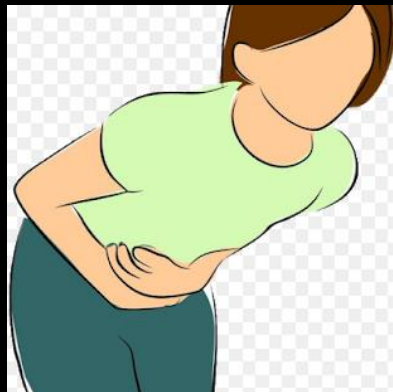
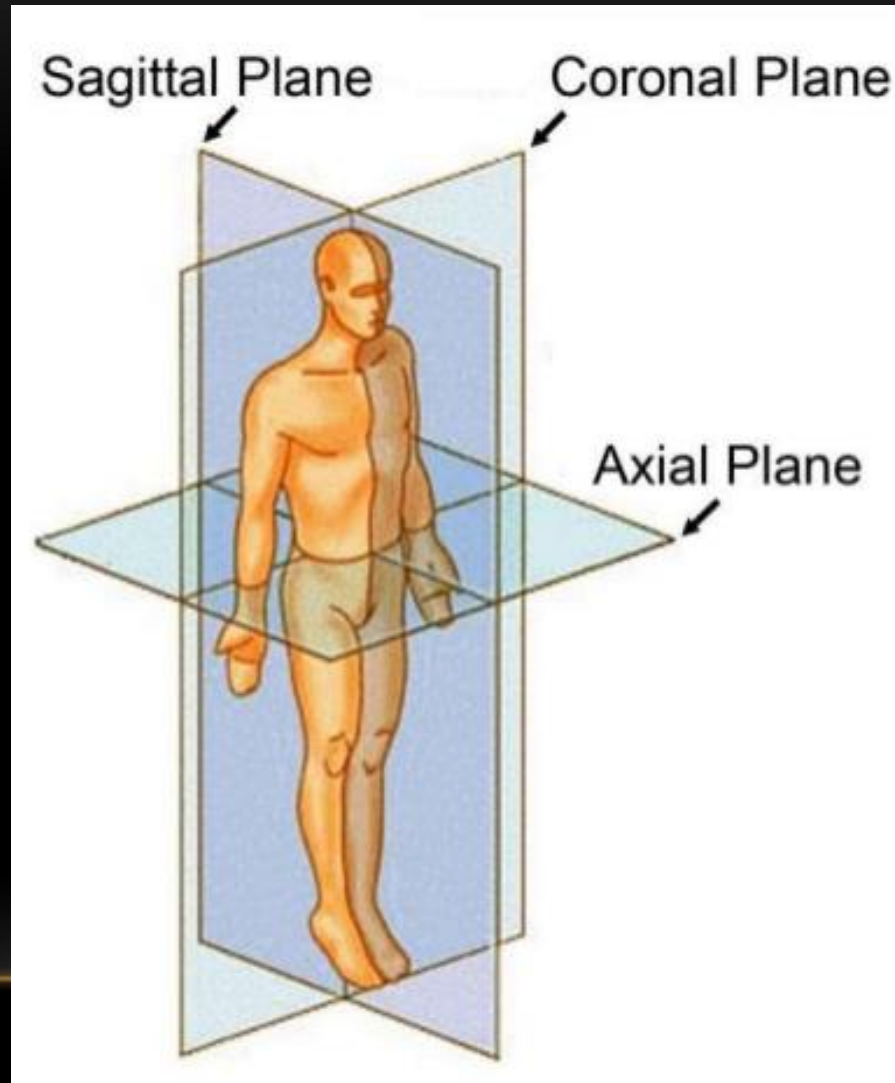


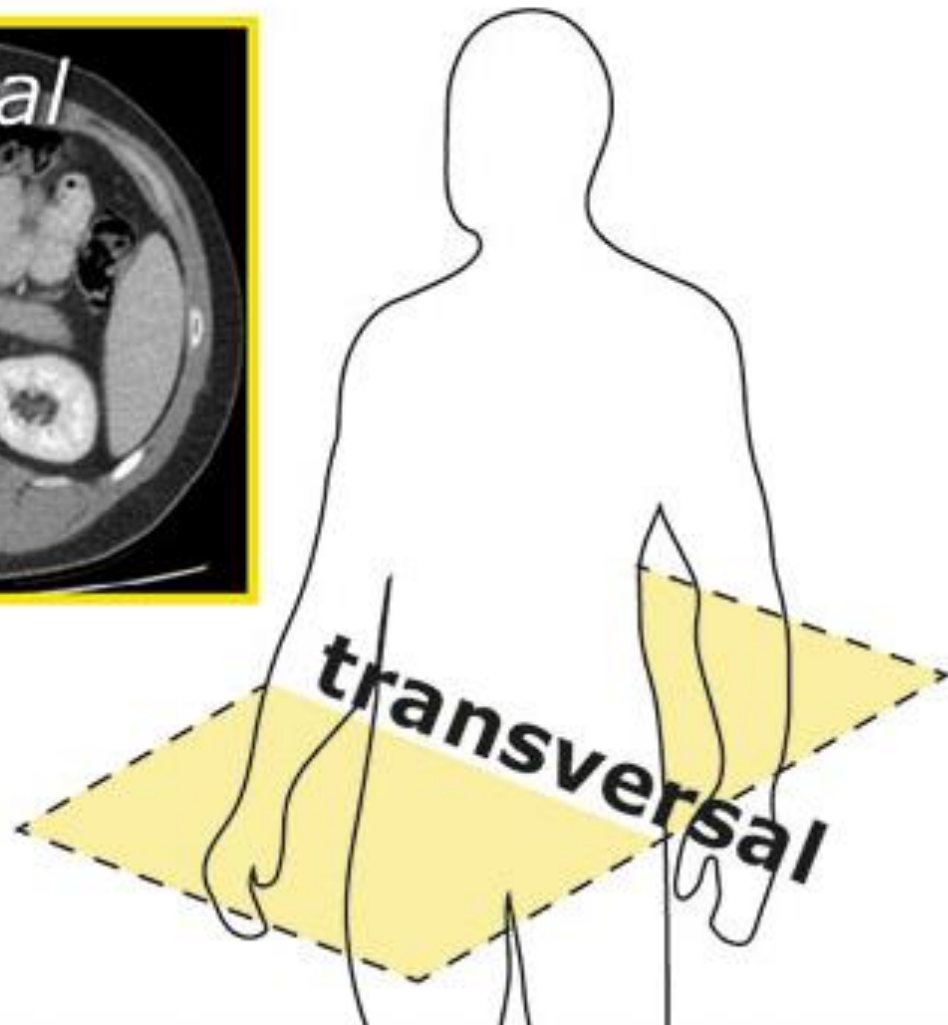
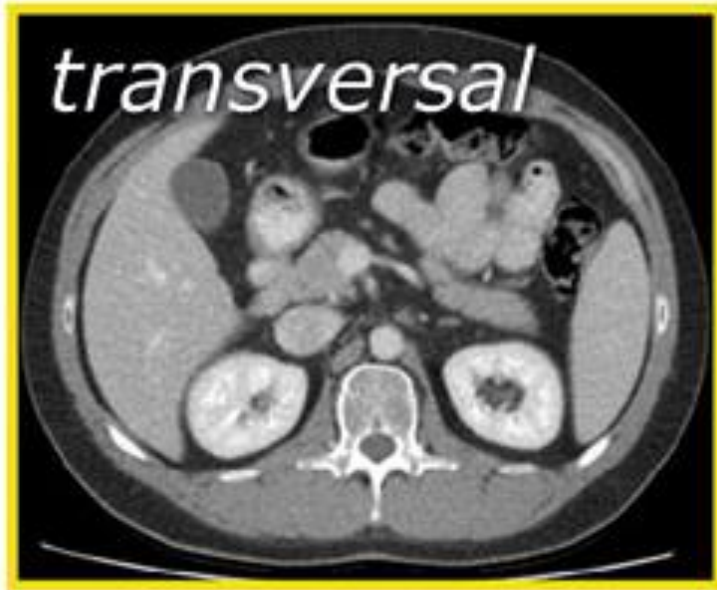
IMAGING APPROACH IN ACUTE ABDOMEN

