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

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Abdomen

GI tract

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Modalities in pediatric abdominal imaging

- Abdominal ultrasound +/- Doppler

- Abdominal X-ray
- Fluoroscopy
- Nuclear medicine (isotope scanning, FDG-PET)
- Magnetic resonance imaging
- Computed tomography

Conventional abdominal radiography

- Indications neonates:
  - Nectrozing enterocolitis (NEC)
    - AP & lateral supine
  - Anal atresia
    - PA in prone position
  - Acute abdomen (free air)
    - AP and lateral supine with horizontal beam
    - Or on left side when >10 yoa
- Other possible indications (older children):
  - Swallowed foreign body
  - Bowel perforation
  - Pneumoperitoneum
  - Hematuria
  - Constipation(?) → ultrasound

Conventional abdominal radiography

- To be assessed:
  - Diaphragms → basal pneumonia
  - Abdominal wall → edema
  - Skeletal structures
  - Liver and spleen shadow
  - Retroperitoneum → psoas muscles
  - Calcifications
  - Bowel structures → air, position stomach, jejunum, ileum, colon

Conventional abdominal radiography

- To be assessed:
  - Duodenum → limited air
  - Jejunum → wall thickening, width, air-fluid levels
  - Ileum → similar as jejunum, especially in RLQ
  - Coecum → localization (invagination)
  - Colon → wall thickening, loss of haustration
  - Space-occupying lesions → round, oval shadows shifting bowel structures

Neonatal abdominal X-ray

- Air in bowel structures after birth in neonates
  - Stomach → 0-15 minutes
  - Duodenum → <1 hour
  - Proximal small bowel → <3 hours
  - Distal small bowel → 12 hours
  - Colon/rectum → 24 hours

Radiopaedia, courtesy Ian Buckle

Acute Abdomen in the Neonate

High obstruction	Low obstruction	Acquired diseases
esophageal atresia	ileal atresia	Necrotizing enterocolitis (NEC)
duodenal atresia	meconium ileus	Hypertrophic pyloric stenosis
duodenal web	meconium plug	Incarcerated inguinal hernia
annular pancreas	Hirschsprung disease	Gastro-enteritis
malrotation	anal atresia	Sepsis
jejunal atresia		Perforated stress ulcus
		Ovarian torsion

Acute abdomen in neonate: assessment

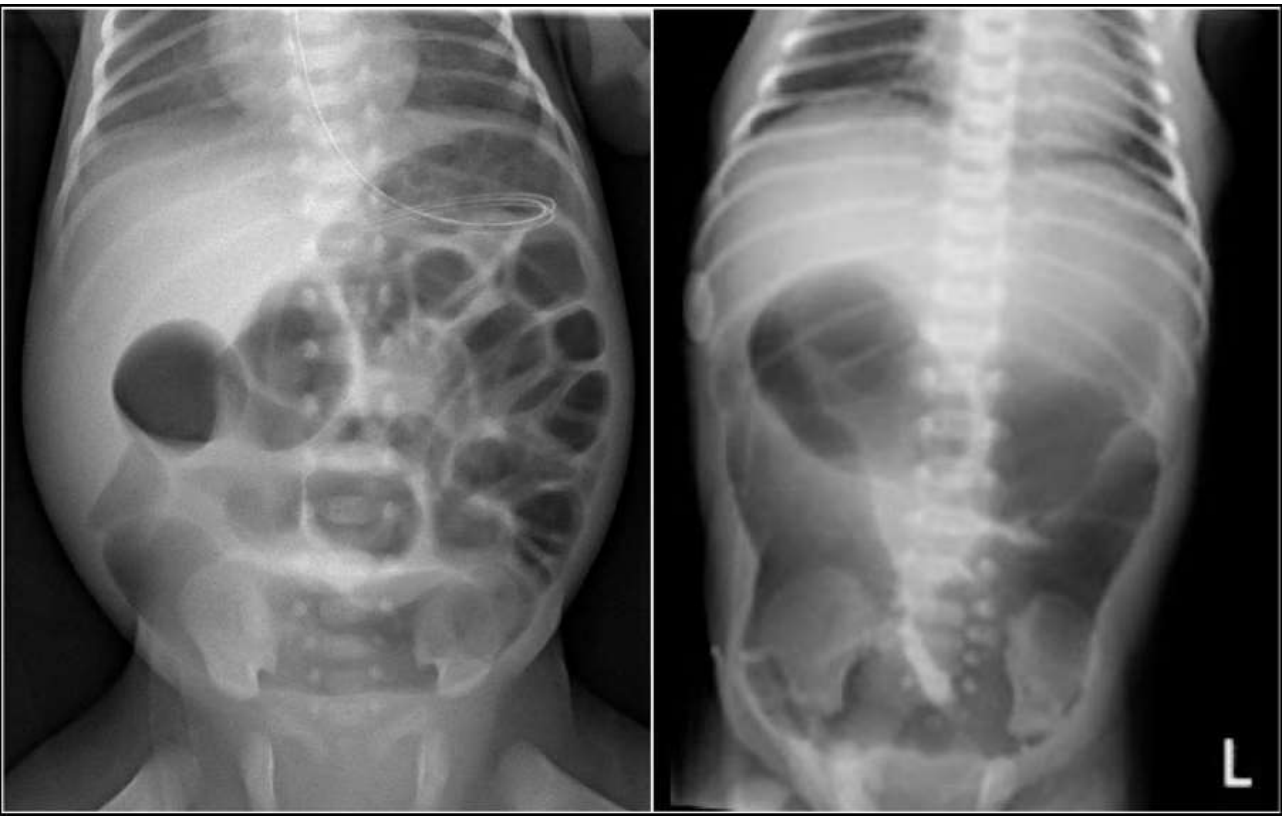
Bowelgas pattern on the radiograph

1. Dilatation
2. Number of dilated bowel loops
3. Small bowel or colon
4. Airfilled rectum
5. Pneumatosis intestinalis
6. Free air and ascites

Radiology Assistant

Acute abdomen in neonate: assessment

Radiology Assistant



- Dilatations
- More than interpedicular width L2
- Unchanging bowel gas pattern → abscence of bowel movement

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Acute abdomen in neonate: assessment

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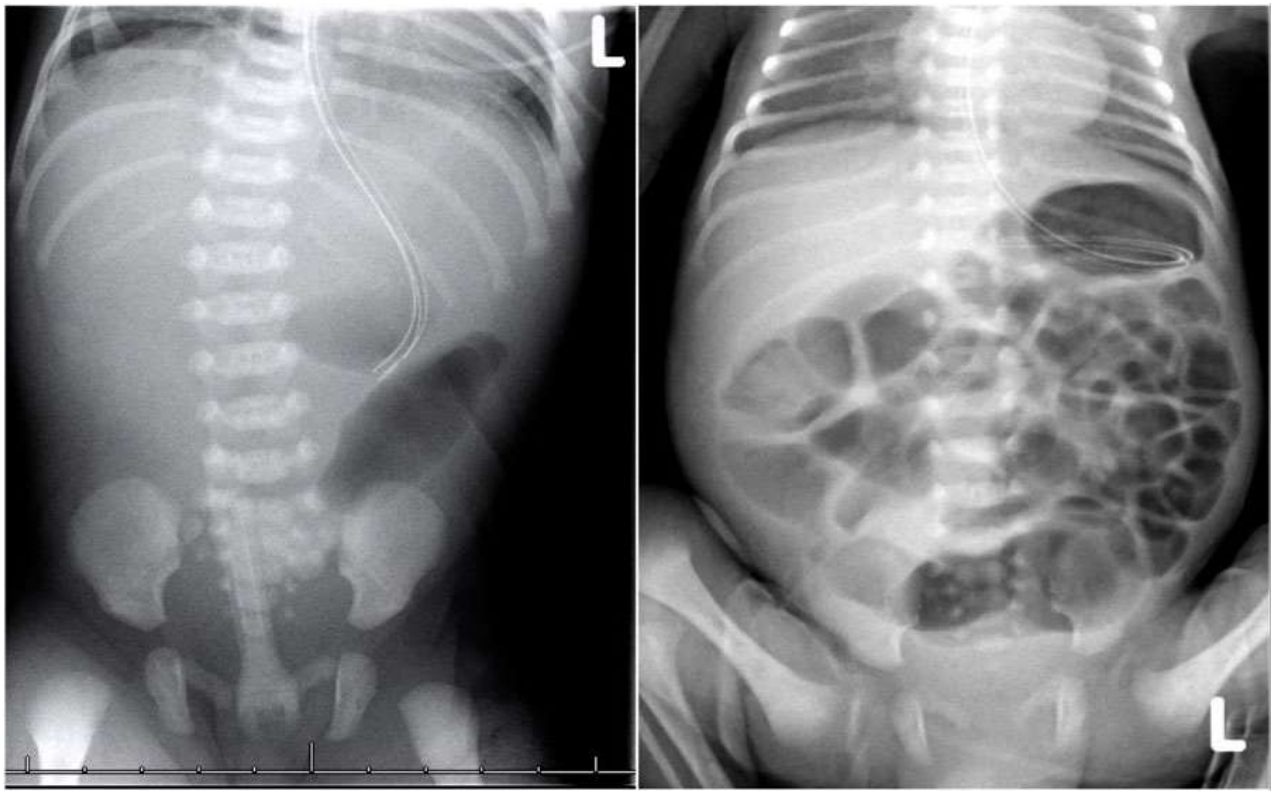

