# Pediatric Imaging

MRT Program

# Objectives

- List the technical considerations for pediatric patients
- Compare the technical considerations required to image various parts of a pediatric patient to those required for an adult patient
- Determine the additional equipment required to obtain an optimal image on a pediatric patient
- Identify the challenges associated with X-raying pediatric patients

# Children in the X-ray room

- Adapt your communication to the age of the child
- Prepare your room ahead of time
- Involve the parents when possible
- Establish a rapport
- Be patient
- Be adaptable

# Care givers in the X-ray Room

- Help or Hinder?
- 3 levels of parent participation
  - Observe/support
  - Actively assists with positioning and immobilization
  - Is not in the room
- Proper instructions necessary
- Only 1 caregiver at a time
- Check LMP if female caregiver of childbearing age

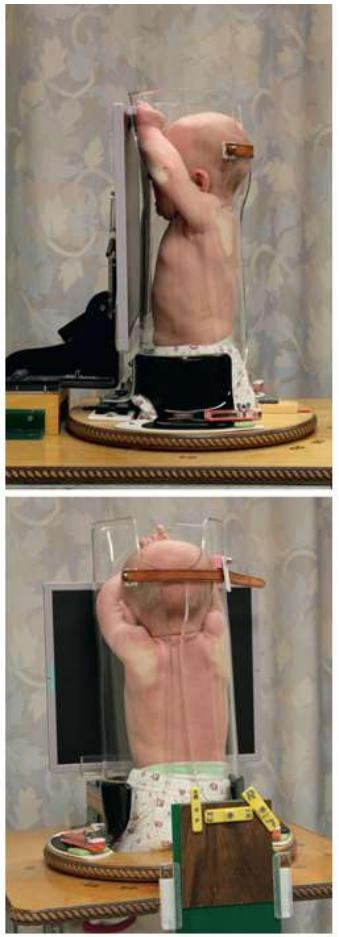
# Immobilization

- Requires caregivers' permission
  - Education key to obtaining this permission
- Many different devices and tools depending on need
- Reduces repeat exposures
- Less scary than multiple adults in lead

# Pigg-o-stat

- In use since the 1950's
  - Tried and true
- Chest, abdomen, thoracic, and lumbar spine
- 6 months – 3 years*
  - Child must be able to hold their head up
- Reassure parents that this doesn't hurt!

*Bontrager says 5, but this isn't terribly realistic



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# Steps to Using a Pigg-o-stat

- Disinfect the Pigg-o-stat
  - In front of parent if possible
- Change plastic sleeves if necessary
- Adjust seat up or down
  - As low as possible
  - Child's mouth should be near the bottom of the window
- Have a caregiver or second tech present
- One person behind the immobilizer
  - Places child on the seat
  - Fastens all closures
- One person in front of immobilizer
  - Guides feet
  - Holds arms with head in between

# Using a Pigg-o-stat cont.

- Seat child on bicycle seat
- Front tech holds arms firmly beside head
- Back tech closes sleeves and fastens head strap first
  - Prevents strong child from thrashing
  - Easier to close all other closures
- Front tech releases hands and helps place tabs over bottom of sleeves and wrap Velcro around base of sleeves
- Turn child in desired direction and use built in markers and shielding

# Octostop

- Infant - 5 years
- Recumbent imaging of just about anything
- Sponges and straps can be customized for each case
- Can rotate for obliques or laterals



B

A courtesy of Natus Medical Incorporated, Seattle, WA; B from Long B, Frank E, Ehrlich RA. *Radiography essentials for limited practice*, ed 3, St Louis, 2010, Saunders.

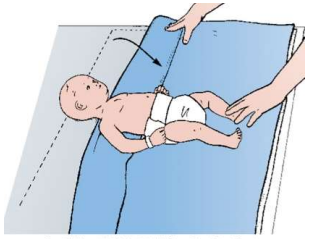
# Using an Octostop

- Disinfect Octostop and cover with a towel or pillowcase
- Place ends of Octostop in curved stands
- Select appropriate sponges, straps, or wraps
  - Use curved head sponge even if not doing skull work (more comfortable for child)
- Lay child on board
  - Arms up or down depending on desired images
- Wrap straps around head, chest, hips, and knees
- Place sandbags at the ends of the board if child is very strong

# Mummy/Bunny Wrap

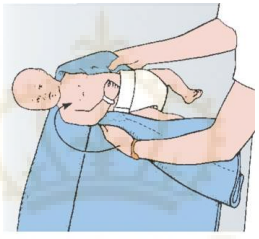
- Excellent for cranial work
- Used on small infants
- Makes them feel safe
- Immobilizes shoulders and arms
- May even fall asleep
- Most swaddling techniques will work if arms are restrained

