



PEDIATRIC RADIOLOGY

Enrico B. Arkink

5th year - 28.09.2022-30.09.2022



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Schedule

- **Wednesday 28.09.2022**
 - 13.00-13.45: Introduction and MSK
 - 14.00-14:45: Thorax
- **Friday 30.09.2022**
 - 13.00-13.45: Abdomen
 - 14.00-14.45: Neuro and ENT





PEDIATRIC RADIOLOGY

Introduction



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„Children are small adults“

- Of course, also in radiology, UNTRUE
- Different diseases in different prevalences
- Acquisition of imaging more challenging → communication (parents!), inability to cooperate
- Variable size and physiology → contrast and other drug dosing





„Children are small adults“

- Different radiological findings (age-dependent changes, f.i. maturing brain or bone marrow on MRI)
- Different radiological DDx
- However, the main difference: modality choice





Pediatric radiology: the beginning



- Arch Clin Skiagraphy 1896
- 3 month old child
- Exposure time: 14 minutes
- Question: situs inversus?





Pediatric radiology: the beginning



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- 3 month old child
- Exposure time: **14 minutes**
- Question: situs inversus?



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Pediatric radiology: the beginning

Benson & Doubilet,
Radiology 2014, 273: Suppl 2



- Confirm pregnancy and fetal position
- Initially no known harm to the fetus
- 1931: increased rate of structural abnormalities after radiation exposure (microcephaly, developmental delays)
- 1952: fetal embryo likely highly susceptible for developing malformations due to radiation, particularly in early development phase (week 4-8); higher risk of miscarriage



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Risk of radiation in the smallest

- Deterministic risks:
 - Teratogenic → developmental errors
- Stochastic risks:
 - Carcinogenic → cancer
 - Genetic → genetic disorders





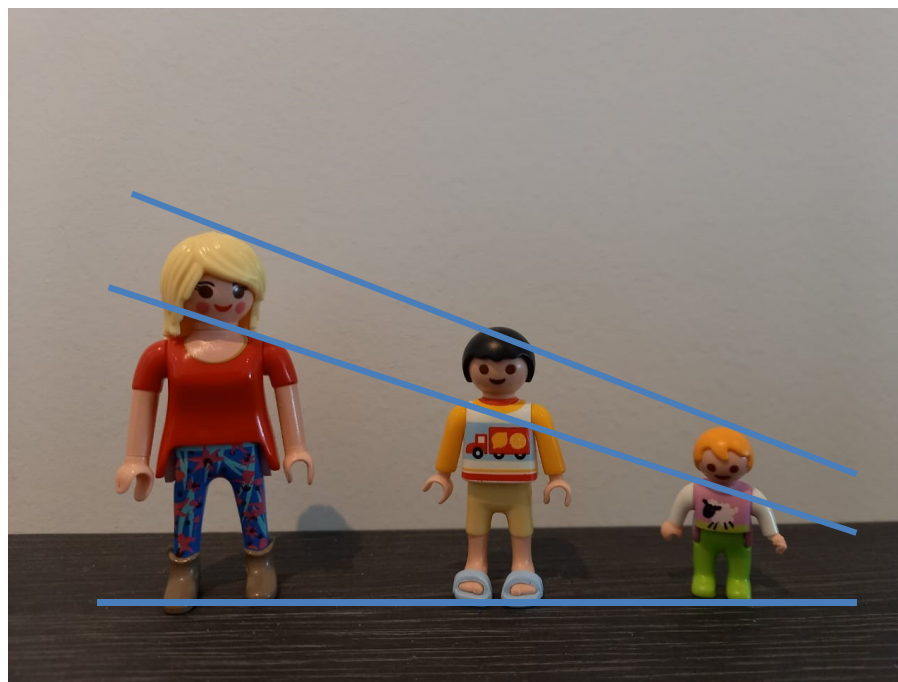
Risk of radiation in the smallest

- Deterministic risks:
 - Require a threshold dosis
 - Effects known from animal experiments, offspring of RTx patients, Japanese atomic bomb victims
- Stochastic risks:
 - Do not require a threshold dosis





„Children are small adults“



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What would you choose?

0,03 mSv

1 (o-n-e) abdominal X-ray

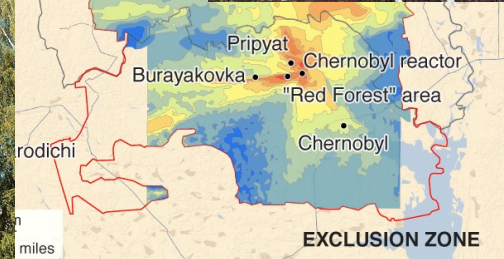
Radiopaedia, courtesy Ian Bickle



0,0012 mSv/hr = 0,029 mSv/day

1 day in Pripyat, Chernobyl

Current radiation levels in the Chernobyl



Portsmouth with data from ARPA Russia-Belarus

BBC



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Est. medical radiation doses for 5 yoa

Exam	Effective dose (mSv)	No. of equivalent chest X-rays
Ankle X-ray, 3 projections	0.0015	1/14th
Chest X-ray, 2 projections (PA and lateral)	0.02	1
Abdominal X-ray, 2 projections (AP and lateral)	0.05	2.5
Tc-99m2 radionuclide cystogram	0.18	9
Tc-99m radionuclide bone scan	6.2	310
FDG-PET scan	15.3	765
Fluoroscopy, upper GI follow-through	1	50
CT head	4	200
CT thorax	3	150
CT abdomen	5	250

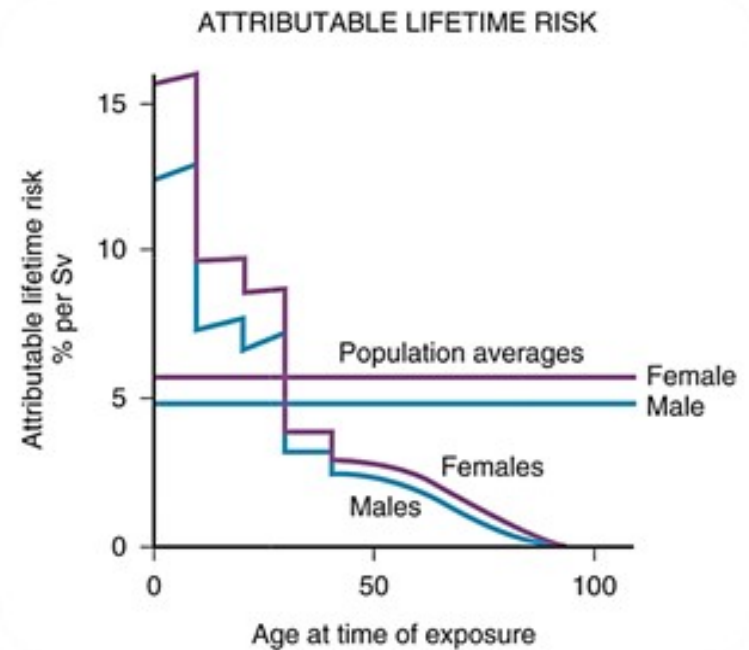
Abaza, IAEA-CN-255/44





Risk of radiation in the smallest

- Carcinogenic effect per Sv effective dose:
 - 5% (0-5 yoa: 17%)
- Tissues more sensitive, longer life expectancy