- Number of dilated loops
  - Double bubble sign
  - Triple bubble sign
- More than three dilated loops → distal obstruction

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Acute abdomen in neonate: assessment

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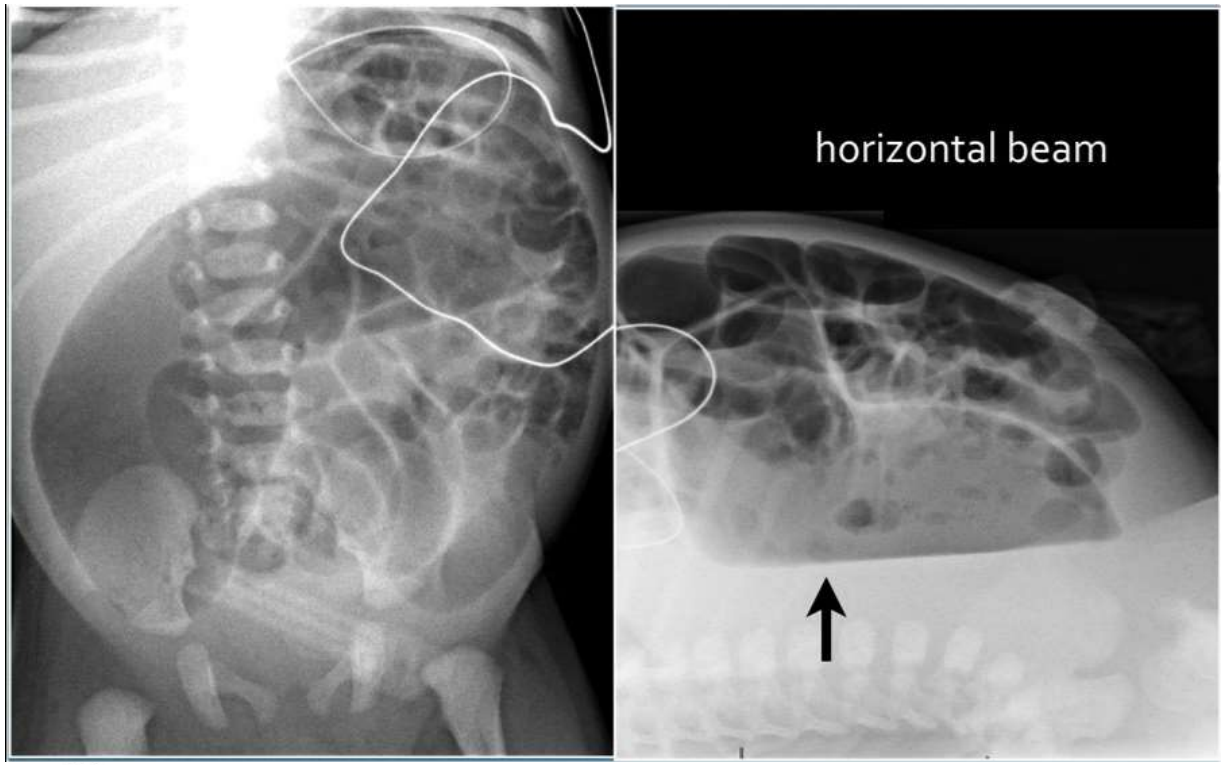

- Small bowel or colon?
  - Difference difficult since no haustrations in colon yet
  - Position (colon more dorsally located)
  - Colon enema study is sometimes necessary to discriminate between them with certainty
- Airfilled rectum?
  - No → obstruction

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Acute abdomen in neonate: assessment

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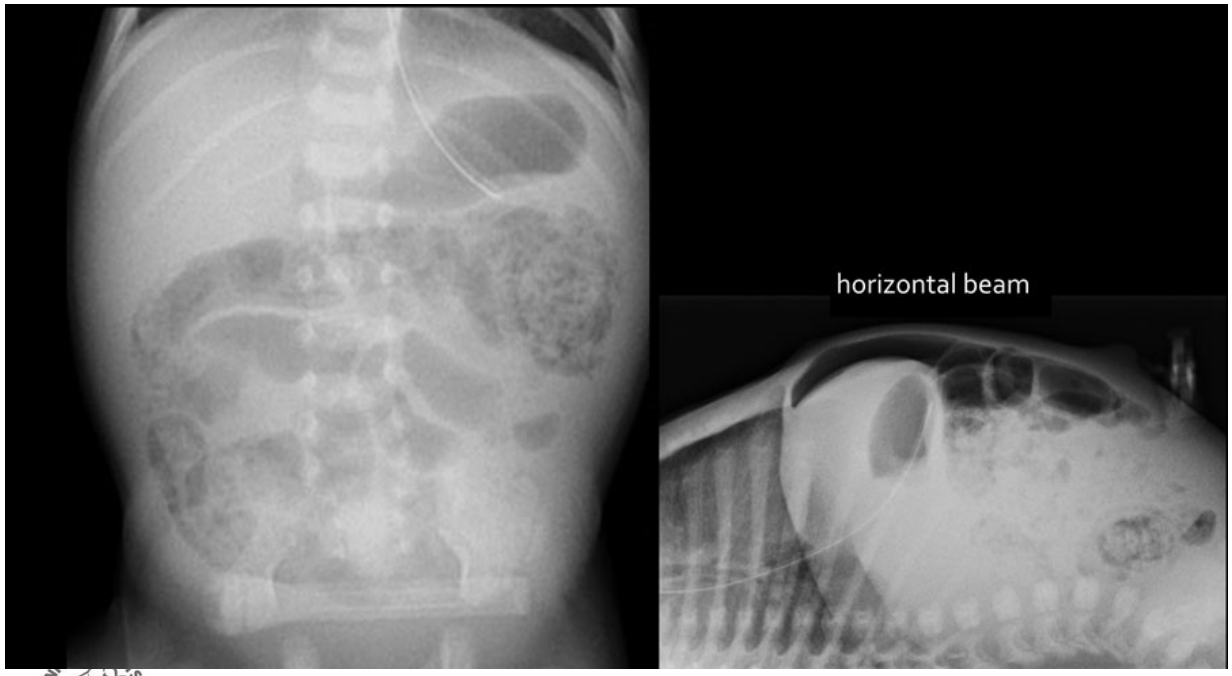

- Pneumatosis intestinalis → air in the wall
- Free air and ascites

Neonatal abd. X-ray: duodenal atresia

- Congenital malformation in the duodenum
- Presenting with abdominal distension, vomiting (often bilous, because atretic segment distally to ampulla Vateri), absent bowel movements
- 1:5000/10.000, M=F
- “Double bubble sign”
- No air distally to area of atresia in duodenum