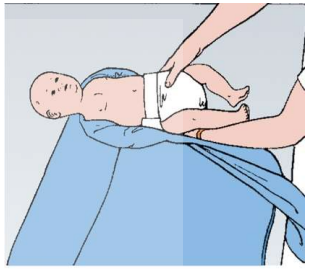
# Using a Bunny Wrap

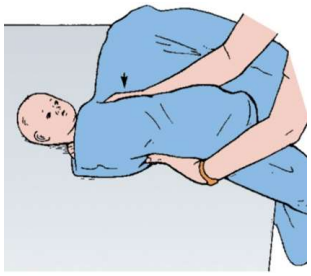


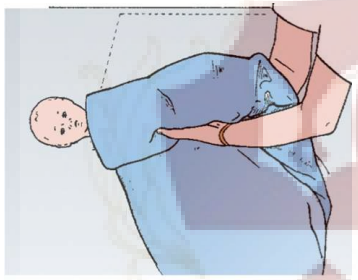






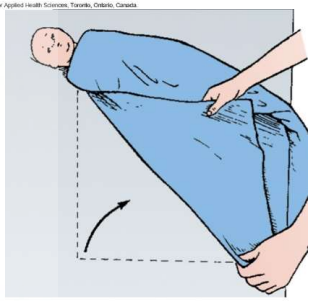


















# Pediatric Positioning Chair

- Alternative to the Pigg-o-stat
- Allows child to face into the room
- Highly adjustable
- C-spine, chest, Abdomen, standing lower extremities (AP only)



https://clearimagedevices.com/products/pedia-poser

# Pediatric Positioning Chair cont.





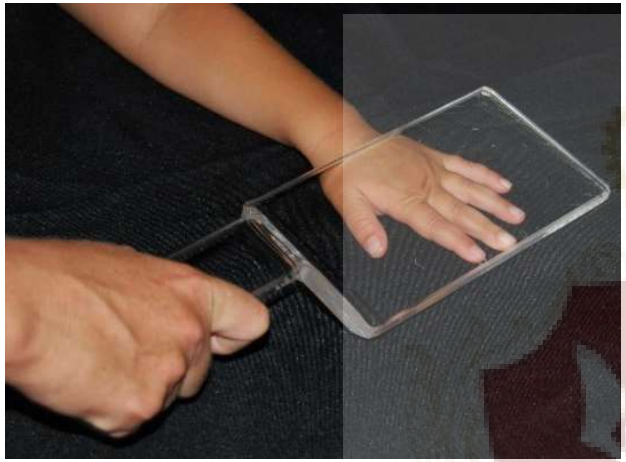




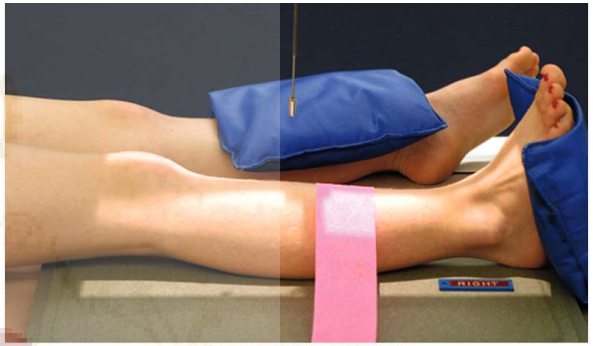
# Other Immobilization Equipment

- Sandbags
  - Help hold limbs in place
  - Less uncomfortable than hands
- Sponges
- Tape
  - Do not place adhesive directly on skin
  - Flip tape or use a cloth
- Plexiglass paddle
- Octostop straps

# Other Equipment cont.



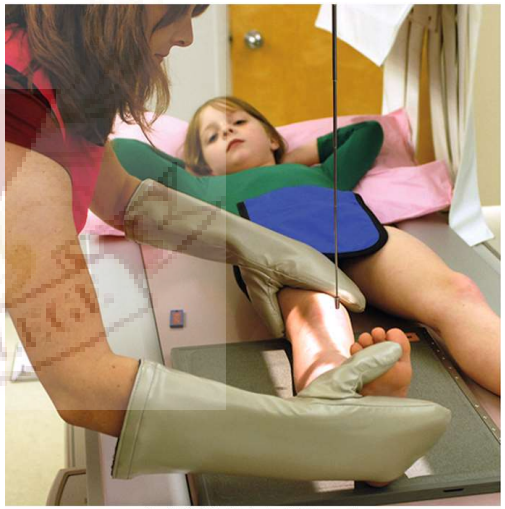
https://myemail.constantcontact.com/Need-to-Keep-The-Child-s-Hand-Flat-During-an-Exam-.html?soid=1103596069869&aid=X9roVmcJvdg



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# Pediatric Techniques

- Generally lower than adults
  - Allowing for small size
- High kVp & low mAs
- Fast exposure times to minimize motion
- Use grids for >10cm body parts
  - Exception is infant CXR

# Pediatric CXR – AP/PA & Lat

- Upright whenever possible
  - Exceptions – Unable to hold head up
- AP or PA depending on the situation
  - 3-6 years usually done AP
- If child cannot follow breathing instructions, watch belly rise or wait for inhalation during crying
- kVp 80-85
  - Adults kVp 110+
- Remove grid for infants and small children
- More likely to clip apices than costophrenic angles

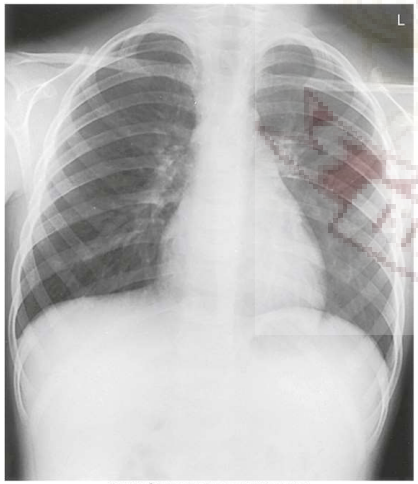
# CXR cont.



