



# Pediatric radiology

Varga Edit



# Modalities

- radiography (x-ray, fluoroscopy)
- ultrasound
- computer tomography (CT)
- magnetic resonance imaging (MRI)
- nuclear medicine (planar scintigraphy, SPECT, PET)



# Special considerations

- physical and mental development process (radiation-sensitive)
  - ultrasound and MRI are the preferred imaging modalities
- if ionising radiation is necessary – doses should be kept to a minimum (ALARA – As Low As Reasonably Achievable)
- ionising radiation increases the risk/frequency of malignant diseases
- lack of cooperation – sedation, anesthesia
- different disease etiology and morphology



# Biological effects of ionizing radiation

- deterministic effects
- stochastic effects

cumulative!!!



# 1y background radiation: 3 mSv

imaging	typical Effective Dose (mSv/time)	Comparable to chest x-ray for:	Comparable to natural background radiation for:
chest x-ray	0,02	1	2,4 days
abdominal x-ray	0,2-0,6	10-30	24-72 days
LS spine x-ray	1,3	65	158 days
fluoroscopy	3	150	1 year
head CT	2	100	243 days
pelvic CT	3-5	150-250	1-1,6 years
abdominal CT	5-7	250-350	1,6-2,3 years
abd/pelvic CT	8-12	400-600	2,6-4 years

> 50 mSv cumulative effective dose represents a significantly higher risk of malignancy



# Deterministic effects

- it develops due to high radiation doses
  - the effect occurs immediately
  - dose-dependent severity
  - only occur once a threshold of exposure has been exceeded
- 
- examples: hair loss, cataract, nausea, skin lesions, infertility, CNS damage, death



# Deterministic effects





# Stochastic effects

- no threshold level for these effects
- the risk of an effect occurring increases linearly as the dose increases
- the severity is dose-independent
- effects: carcinogenesis, genetic effects



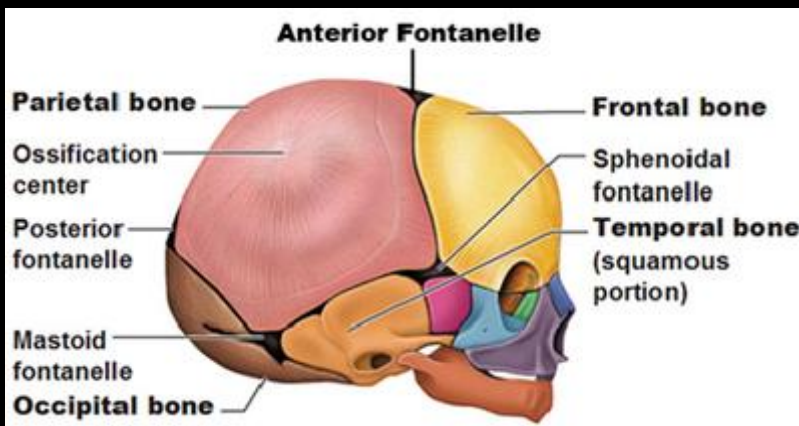


## Special considerations (premature and mature babies)

- intensively developing brain (very sensitive for radiation exposure)
- transportation trauma
- sedation and ventilation is needed for imaging (movements)
- open fontanelles and sutures (acoustic windows)

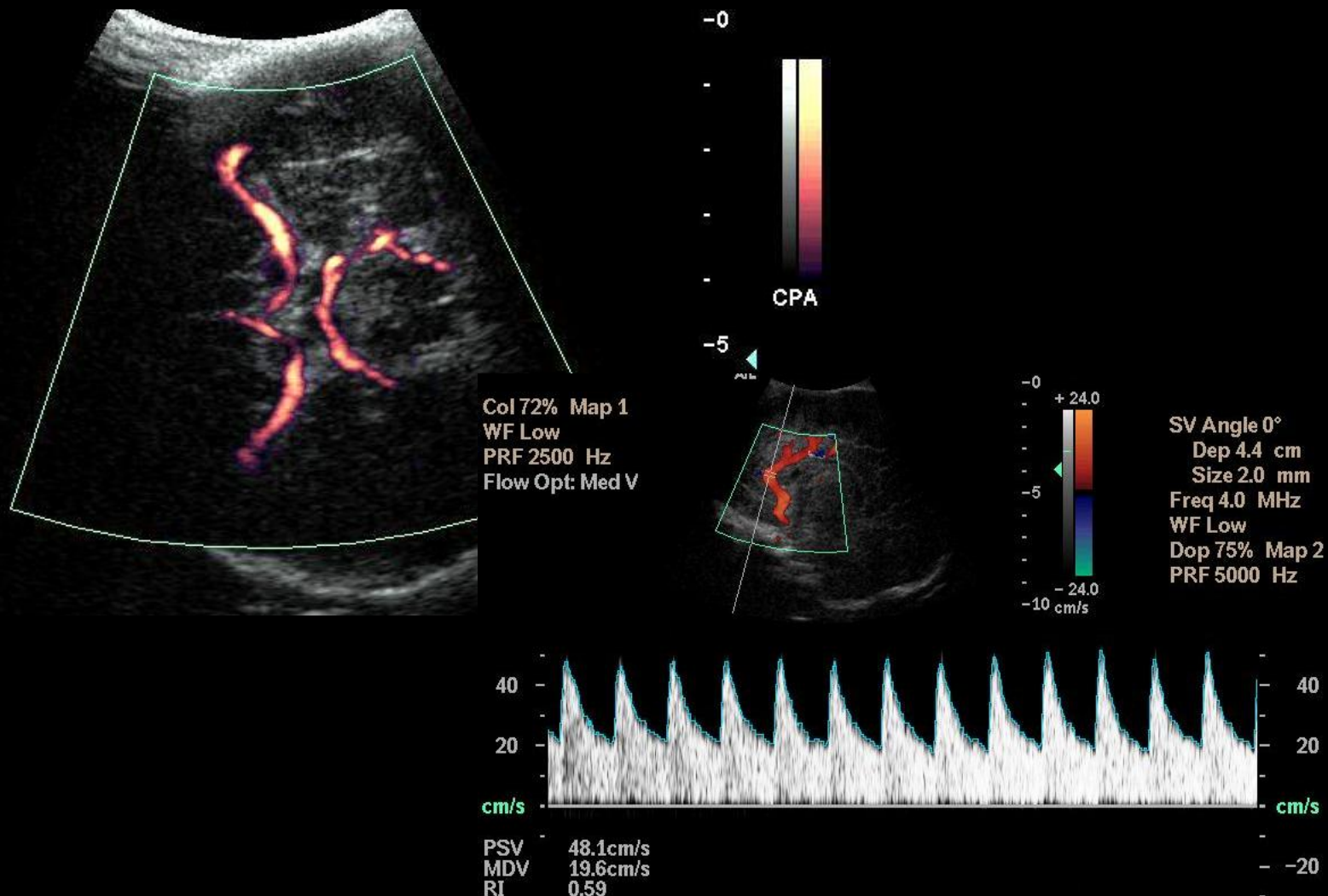


# Acoustic windows





# Doppler ultrasound





# Differences arising from maturing



premature

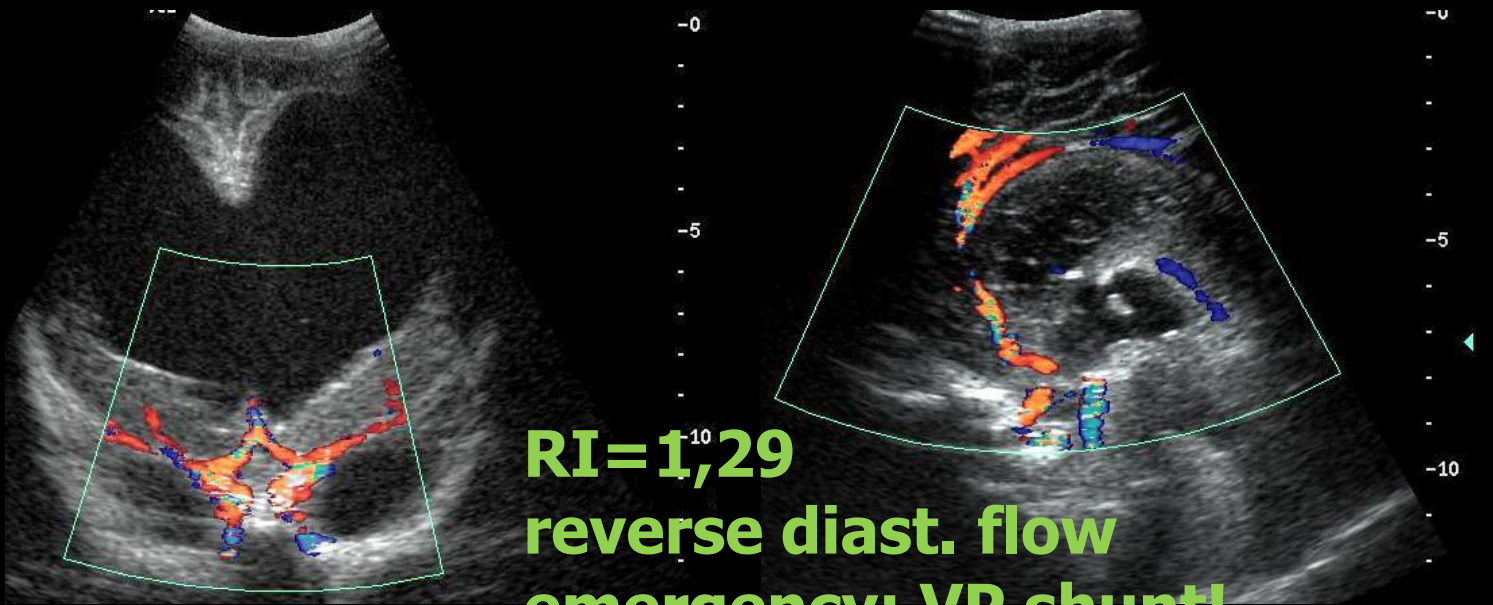


mature





# Hydrocephalus

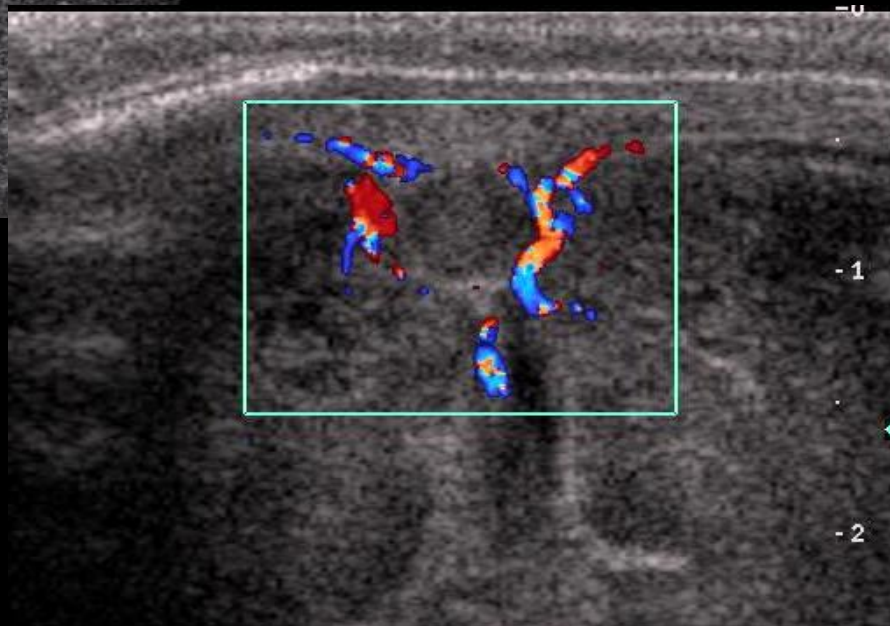
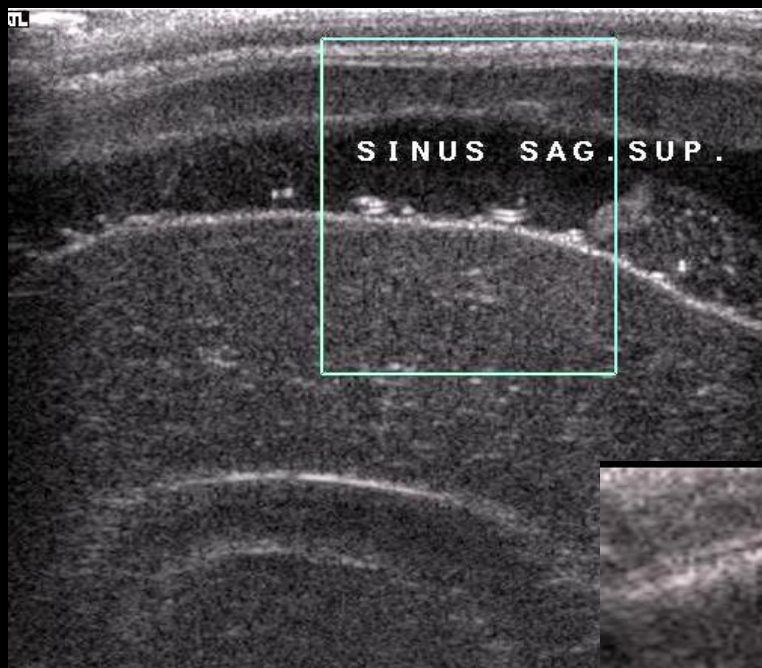


**RI=1,29**  
**reverse diast. flow**  
**emergency: VP shunt!**





# Sinus thrombosis - meningitis





# Ultrasound

- brain (newborns, early infancy)
- chest (pleural effusion, tumor)
- abdomen
- pelvis
- soft tissues (thyroid gland, testicle, etc.)



