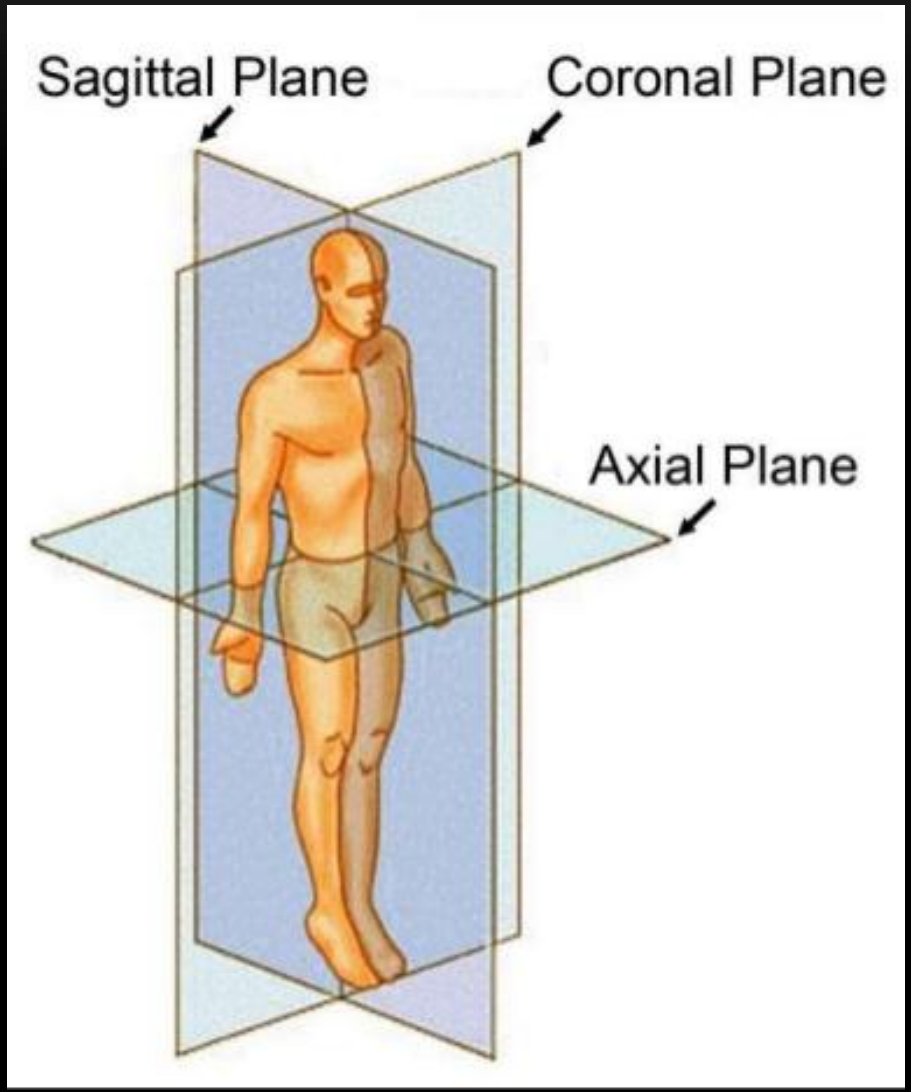
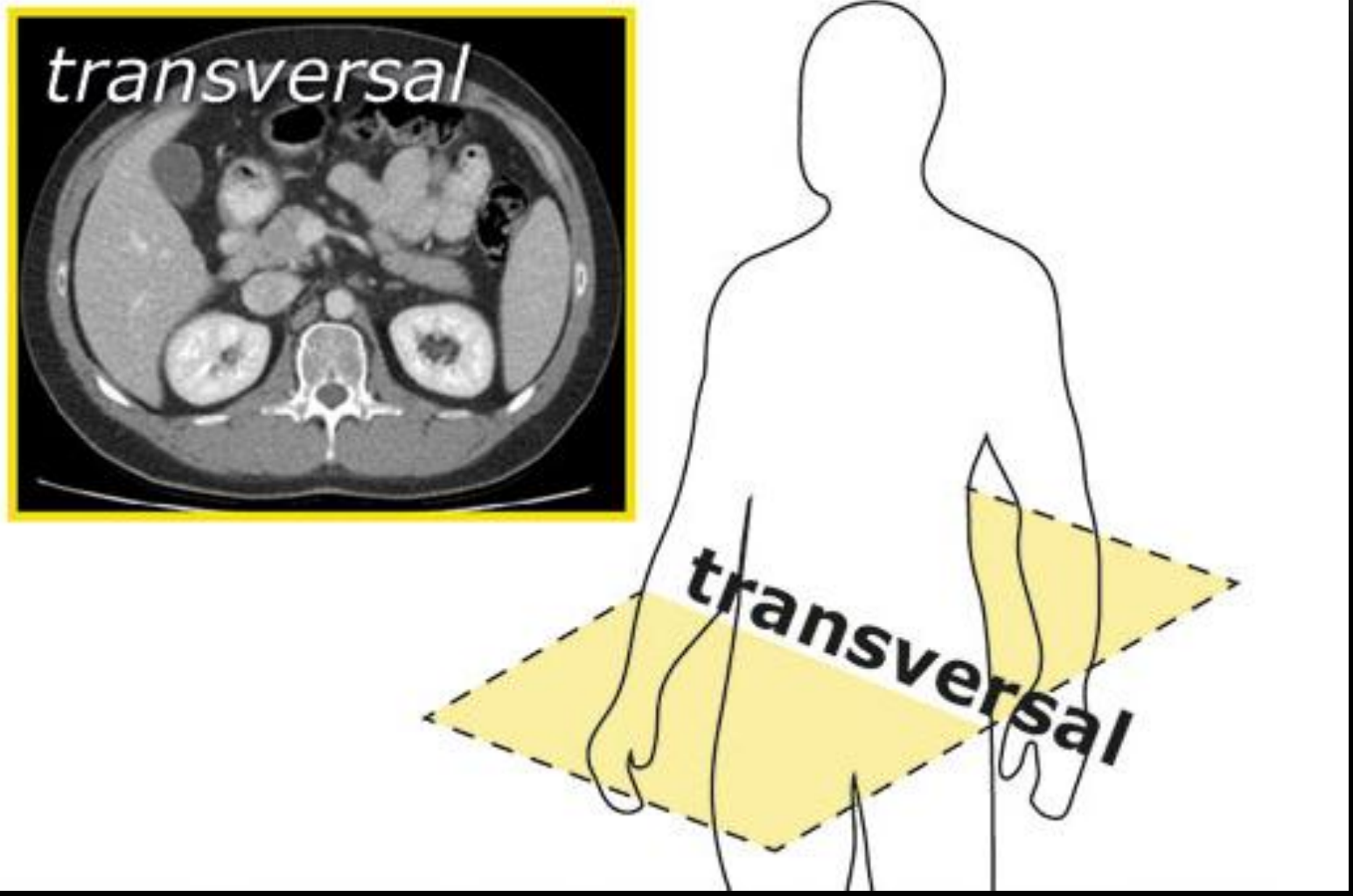
كلية الطب البشري