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Evaluation criteria the same as an adult

# Pediatric Abdomen

- Can usually get diaphragm and symph on one image
- Upright and supine
  - Decubitus for very young infants
- kVp 70-85
  - Adults kVp 80-85
  - Very size dependent
- Older children can follow breathing instruction with practice
  - Infants – watch belly rise/fall

# Abdomen cont.



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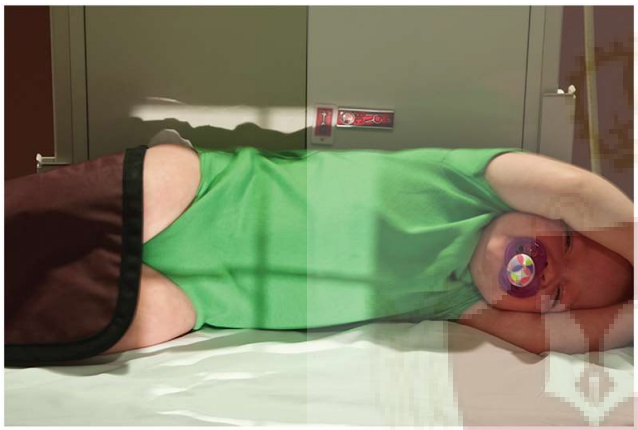

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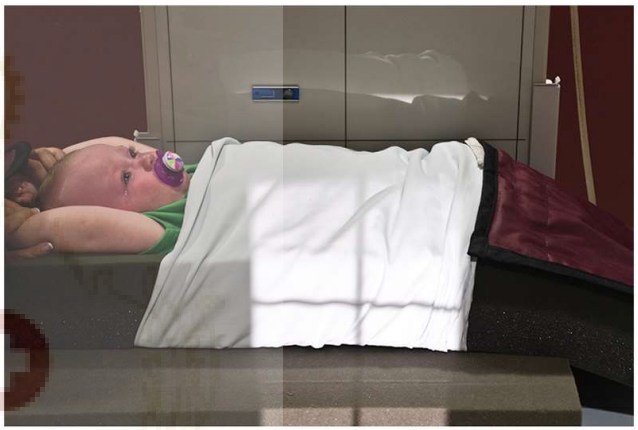

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Evaluation criteria the same as an adult

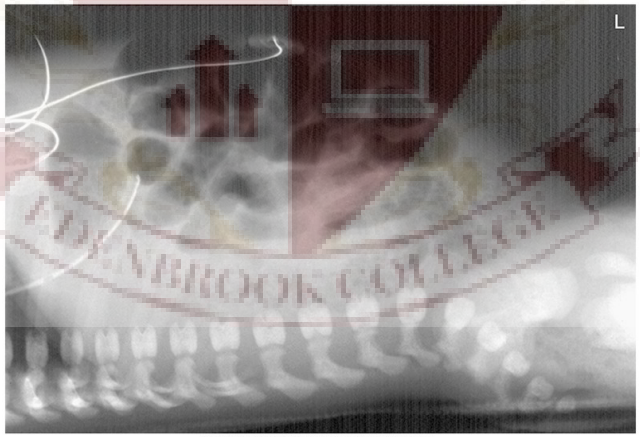
# Abdomen cont.



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# Pediatric Bone Development

- Diaphysis
  - Shaft or body of the bone
  - Most appear before birth
- Epiphysis
  - Usually at the end of long bones
- Epiphyseal plate
  - Cartilage between diaphysis and epiphysis
  - Diaphyseal edge hardens into new bone
  - Epiphyseal end grows more cartilage
- Different bones mature at different rates
- Often present until the 20's
- Views requested by radiologist depend on development

# Upper and Lower Limbs

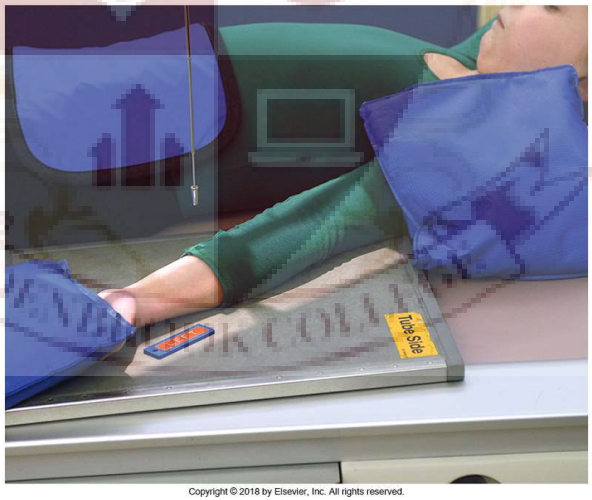
- May combine views if multiple areas ordered
  - Very site and case dependent
- kVp 50-60
  - Adults 60-75+
- No grid unless >10cm
- Older children may still need immobilization, even if following directions
  - Sandbags, tape, and sponges
- Radiologist may request a comparison image of the other side.

