

# *Imaging of Pediatric Emergencies*



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# *PRINCIPLES OF RADIOGRAPHY*

- Shades of gray
  - X-ray beam passes through patient
  - Tissue density results in variable attenuation of x-rays
  - Attenuation of beam yields variable exposure of film

# *PROCESS OF INTERPRETATION*

- Pattern approach
  - Outside-in
  - Start with the less important areas
  - Focus on the region of interest
  - Finish with “blind spots”
  - Beware “satisfaction of search”

# *PRINCIPLES OF INTERPRETATION*

- Normal versus abnormal
  - Knowledge of normal is crucial
  - Be aware of normal variants
- WWW.radiologic diagnosis
  - What is abnormal → “not normal”
  - Where is the abnormality → “location, ...”
  - Why is it abnormal → differential dx

Clinical History:  
“failure to thrive:  
rule out reflux”



# Imaging modalities

- Conventional radiography
- Contrast fluoroscopy
- Ultrasonography
- Computed Tomography
- Nuclear Medicine
- Magnetic Resonance Imaging

# RADIOGRAPHIC TECHNIQUES

- Conventional Radiography - “CXR”
  - AP (anteroposterior)/PA (posteroanterior) and Lat (lateral)
  - Supplemental views
    - Oblique
    - Inspiratory/Expiratory
    - Decubitus

# Abdominal series

- Supine abdominal film (KUB)
- Horizontal beam film
  - Upright
  - Lateral decubitus
  - Cross-table lateral
- Findings:
  - “bones, stones, masses and gasses”

# Abdominal Findings

- Bowel gas pattern – small vs large bowel
- Obstruction – level of obstruction
- Perforation – potential etiologies
- Calcifications
- Intraabdominal mass/organomegaly

# Fluoroscopic Examinations

- Esophagram or Barium swallow
  - evaluating for foreign body or perforation
- Upper GI
  - What does it include?
- Contrast enema
  - Water soluble material (positive contrast)
  - Air only (negative contrast)

# Ultrasonography

- What can the radiologist do for you?
- Very versatile modality – potential utility in all anatomic areas
- Well-tolerated exam – low risk, no ionizing radiation
- **Real-time imaging**

# Ultrasonography

- Gastroduodenal disease
  - Hypertrophic pyloric stenosis
  - Intestinal malrotation (SMA/SMV relationship)
- Small bowel processes, including IBD, mesenteric adenitis, inguinal hernia
- Appendicitis - +/- abscess drainage
- Intussusception

# Computed Tomography

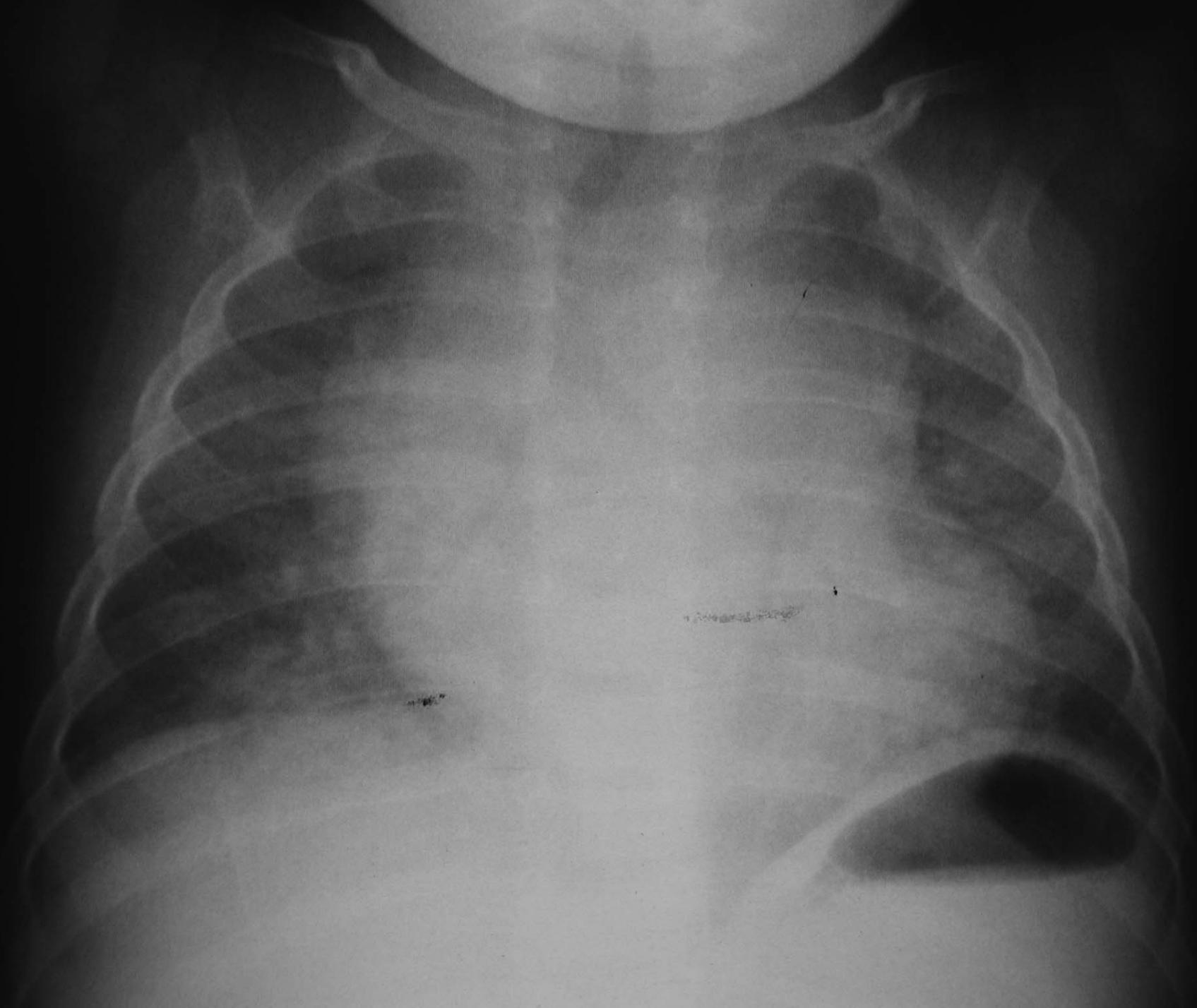
- Problem solver
- Complementary exam to Xray and ultrasound
- More useful in older children
- With or without contrast? If so, which?
  - Intravenous
  - Oral
  - Rectal

# Pediatrics – “just small adults?”



14 MAY 2001



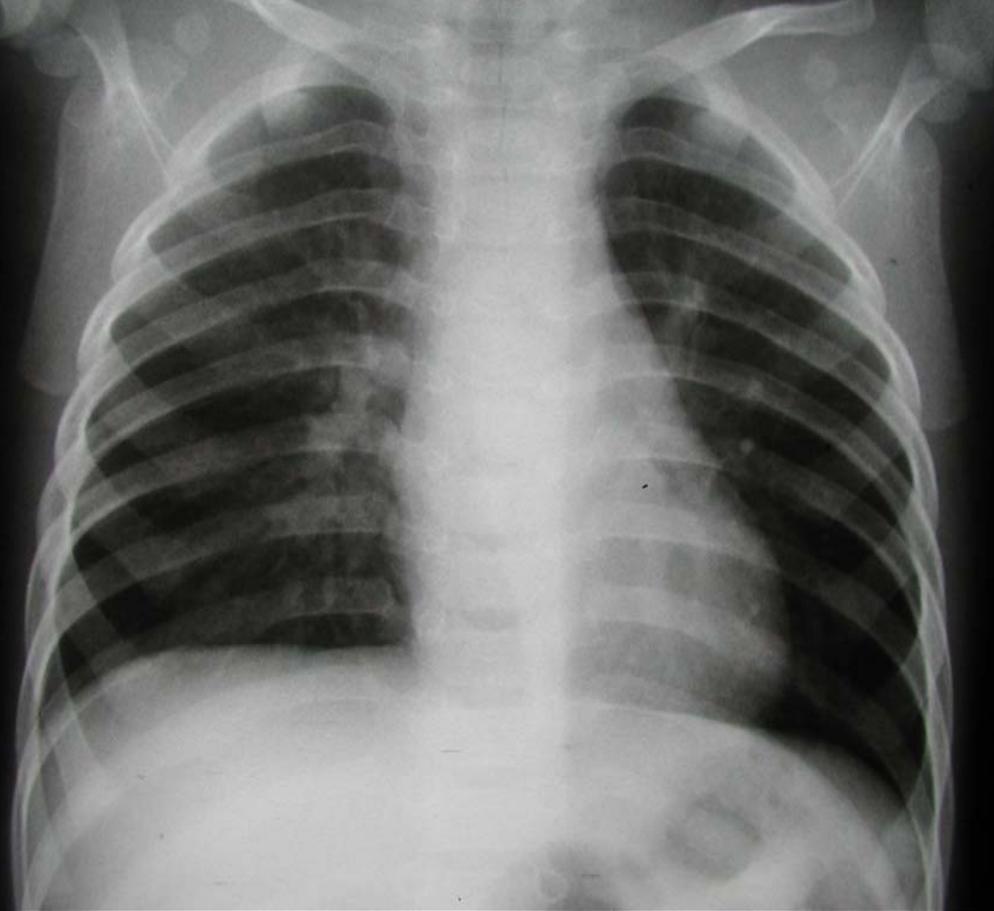


14 MAY 2001



# *Chest: Case 1a*

- Abnormal lung inflation
  - Hyperinflation – air trapping
  - Hypoinflation - atelectasis
- Reactive airway disease
  - Common cause of tachypnea, cough and respiratory distress in children
  - Small caliber airways with mural thickening and intraluminal mucous results in obstruction



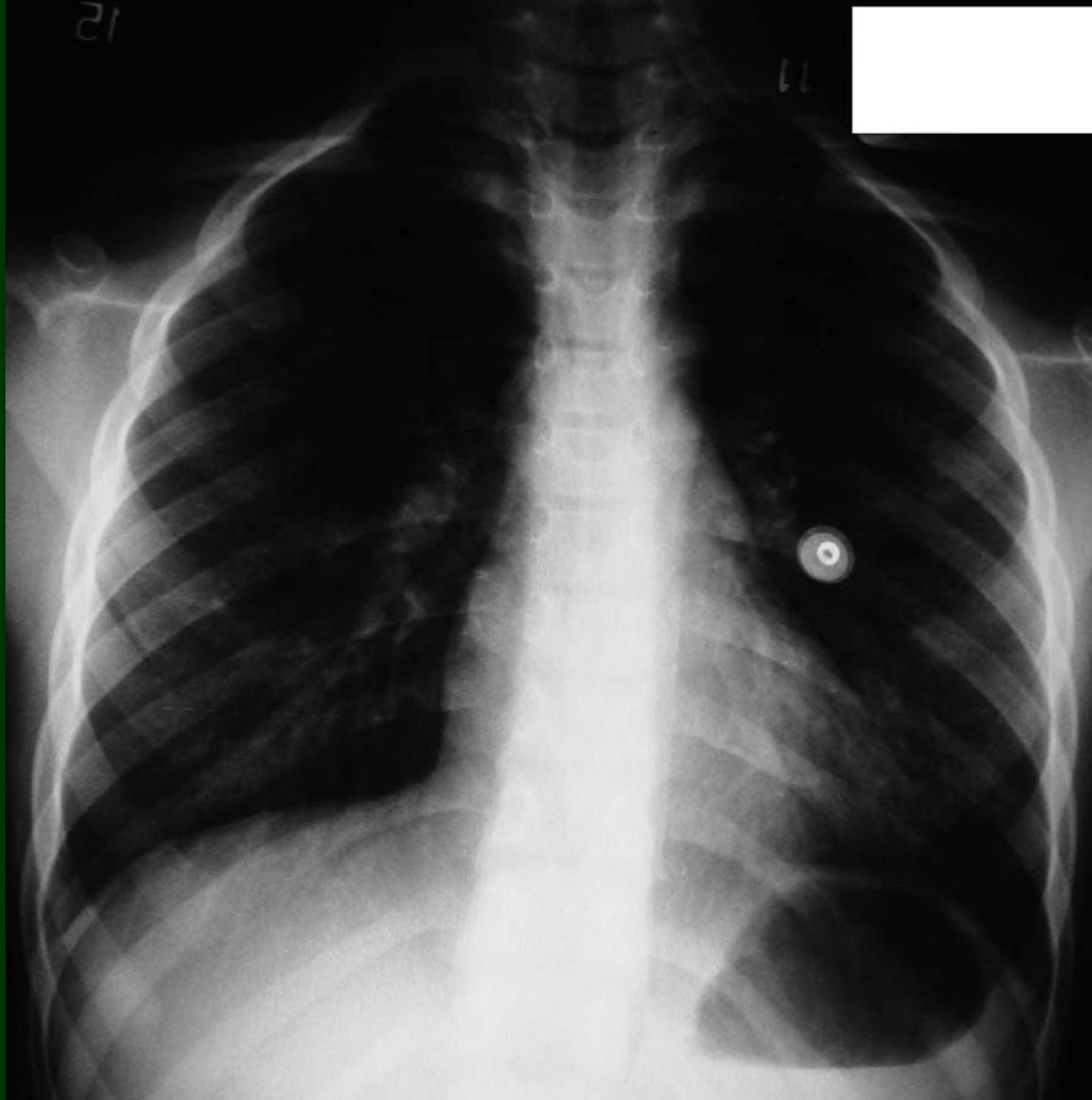
Reactive airway disease  
- hyperinflation  
- peribronchial cuffing