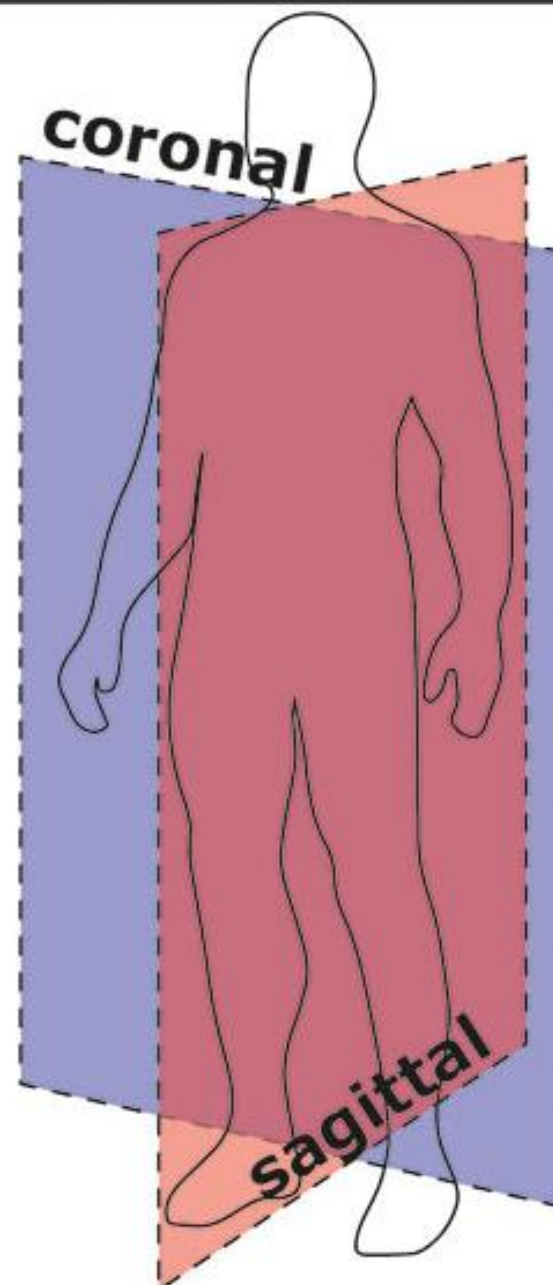


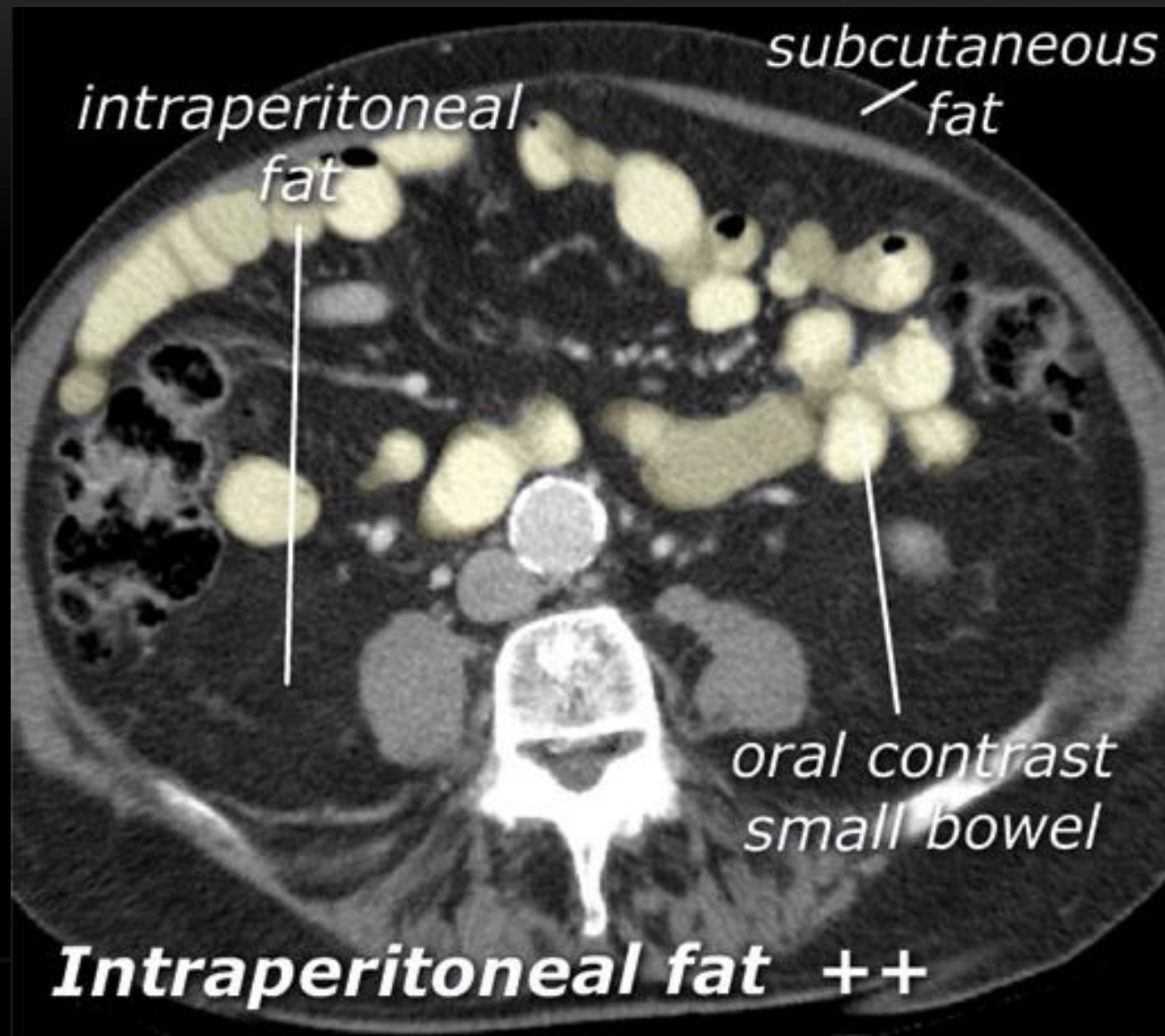
الدكتورة: رفيف تركاوي

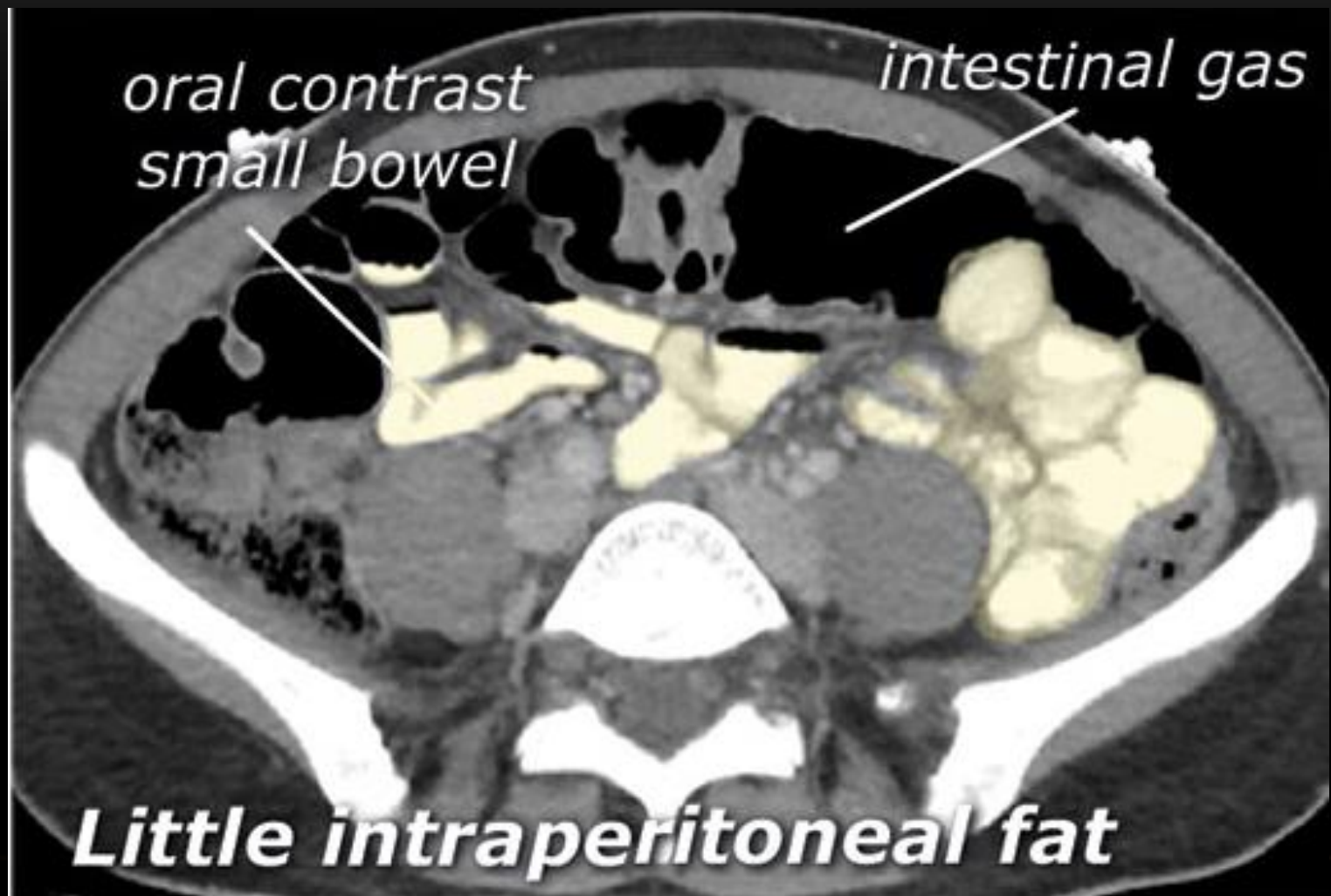
CT abdomen



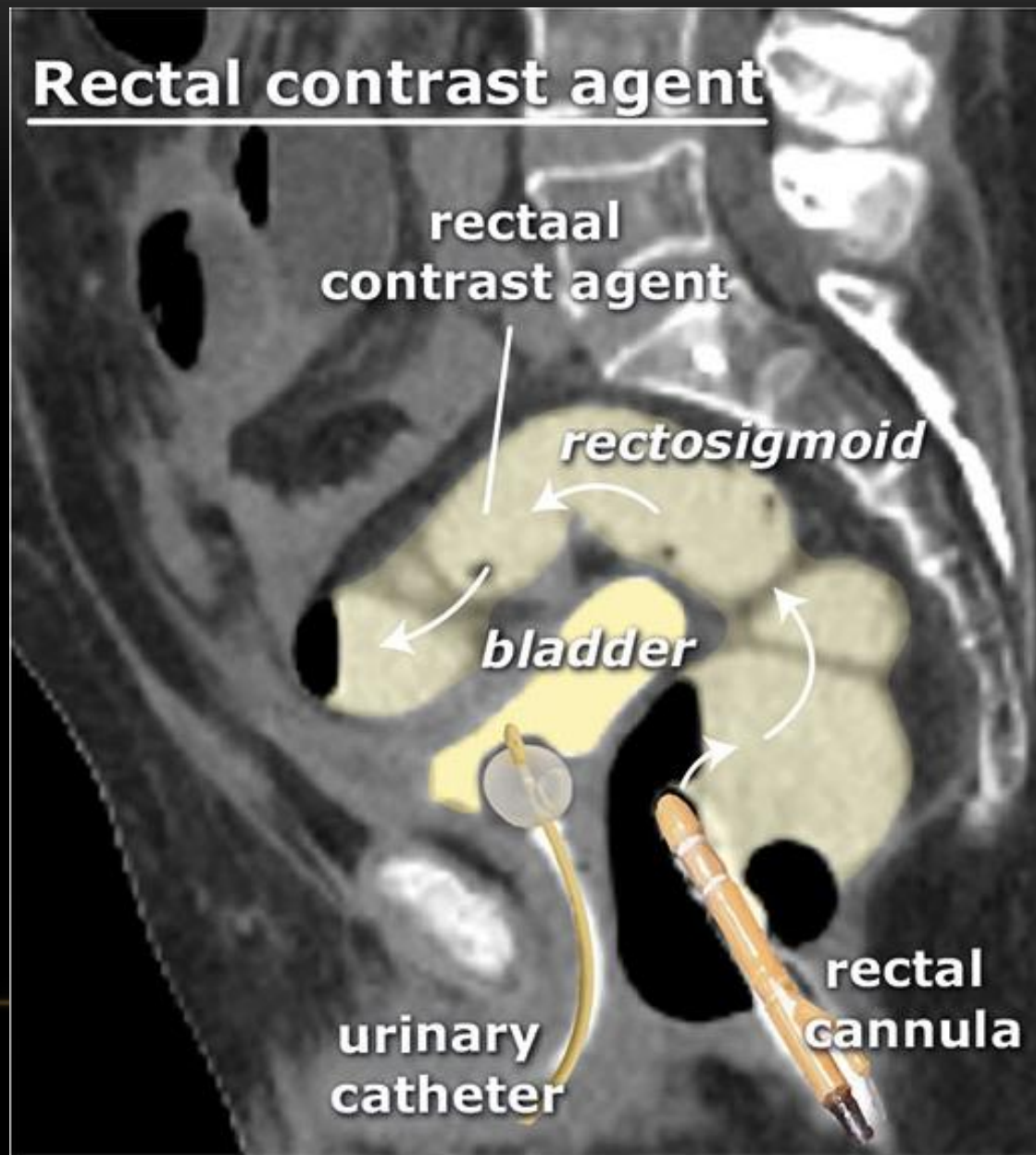




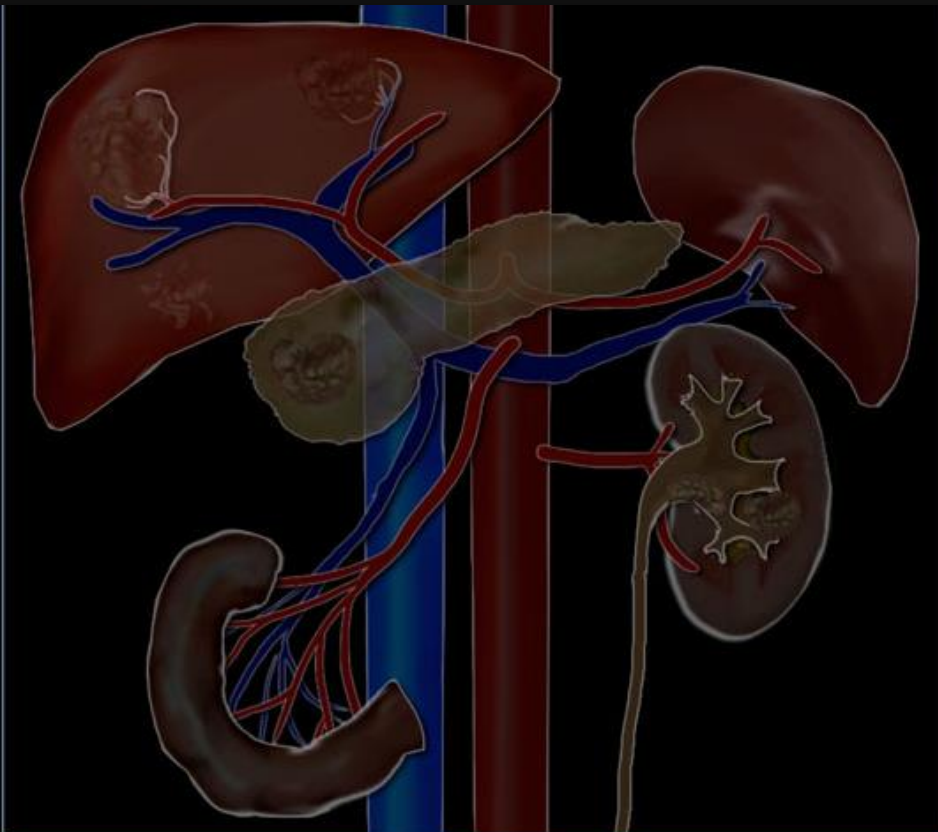




Rectal contrast agent



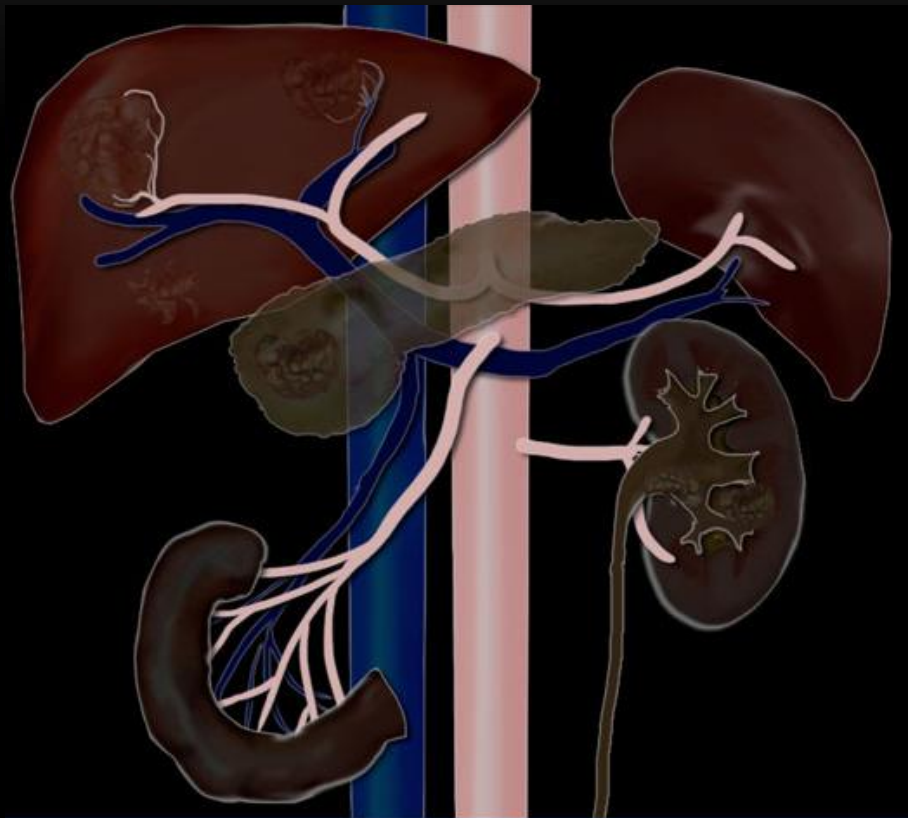
Phase	Time	Indications
No contrast	-	<i>Kidney/ureteral stones, arterial calcifications</i>
Arterial	<i>20 - 30 sec</i>	<i>Abdominal bleeding, aortic aneurysm, arterial stenosis/occlusions, hypervascular liver metastases, pancreas tumors</i>
Portal venous	<i>60 - 80 sec</i>	<i>Screening, hypovascular liver metastases, abscess formation, venous thrombosis</i>
Nephrogenic	<i>80 - 100 sec</i>	<i>Kidney tumors, kidney trauma</i>
Equilibrium /delayed	<i>6 - 10 min</i>	<i>Ureteral obstruction or leaks, characterization of liver tumors</i>



Non Enhanced CT

Detection of:

- Stones in kidney, ureter and sometimes in CBD
- Calcifications in liver, pancreas
- Fat in liver tumors
- Fat in adrenal adenoma or myelolipoma



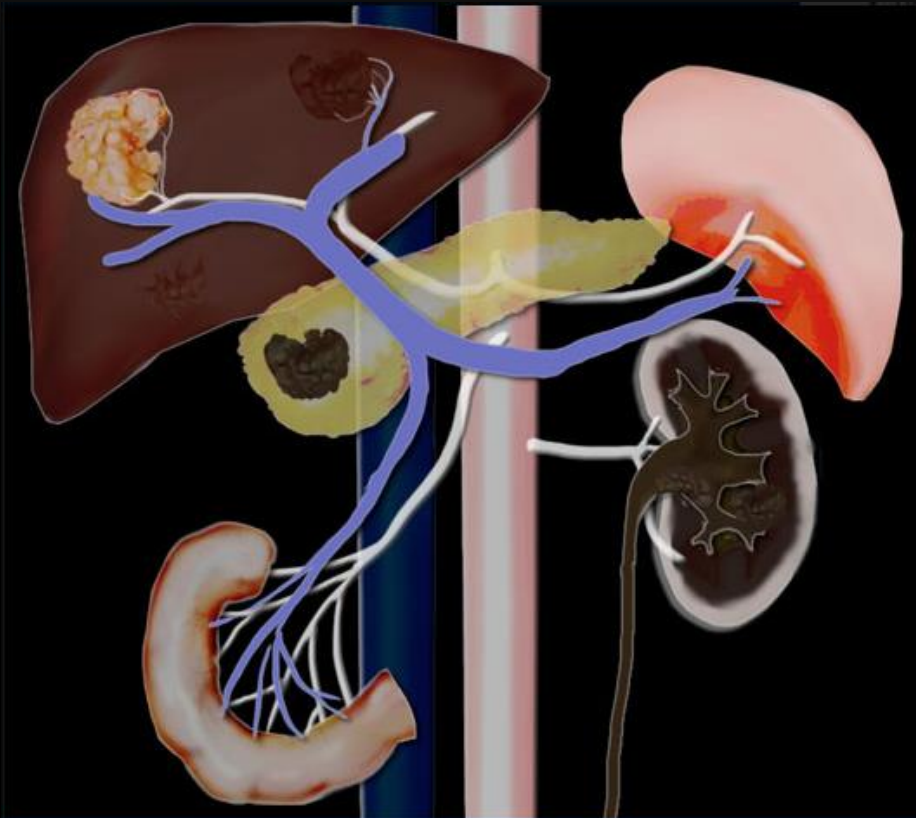
Early arterial phase

15-20 sec p.i.
or immediately
after bolustracking

Demarcation of vessels

Detection of :

- Dissection of aorta
- Arterial bleeding



Late arterial phase

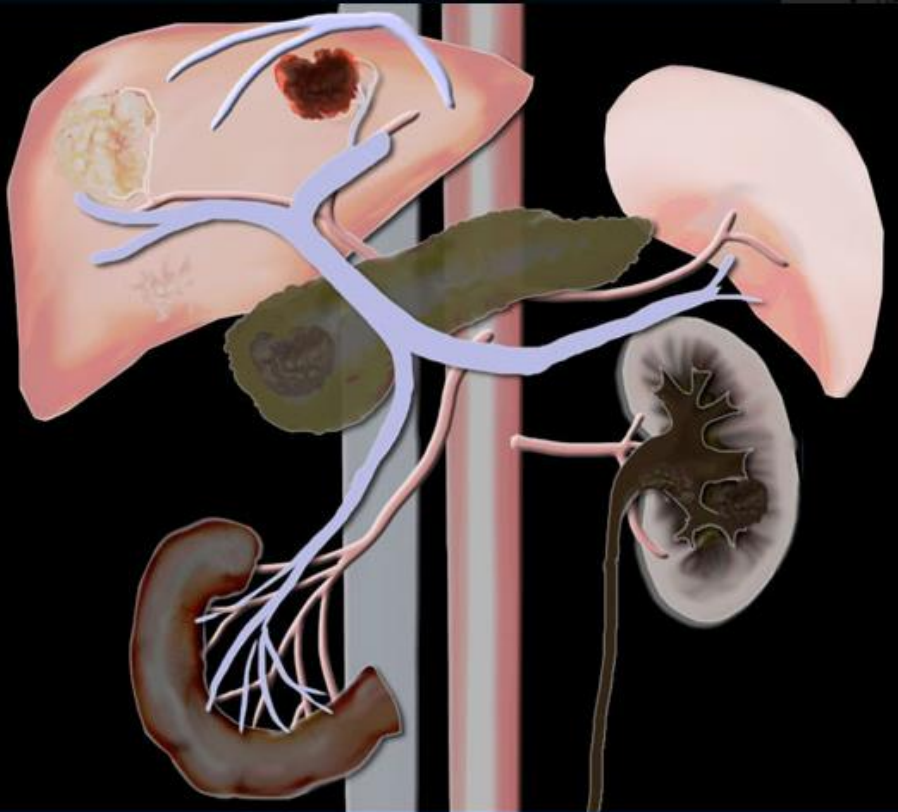
35-40 sec p.i.
or 20 sec after bolustracking

Enhancement of :

- hypervascular lesions
- stomach
- bowel
- pancreas parenchyma
- spleen
- kidney outer cortex

Detection of :

- Liver: HCC - FNH - Adenoma
- Pancreas: adenocarcinoma -
Insulinoma
- Bowel ischemia



Hepatic phase

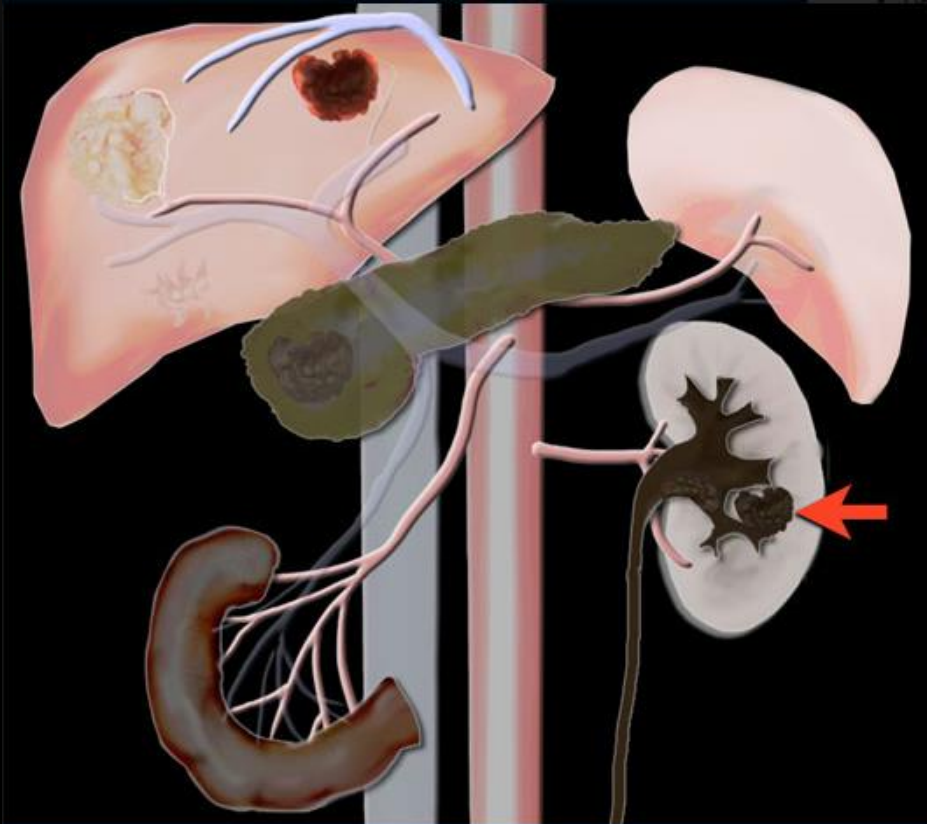
70-80 sec p.i.
or 50-60 sec after bolustracking

Enhancement of :

- Hepatic parenchyma

Detection of:

- Hypovascular liver lesions:
cysts, abscess, most
metastases



Nefrogenic phase

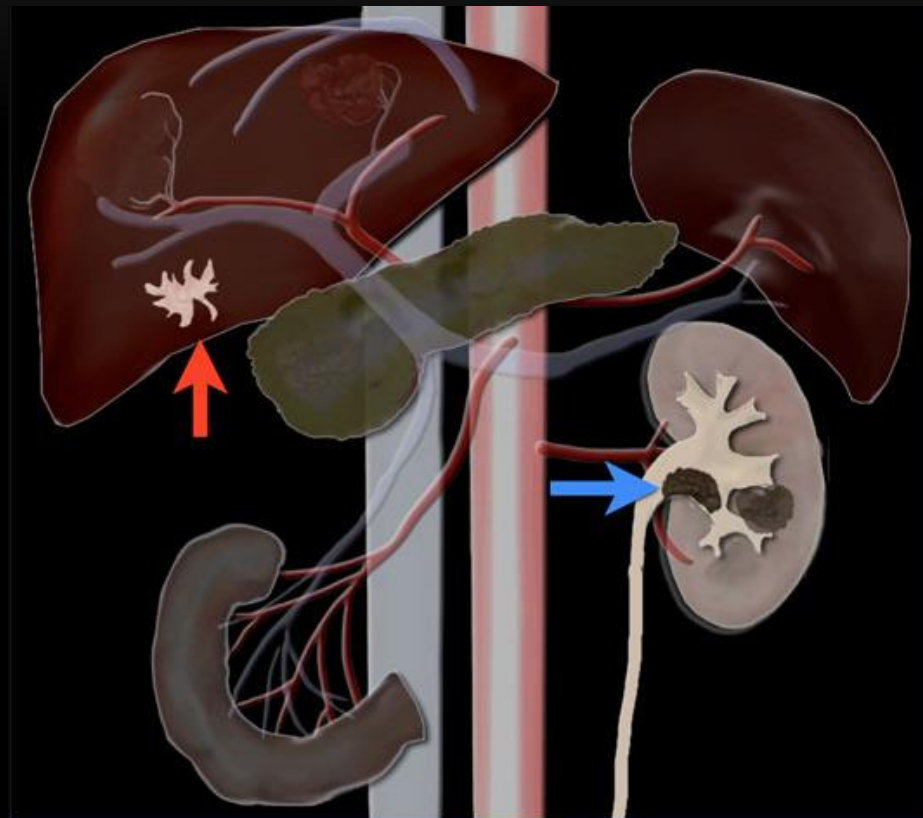
100 sec p.i.
or 80 sec after bolustracking

Enhancement of :

- All renal parenchyma including medulla

Detection of:

- Renal cell carcinoma (arrow)



Delayed phase

6 minutes p.i.
or 6 minutes after bolustracking

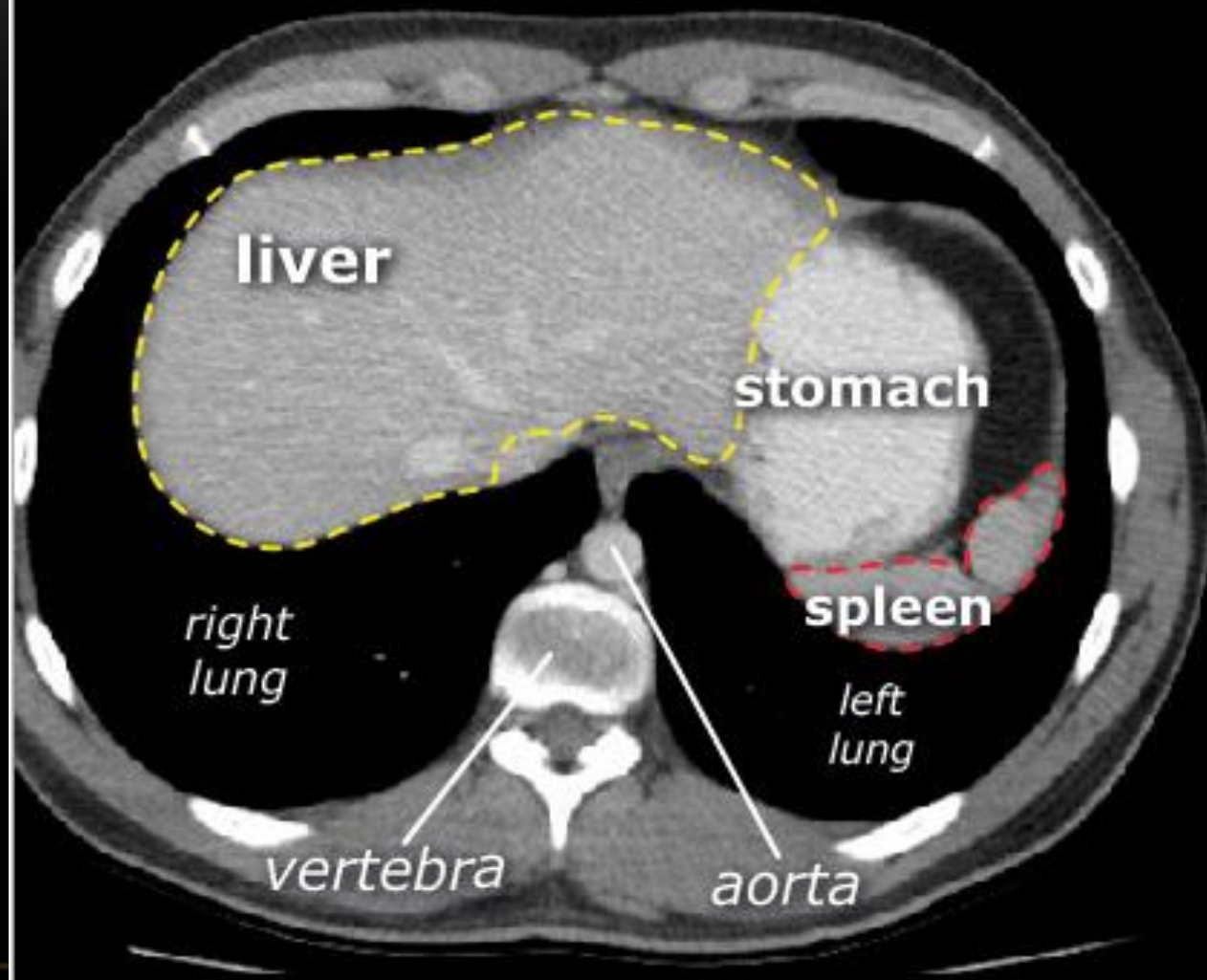
Enhancement of :