Radiopaedia, courtesy Tamsir Rongpipi

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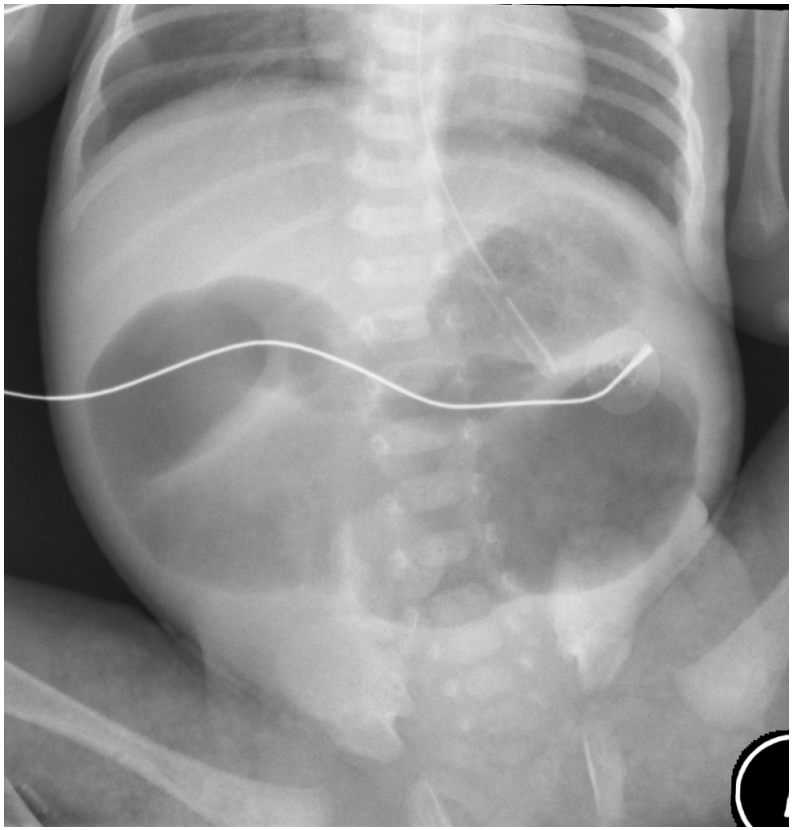
Neonatal abd. X-ray: jejunal atresia

- Congenital malformation in the jejunum
- Presenting with abdominal distension and bilous vomiting < 24 hours after birth
- 1:1000
- “Tripple bubble sign”
- No air distally to area of atresia in jejunum



Radiopaedia, courtesy Hani Makky Al Salam

Neonatal abdominal X-ray: NEC

- Necrotizing enterocolitis:
  - Premature infants; risk when <1000 grams; in first 3 weeks of life
  - Areas affected: distal ileum and (right-sided) colon
  - Etiology: combination of ischemia & sepsis/infection
  - Symptoms: feeding intolerance, abdominal distention, sepsis, bloody stool
  - Complications:
    - Gangrene & perforation
    - After therapy: stenoses/strictures → colon at the level of the splenic flexure

Neonatal abdominal X-ray: NEC

- Abdominal X-ray in NEC:
  - Dilatation of bowel structures (RLQ, ileus)
  - Bowel wall thickening
  - Pneumatosis intestinalis
  - Portal venous gas

Radiopaedia, courtesy Hani Makky Al Salam

Neonatal abdominal X-ray: NEC

- Abdominal X-ray in NEC:
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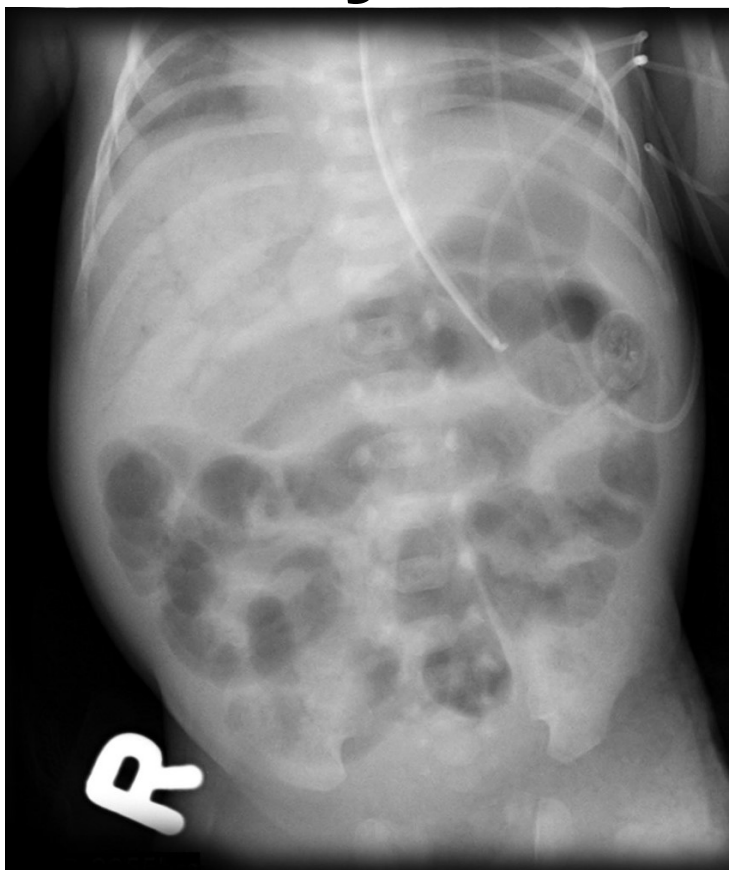
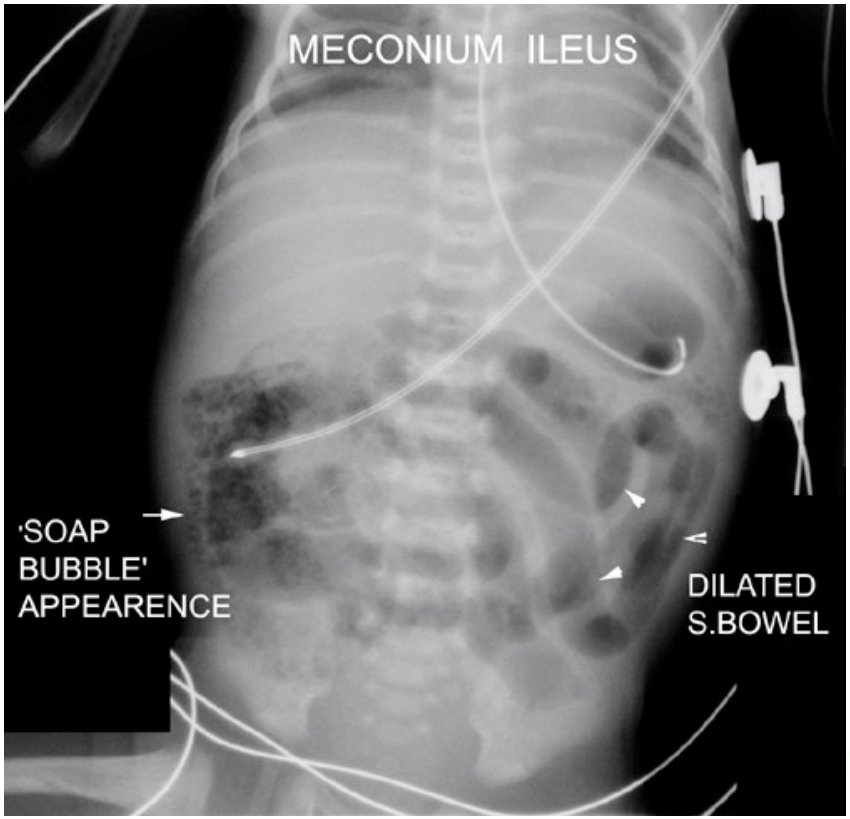
  - Portal venous gas



Radiopaedia, courtesy Frank Gaillard

Neonatal abd. X-ray: meconium ileus

- Accumulation of meconium in distal ileum and caecum
- Microcolon
- Often first manifestation of cystic fibrosis
  - Dilated, air-filled small bowel loops
  - No air-fluid levels
  - Soap bubble sign (air between meconium pellets)