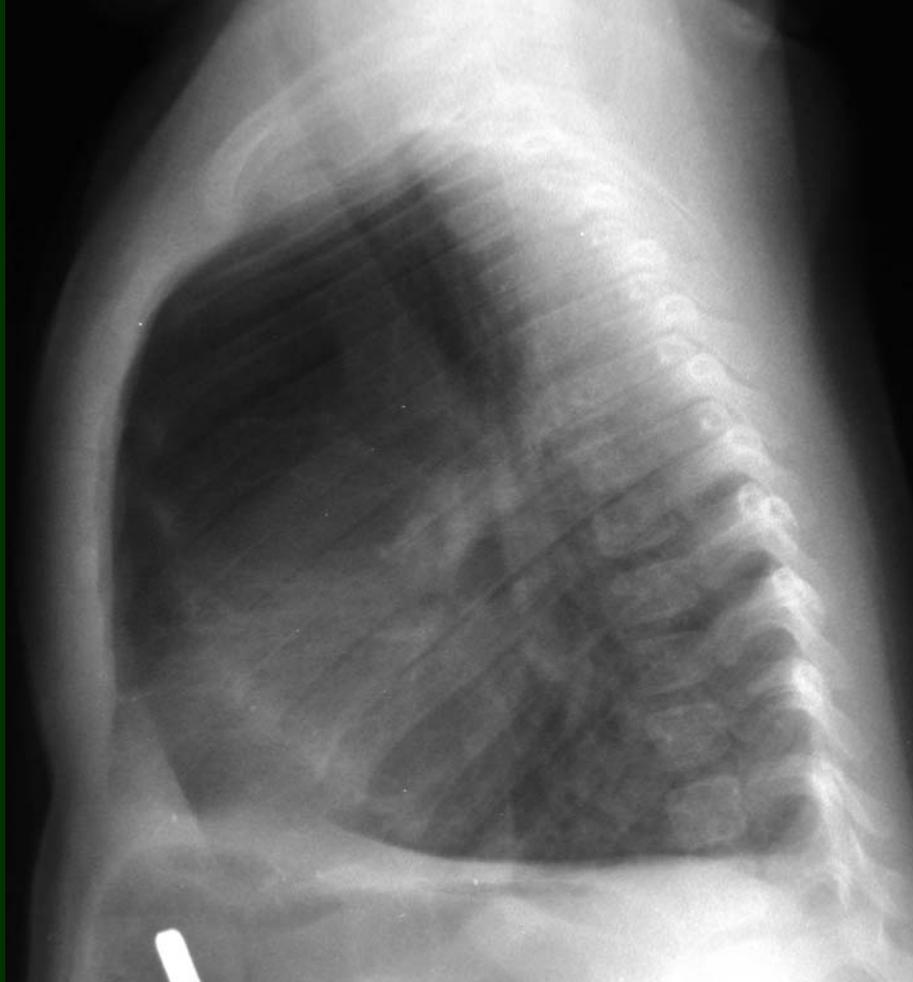
10 yo girl with tachypnea and wheezing  
DX: Left upper lobe collapse due to mucous plug

# Same patient after nebulizer treatments



## *Chest: Case 1b*

- Congenital lobar emphysema
  - Hyperinflated lobe with compression of ipsilateral lobes and mediastinal shift
  - Distended alveoli, decreased vascularity
  - Usually one lobe involved:
    - LUL 40%, RML 30%, RUL 20%
  - Idiopathic 50%; bronchial obstruction, developmental alveolar abnormality, alveolar/interstitial destruction



16 March 2002

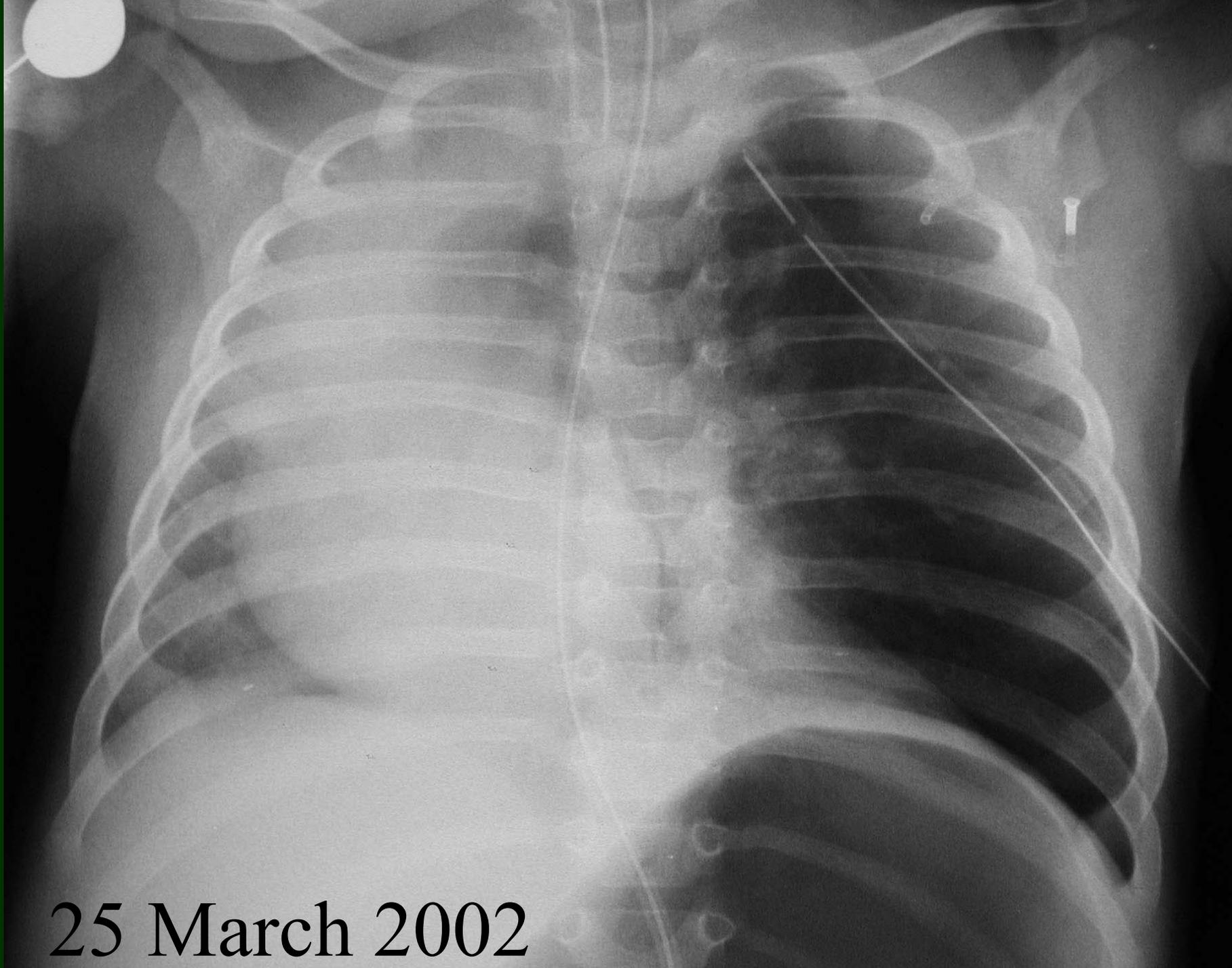
3 mos old w/ respiratory distress

PhysEx: “equal breath sounds bilaterally”

Clinical Dx: “Bronchiolitis”



24 March 2002



25 March 2002

CT HiSpeed Adv SYS#CT01

CHILDRENS HOSP, WASH D.C.

Ex:28851

Se:3 RETRO

SN I55.5

Im:72

7M F

JUL 14, 2000

512

DFOV 13.0cm

LUNG

R  
4  
0

L  
9  
0

R

L

kV 120

mA 120

Smart mA 110

Small

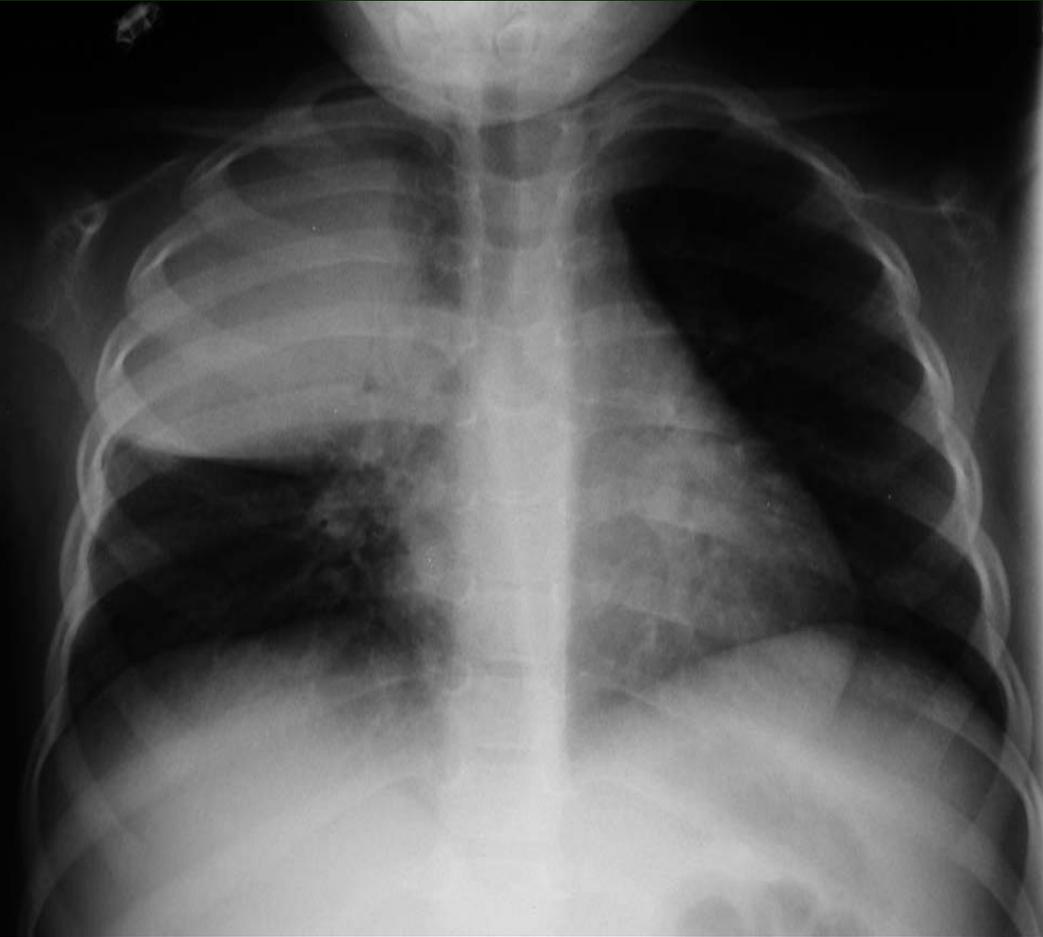
5.0mm/1:1

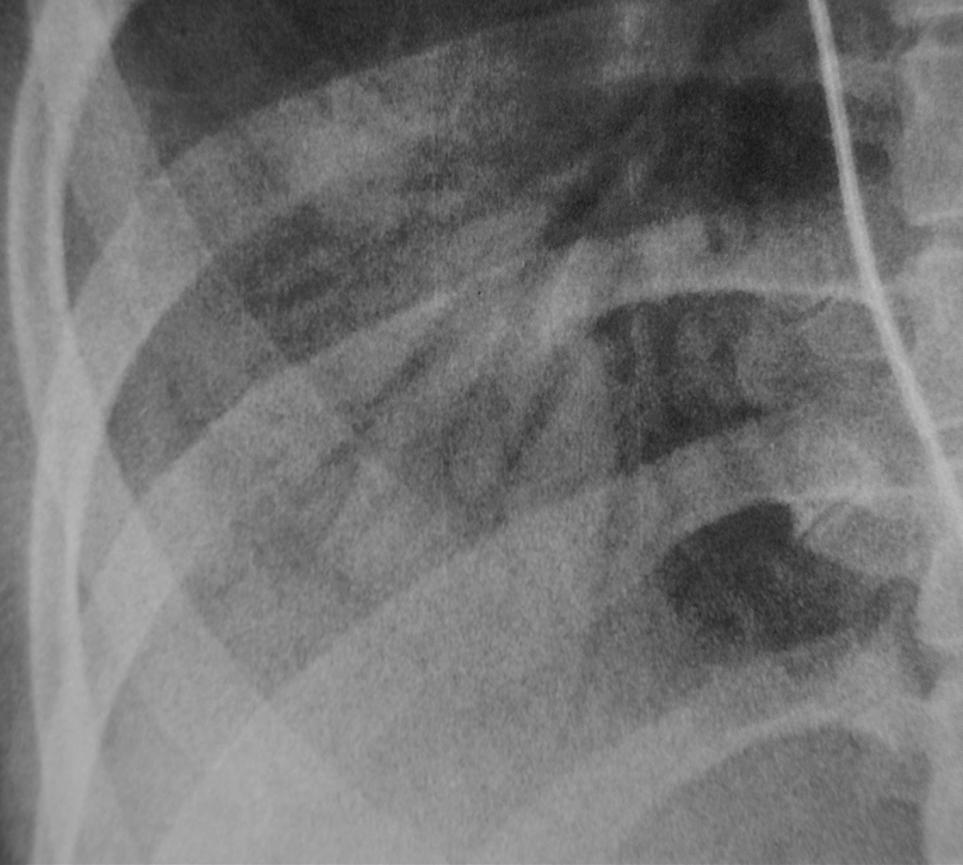


## *Chest: Case 2*

- Acute bacterial pneumonia
- Clinical presentation: high fever, tachypnea, cough (+/- productive), tachycardia
- CXR findings: dense focal opacity with air bronchograms – no volume loss
- Most common organisms are *Strep pneumoniae* and *Staph aureus*