# Ultrasound

- **pros:**
  - unexpensive
  - safe, no radiation
  - any plane, realtime
  - bedside
  - biopsy and drainage
  - Doppler
- **cons:**
  - user dependent
  - poor image quality in obes
  - can't penetrate gas and bone





# Signs

1st case

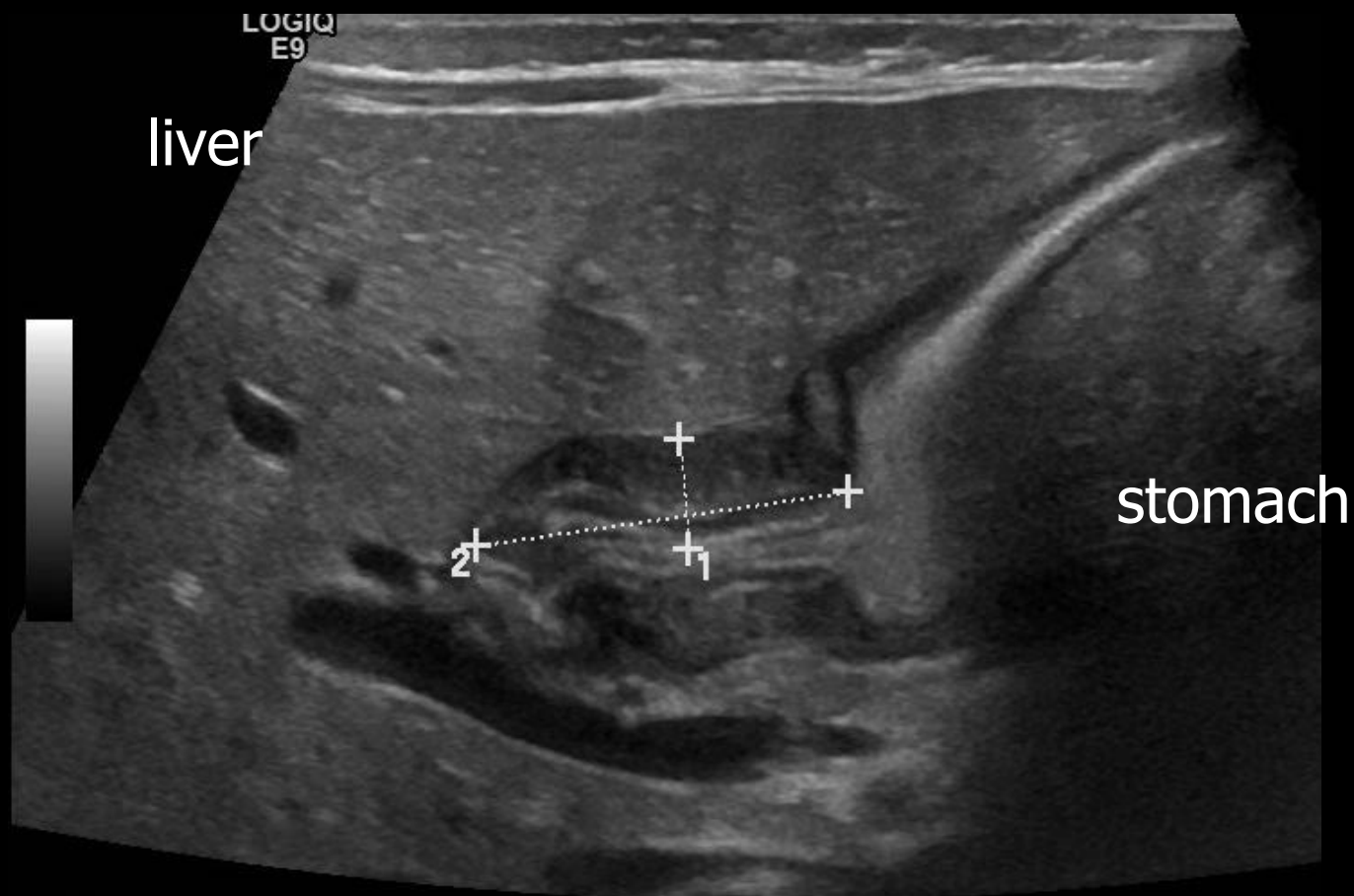
- projectile vomiting
- dehydration
- lagging growth



?



# Ultrasound



●	MR
1	L 0.61 cm
2	L 2.09 cm



# Pyloric stenosis

- muscle hypertrophy
- boy:girl = 4:1
- usually 3-8 weeks after birth
- often palpable
- on ultrasound the pyloric canal is elongated, the wall is thickened



# Signs

## 2nd case

- 2 y/o
- drowsiness
- intermittent abdominal pain
- vomiting
- blood in stool





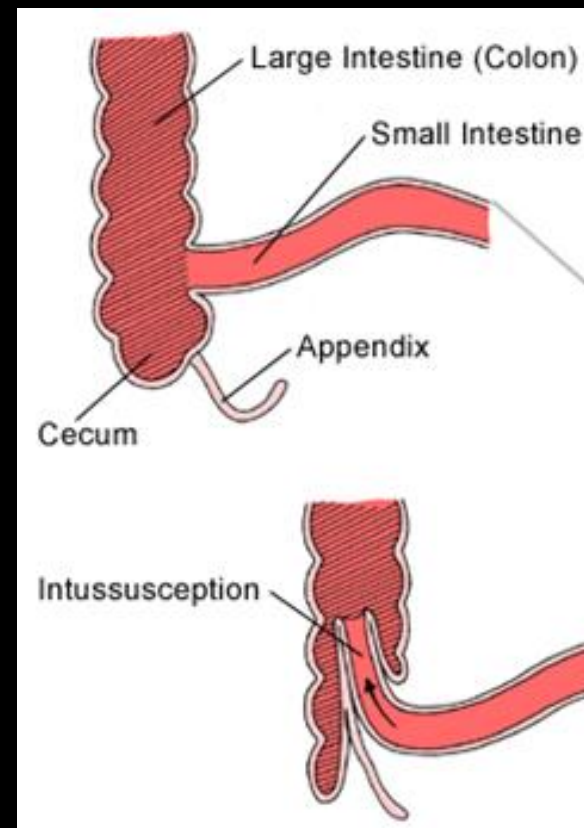
# Ultrasound





# Intussusception

- bowel section herniates into an other
- the majority is ileocoecal
- bowel infarct
- peak incidence is between 6 months and 2 years of age
- in olders - malignancy
- reduction





# Signs

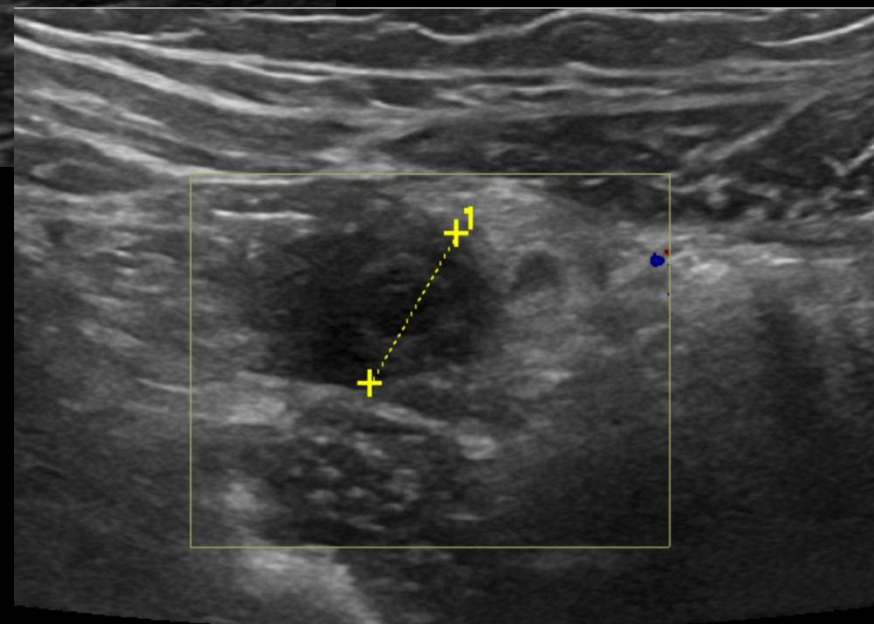
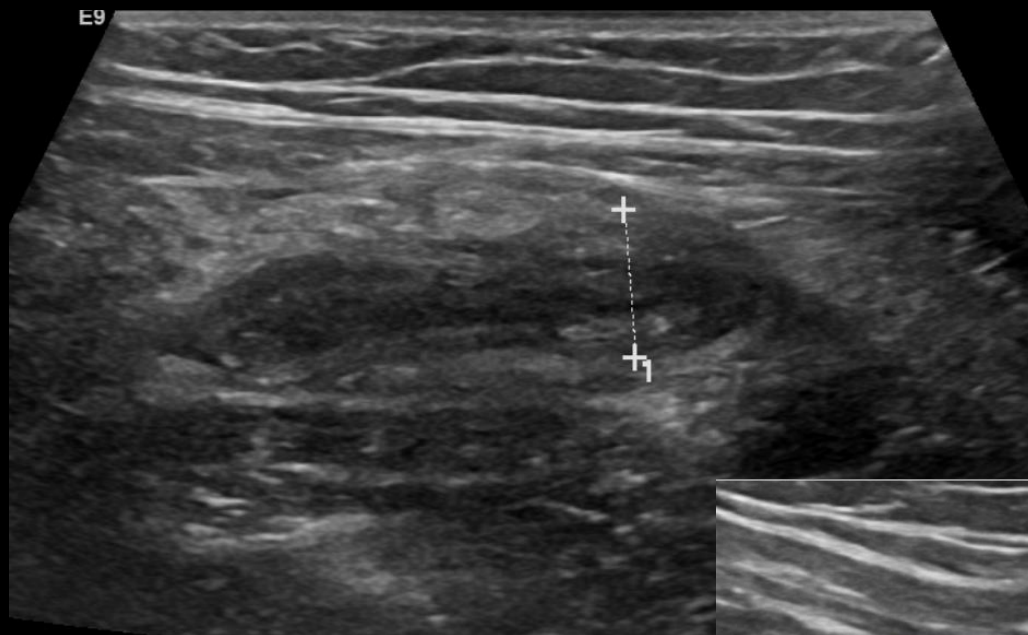
3rd case

- initial epigastric pain
- later LRQ pain





# Ultrasound







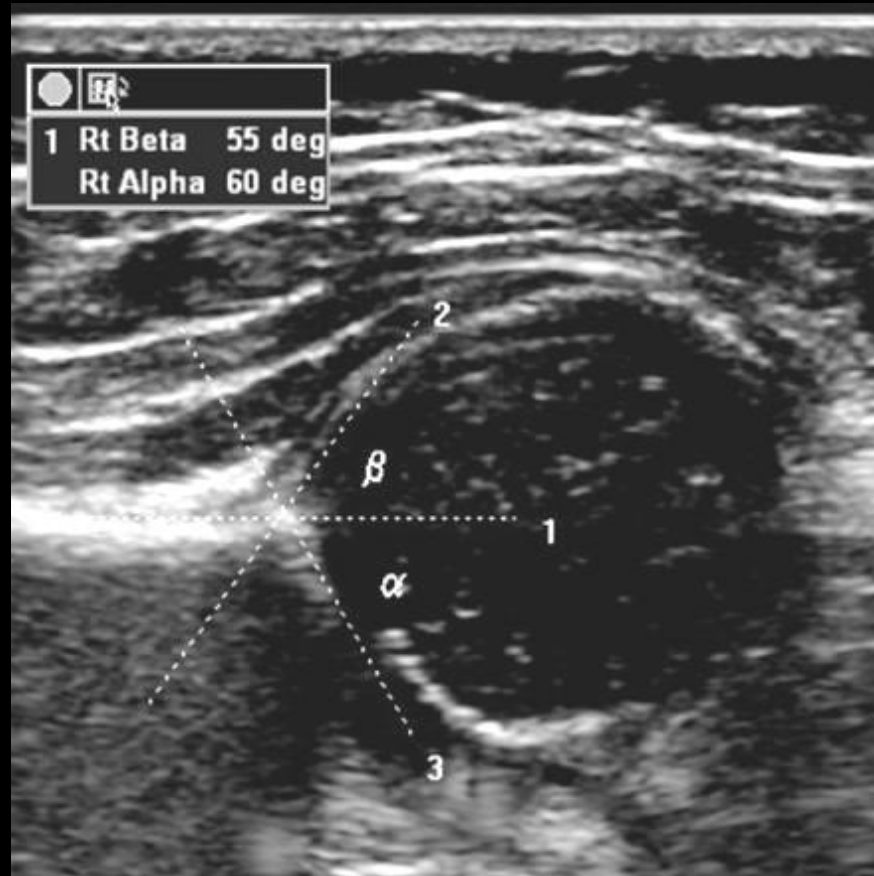
# Appendicitis

- not compressible tubular lesion
- thickened wall
- high blood flow
- edema in surrounding tissues
- free fluid
- enlarged lymph nodes



# Congenital hip dysplasia

- US is the first modality of choice – screening





# X-ray

- chest (0,02mSv)
- evaluating bones
- abdomen (ileus, foreign body, perforation)
- 5 basic density:
  - air - dark (lung, air in abscess)
  - fat (subcutaneous fat)
  - soft tissue (solid organs)
  - bone – bright
  - metal