# Limbs cont.

AP shoulder to wrist

- Tape and sandbags used to help the child hold still


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# Pediatric Cranium

- Performed supine for very young children and infants
- Sponges, tape, and straps essential for maintaining proper position
- 70-80 kVp
  - Adults 80-90 kVp
- No grid for infants and very small children
  - Reduces dose considerably
- Sinus formation
  - Maxillary – at birth
  - Frontal/sphenoid – 6-7 years
  - Ethmoid – teenage years

# Cranium - AP

- Octostop to restrain body or parent can hold still
- Sponge paddles to prevent rotation or flexion/extension
- Evaluation criteria the same as an adult



Image courtesy of Canada Diagnostic Centres



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# Cranium - Lateral



Image courtesy of Canada Diagnostic Centres



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- Rotate the body 45º and allow head to flop into a lateral position
- Warn parents
  - Looks bad, but is actually quite comfortable for patient
- Strap allows you to make small adjustments
- X-table lateral also possible using tape and sponges

# Pediatric GI Exams

- Less preparation than adult exams
  - Pediatric GI system moves more quickly, so emptying takes less time
- Instructions must be given in language the child understands
- More encouragement needed to ensure cooperation of young children
- All tubes must be appropriately sized
  - Retention cuffs are never used

# Pediatric UGI

- Preparation
  - <3 months = 3 hours NPO
  - 3 months – 5 years = 4 hours NPO
  - 5+ years = 6 hours NPO
- If child is hungry, they are more likely to drink the barium
- Barium is often diluted for infants
  - Much smaller amount administered than for an adult
- Entire exam often done recumbent
- Special care must be take with water soluble contrast
  - Pediatrics more prone to dehydration

# Pediatric BE

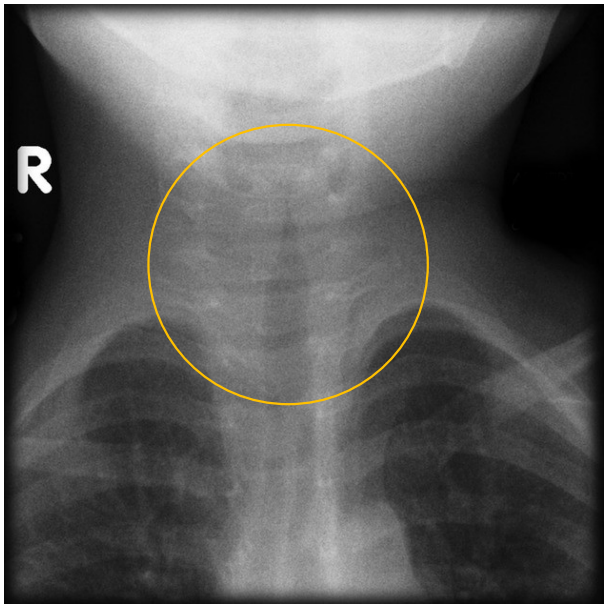
- Preparation
  - <2 years = no preparation
  - 2-10 years = Low residue diet, laxative tablet the night before exam, and possible fleet enema
  - 10 years to adult = low residue diet, 2 laxative tablets, and possible fleet enema
- Single contrast
  - Air contrast only used in very specific indications
- Pediatric enema tip
  - No retention cuff
  - Tape buttocks closed
- No enema bag used for neonates. Barium injected manually using a 60cc syringe

# Pediatric Genitourinary exams

- Voiding cystourethrogram (VCUG) is most commonly done on pediatrics
  - Reflux of urine into ureters during urination
- Scary exam for children
  - Must be explained in age appropriate terms
- Young school aged children find it extremely difficult to urinate on command
  - Toilet training is very recent
  - Easily embarrassed
- Constant encouragement and reinforcement required

# Peds Resp Pathology - Croup

- Viral infection
- Mostly seen in children 1-3 years old
- Hoarse cough and wheezing
- Worse at night
- Worsened by agitation and crying
  - Attempt to keep child calm while imaging
- Difficulty breathing if not upright
  - Do all imaging upright if at all possible

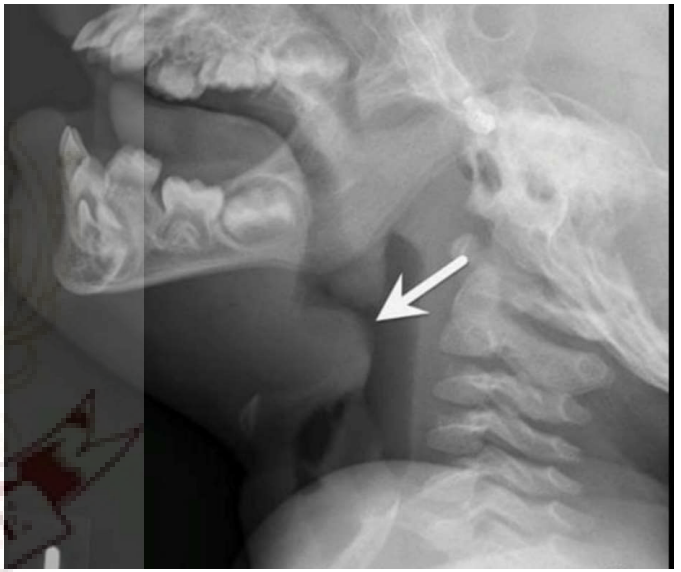



https://radiopaedia.org/articles/croup

Steeple sign

# Peds Resp Pathology - Epiglottitis

- Bacterial infection
- 3-6 years of age
- Can appear similar to croup
  - Drooling is an additional symptoms
- Airway occlusion may occur if placed supine
- Child should be accompanied by a physician or respiratory therapist