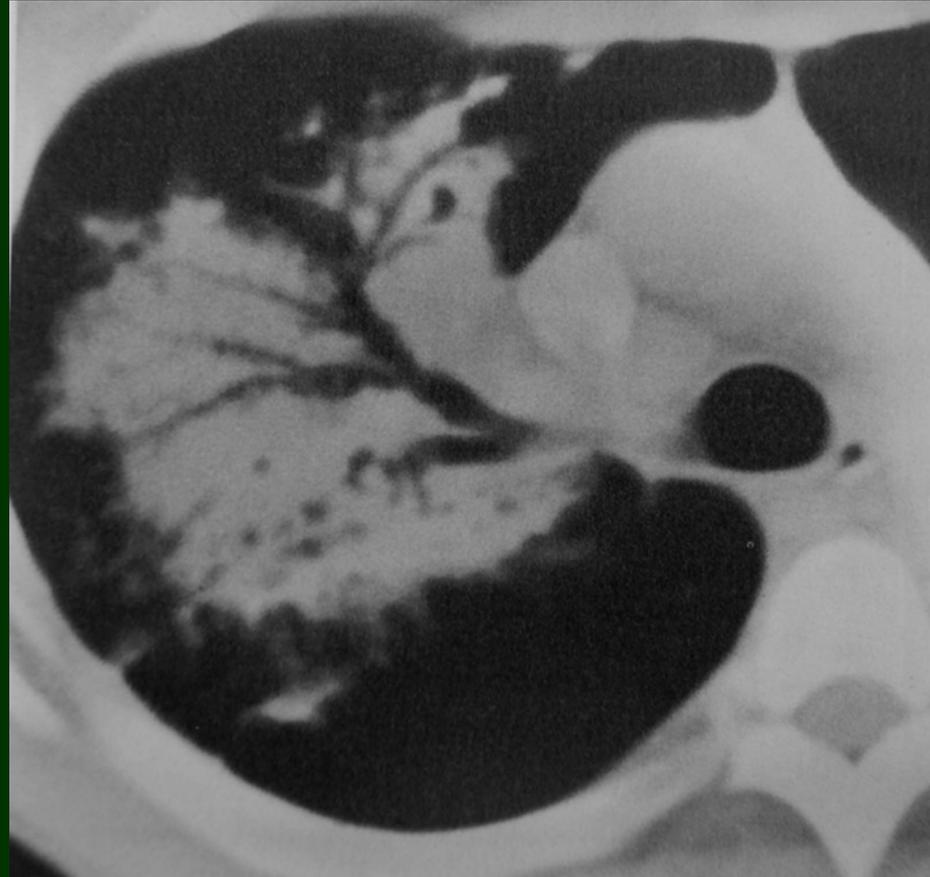
# Right upper lobe pneumonia



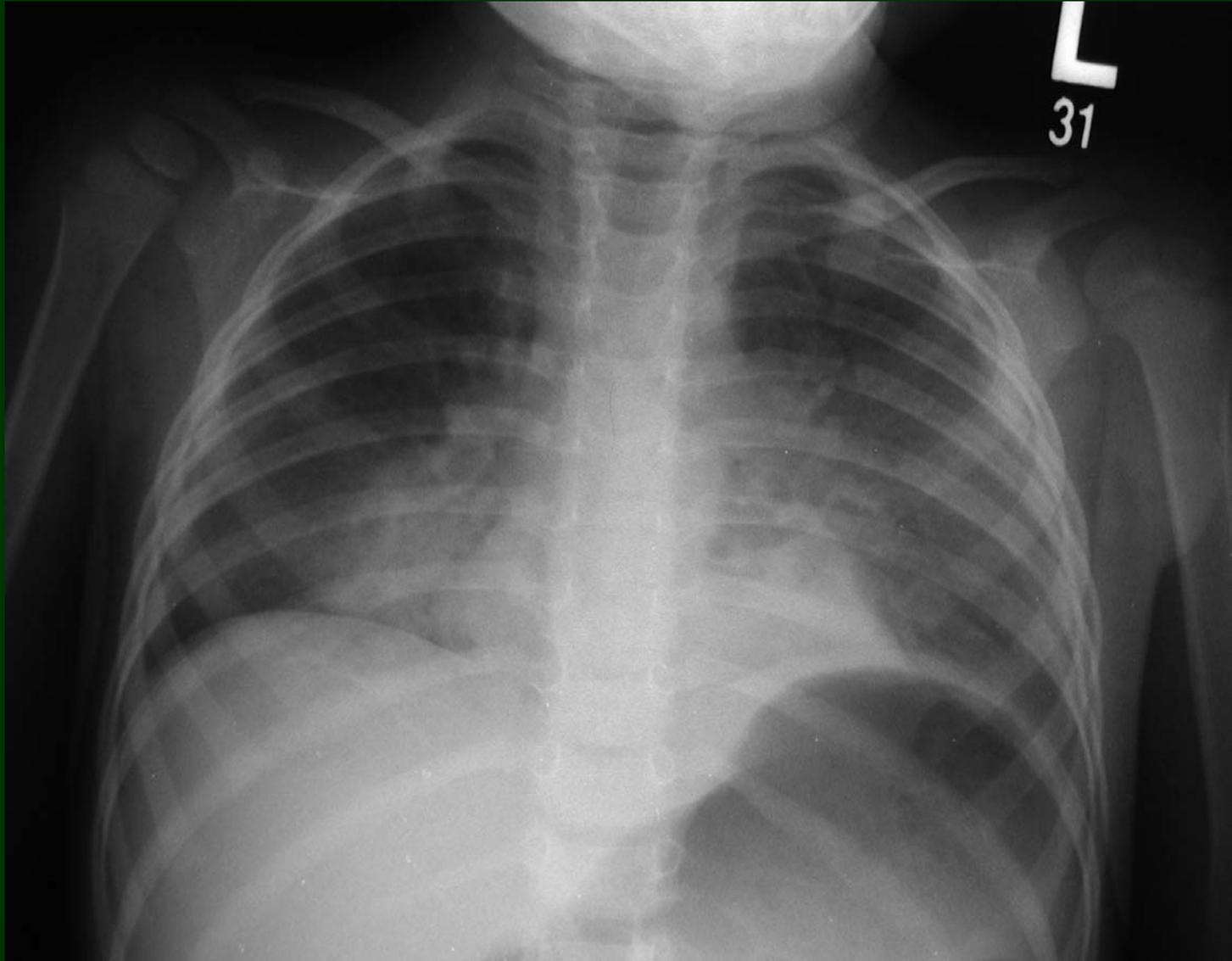


Right lower lobe  
pneumonia

Air bronchograms  
on CT



# Necrotizing pneumonia



Im: 60+C

DOB: May 14 2002

Nov 15 2003

512

DFOV 20.0cm

STND

MF:1.2

R

1  
0  
0

L

6  
7

kV 120

mA 100

Large

5.00mm/11.25 HQ



## *Chest: Case 3*

- Foreign body ingestion/aspiration

# ESOPHAGEAL FOREIGN BODY

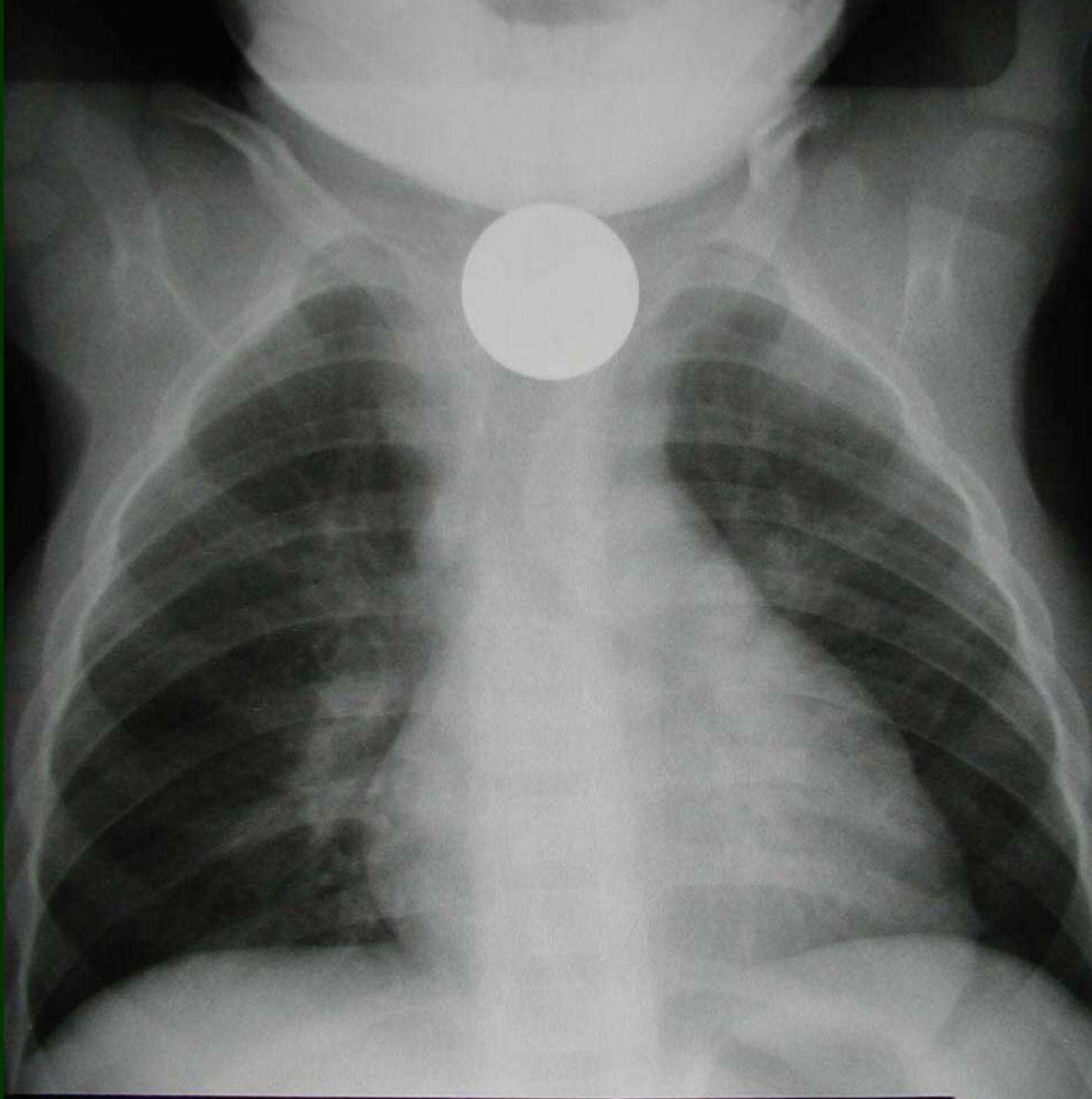
- Common in toddlers, boys > girls
  - Most pass without complication
  - If impacted in esophagus, most acutely symptomatic
- Tend to impact at points of narrowing
  - Normal: thoracic inlet, aortic arch, left mainstem bronchus, GE junction(uncommon)
  - Abnormal: pre-existing stricture (eg. atresia repair)
- May cause inflammation and possible perforation
  - Increased risk if present greater than 24 hours