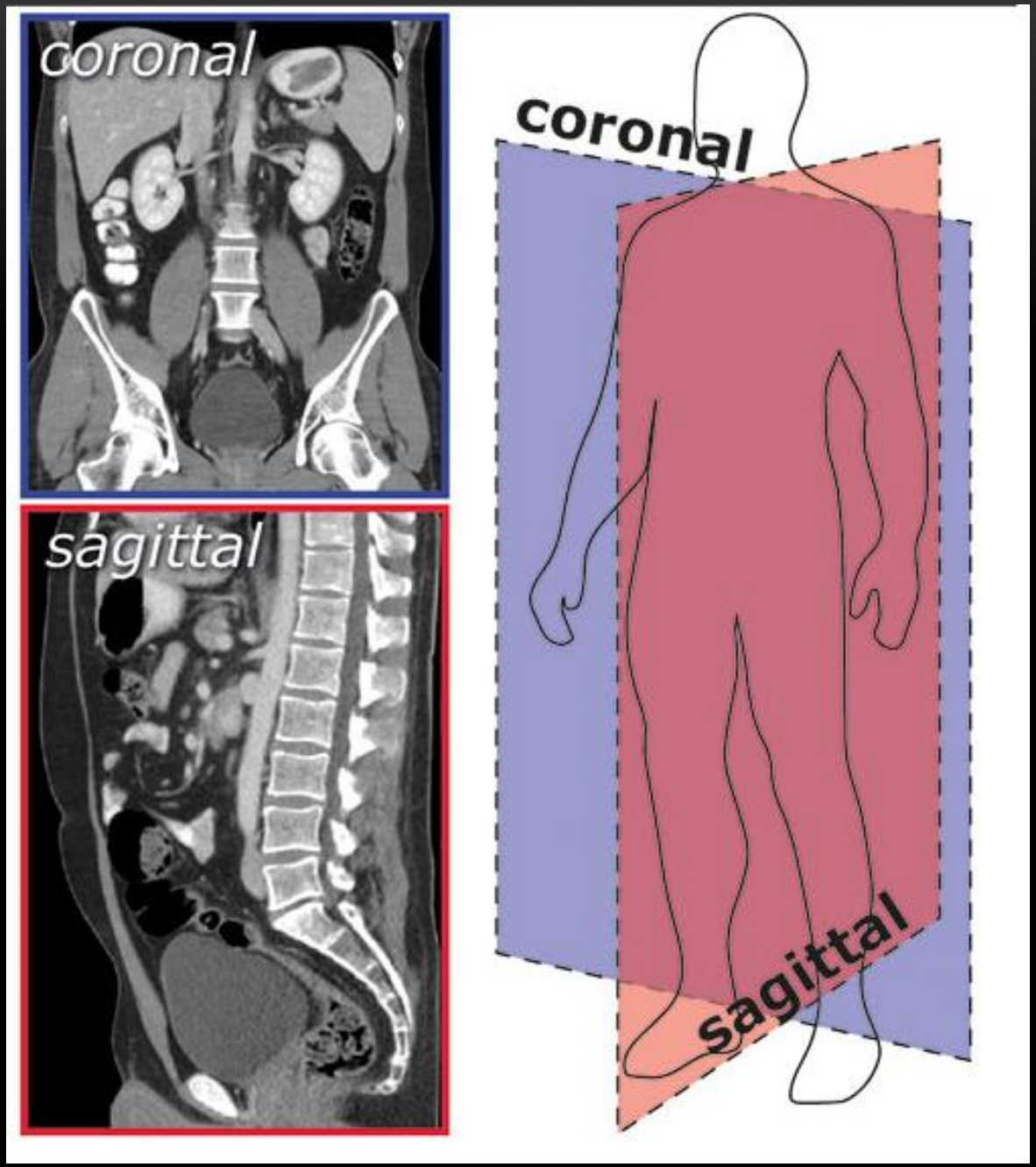
IMAGING APPROACH IN ACUTE ABDOMEN

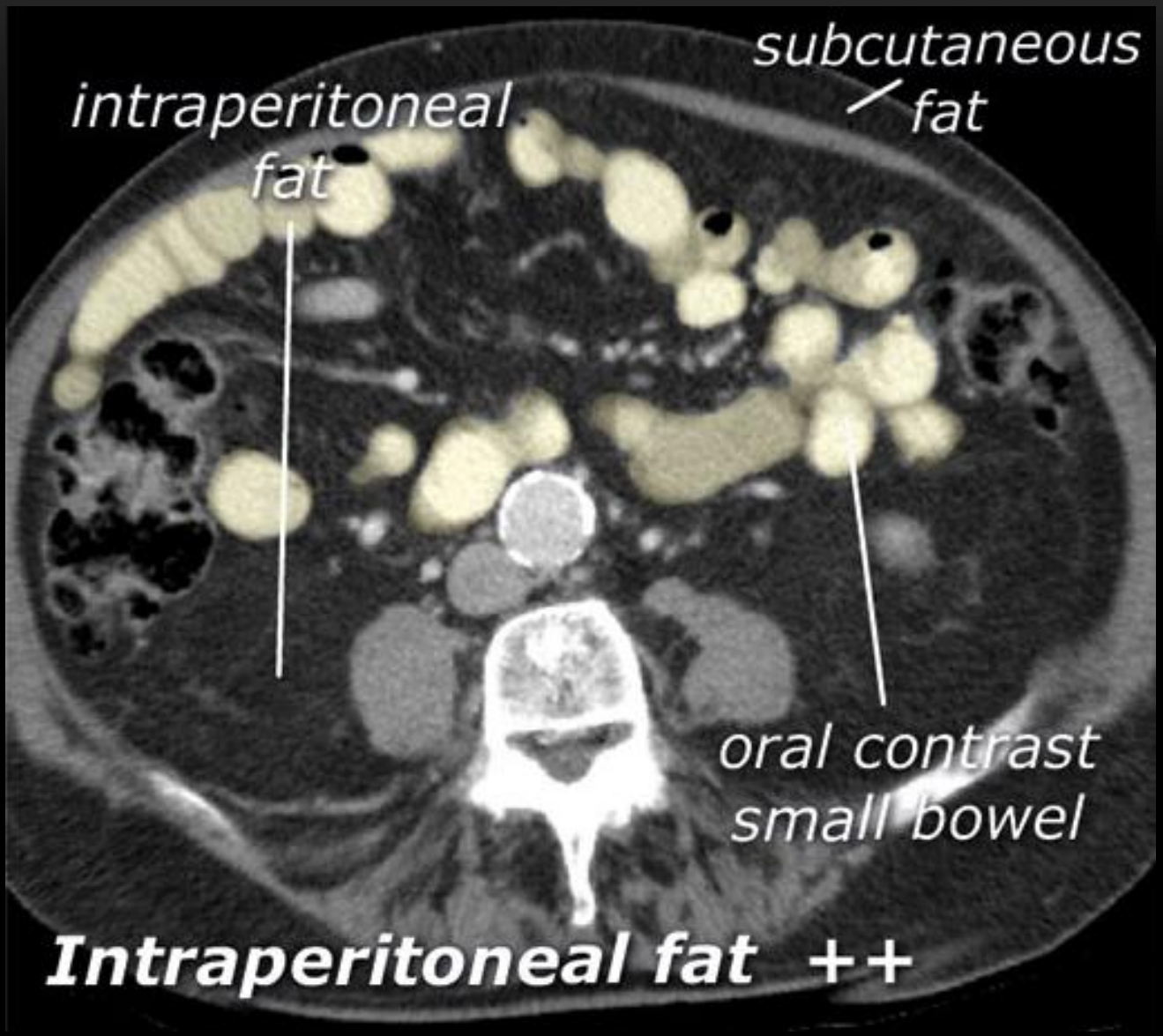
الدكتورة: رفيف تركاوي

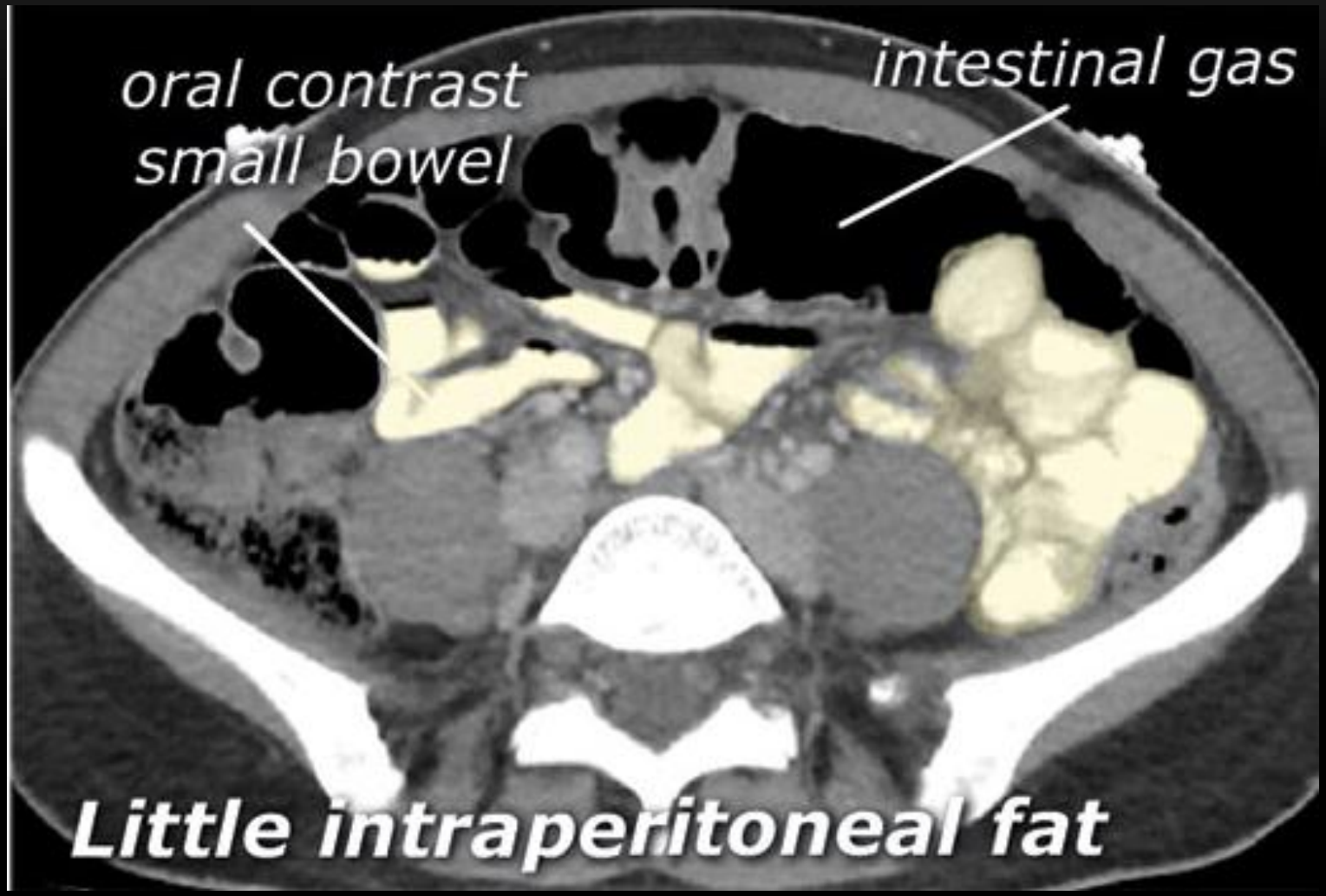
CT abdomen

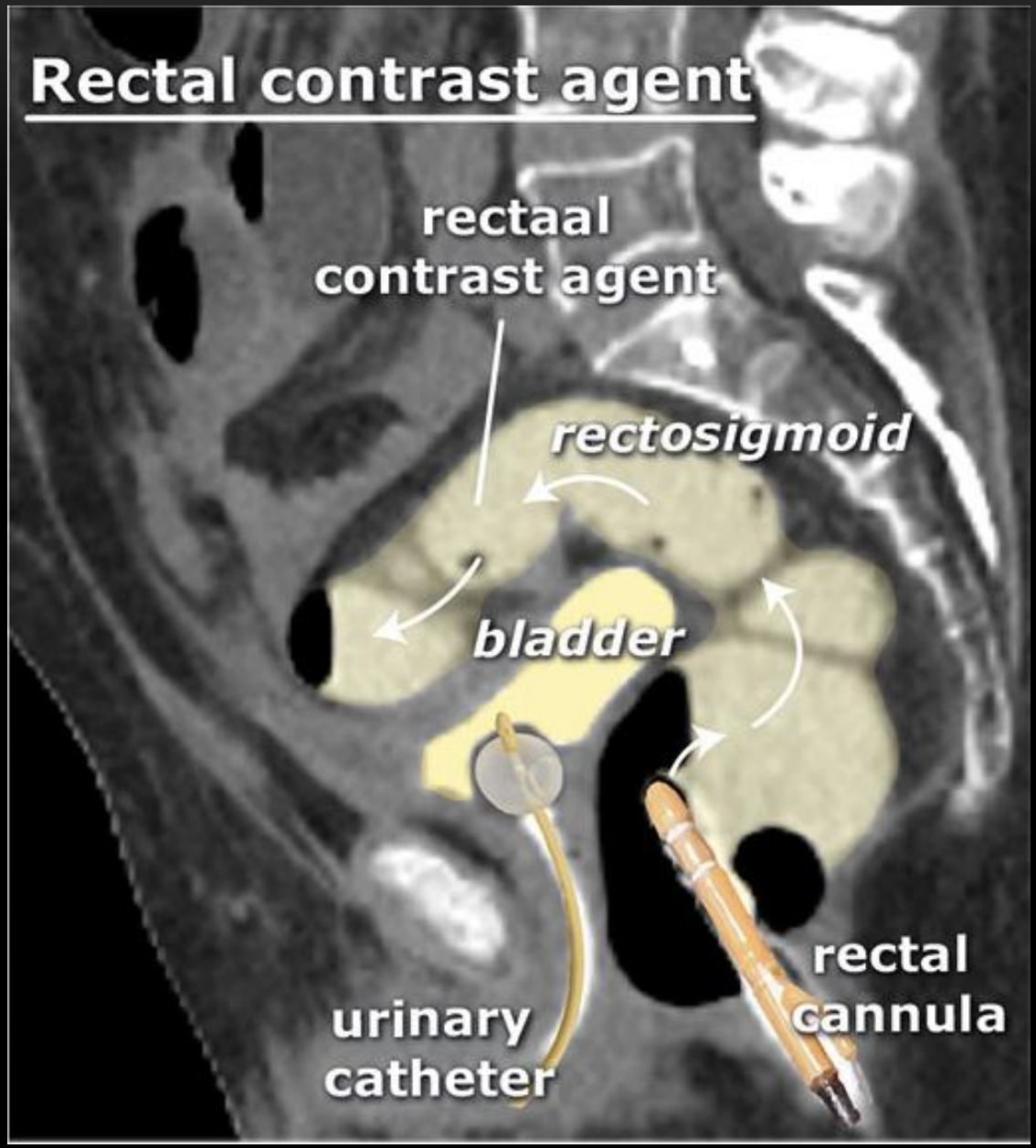



transversal
transversal

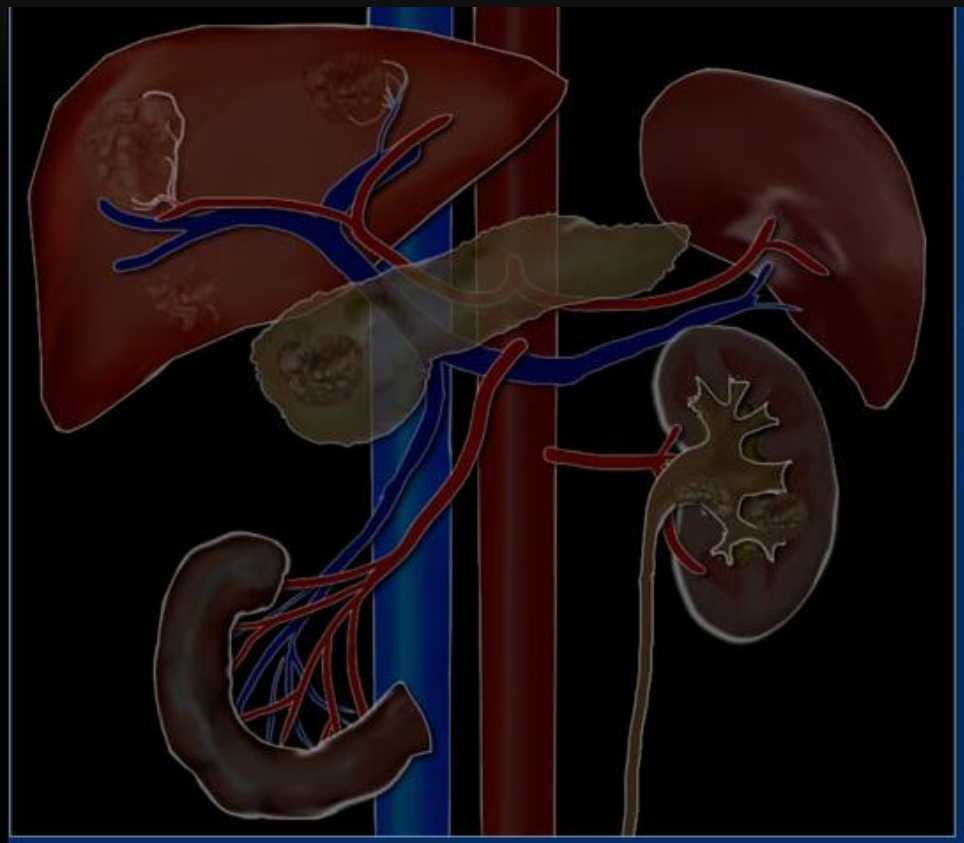

coronal
sagittal
coronal
sagittal


intraperitoneal fat
subcutaneous fat
oral contrast small bowel
Intraperitoneal fat ++


oral contrast
small bowel
intestinal gas
Little intraperitoneal fat


Rectal contrast agent