# Pitfalls



exhalation



inhalation



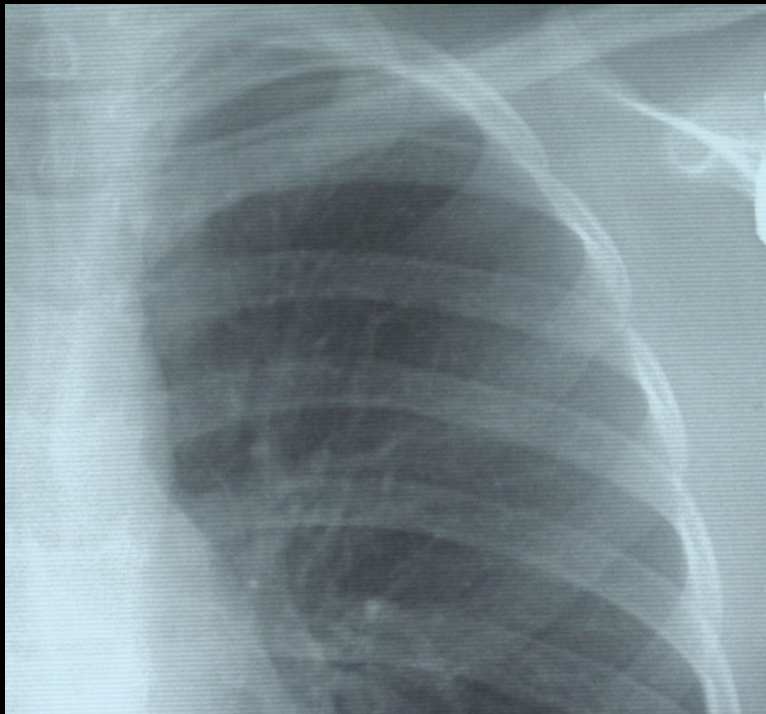
# Pitfalls



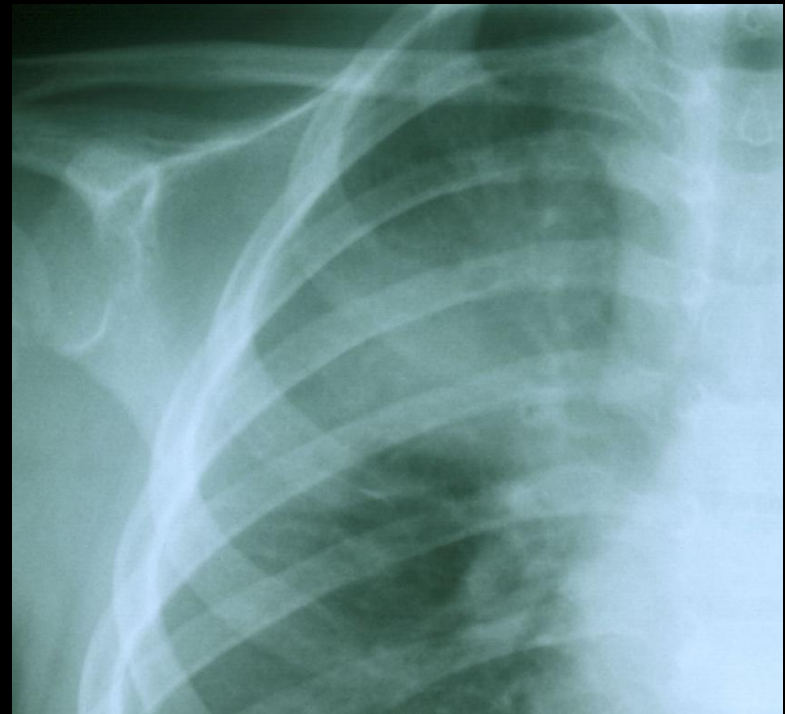


# Lung transparency

normal



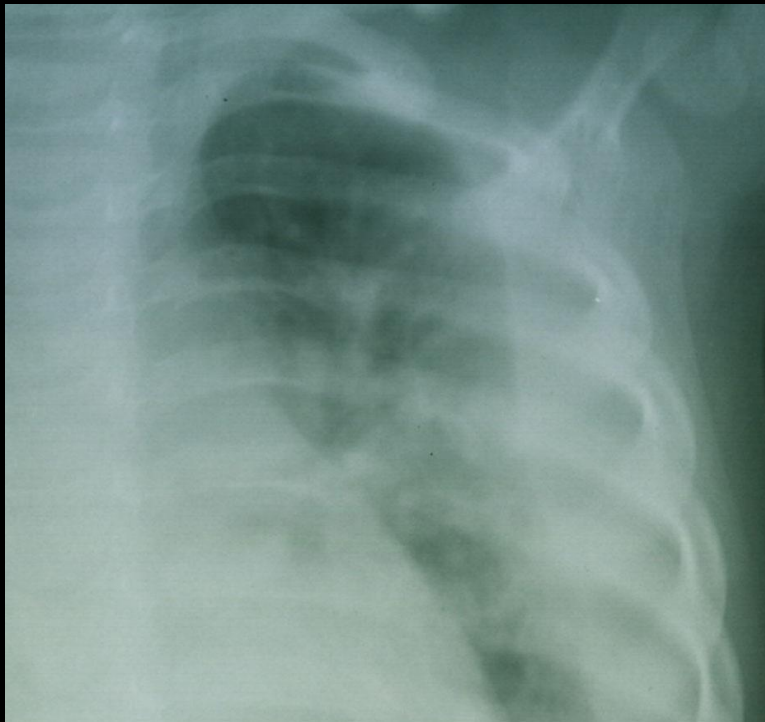
infiltrate



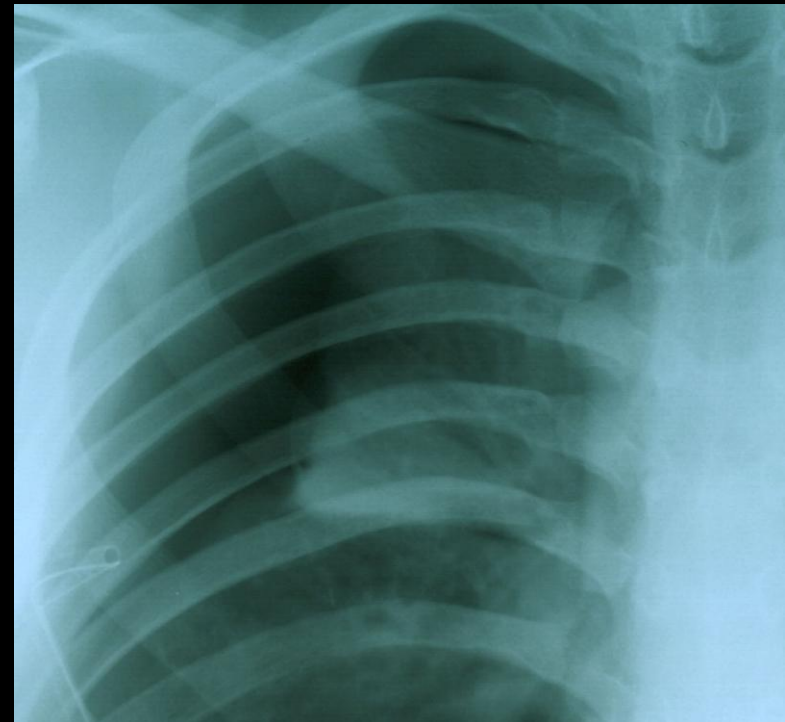


# Pleural cavity

pleural effusion



ptx







# Pleural cavity

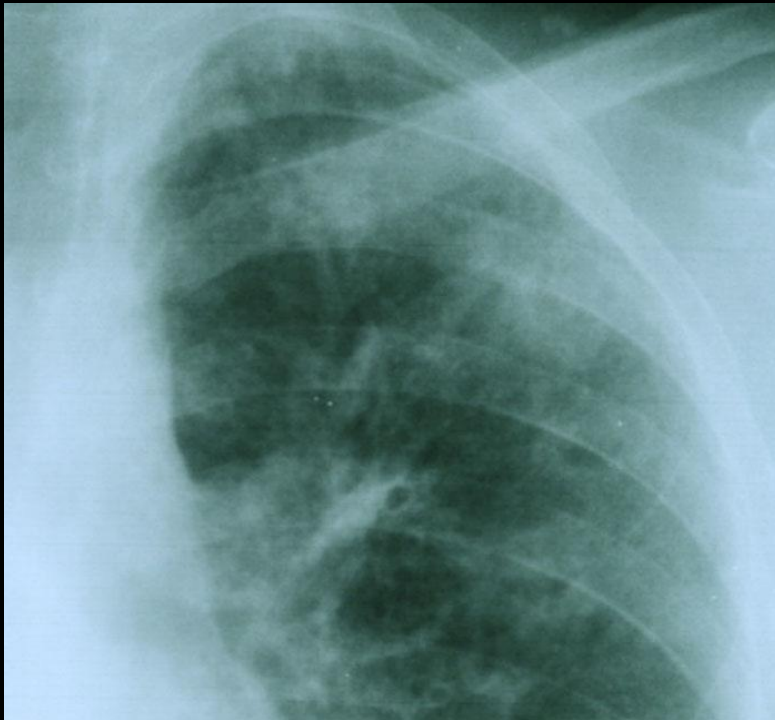




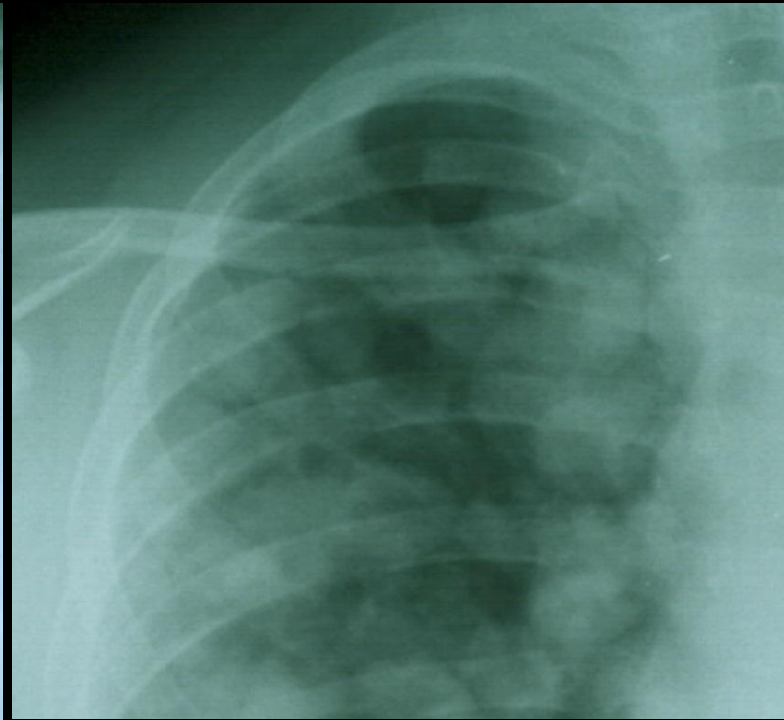


# Lung transparency

interstitial infiltrate



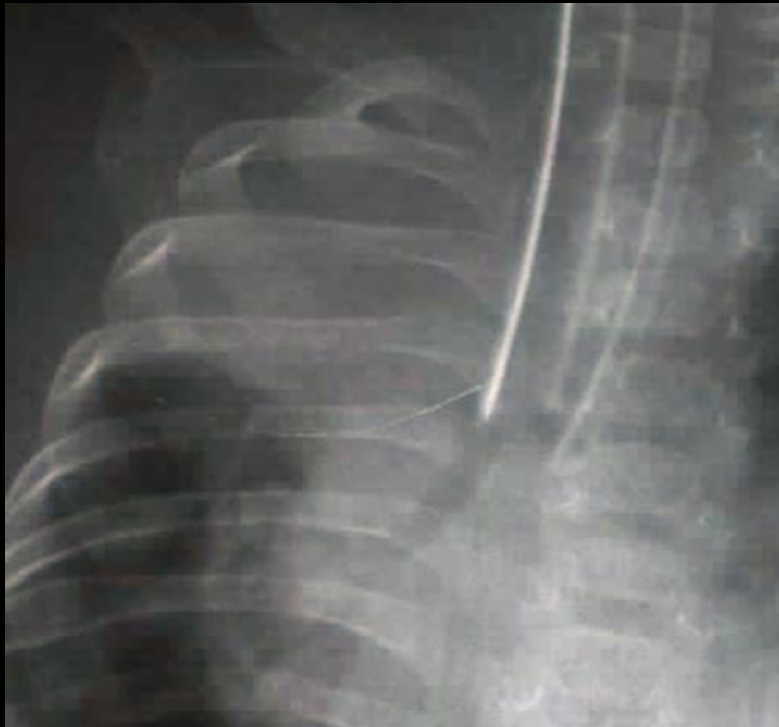
pulmonary nodules



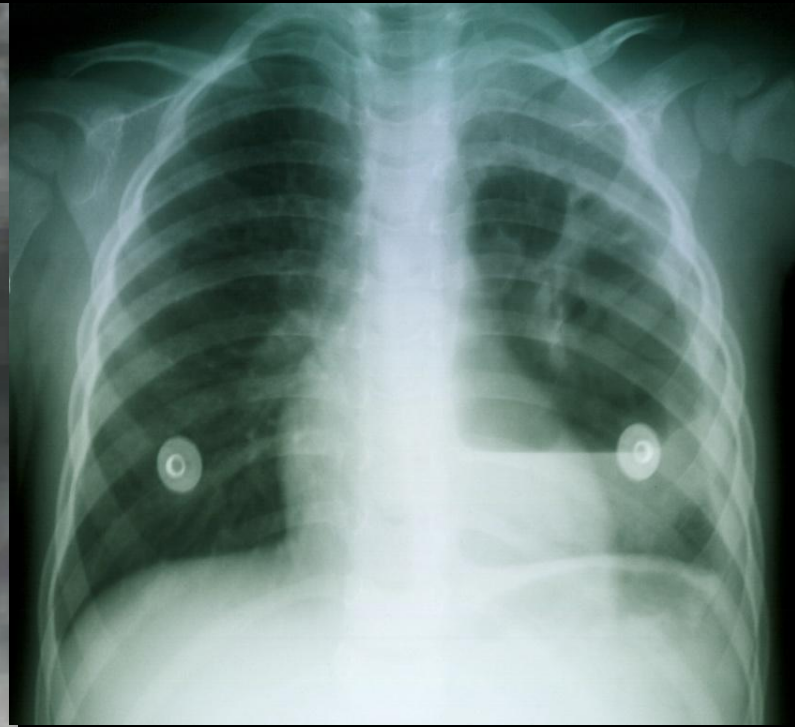