# One yr old presents with “? seizure”



# ESOPHAGEAL FOREIGN BODIES

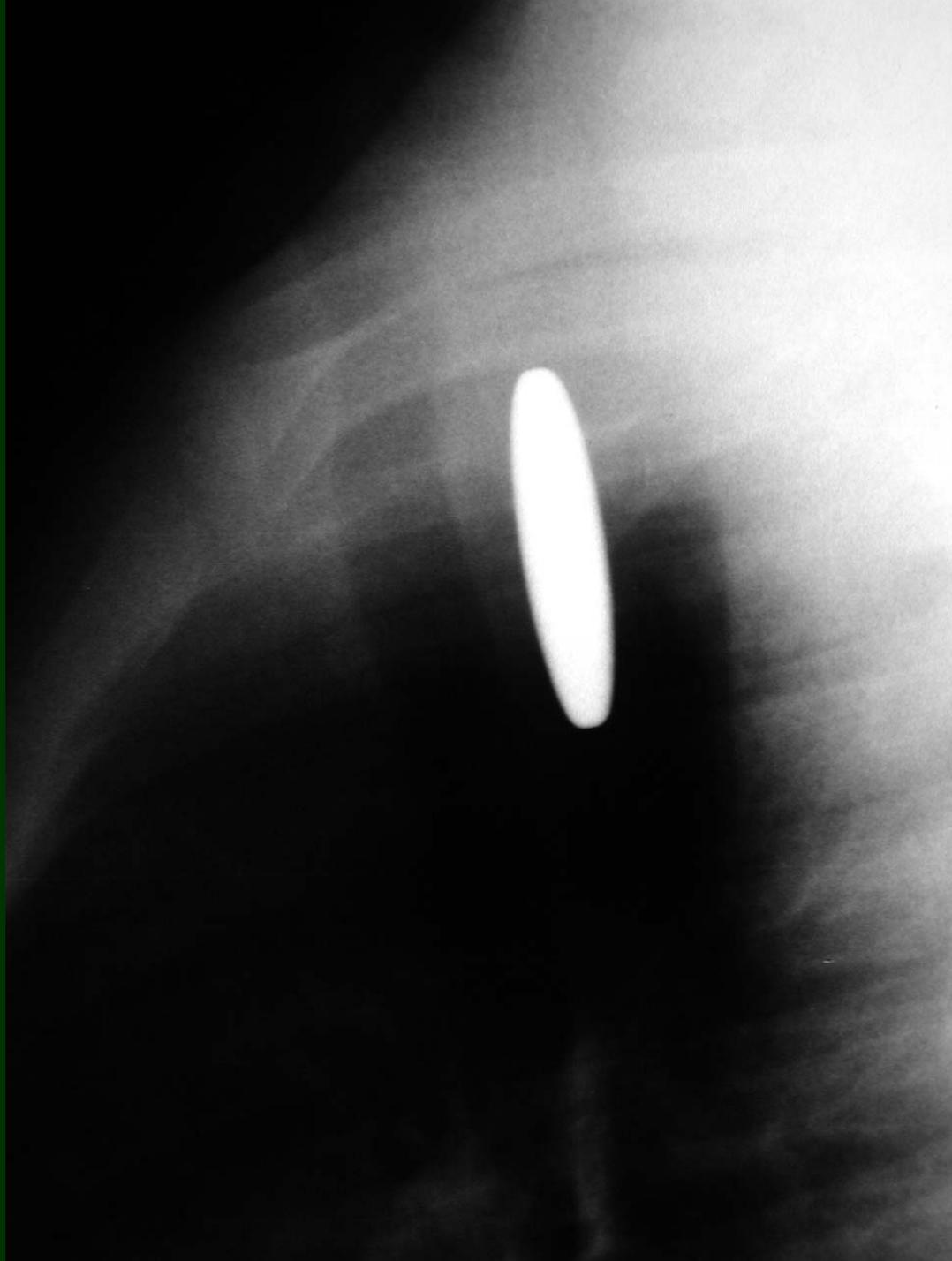
- AP film of child from nose to anus
  - Lateral view as needed to further localize
- Contrast esophagram (water-soluble agent)
  - if suspicious for radiolucent object
- Removal usually with endoscopy
  - Fluoroscopic Foley method controversial (must meet criteria)



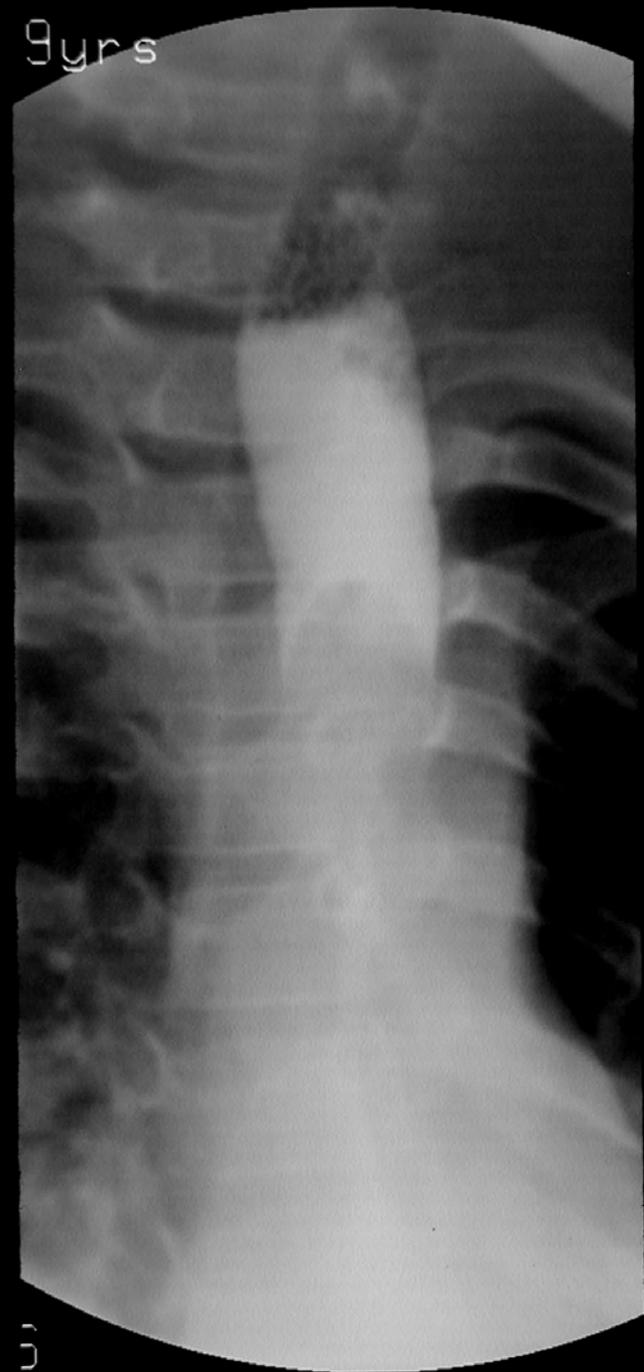
# Esophageal foreign body

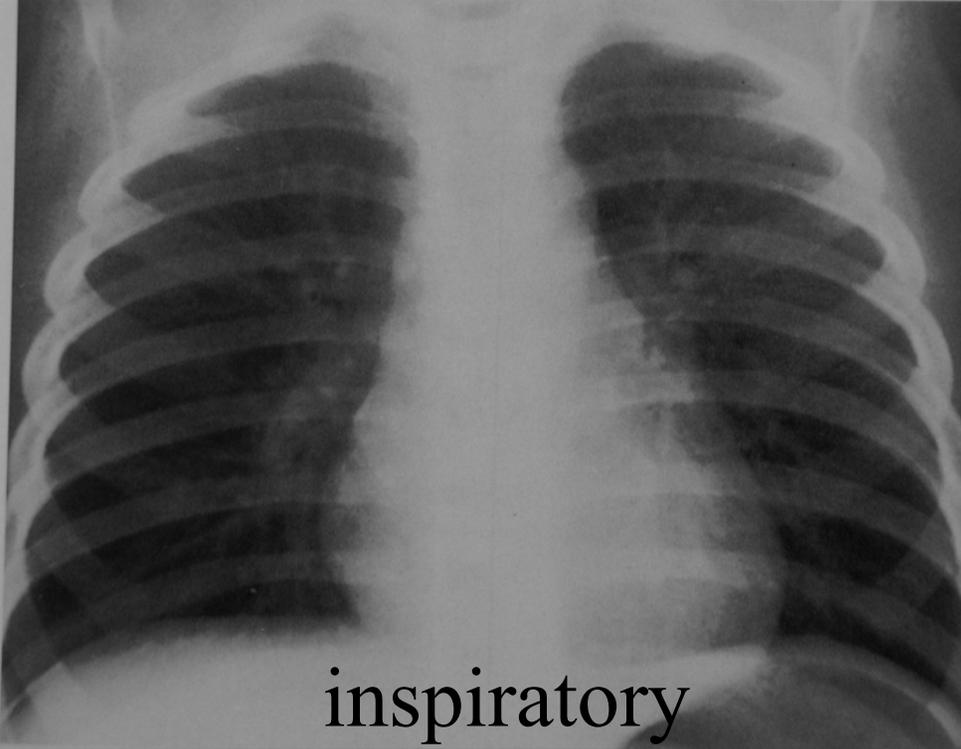
lateral view can be  
very helpful

- anatomic  
localization
- detection of  
complications



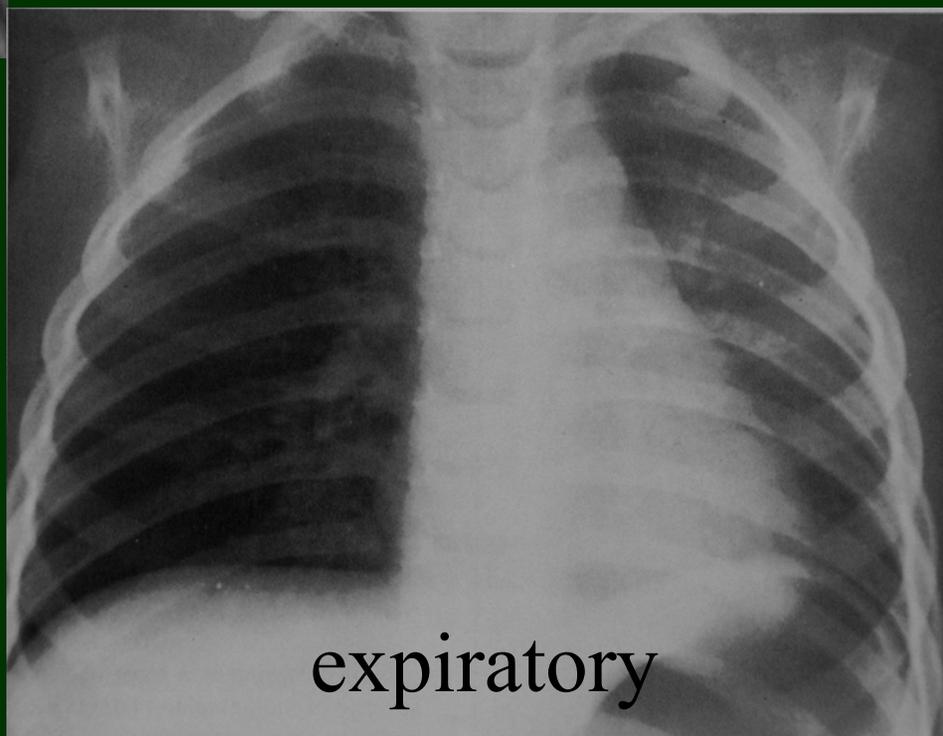
Esophagram  
- radiolucent  
foreign body





inspiratory

Right mainstem  
foreign body  
- air trapping



expiratory

Could also obtain  
bilateral decubitus  
views

## *Abdomen: Case 4*

- Non-bilious emesis

# Hypertrophic pyloric stenosis

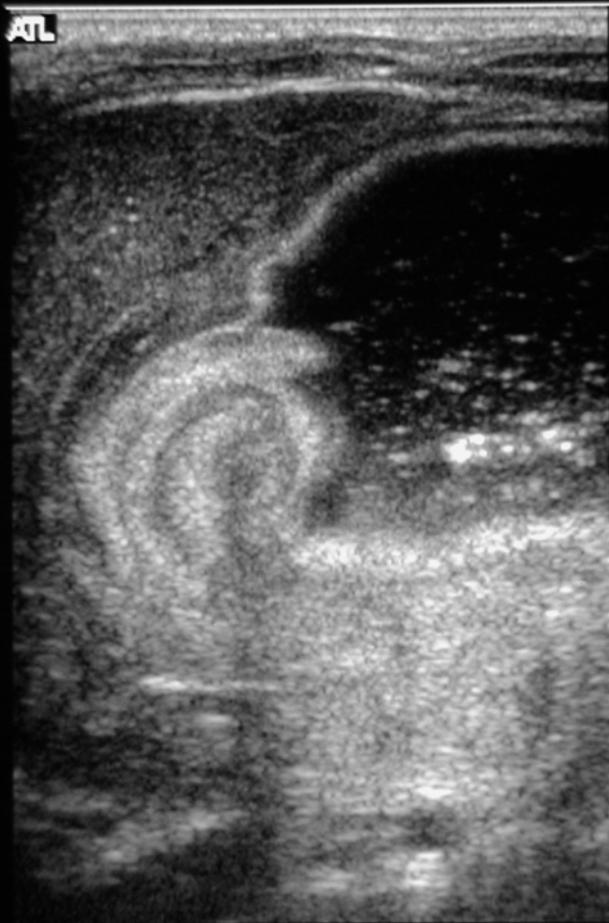
- Clinical presentation
  - 3 – 6 week old infant, male > female
  - Progressive, projectile non-bilious emesis
  - “olive” in RUQ may be palpable
- Plain film findings
  - Distended, air-filled stomach
  - May see circumferential contraction bands

