Pediatric radiology

Part I,

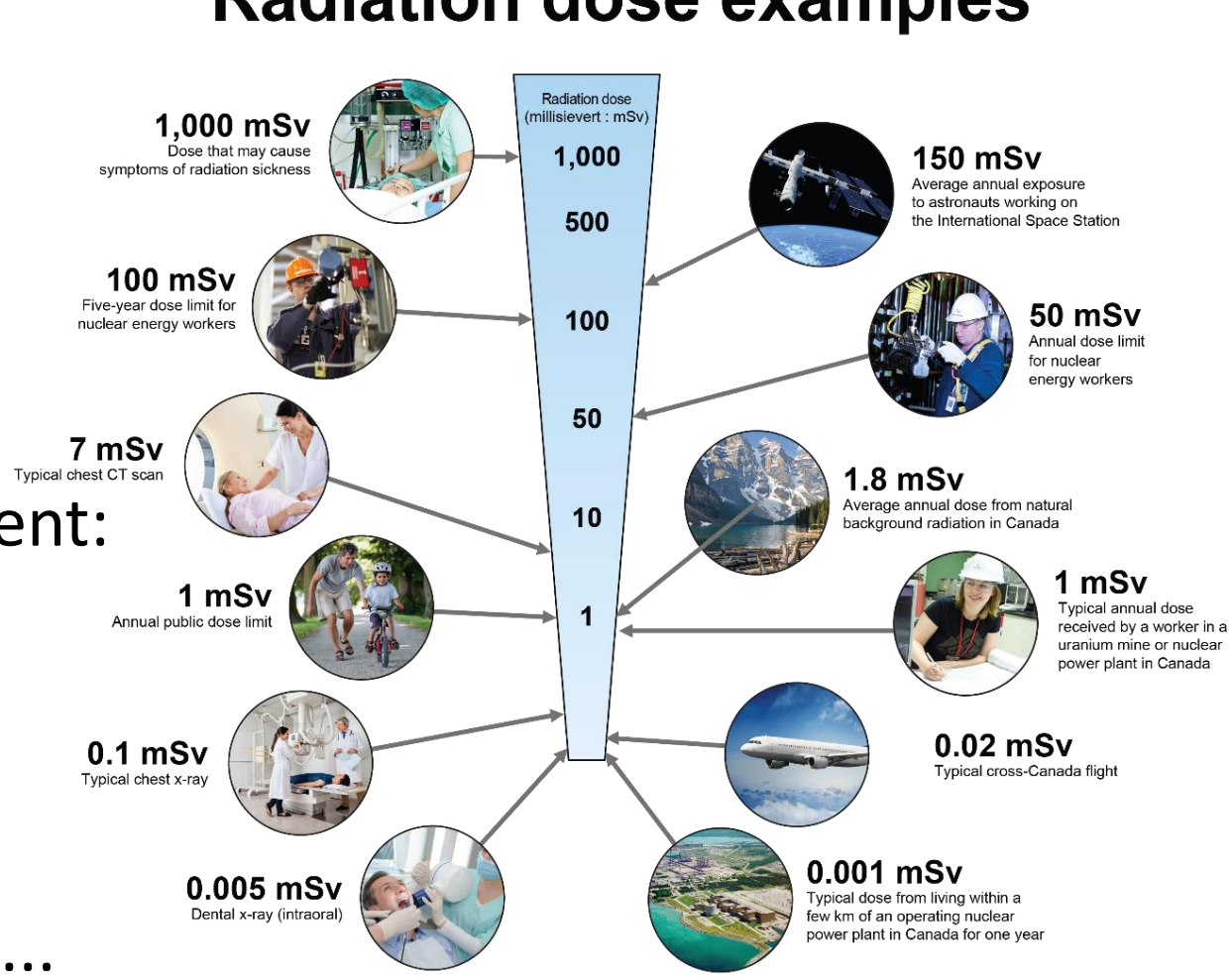
VFN a 1. LF UK v Praze

Organization of X-ray Teaching in Pediatrics

- **Lecture – Abdomen, Head, Skeleton, Uro-radiology.**
- **Seminar – Thorax.**
- **Study materials:** mudr.org, under the „Přednášky" tab.

General Principles

- **ALARA,** justifications.
- Children are more radiosensitive.
- Additional risk of cancer development:
- Chest X-ray – 0.005%
- Head CT – 0.05%
- Abdominal CT – 0.5%
- Low dose protocols, Ultra low dose...
- Communication with parents.

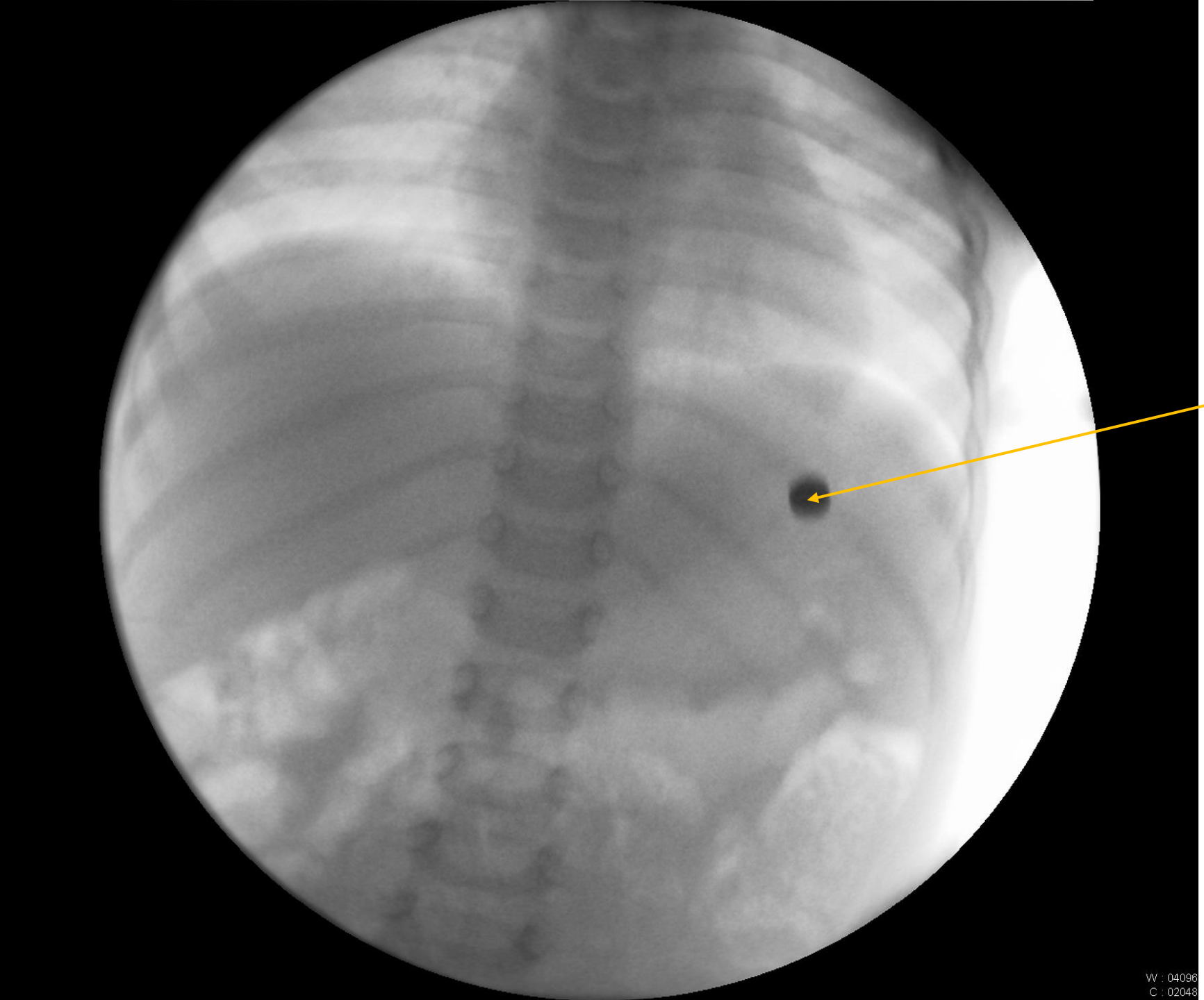


Swallowed foreign bodies

Abdominal X-ray (and its description)
Shadow that projects into...

Abdomen radiograph non-contrast,

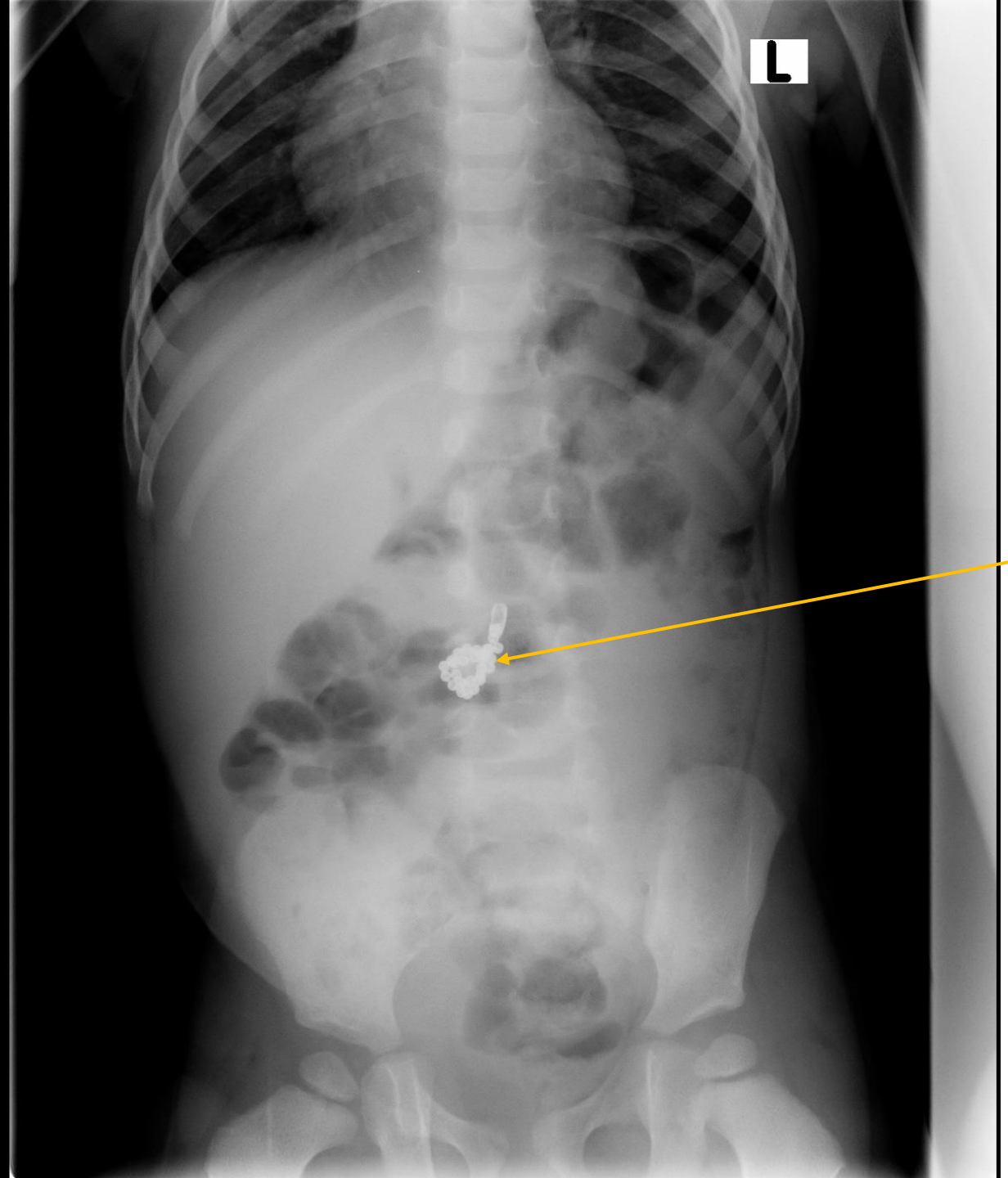
Coin-like shadow is projecting to vertebral body L2.



Abdomen radiograph,
Fluoroscopy image

Shadow of the foreign body is projecting to left subfrenic region.

Reversed scale of grey



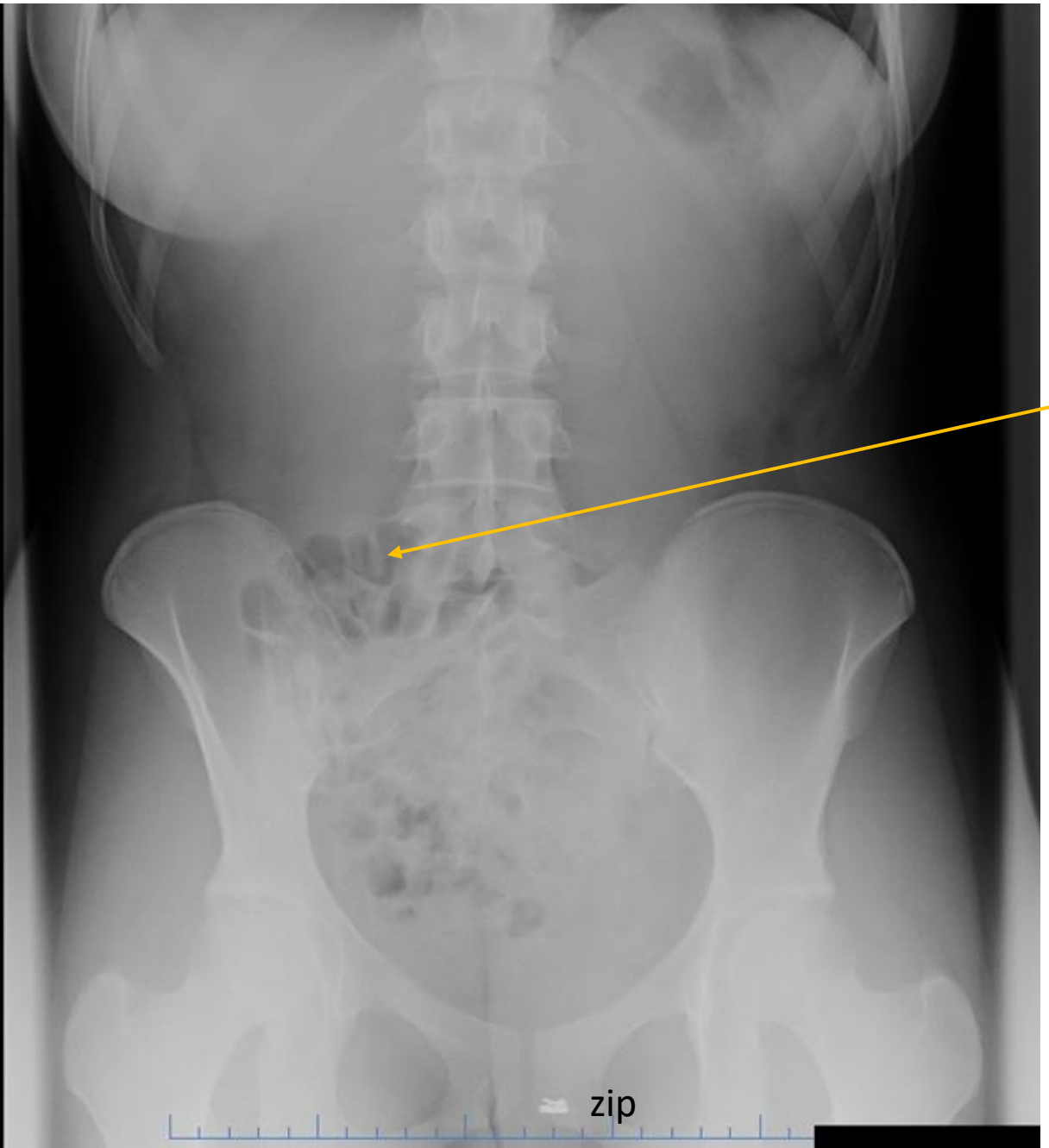
Abdomen radiograph
Plain image

Irregular shadow projecting to vertebral body L4.

Foreign bodies in GI tract

- **Children under 5 years old**
- Most serious – flat batteries in the esophagus, magnetic beads (2 or more).
- Objects larger than 25mm in diameter do not pass through the pylorus.
- Objects longer than 6cm do not pass through the duodenum or ileocecal junction.
- CT - if complications are suspected (perforation, abscess, fistula).
- Monitoring – depending on the object nature, daily/weekly X-rays.
  Batteries – if not proceeding aboral direction, endoscopy or surgery.

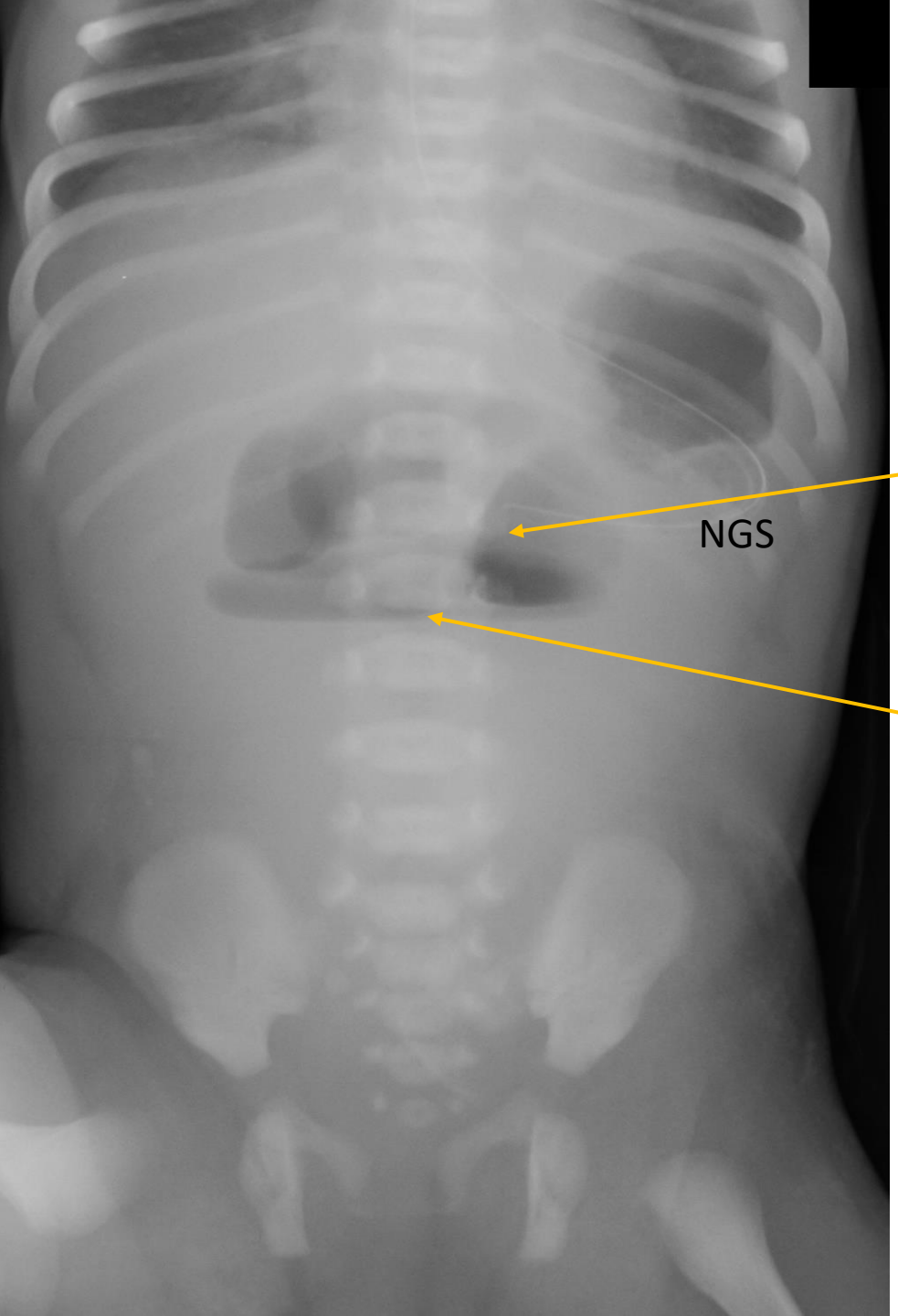
Passage disorders, pneumoperitoneum, fluoroscopy



Abdomen radiograph, plain image, non-contrast
Patient in upright position
Horizontal x-ray beam

Plain abdominal radiograph:

There is no pneumoperitoneum. Bowel loops are normal in apperance. No signs of bowel obstruction.



Plain abdominal radiograph
Erect position

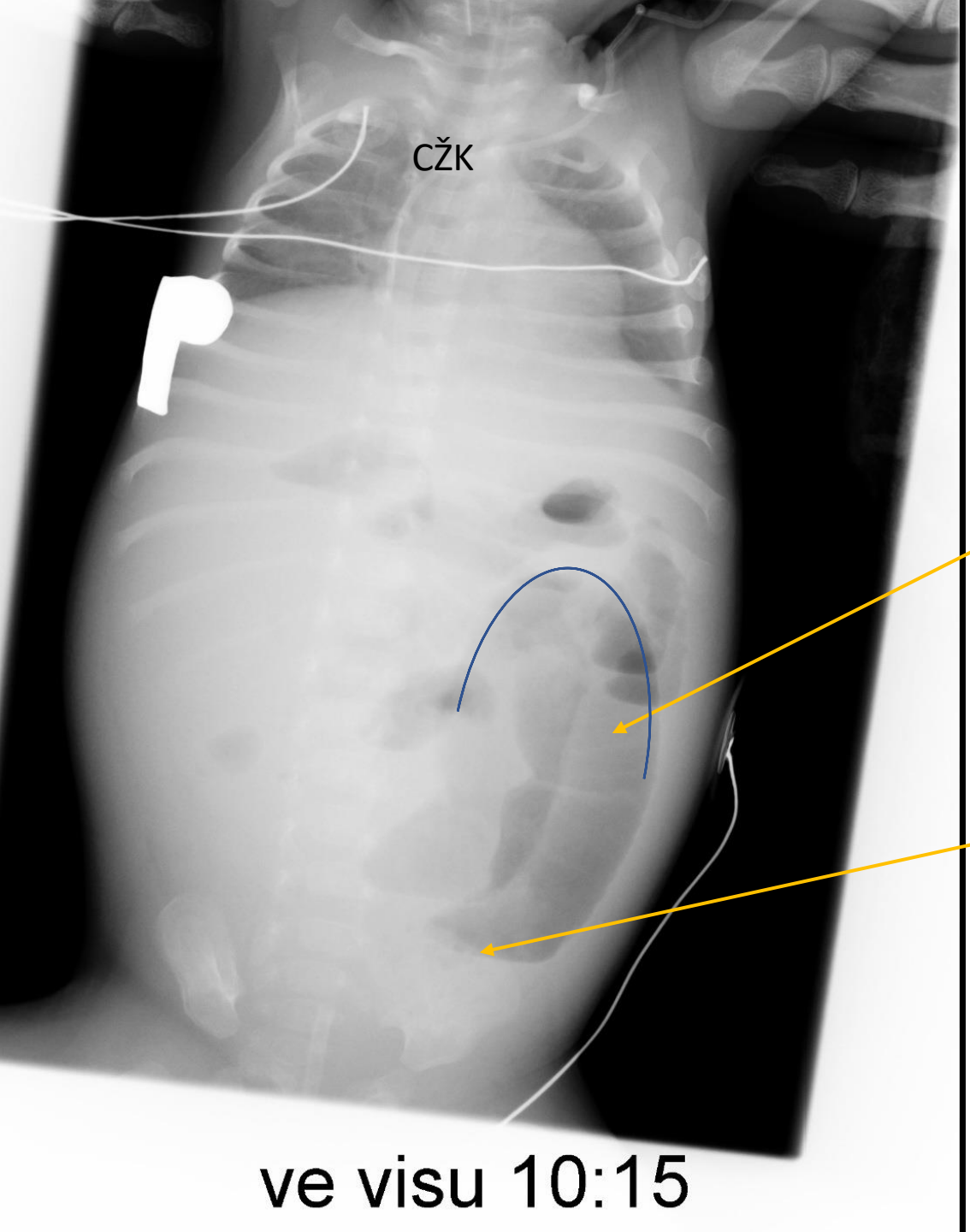
Multiple dilated bowel loops

+

Air-fluid level

= Ileus – level of jejunum, tripple bubble sign.