# Lung transparency

atelectasis



air-fluid level



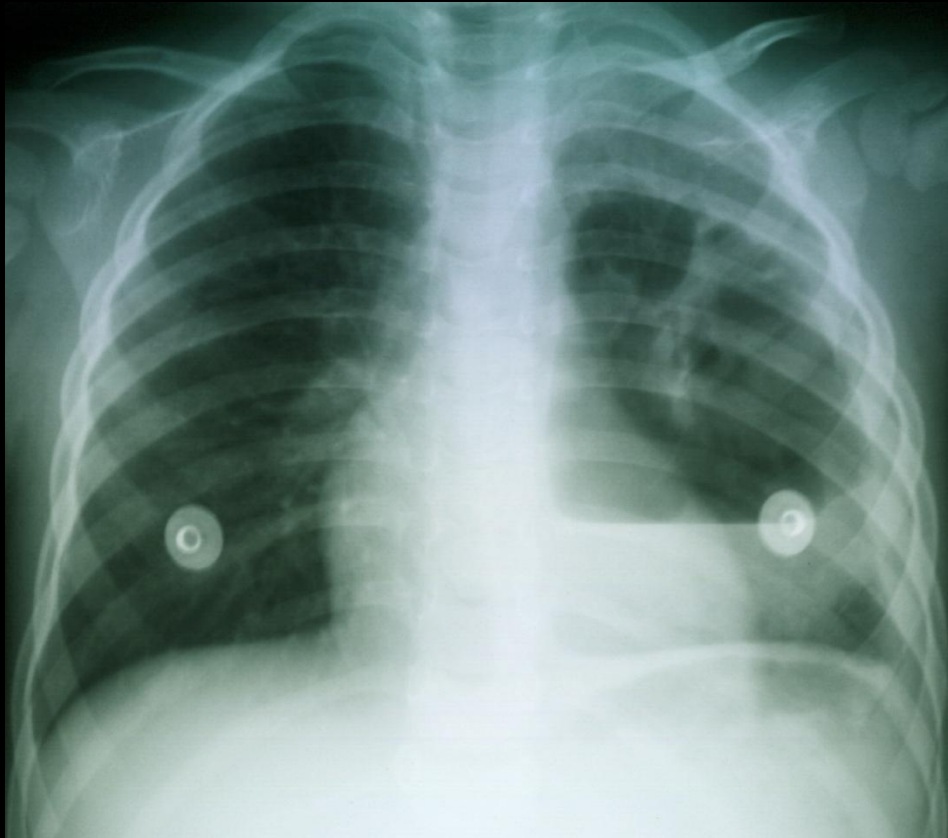


# Lobar pneumonia





# Pulmonary abscess





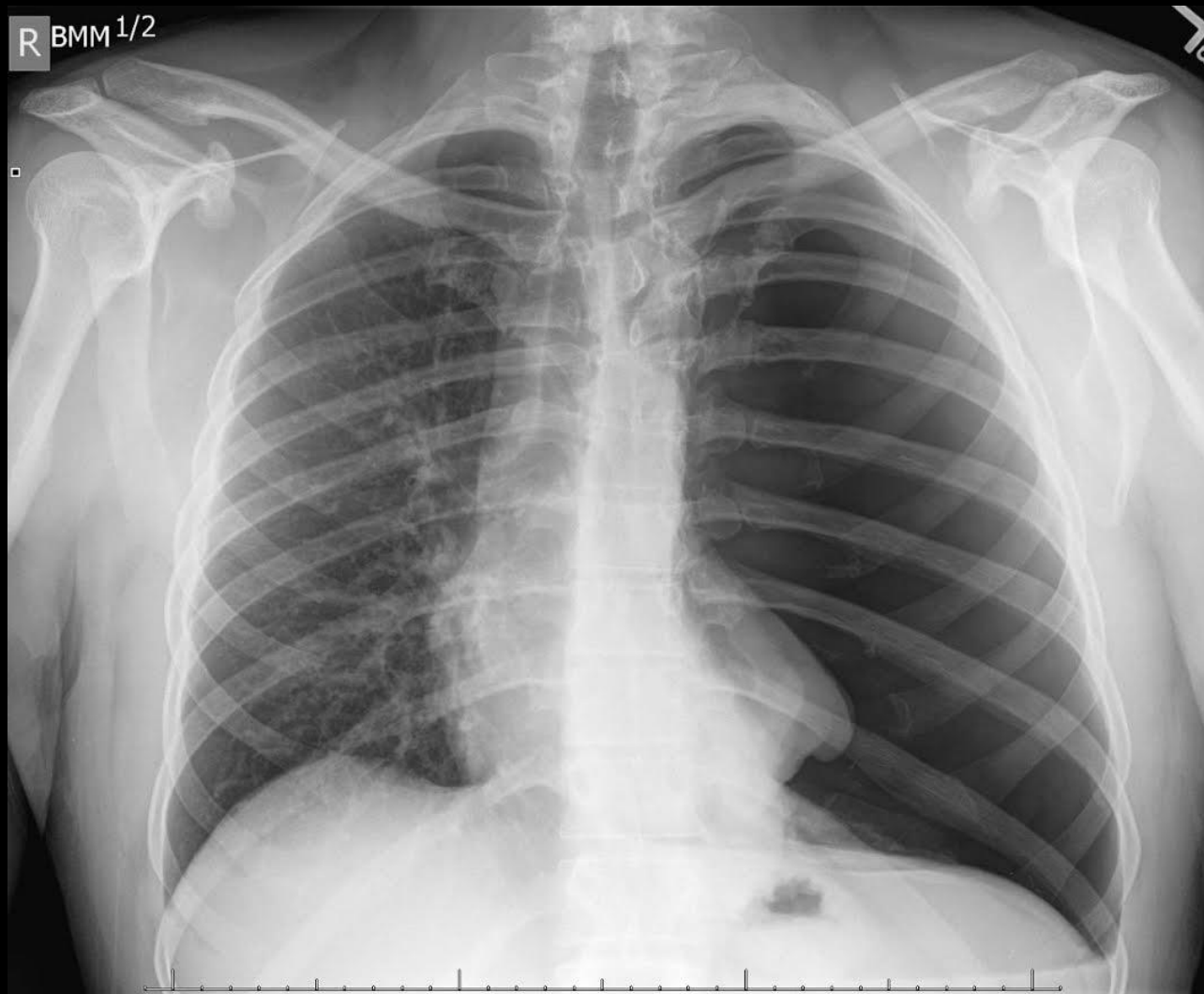
# Posterior mediastinal mass (NBL)





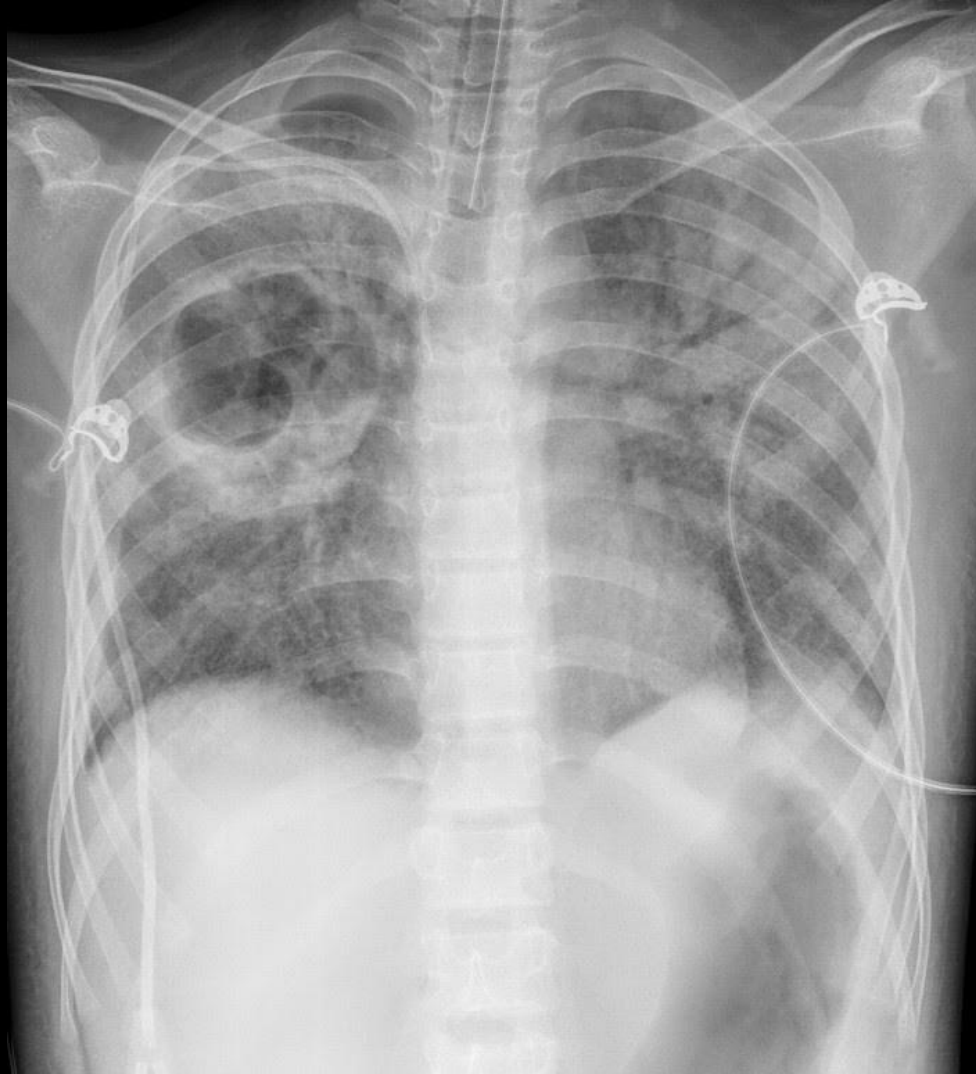


# Pneumothorax





# Pulmonary abscess





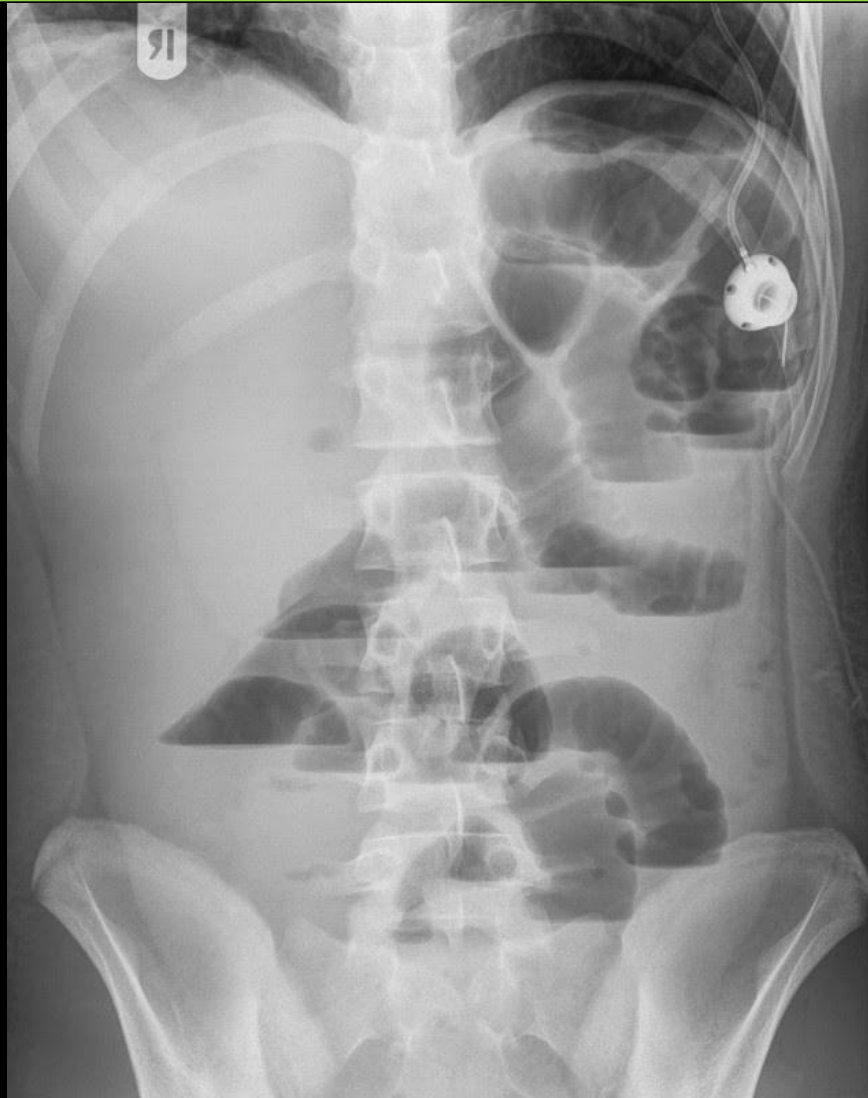
# Pleuropneumonia







# Ileus





# Signs

4th case

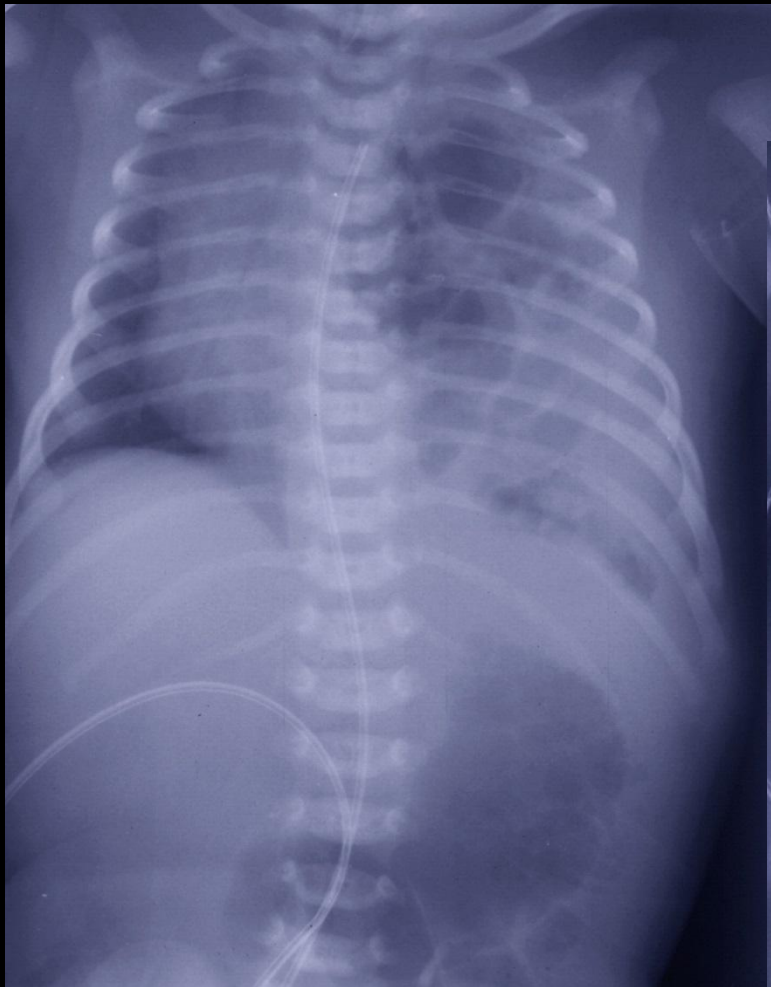
- newborn
- severe respiratory distress



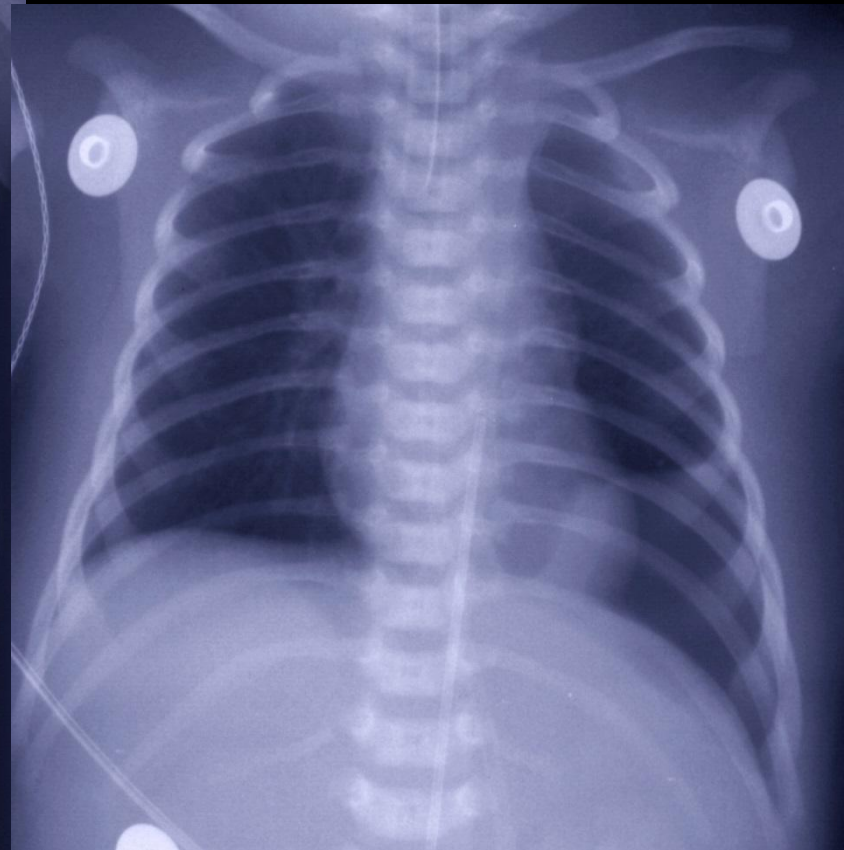
?