5 week old  
male with  
progressive  
projectile  
vomiting



# Hypertrophic pyloric stenosis

- Ultrasound: imaging modality of choice
  - Elongated pylorus with thickened wall
  - 3 mm muscle thickness
  - 14 mm channel length
- Upper GI examination: if US negative or equivocal
  - Delayed gastric emptying
  - “Shouldering”, “beak” sign
  - “String” sign, “double track” sign



Hypertrophic pyloric stenosis  
on sonography

# Hypertrophic pyloric stenosis on Upper Gastrointestinal exam



# *Abdomen: Case 5*

- Bilious emesis

# Intestinal malrotation/volvulus

- Developmental abnormality of gut rotation
  - Normally rotates 270 degrees counterclockwise
- Short small bowel mesentery allows greater mobility, more likely to twist
  - Normally fixed at ligament of Treitz (LUQ) and at distal ileum (RLQ)
- Fibrous peritoneal Ladd's bands may cause extrinsic compression

# Intestinal malrotation/volvulus

- Clinical exam:
  - Majority present in first month of life, often in first few days
  - Sudden onset bilious emesis
  - Abdominal distension
- Plain film findings
  - May have normal bowel gas pattern
  - Often proximal small bowel obstruction or ileus
  - Bowel wall thickening or pneumatosis

# Intestinal malrotation/volvulus

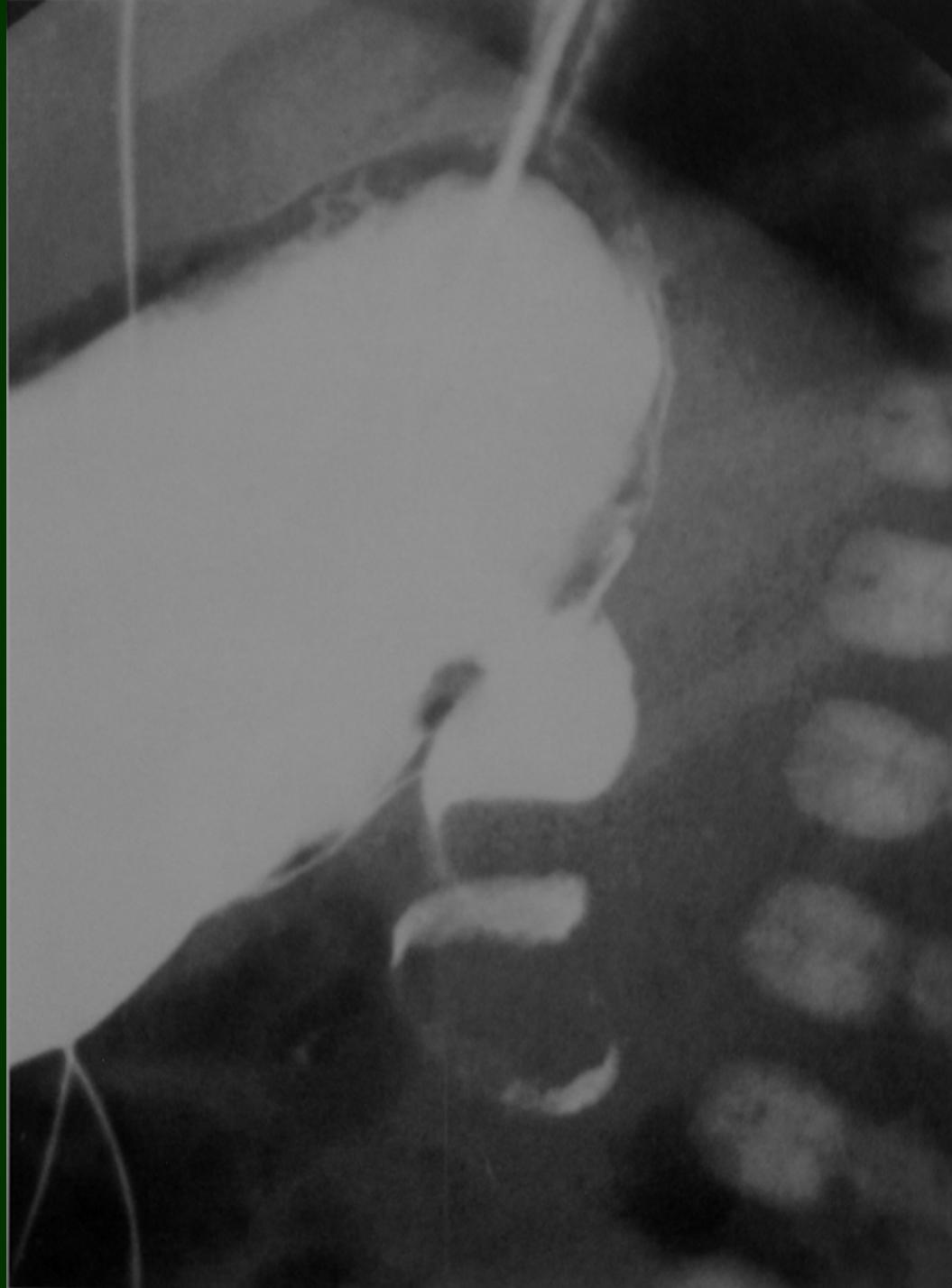
- Upper GI : study of choice
  - Duodenal obstruction, mural edema
  - Corkscrew duodenum
  - Abnormal position of Ligament of Treitz
- Ultrasound: helpful adjunct in equivocal UGI
  - abnormal relationship of superior mesenteric artery and vein (vein usually anterior and to the right of the artery)
- Contrast enema: abnormal position of cecum
  - Significant number of false positive and false negative

# UGI: malrotation

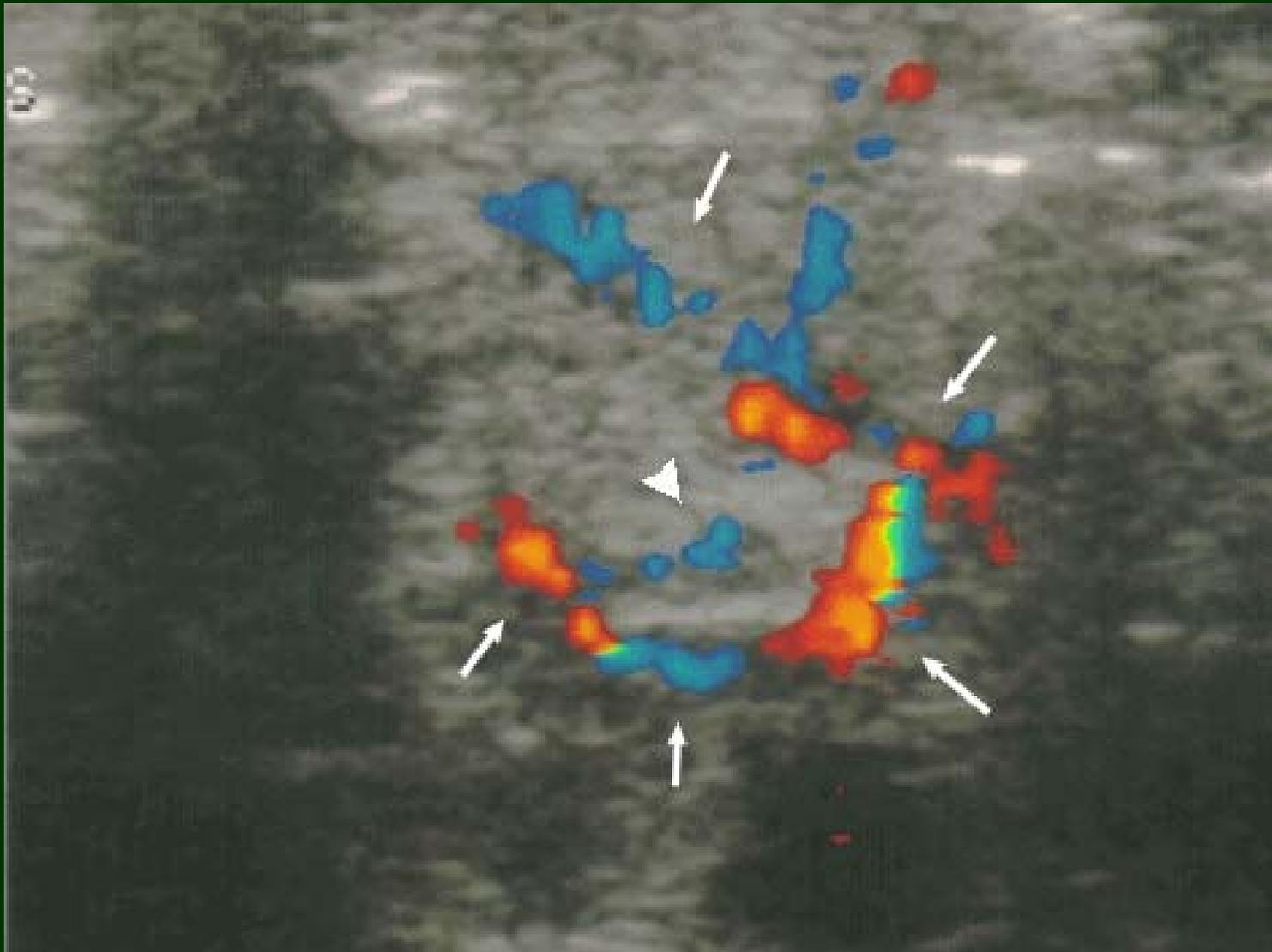


Malrotation with  
volvulus

“corkscrew sign”



# Ultrasound: midgut volvulus



## *Abdomen: Case 6*

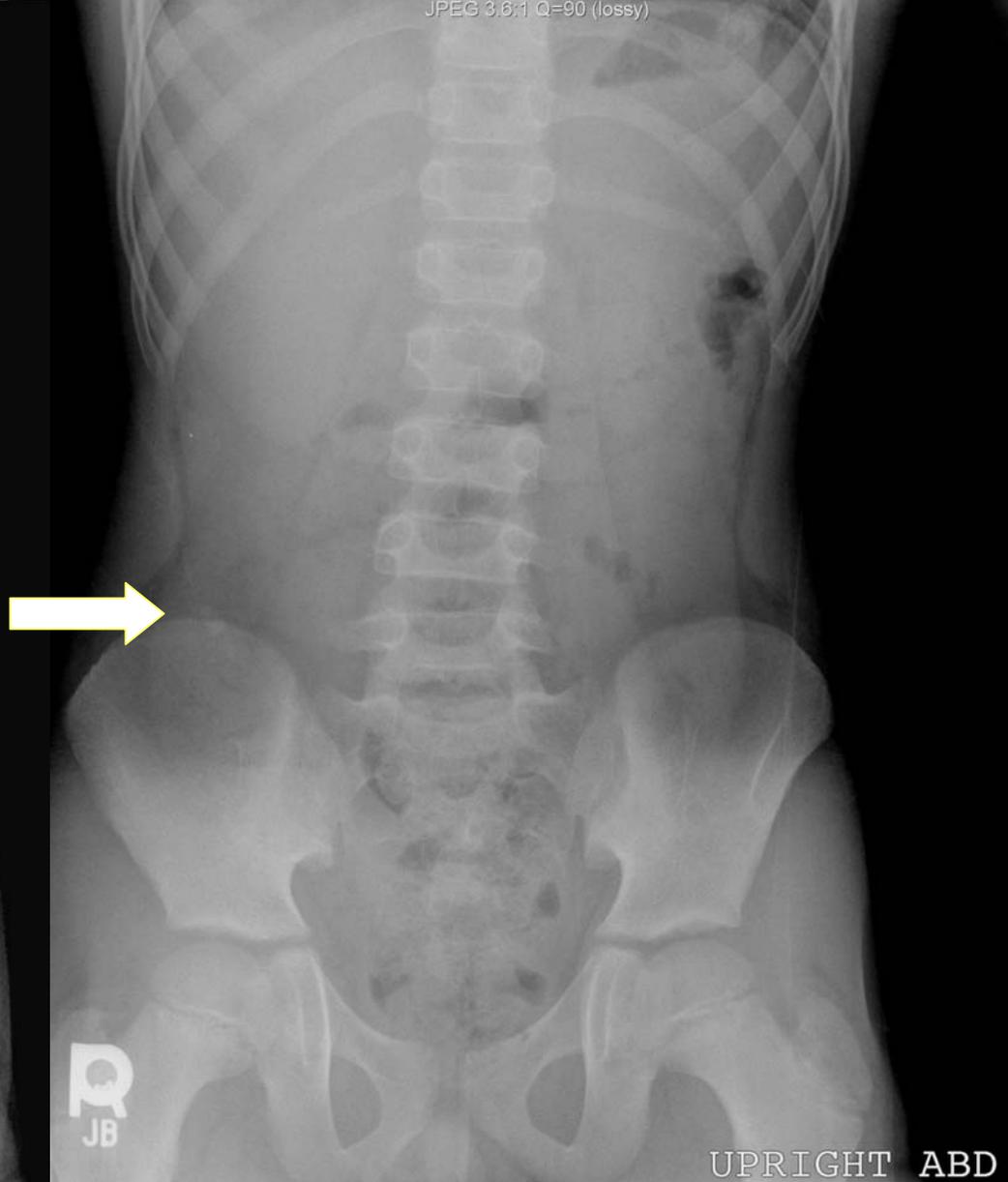
- Acute right lower quadrant pain

# Appendicitis

- Obstructed appendiceal lumen
- Most common cause of emergency surgery in children
- Incidence increases with age during childhood
- Perforations more common in children
  - Non-specific, vague symptoms