Naso-gastric tube inserted in stomach.



Plain abdominal radiograph
Erect position

Multiple dilated bowel loops

+

Air-fluid level

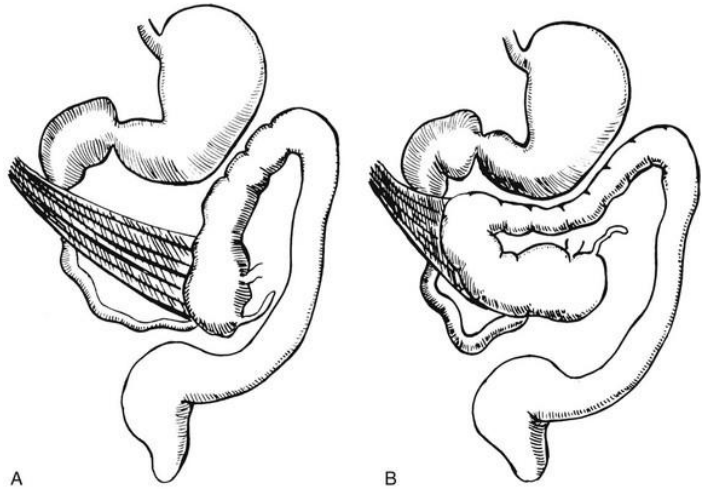
= Ileus

High obstruction

- **Complete X incomplete**
- Esophageal, pyloric, duodenal, jejunal, and oral ileal atresia.

- Duodenal membrane, annular pancreas.
- Duodenal stenosis, perforated duodenal membrane,

- Malrotation and obstruction by Ladd's bands.

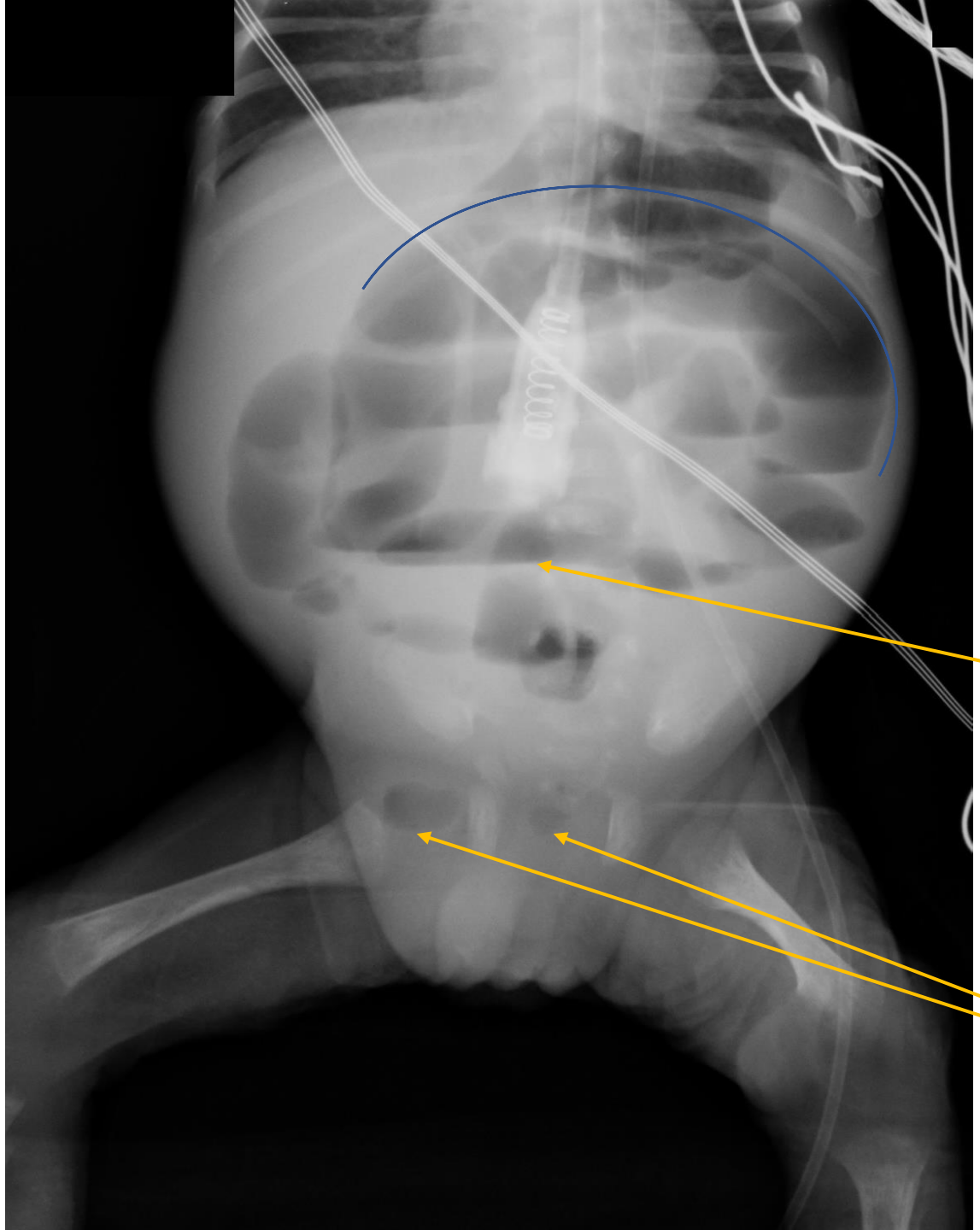


Diagnostics

- **Plain abdominal X-ray, Ultrasound**
- Gastrointestinal passage (stomach capacity – newborn 20ml, after 2 months – 200ml)
- Irrigography

Low obstruction

- Meconium ileus (microcolon),
- atresia of the terminal ileum,
- Hirschsprung's disease.



Plain abdominal radiograph
Erect position

Multiple dilated bowel loops

+

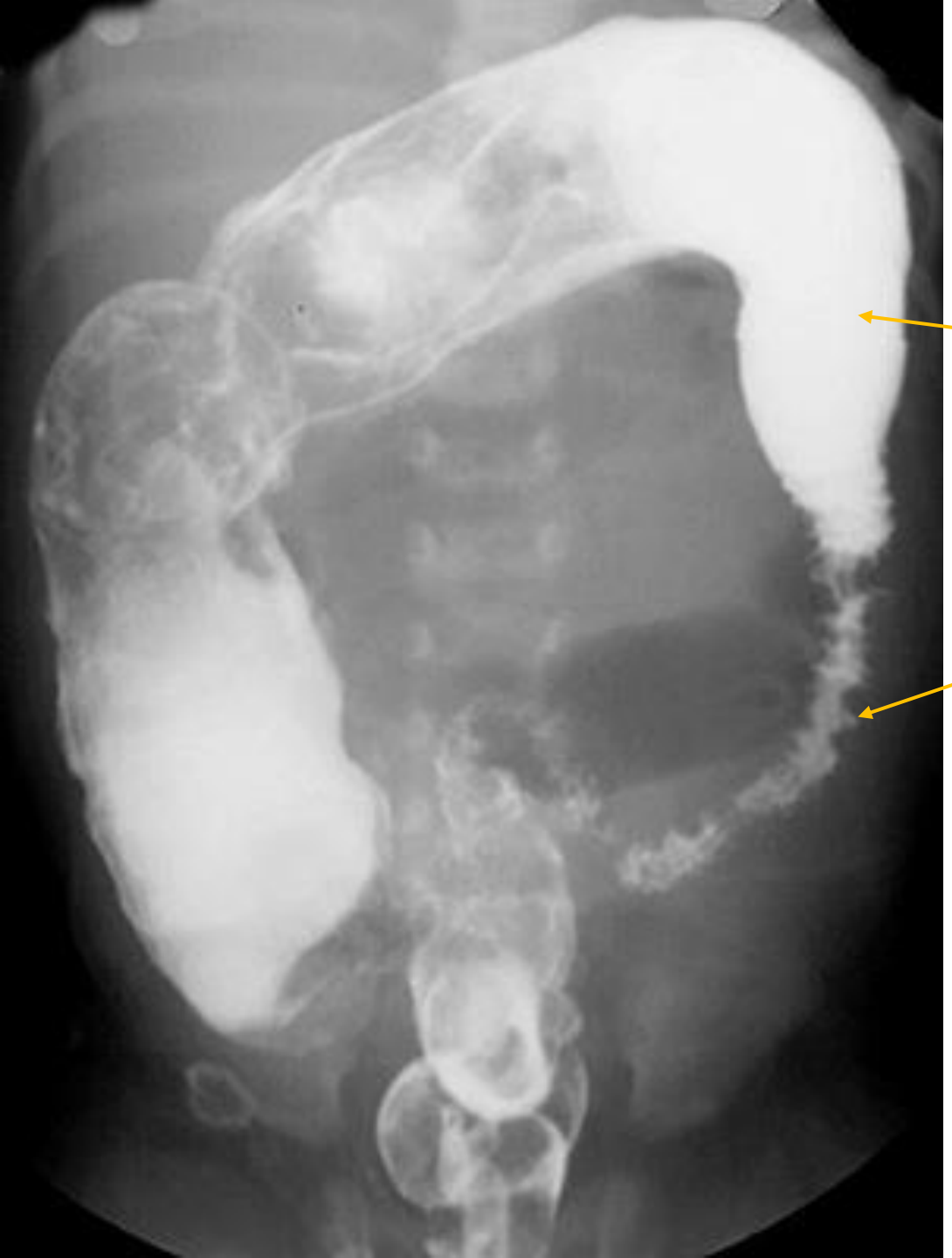
Air-fluid level

= Ileus

Bilateral scrotal hernia

Hirschsprung's disease

- **Congenital absence of ganglion nerve cells in the intestinal wall,**
- poor function of the uninervated segment of the intestine with its permanent narrowing and impaired passage of digested food.
- Delayed passage of meconium,
- Surgical treatment.



Barium enema, irrigography

= **Double contrast barium enema**

- The '**double contrast**' refers to the use of positive and negative contrast agents to increase the sensitivity of the examination.

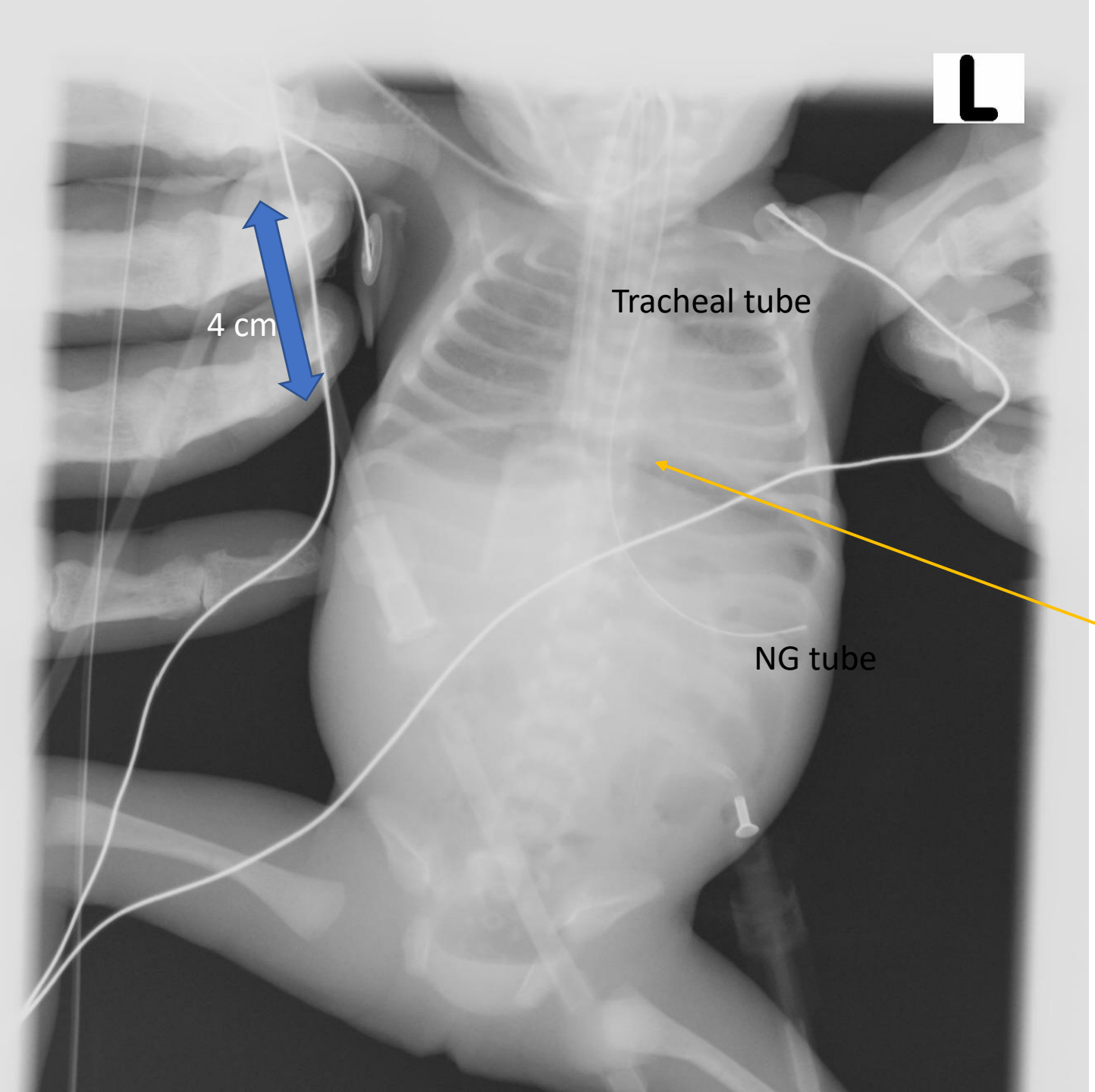
Proximal dilatation.

The affected segment is of small caliber.

Hirschprung disease

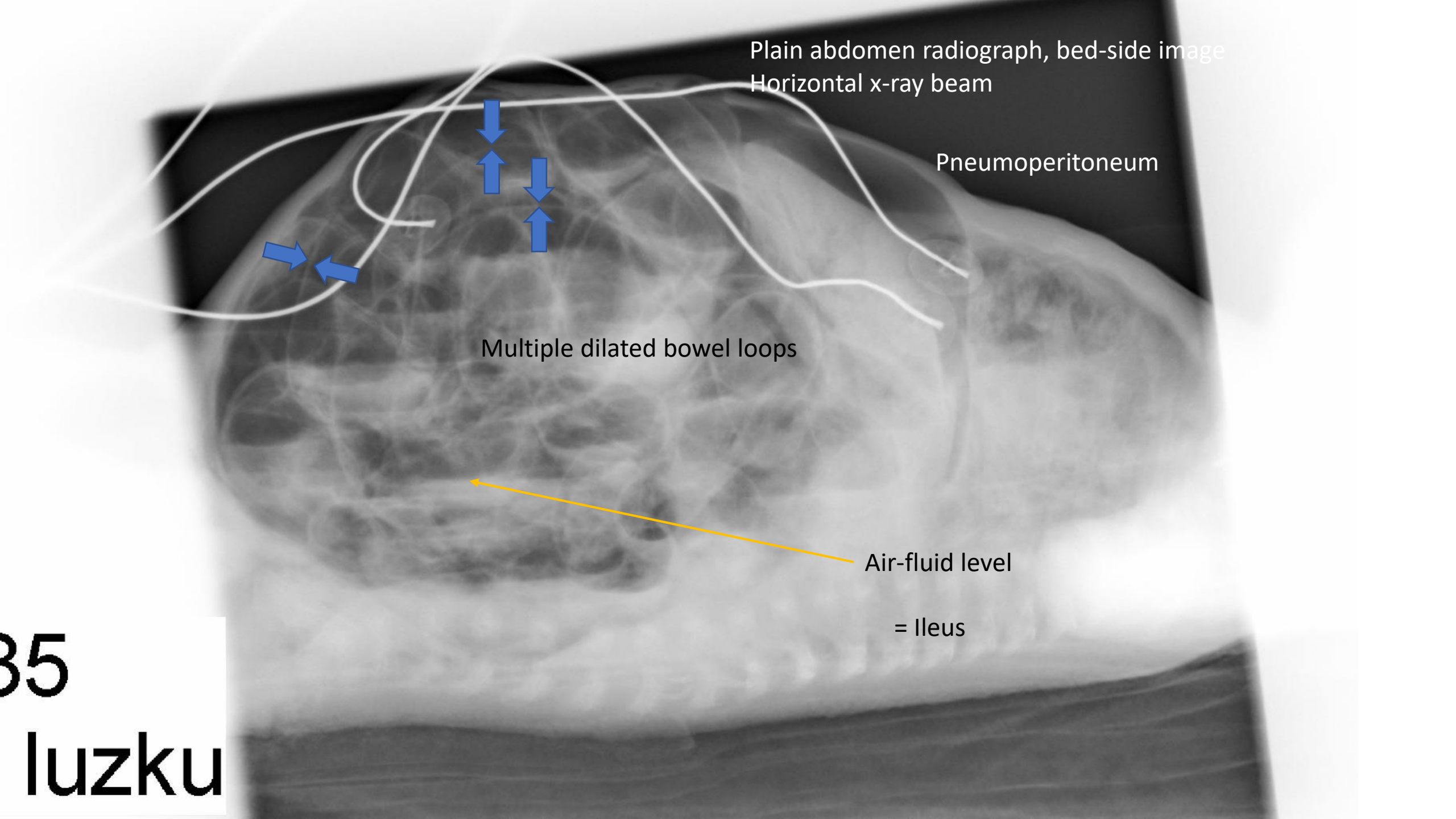
Necrotizing enterocolitis

- **Main cause of acute abdomen in premature neonates,**
- bacterial invasion of the mucosa, intramural gas, necrosis, perforation.
- **X-ray:** initially, distention of bowel loops (interpeduncular distance at L2 – reference value). Irregular gas distribution. Gas in the wall – pneumatosis intestinalis. Free gas – PNP (pneumoperitoneum).



Plain abdominal radiograph
Erect position

Pneumoperitoneum


Plain abdomen radiograph, bed-side image
Horizontal x-ray beam
Pneumoperitoneum
Multiple dilated bowel loops
Air-fluid level
= Ileus

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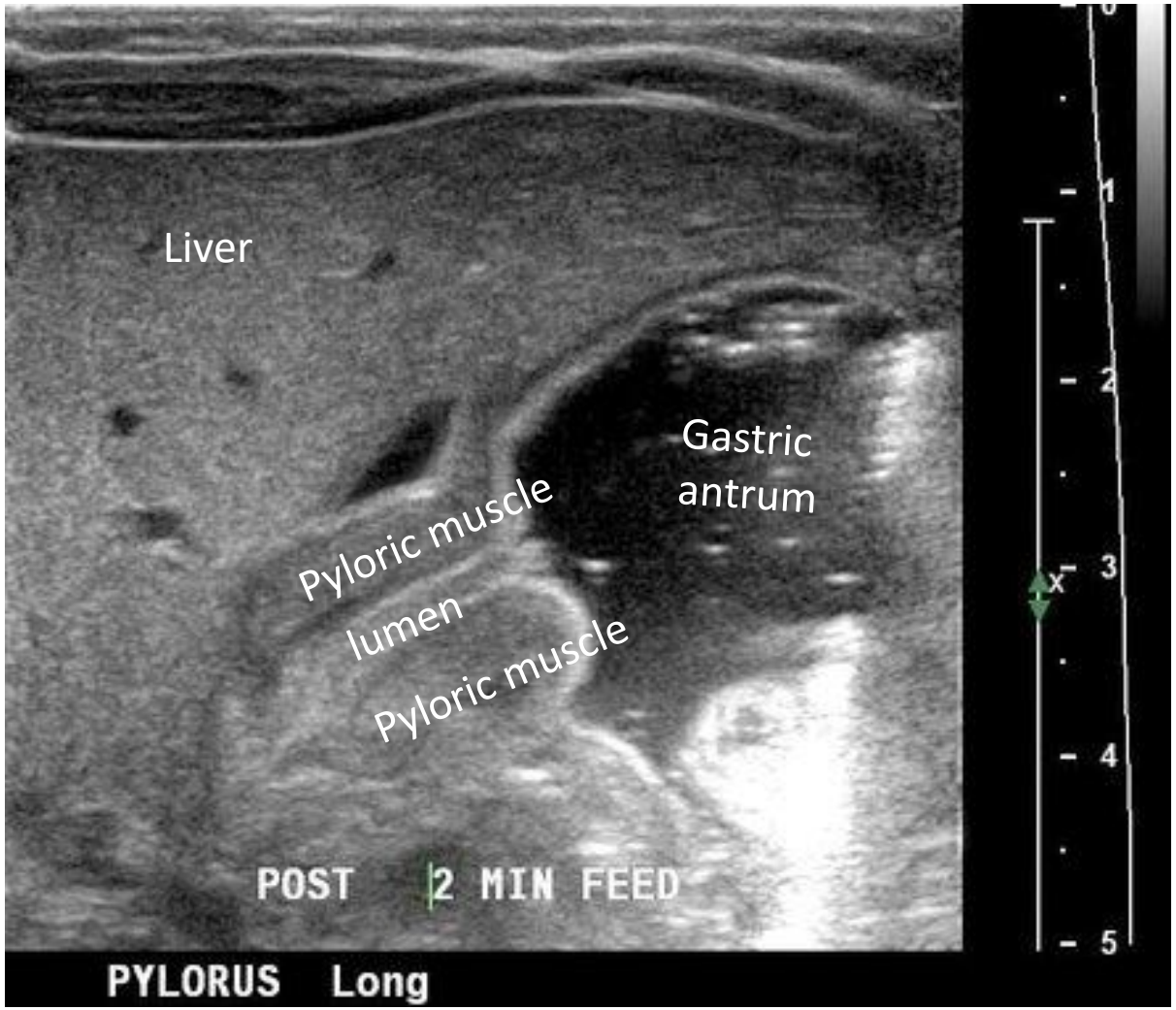
Pyloric stenosis

- **Idiopathic hypertrophy of the muscle layer,**
- projectile vomiting, infants 3rd to 6th week of life.
- **Management:** pyloromyotomy.