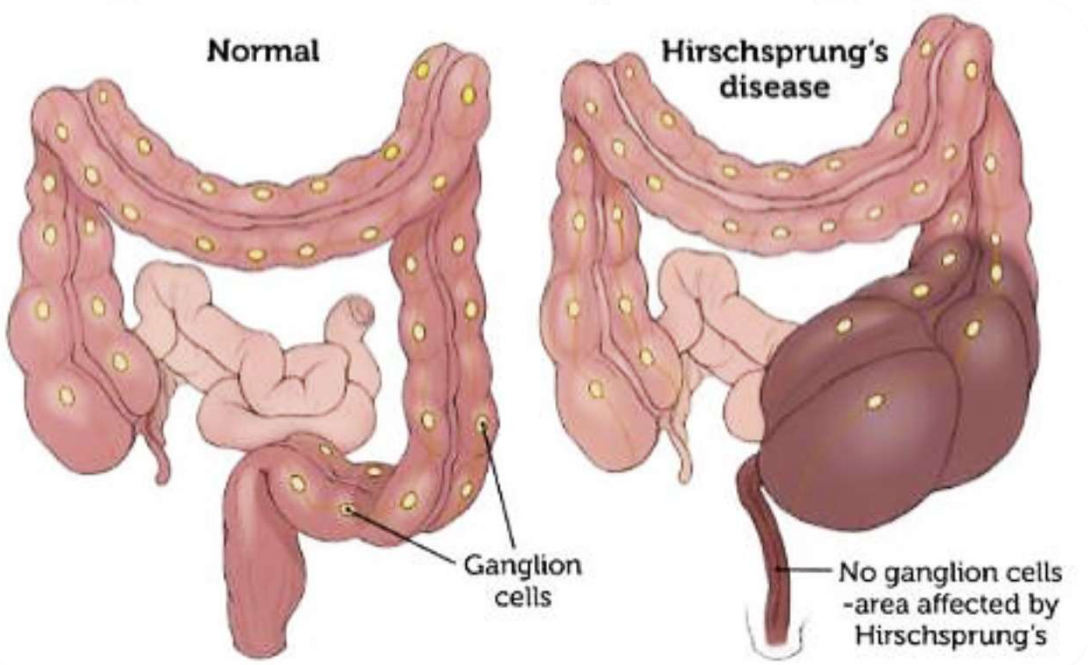
Neonatal abd. X-ray: meconium plug sx

- Obstructing meconium plug in left colon (“small left colon syndrome”)
- Dilation of colonic loops, f.i. splenic flexure
- Association with maternal DM, Hirschsprung; less with CF

Radiopaedia, courtesy Radswiki

Neonatal abd. X-ray: Hirschsprung

- Most common cause of neonatal colonic obstruction (15-20%)
- Aganglionosis in distal colon and rectum → abscence of ganglion cells → spasm in denervated colon
- 1:5000/8000 births, more boys
- If X-ray is abnormal and suggestive of distal bowel obstruction, water-soluble contrast enema fluoroscopy the next step for evaluation of the colon



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Neonatal abd. US: pyloric stenosis

- Hypertrophic pyloris stenosis (HPS)
- Idiopathic thickening of gastric pyloric musculature; progressive gastric outlet obstruction
- 2,5/1000, M>F 4:1, Caucasians
- Risks: being firstborn, mother with HPS
- Non-bilous, projectile vomiting; weight loss, dehydration
- Seldom <3 weeks of age, normally 6-12 weeks of age

Radiopaedia, courtesy Frank Gaillard

Neonatal abd. US: intussusception

- Ileocolic or ileoileal; due to peristalsis
- 3-24 months, peak 6-9 months
- Idiopathic, possibly increase lymph nodes after viral infection
- Other lead points: duplication cyst, Meckel's diverticulum, lymphoma
- US:
  - Targetlike mass with bowel-within-bowel → doughnut sign
  - Pseudokidney sign

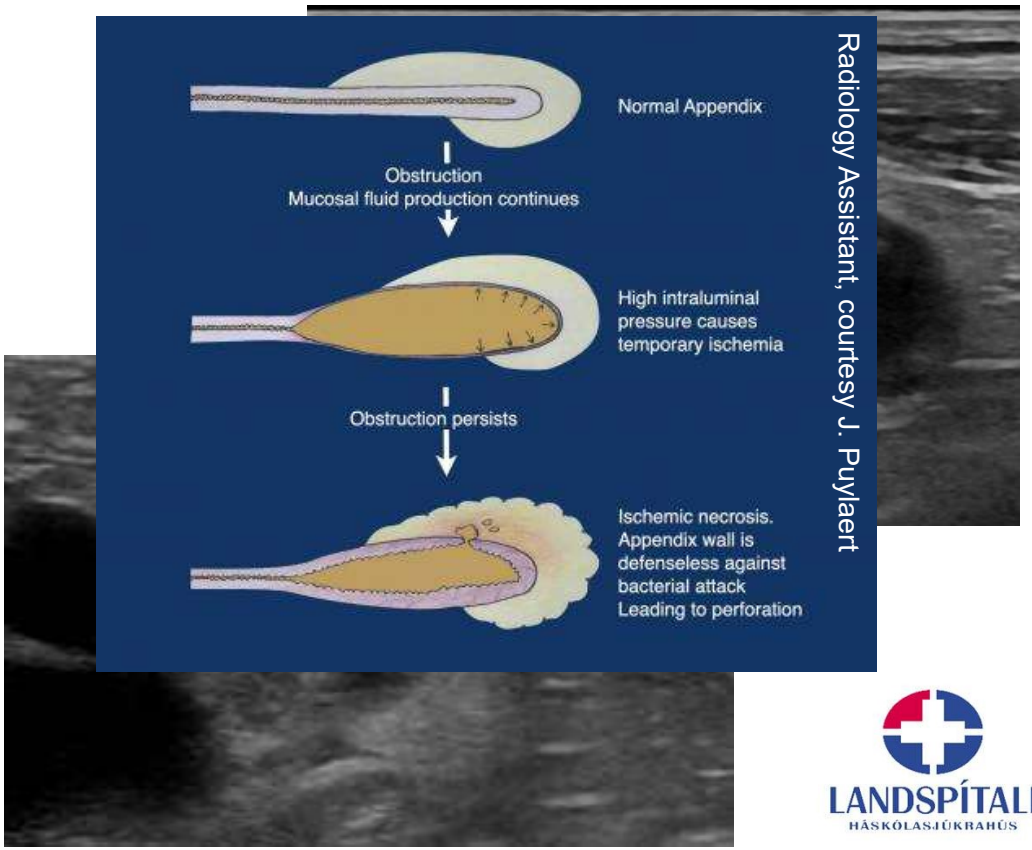
Neonatal abdomen: intussusception

- Contrast enema fluoroscopy is golden standard
- Intussusception occluding mass prolapsing into the lumen
- Contrast enema fluoroscopy may also be the treatment in a lot of cases (preferred over surgery)

Pediatric abd. US: appendicitis

- Typically children and young adults
- Periumbilical pain → RLQ
- On US: aperistaltic, concentrically layered, non-compressible, blinding, sausage like structure; fecolith in 35%