# X-ray



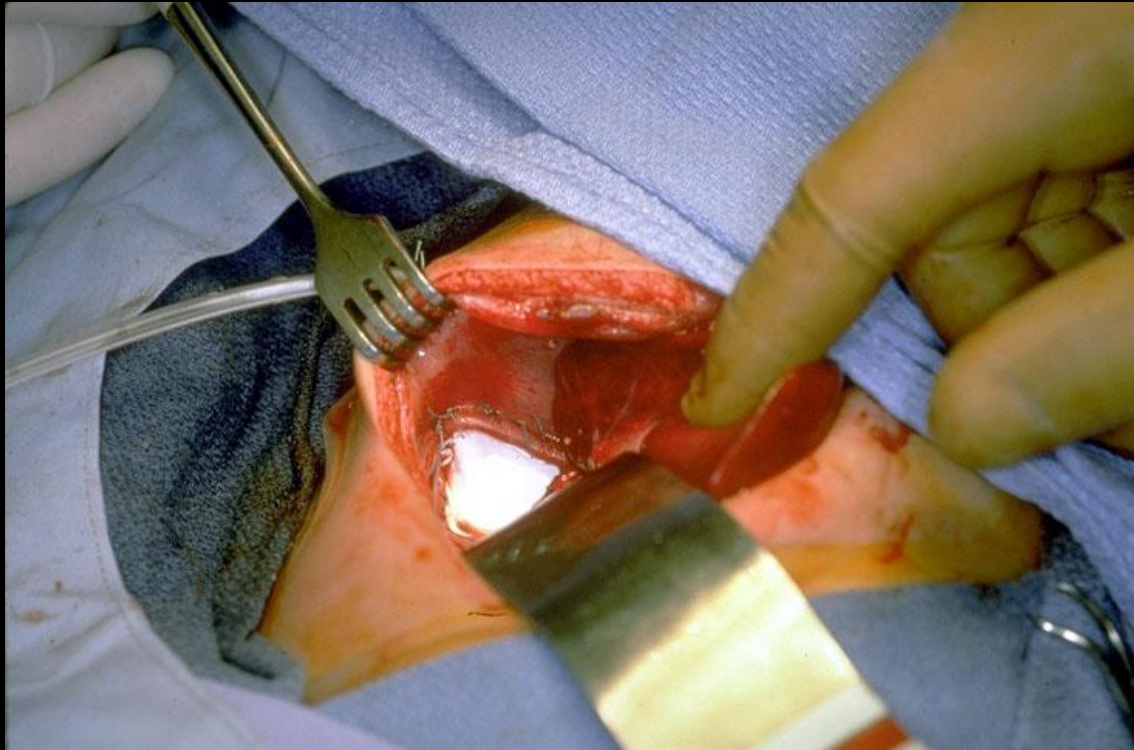
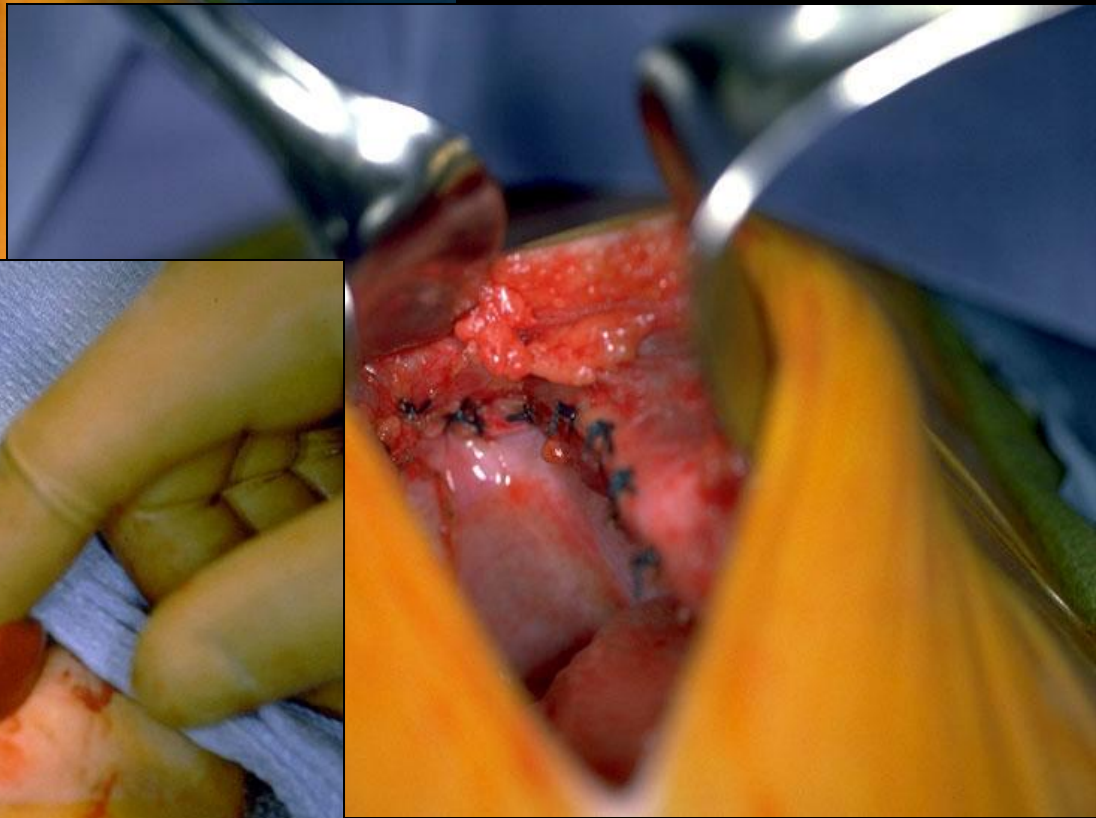
post op.





# Congenital diaphragmatic hernia

- congenital diaphragm defect
- abdominal organs, bowel in chest
- lung hypoplasia - outcome
- intrauterine ultrasound







# Signs

6th case

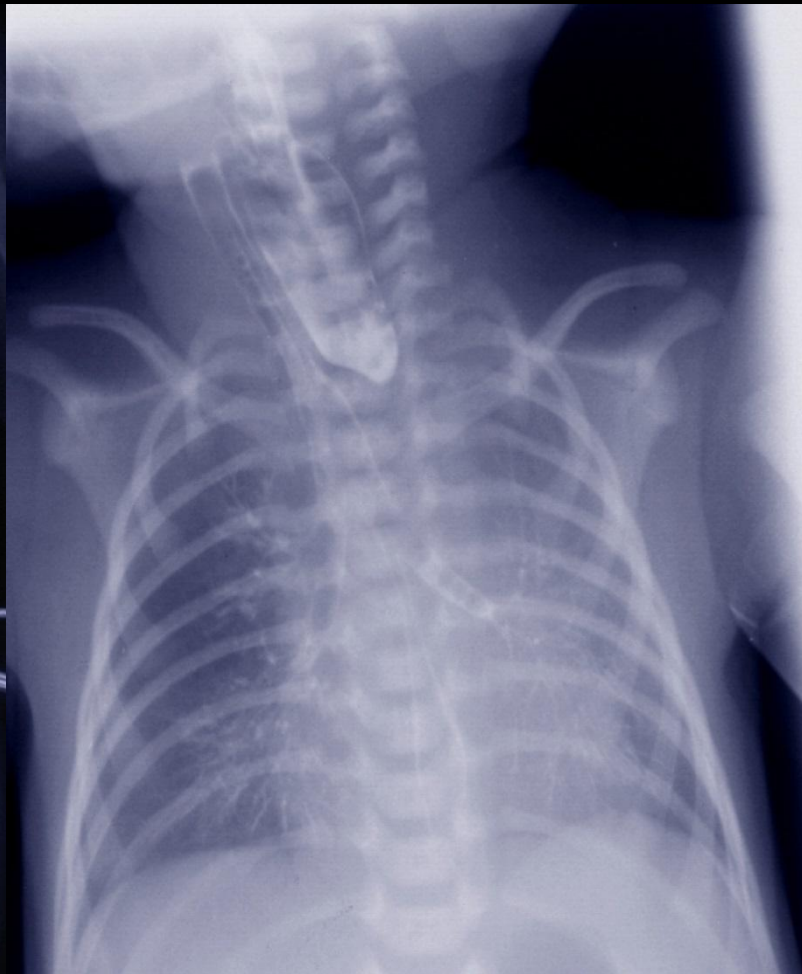
- newborn
- respiratory distress
- perioral cyanosis following feeding
- excessive salivation



?



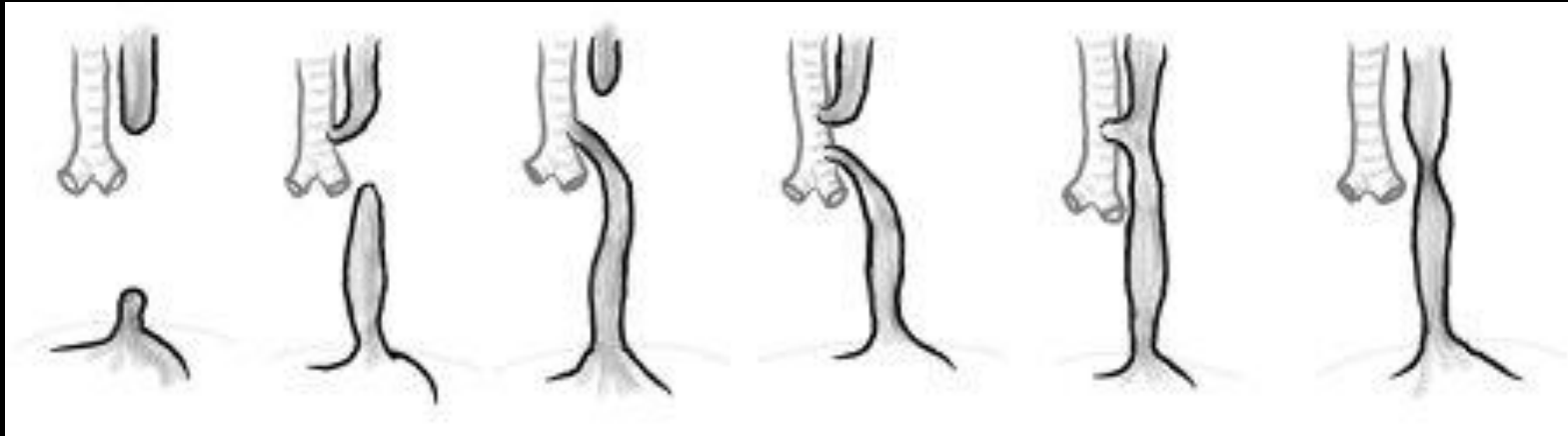
# X-ray







# Esophageal atresia



- signs depending on types
- often accompanied by other GI anomaly
- surgery needed



# CT

- polytrauma
- intrapulmonary lesions
- skeletal
- in case MRI contraindicated!
- rarely angiography

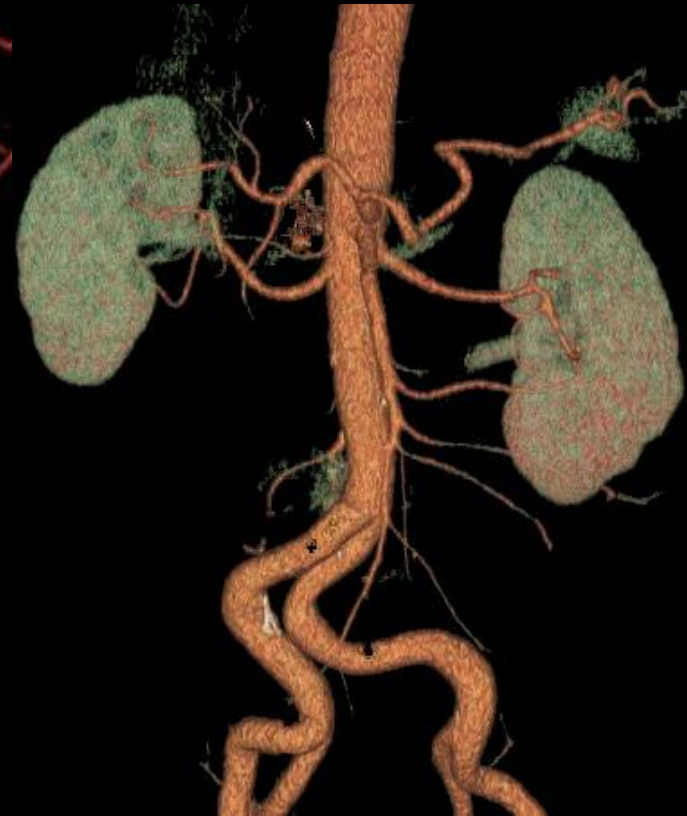
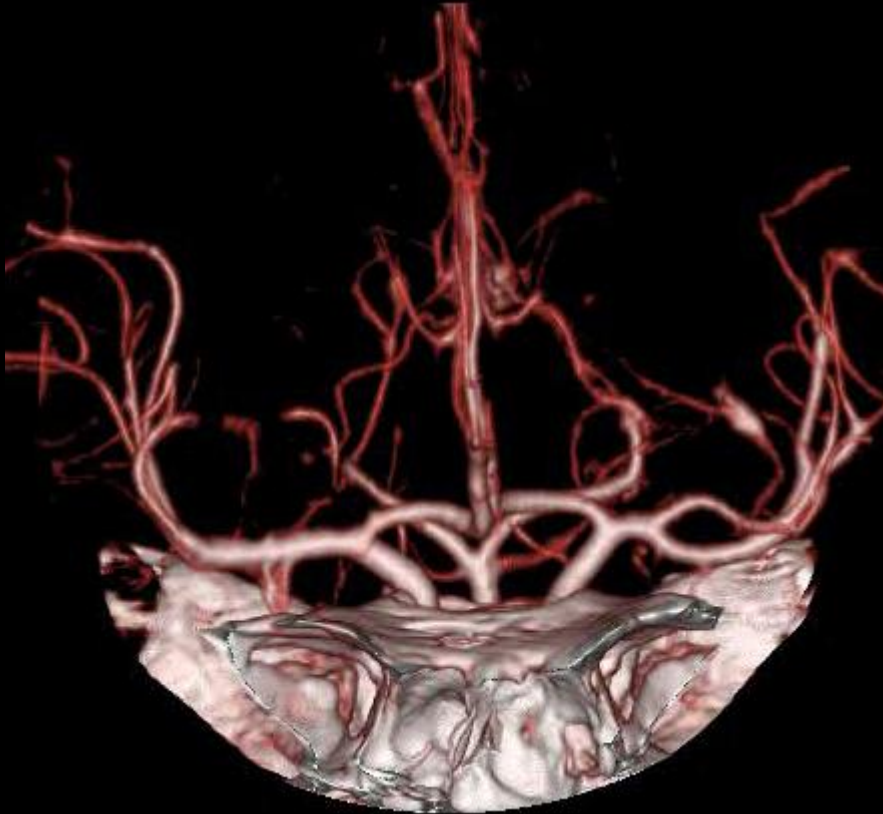
in case of renal impairment  
administration of CT contrast  
is forbidden!

labs: UN, creatinine





# CT angiography (CTA)





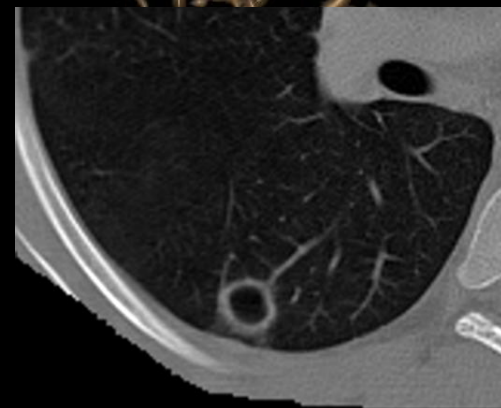
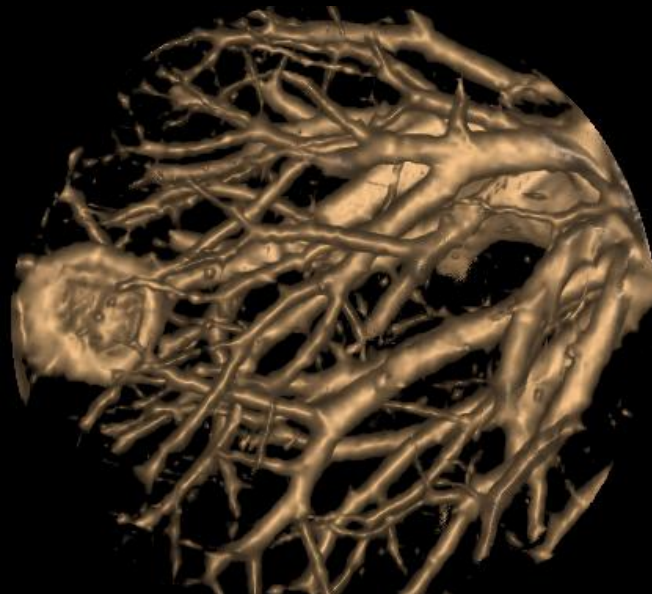
# CT – 2D, 3D reconstructions