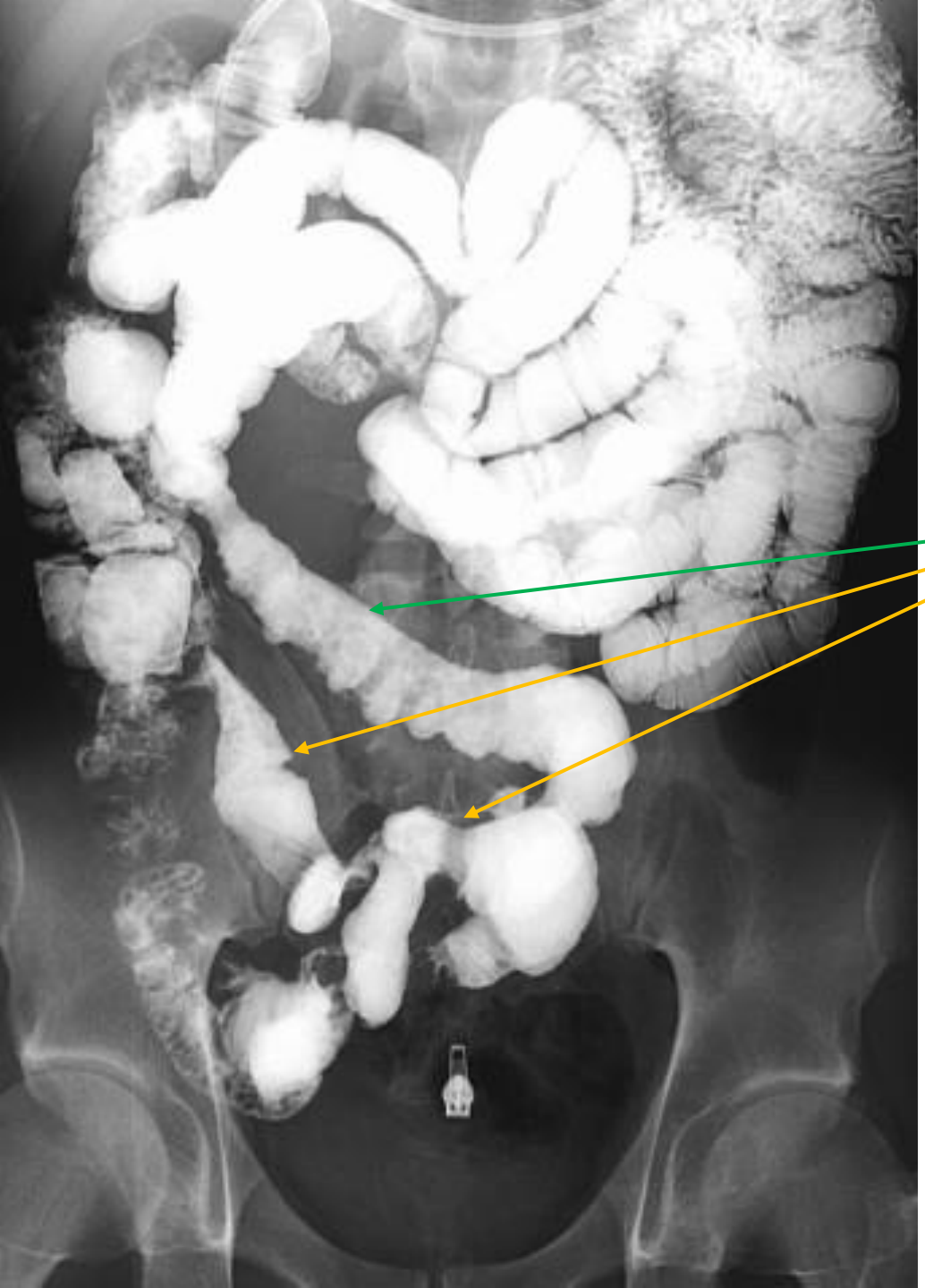
Hypertrophic pyloric stenosis sonography



Increased muscle thickness, 3mm
Elongated pylorus, 15mm

IBD - Inflammatory Bowel Disease

- **Crohn's disease, Ulcerative colitis (UC).**
- Ultrasound, MR enterography / CT enterography
  Signs of active vs. chronic inflammation, possible complications (abscess, fistula)
- Wall thickening, type of enhancement. Limits – 3mm for small intestine, 4mm for colon.

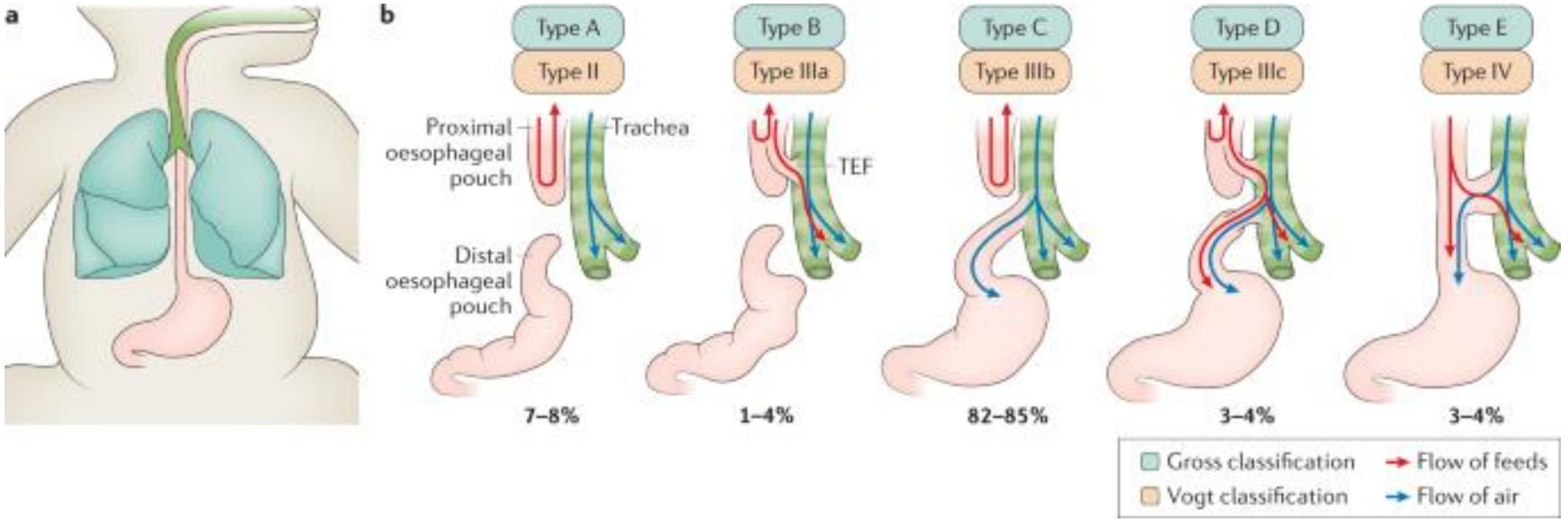


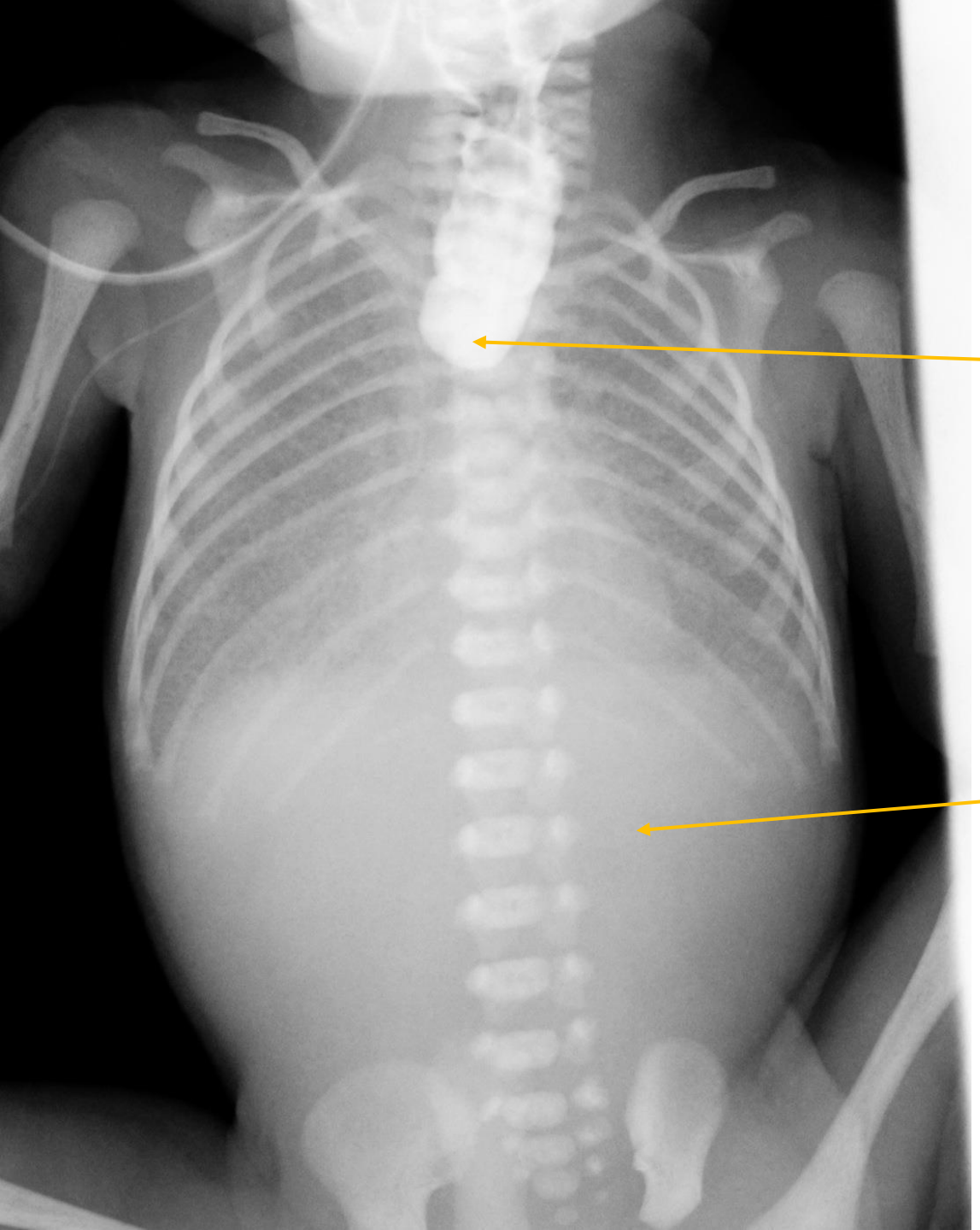
Enteroclysis

Irregular lumen, tubular narrowing , prestenotic dilatation, transverse stripes, when severe leads to cobblestone appearance.

Esophageal atresia

- **Type A, B – no gastrointestinal gas on X-ray**
- Fluoroscopy – 0.5ml undiluted iodine contrast. Postoperative follow-up – 7th postoperative day, Balloon dilation of potential strictures.





Esophageal atresia

Contrast swallow may show contrast blindly ending and pooling in an esophageal stump and/or may show evidence of the tracheo-esophageal fistula.

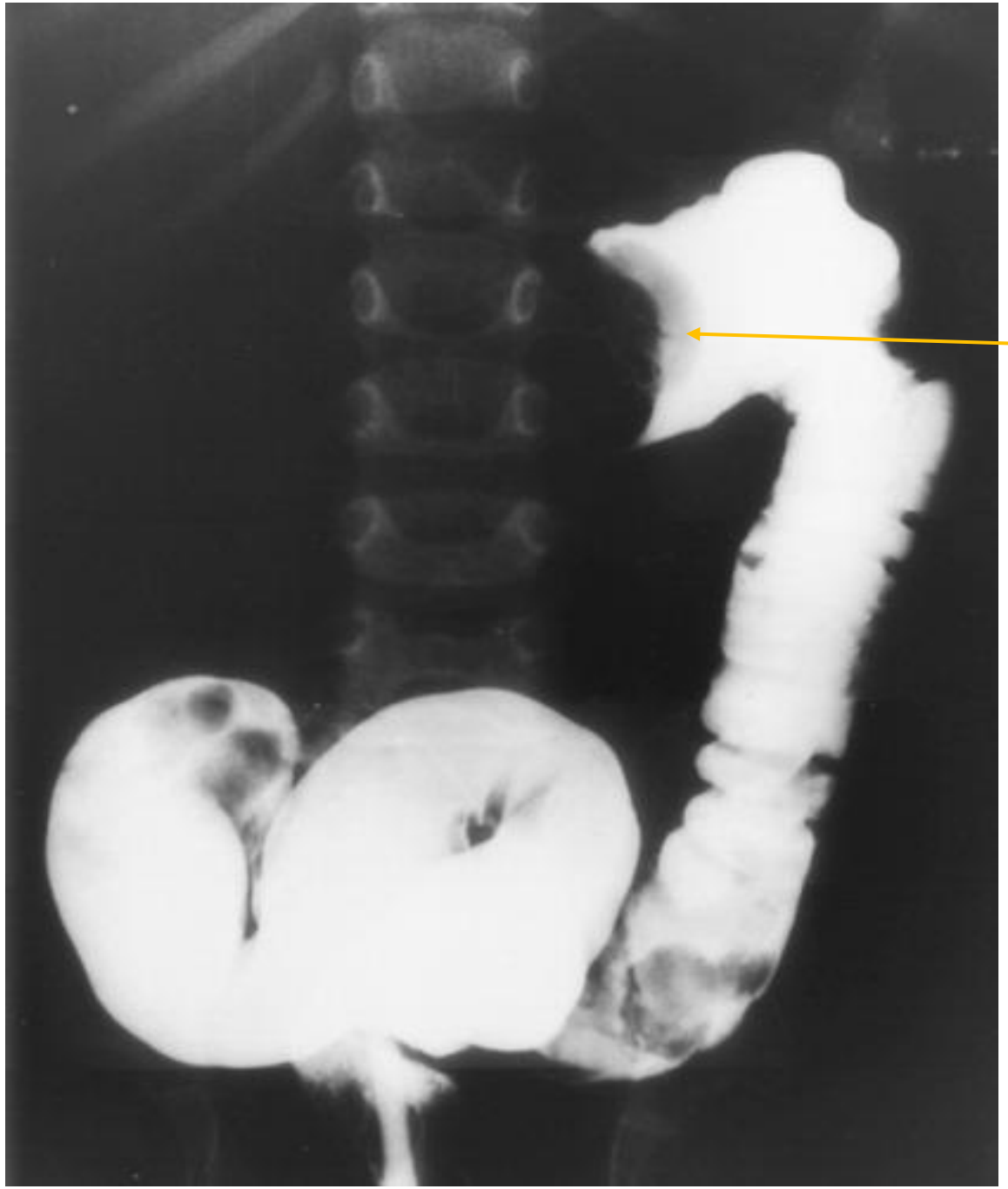
The absence of air in the stomach and bowel.

Intussusception

- Telescope-like invagination of the oral segment of the intestine into the aboral segment, including the mesentery and blood vessels.
- **Risks:** gastrointestinal obstruction, venous congestion, edema, ischemia, necrosis, perforation.
- **Idiopathic –** possible causes include lymphoid hyperplasia due to viral infections. **Leading point:** Meckel's diverticulum, duplicature, polyp, lymphoma, tumors.
- **Ileocolic –** most common**, enteric –** often transient**, colic.**

- Ultrasound (US).

- Hydrostatic desinvagination under general anesthesia (GA), Ultrasound (US).



Barium enema, irrigography

= **Double contrast barium enema**

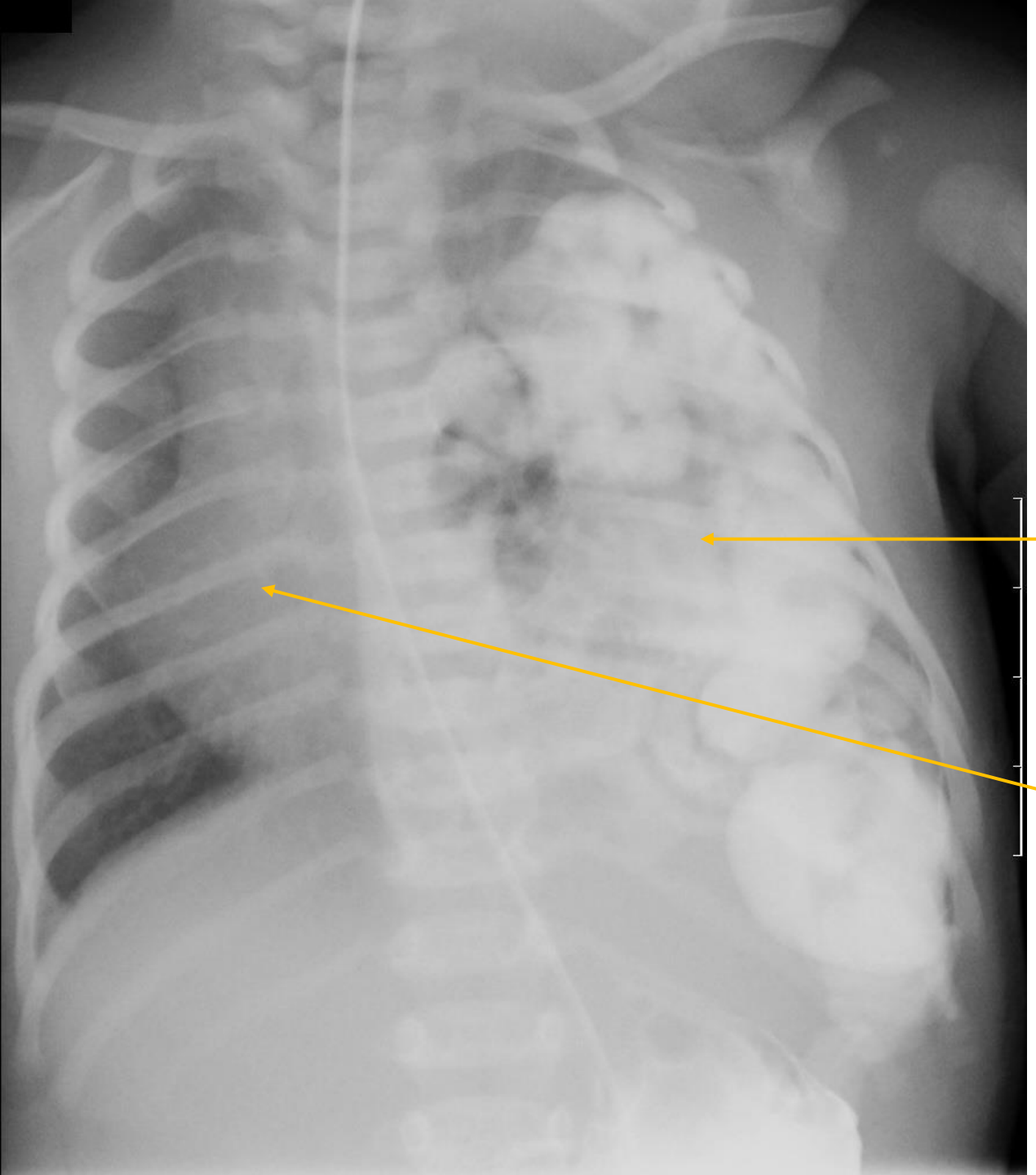
- The '**double contrast**' refers to the use of positive and negative contrast agents to increase the sensitivity of the examination.

the intussusception as an occluding mass prolapsing into the lumen

Intussusception

Congenital diaphragmatic hernias

- **Bochdalek hernia** – most common type, located lumbocostally on the left.
  Morgagni hernia – rare, located sternocostally on the right.
- **Hiatal hernias** – short esophagus, sliding hernia, paraesophageal hernia.