Test	29-08-2007 21:32	30-08-2007 09:10
WBC	15.7 H	9.1
▲CHEMIE		
CRP	3	84 H



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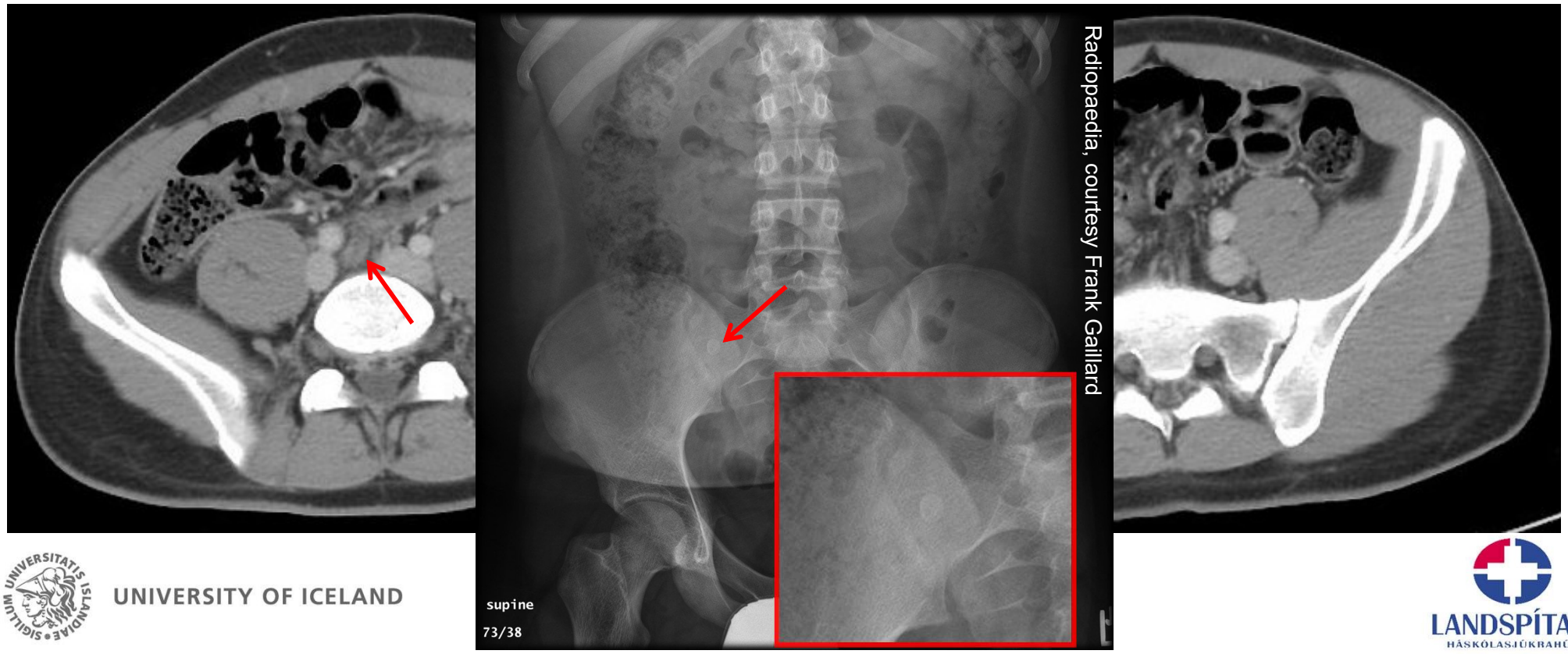
Pediatric abd. CT: appendicitis



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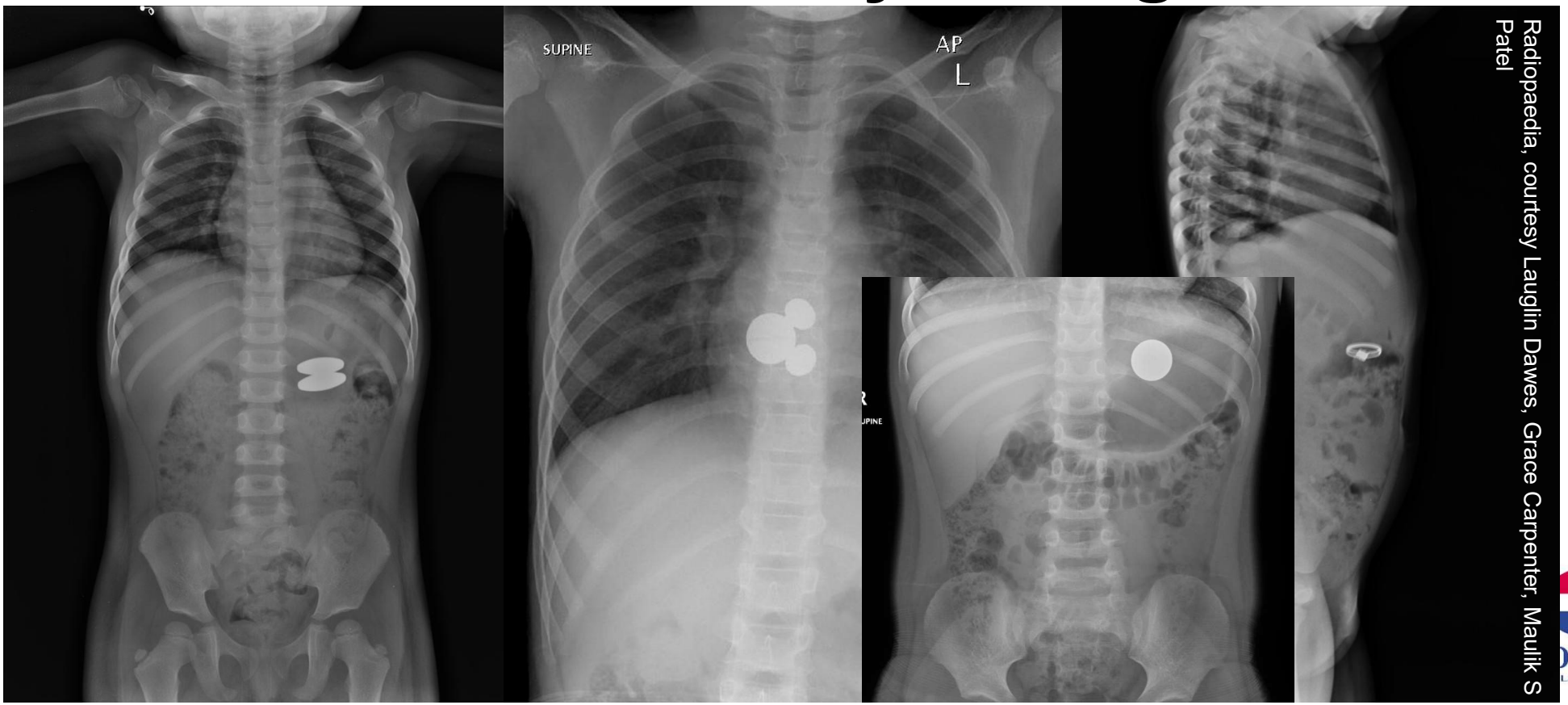
Pediatric abd. X-ray: foreign bodies



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Abdomen

Urinary tract

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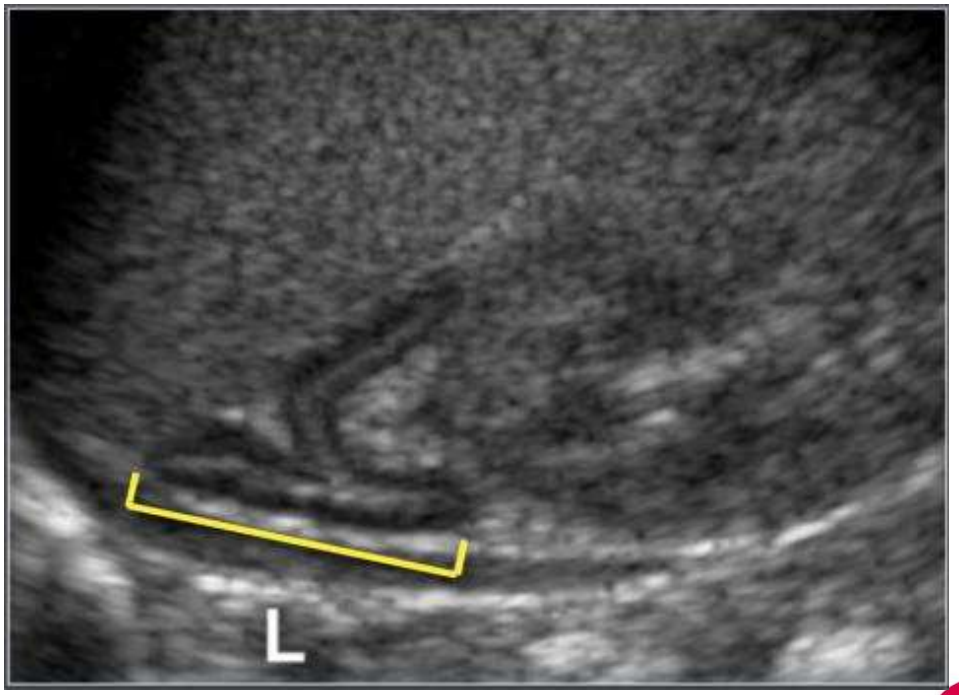
Pediatric renal US: normal anatomy