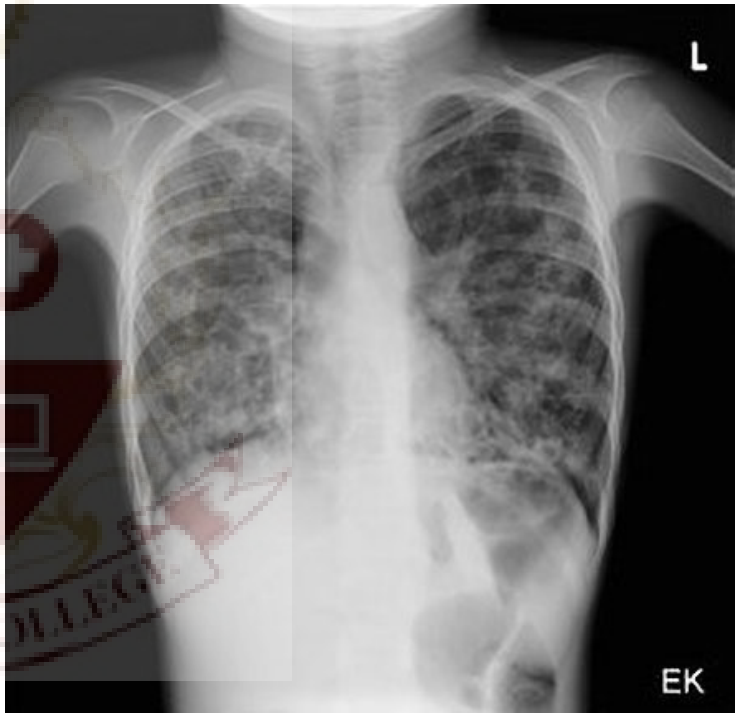


https://openpress.usask.ca/undergradimaging/chapter/epiglottitis-child/

"Thumb-like" swollen epiglottis

# Peds Resp Pathology – Cystic Fibrosis

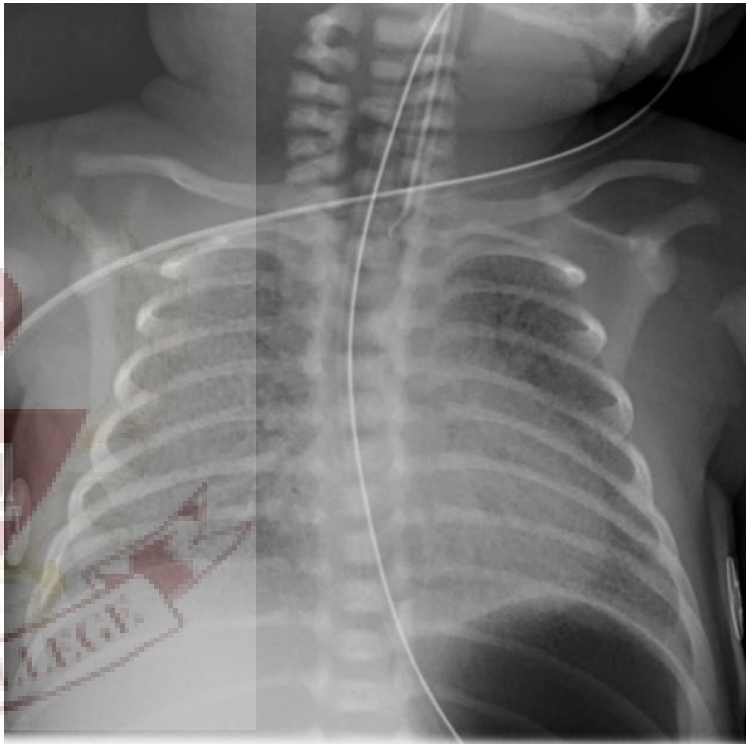
- Inherited condition
- Excess mucous produced in lungs
- Increased density of lungs on imaging
  - Increase technique
- Multiple CXRs over lifetime
  - Used to the X-ray room
  - Avoid repeats




https://radiopaedia.org/articles/cystic-fibrosis

# Peds Resp Pathology - RDS

- Respiratory Distress Syndrome or Hyaline Membrane disease
- Mostly affects premature infants
- Usually request a mobile CXR in the Neonatal Intensive Care Unit (NICU)