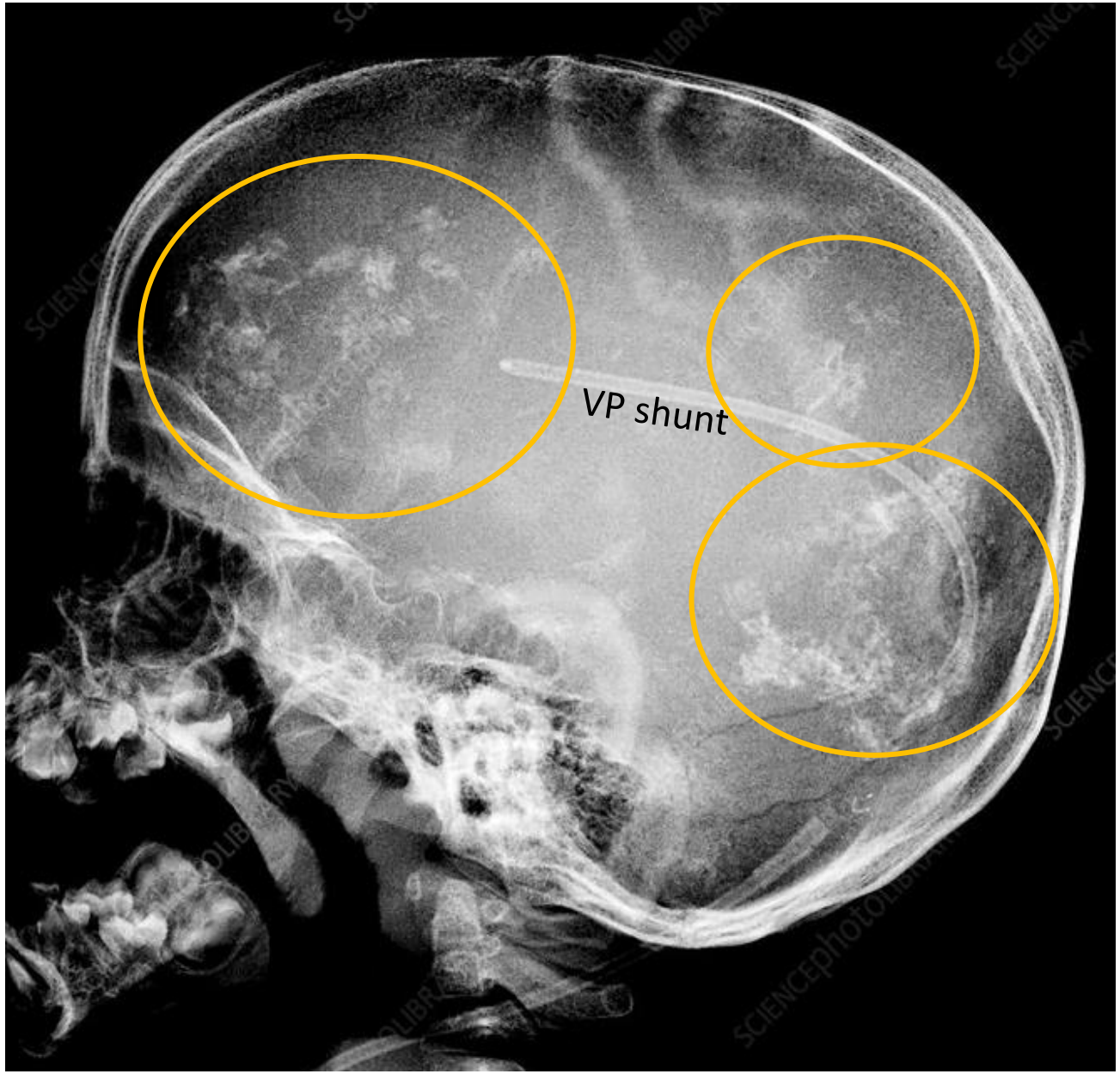


Diaphragmatic hernia

Prolaps of intra-abdominal organs into thoracic cavity. Contrast enema.

Shift of mediastinal structures.

Head



- **Multiple intracranial calcifications**
- **Skull x ray**

Calcifications – intracranial, gyrific-like

- Congenital infections: TORCH (Toxoplasma, Rubella, CMV, HSV2),
- Consequences: cortical malformations, cerebellar hypoplasia, calcification, ventricular dilatation, leukoencephalopathy.
- Sturge-Weber syndrome – phacomatosis, neurocutaneous syndrome – capillary malformations of the face, eyes, meninges.

Extracranial hemorrhage(neonates)

- Cephalhematoma – birth injury, subperiosteal hemorrhage limited by cranial sutures to one bone. Ossification, remodeling.
- Subgaleal hemorrhage – blood loss can lead to anemia, not limited by cranial sutures.
- Caput succedaneum, “birth tumor”, subcutaneous localization, spontaneously disappears.

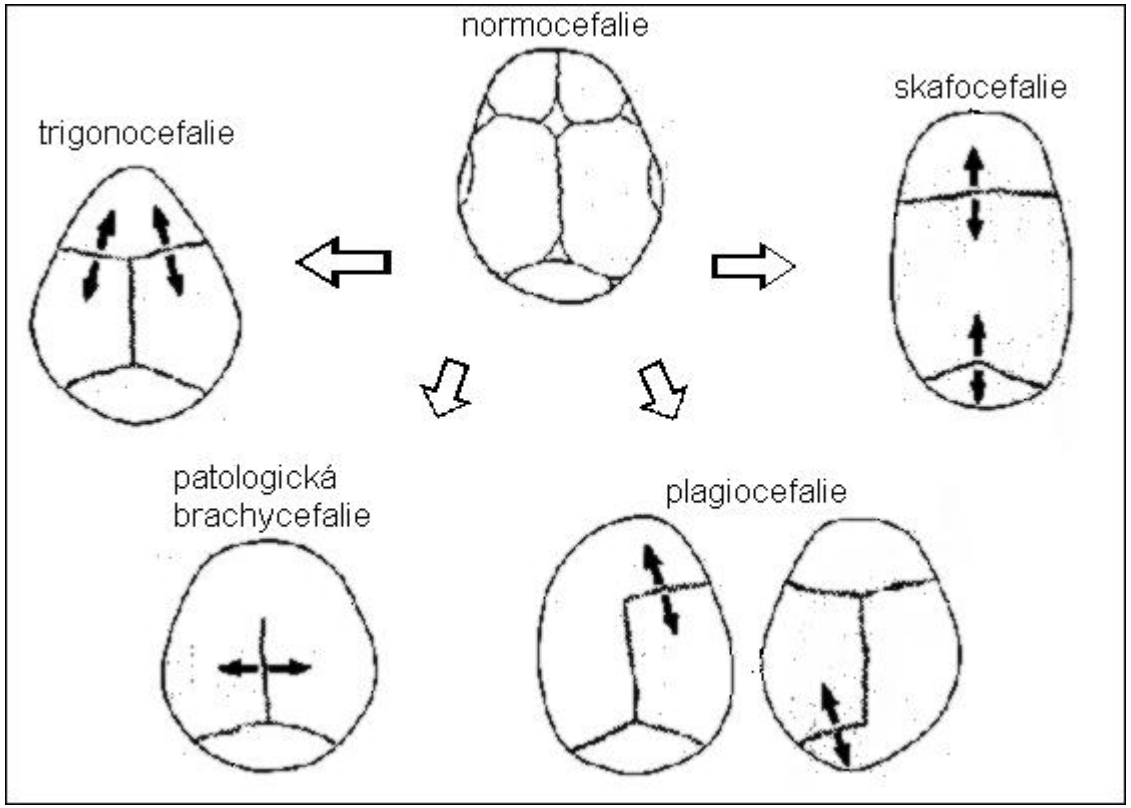
Calcified cephalohematoma

Skull x- ray

A smooth ossified sessile lump is seen arising from the left parietal bone. The skull appears otherwise normal.

Craniosynostosis

- Most often, the fusion affects one suture,
- Sometimes association with congenital skeletal disorders or syndromes.



Craniosynostosis

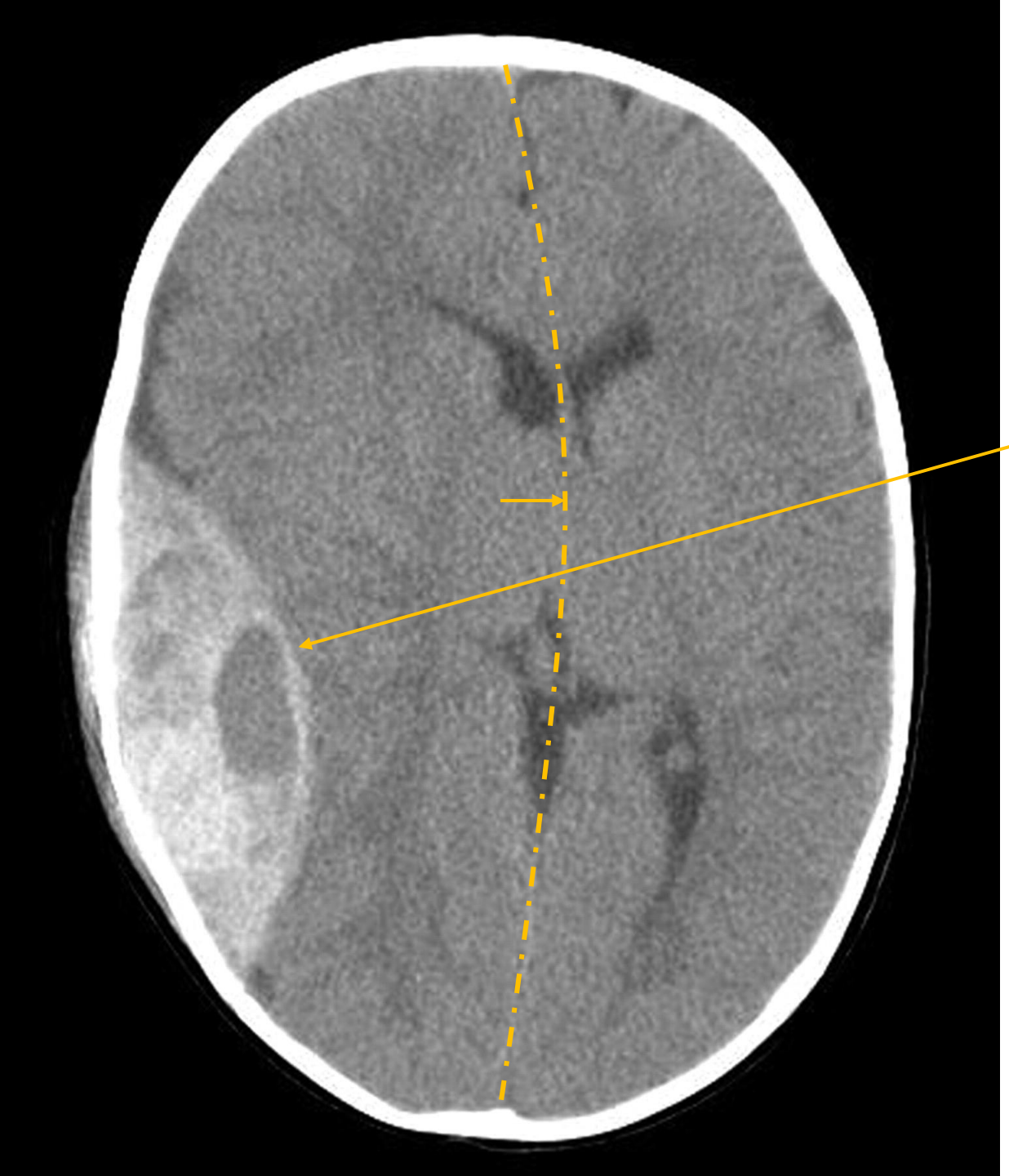
Skull x-ray

Multiple radiolucent foci = impressions of cerebral gyri.

Intracranial extraaxial hemorrhage

- Epidural hematoma – between the calva and dura mater.
- Subdural hematoma – between the dura and arachnoid.
- Subarachnoid hemorrhage – between the arachnoid and pia mater.

- TRAUMA – X-ray of the brain is not routinely indicated, CT. Multiple fissures – inconsistent history – suspected child abuse.

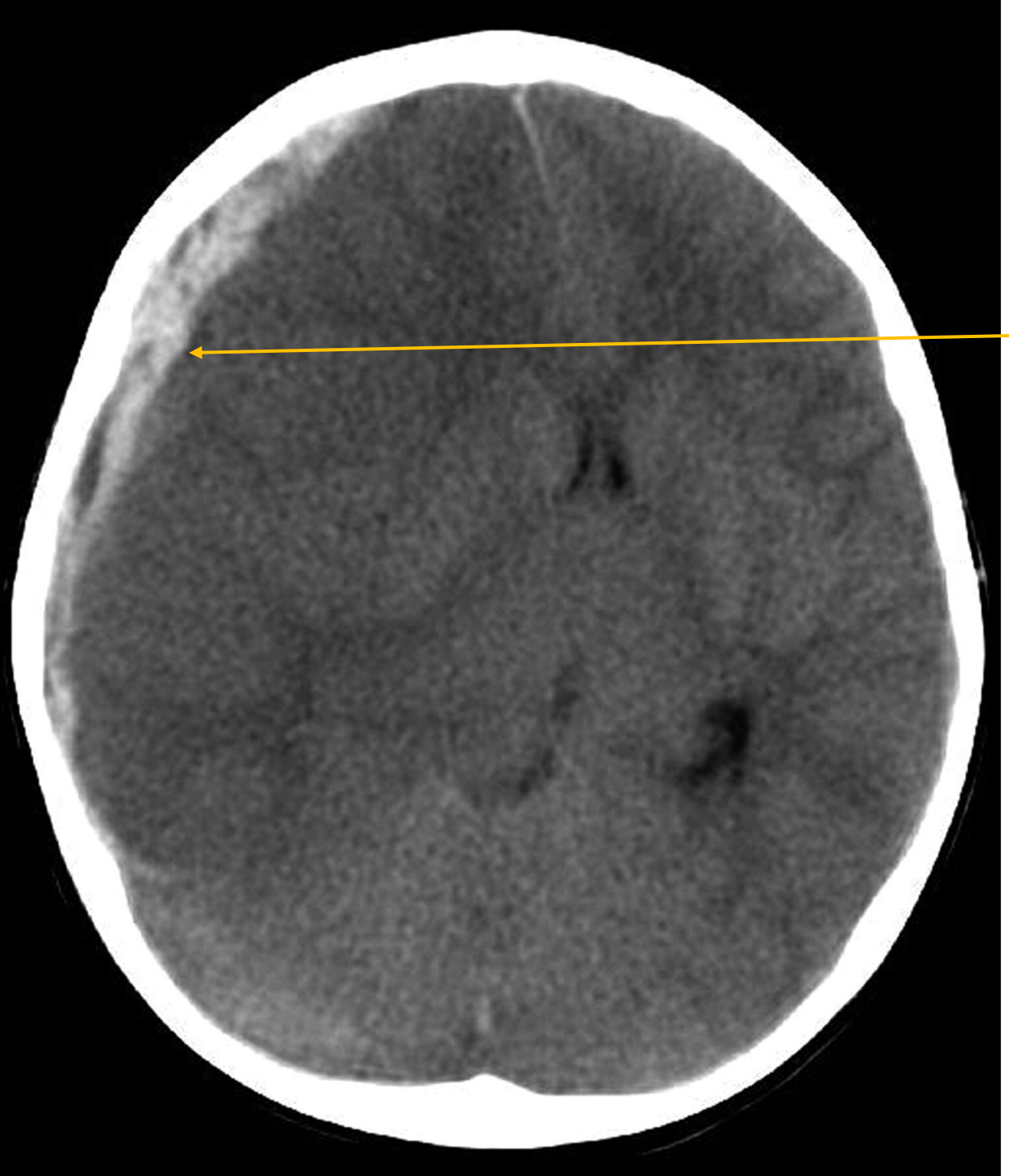


Epidural hematoma, CT scan:

Hyperdense lentiform collection,

On the right side, parietal.

Midline shift, brain edema on the right.



Brain CT

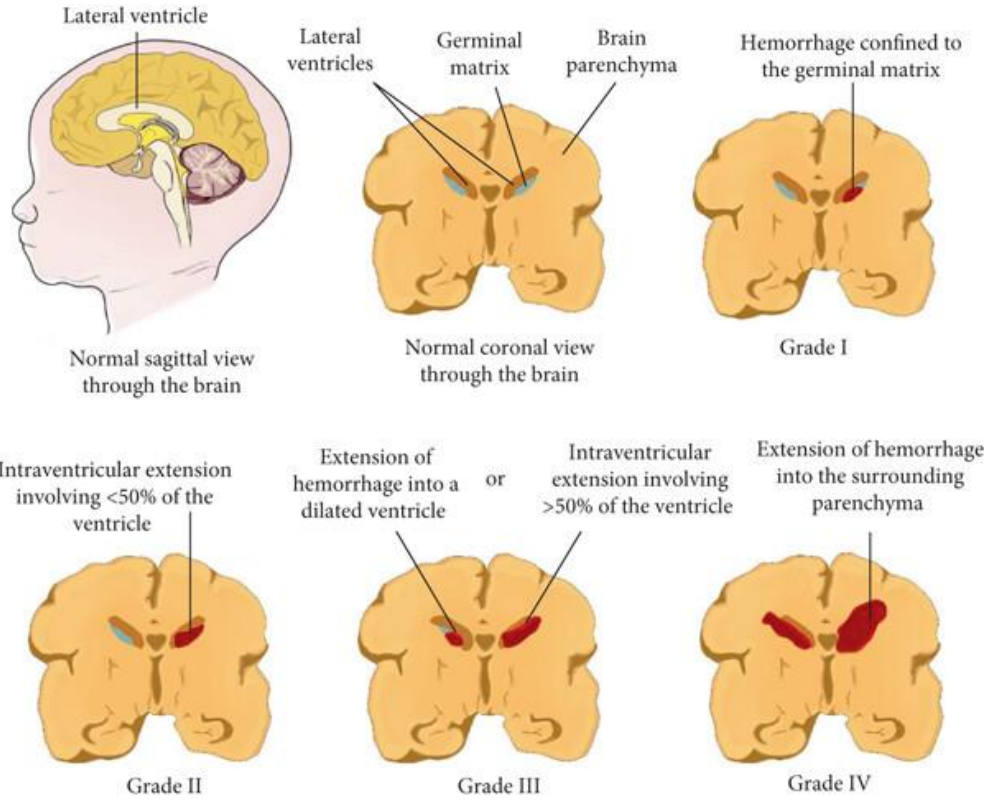
Subdural hematoma

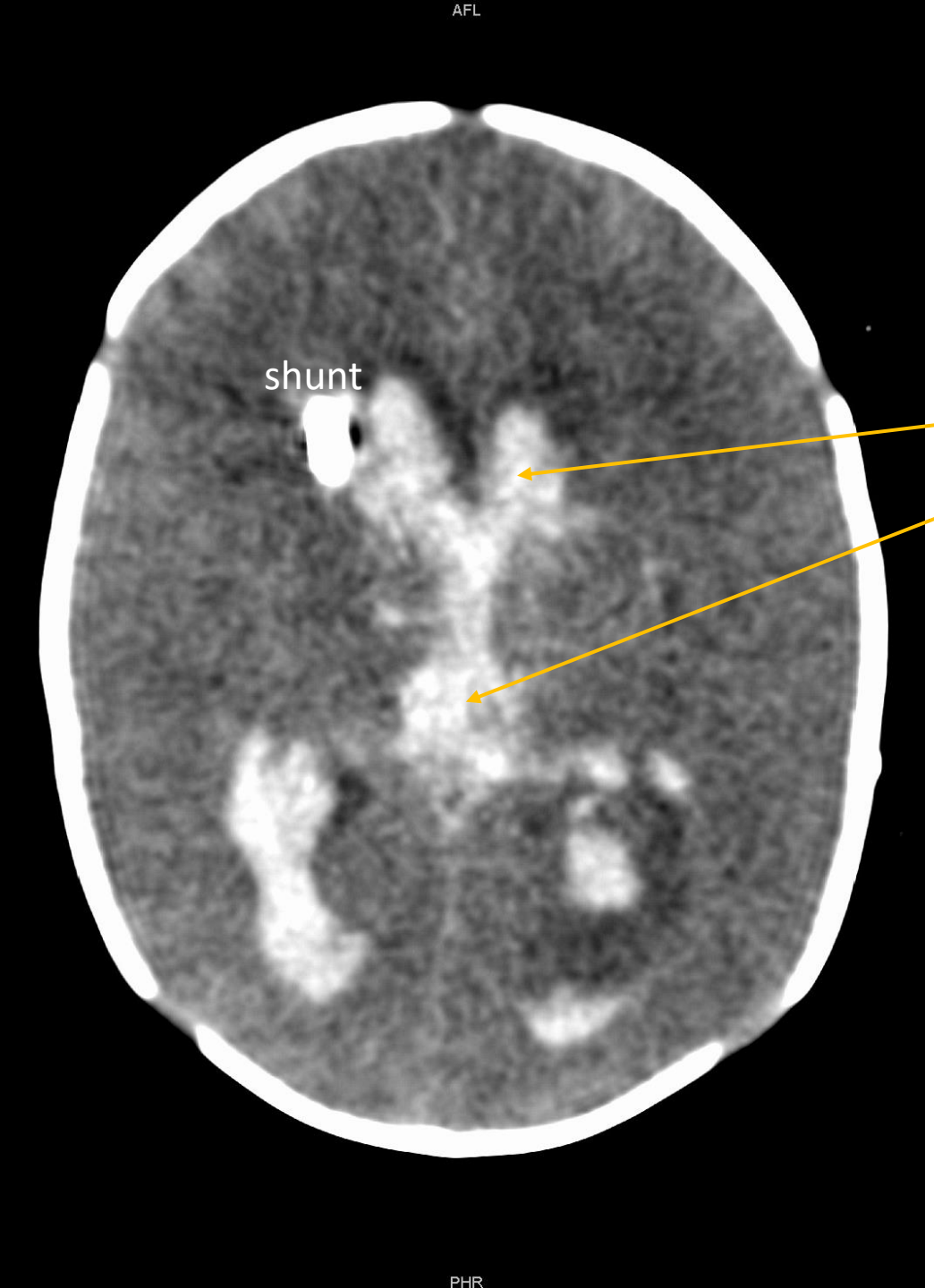
Brain edema, midline shift

crescent-shaped homogeneously hyperdense extra-axial collection on the right side, fronto-parietal.