Risk of radiation in the smallest

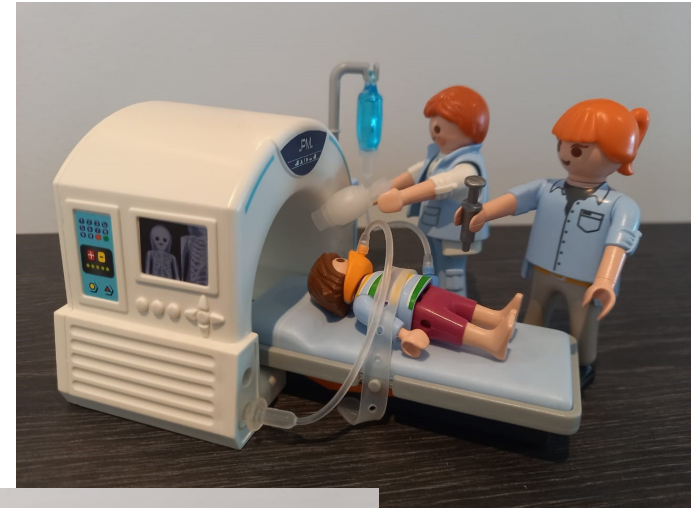
- 10 mSv in pregnant women (equals app. 1 CT abdomen on state-of-the art CT scanners) doubling the risk of childhood cancer
- ALARA, ALARA, ALARA...

dose (mSv)	no childhood cancer
0 (background)	99.93%
1	99.921%
5	99.89%
10	99.84%
50	99.51%
100	99.07%





Modality choice



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Musculoskeletal imaging



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Count the bones...

Radiopaedia, courtesy Ian Bickle



Radiopaedia, courtesy Jeremy Jones



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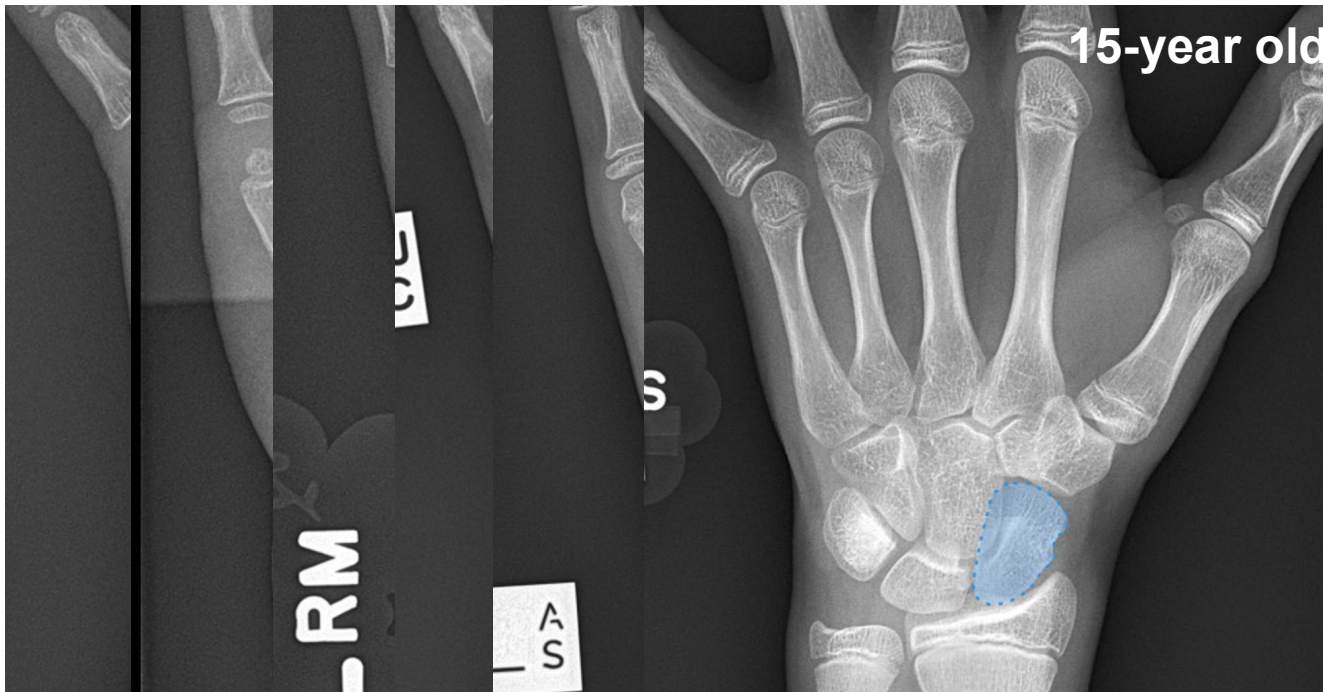
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Carpal ossification

Asking for scaphoid views in younger children in addition to conventional wrist projections often a nono

Radiopaedia, courtesy Jeremy Jones



- Scaphoid fractures uncommon in children, most common carpal #
- Clinical suspicion on scaphoid fracture, 4-11 yoa: no X-ray
(Porter et al., *Pediatr Emerg Care* 2020)