rectaal
contrast agent
rectosigmoid
bladder
urinary
catheter
rectal
cannula

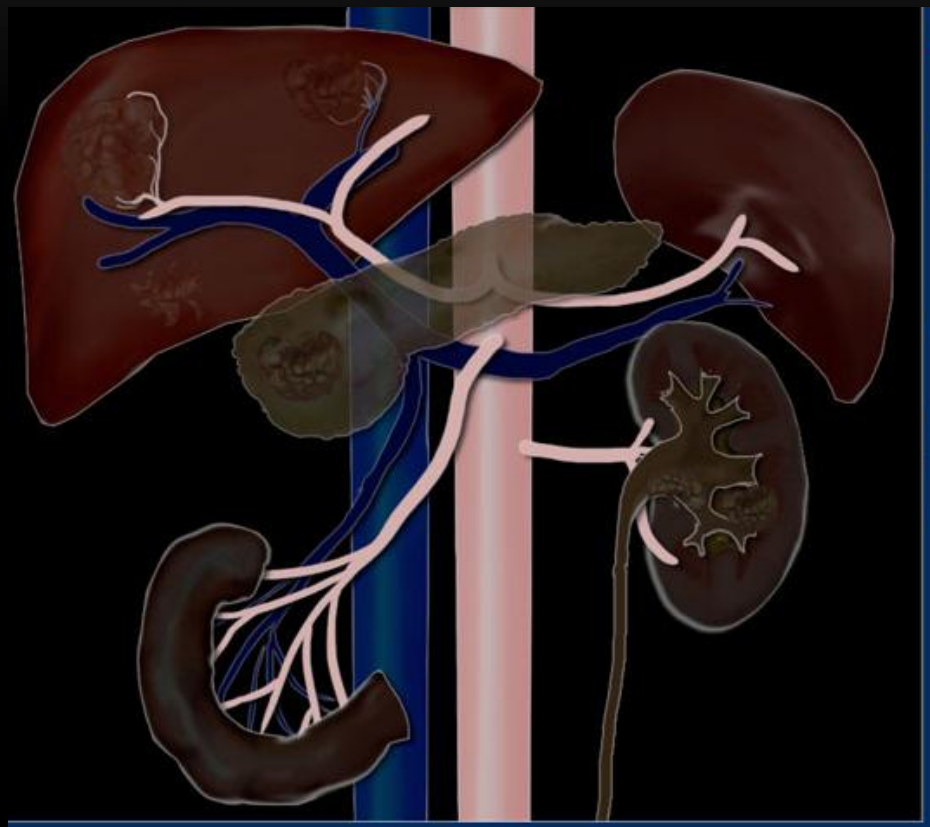
Phase	Time	Indications
No contrast	-	*Kidney/ureteral stones, arterial calcifications*
Arterial	*20 - 30 sec*	*Abdominal bleeding, aortic aneurysm, arterial stenosis/occlusions, hypervascular liver metastases, pancreas tumors*
Portal venous	*60 - 80 sec*	*Screening, hypovascular liver metastases, abscess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



Non Enhanced CT

Detection of:

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

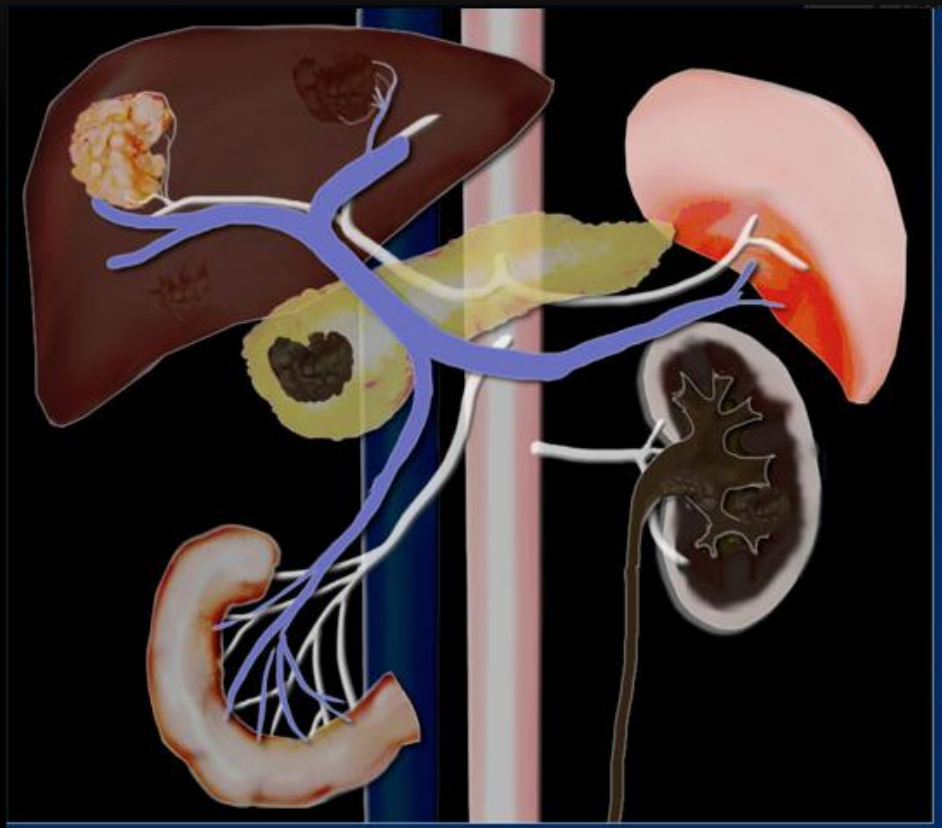


Early arterial phase

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

Demarcation of vessels

Detection of :
- Dissection of aorta
- Arterial bleeding

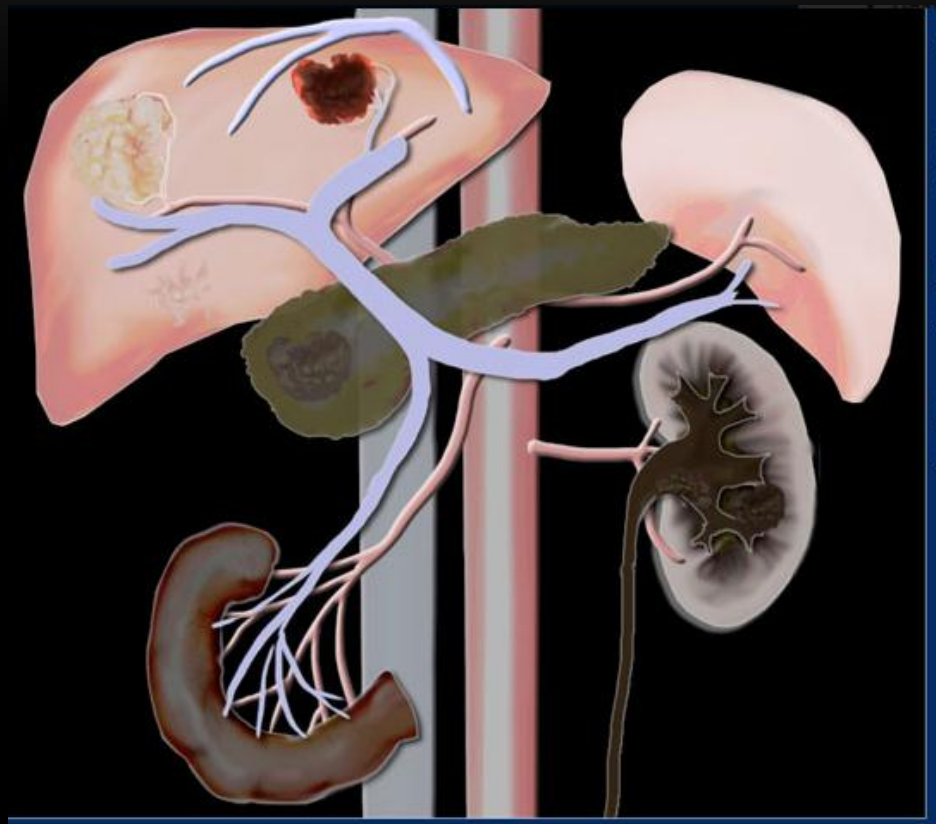


Late arterial phase

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

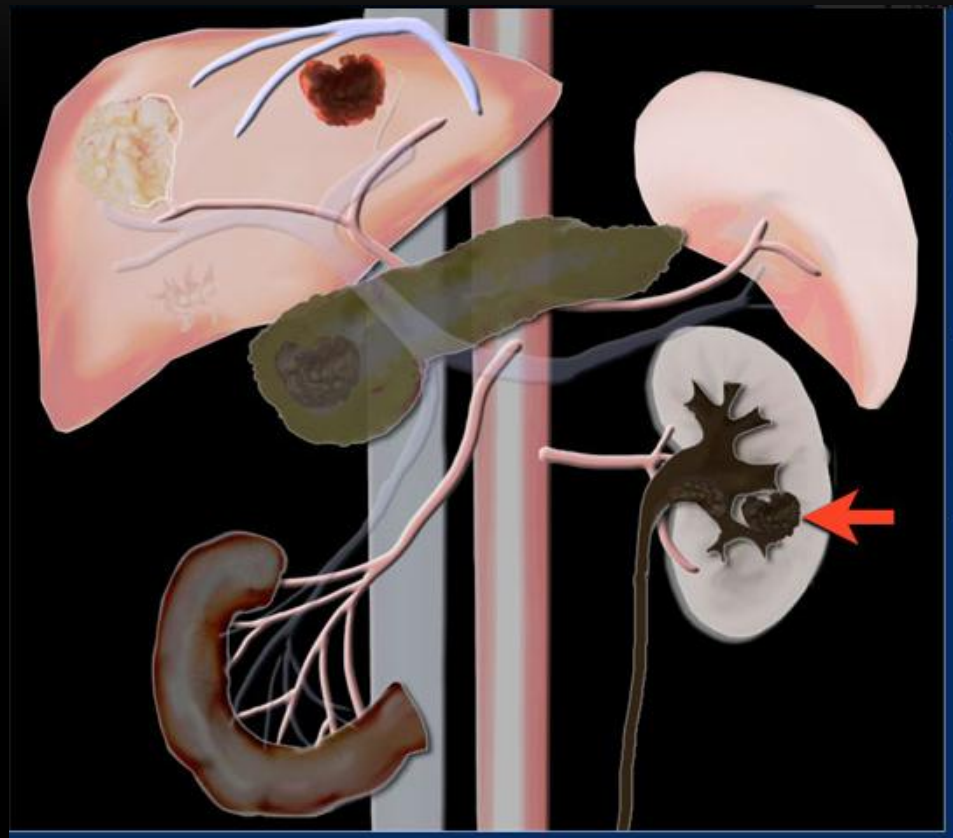


Hepatic phase

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

Enhancement of :
- Hepatic parenchyma

Detection of:
- Hypovascular liver lesions: cysts, abscess, most metastases

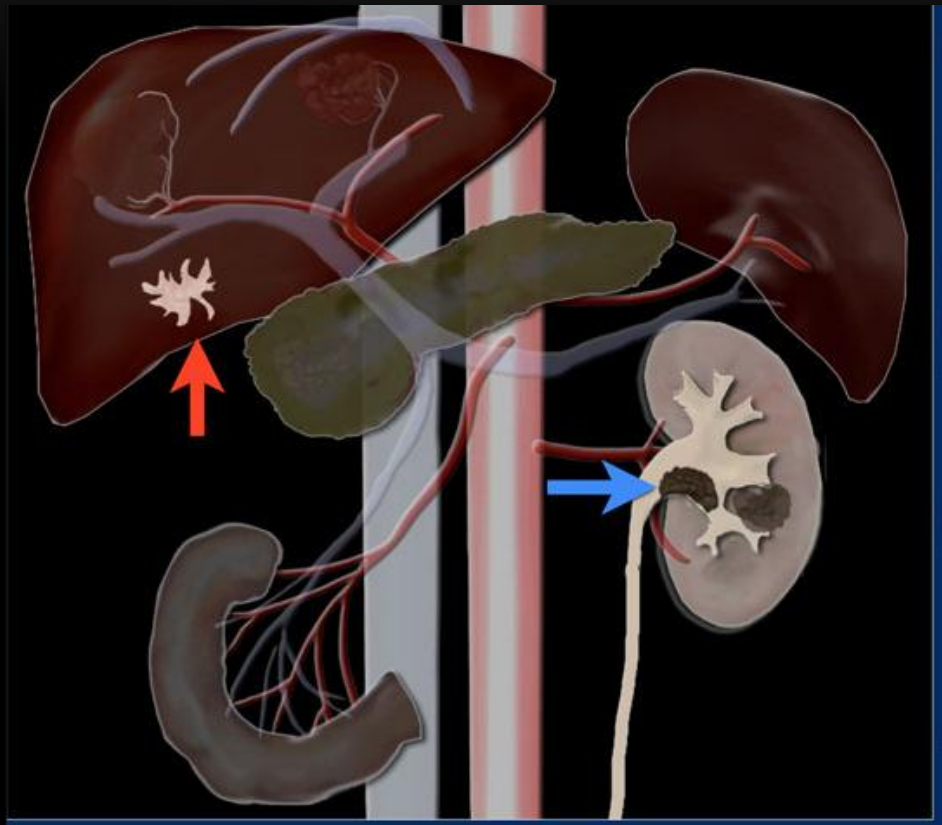


Nefrogenic phase

100 sec p.i.
or 80 sec after bolustracking

Enhancement of :
- All renal parenchyma including medulla

Detection of:
- Renal cell carcinoma (arrow)