Periventrikular/intraventrikular hemorrhage

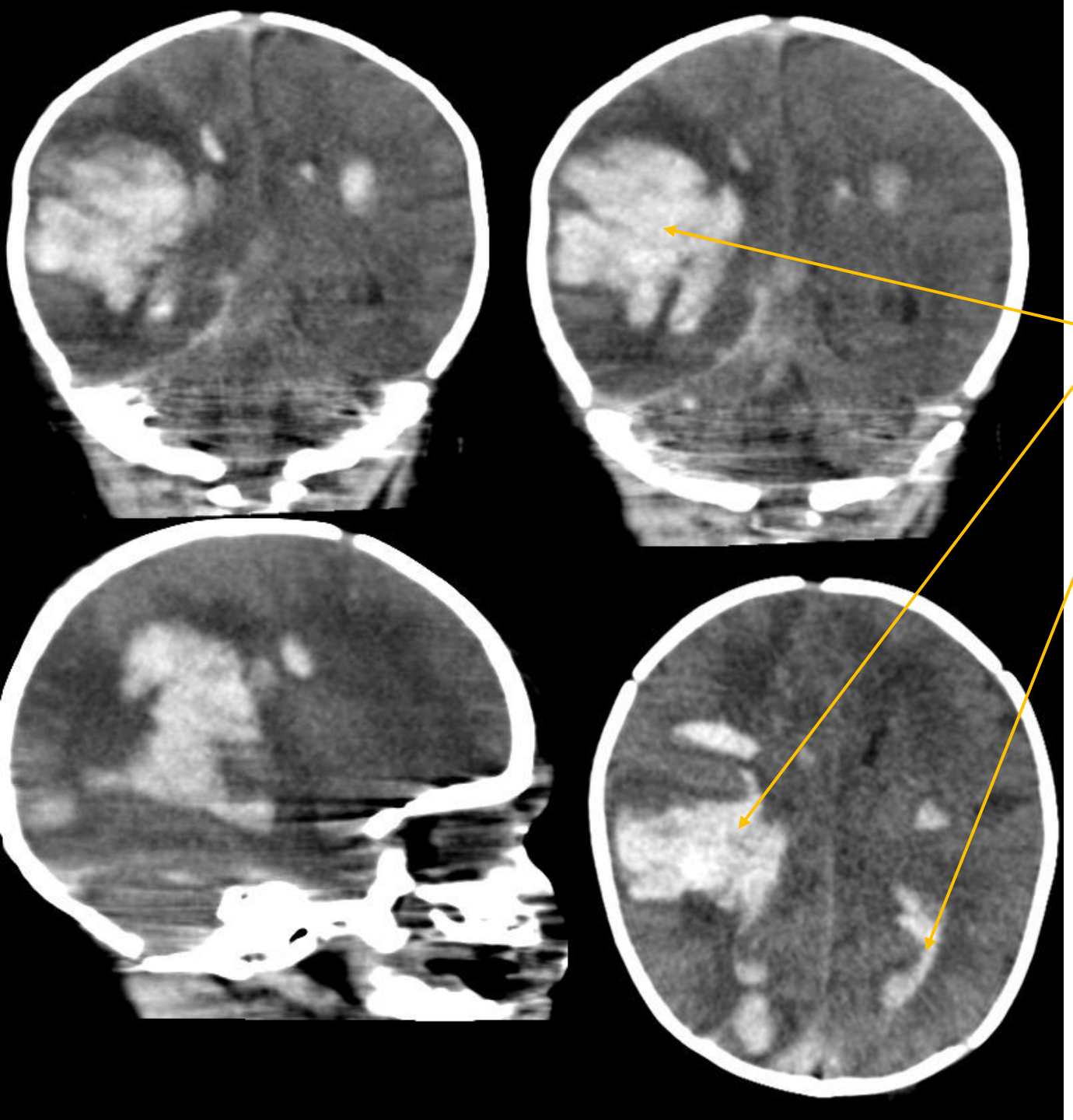
- Subependymal germinal matrix,
- Grade IV – hemorrhage in the ventricles + in the white matter (hemorrhage infarct) . US, MRI.
- Diff. Dg. Choroid plexus hematoma,
- Complication of vasculature thrombosis.





Hemocephalus

Ventricular hemorrhage.



Brain CT

Intracranial hemorrhage

Intraparenchymal.

Hemocephalus.

Hydrocephalus

- Causes: hemorrhage in premature infants, infections, VVV (Dandy-Walker), tumors.
- US, CT, MRI
- Obstructive hydrocephalus is caused by blockage of cerebrospinal fluid circulation.
- non-communicating, when the obstruction is in the ventricular system.
- communicating, when the obstruction is in the subarachnoid spaces or venous system.
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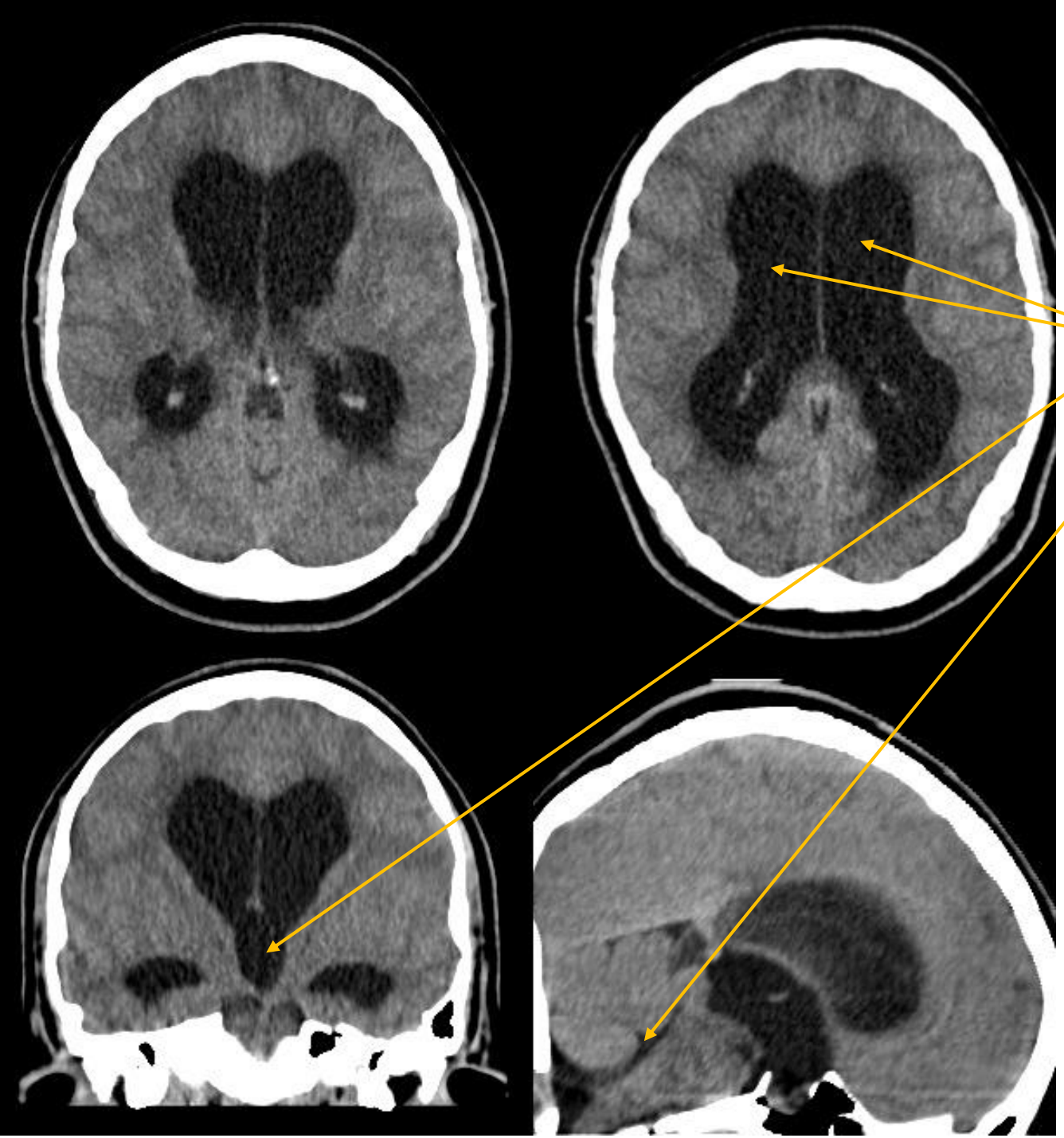
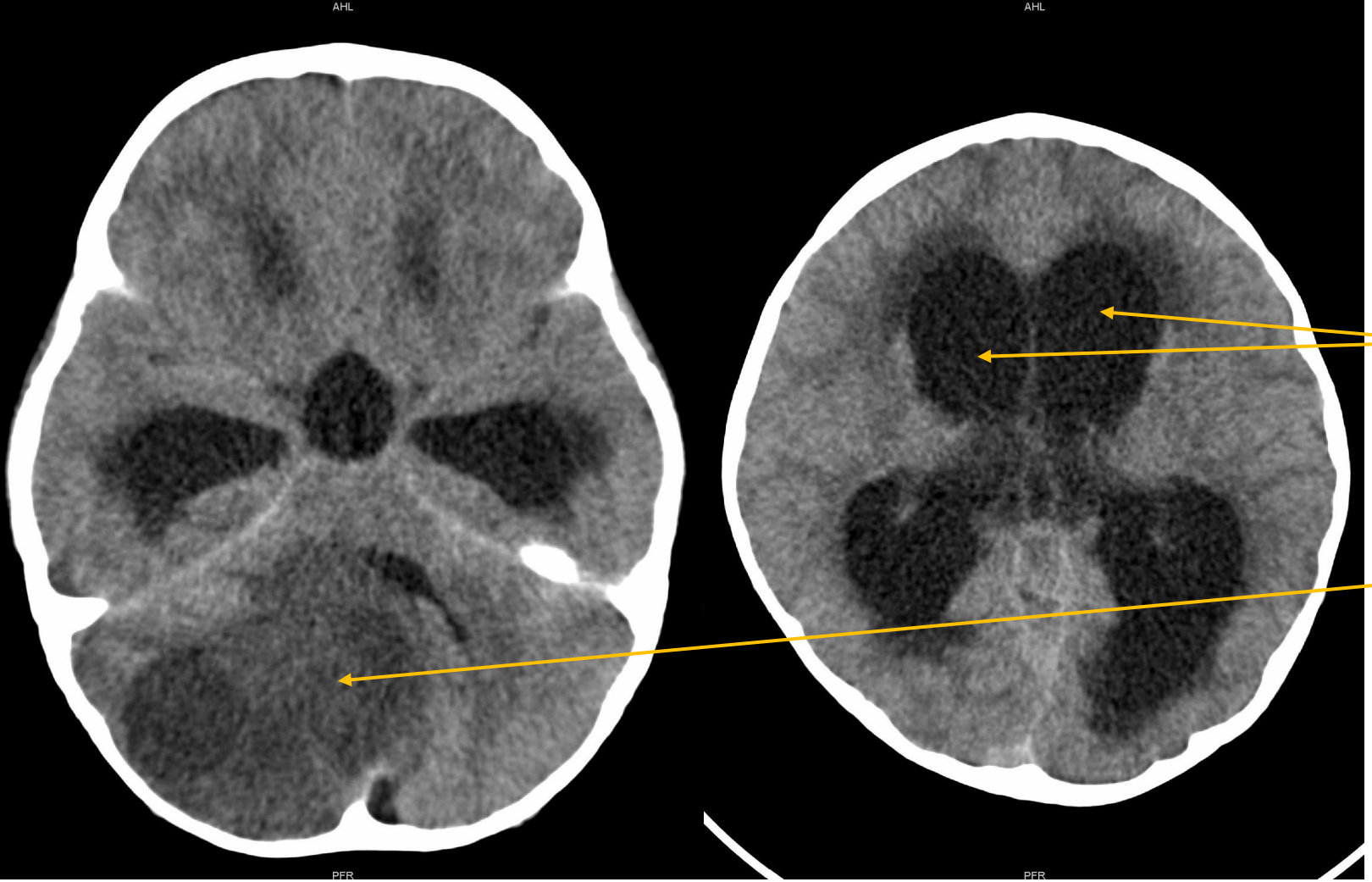


Hydrocephalus (triventricular)

- Ventricle dilatation.

Meduloblastoma

- Malignant tumor, posterior fossa
- CT, MRI 4 groups – Wnt-activated, Sonic hedgehog activated, …,
- Diff. Dg.for posterior fossa: Pilocytic astrocytoma, Ependymoma (3rd most common tumor in children).
- Brain tumors (general): astrocytic tumors (subgroup of low-grade glioma).



Brain CT

Hydrocephalus

Brain tumor on the right side in the level of cerebellar fossa.

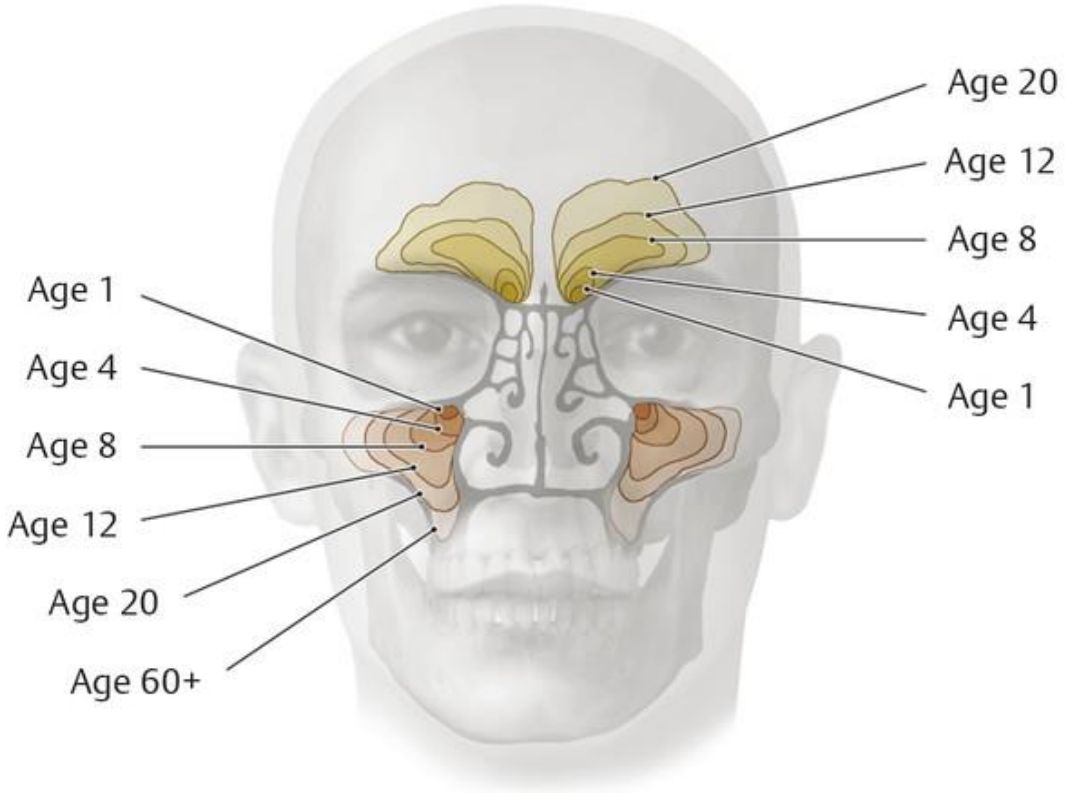
Acute sinusitis

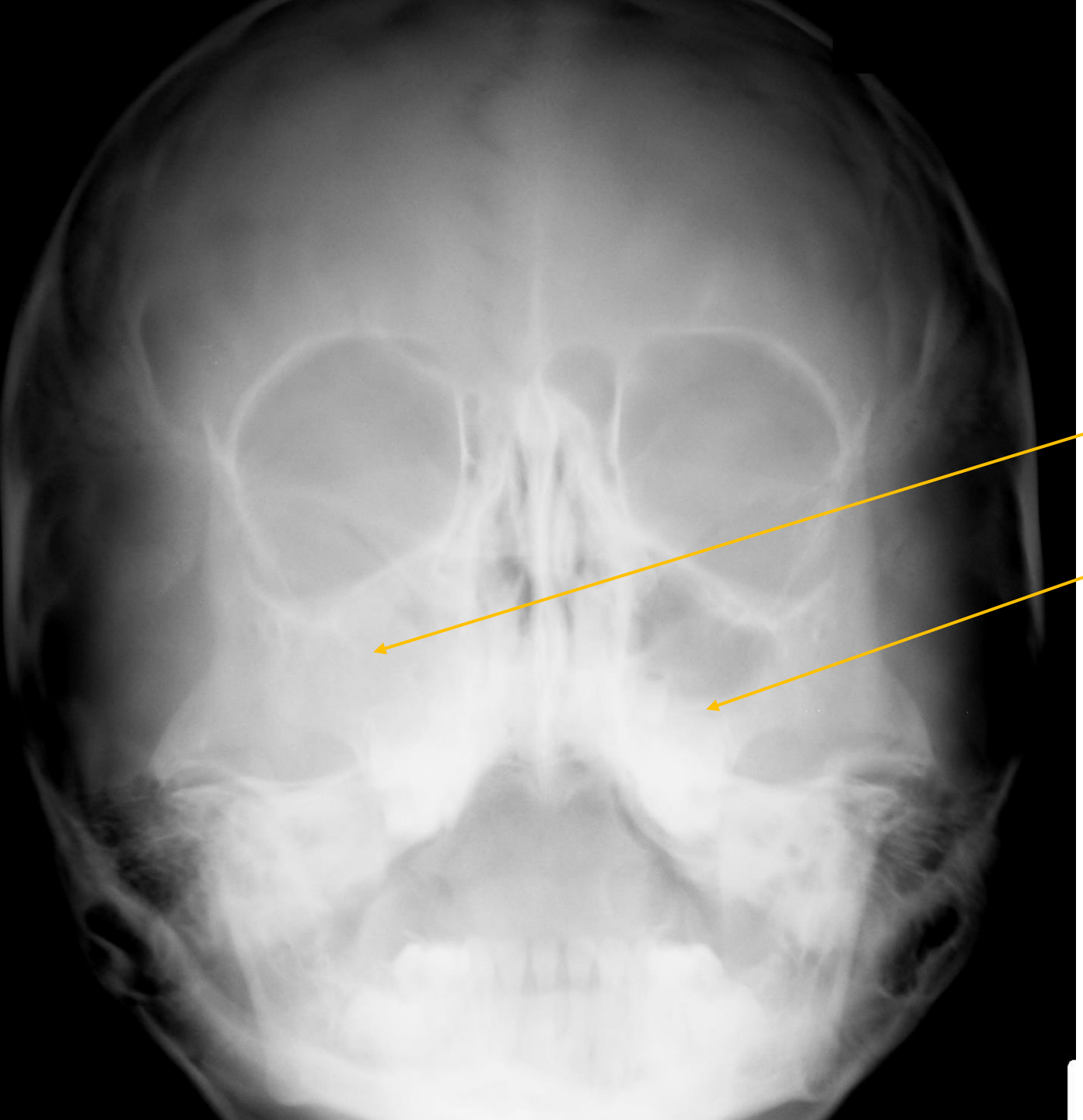
- X-ray is not routinely recommended.
- Complications: Orbitocellulitis.

X

Mastoiditis
(complication of otitis media).

CT.





Skull x-ray, Water view

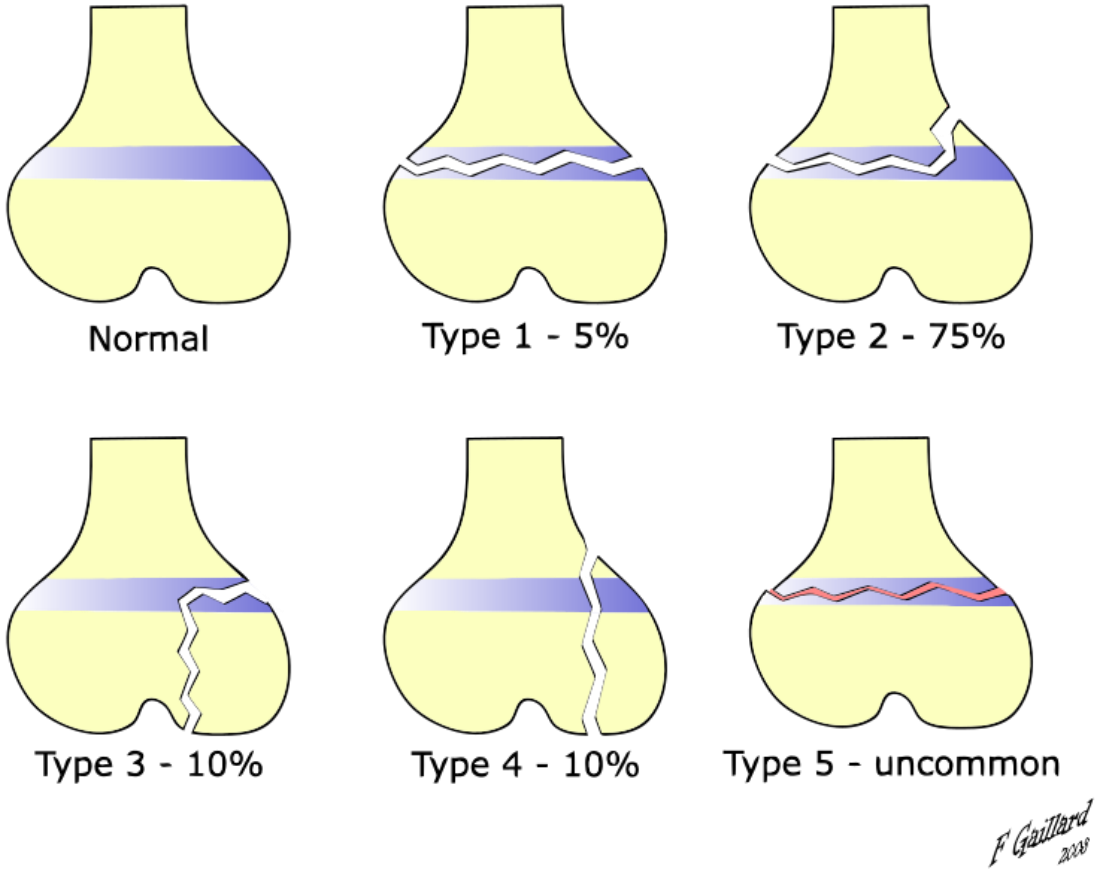
Opacification of both maxillary sinuses.

Gas-fluid level on the left.