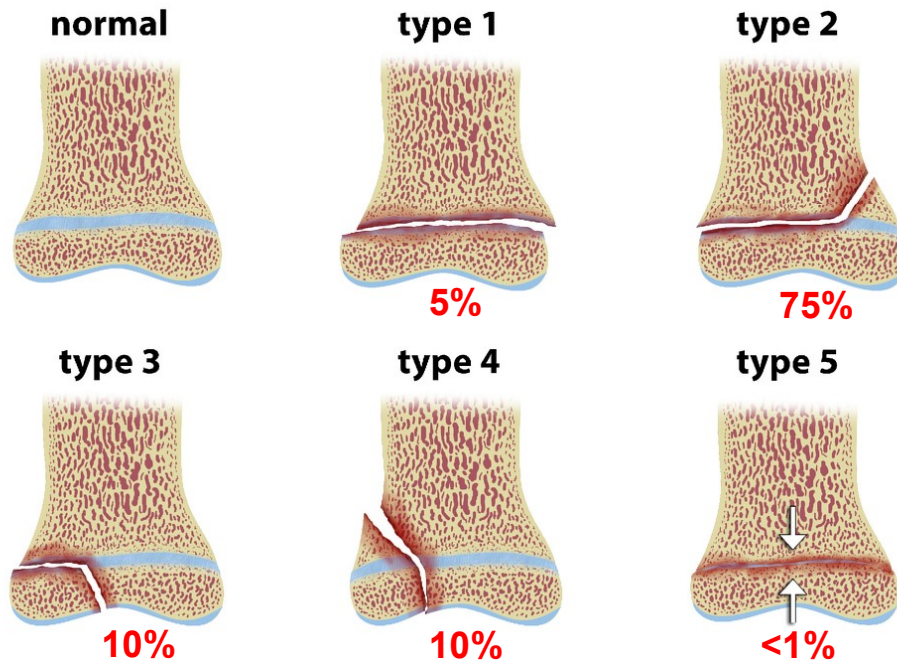


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Different bone locations of fracture

Radiopaedia, courtesy Matt Skalski



Salter-Harris classification



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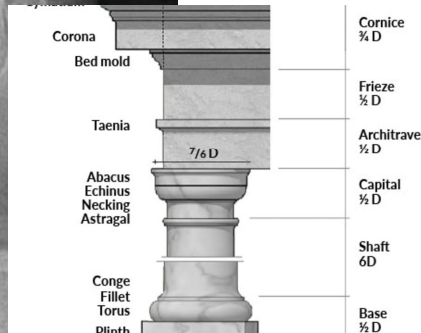
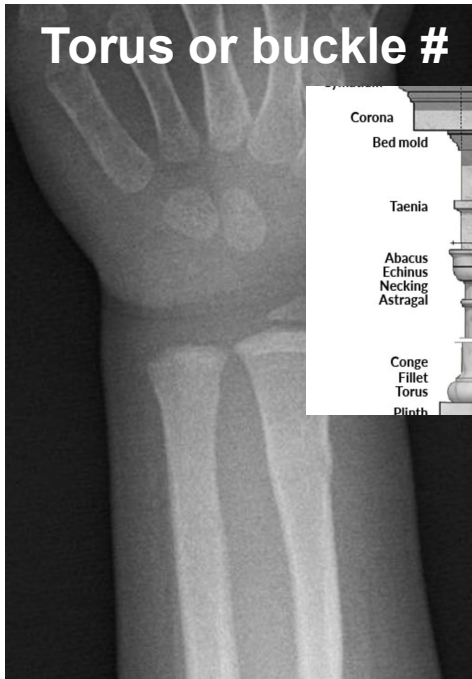


Different type of fractures in children

Mechanical properties of bone tissue in children differ from adults leading to different fracture types

Radiopaedia, courtesy Pir Abdul Ahad Aziz Qureshi

Torus or buckle



Radiopaedia, courtesy Jeremy Jones

Bowing



Radiopaedia, courtesy Sharifah Intan

Greenstick



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Different types of fracture mechanisms

Arkink et al., Radiol Case Rep 2017



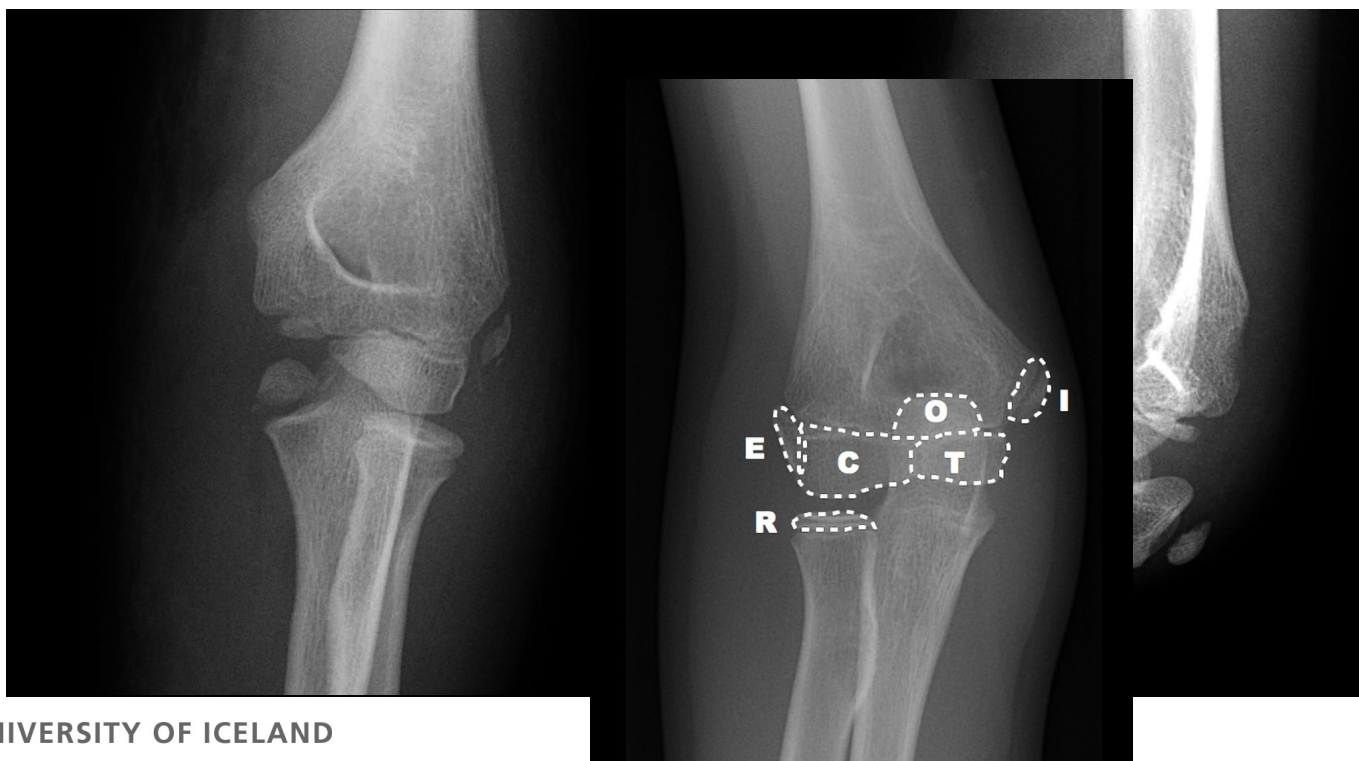
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Why that knowledge is important...