- fibrotic lesions
- still enhancement of kidney and urinary collecting system

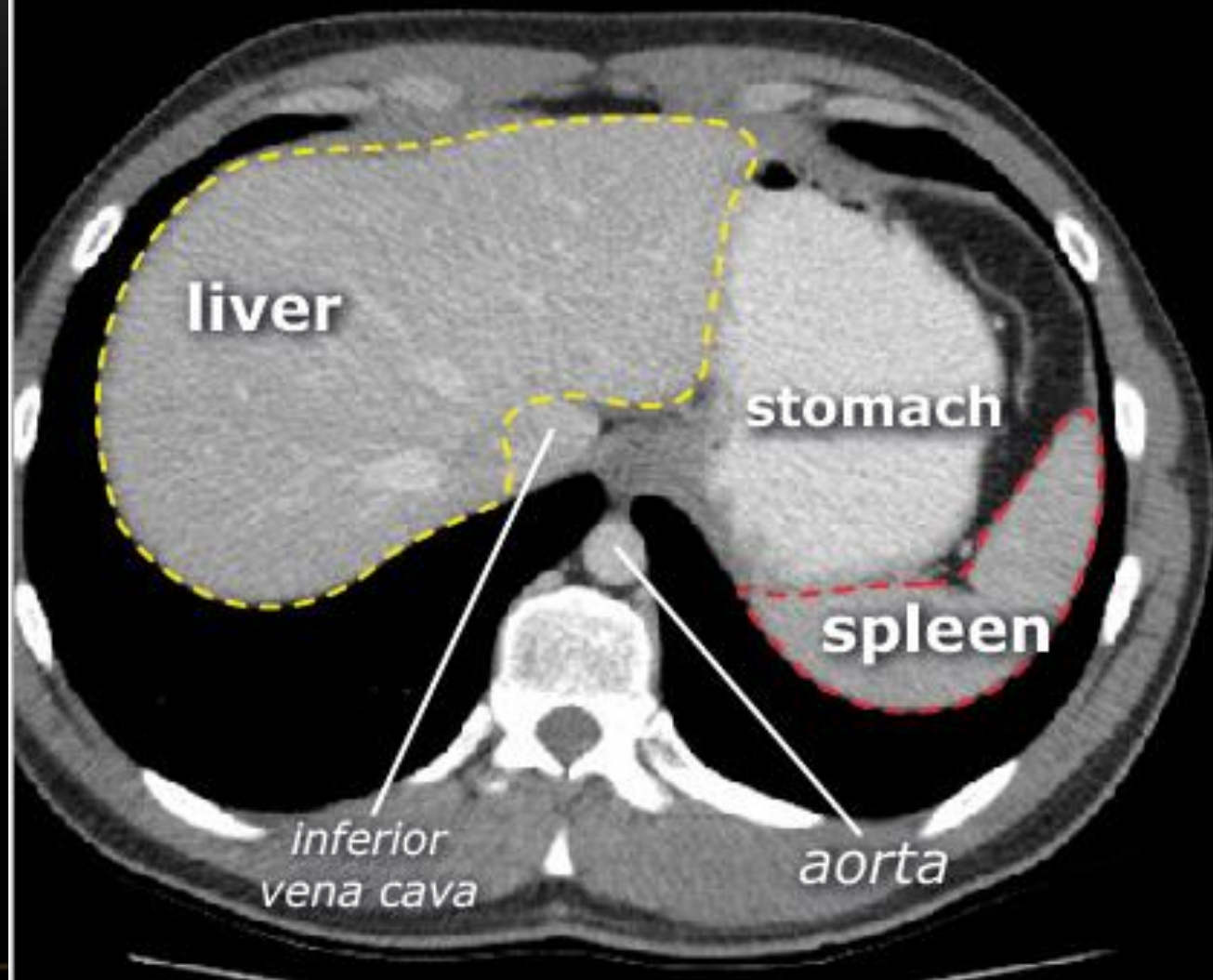
Detection of :

- Liver :
 - Cholangiocarcinoma (arrow)
 - Fibrotic metastases, most commonly breastcacer
- Kidney :
 - Transitional cell carcinoma (blue arrow)