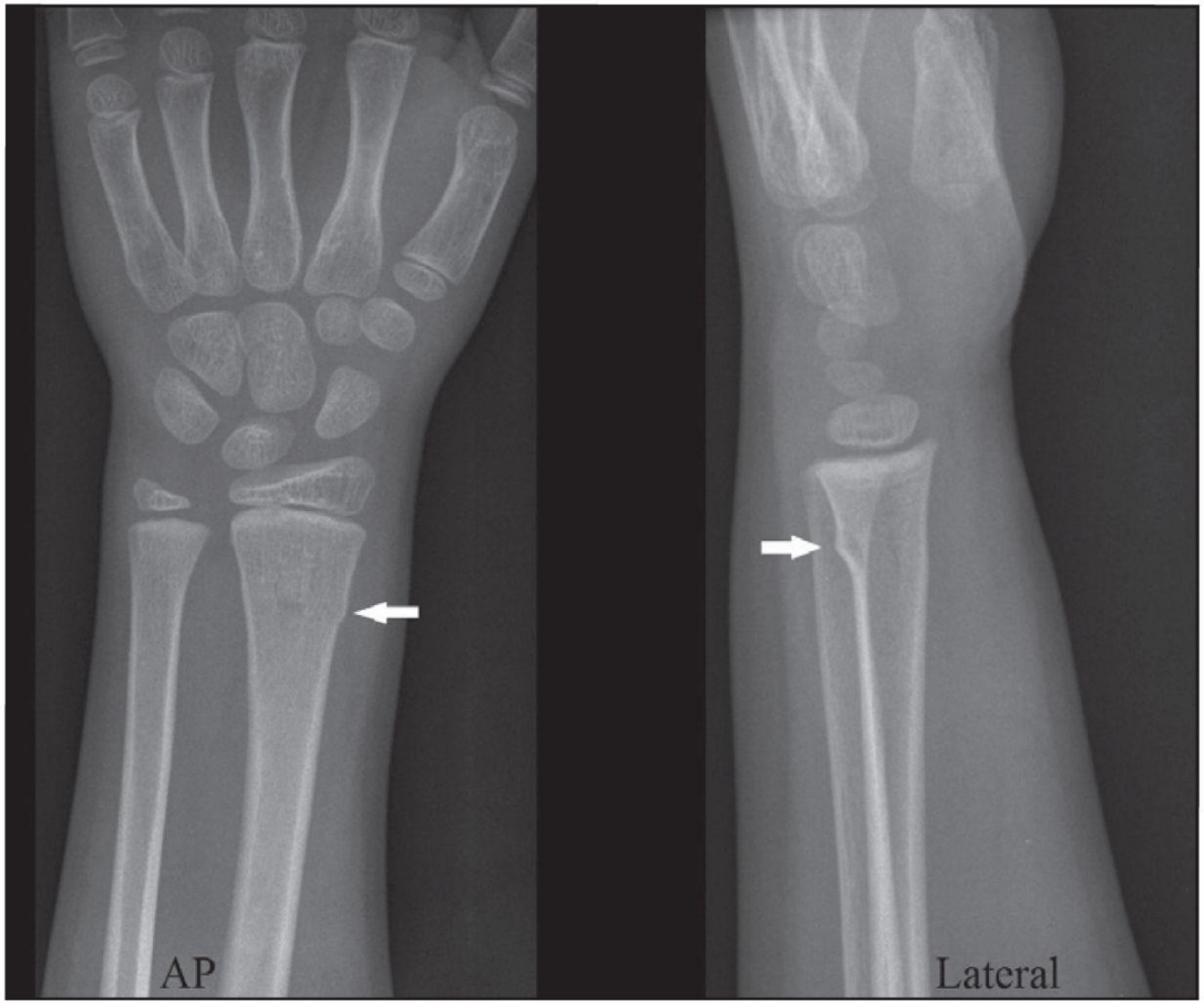
Bones

Talocrural joint, x-ray

Dorsal displacement of distal tibial metaphysis – Salter Harris type I.



- Epiphysiolysis: Salter-Harris classification
- Prognosis: SH I+II good, SH III+IV worse, SH V worst.
- Complications: premature closure of the physis – growth disorder, bone deformation, joint incongruence.



Wrist radiograph

Torus fracture of distal radius.

Sub/periostal fractures

- The periosteum remains intact, the macroscopically visible fracture line does not extend the entire width of the bone.
- Torus – deformation of the compact bone on the side of compressive forces. E.g. metaphysis.
- Bowing – bending of the bone on the basis of microfractures, accompanies the fracture of a paired bone.
- Green stick – fracture of the convex compact bone, the concave compact bone intact, angulation, e.g. diaphysis.

Toddler fracture

- At the age when children learn to walk.
- A subtle spiral fracture of the diaphysis of the tibia. Very discreet – therefore sometimes dg. only retrospectively on a control image, when a periosteal reaction is visible as part of healing.

Supracondylic fraktures

- Distal humerus. One of the most serious types of fractures – complications = disruption of the neurovascular bundle, deformity.

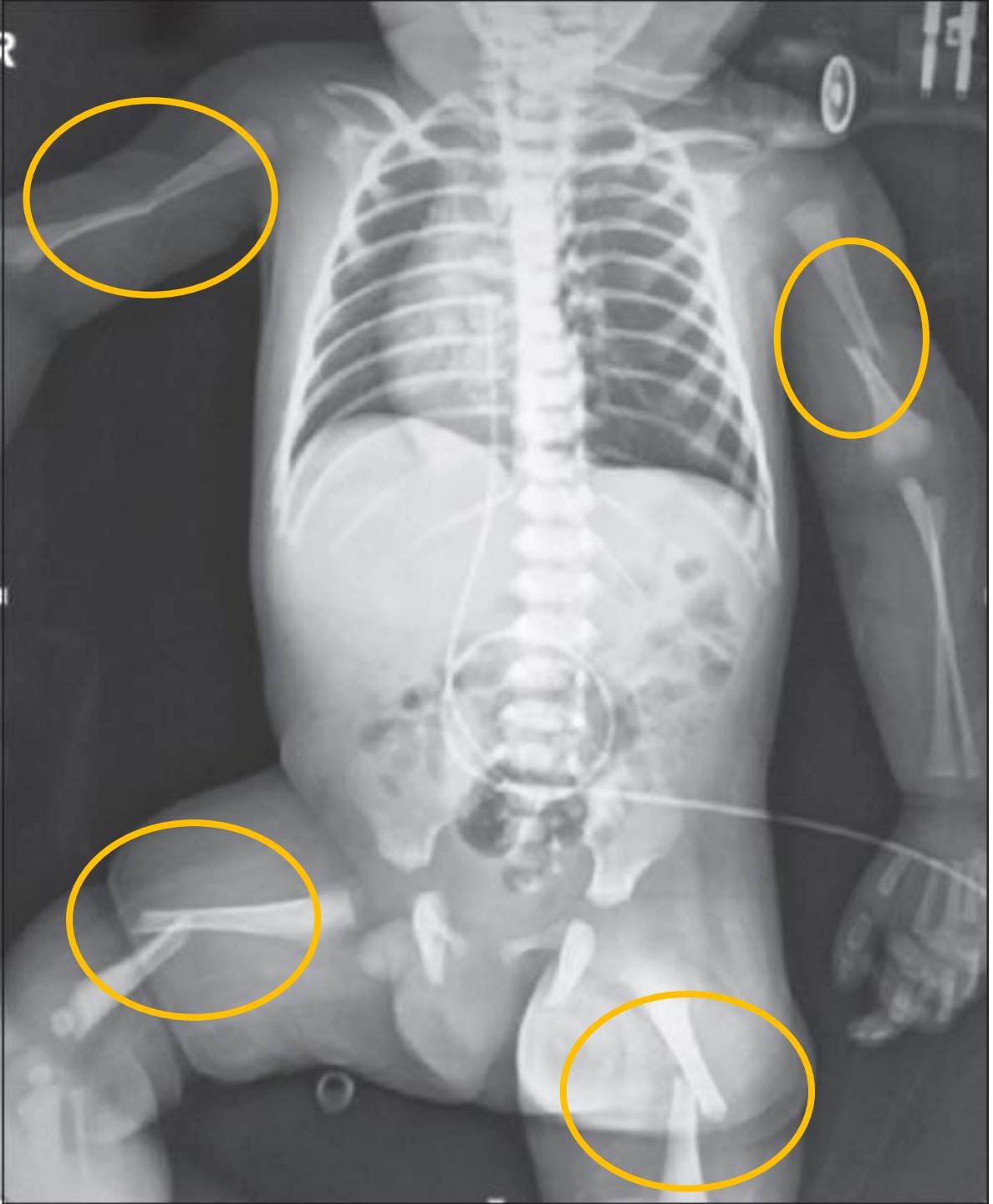
- For discrete fractures in the elbow area: “fat pad sign”

Elbow radiograph

Supracondylic fracture of humerus, severe dorsal dislocation of peripheral fragment.

Osteogenesis imperfecta

- Collagen formation disorder,
- Osteoporosis, Blue sclera, damaged dentin, skin and blood vessel damage.



Humeral fractures.

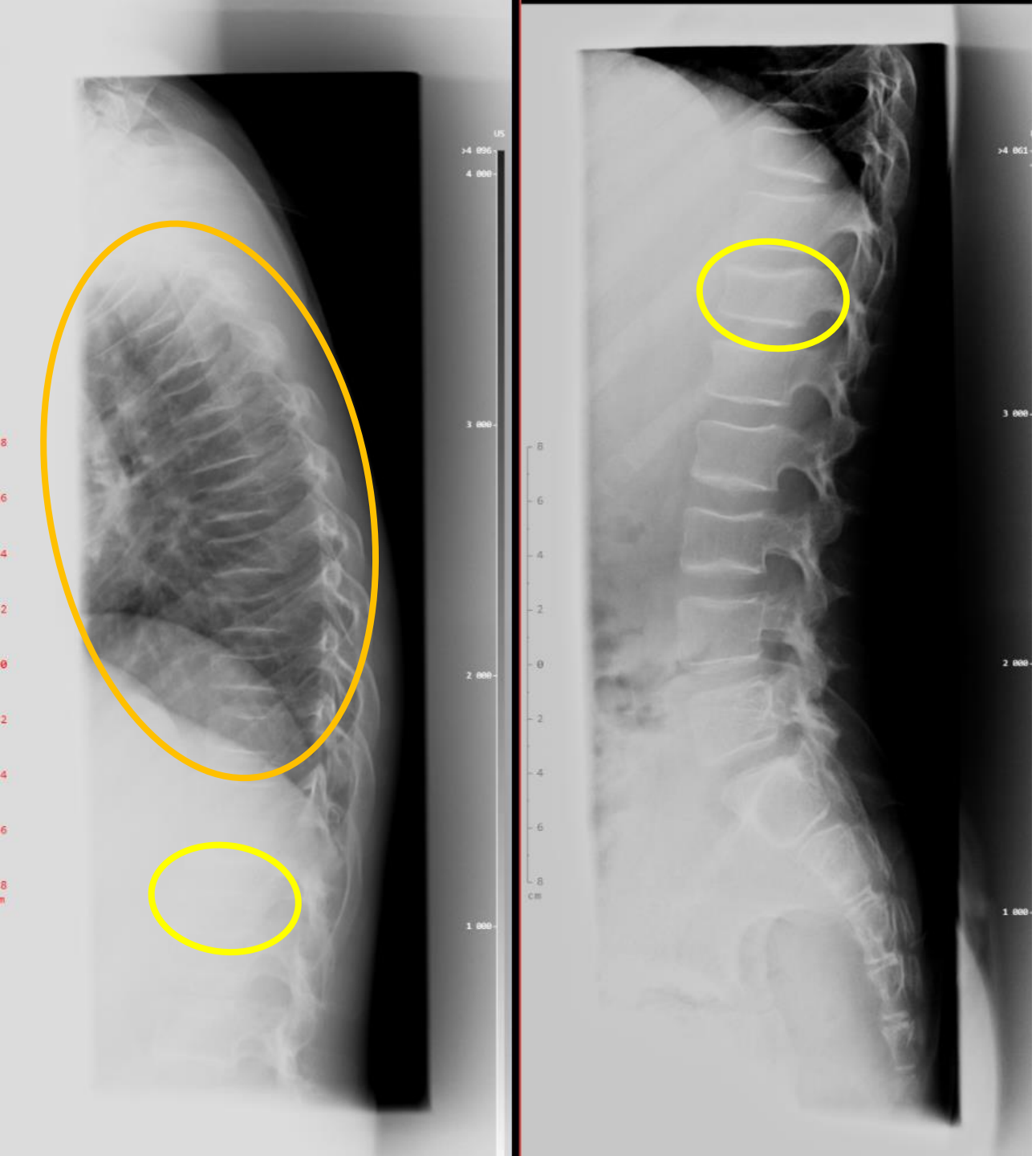
Femoral fractures,

Severe dislocations.

Dif. Dg. Osteogenesis imperfecta.

Juvenile osteoporosis

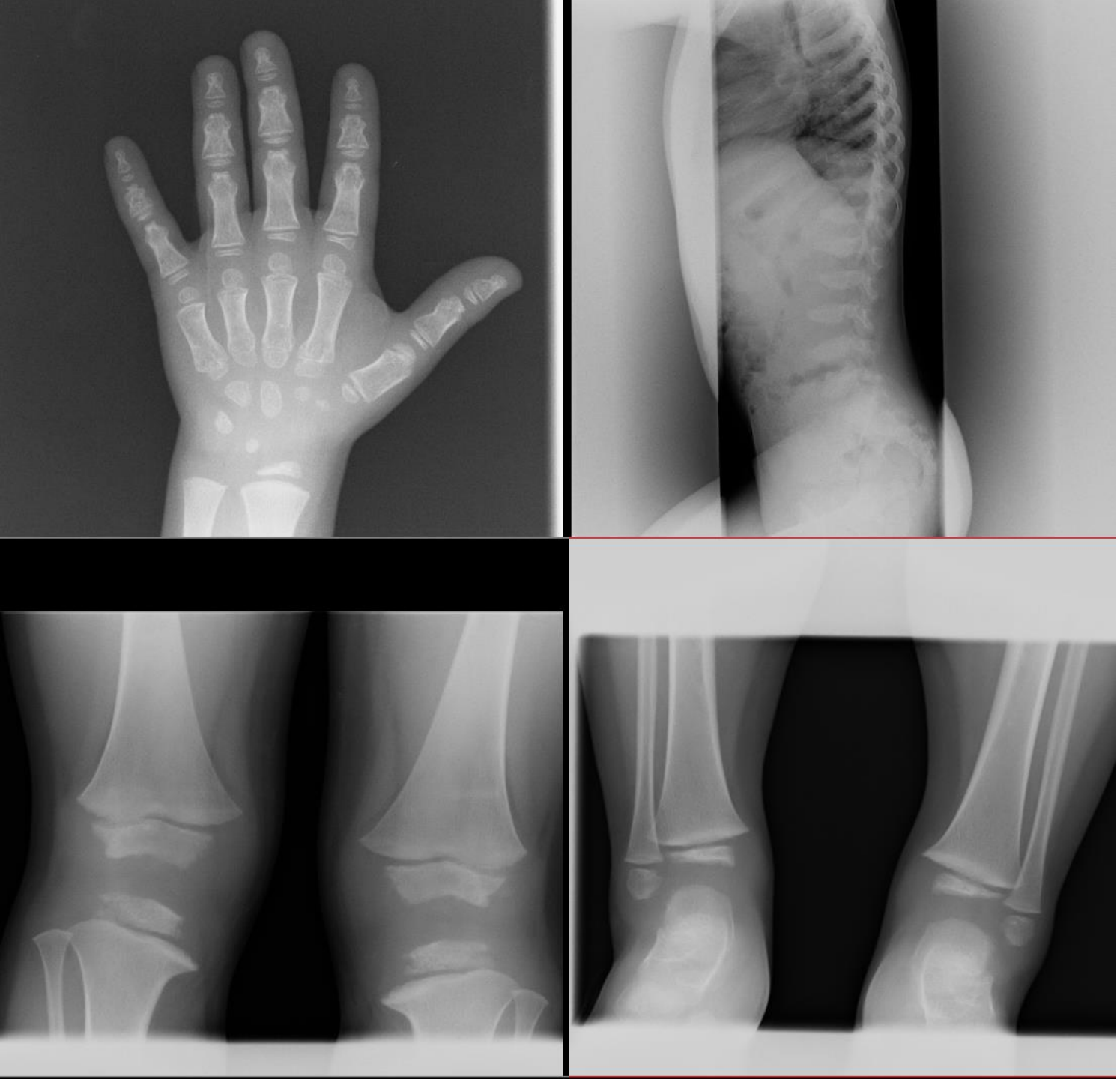
- before puberty,
- in some cases it may have a hereditary origin and be noticeable from an early age.
- Idiopathic,
- it can arise secondarily as well (endocrine, metabolic, gastrointestinal and other diseases).



Multiple narrowing of vertebral bodies in patient with juvenile osteoporosis.

Skeletal dysplasia

- collective term for a group of genetic disorders.
- Abnormal development of bones, joints, cartilage.
- Most common: legs, hands, spine, ribs, skull.
- Mild form: short stature, disproportionality.
- 400 types: most common type = achondroplasia.

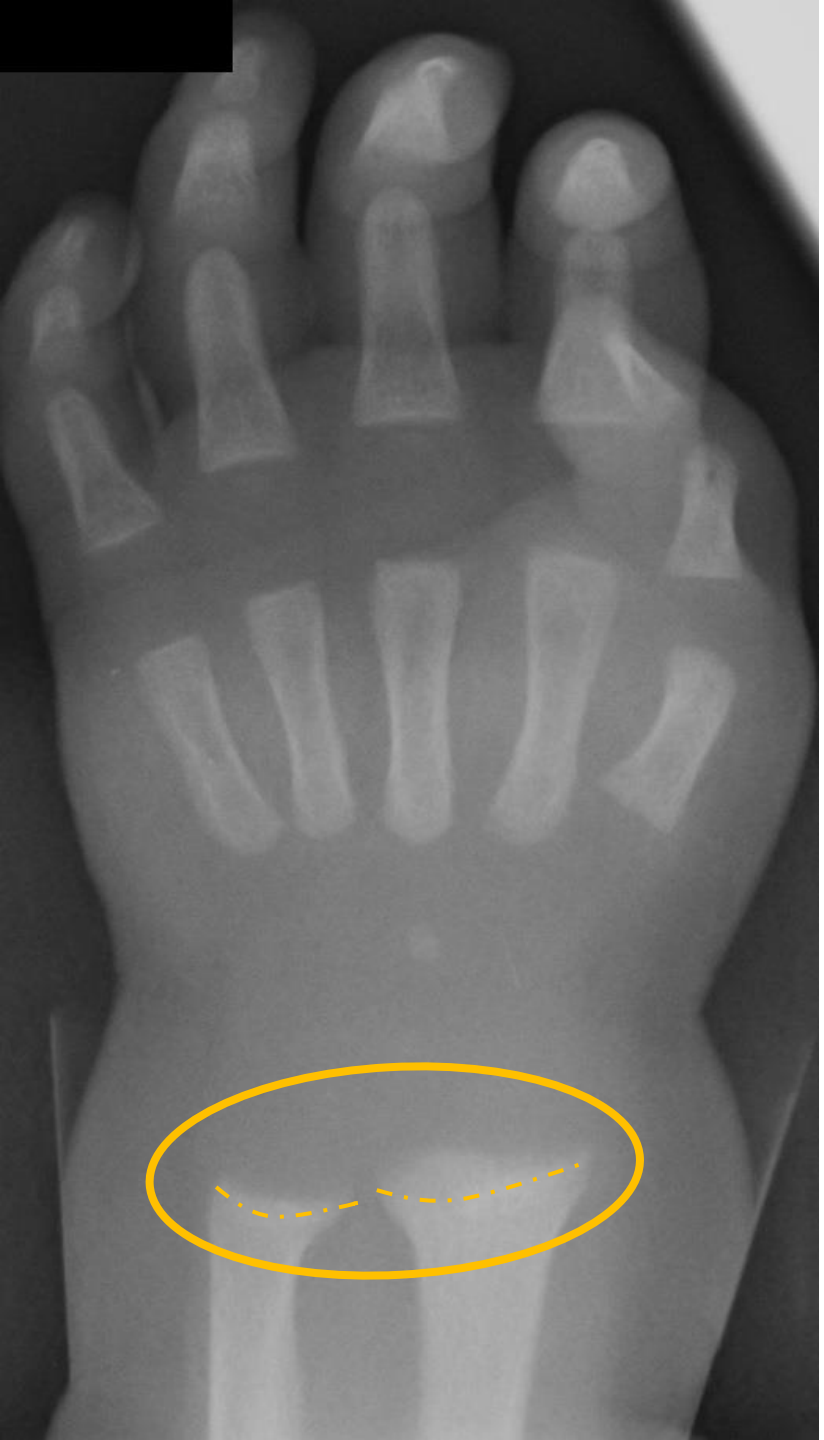


- Multiple bone deformities in patient with skeletal dysplasia.

Rachitis, rickets

- Calcipenic rickets - deficiency of Ca or vitamin D.

- Phosphopenic rickets - deficiency of phosphates, which is caused, for example, by their increased losses in the kidneys. prophylaxis is mandatory in our country.



Rickets

widening of metaphyseal ends

Cupping = concavity

Hypermineralisation of distal metaphysis of radius and ulna.

Subperiostal resorption.

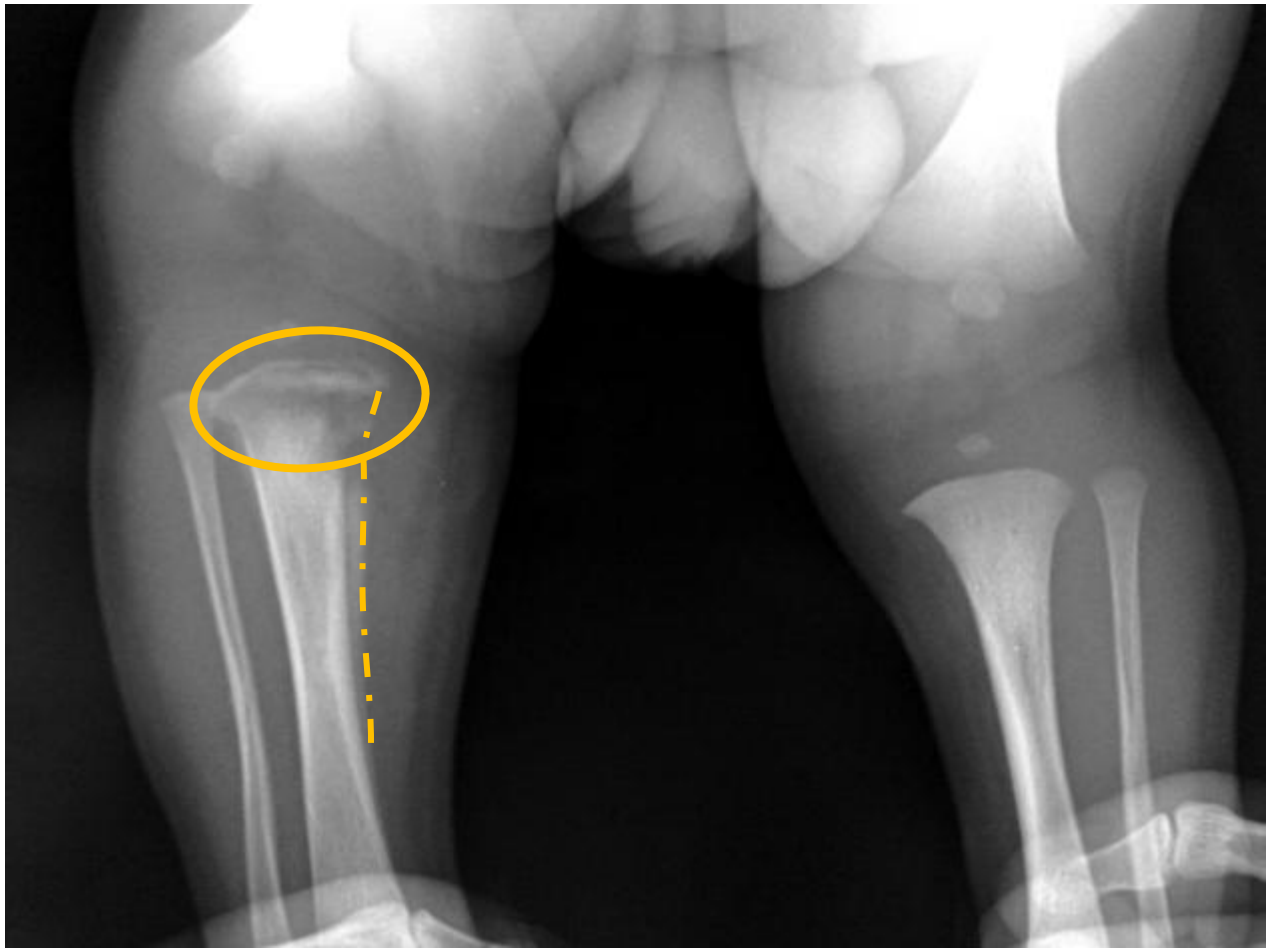
Rickets, follow-up during therapy.