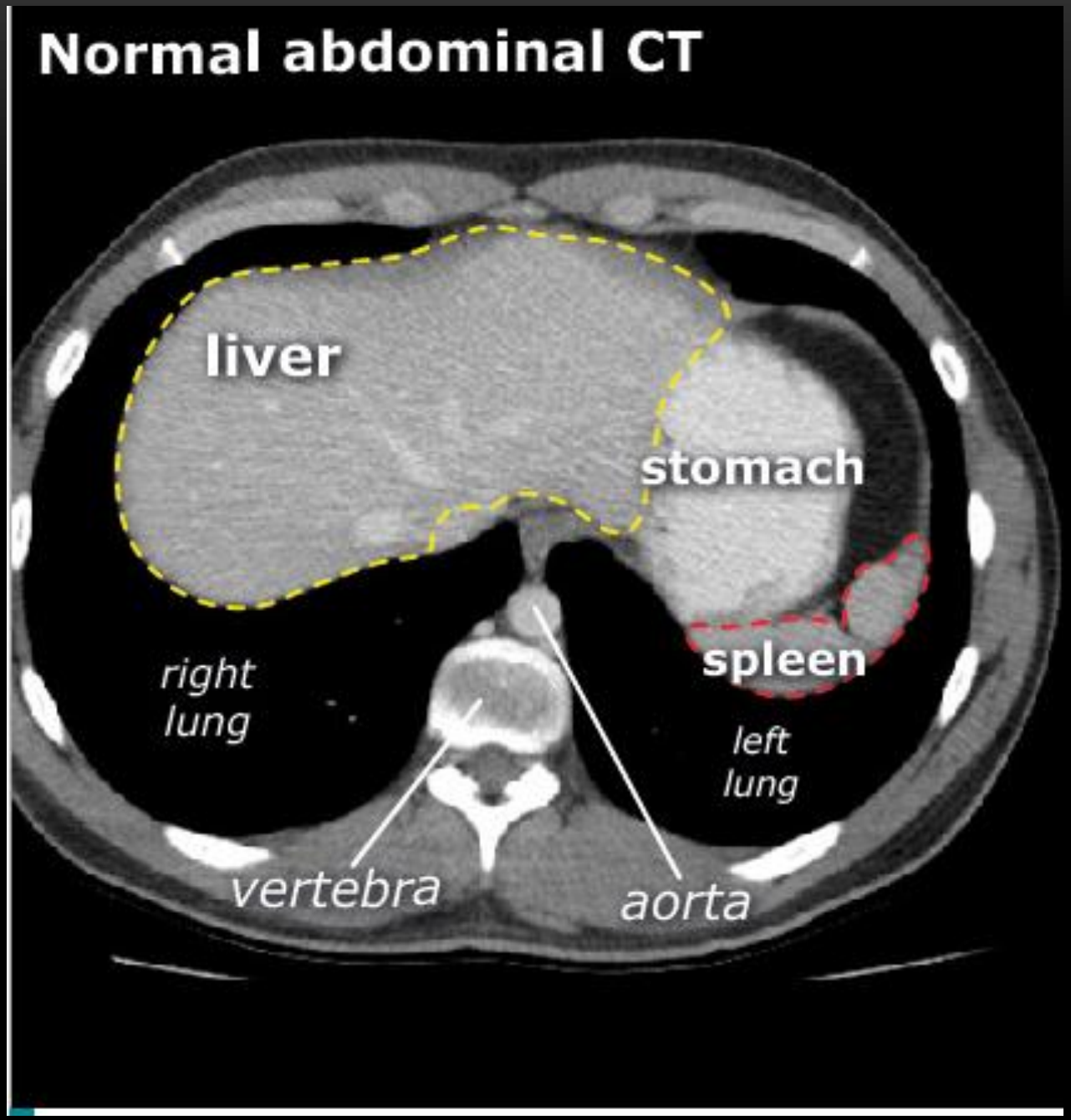


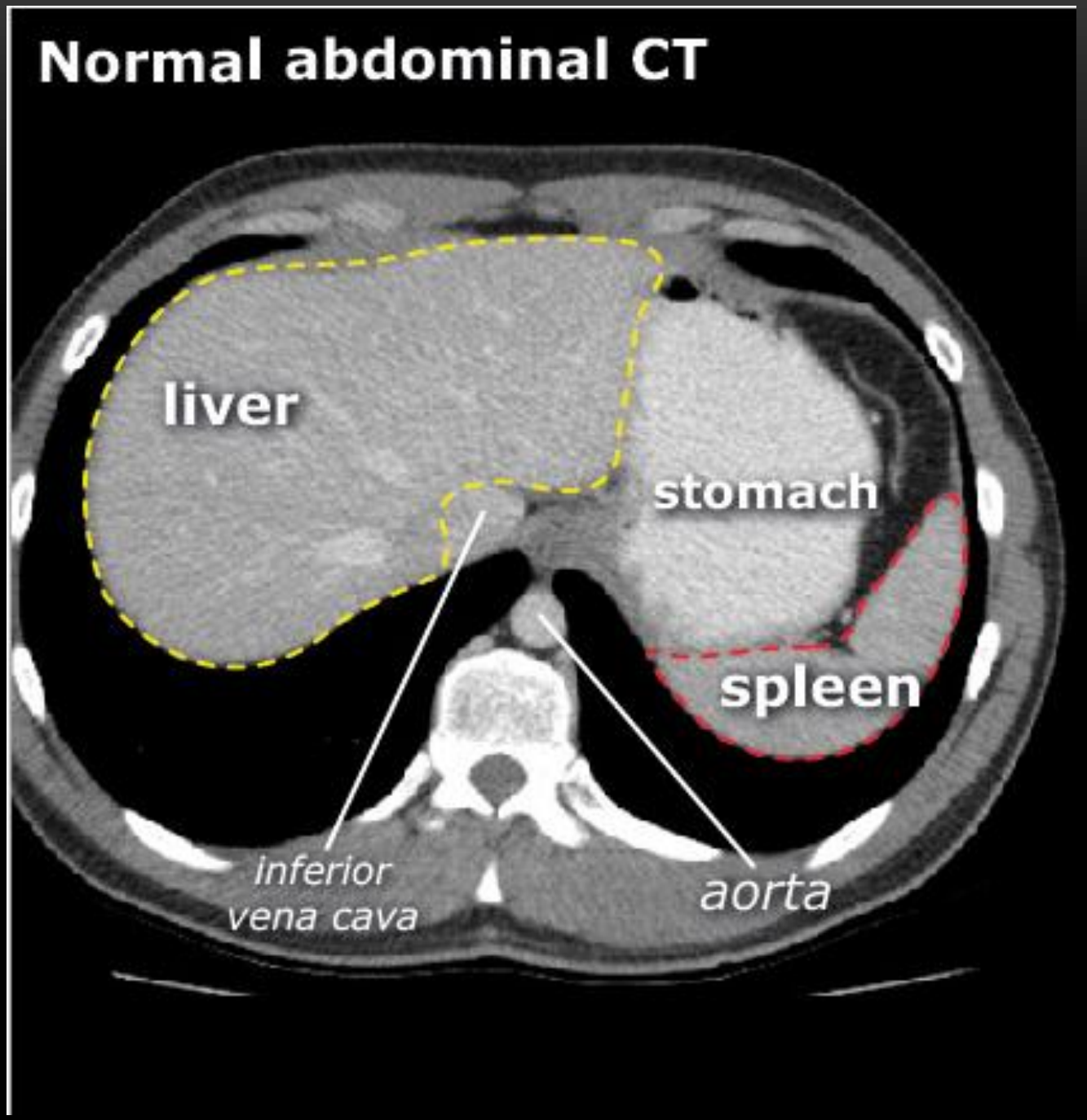
Delayed phase

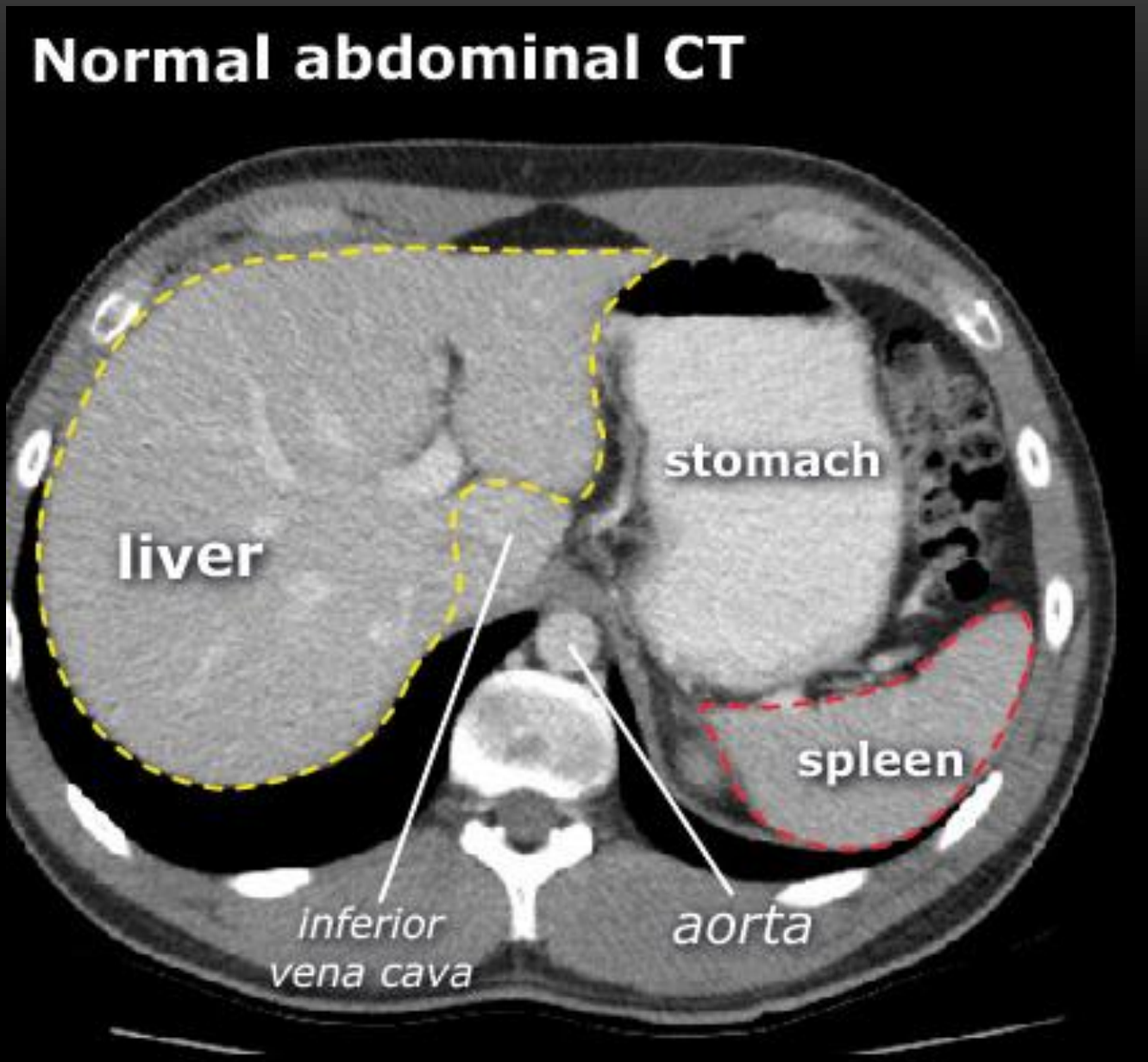
6 minutes p.i.
or 6 minutes after bolustracking