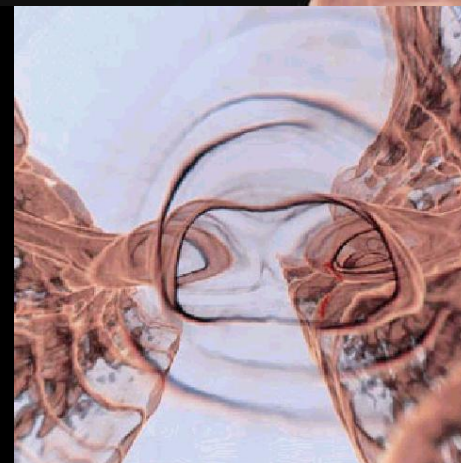


# CT – 2D, 3D reconstructions





# CT – 2D, 3D reconstructions





# MRI

- CNS: basic technique in brain and spinal imaging
- musculoskeletal system (joints and soft tissue lesions)
- cardiac MRI
- chest (mediastinum, vessels, chest wall)
- abdomen, pelvis
- whole body MRI

more, than 200 sequences





# MRI

- pros:
  - anatomic and functional information
  - any plane
  - no radiation exposure, repeatability
  - good tissue resolution without contrast material
  - angiography with or without contrast material
  - very sensitive for detection of bleeding
- cons:
  - high costs
  - lung parenchyma – poor image quality
  - relatively long scan time - anesthesia
  - contraindicated: pacemaker, metal implantation (if not MR compatible)
  - pulsation and movement artifacts



# Multiparametric MRI

- we examine the tissue characteristics of a given lesion with different **anatomic and functional sequences**
- 2D, 3D sequences
- MR angiography - without or with contrast material (extracellular, blood-pool)
- MR enterography
- MR urography
- MRCP (MR-Cholangio-Pancreatography)

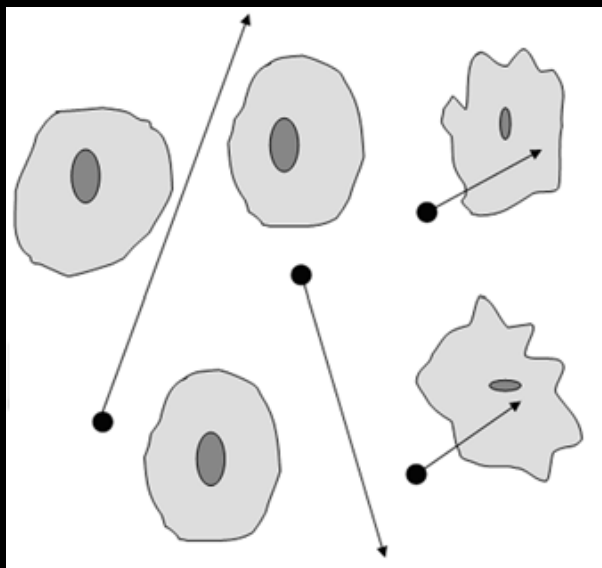


# Functional MR sequences

- diffusion (DWI, DWIBS, DTI)
- fMRI (surgical planning – tumor, epilepsy, drug efficacy studies)
- MR spectroscopy (chemical composition – metabolites)
- MR perfusion (blood supply – tumor, stroke, asphyxia)

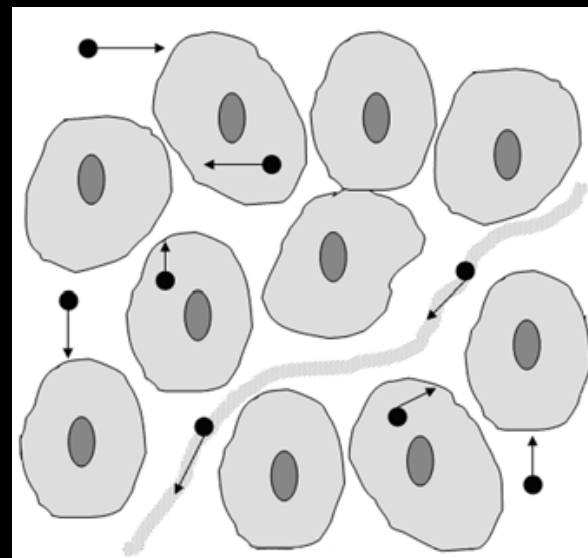


# Diffusion



## free diffusion

- low cell count
- damaged cell membrane - water molecules moving between the intra- and extracellular space

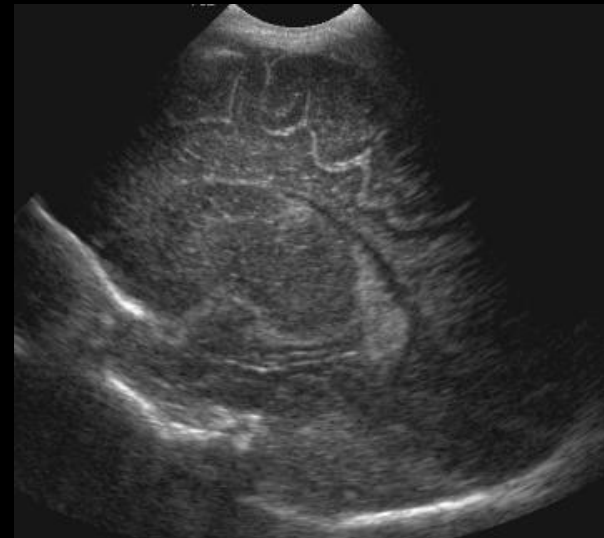
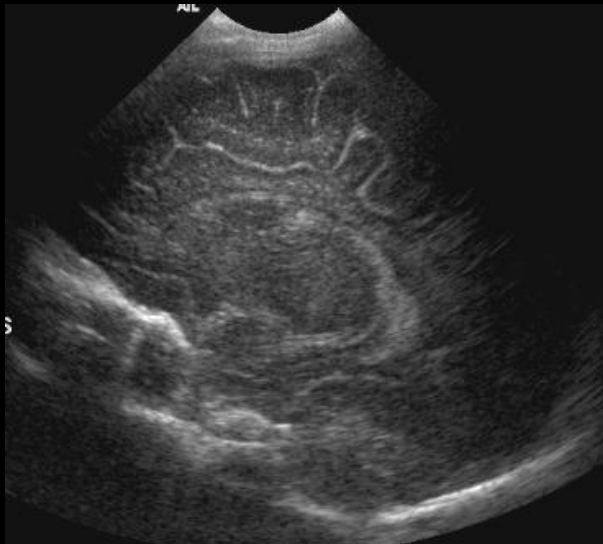
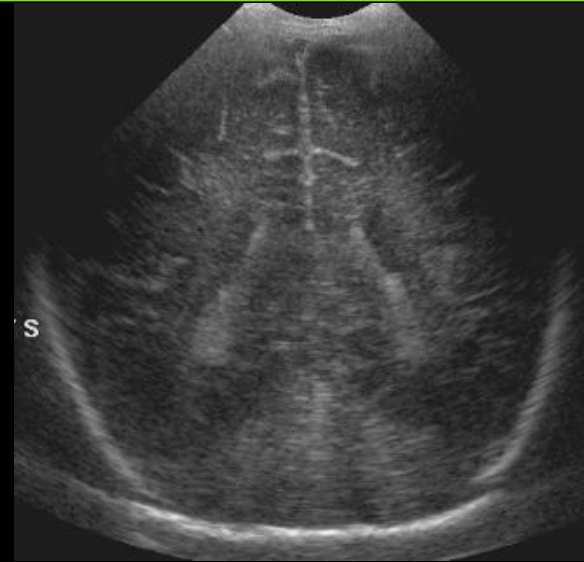
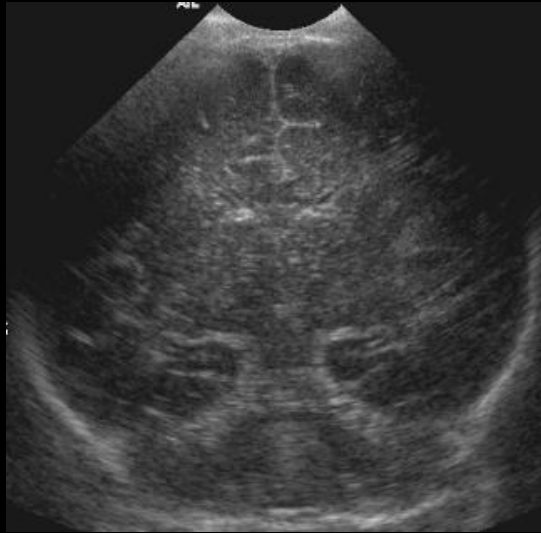


## restricted diffusion

- high cell count – narrowed extracellular space

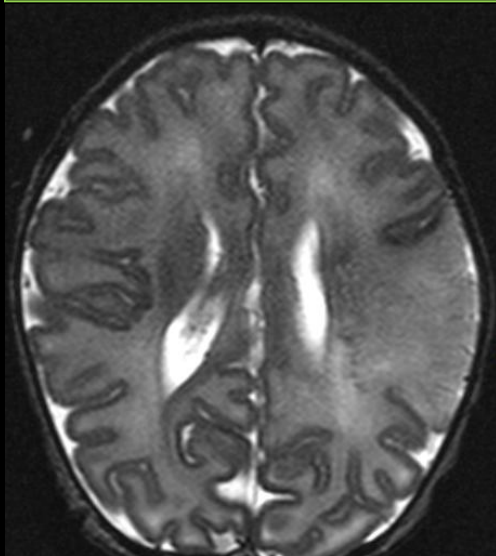


# Neonatal MCA stroke - US

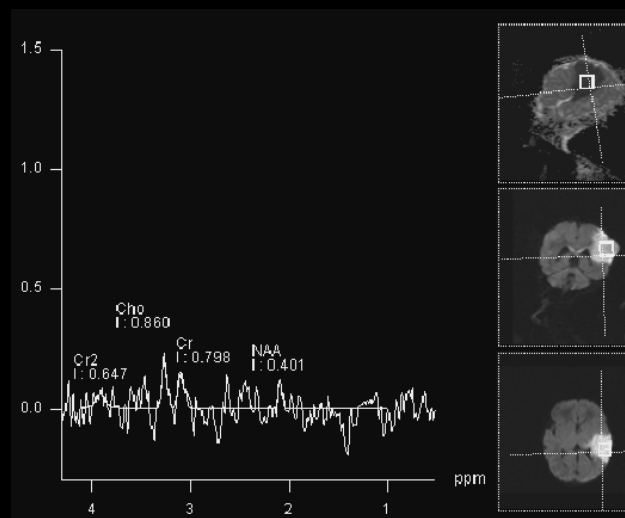
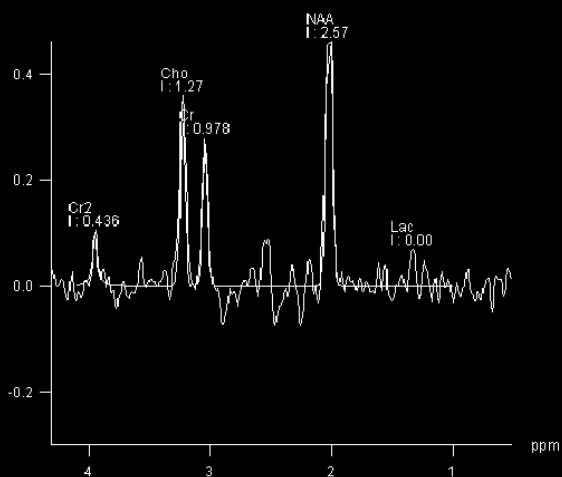
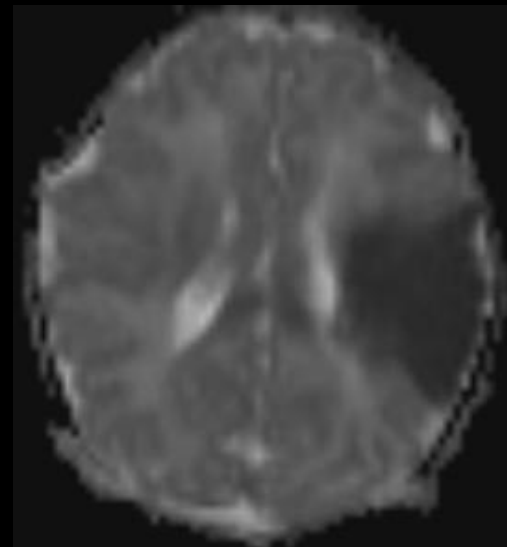
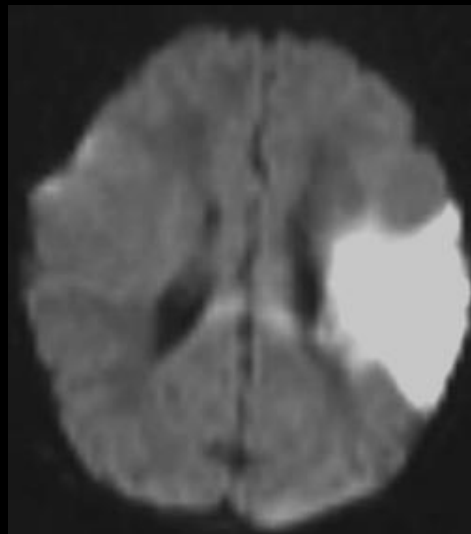