Radiopaedia, courtesy Andrew Dixon



- Boy
- 12 years old
- Fall

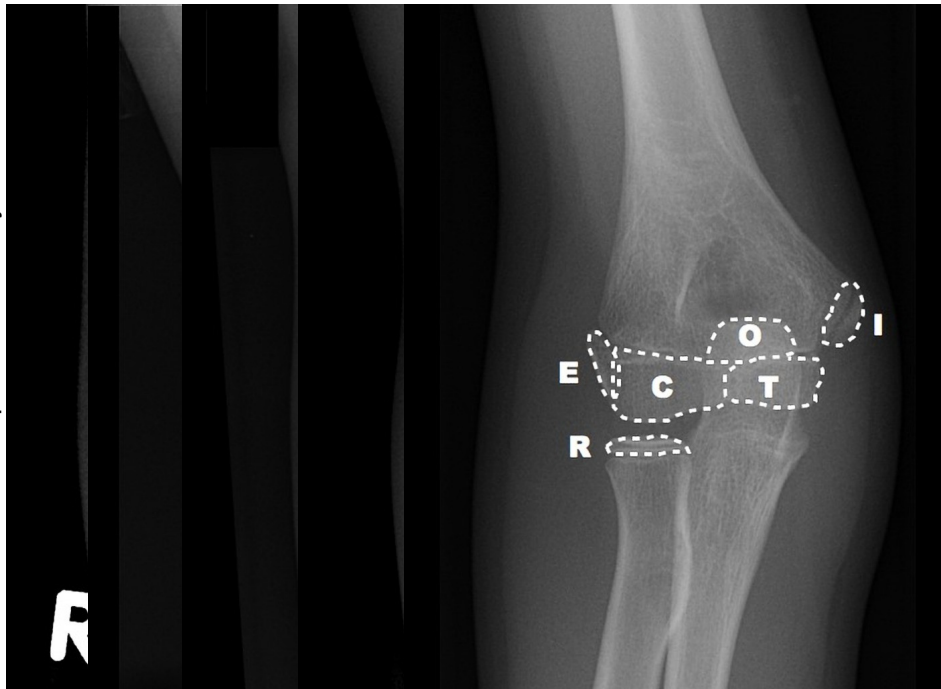


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Different body locations → elbow



- Strict order of ossification centers
- CRITOE or CRITOL:
 - 1: Capitellum
 - 3: Radial head
 - 5: Internal (medial) condyle
 - 7: Trochlea
 - 9: Olecranon
 - 11: External/lateral condyle
- 1-3-5-7-9-11 → simple
- 1-5-7-10-10-11 → more accurate



Why is that knowledge important?

Radiology Assistant, courtesy Robin Smithuis



- 60% of elbow fractures in children →
- Supracondylar humerus fracture most common (compared to radial head # in adults)
- 95% due to hyperextension trauma
- Positive fat pad sign anteriorly and posteriorly



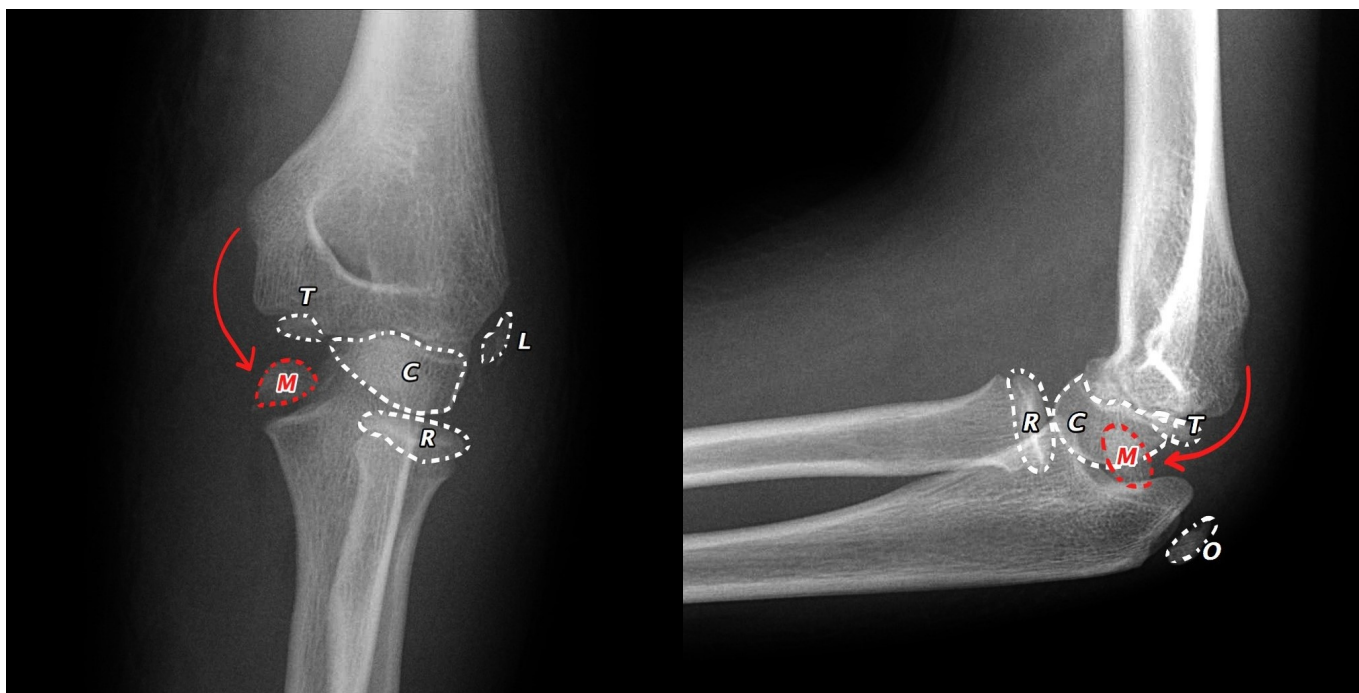
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Radiopaedia, courtesy Andrew Dixon