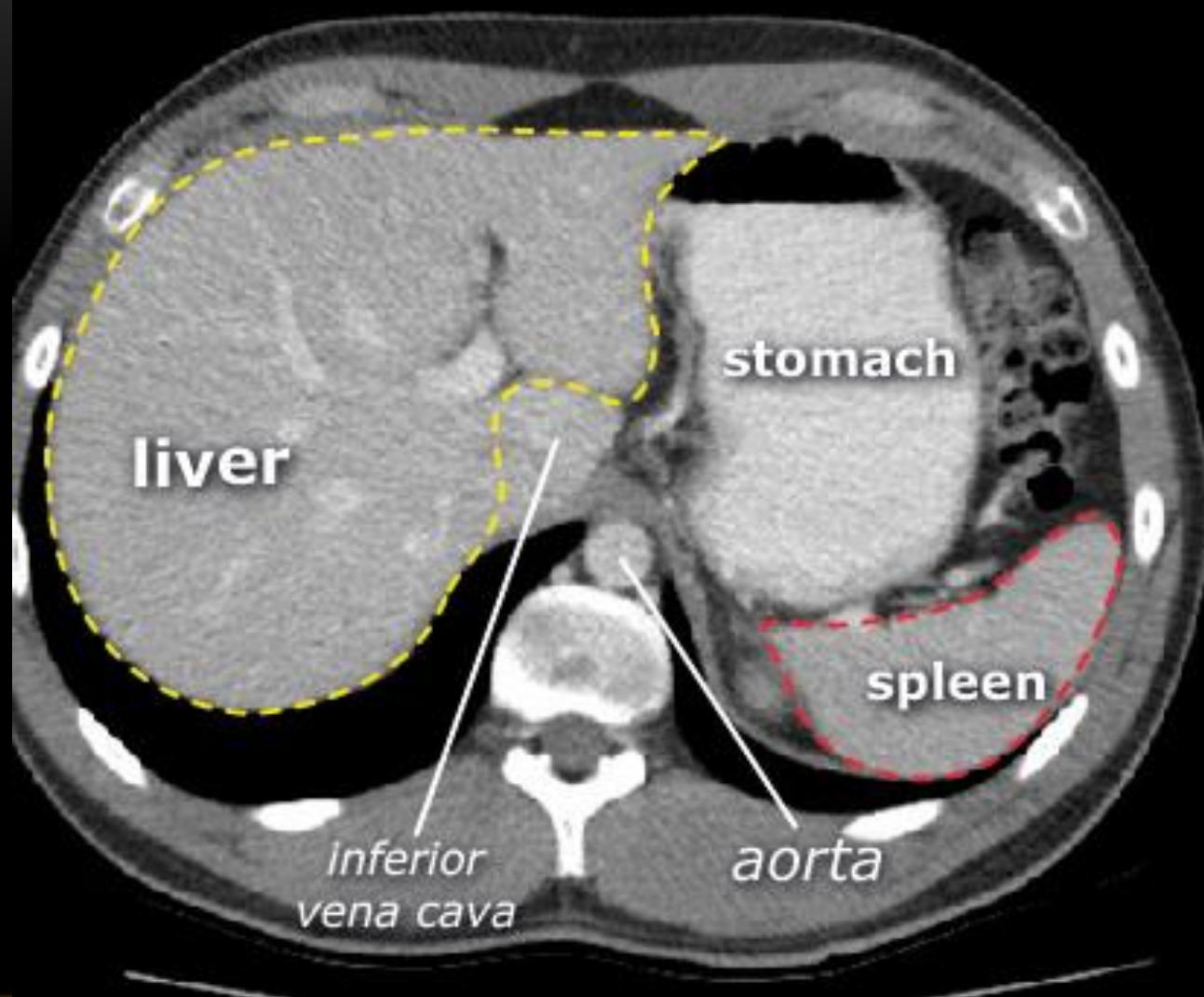
Normal abdominal CT



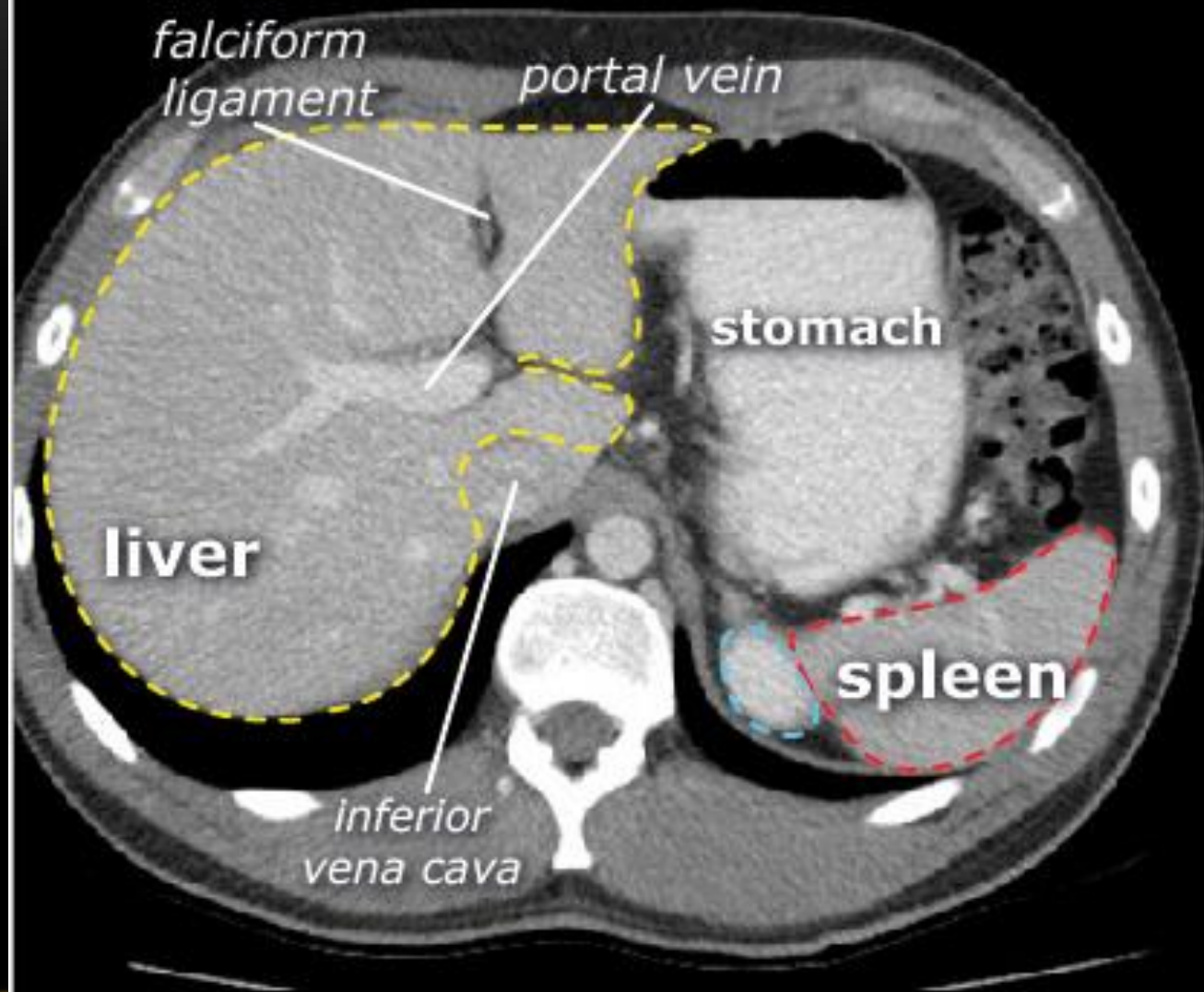
Normal abdominal CT



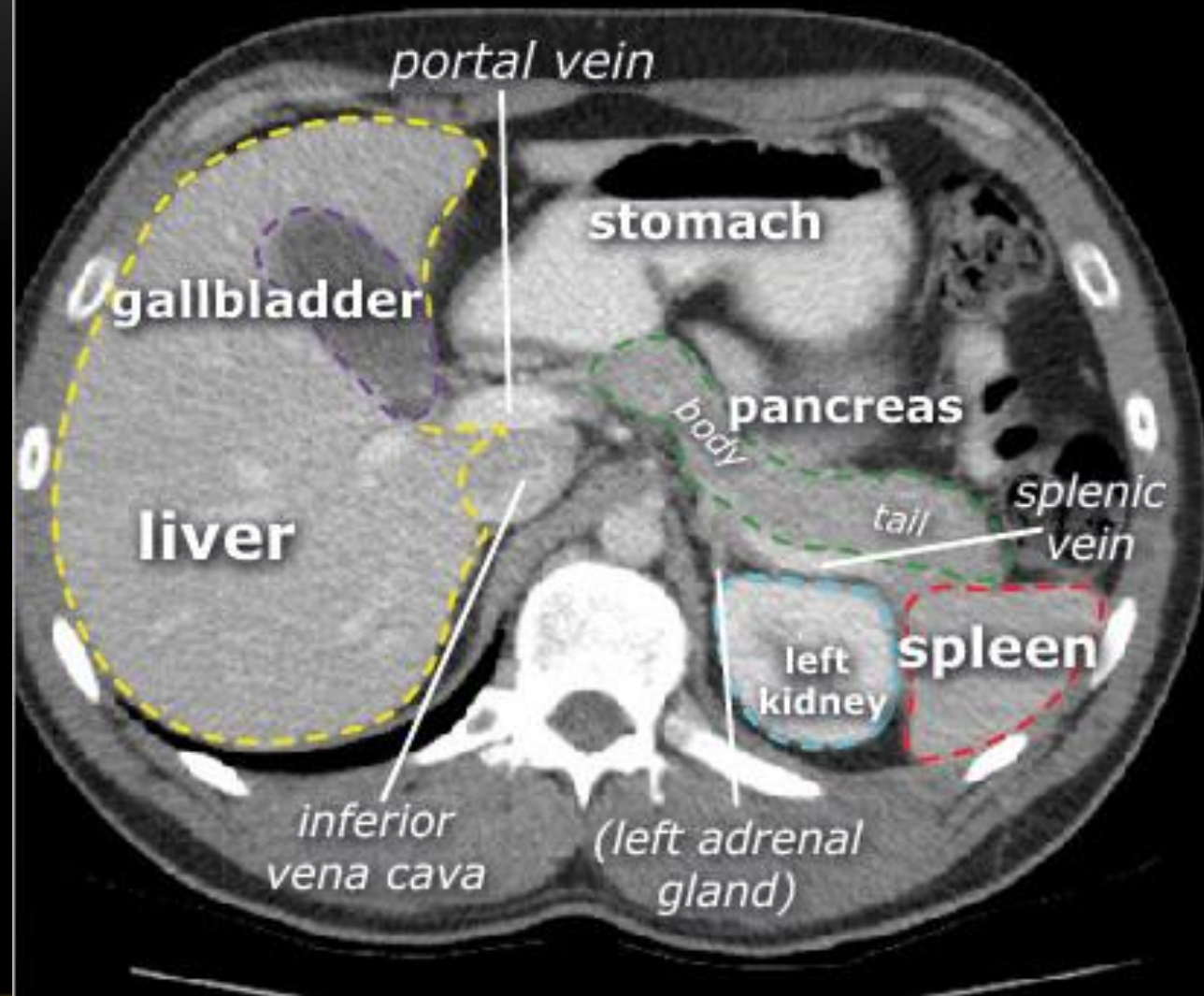
Normal abdominal CT



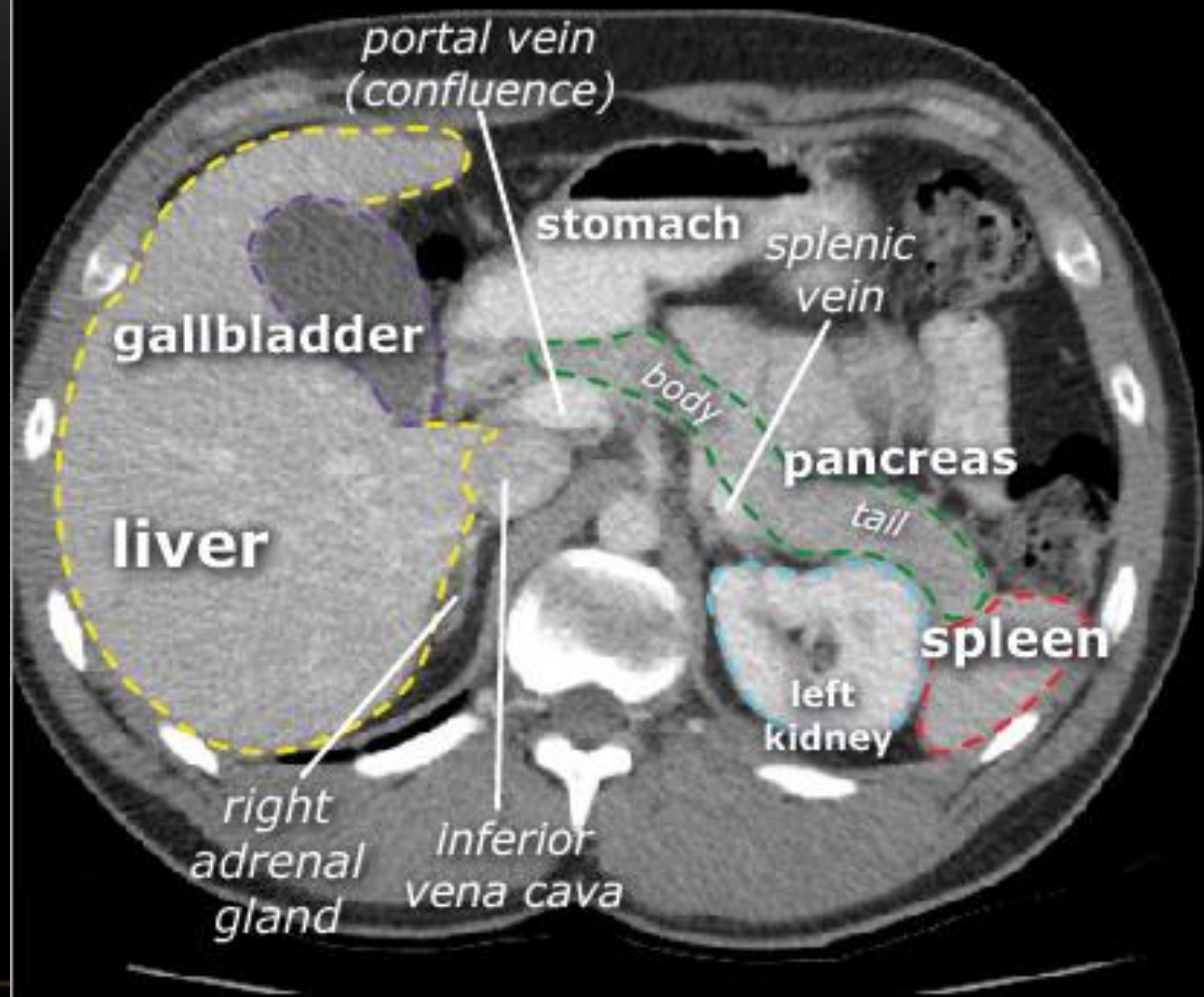
Normal abdominal CT



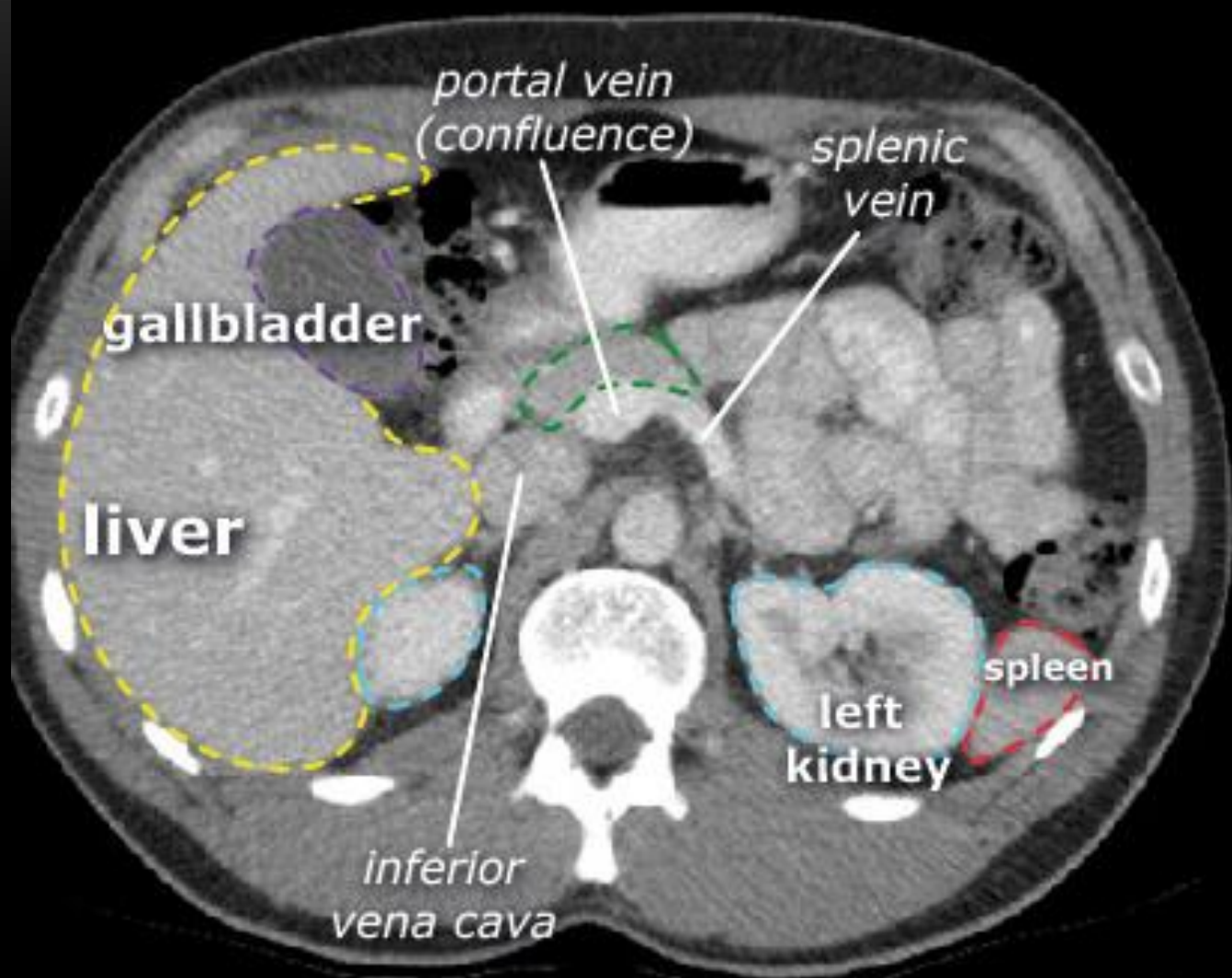
Normal abdominal CT



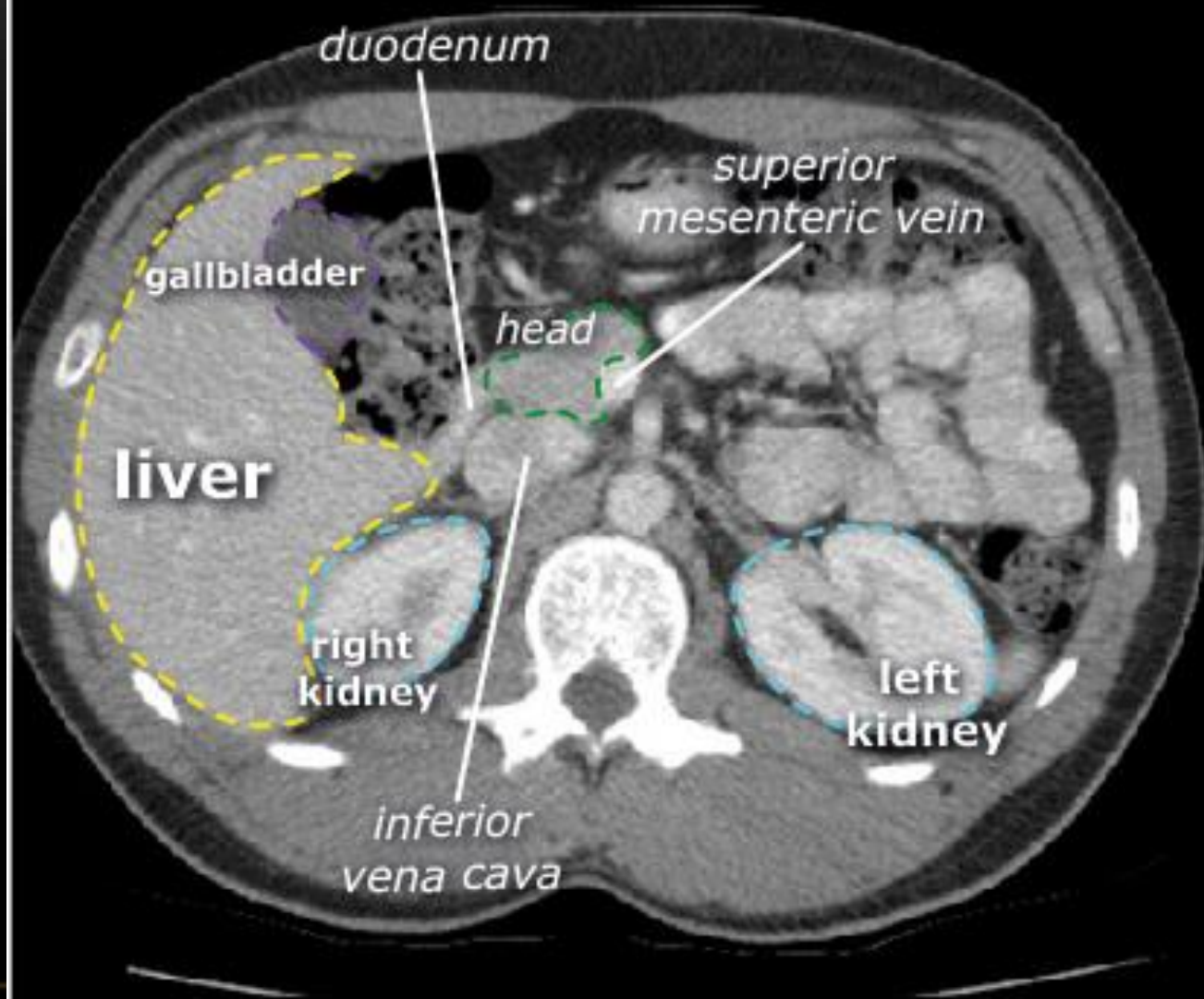
Normal abdominal CT



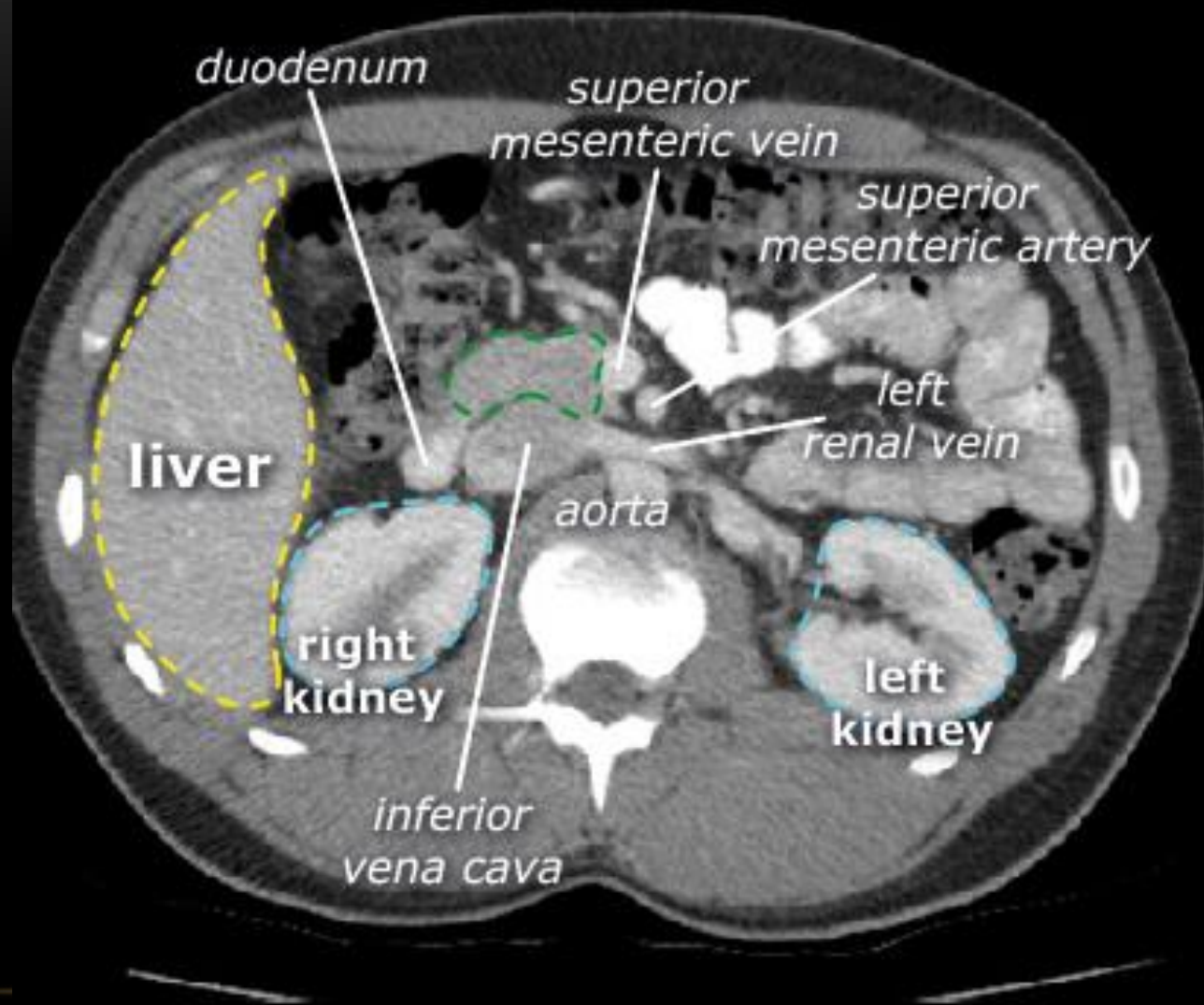
Normal abdominal CT



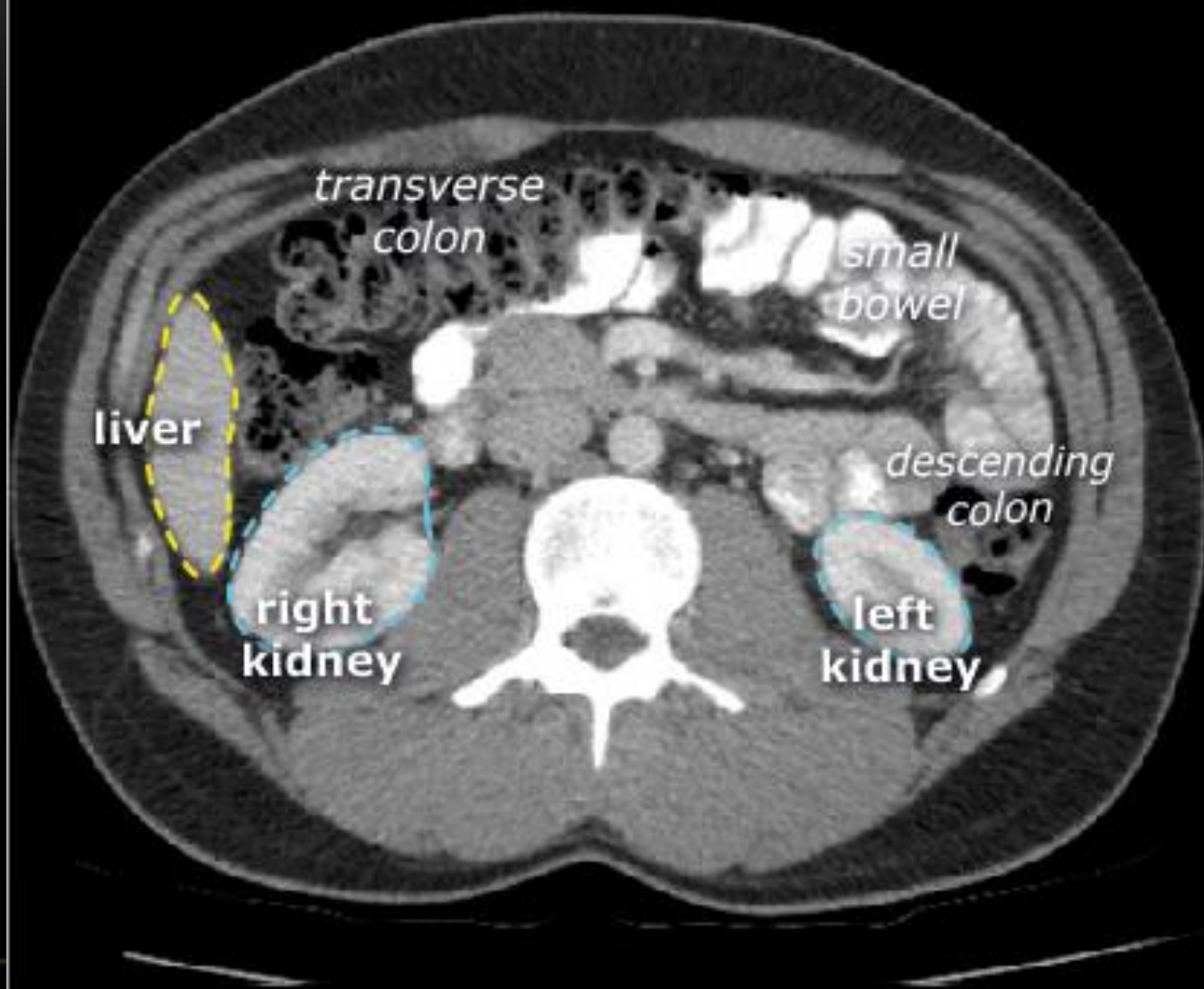
Normal abdominal CT



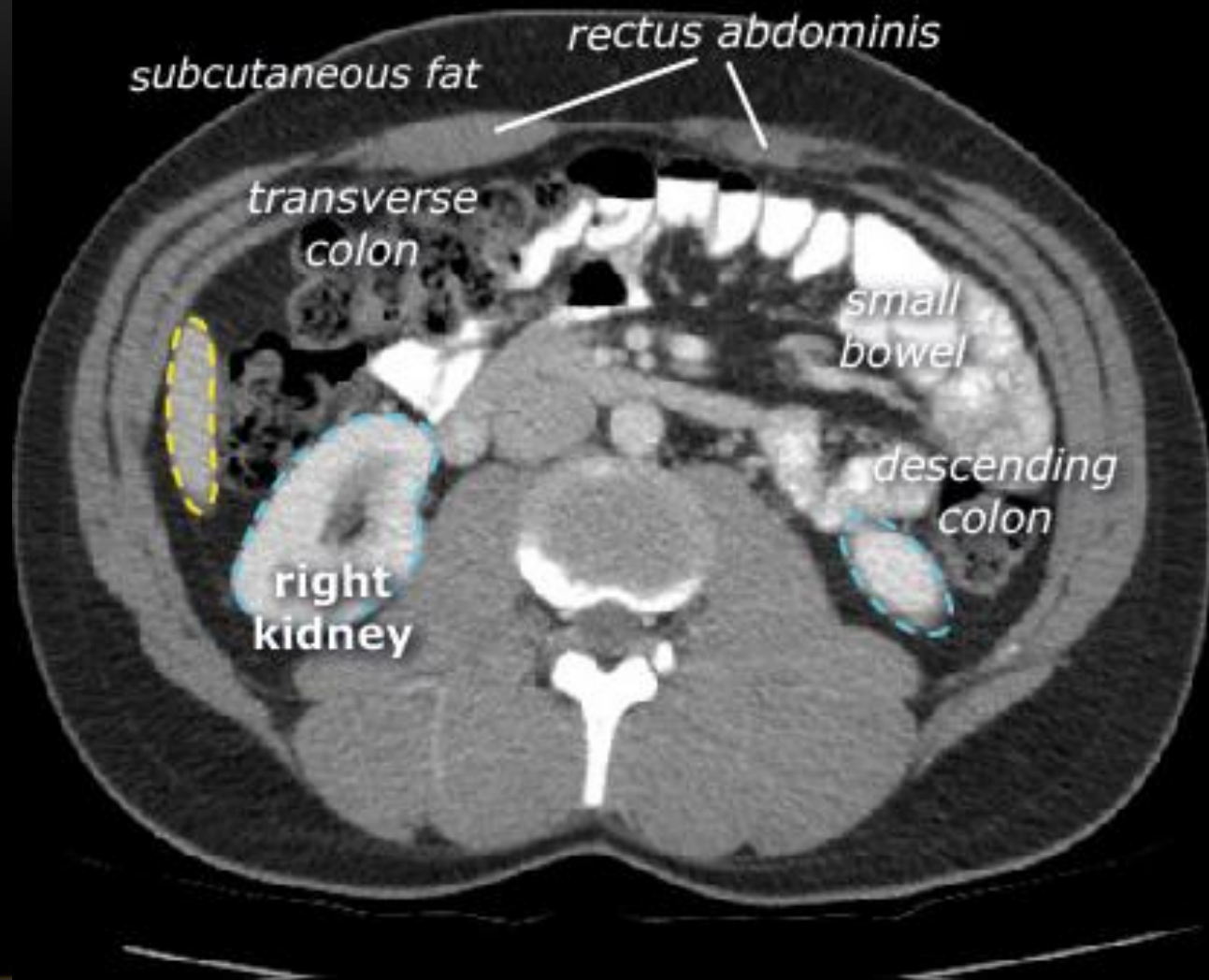
Normal abdominal CT



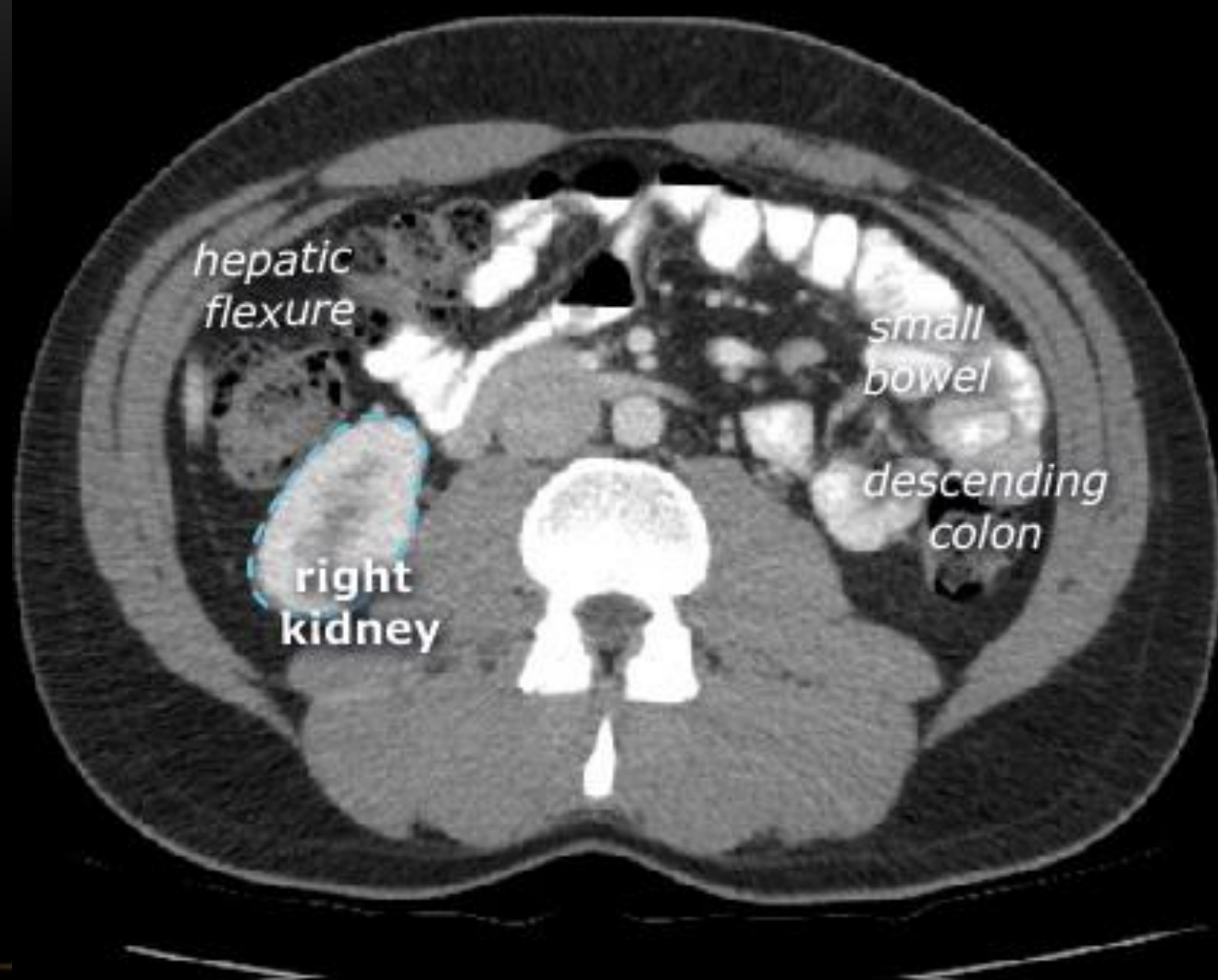
Normal abdominal CT



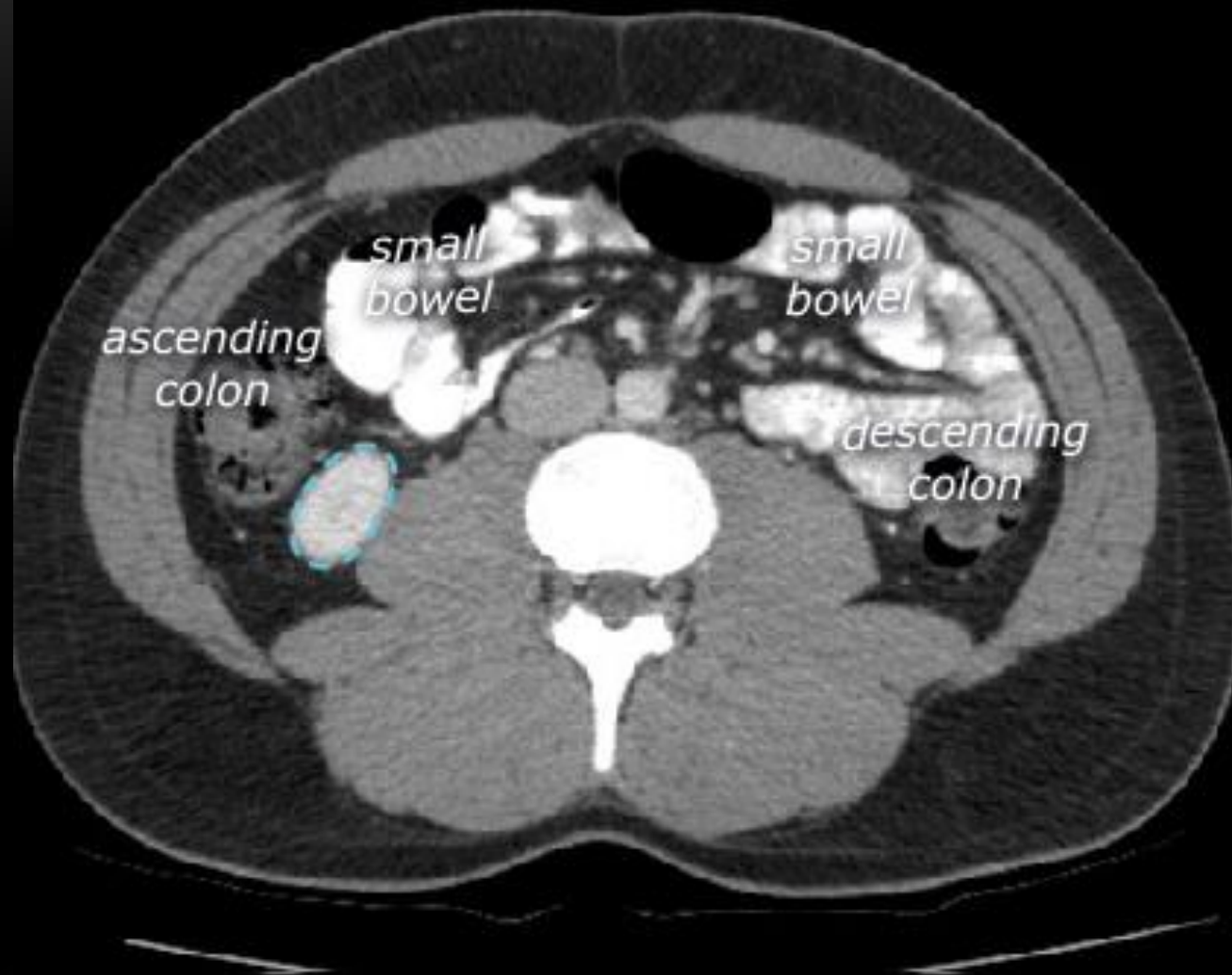
Normal abdominal CT



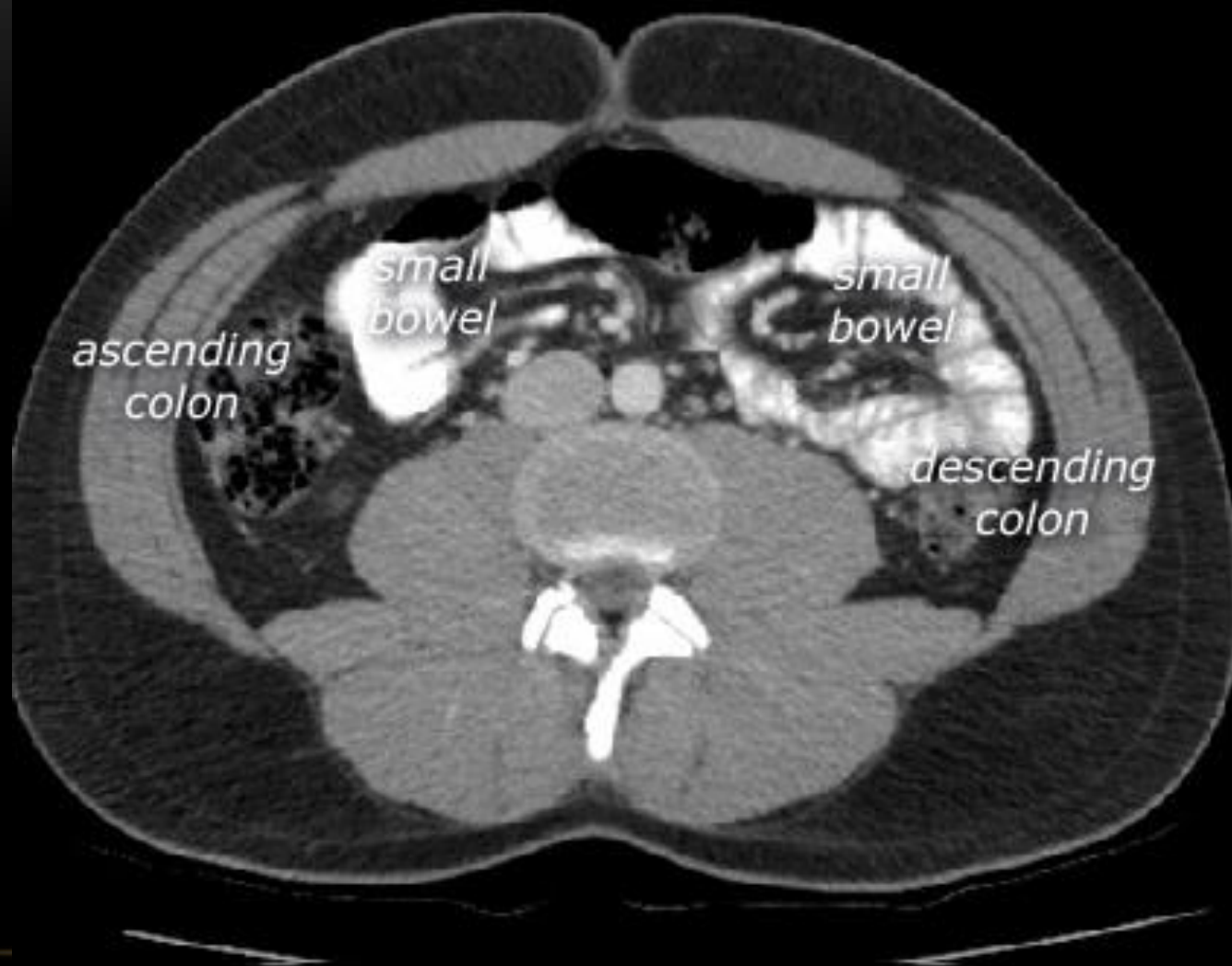
Normal abdominal CT



Normal abdominal CT



Normal abdominal CT



ACUTE ABDOMEN - PRACTICAL APPROACH

Natural history of frequent causes of an acute abdomen

Life-threatening



Self-limiting

Aortic aneurysm rupture
Pancreatitis
Bowel ischemia
Perforated peptic ulcer
Perforated diverticulitis

Appendicitis
Cholecystitis
Sigmoid diverticulitis
Salpingitis

Gastroenteritis
Lymphadenitis
Epiploic appendagitis
Omental infarction
Cecal diverticulitis

- Before imaging, clinical history, physical examination findings, top diagnosis and possible differentials have to be obtained.
- This helps in choosing the appropriate imaging modality as well as narrows down the area to be concentrated

Plain abdominal film