# Appendicitis

- Plain film findings
  - NORMAL in majority
  - Small bowel obstruction/ileus
  - Free air
  - Abnormal RLQ soft tissue density
  - Appendicolith (20 %)

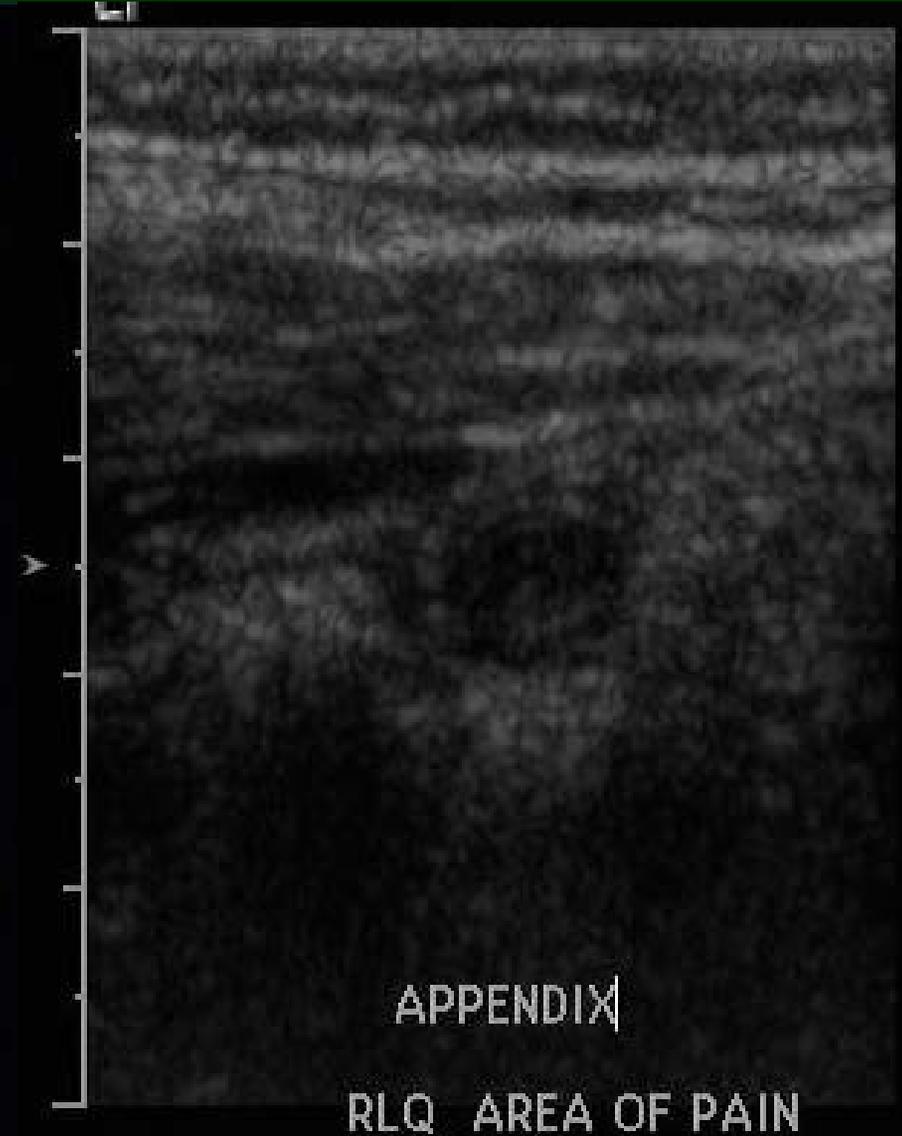
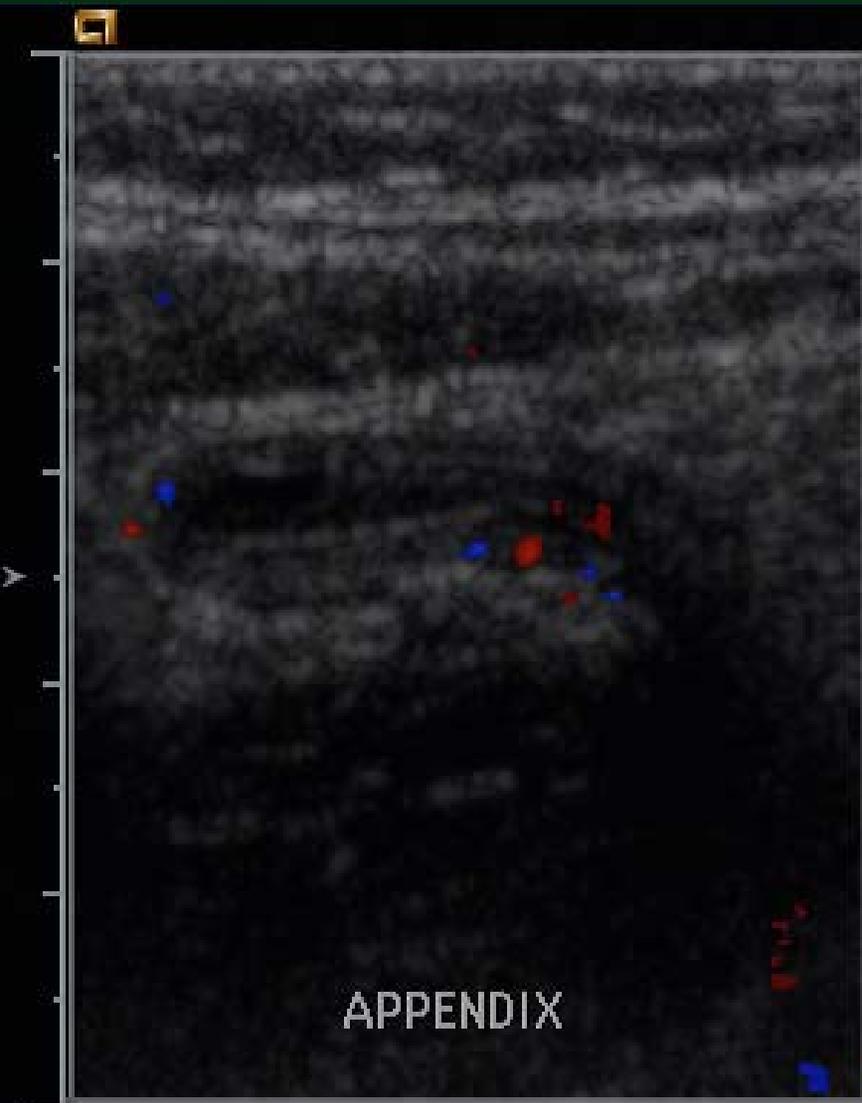


Appendicolith

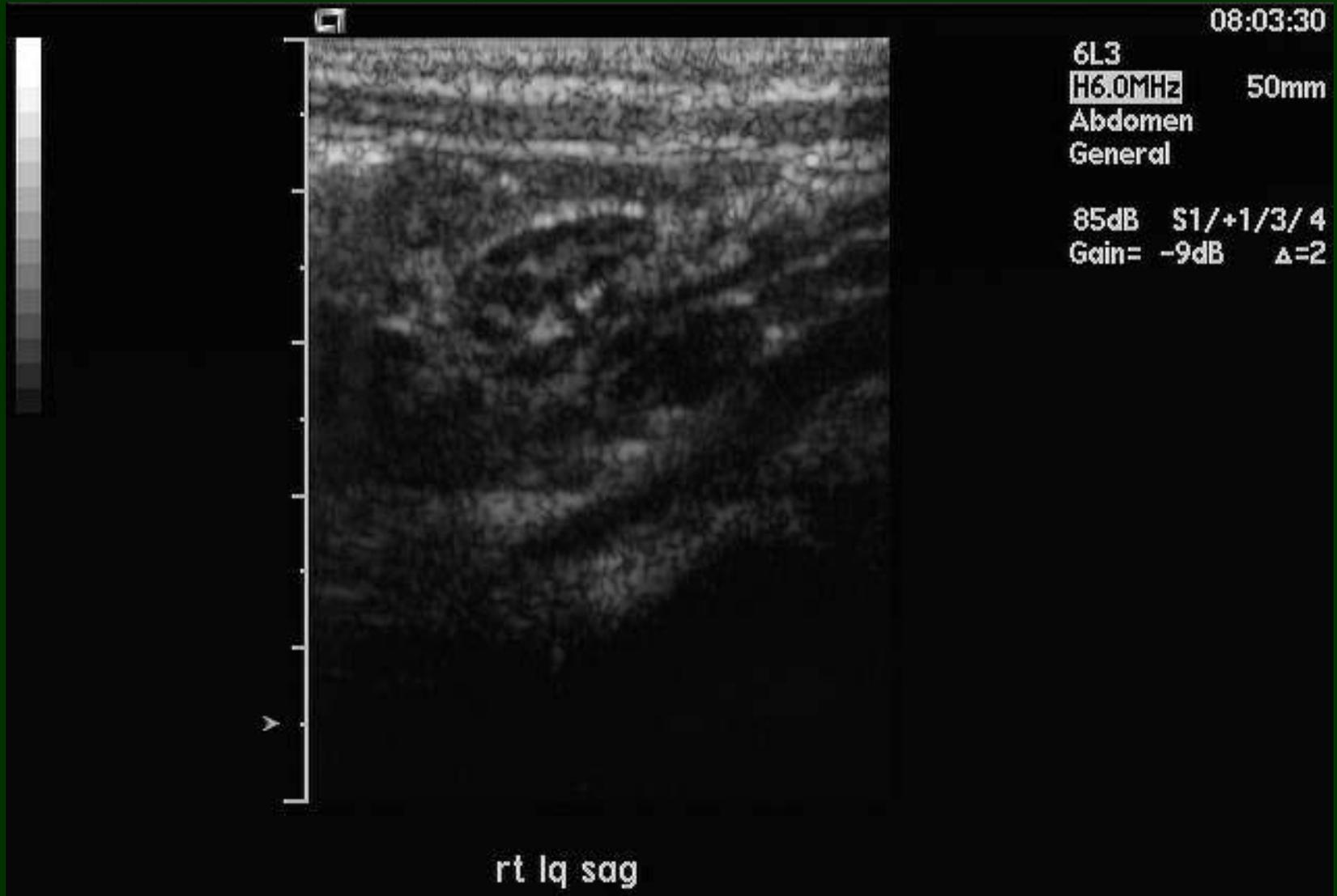
# Appendicitis: imaging

- Ultrasound is most sensitive and specific
- Graded compression in area of focal tenderness
- Non-compressible, blind ending tubular loop measuring  $> 6$  mm diameter
- Appendicolith in 30 – 50 % by US
- May see free fluid, abscess if perforated