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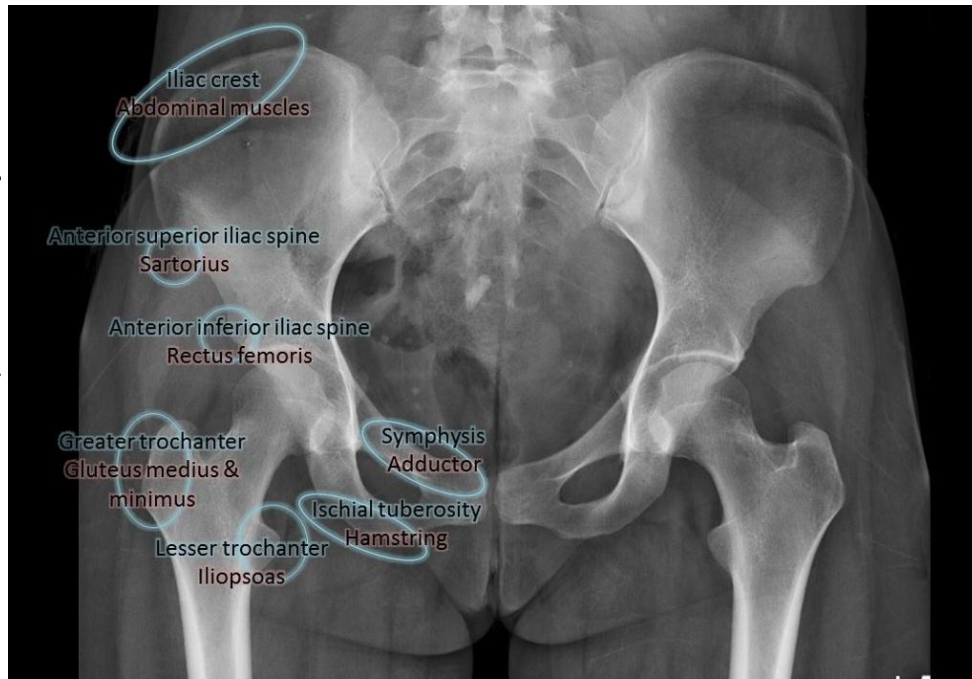
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Same same but different

Radiopaedia, courtesy Andrew Ho



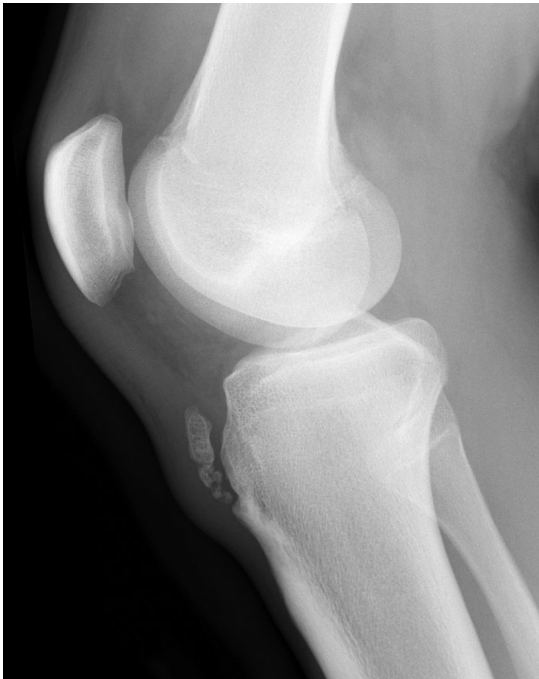
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Tendons and ligaments pull at bone...

Radiopaedia, courtesy Frank Gaillard



- Pain and swelling over the tibial tuberosity
- Typically affecting boys between ages 10-15 years, slightly younger in girls (8-12 years)
- Osgood-Schlatter disease
- Repetitive microtrauma at the patellar ligament insertion at the tibial tuberosity

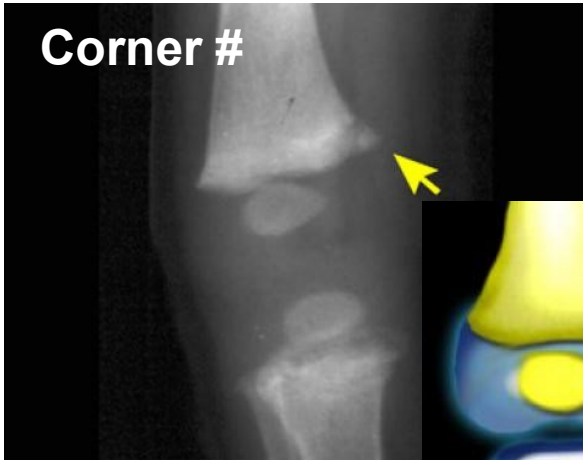


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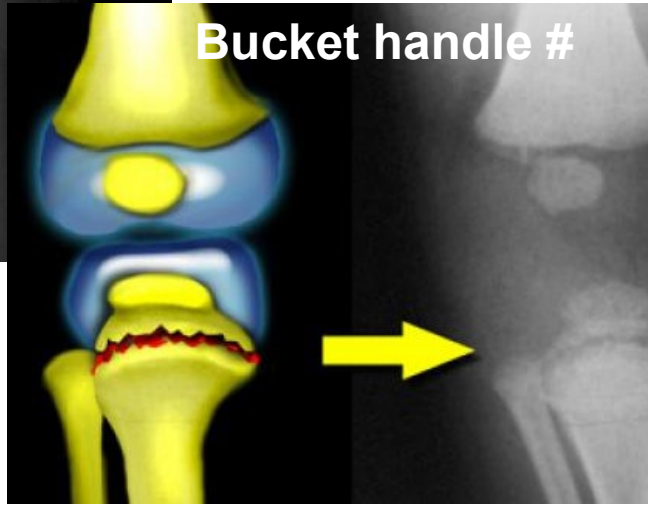


Non-accidental injury

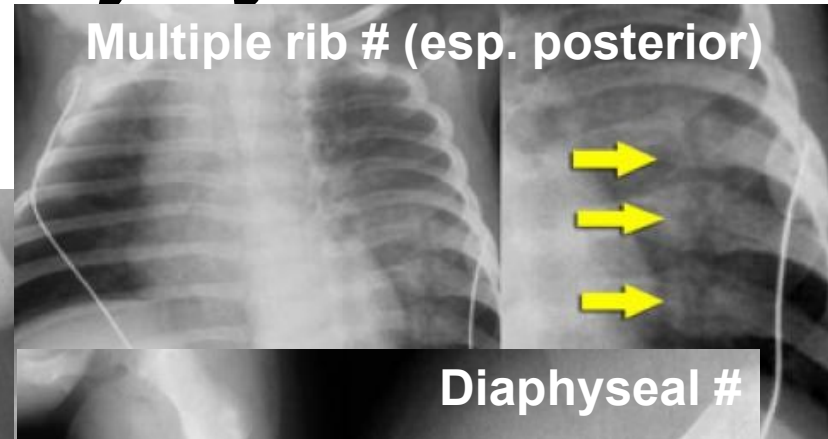
Corner #



Bucket handle #



Multiple rib # (esp. posterior)