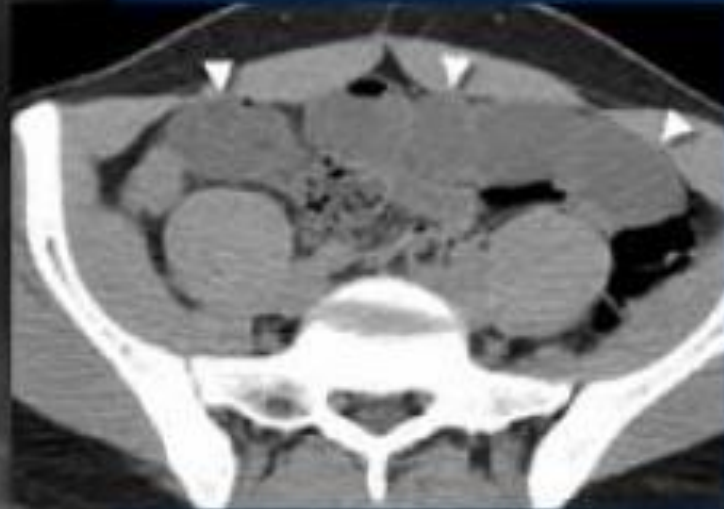
- Normal plain abdominal film does not exclude ileus or other pathology
- Plain abdominal film is useful for:
 - Kidney stone detection
 - Pneumoperitoneum detection
- All other indications: use Sonography or / and CT

Key to densities in AXRs

- Black—gas
- White—calcified structures
- Gray—soft tissues
- Darker gray—fat
- Intense white—metallic objects



- q The clarity of outlines of structures depends, on the differences between these densities.



LEFT: Plain abdominal film in a patient with an acute abdomen, showing no abnormalities. RIGHT: Subsequent CT shows distended small bowel loops (arrowheads) that are not seen on plain abdominal film because they are filled with fluid only and do not contain intraluminal air.

Confirm or exclude the most common disease

Location of pain determines strategy

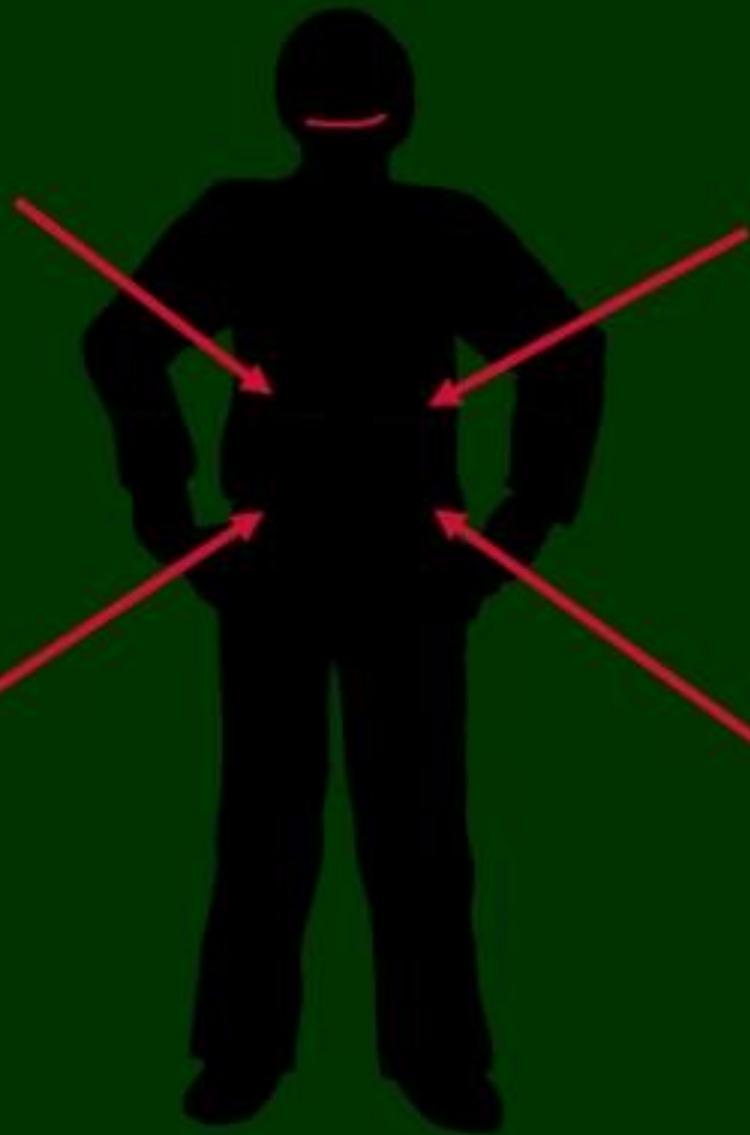
- Pain in RLQ: look for appendicitis
- Pain in LLQ: look for sigmoid diverticulitis
- Pain in RUQ: look for cholecystitis

Cholecystitis

**Pancreatitis
Ulcer**

Appendicitis

Diverticulitis



RLQ : Appendicitis

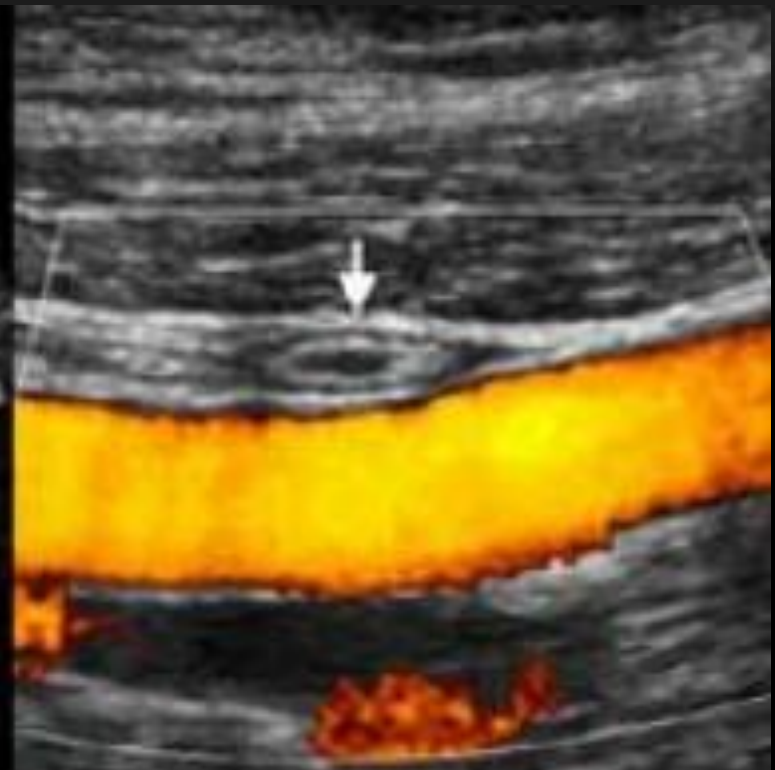
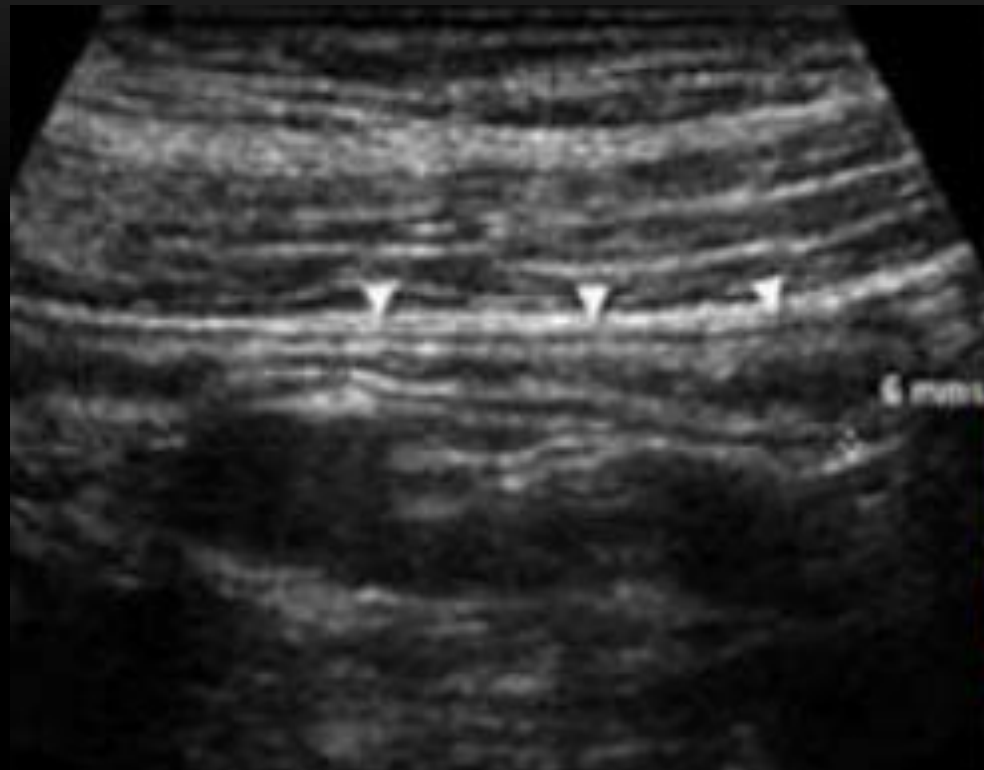
Pain in the RLQ, regardless of any other symptom or laboratory results, should be considered to be appendicitis until proven otherwise.

If you are unable to find the appendix you cannot rule out the diagnosis of appendicitis unless a good alternative diagnosis is found.