https://radiopaedia.org/articles/respiratory-distress-syndrome

"Ground glass" appearance of the lung markings

# Peds Skeletal Pathology – Bone Age

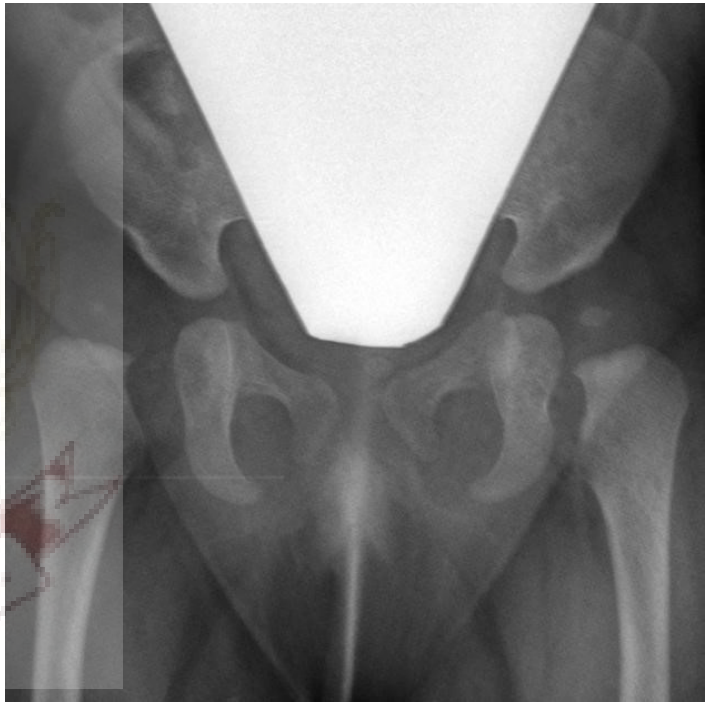
- Assess the maturity of the skeleton
- Diagnosing and managing growth and endocrine disorders
- Usually a single image of the non-dominant hand and wrist
  - Many site protocols call for left hand no matter which hand is dominant



https://radiopaedia.org/articles/bone-age-assessment

# Peds Skeletal Pathology - DDH

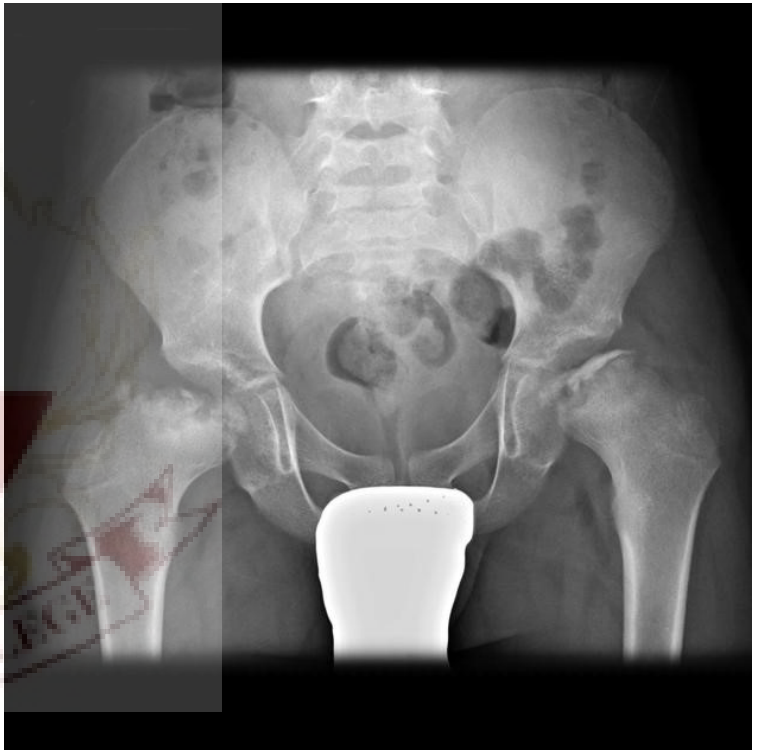
- Developmental Dysplasia of the Hip or Congenital Dislocation of the Hip (CDH)
- Abnormal position of the hip within the acetabulum
- Usually unilateral
- Diagnosed with ultrasound in neonates
- Symmetry in radiographs is ESSENTIAL for diagnosis
  - Absolutely NO rotation on your AP pelvis!



https://radiopaedia.org/articles/developmental-dysplasia-of-the-hip

# Pathology – Legg-Calvé-Perthes

- LEG-kahl-VAY-PER-tuz
- Avascular necrosis of the femoral head
- Idiopathic
- Usually unilateral
- Usually diagnosed at 5-6 years
- AP pelvis for diagnosis
  - Symmetry essential!