Diaphyseal #



Acromion #

Sternal #

Occipital
impression #

Spinous process #

Radiology Assistant, courtesy Simon Robben



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Non-accidental injury

- Role radiologist
 - Awareness of existence NAI
 - Detection of occult NAI
 - Skeletal survey with X-ray (or even nuclear bone scan if X-ray negative but high suspicion)
 - Detection discrepancy between history and severity, mechanism and age of fractures



Radiology Assistant, courtesy Simon Robben



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Non-accidental injury

- 6-month-old boy, restricted movement in the right hip



Bomer et al., Insights Imaging 2013

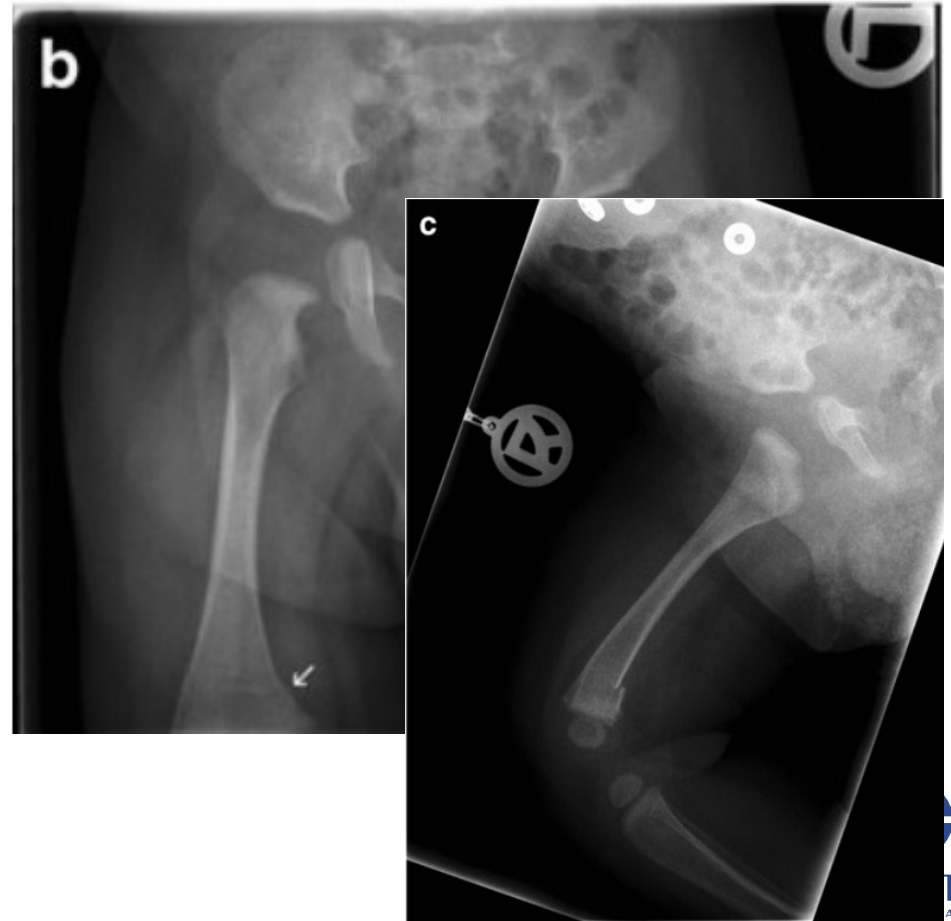


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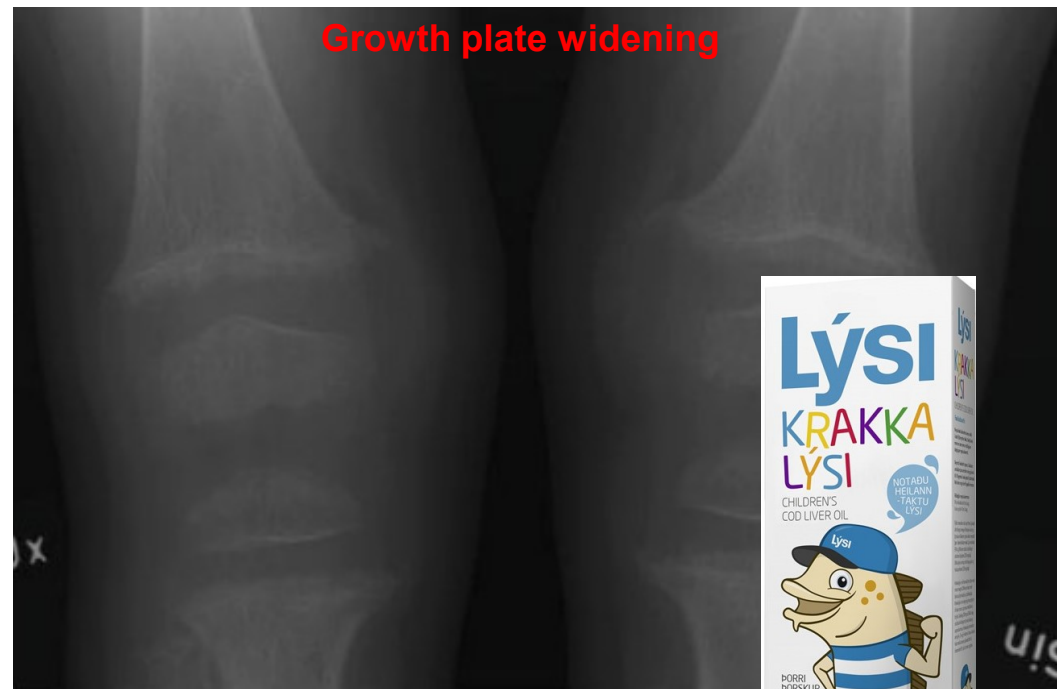
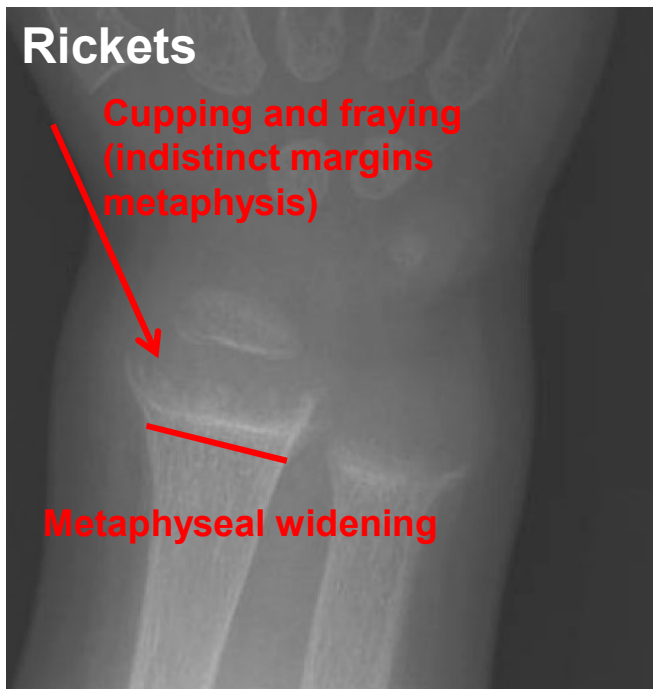
Non-accidental injury: injury: electronical collimation issues