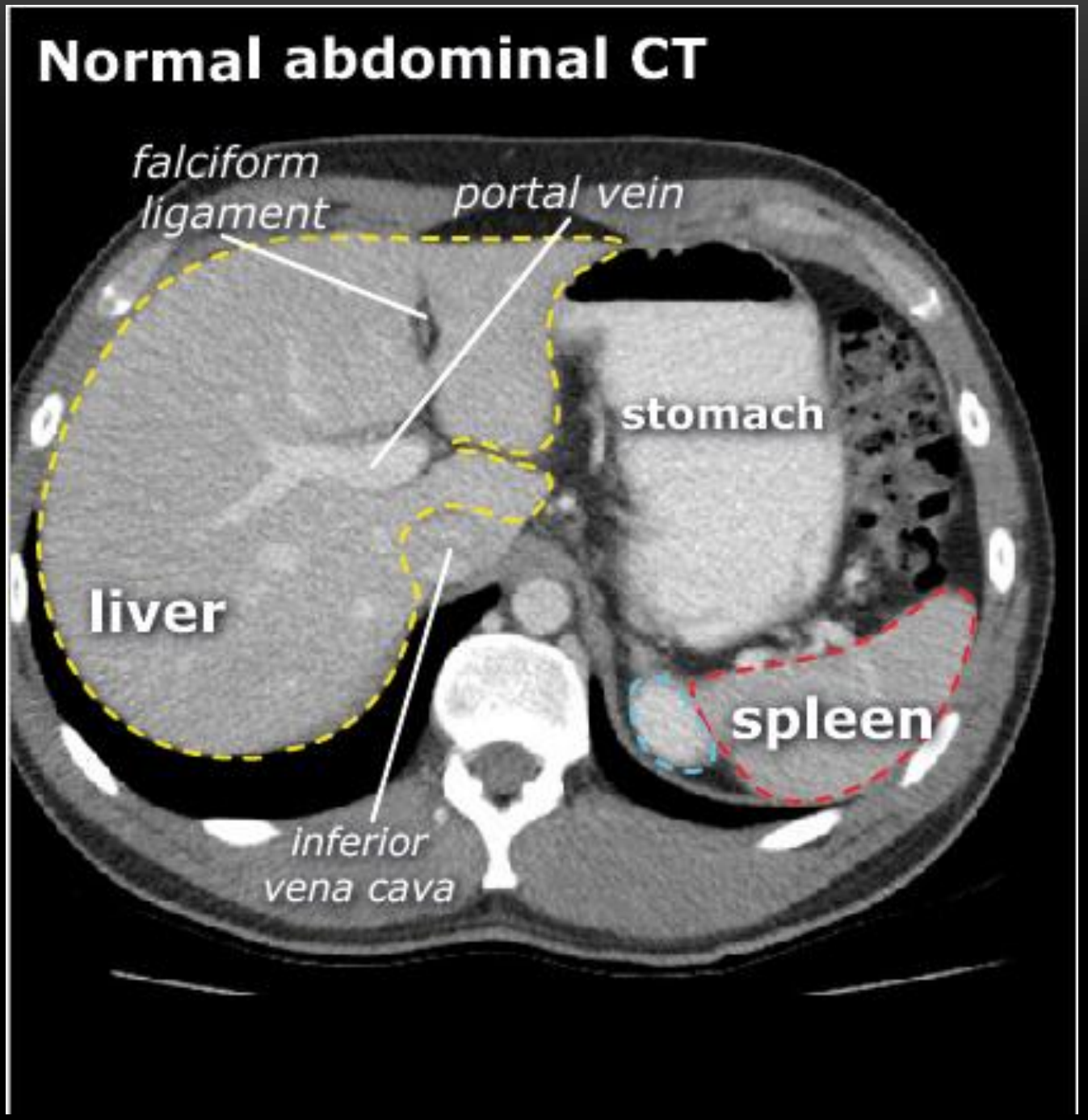
Enhancement of :
- fibrotic lesions
- still enhancement of kidney and urinary collecting system

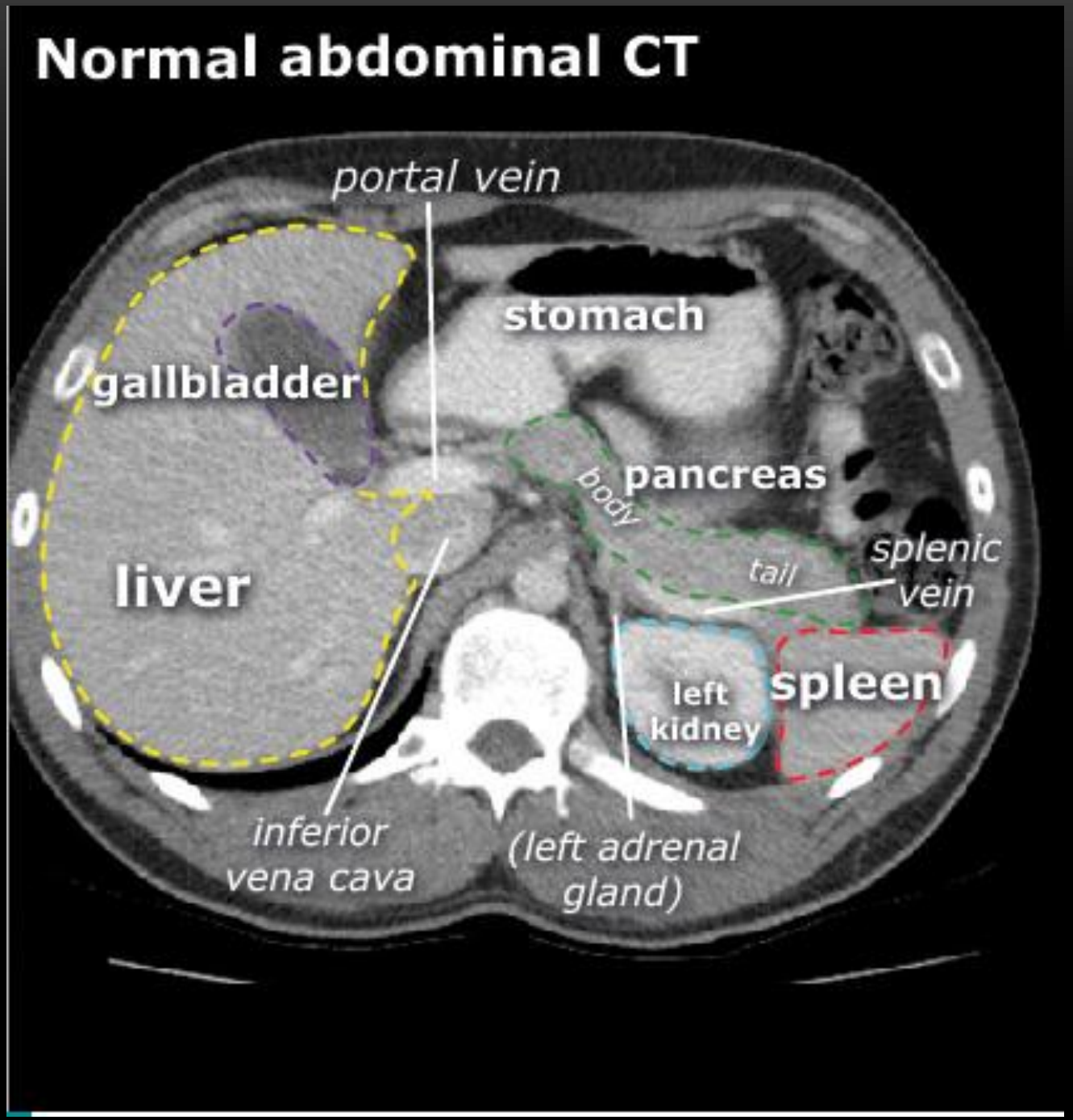
Detection of :
- Liver :
  - Cholangiocarcinoma (arrow)
  - Fibrotic metastases, most commonly breastcacer
- Kidney :
  - Transitional cell carcinoma (blue arrow)