# Neonatal MCA stroke - MRI



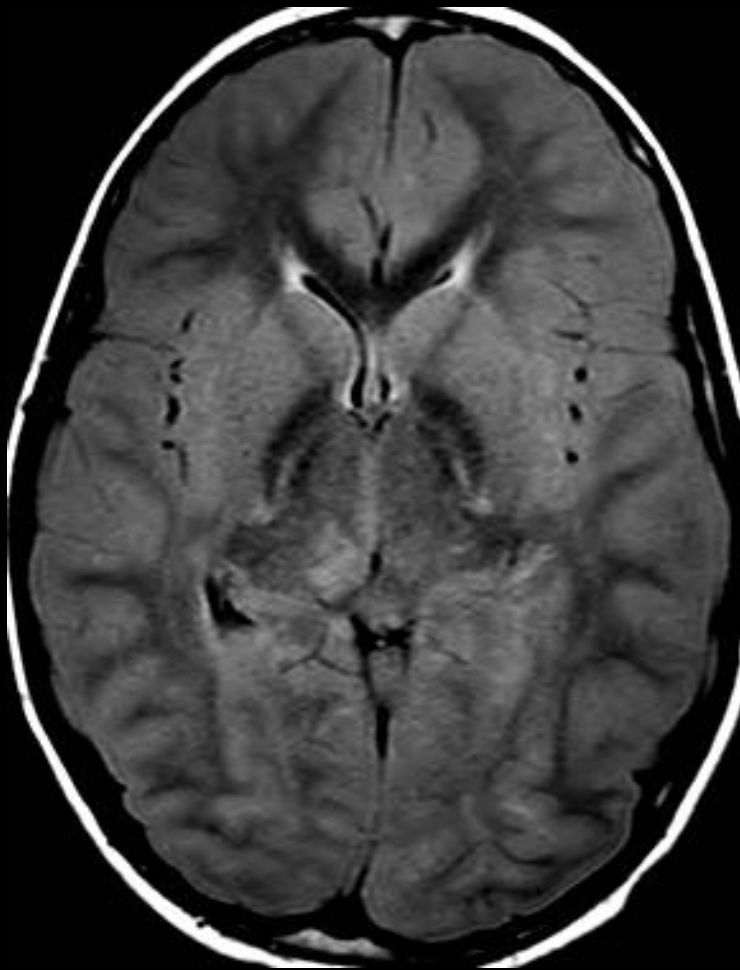
I: Integral







# MRI – cerebral edema (DKA)



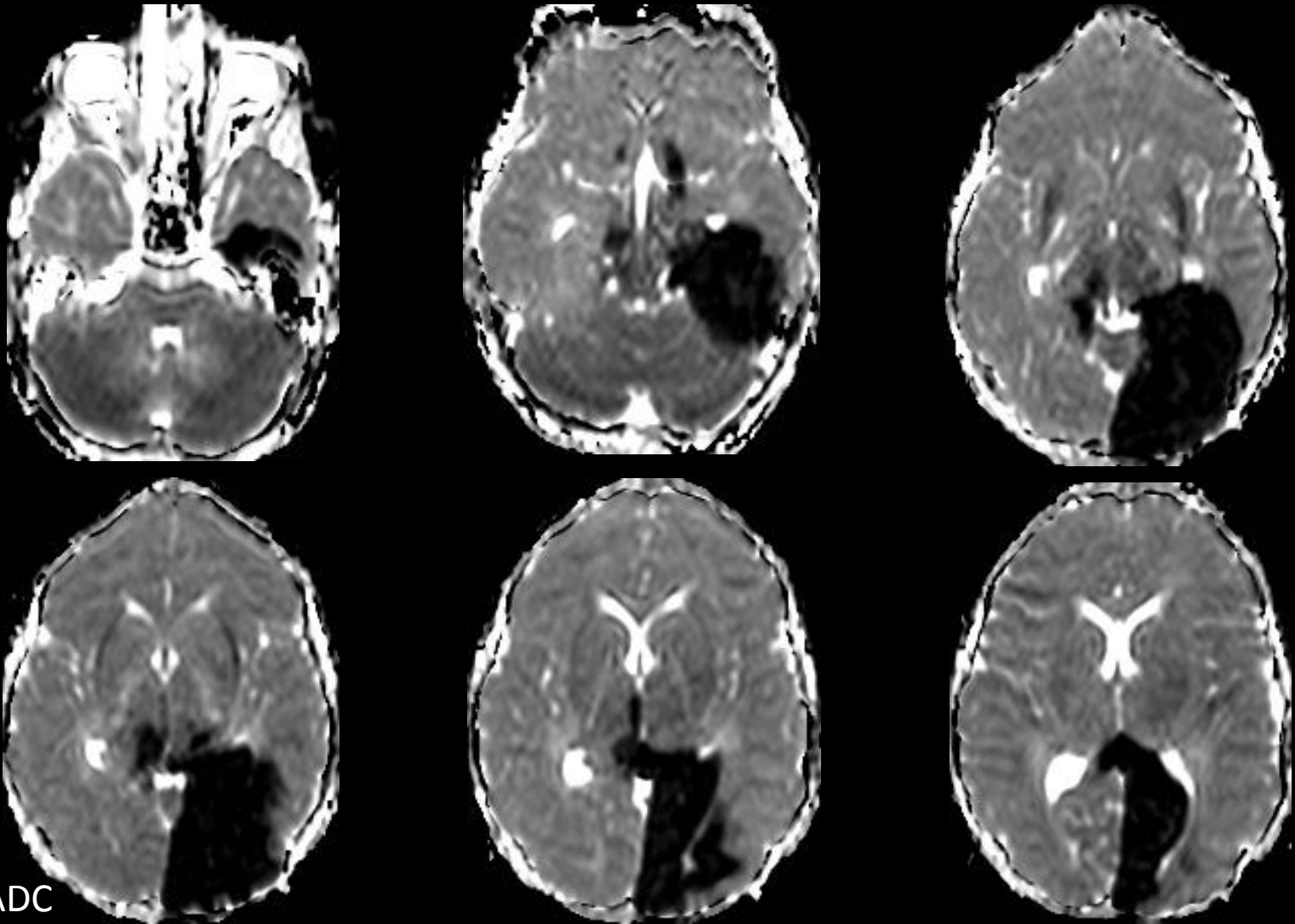
FLAIR



T2W



# MRI – stroke (DKA)



ADC



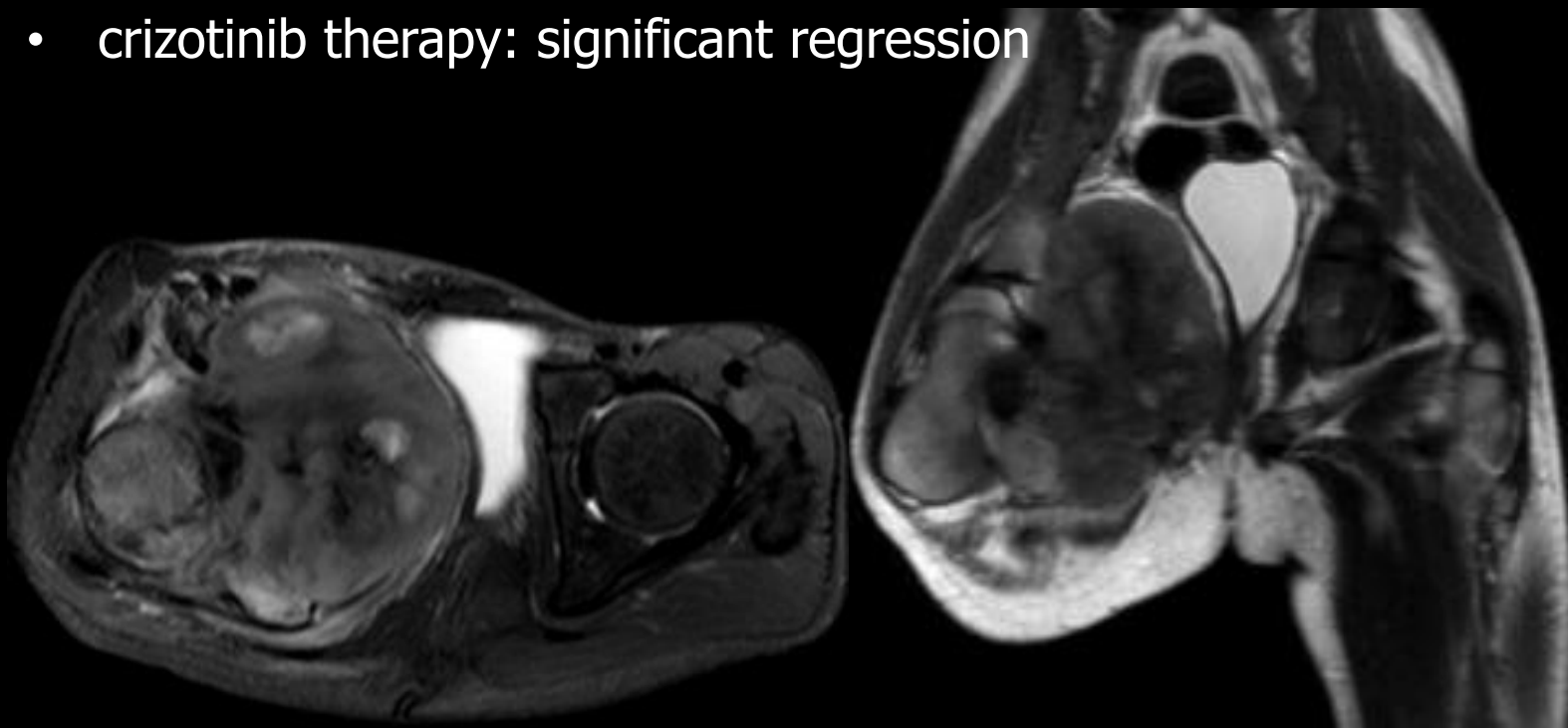
# MR angiography – vasculitis (DKA)





# IMT (inflammatory myofibroblastic tumor)

- 12y/o boy
- tumor involved: adductor muscles, hip
- surgery, chemotherapy was ineffective – recurrence and progression
- crizotinib therapy: significant regression



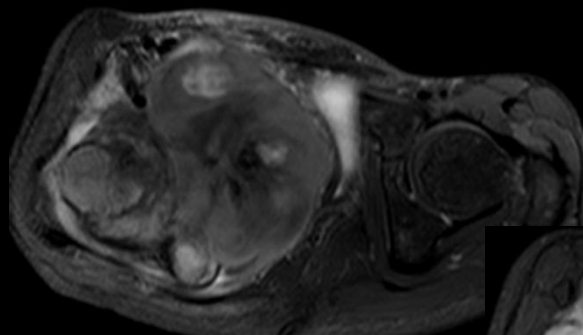
T2 SPAIR

T2

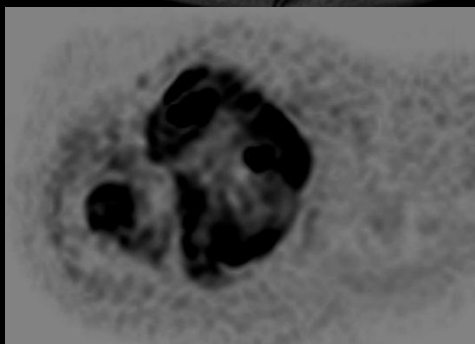
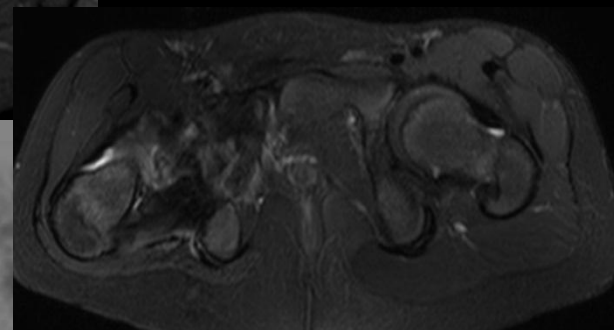
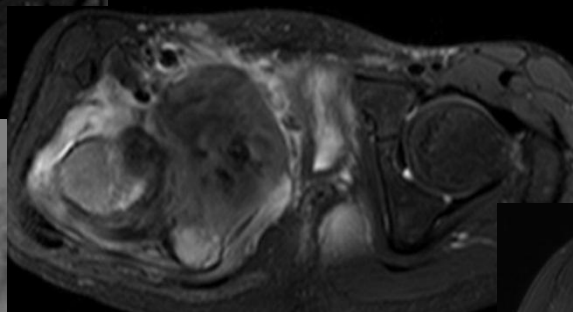




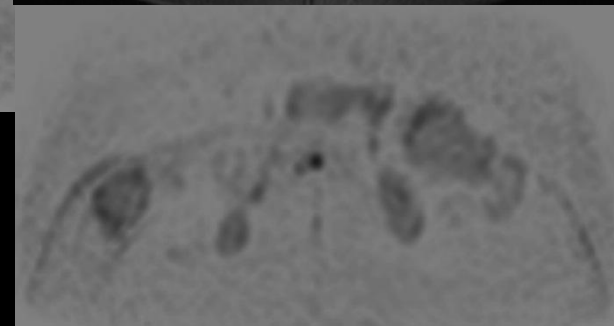
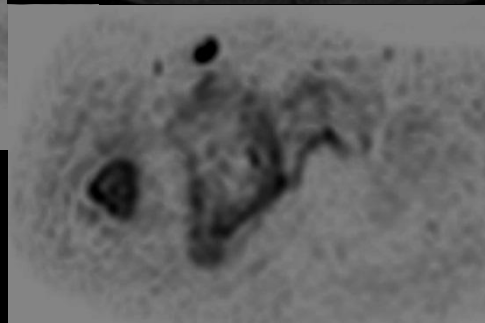
# Crizotinib therapy