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Abnormal bone development



Kristinsdóttir et al., Læknablaðið 2011



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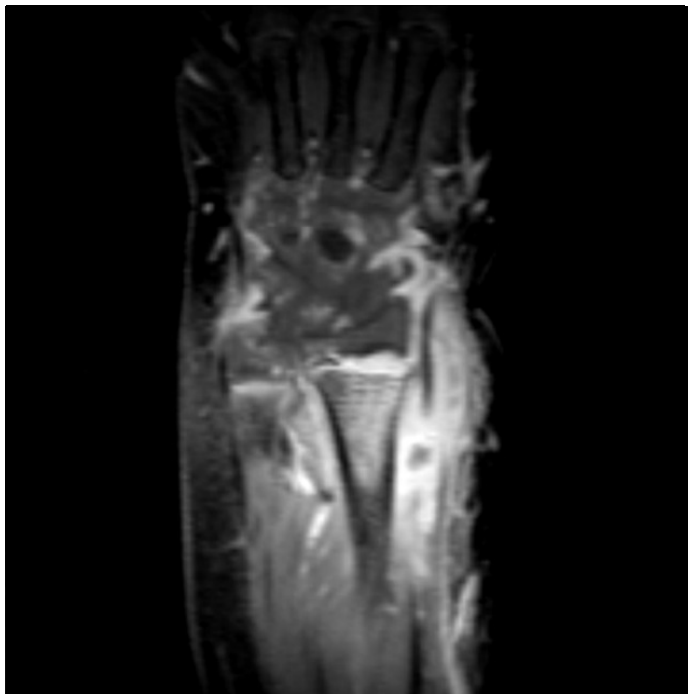
- 27-month old girl, strange gait and crooked legs





Abnormal bone

Radiopaedia, courtesy Andrew Dixon



- 8 months old boy
- 10 day history of left wrist swelling
- Osteomyelitis:
 - Pyogenic infection (*S. aureus*)
 - Longer bones, metaphysis > growth plate > diaphysis
 - Multifocal in 10% (22% in neonates)
 - Soft tissue swelling: <7-14 days
 - Periosteal reaction: after 7-10 days
 - Lucency: >7-14 days



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Abnormal bone

Radiopaedia, courtesy Andrew Dixon



- X-ray may be negative for the first weeks
- To be performed to exclude other pathology and to be used as a starting point
- US to show hydrops
- Depending on age, bone scintigraphy or MRI as next step



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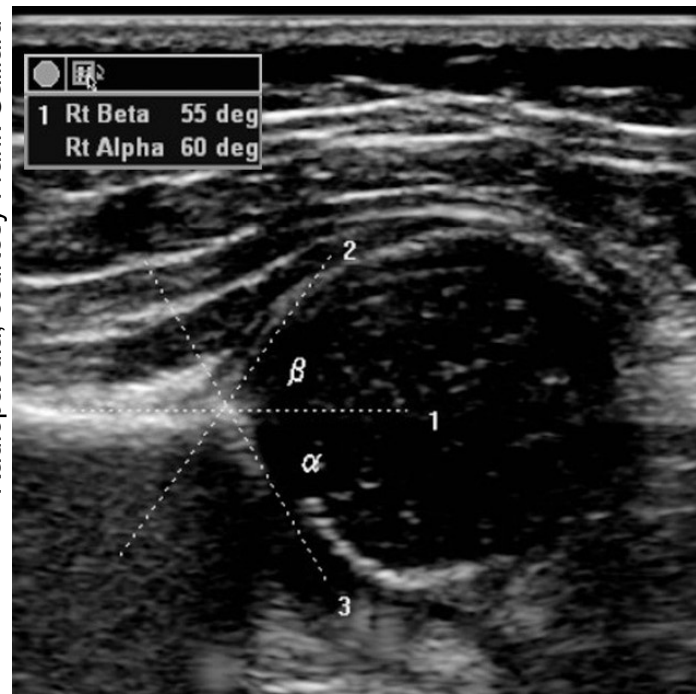
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Ultrasound in pediatric MSK imaging?



Radiopaedia, courtesy Frank Gaillard





Developmental dysplasia of the hip

- One of most common MSK issues in newborn
- “Congenital hip dysplasia” → misnomer
- Dynamic disease, not always present at birth
- Treatment easier and prognosis better when detected early





Developmental dysplasia of the hip

- 1/1000
- Girls > boys; left > right
- Risk:
 - Girls in breech 12%, boys in breech 2.6%
 - Girls with + family history 4.4%, boys 0.9%