Osteomyelitis

- Staphylococcus aureus, metaphyseal region,
- Up to 18 months, common vascular supply for metaphysis and epiphysis, i.e. also the possibility of infection transfer through the growth cartilage.
- Up to 16 years, the growth cartilage forms a barrier.
- Subacute OM – Brodie's abscess forming,
- Chronic OM – sequestration
- CRMO – chronic recurrent multifocal OM – no agent is proven, autoinflammatory process. (Clavicle, multifocality, bilaterality)

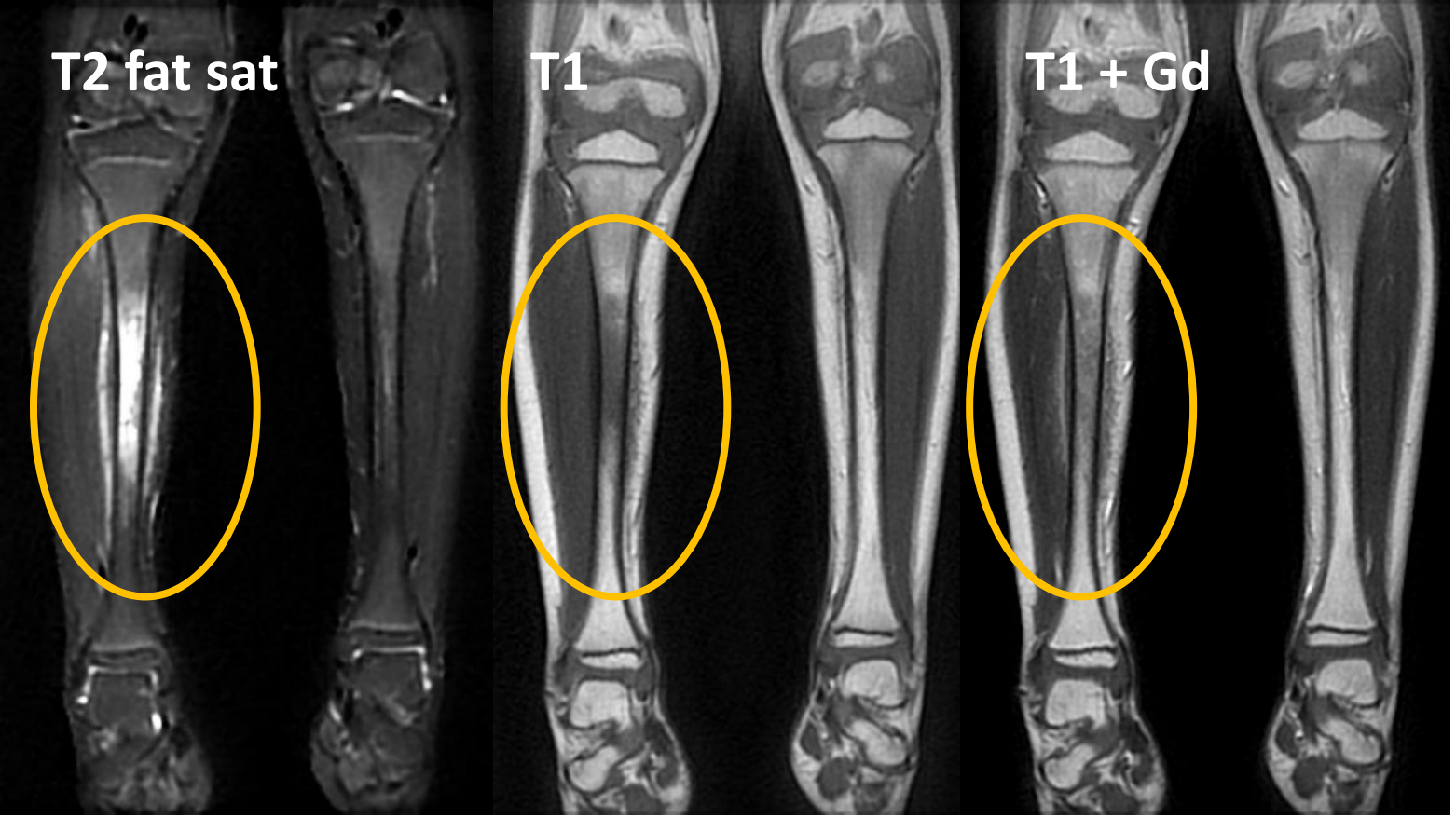
Osteomyelitis

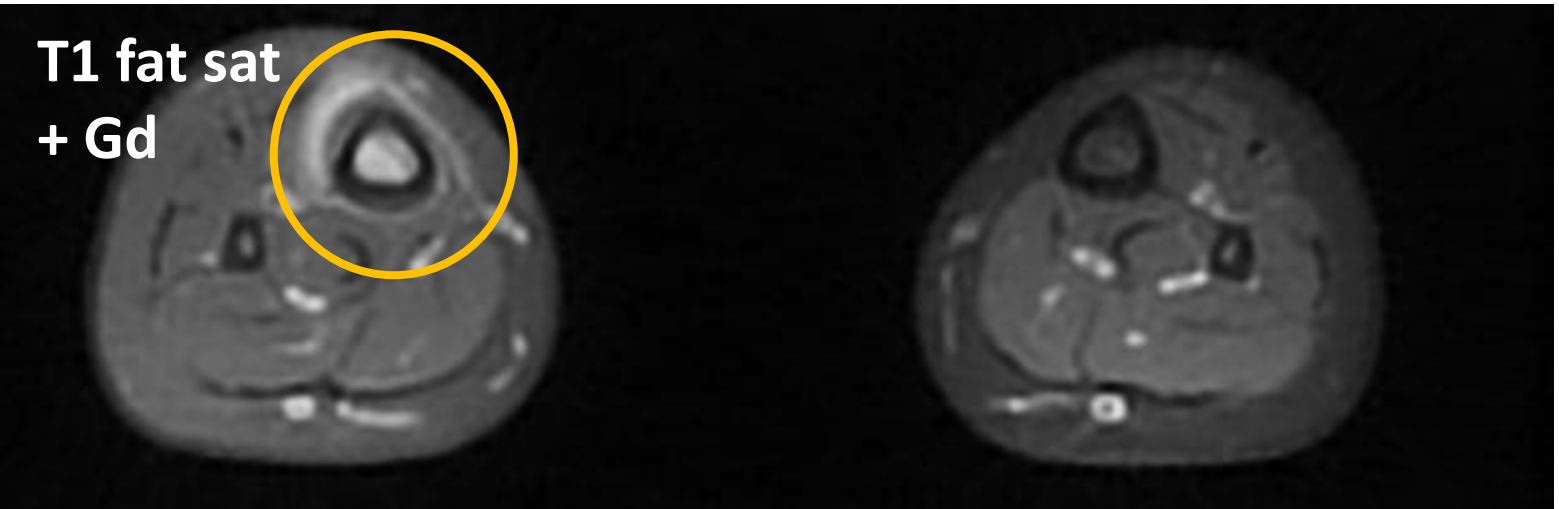
Increased radiolucency of distal radius with periosteal reaction.



Osteomyelitis:

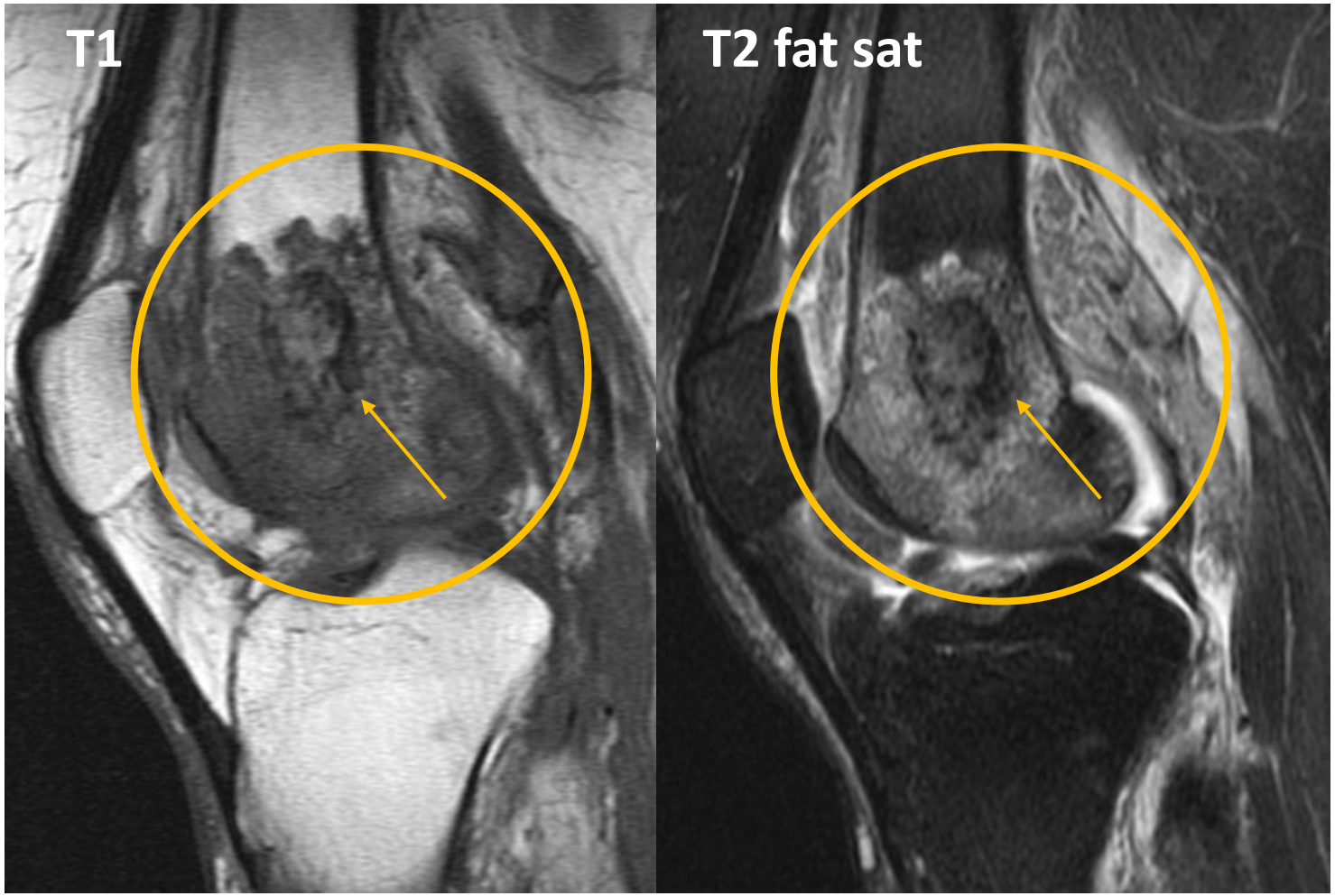
Inhomogenously increased radiolucency of proximal tibia on the right, periostosis.





Osteomyelitis:

MRI scan, signal changes in patient with tibial osteomyelitis.

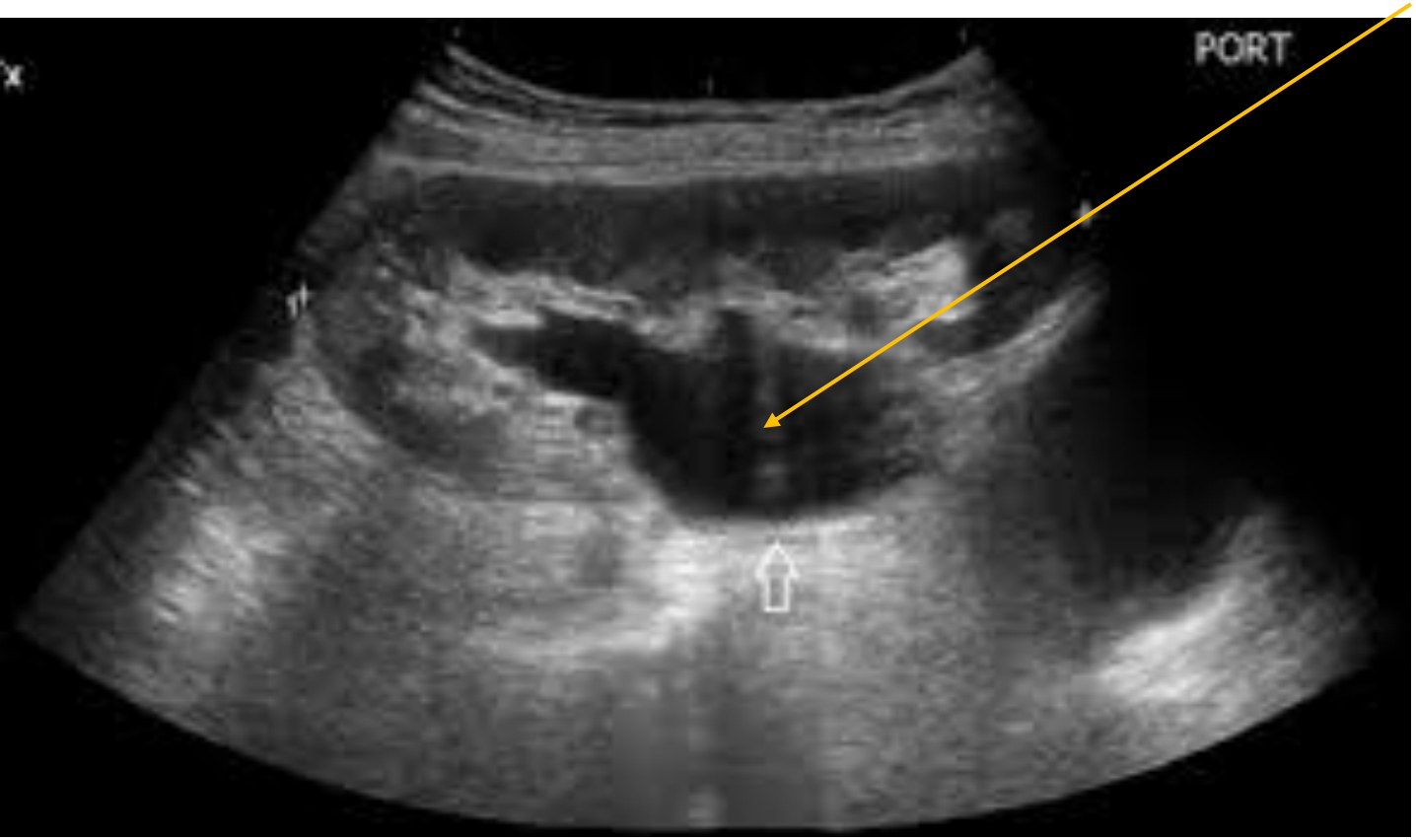


Bone sequestration in patient with osteomyelitis.

Uro

- US – 1. choice. (CEUS?)

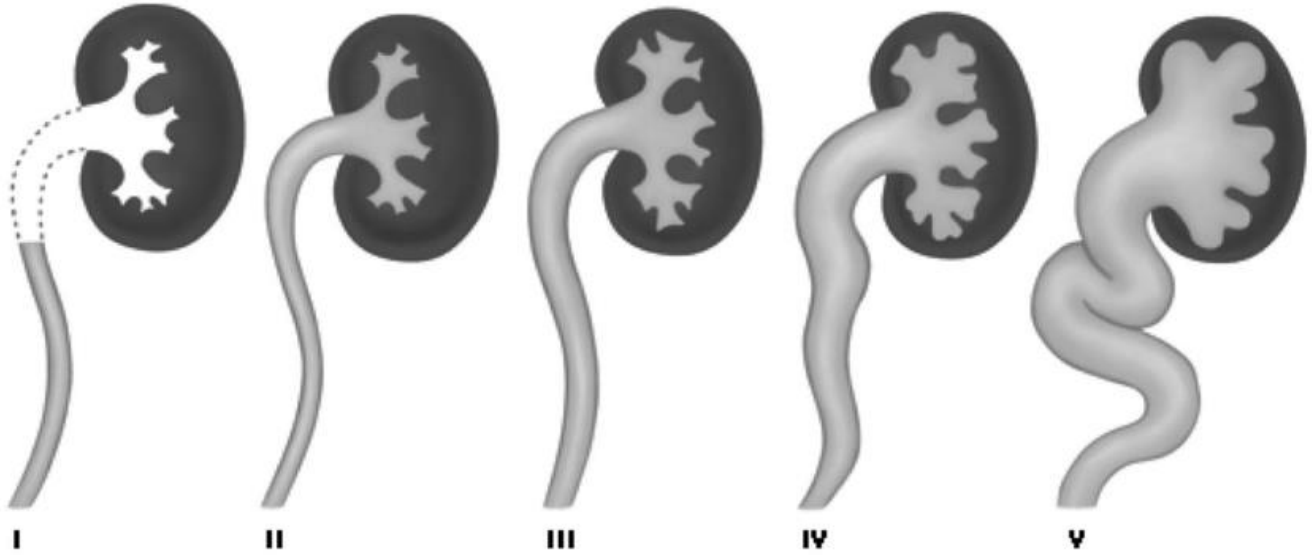
Renal sonography

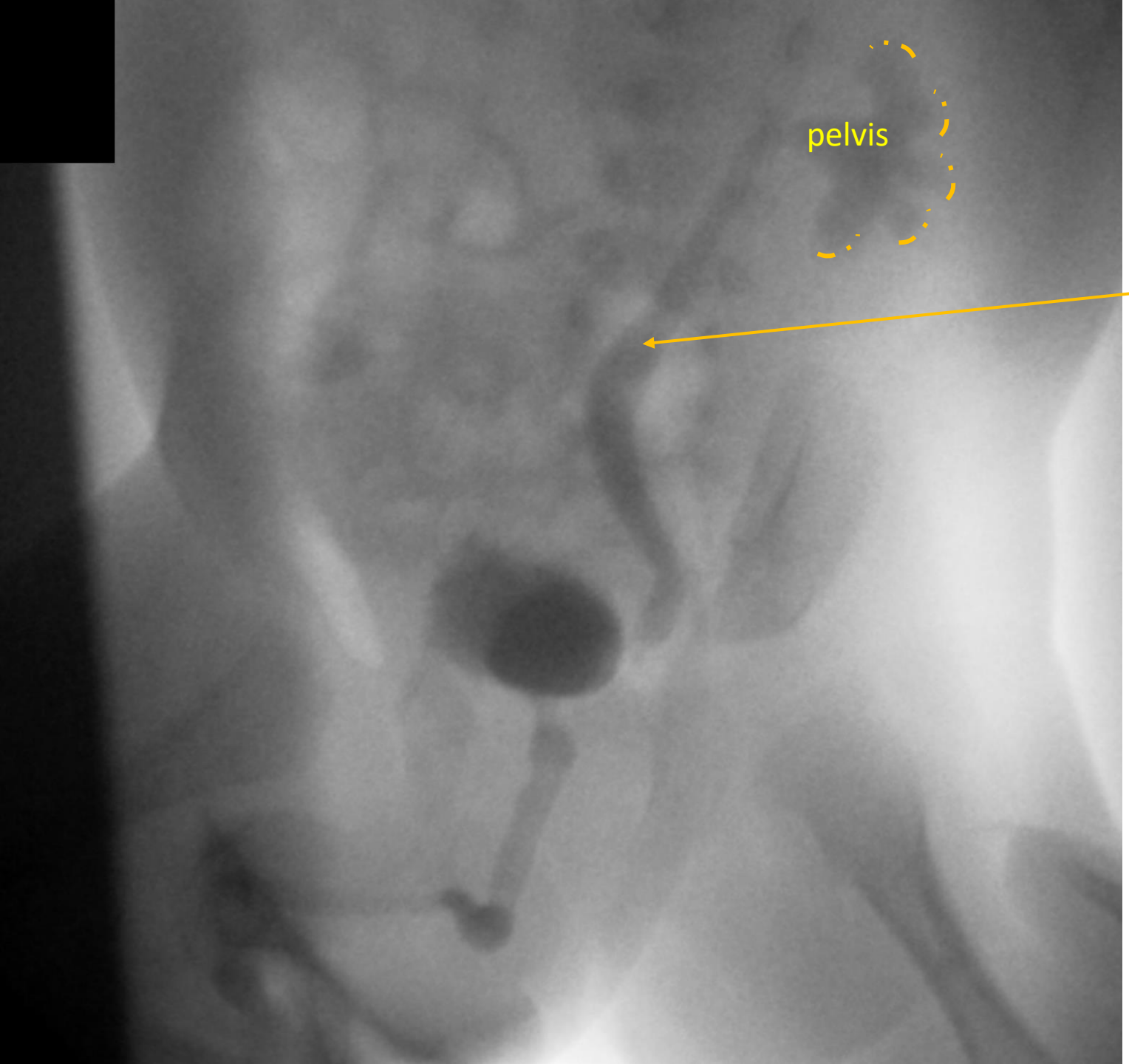


- Hydronephrosis grade III.