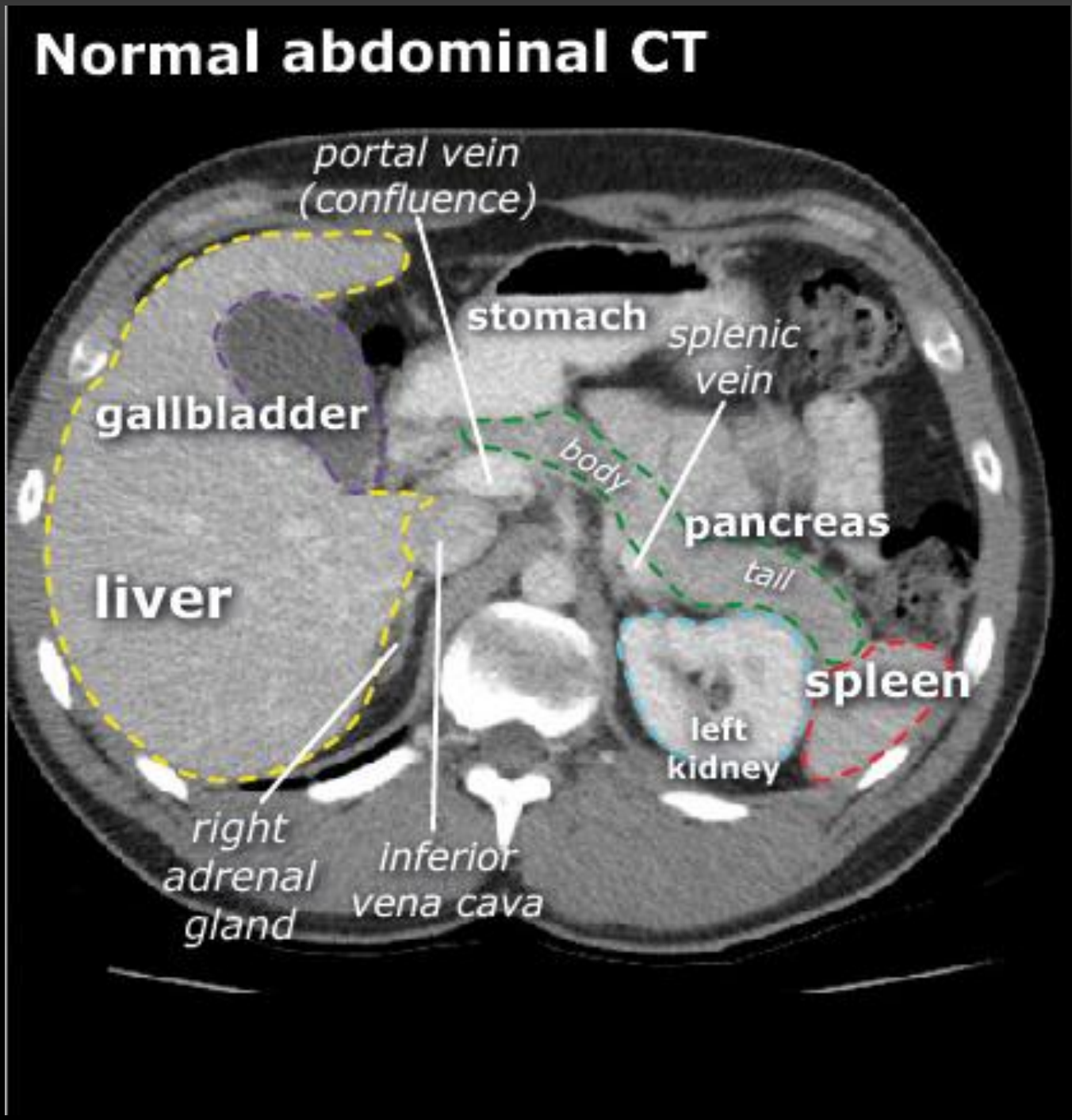

Normal abdominal CT
liver
stomach
spleen
right lung
left lung
vertebra
aorta

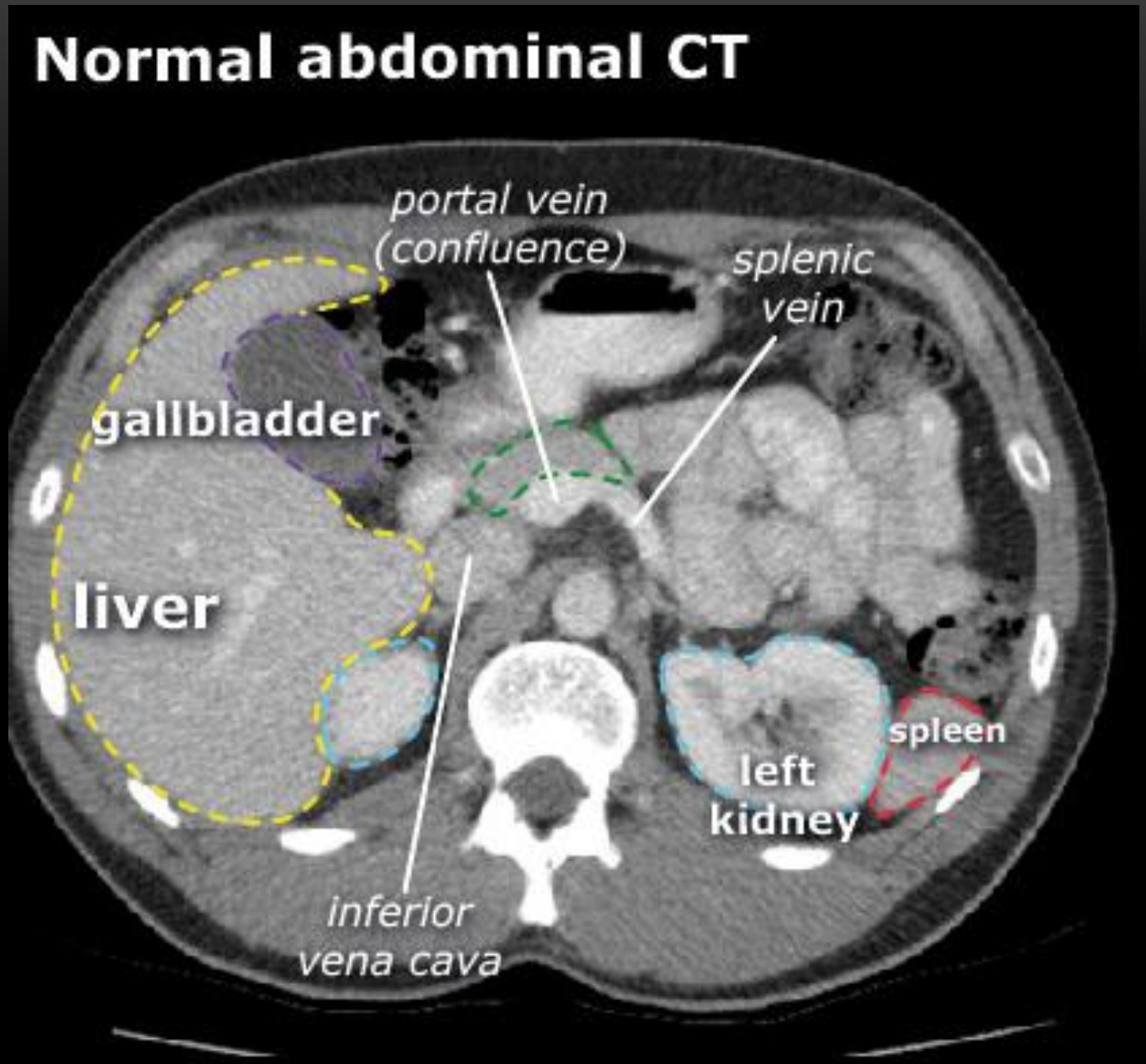

Normal abdominal CT
liver
stomach
spleen
inferior
vena cava
aorta

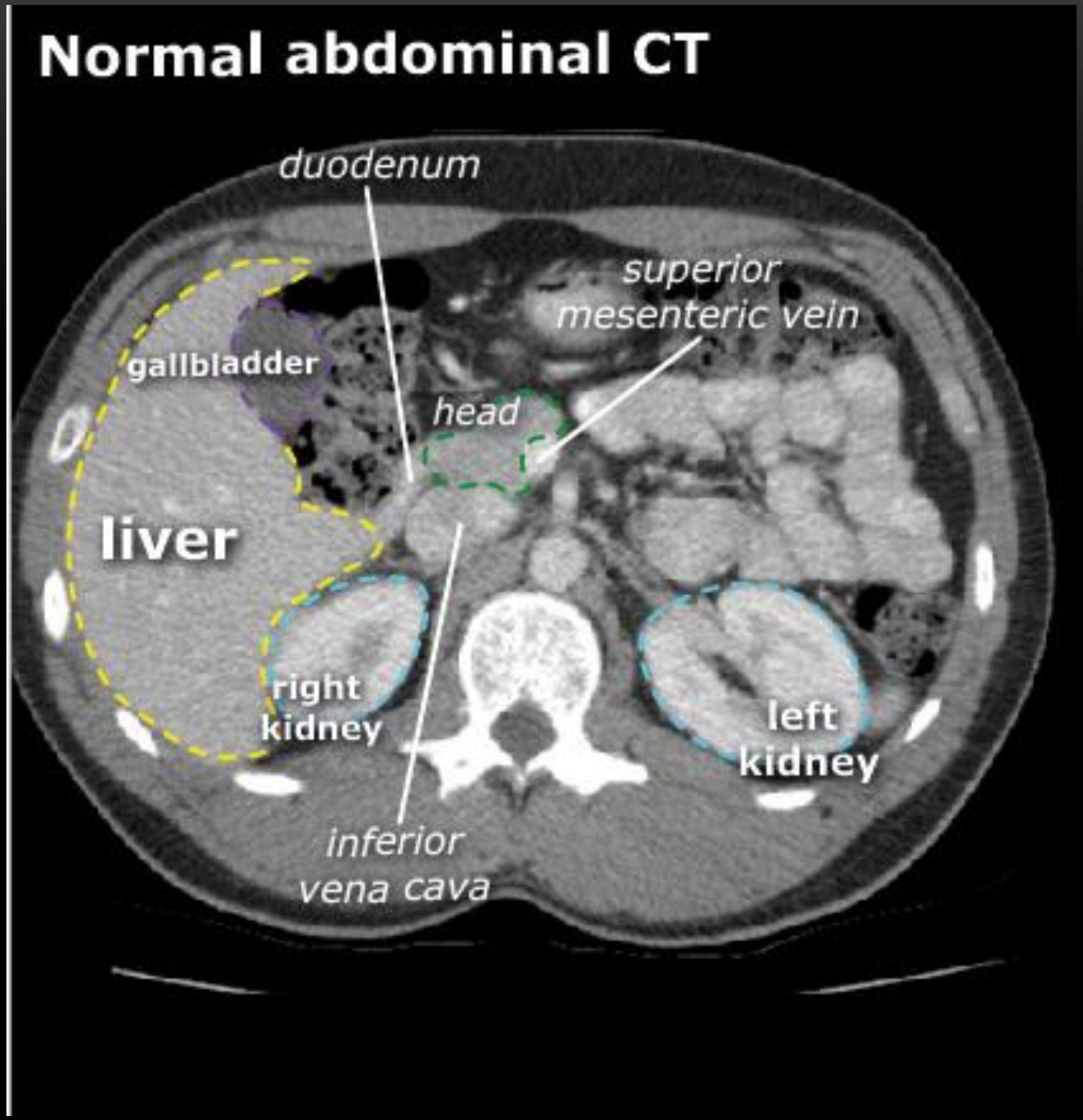

Normal abdominal CT
liver
stomach
spleen
inferior
vena cava