# Acute appendicitis: sonography



# Mesenteric adenitis



# *Abdomen: Case 7*

- Intussusception

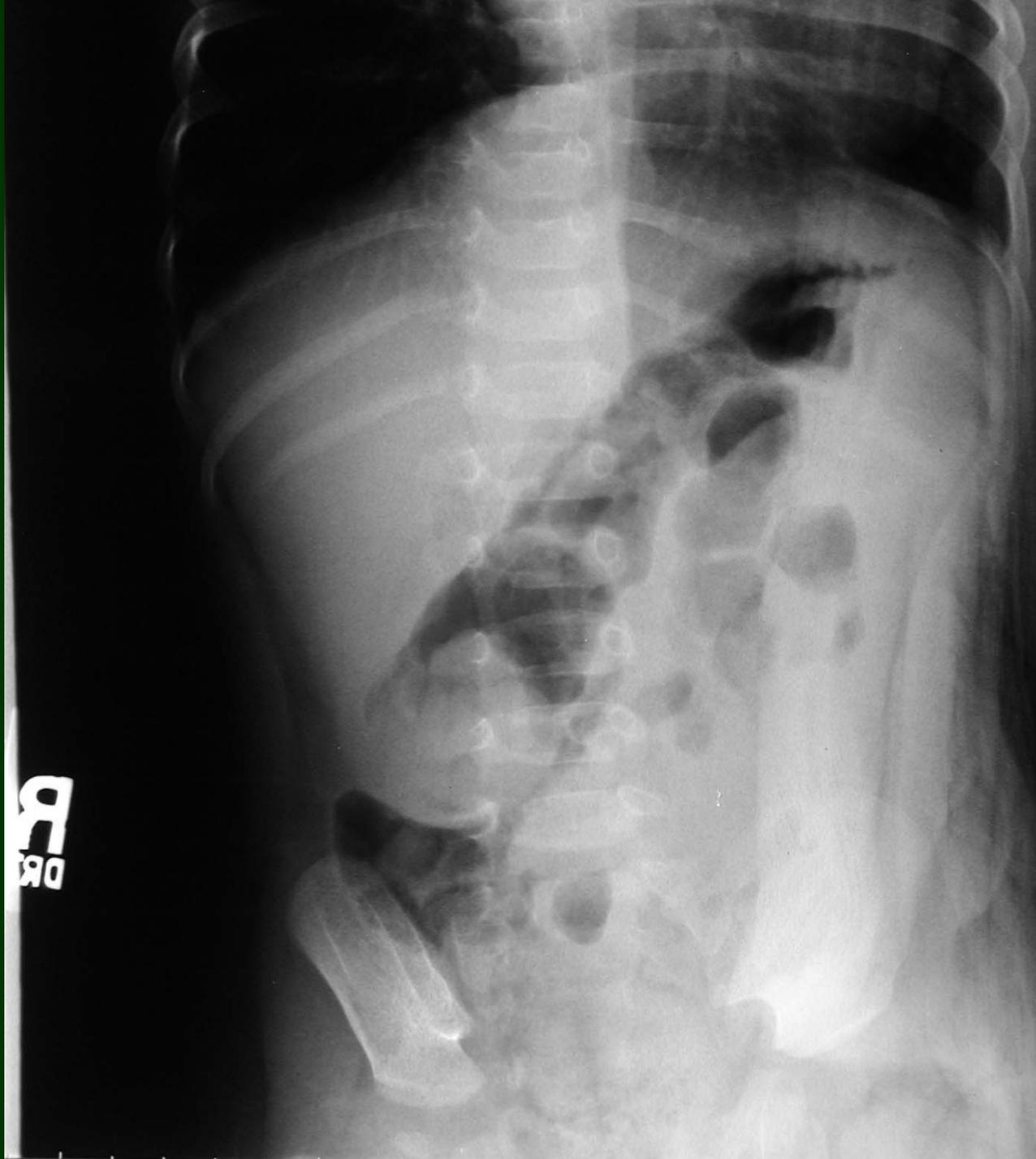
# Intussusception

- Clinical presentation
  - Severe abdominal pain, Bloody stool
  - Peak age 6 months to 2 years
  - More common in early winter and spring
- Plain film findings
  - Variable, may see dilated small bowel or decreased gas
  - Rounded soft tissue density in right abdomen

18 month old with  
intermittent severe  
abdominal pain and  
bloody stool



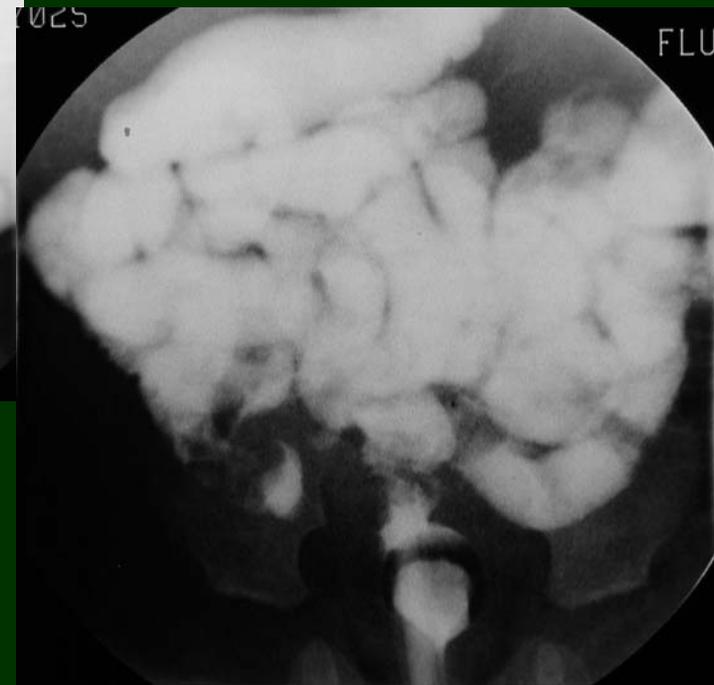
Left side  
down  
lateral  
decubitus  
film



# Intussusception: imaging

- Enema: fluid (+) or air (-) contrast
  - Contraindications: perforation, peritonitis, shock
  - Diagnostic and therapeutic
  - Rule of 3's
    - 3 attempts, 3 mins each, @ 3 ft height (or 120mm Hg maximum)
- ~ 10 % will have pathologic lead point
- ~ 10 % will recur in 24 hours

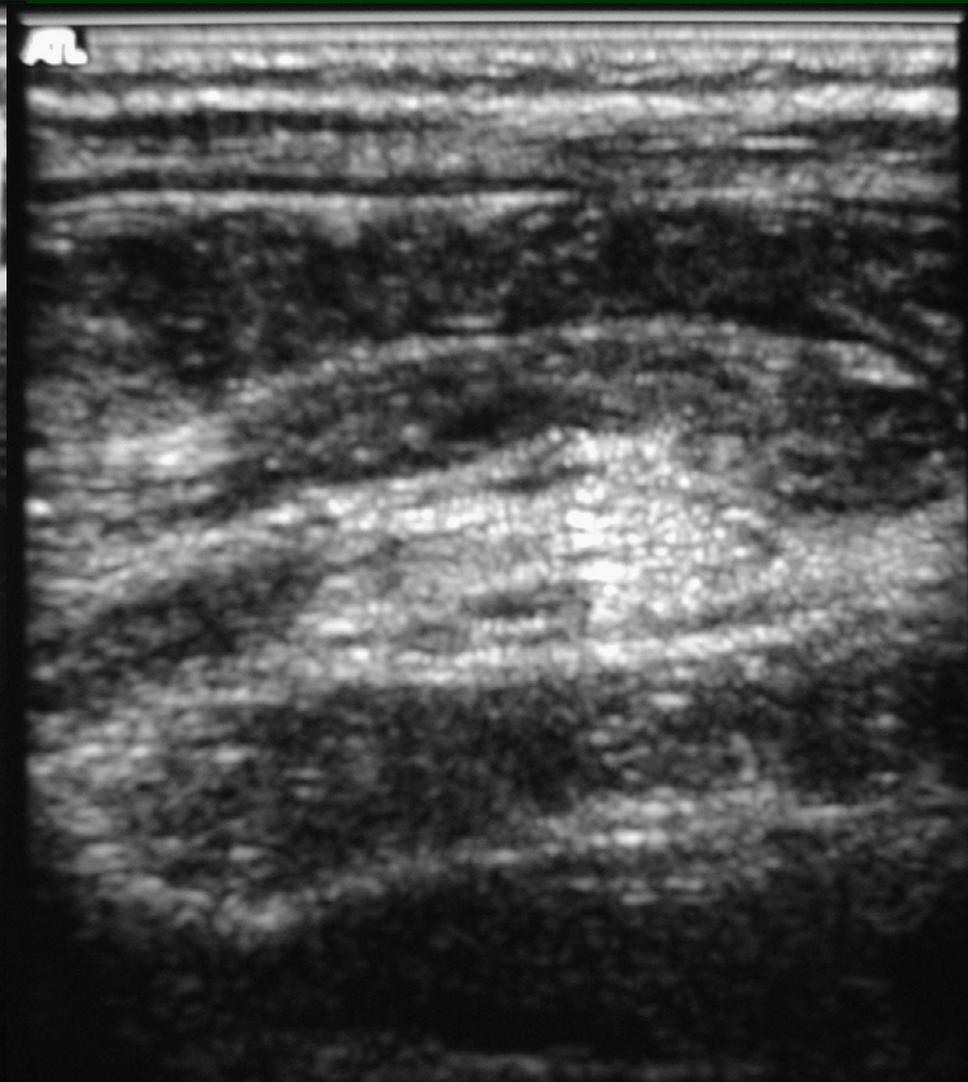
# Contrast enema: successful reduction of ileocolic intussusception



# Intussusception: imaging

- Ultrasound
  - Highly sensitive and specific
  - Findings: “pseudokidney”, “doughnut” signs
  - Some centers attempt saline enema reduction under ultrasound guidance

# Ileocolic intussusception: sonography



## *Trauma: Case 8*

- Clavicle fracture is most common skeletal injury from birth process
- Periosteal reaction with new bone formation begins at 5 – 14 days
- Callus formation begins at 10 – 14 days and lasts 3 – 4 weeks
- Knowledge of stages of healing helps to date fractures