Developmental dysplasia of the hip

Radiology Assistant, courtesy Simon Robben



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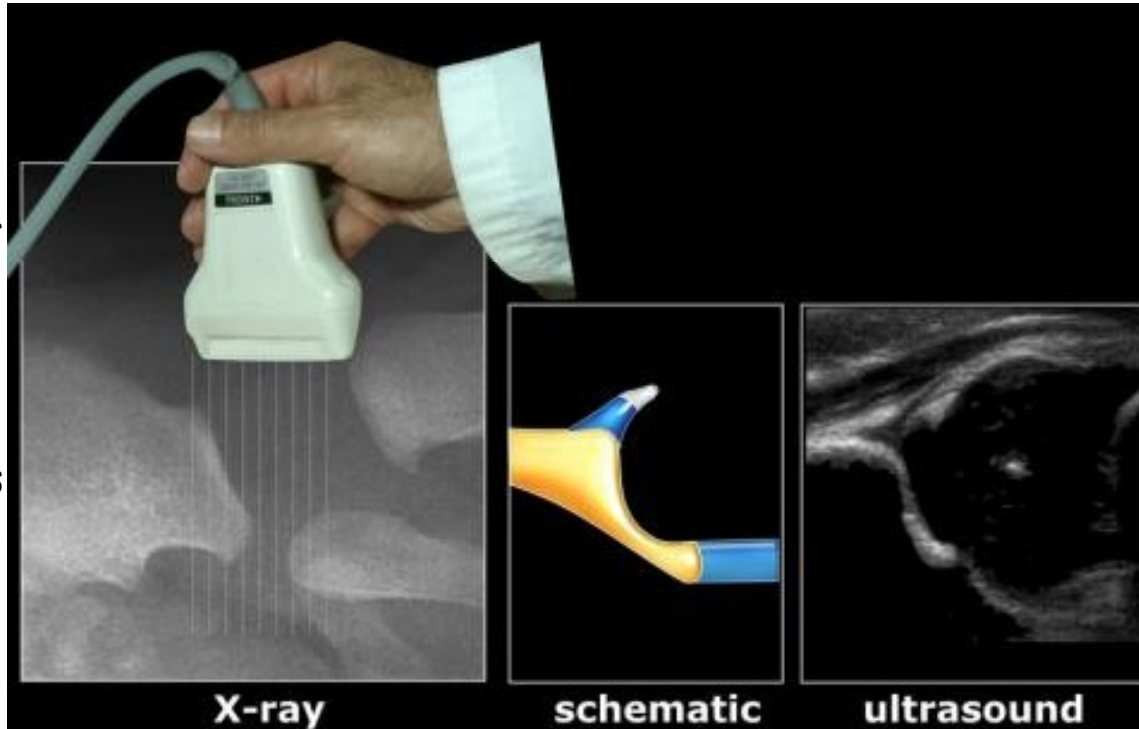


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Developmental dysplasia of the hip

Radiology Assistant, courtesy Simon Robben



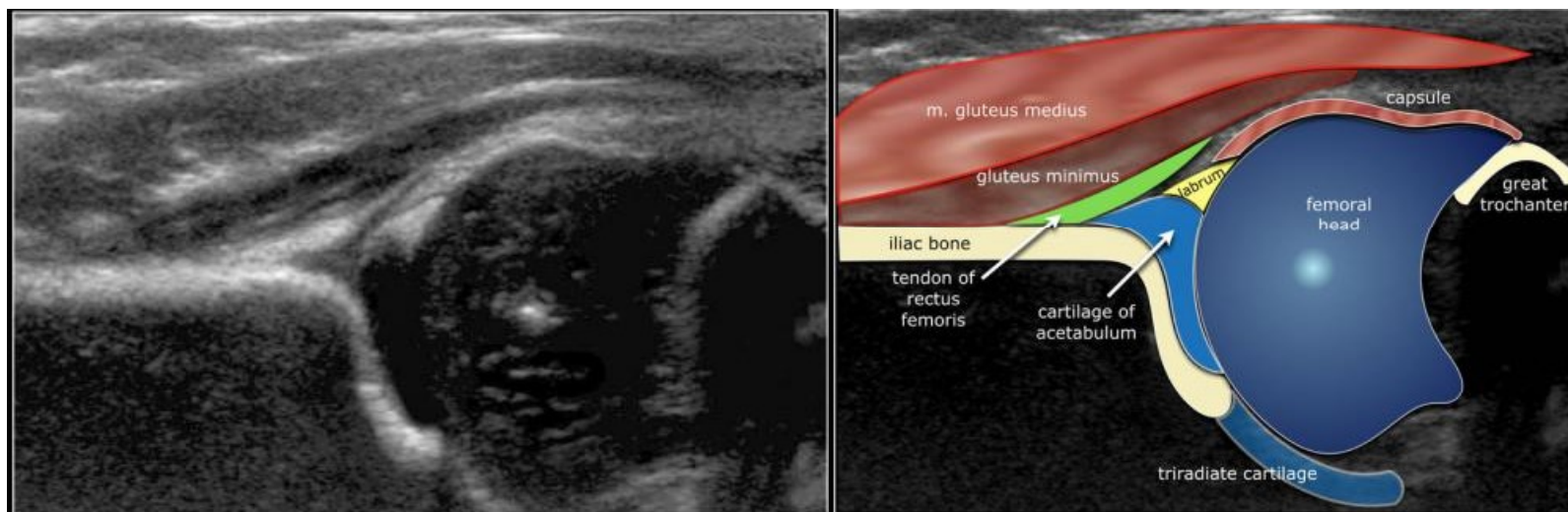
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Developmental dysplasia of the hip

Radiology Assistant, courtesy Simon Robben



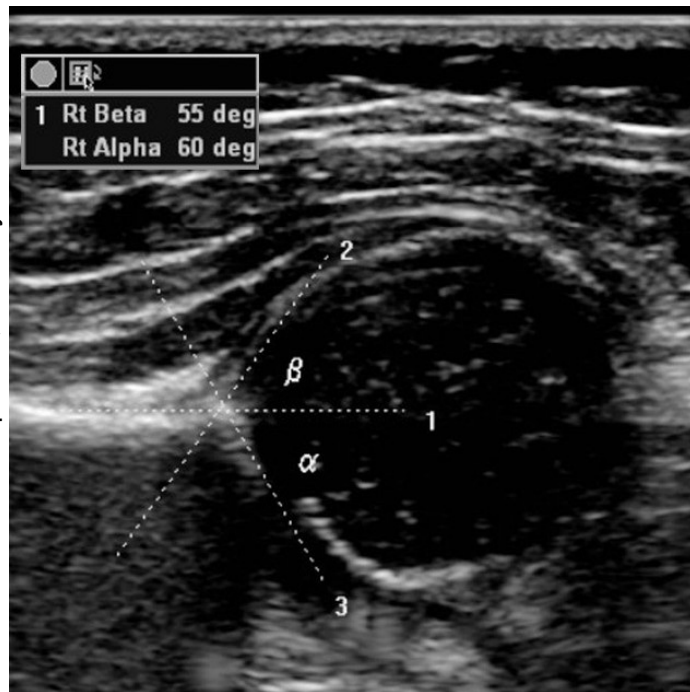
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Developmental dysplasia of the hip

Radiopaedia, courtesy Frank Gaillard



Radiology Assistant, courtesy Simon Robben

Developmental Dysplasia of the Hip

α -angle

Type I	$\alpha \geq 60^\circ$	
IIa	$\alpha 50 - 59^\circ$	appropriate for age
Type IIb	$\alpha 50 - 59^\circ$	inappropriate for age
IIc	$\alpha 43 - 49^\circ$	
Type D	$\alpha 43 - 49^\circ$	decentring hip
Type III	$\alpha < 43^\circ$	eccentric hip
Type IV	$\alpha < 43^\circ$	inverted labrum



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Questions?



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Acknowledgements

- Boris Brkljačić
- Hanna & Svea



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