https://radiopaedia.org/articles/perthes-disease

# Peds Skeletal Pathology - Scoliosis

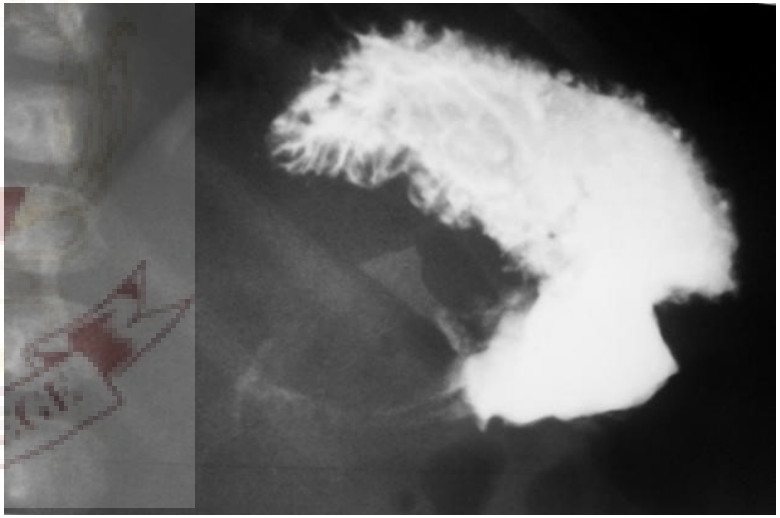
- Abnormal lateral curvature of T&L spine
  - Often some rotational abnormality as well
- Images upright when possible
  - AP, Lateral, and/or lateral bending
- Entire spine on one image
  - Computer program stitches 2 images on larger patients
- Cobb angle determines severity
- Done PA when possible to reduce breast dose
  - 90% less dose when done PA
  - Repeated X-rays over a lifetime




https://radiopaedia.org/cases/scoliosis-7

# GI Path – Hypertrophic Pyloric Stenosis

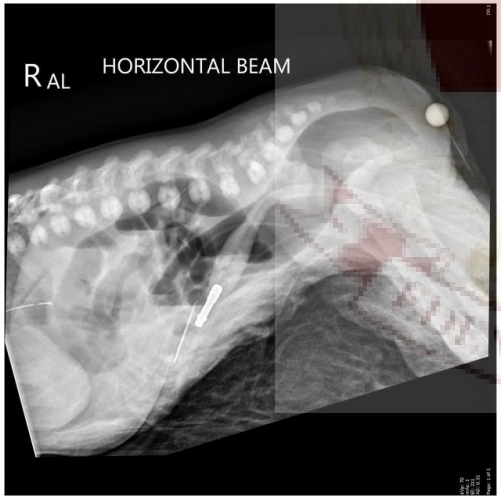
- Overgrowth of pyloric muscles
- Gastric outlet obstruction
- Often diagnosed with ultrasound
  - UGI fluoro also used
- Projectile vomiting
  - Avoid giving too much barium during UGI



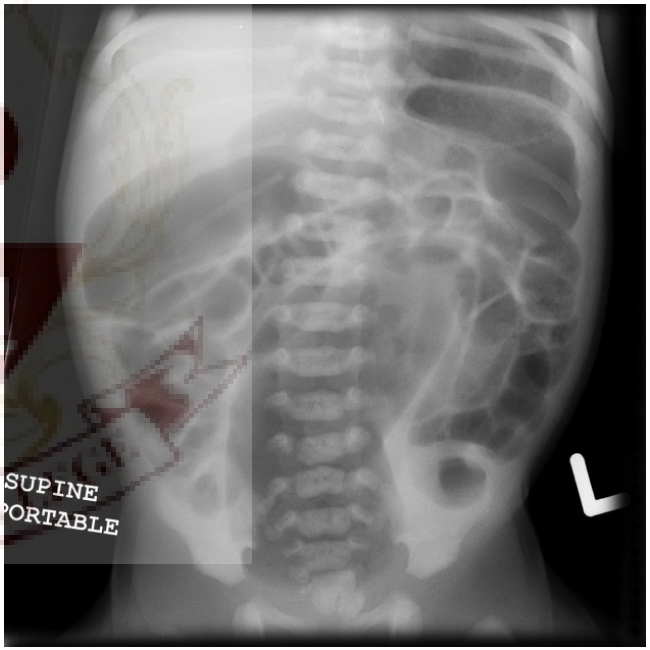
https://radiopaedia.org/articles/pyloric-stenosis?lang=us

# Peds GI Pathology - Anal Atresia

- Membranous separation or absence of anus
- Dilated bowel loops
- Fistulas to vagina or bladder



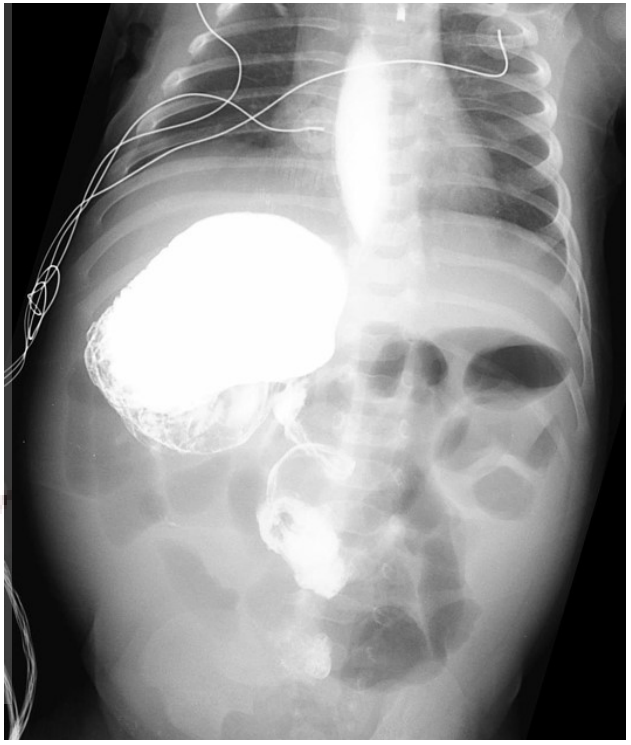

https://radiopaedia.org/articles/anal-atresia




https://radiopaedia.org/articles/anal-atresia

# Peds GI Pathology - Volvulus

- Usually a complication of a small bowel malrotation
- 75% of cases occur in first month of life
- Loops of bowel rotate around the mesentery
- Loss of blood flow leads to peritonitis and shock
- Shown by UGI or occasionally BE