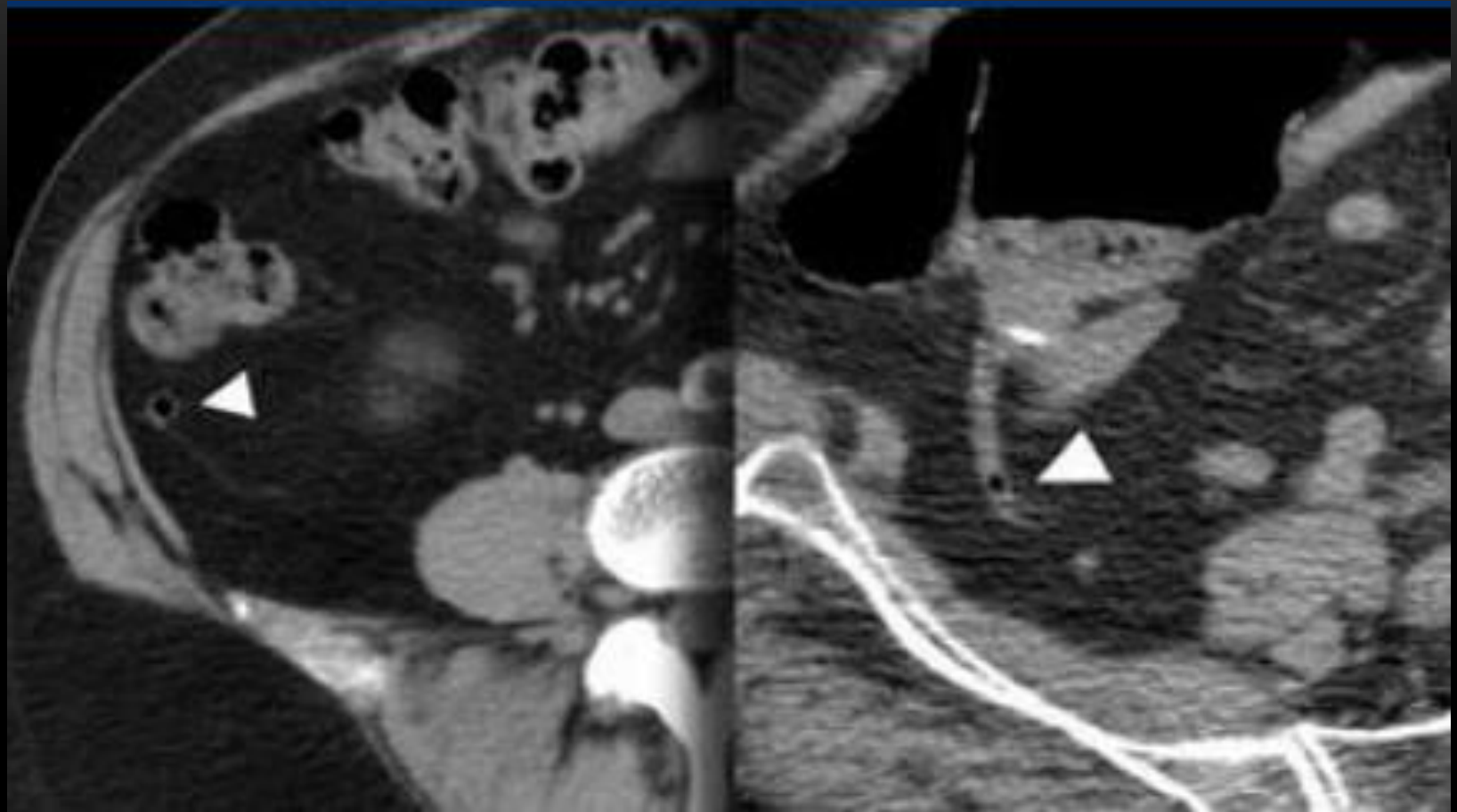
If you do not find the appendix and there is no alternative diagnosis call the results of the examination indeterminate. Do not call it: 'no appendicitis'.

Signs of appendicitis

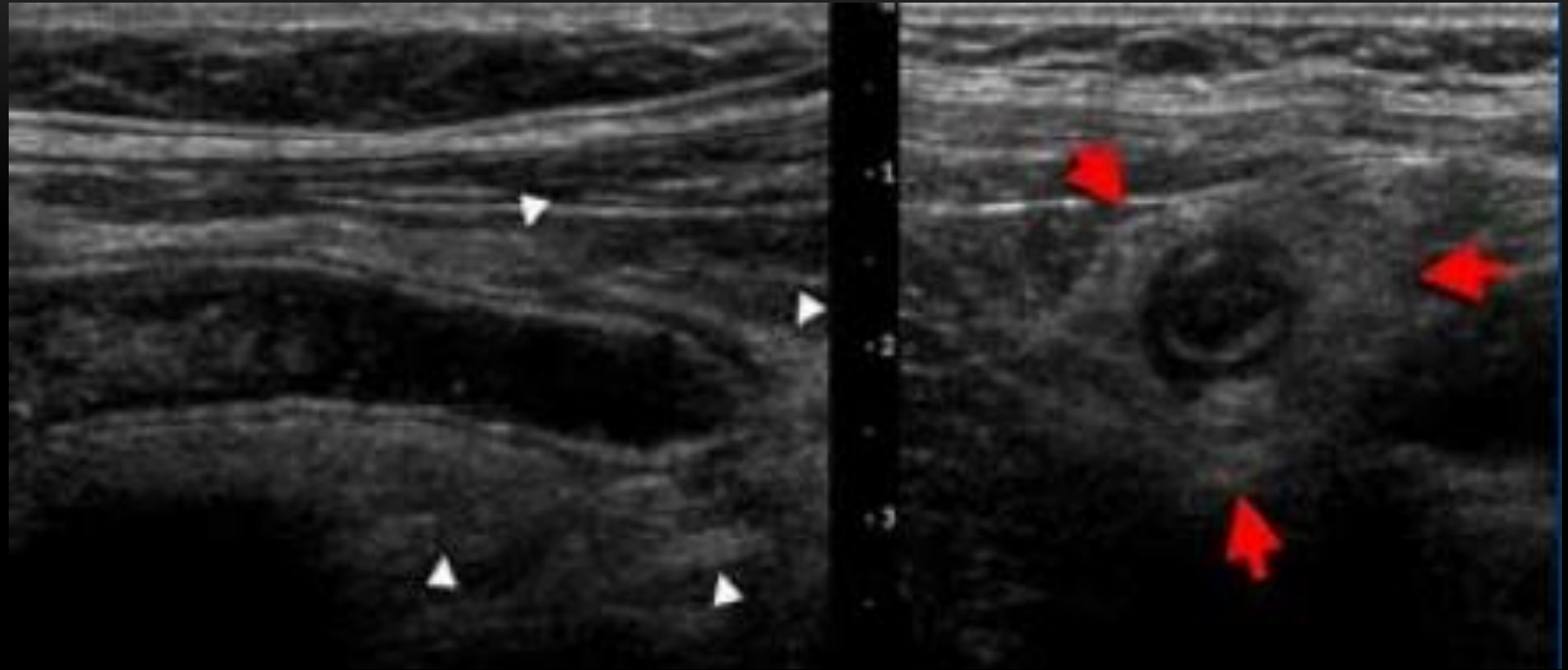
- Outer-to-outer diameter >6mm
- Inflamed periappendiceal fat
- Fecolith
- Hypervascularity on power Doppler



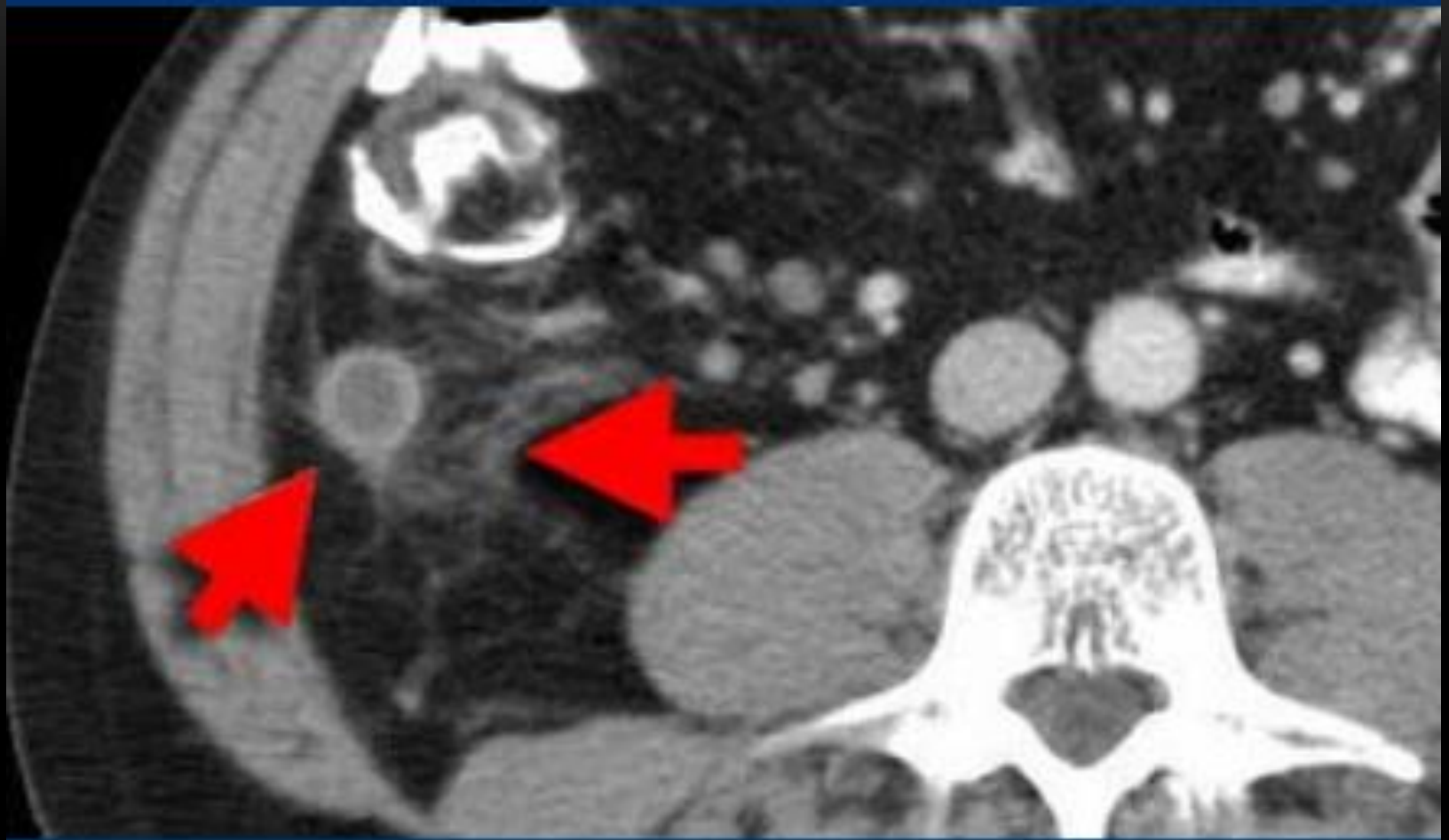
Normal appendix : Longitudinal (A) sonogram depicts a blind-ending tubular structure (arrowheads) with 'gut-signature', with a maximum outer diameter of 6 mm, with noninflamed surrounding fat. On an axial view (B) the appendix can be compressed crossing the iliac vessels.



Normal appendix: CT shows an air-containing non-distended appendix (arrowheads), with homogeneous low-density periappendiceal fat.



Inflamed appendix at sonography. Longitudinal (A) and transverse (B) cross-section show a distended noncompressible appendix, surrounded by hyperechoic inflamed fat (arrowheads).



Inflamed appendix at CT. The appendix (arrows) is fluid-filled and distended with periappendiceal fat-stranding.

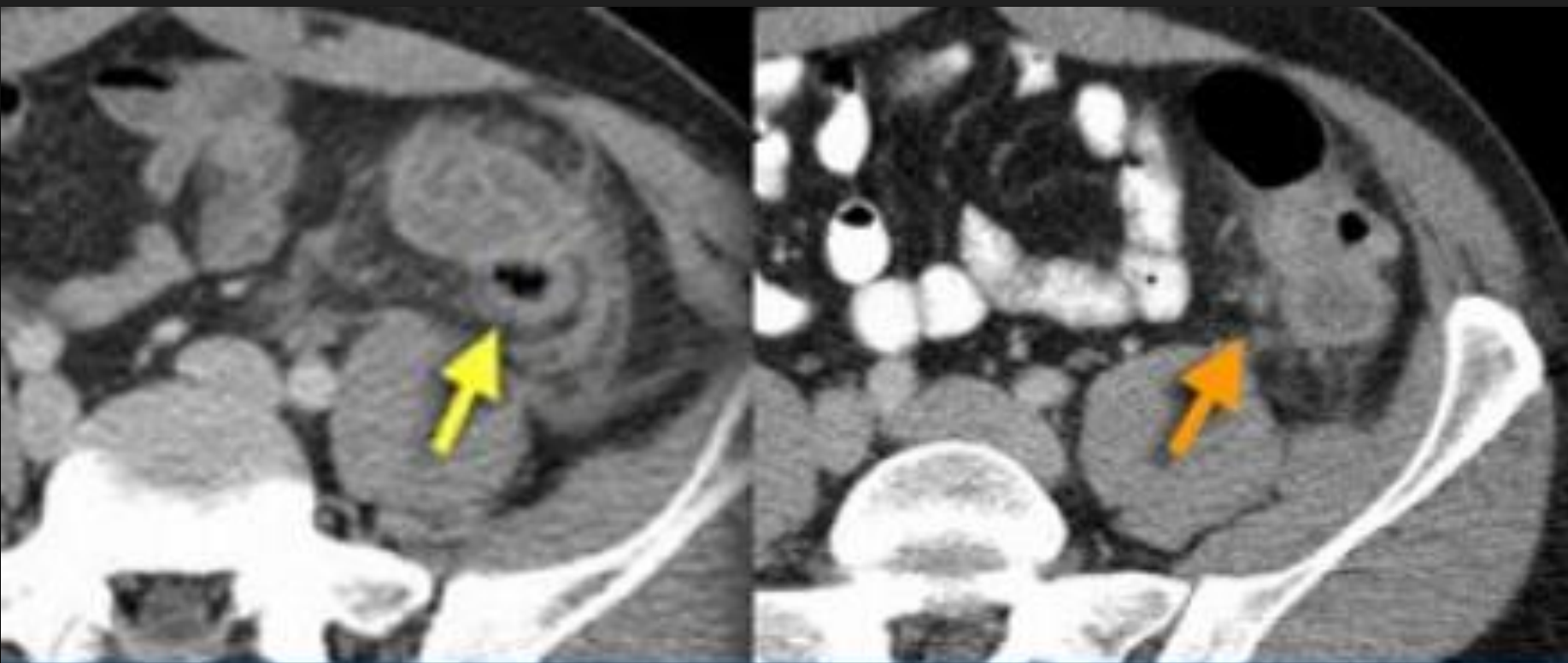
LLQ : Diverticulitis

If the pain is located in the LLQ your main concern is sigmoid diverticulitis.

In diverticulitis sonography and CT show diverticulosis with segmental colonic wall thickening and inflammatory changes in the fat surrounding a diverticulum.



Sigmoid diverticulitis at sonography. A hypoechoic thickened diverticulum is surrounded by hyperechoic inflamed fat (arrows).



LEFT: Sigmoid diverticulitis. Diverticulum (arrow) is surrounded by hyperattenuating fat. The sigmoid wall is thickened. RIGHT: Sigmoid carcinoma with limited fat stranding.

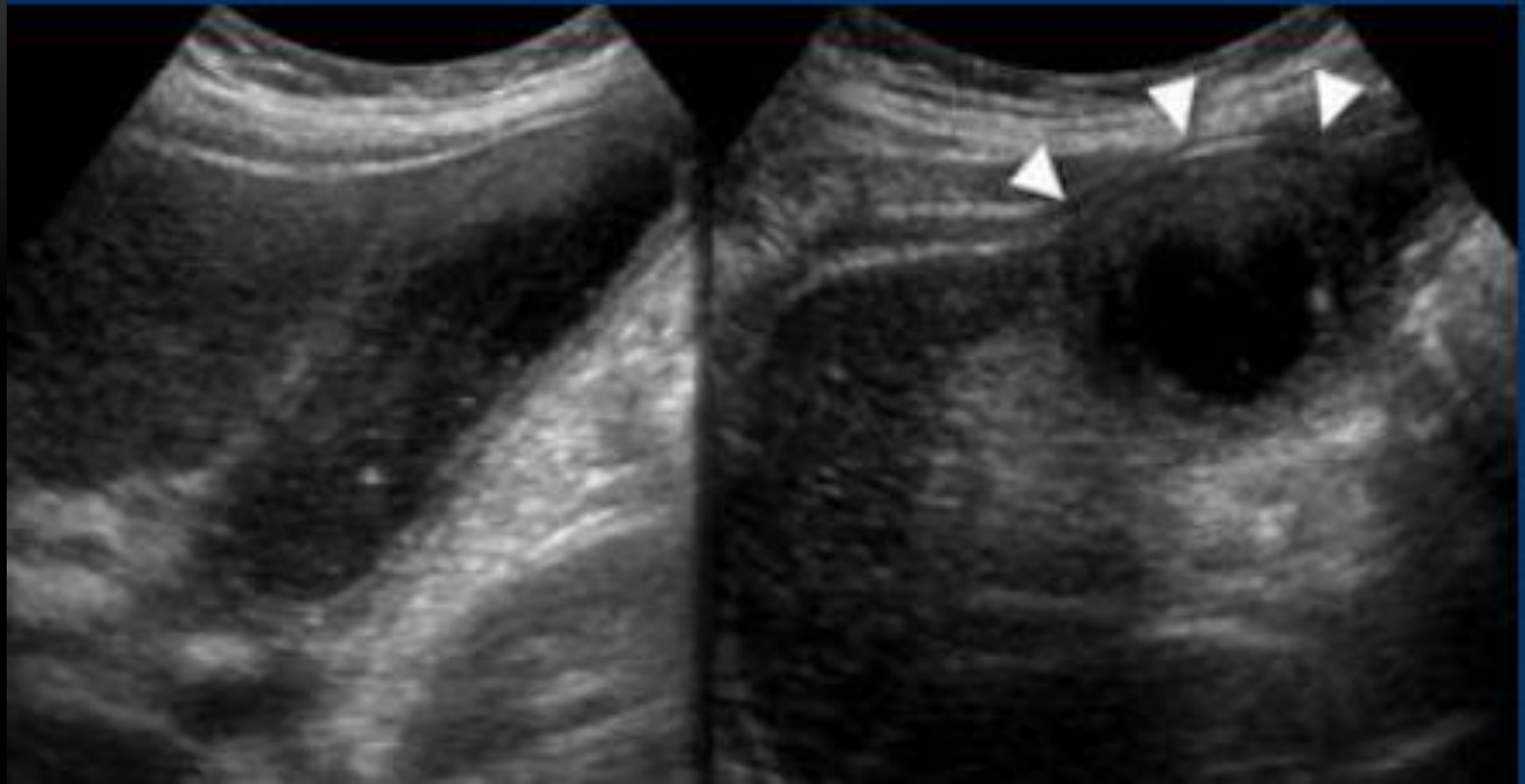
RUQ : Cholecystitis

Cholecystitis occurs when a calculus obstructs the cystic duct. The trapped bile causes inflammation of the gallbladder wall. As gallstones are often occult on CT, sonography is the preferred imaging method for the evaluation of cholecystitis, also allowing assesment of the compressibility of the gallbladder.