- Immature neonatal cortex: echogenic
- Hyperechoic relative to the liver
- Excellent corticomedullary differentiation
- Postnatally echogenicity of the cortex gradually decreases – hypoechoic relative to the liver by 4 months (6)
- Hypoechoic pyramids
- After 1 year → hypoechoic cortex, renal sinus → central echogenic area

Pediatric renal US: normal anatomy

- Adrenal gland may be seen in neonatal infants!
- Normally not seen in older children and adults



Radiology Assistant, courtesy S. Robben, R. van Rijn, R. Smithuis

Pediatric renal US: normal anatomy

Kidney length neonates in cm

Gestational age	Length (1sd)	Min-max	No
24-31 wk	3.3 (0.4)	2.5 – 4.0	29
32-35 wk	3.6 (0.4)	2.5 – 4.6	33
36-37 wk	4.1 (0.4)	3.0 – 4.9	35
38-41 wk	4.1 (0.4)	2.6 – 5.2	153

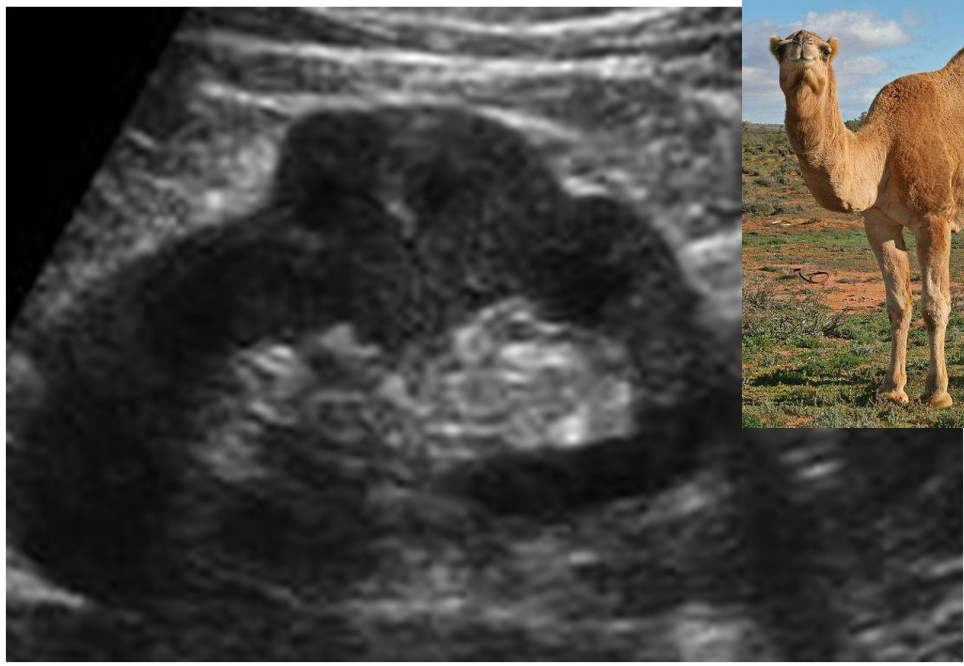
Radiology Assistant, courtesy S. Robben, R. van Rijn, R. Smithuis

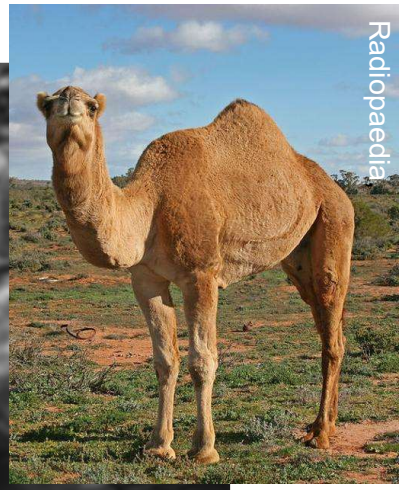
Kidney length in cm

Age	Length (sd)	No	Age	Length (sd)	No
0 – 1 wk	4.5 (0.3)	10	8 – 9 y	8.9 (0.9)	18
1 wk – 4 mo	5.3 (0.7)	54	9 – 10 y	9.2 (0.9)	14
4 – 8 mo	6.2 (0.7)	20	10 – 11 y	9.2 (0.8)	28
8 – 12 mo	6.2 (0.6)	8	11 – 12 y	9.6 (0.6)	22
1 – 2 y	6.6 (0.5)	28	12 – 13 y	10.4 (0.9)	18
2 – 3 y	7.4 (0.5)	12	13 – 14 y	9.8 (0.8)	14
3 – 4 y	7.4 (0.6)	30	14 – 15 y	10.0 (0.6)	14
4 – 5 y	7.9 (0.5)	26	15 – 16 y	11.0 (0.8)	6
5 – 6 y	8.1 (0.5)	30	16 – 17 y	10.0 (0.9)	10
6 – 7 y	7.8 (0.7)	14	17 – 18 y	10.5 (0.3)	4
7 – 8 y	8.3 (0.5)	18	18 – 19 y	10.8 (1.1)	8

Pediatric renal US: normal variants

- Dromedary hump
- Focal bulge in the lateral margin of the midpole of the left kidney
- Caused by splenic impression onto the superolateral border of the left kidney
- Echogenicity as (other) normal tissue
- May mimick mass



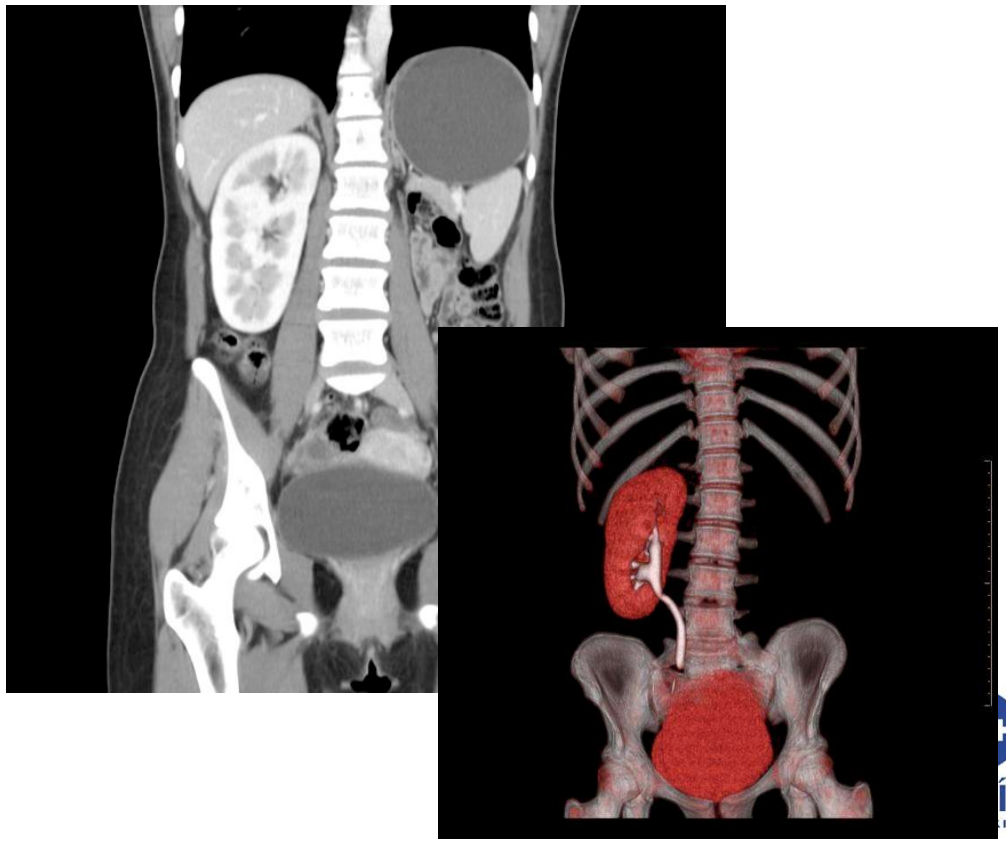


Pediatric renal US: normal variants

- (Prominent, hypertrophied) column of Bertin
- Column of Bertin in 50% of the population, 20% bilateral, hypertrophied columns less common
- Extension of renal cortical tissue separating pyramids; normal tissue
- May mimick renal mass (renal pseudotumour)