https://radiopaedia.org/articles/midgut-volvulus?lang=us

# Peds GI pathology - Intussusception

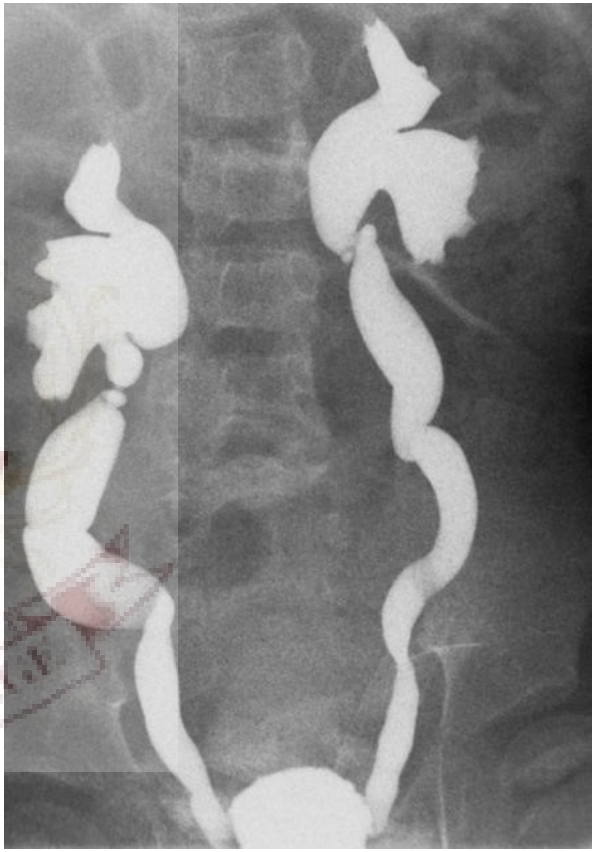
- One loop of bowel telescopes into another
- Can compromise blood supply and cause necrosis
- BE to diagnose and to treat
  - Water soluble contrast and/or air
  - Extremely delicate



http://onradiology.blogspot.com/2011/02/coiled-spring-appearance-of.html

# Peds GU Path – Vesicoureteral Reflux

- Reflux of urine into ureter during micturition
- Causes repeated urinary tract infections and pyelonephritis
- VCUG is the exam of choice to diagnose
- Graded by severity



https://radiopaedia.org/articles/vesicoureteric-reflux

# Non-Accidental Trauma (NAT)

- Child abuse
  - Child abuse is any form of physical, emotional and/or sexual mistreatment or lack of care that causes injury or emotional damage to a child or youth.
- Technologists have the most direct experiences with suspected or confirmed physical abuse
- Certain fractures, or fracture patterns are indicative of physical abuse
- Technologist's role is to provide good diagnostic images to allow for radiologist to make a definitive report

# Imaging for NAT

- X-ray: Skeletal survey
  - Series of images done to demonstrate as much of the body as possible
  - Combine images where possible to minimize dose, but do not compromise diagnostic clarity
  - Careful technique selection
    - Very small fractures may be obscured by a grainy image

- AP chest – to include AP T-spine
- Rt oblique chest – include entire chest and left scap Y
- Left oblique chest – include entire chest and right scap Y
- Lateral chest
- AP pelvis – to include AP L-spine
- AP and lat lower legs
- AP and lat feet

- AP and lateral humeri and forearms
- AP and Townes skull
- Right lateral skull
- Left lateral skull – to include lateral C-spine
- Lateral T-spine
- Lateral L-spine
- *Lateral T&L spine can be combined

# Imaging for NAT cont.

- Nuclear medicine: Bone scan
  - Demonstrates increased blood flow to a bone
  - More blood flow = inflammation
  - Inflammation = healing
- Can detect fractures up to 10 years old
- Often used in conjunction with a skeletal survey

# Images as Legal Documents

- May be used as evidence in legal proceedings
  - Lead markers necessary. NO ELECTRONIC!
  - All demographics on the image correct
  - All documentation correctly filled out

- Case may be dismissed on technical grounds if the imaging is not correct

# Indications of Abuse

- Specific fractures to look for:
- Classic metaphyseal lesion
  - "Bucket handle" or "corner" fracture
  - End of the diaphysis tears off
  - Caused by pulling trauma
- Rib fractures
  - Multiple posterior fractures
  - Caused by squeezing and shaking
- Multiple fractures over a long period of time
  - Mechanism of injury does not match story
  - Partial healing on a newly reported fracture

# Maintaining Professionalism

- Put your own feelings aside
  - Attend to the patient and the task at hand
- Treat the adults with the child with respect
  - They may not be responsible for the injuries
- Avoid jumping to conclusions or making assumptions