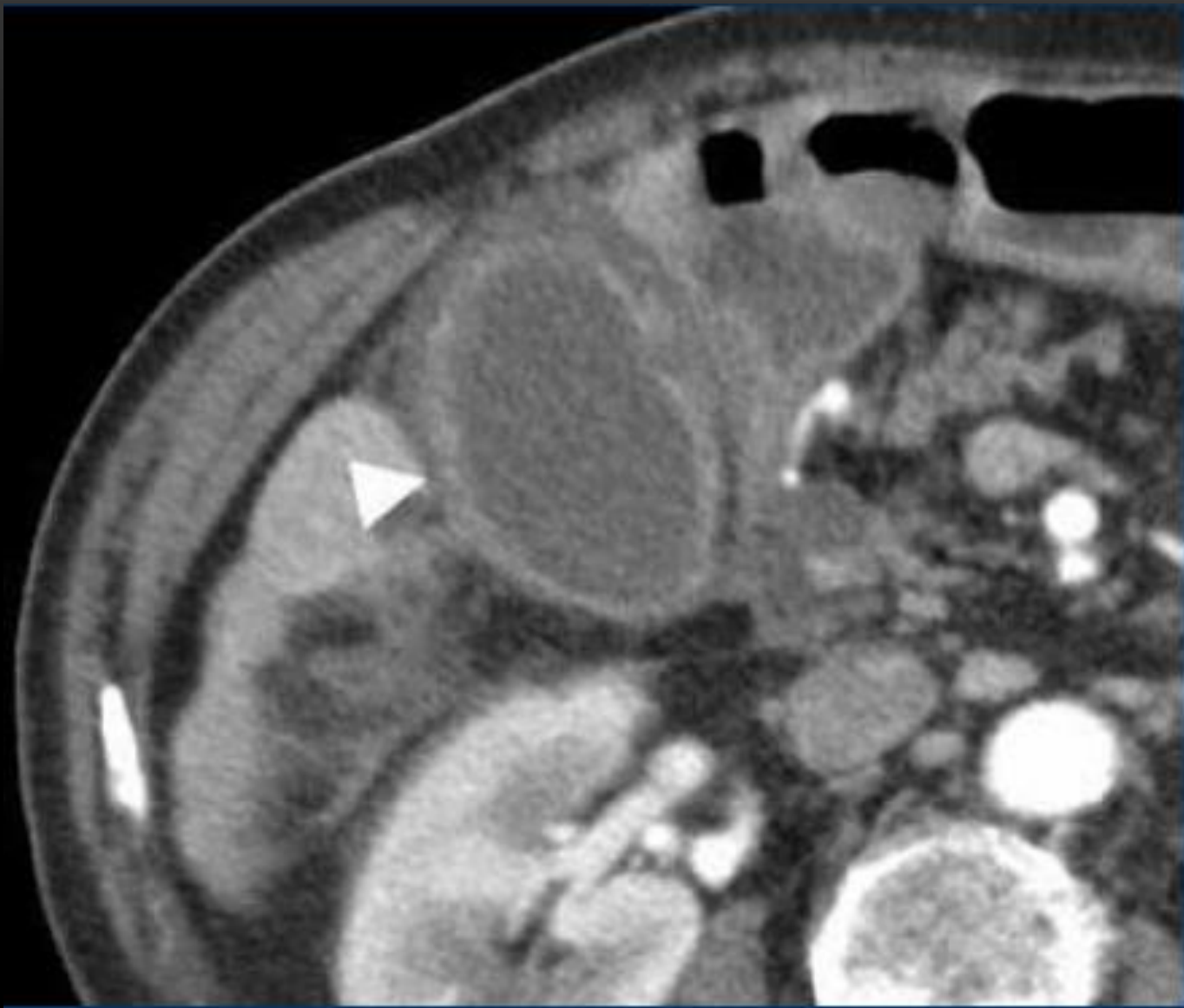
The diagnosis of a hydropic galbladder is solely made on the non-compressability of the galbladder. Do not rely on measurements. Some galbladders happen to be small and others are large.

Signs of cholecystitis

- Gallbladder wall thickening
- Hydropic gallbladder
- Positive Murphy sign



Longitudinal and transverse US show thickened gallbladder wall. The gallbladder is noncompressible ('hydropic') and causes an impression in the anterior abdominal wall (arrowheads).



Cholecystitis at CT. The gallbladder is enlarged with edematous thickening of its wall (arrowhead), and some regional fat-stranding can be found.

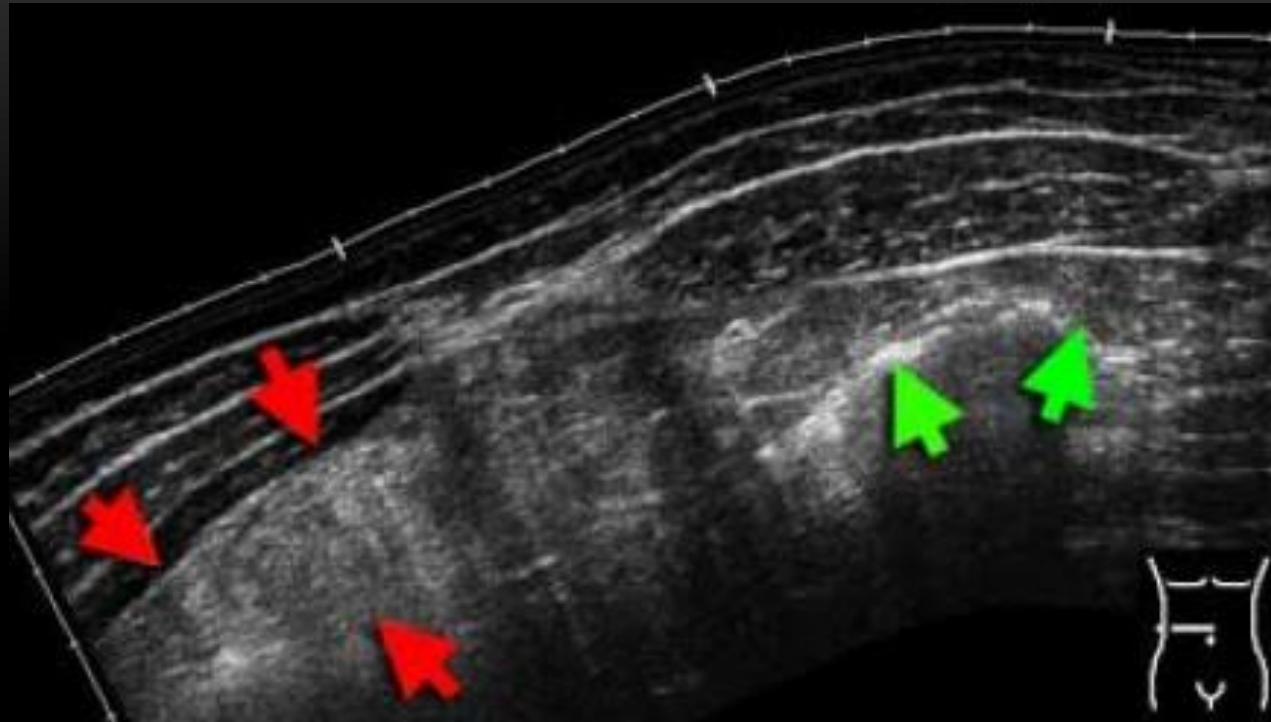
Pain in LUQ

An acute abdomen with LUQ pain is rare.

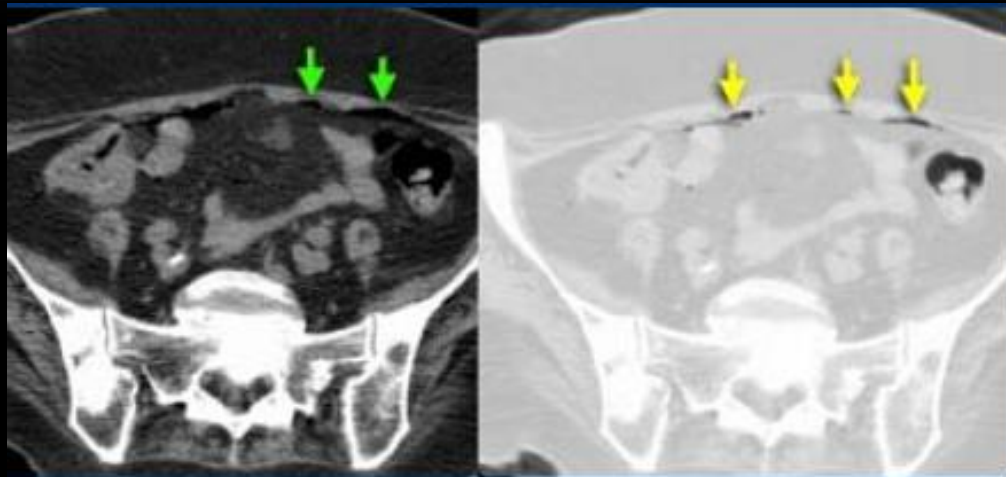
Its most common cause is gastric pathology in which radiological imaging plays a minor role.

Screening an acute abdomen

- Inflamed fat
- Bowel wall thickening
- Ileus
- Free fluid
- Free air



Inflamed fat at sonography. Extended-view of the ventral abdomen depicting an area of hyperechoic noncompressible inflamed fat in the omentum (red arrows). Compare this to the echogenicity of normal abdominal or subcutaneous fat (green arrows). This patient had an omental infarction.



Free air

The presence of free intraperitoneal air is proof of bowel perforation, and indicates a surgical emergency.

A pneumoperitoneum has only two frequent causes:

- Perforation of a gastric ulcer
- Perforation of colonic diverticulitis

Free air is usually not seen in perforated appendicitis).

Always examine the images in lungsetting for better detection of free intraabdominal air (figure).

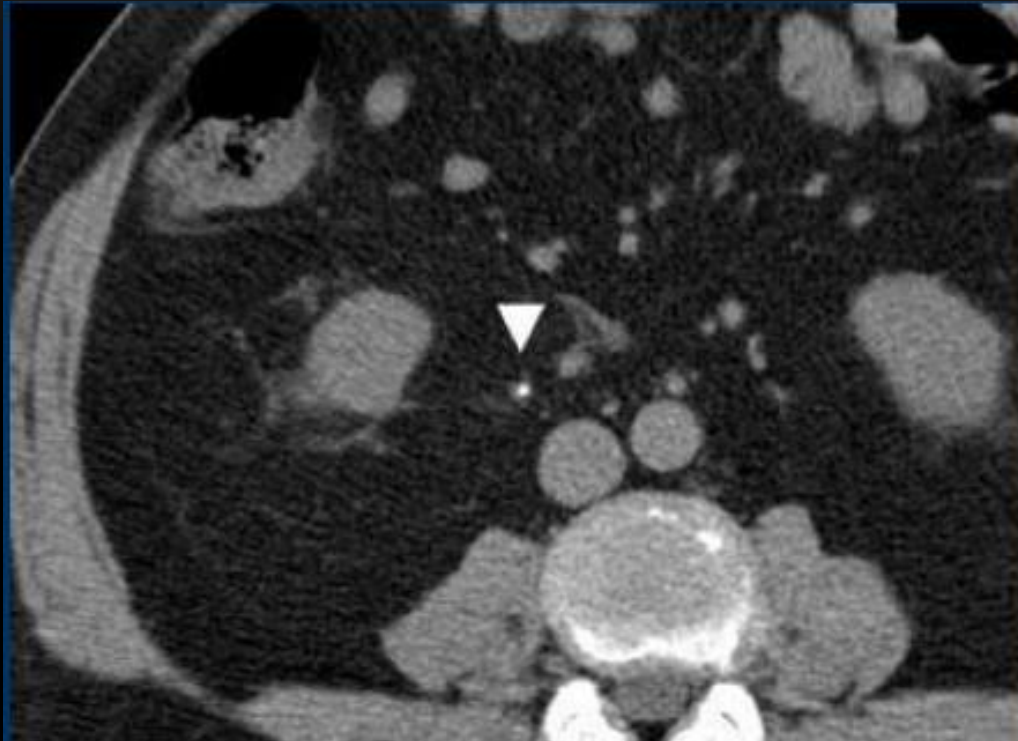
Intraperitoneal air in a patient suspected of having appendicitis. Air better seen on images with lungsetting on the right.



Pelvic inflammatory disease

Pelvic inflammatory disease is a common mimicker of both of appendicitis and diverticulitis. Transvaginal sonography depicts an inhomogeneous enlarged inflamed ovary.

Enlarged adnex due to salpingitis



Urolithiasis

Urolithiasis often causes flank pain, but an ureteral stone (arrowhead) may occasionally present with clinical signs simulating appendicitis, cholecystitis or diverticulitis. Appendicitis on the other hand may cause hematuria, pyuria and albuminuria in up to 25% of patients because of ureteral inflammation from an adjacent inflamed appendix.

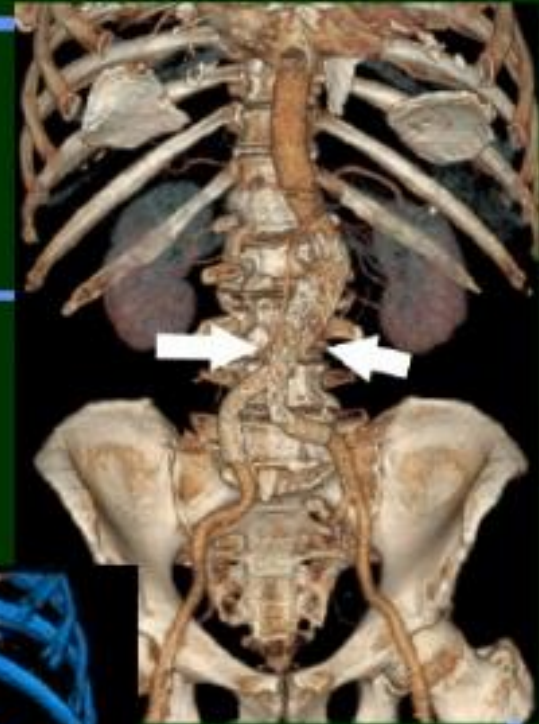
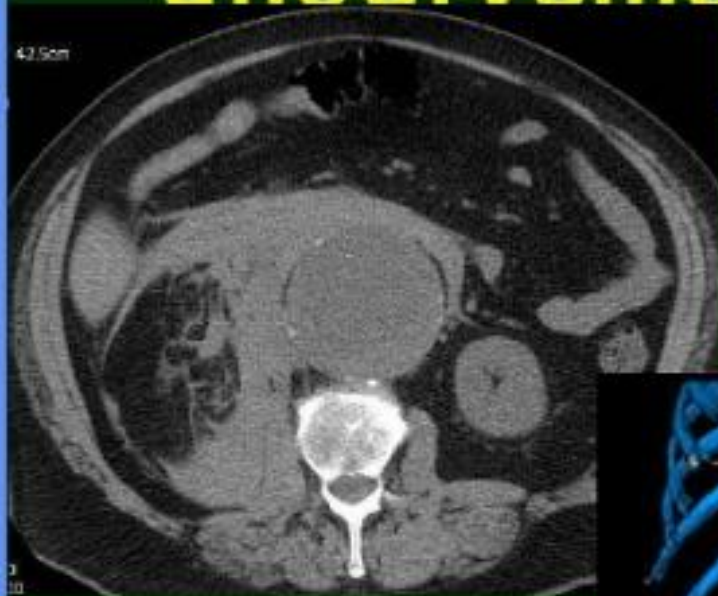
Small stone in right ureter (arrow) causing right flank pain.

Renal Colic



Renal stone right sided hydronephrosis

Aortic aneurysms



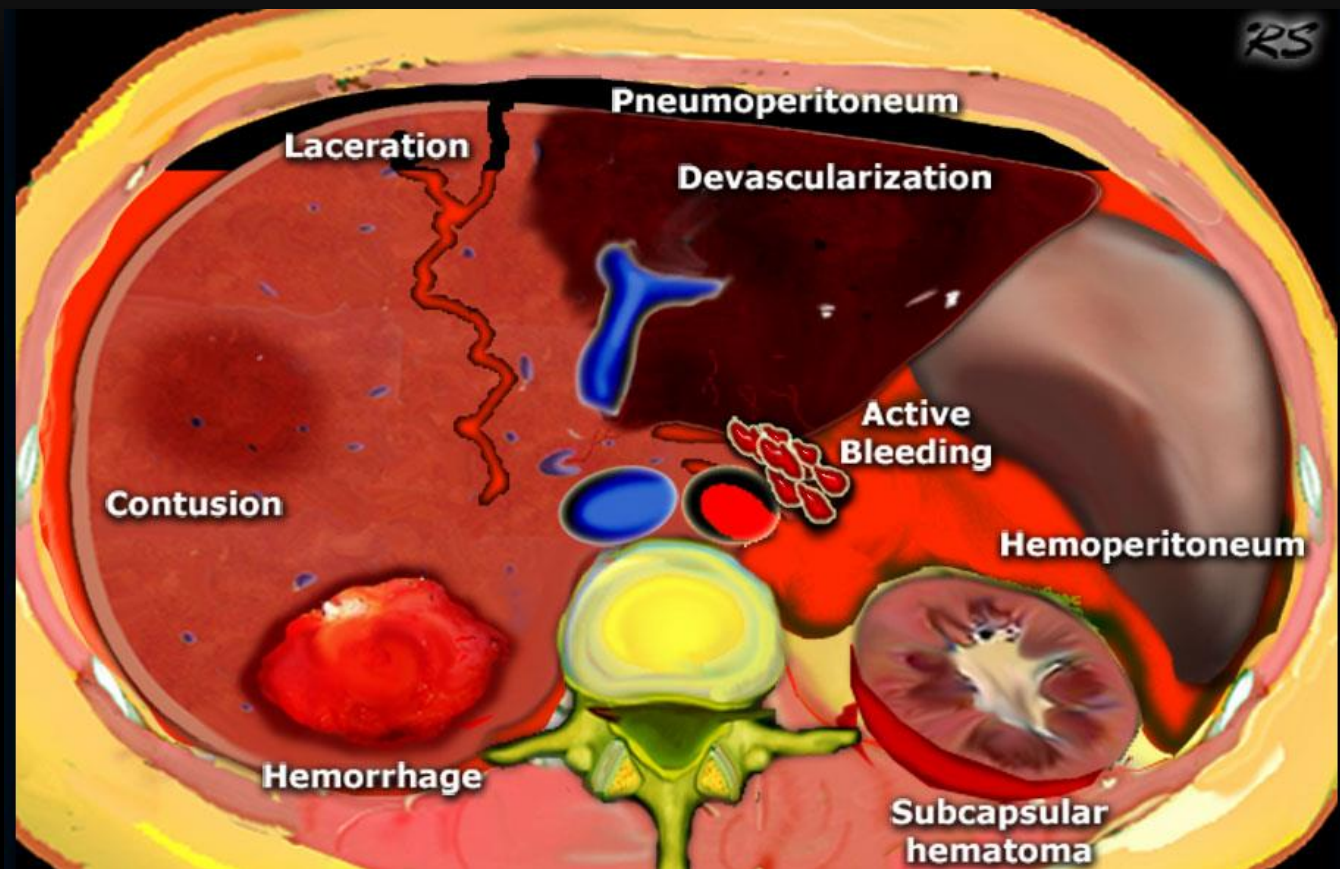


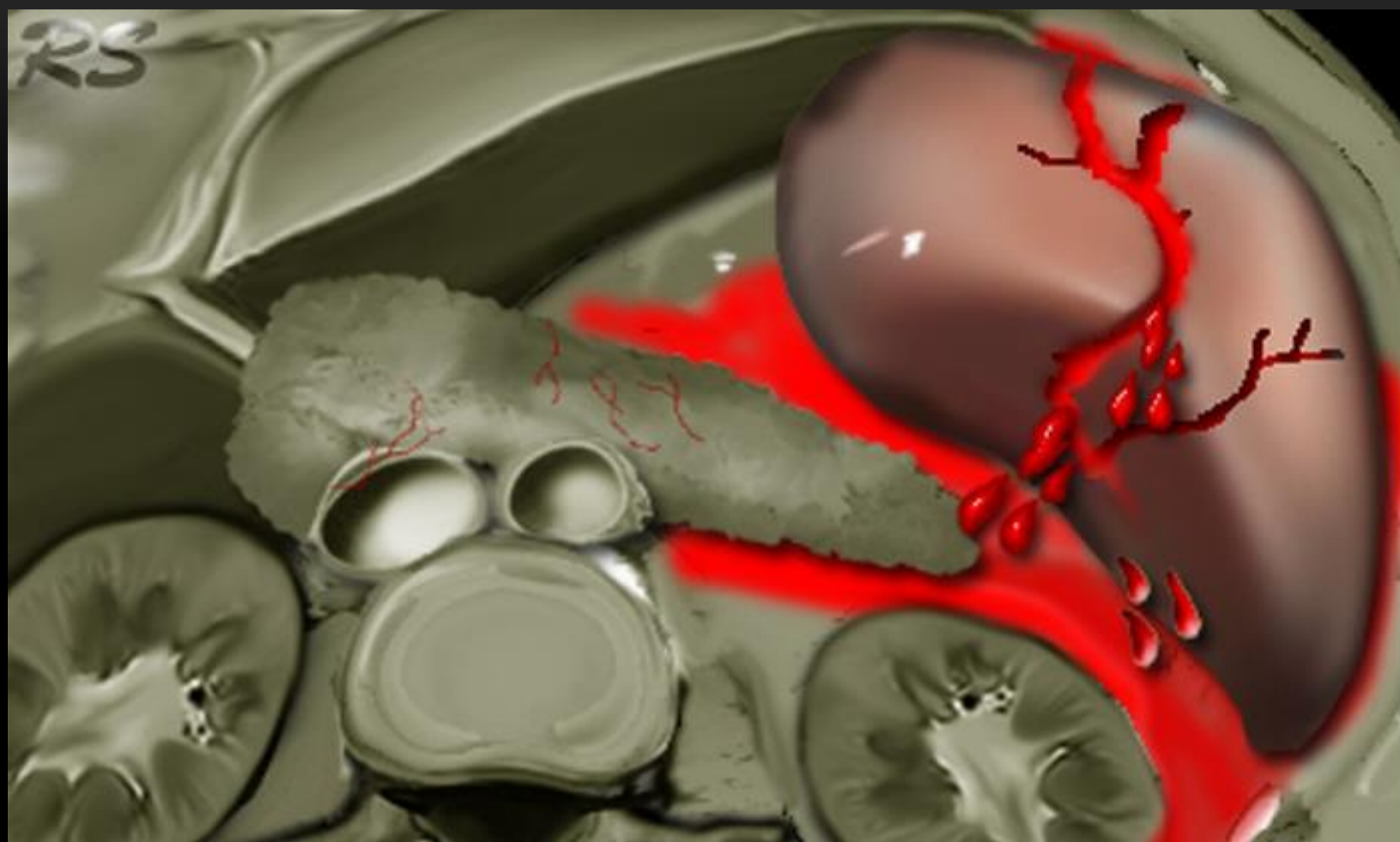
Left retroperitoneal fluid collection due to ruptured aneurysm.