2 week old  
infant

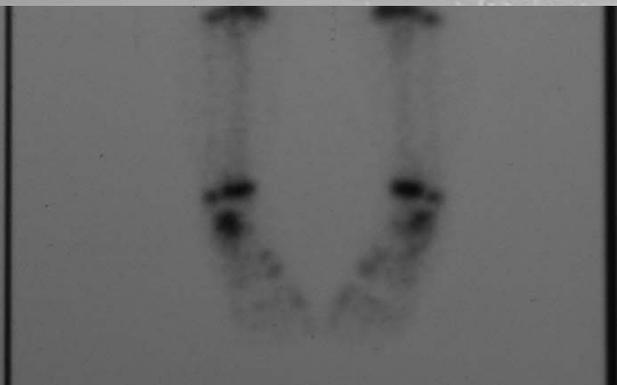
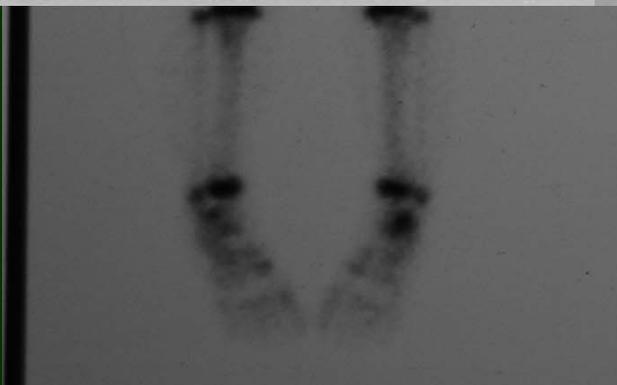
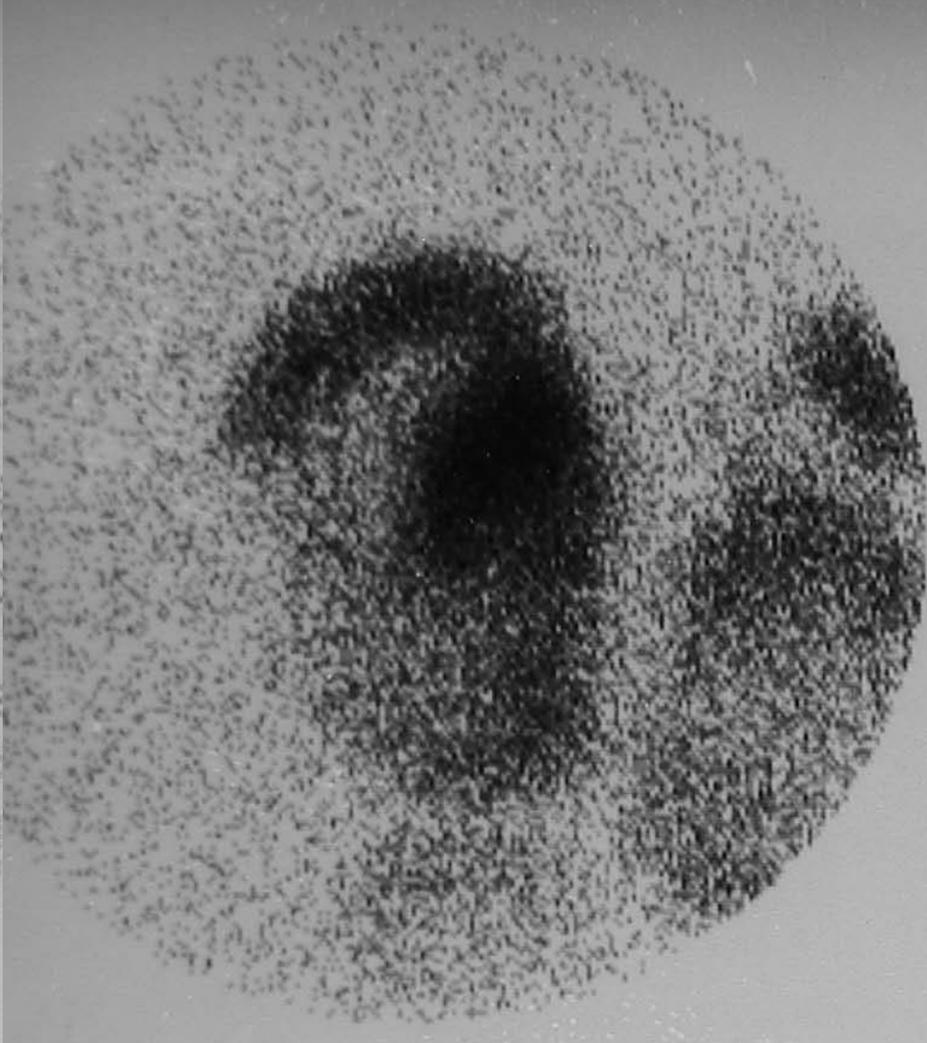
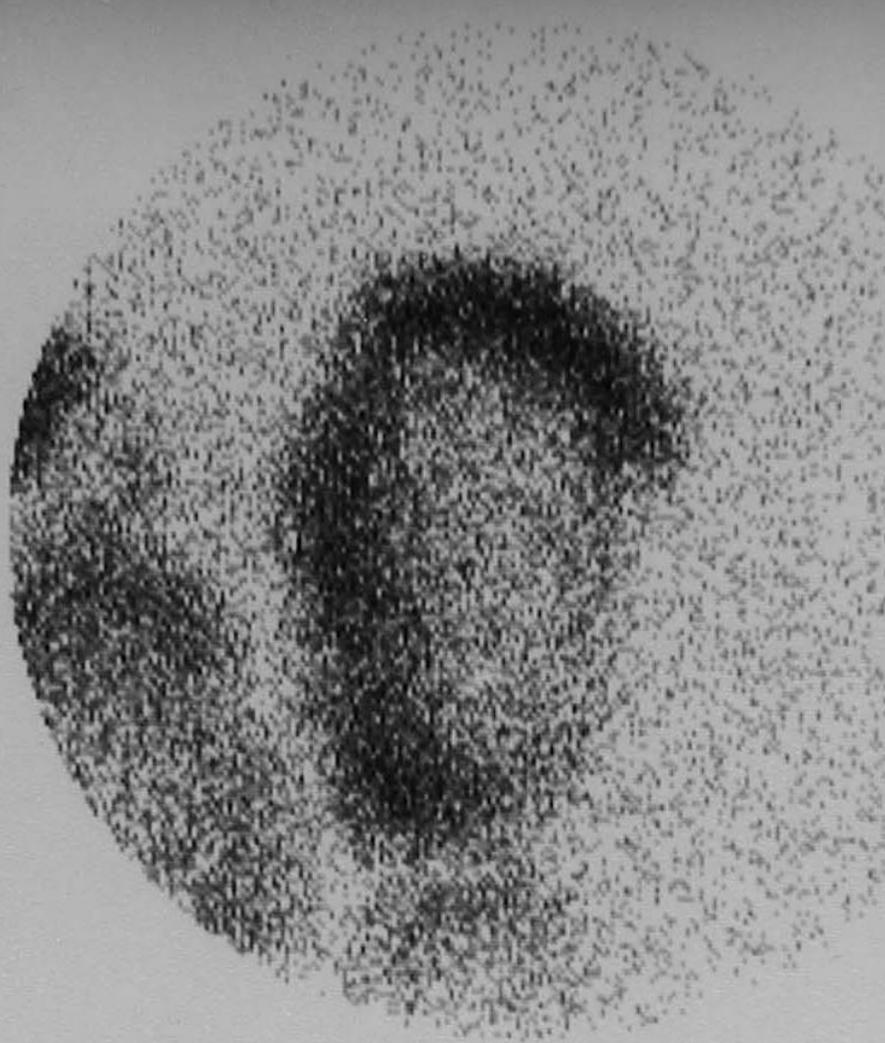
Healing left  
clavicle fx:  
birth trauma

## *Trauma: Case 9*

- Calcaneal stress fracture
- Typically occurs in toddlers – usually no specific injury
- Classic history is child who was walking, now refuses to walk, but will crawl
- Conventional radiographs may be negative initially, until healing sclerosis occurs

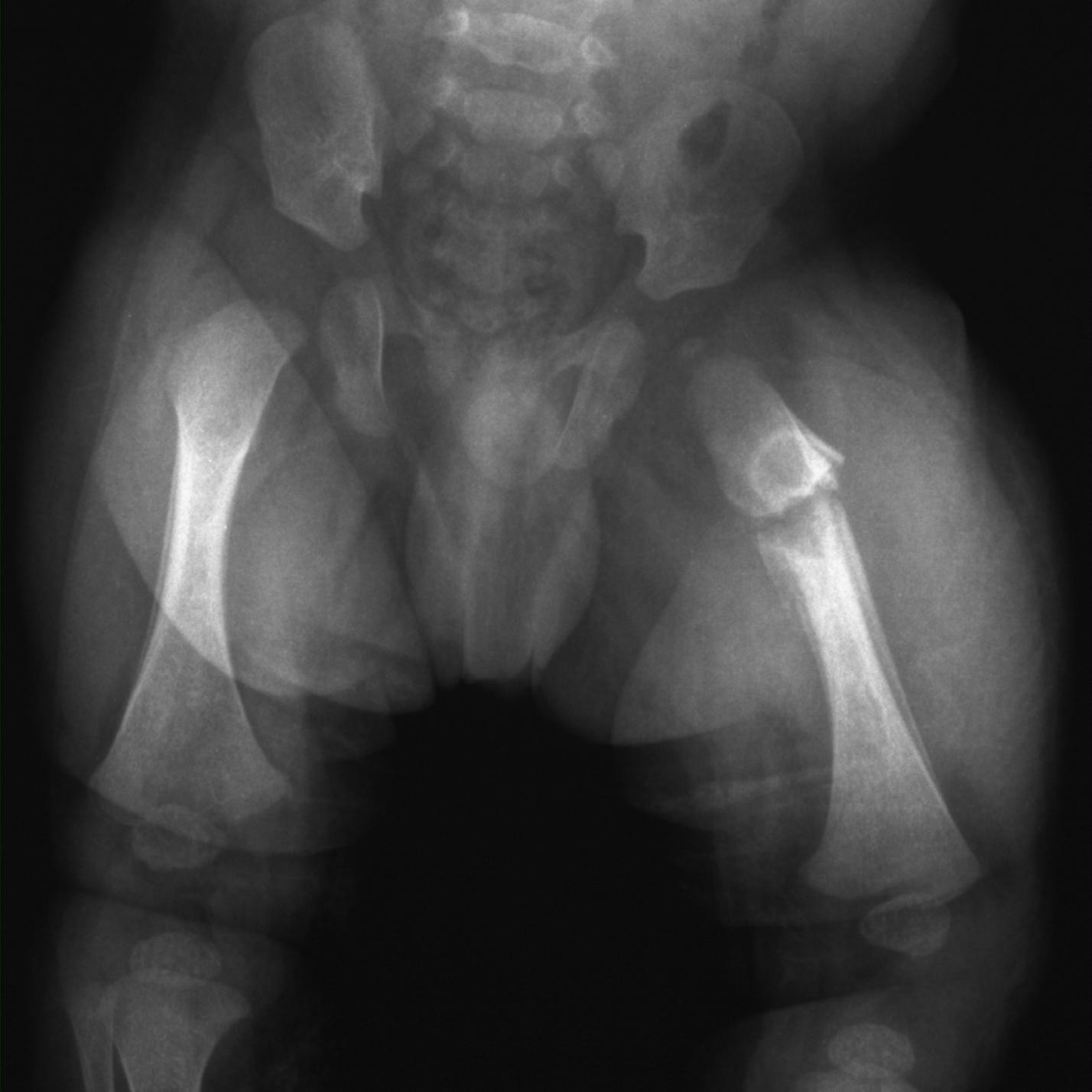
2 yo refusing  
to walk  
– but able to  
crawl

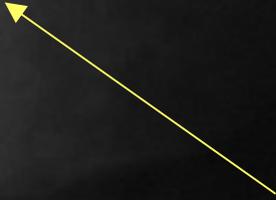


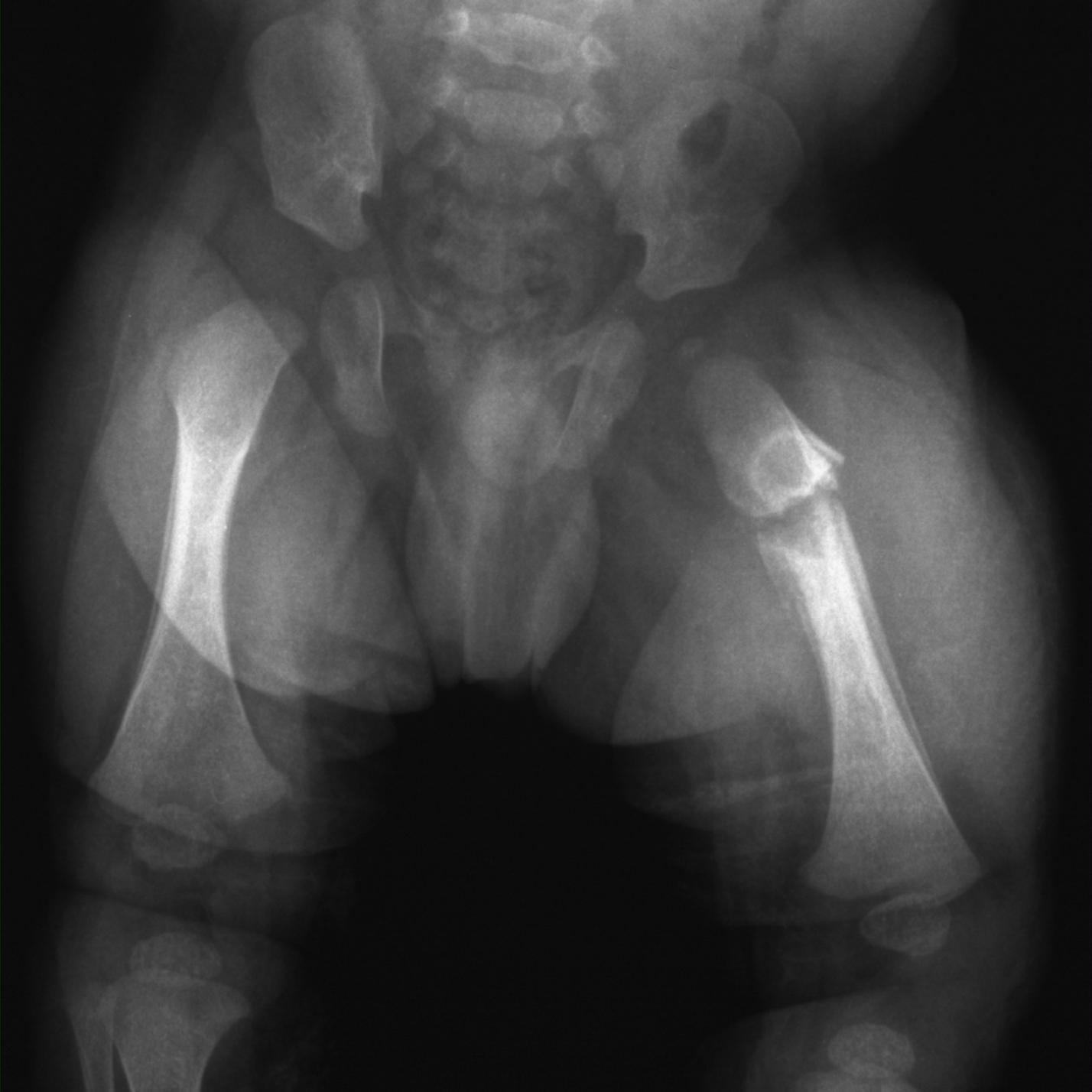


## *Trauma: Case 10*

- 4 month old child with leg swelling and pain with movement
- Parents deny specific history of trauma
- Initial radiographs identified transverse fracture of left femur
  - “possibly accidental”







# Non-accidental trauma

- High specificity
  - Metaphyseal corner fx; posterior rib fxs
- Moderate specificity
  - Multiple bilateral fxs; Fxs of different ages; complex skull fx
- Common, but low specificity
  - Long bone fxs; linear skull fx; clavicle fx

*Thank you*