Pediatric renal imaging: variants

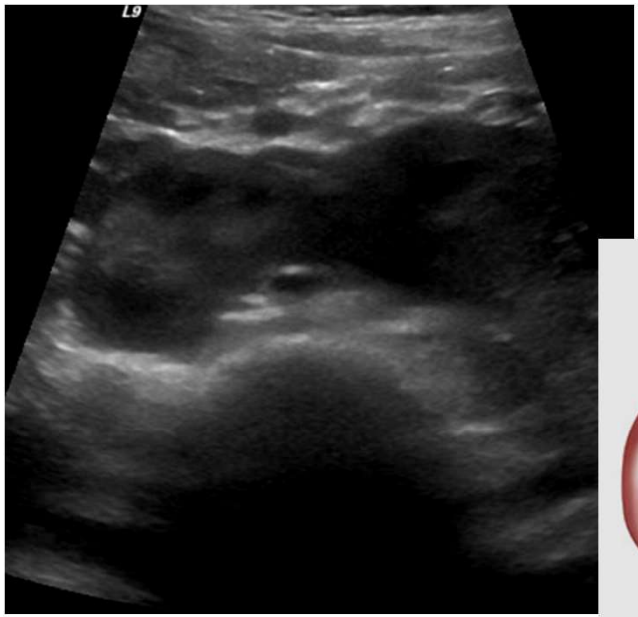
- Renal agenesis
- Congenital absence of one kidney (if two kidneys → Potter sx → fatal)
- 1/500 live births
- Possibly slight male predilection
- If compensatory hypertrophy other kidney, no treatment needed

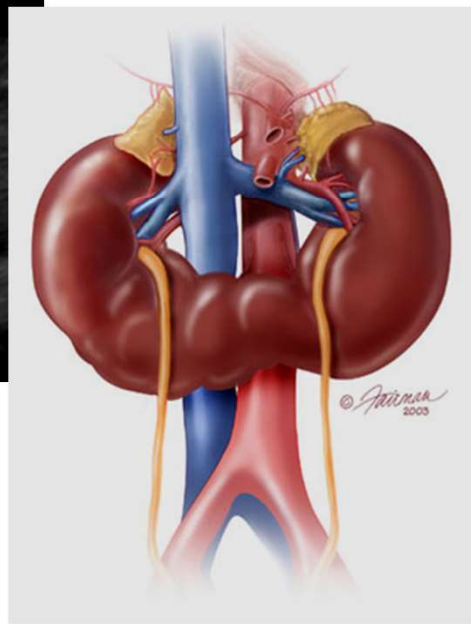


Radiopaedia, courtesy David Puyó

Pediatric renal US: normal variants

- Horseshoe kidney
- 1/400-500: M:F=2:1
- Most common renal fusion anomaly
- Susceptible to trauma
- Higher risk of kidney stone
- Higher risk of transitional cell carcinoma (later age)
- Higher risk of Wilms' tumor





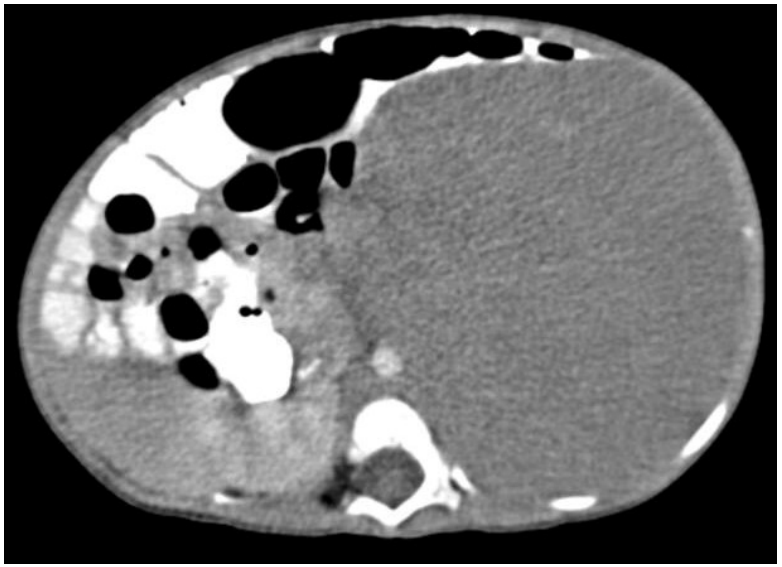
Wilms' tumor

- Nephroblastoma → malignant pediatric renal tumor
- 85% of pediatric renal mass
- 7% of pediatric cancer
- 1-11 years of age, peak 3-4 years (80% before 5 years)
- Painless upper quadrant abdominal mass; hematuria (20%)
- Surgery and chemotherapy curative in app. 90%

Radiopaedia, courtesy Maulik S Patel

Neuroblastoma

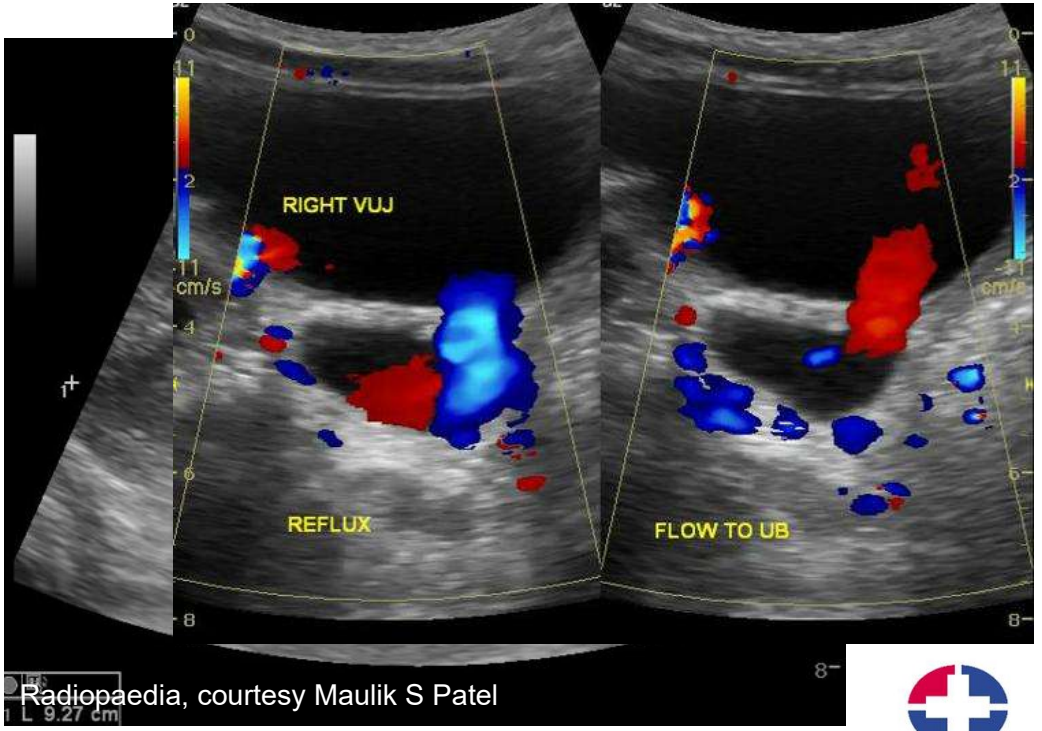
- Tumors of neuroblastic origin
- Along sympathetic chain, vast majority from adrenal gland
- Most common extracranial solid childhood malignancy
- 3rd commonest pediatric cancer after brain tumours and leukemia
- Accounting for 15% of childhood cancer deaths