T2 SPAIR



DWIBS



before therapy

1st follow-up

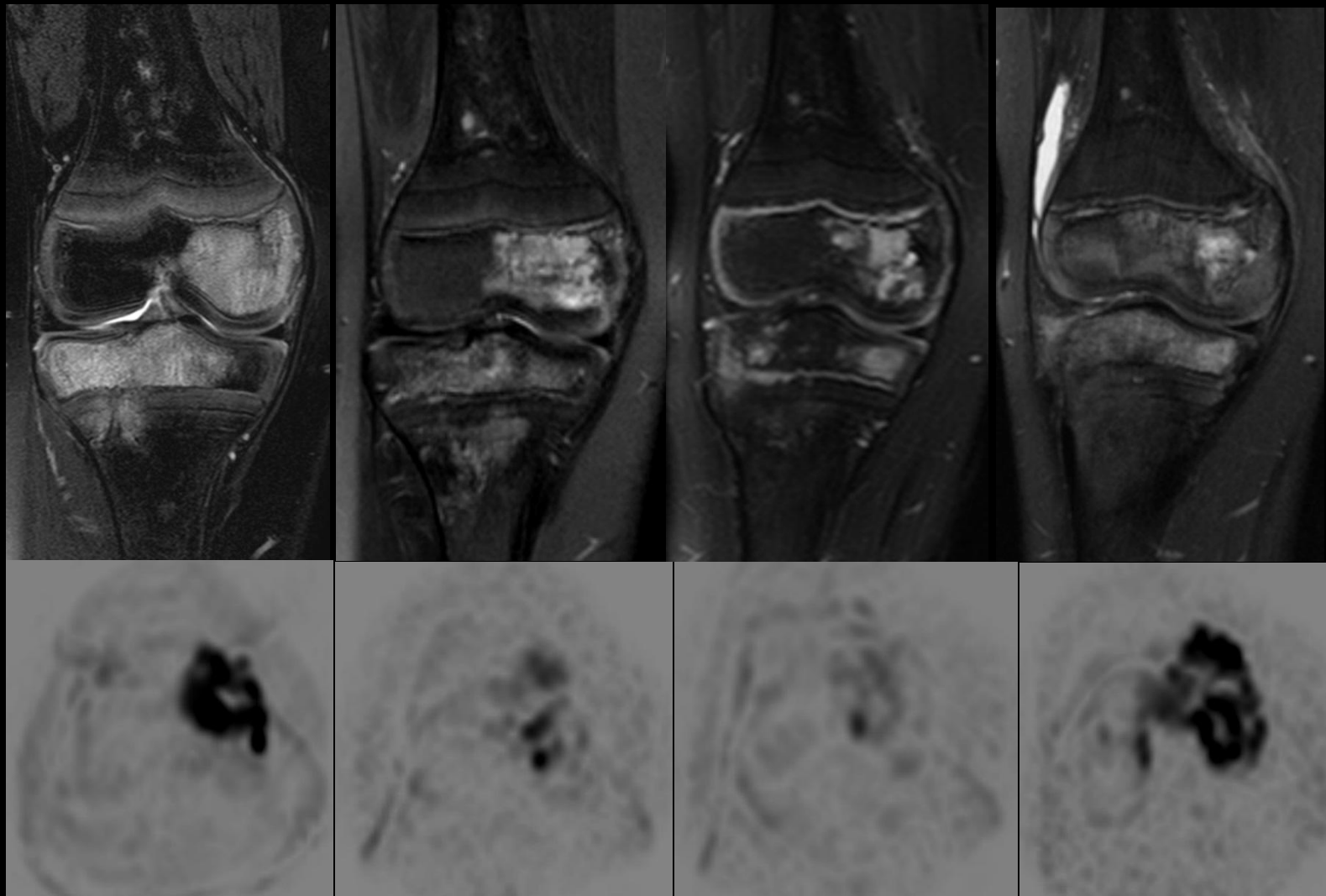
5th follow-up



# Crizotinib therapy

T2 SPAIR

DWIBS



before therapy

1st follow-up

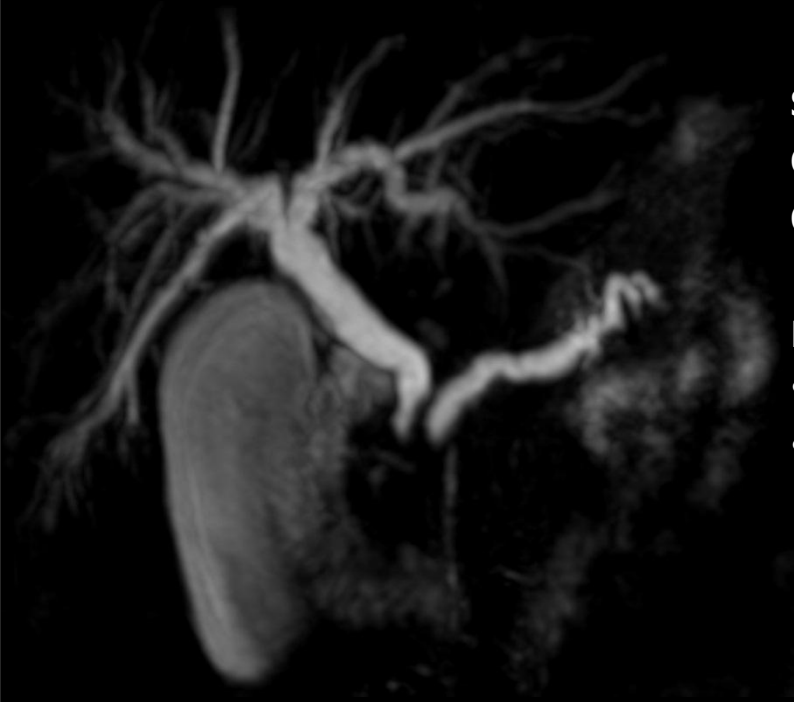
2nd follow-up

3rd follow-up





# MRCP – double duct sign



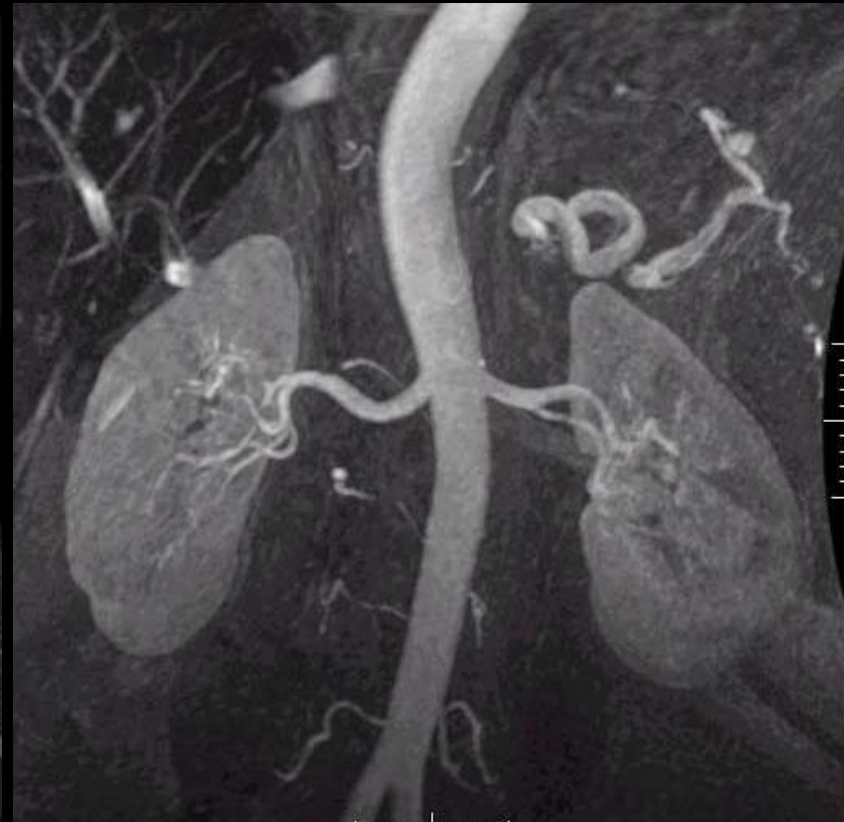
simultaneous dilatation of  
choledochal duct and pancreatic  
duct

most common reasons:

- pancreas head carcinoma
- wedged gallstones



# MR angiography





# Nuclear medicine

functional information

- gastrointestinal (Meckel's diverticulum, IBD)
- biliary system (atresia, cholecystitis, obstruction)
- urinary system
- skeletal system (bone tumor, osteomyelitis)
- thyroidgland (focal nodules)
- parathyroids
- FUO

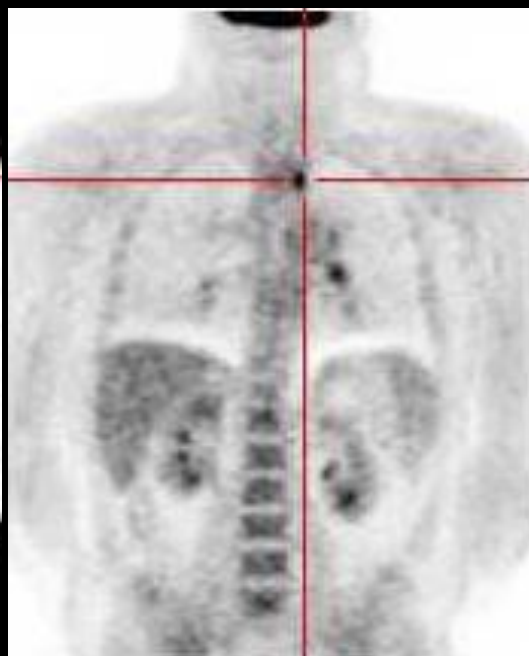


# Nuclear medicine

- SPECT
  - radioisotopes emitting photons - planar
- PET
  - positron-emitting isotopes
  - brain (epilepsy, tumor)
  - tumor (low-grade tumors – false negative!)

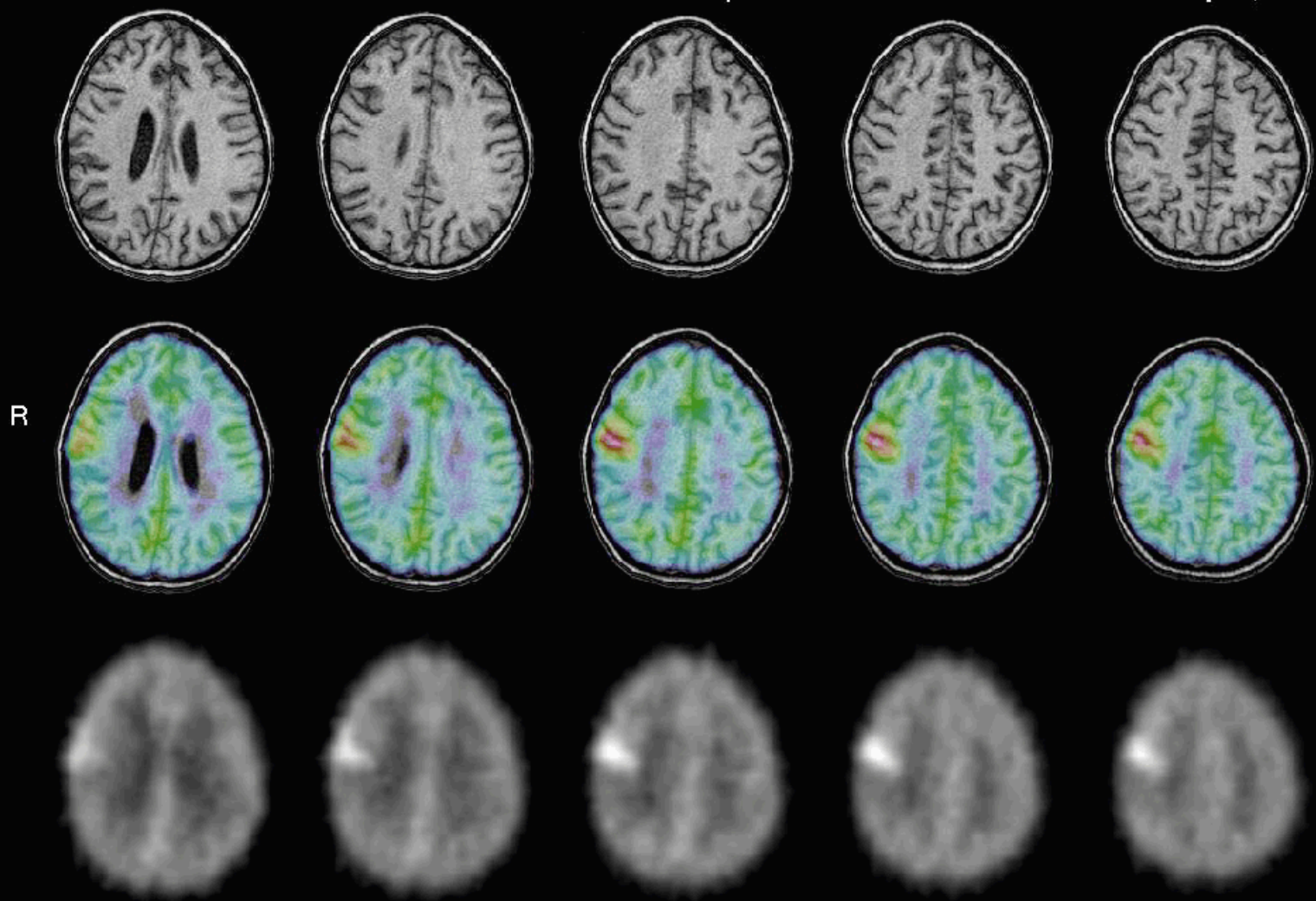


# Fusions: PET/CT





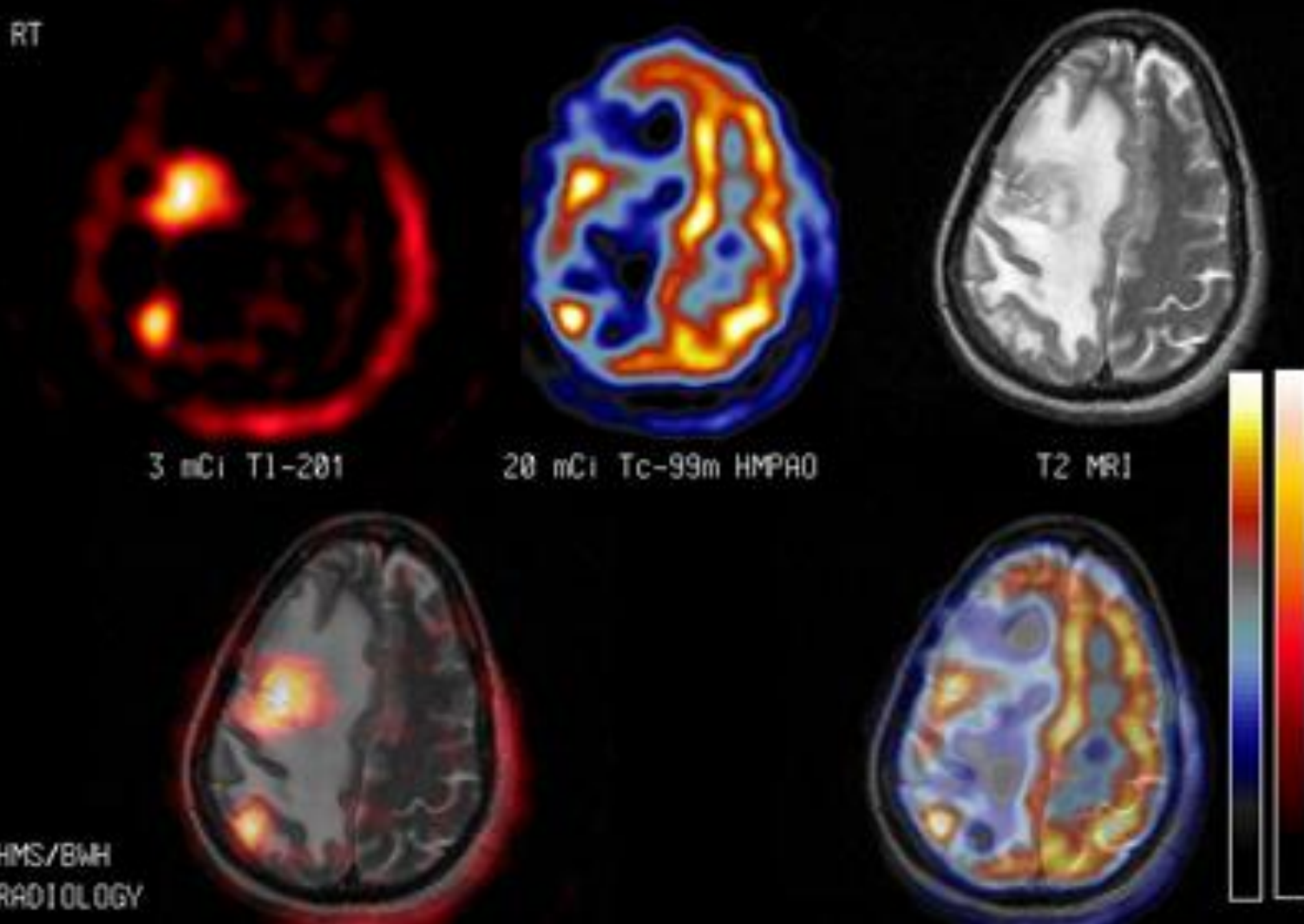
# Fusions: PET/MR







# Fusions: SPECT/MR





Thank you for your attention!