicitis

- ◎ X-ray
 - Rarely helpful – may show focal ileus which is non-specific
- ◎ Ultrasound is still first line investigation
 - Can be difficult due to location, bowel gas, etc.
 - Abnormal ultrasound = Appendicitis
 - Normal ultrasound ≠ Normal ≠ Appendicitis
 - Can demonstrate mesenteric glands / Adenitis
- ◎ CT as next line investigation
 - Single venous phase +/- oral / rectal contrast



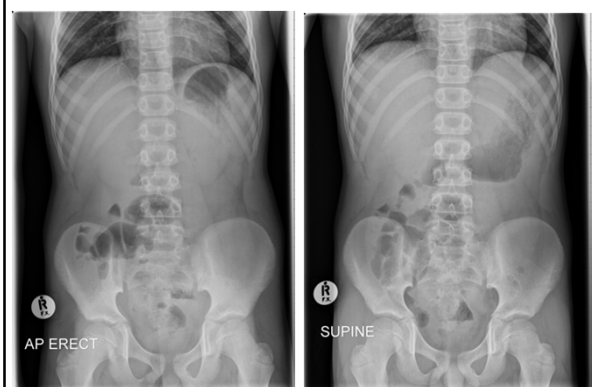
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Appendicitis - US

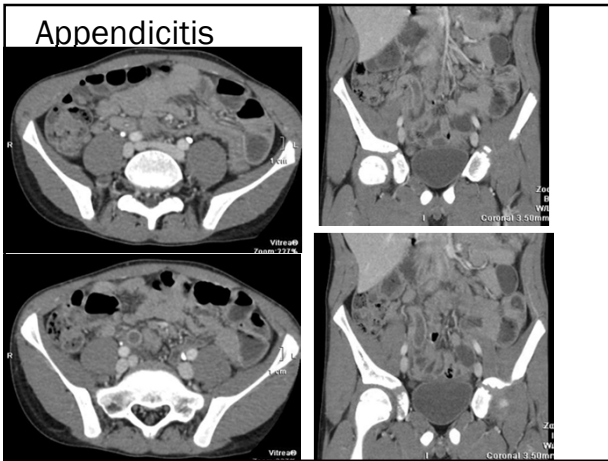


<http://radiopaedia.org/articles/appendicitis>

Appendicitis



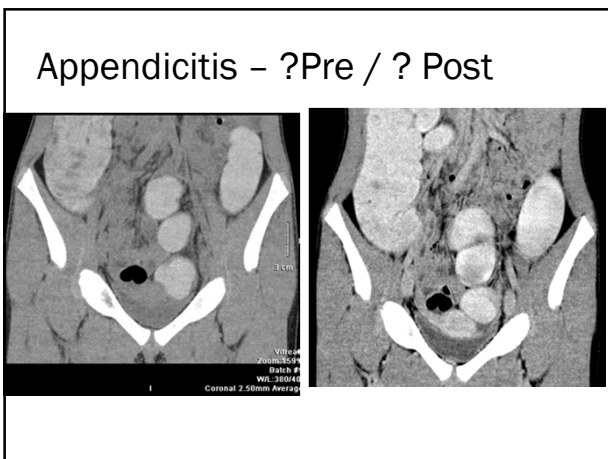
Appendicitis



Intussusception



Appendicitis – ?Pre / ? Post



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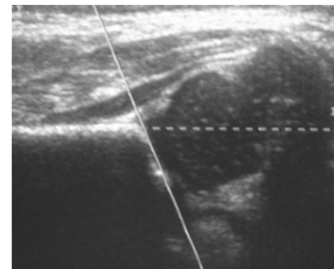
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Pelvic X-rays

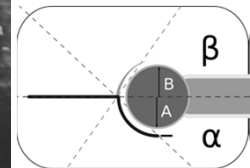
- Limited value for DDH
 - Ultrasound preferred
- Bony lesions, Perthe's and SUFE possible with X-rays, but
 - MRI more sensitive



DDH



Coronal ultrasound of the hip



http://commons.wikimedia.org/wiki/File:Hip_dysplasia_ultrasound.svg

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Urinary tract infection

- Ultrasound is mainstay of UTI imaging
- IVP should not be used
- Nuclear medicine / MAG3 study for obstructive uropathy
- ACR
 - Ultrasound always first
 - VCUG only really appropriate if US abnormal / poor response on Rx / urine retention / recurrent febrile UTI's



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Summary

- Radiation Dose & Risk
- Radiation reduction
- Appropriate imaging for the clinical question



Questions / Comments