Radiopaedia, courtesy Frank Gaillard

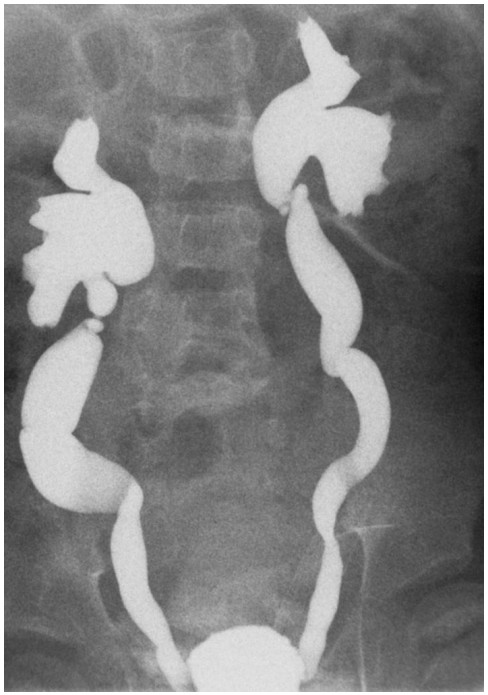
Pediatric renal US: VUR

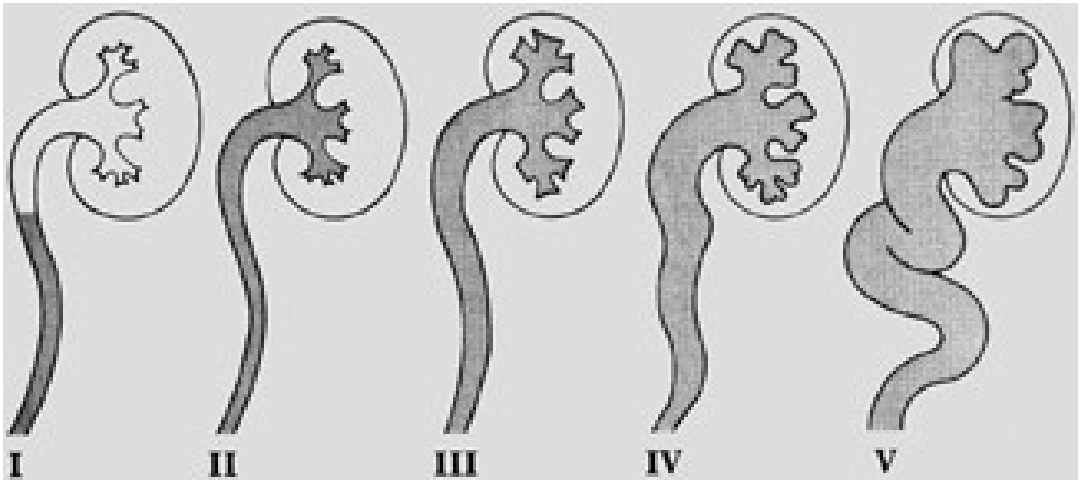
- Vesicoureteric reflux
- Abnormal flow of urine from bladder into upper urinary tract, young children
- 8% of females, 2% of males
- Among children with urinary tract infections → 25-40%
- Reflux predisposes for pyelonephritis → scarring



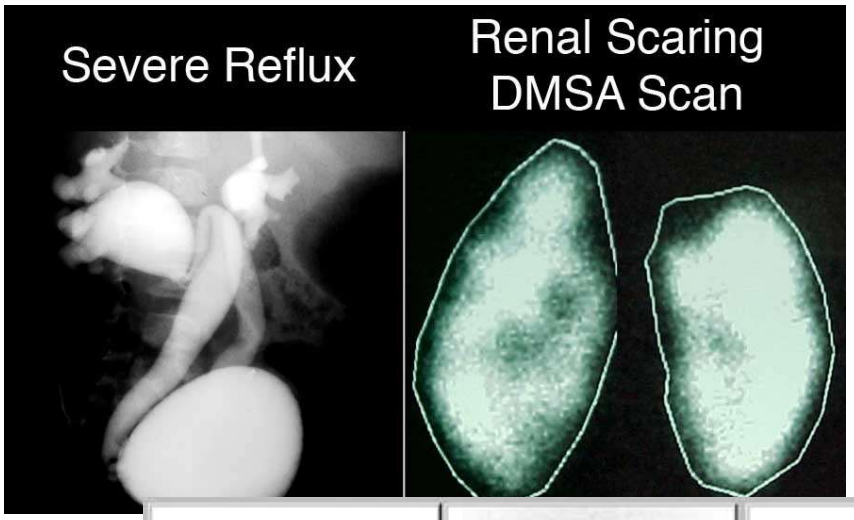
Radiopaedia, courtesy Maulik S Patel

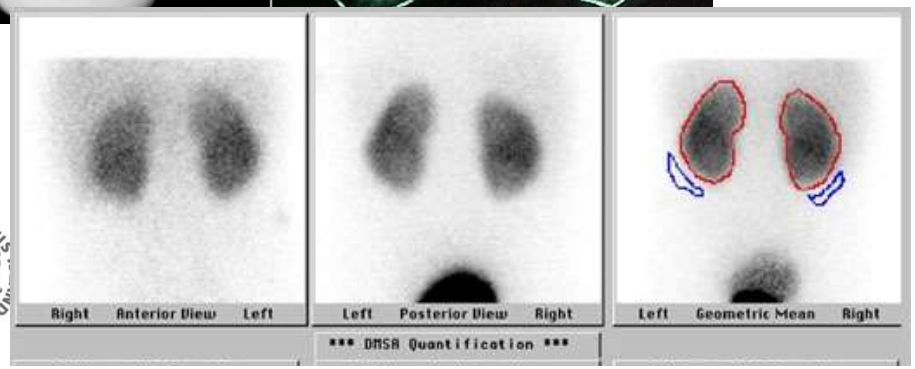
Pediatric voiding cystourethrogram





Renogram, kidney scintigraphy





- Test renal function
- Compare left/right
- Detect defects in functional parenchyma
- DDx for defects: scar, cyst, tumor, infarct, hematoma, infection

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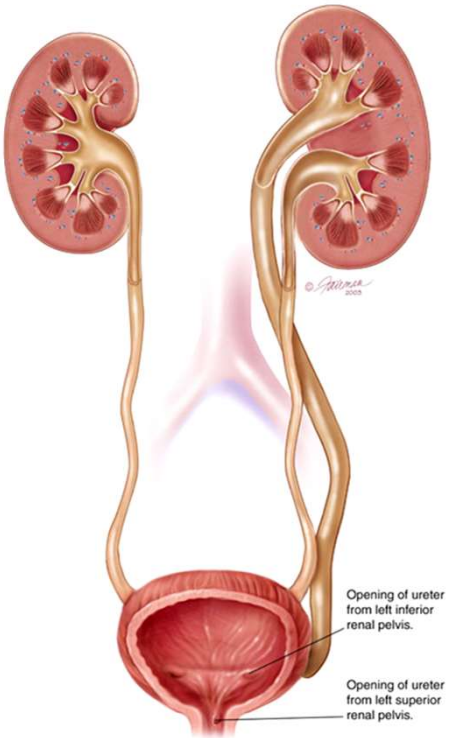
Ureteropelvic duplication

- Supernumerary collecting systems
- Duplex kidney: single renal mass with > 1 collecting system
- Fused kidney: fusion of 2 renal parenchymal masses.
- Some duplication anomalies have ureteral ectopy with or without ureterocele
- Surgery may be needed to correct obstruction or VUR.

Radiopaedia, courtesy Vivek Pai



Questions?

Acknowledgements

- Boris Brkljačić

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