Vesikoureteral reflux

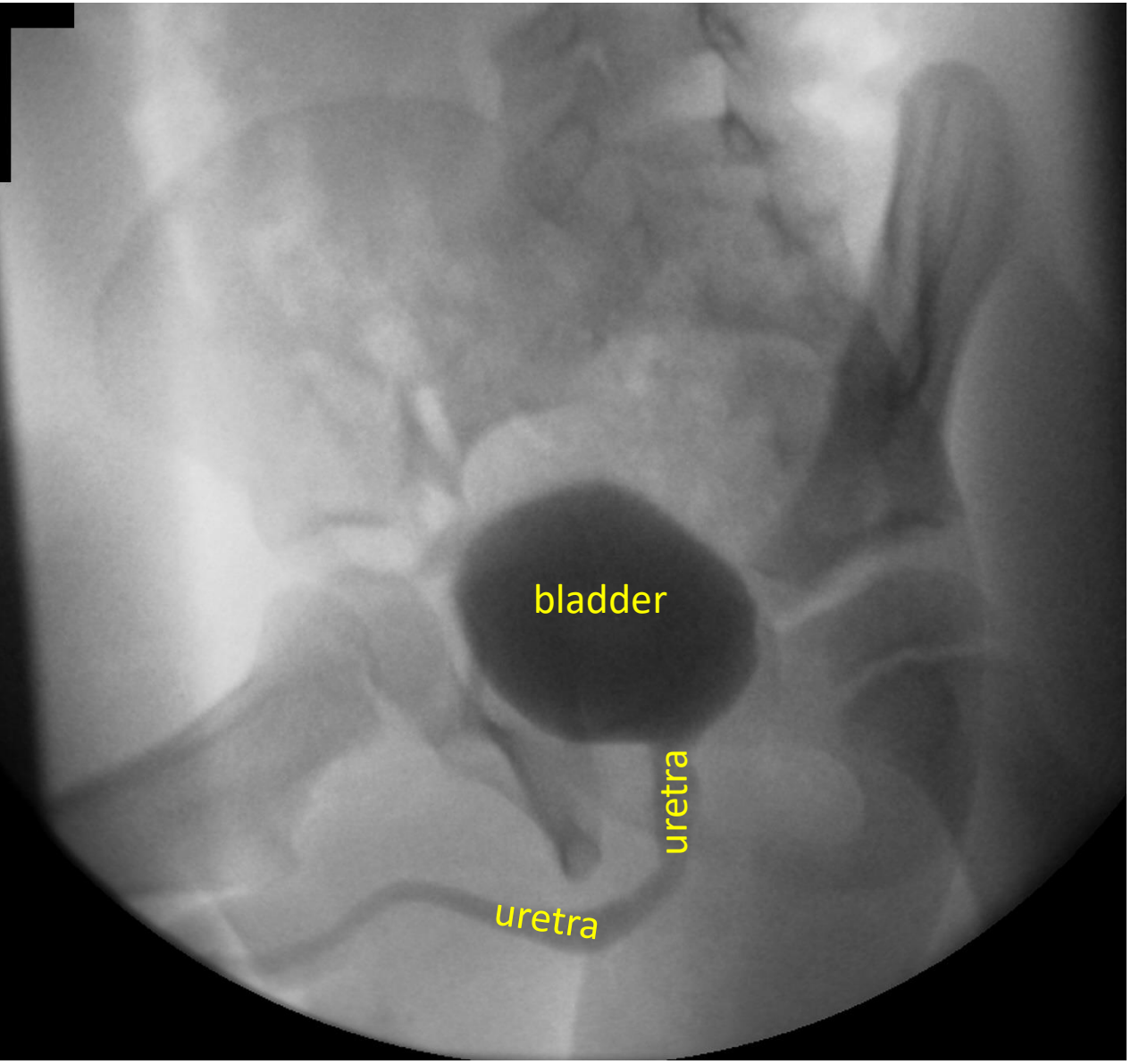
- Primary – congenital insufficiency of the VUJ, shortened intramural course, ureteroceles.
- Secondary – posterior urethral valve.
- Clinical manifestation: UTI (infection, recurrent pyelonephritis). Active X Passive.
- US, MCUG



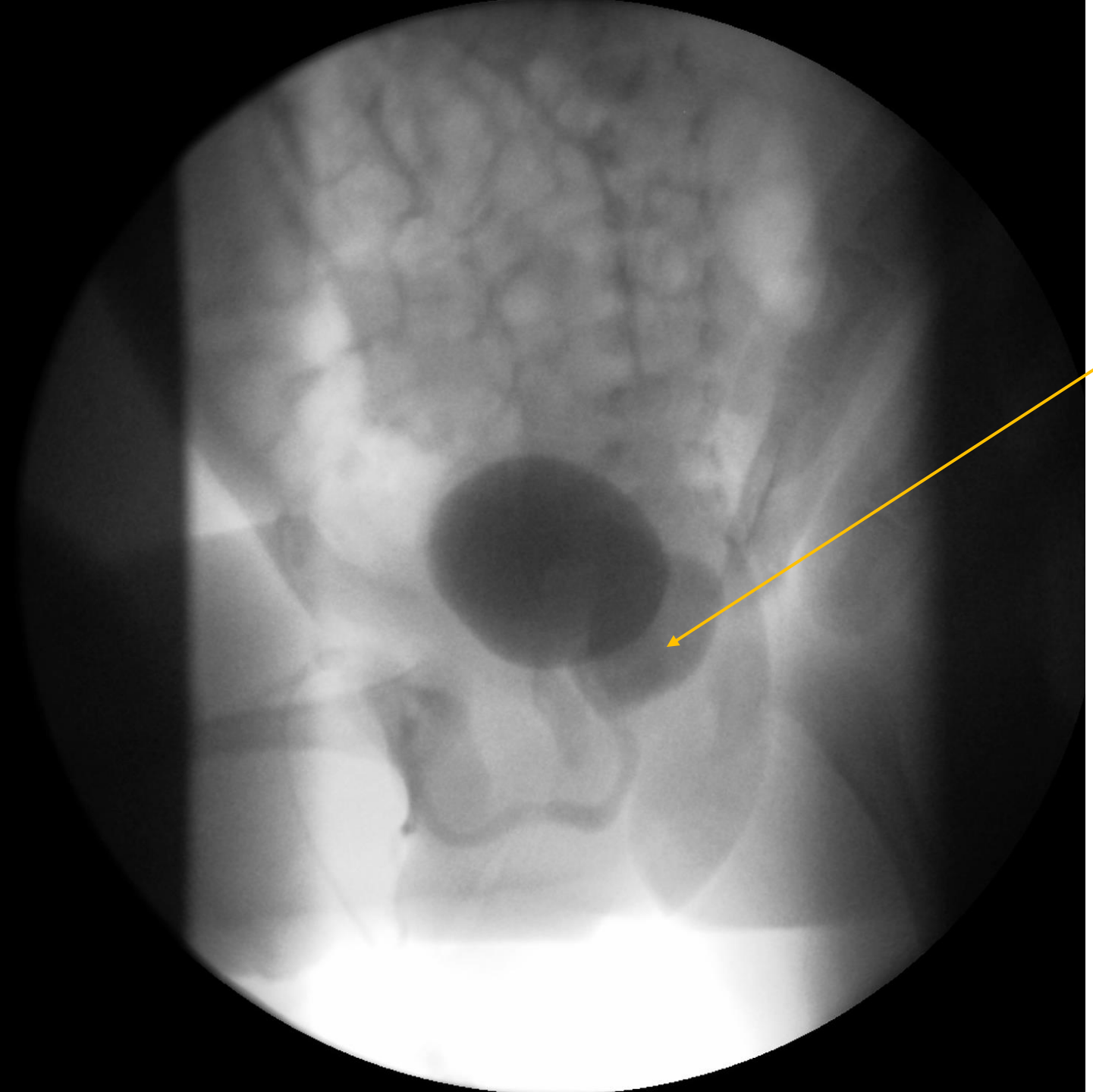


Vesicouretral reflux grade III.

Minor dilatation of the ureter, renal pelvis and calyces with minimal blunting of the fornices.

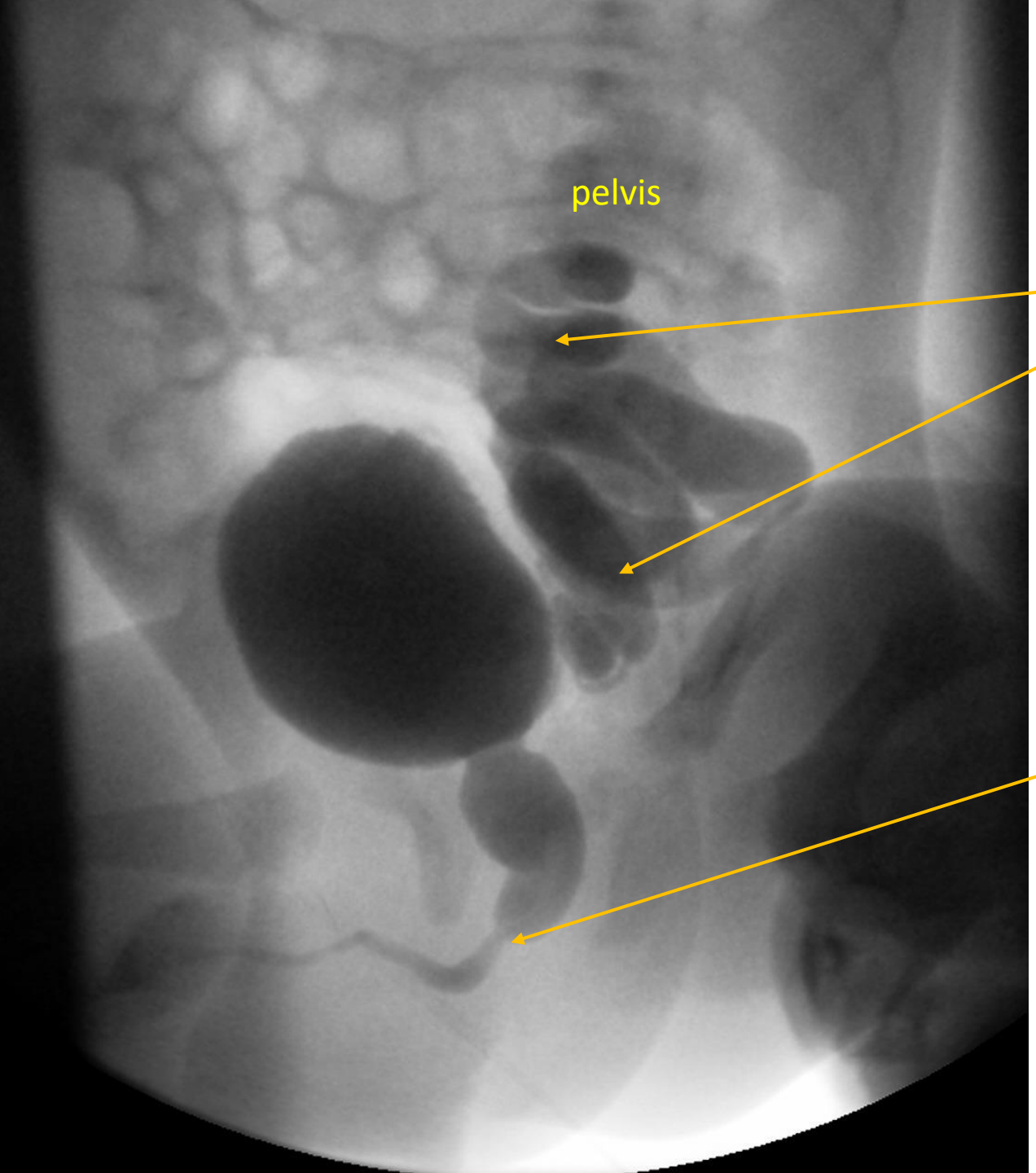


Normal finding, voiding part.



Cystouretrography:

Urethral diverticulum.



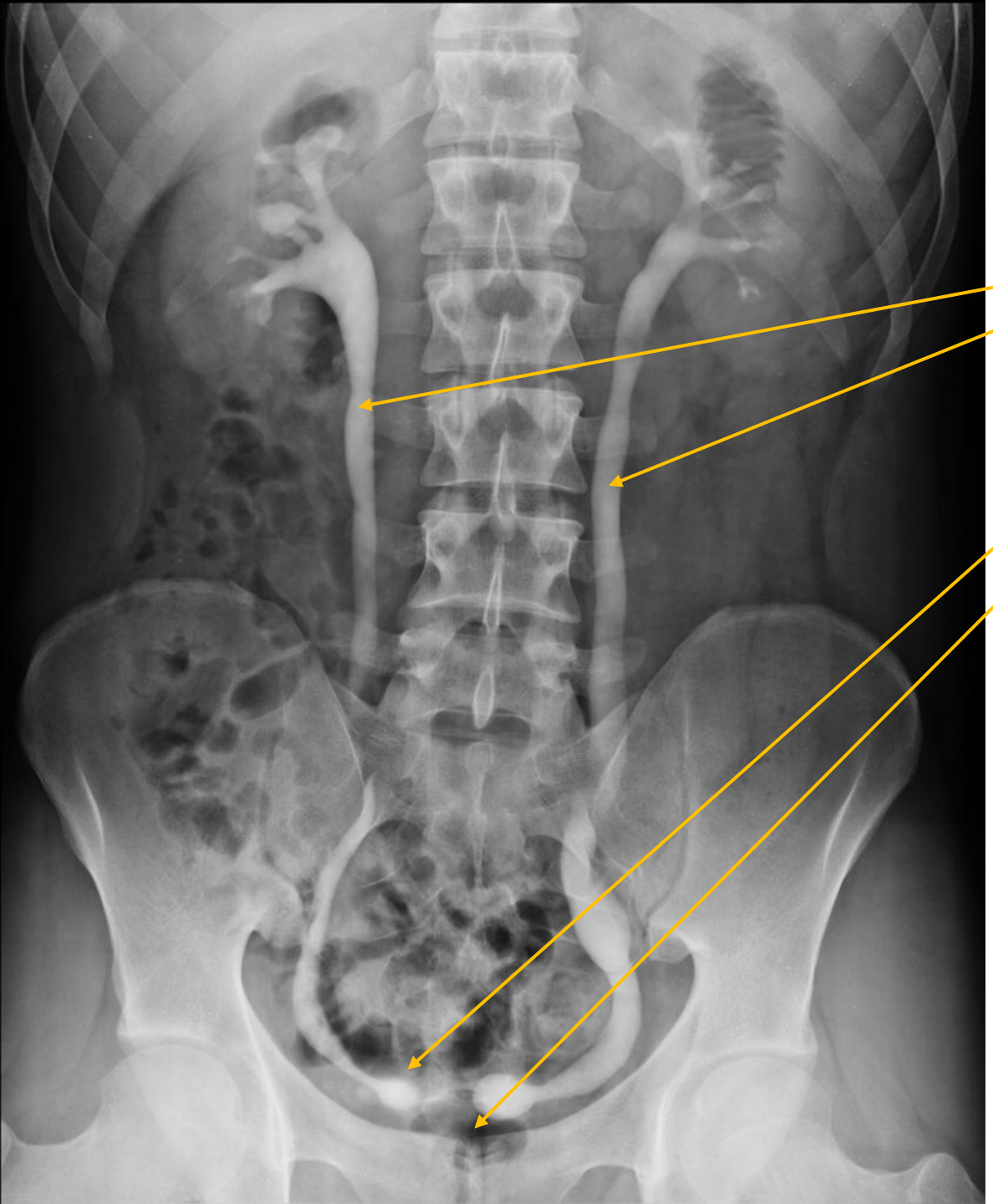
Vesicouretral reflux grade V.

Gross dilatation of the ureter, renal pelvis and calyces with ureteral tortuosity.

Posterior urethral valve. Dilatation of proximal urethra.

Posterior urethra valve

- boys, 1/10,000,
- Associations e.g. Down syndrome,
- UZ – posterior urethral dilatation, MCUG



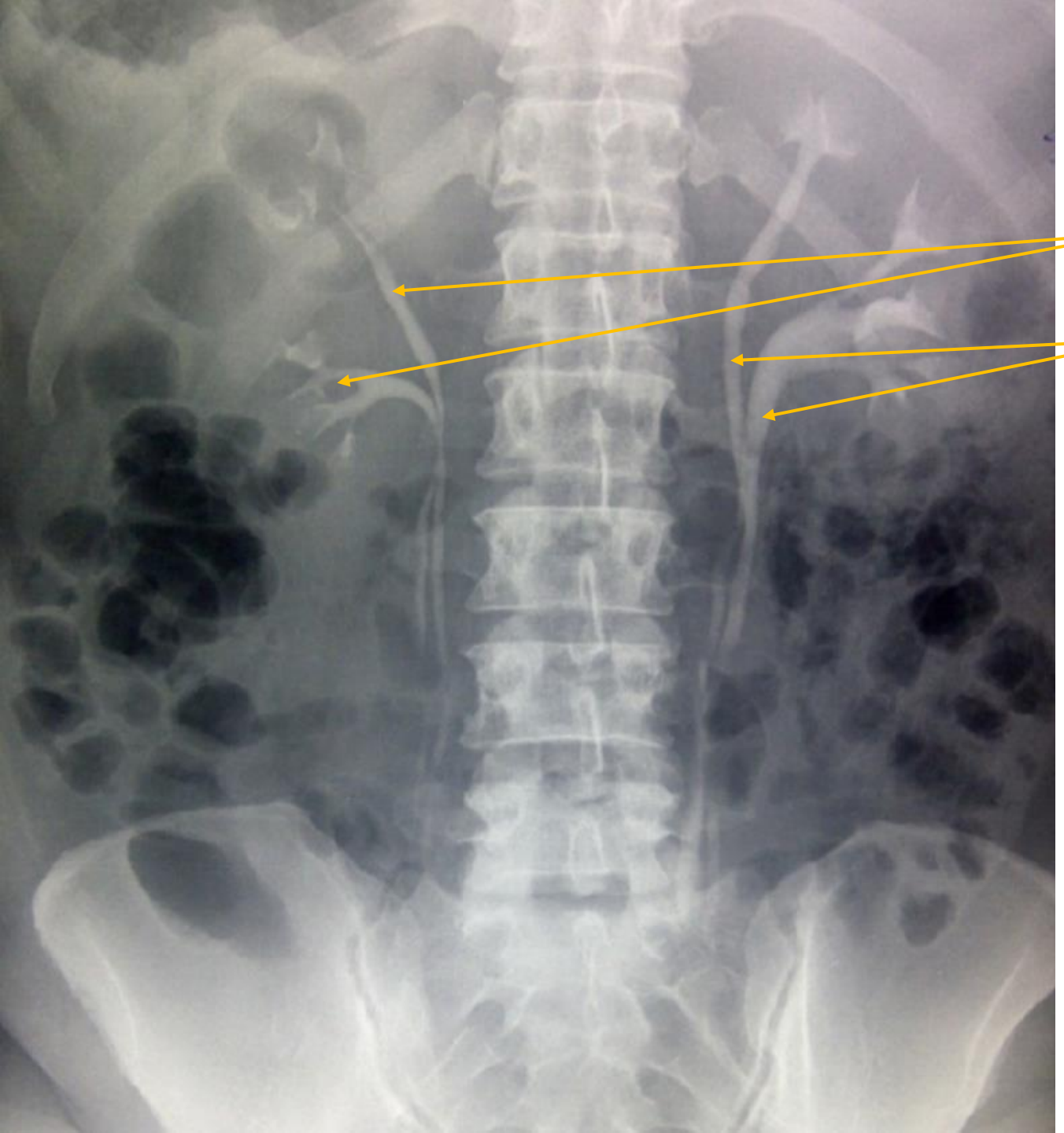
- Excretion urography

Bilateral dilatation of ureters.

Bilateral ureterocele.

Ureterocele

- More common in girls,
- US,
- Orthotopic (in the bladder),
- Ectopic (bladder neck),
- Association – obstruction, hydronephrosis, VUR.

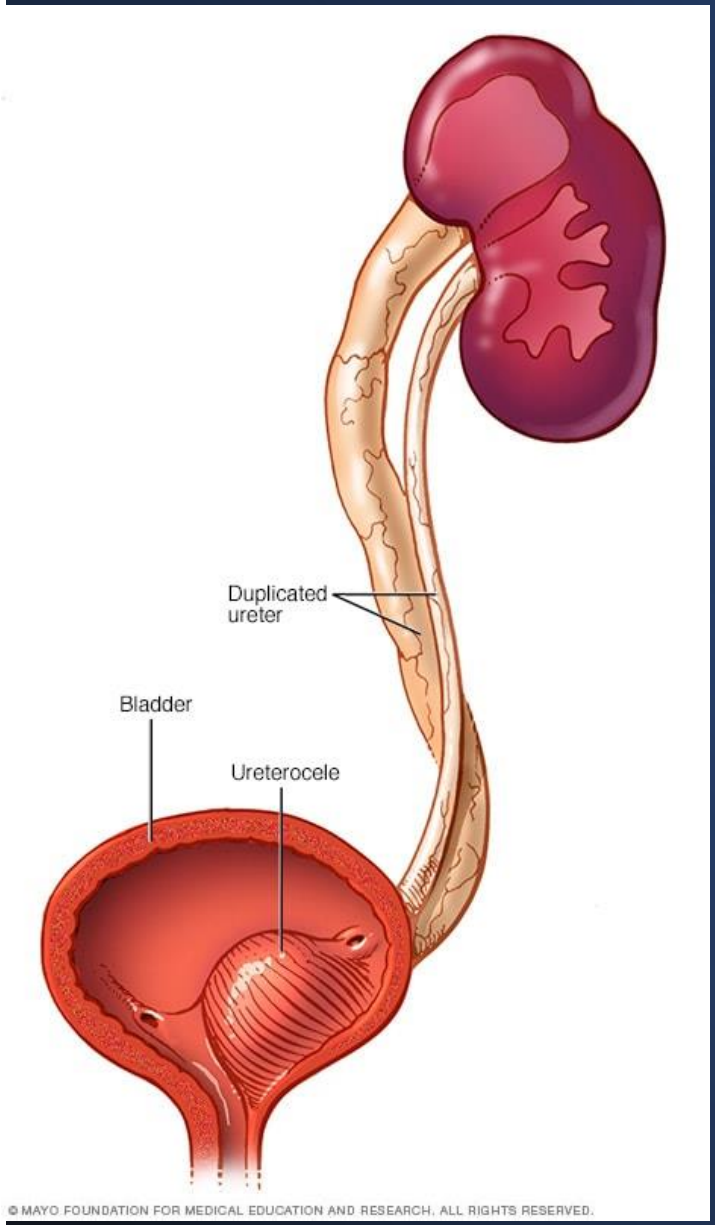


- Excretion urography

– ureter duplex

Ureter duplex

- Weigert-Meyer rule.



Přednášky

4. Září 2013 - 20:30 od Lambert

Pediatrie

- Trénovací obrázky na zkoušku z pediatrie:

  - **Hrudník**

  - **Ostatní**

- Heslo k pdfku je **rtg**
- **RTG hrudníku, břicha - normální nález**

Pediatrics

- Training images for exam in pediatrics:

  - **Chest**

  - **Other**

- If a password is needed: **rtg**

mudr.org

Questions

- mudr.org
- radio.lf1.cuni.cz