Pancreas surrounded by fat stranding due to exsudative pancreatitis.

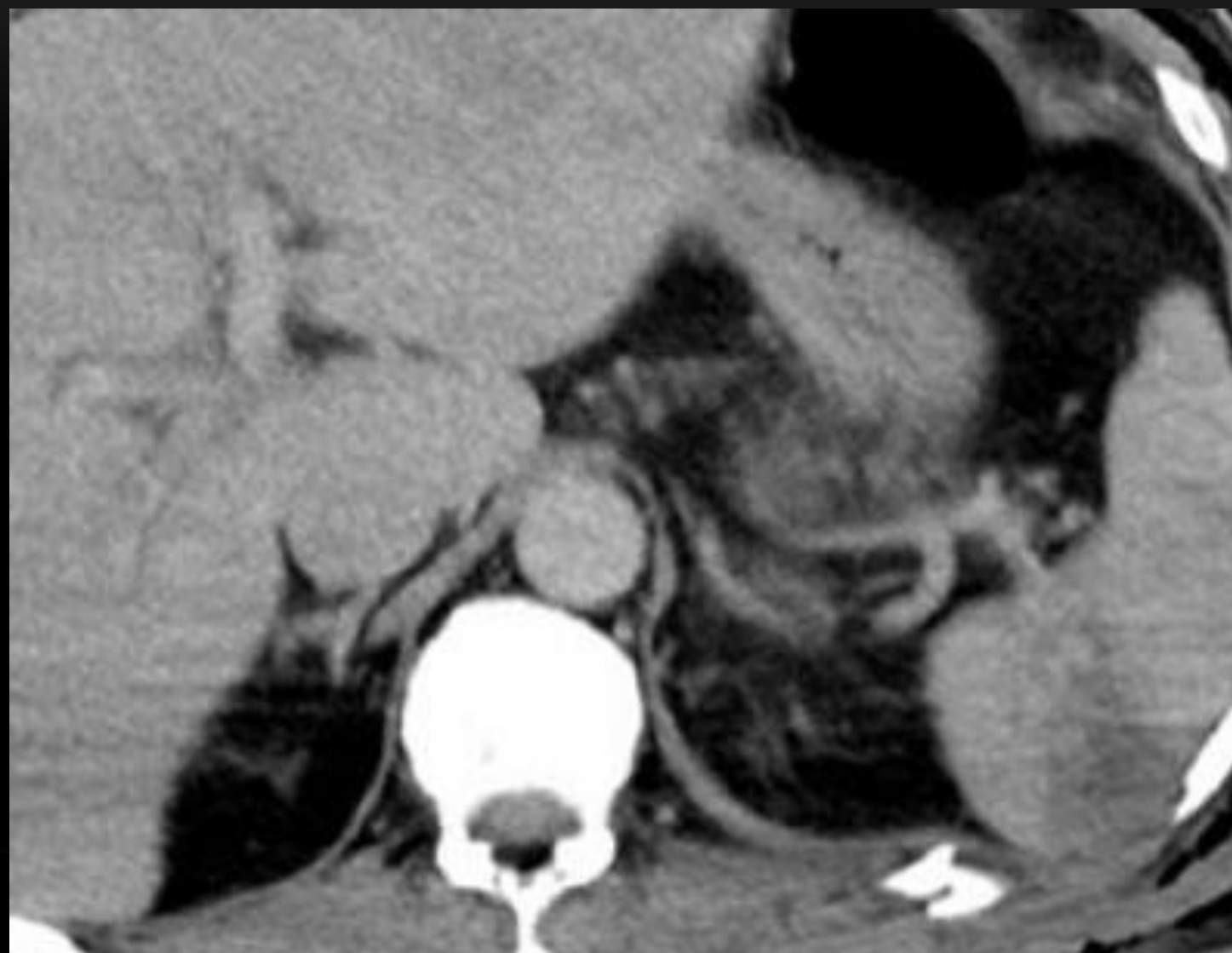
Acute Abdomen - Role of CT in Trauma

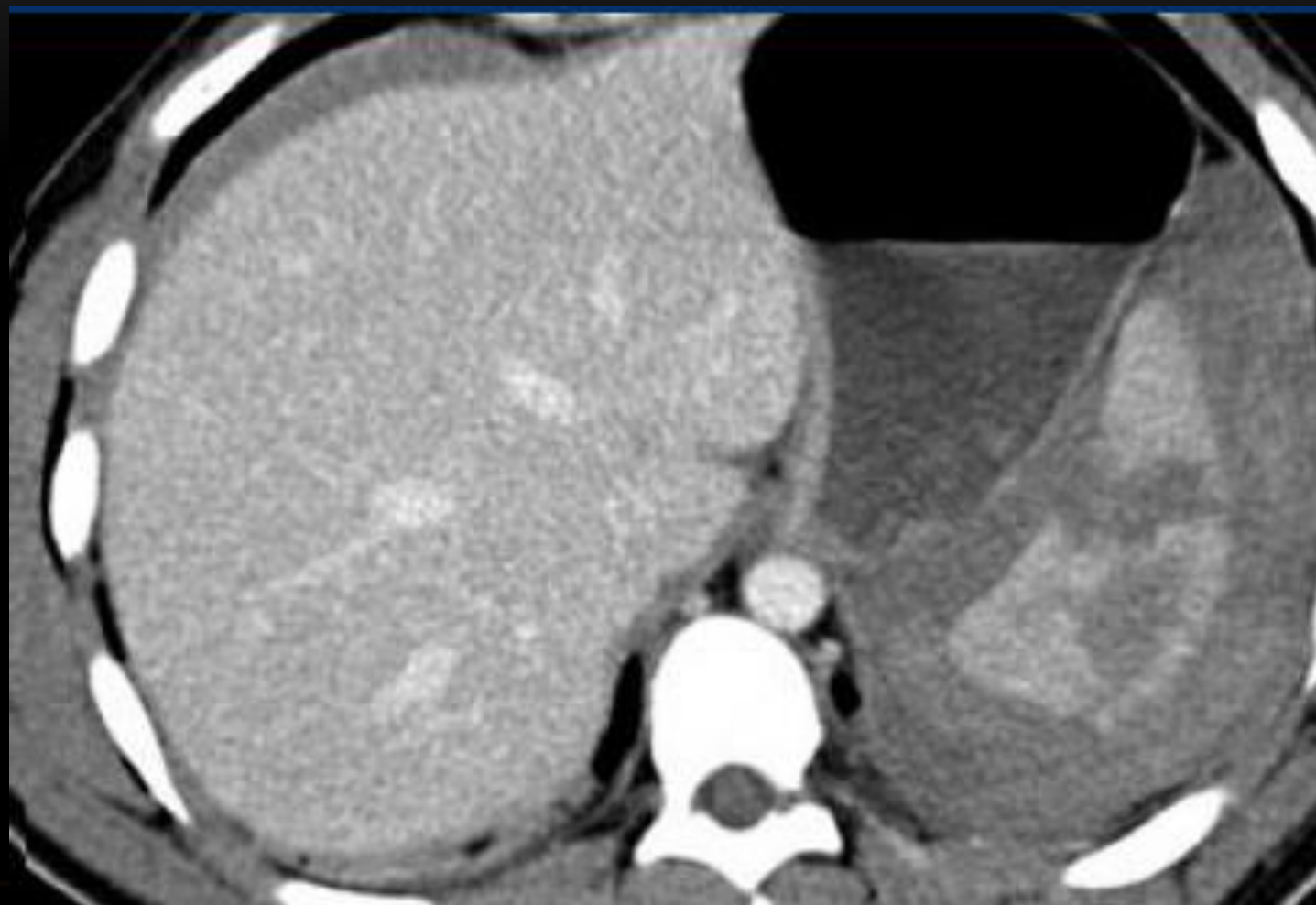






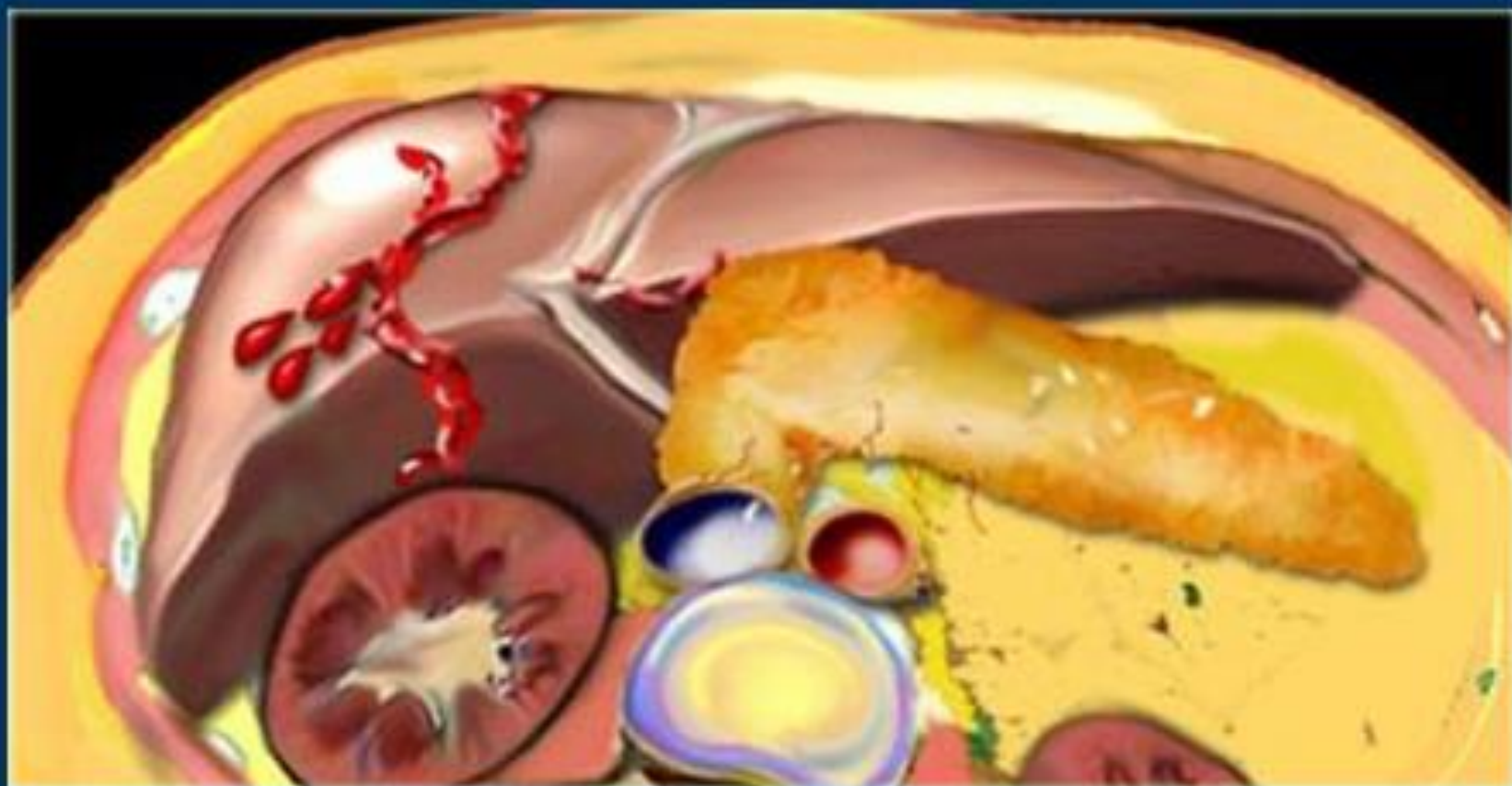




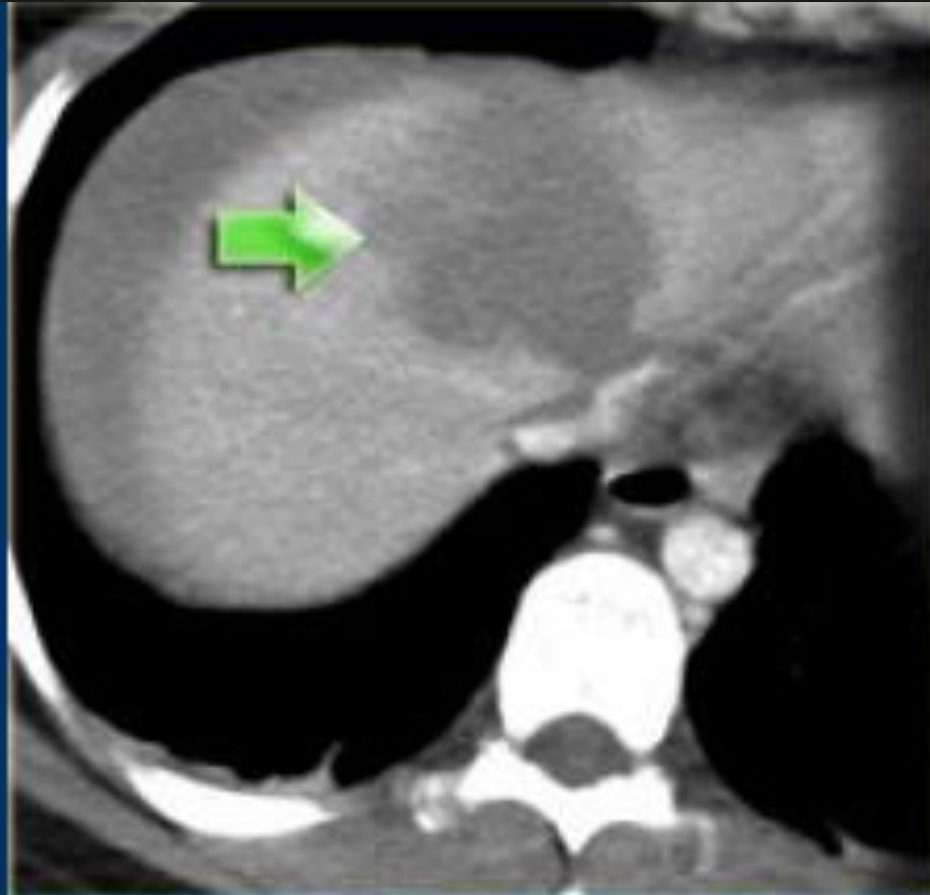


Splenic CT Injury Grading Scale

Grade I	Laceration(s) < 1 cm deep Subcapsular hematoma < 1cm diameter
Grade II	Laceration(s) 1-3 cm deep Subcapsular or central hematoma 1-3cm diam
Grade III	Laceration(s) 3-10 cm deep Subcapsular or central hematoma 3-10 cm diam
Grade IV	Laceration(s) > 10 cm deep Subcapsular or central hematoma > 10cm diam
Grade V	Splenic tissue maceration or devascularization



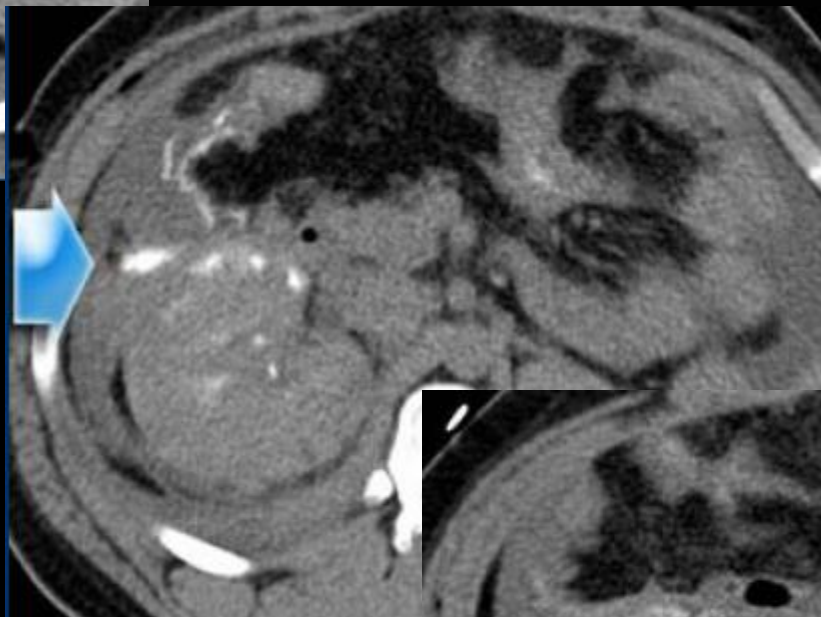
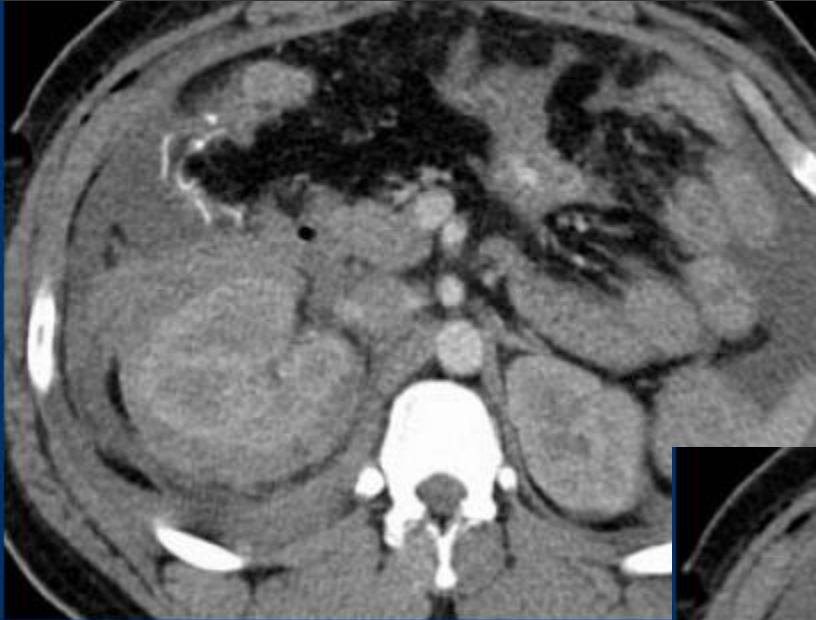
Liver laceration with active bleeding



Liver injury. The arrows indicate different types of injury.

Hepatic CT Injury Grading Scale

Grade I	Laceration(s) < 1 cm deep Subcapsular hematoma < 1cm diameter
Grade II	Laceration(s) 1-3 cm deep Subcapsular or central hematoma 1-3cm diam
Grade III	Laceration(s) 3-10 cm deep Subcapsular or central hematoma 3-10 cm diam
Grade IV	Laceration(s) > 10 cm deep Subcapsular or central hematoma > 10cm diam Lobar maceration or devascularization
Grade V	Bilobar tissue maceration or devascularization





Category I



Category II



Category III

Category IV

Renal Injury – Blunt Mechanism

- › 90% due to blunt trauma - 10% penetrating
- › Kidney is 3rd most common involved organ in adults
 - 10% of solid visceral injury
- › Most common injured organ in children
- › Evaluation for
 - parenchymal injuries
 - vascular injuries
 - collecting system injuries

Renal Injury Scale

Grade I	Contusion / Subcapsular hematoma No parenchymal laceration
Grade II	Laceration < 1 cm depth of renal cortex No urinary extravasation
Grade III	Laceration > 1 cm depth of renal cortex No urinary extravasation
Grade IV	Laceration extending through renal cortex, medulla and into collecting system Minor renal artery or vein injury with contained hematoma
Grade V	Shattered kidney Devascularized kidney, hilar avulsion

Renal injury scale according to the Organ Injury Scale of the American Association of Surgery of Trauma (AAST)

Conclusion

In patients with an acute abdomen 'the stakes are high'. A misdiagnosis may have serious consequences. We advocate a systematic approach:

1. First focus on the most common diseases and make a firm diagnosis or exclude them.
2. Always screen the whole abdomen for general signs of pathology.