aorta

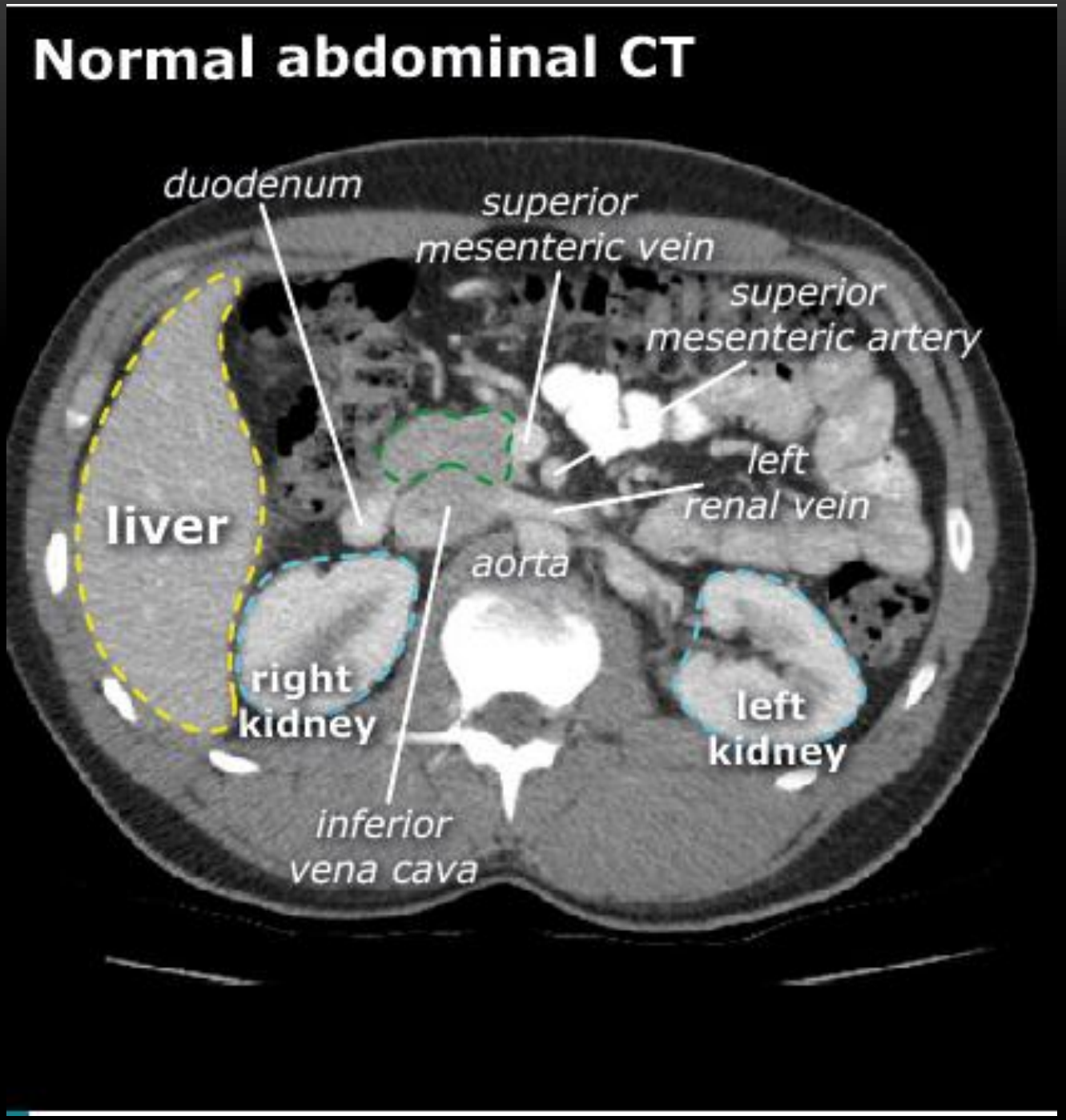

Normal abdominal CT
falciform ligament
portal vein
stomach
liver
spleen
inferior vena cava

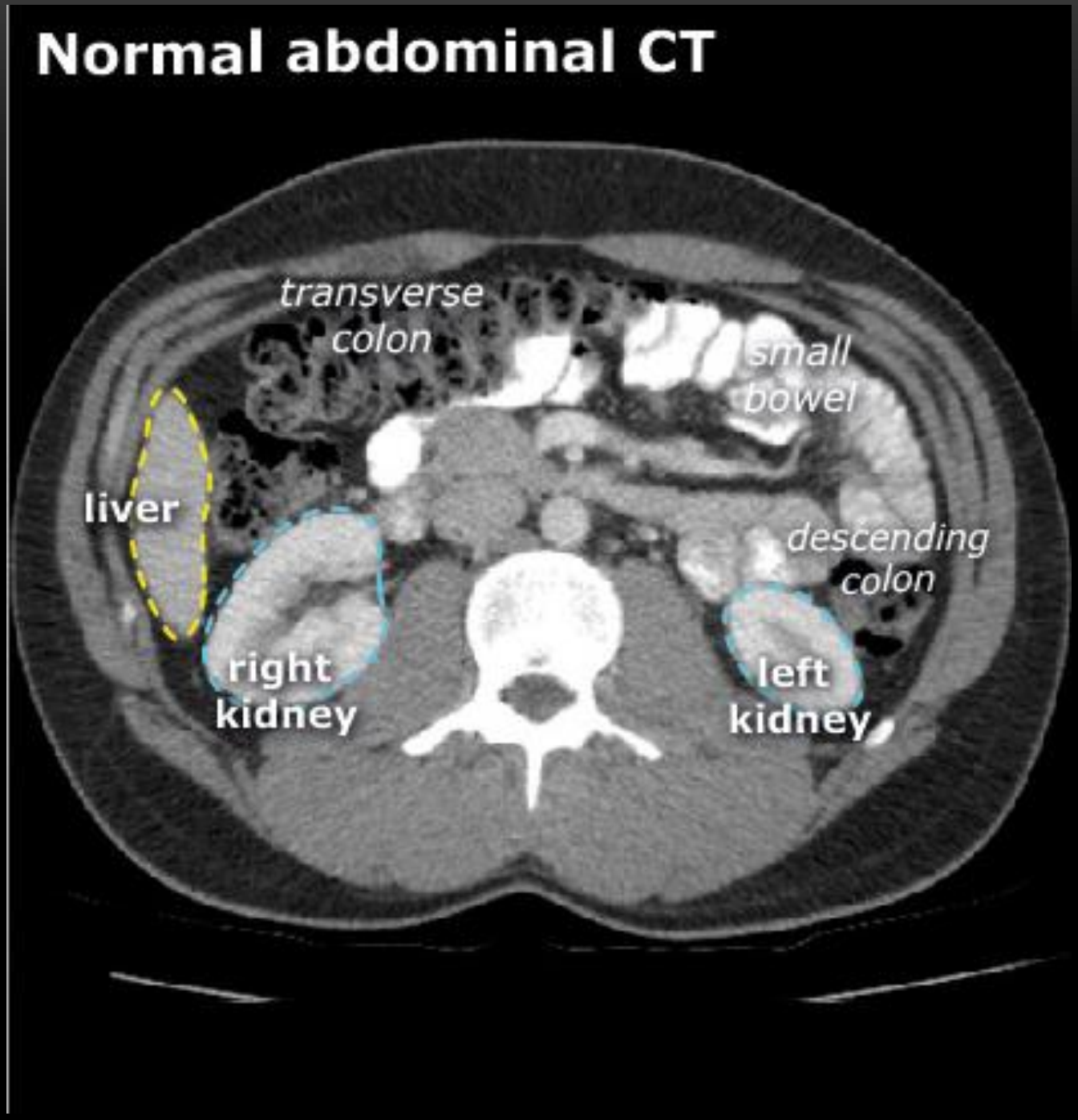

Normal abdominal CT
portal vein
stomach
gallbladder
pancreas
body
tail
splenic vein
liver
left kidney
spleen
inferior vena cava
(left adrenal gland)

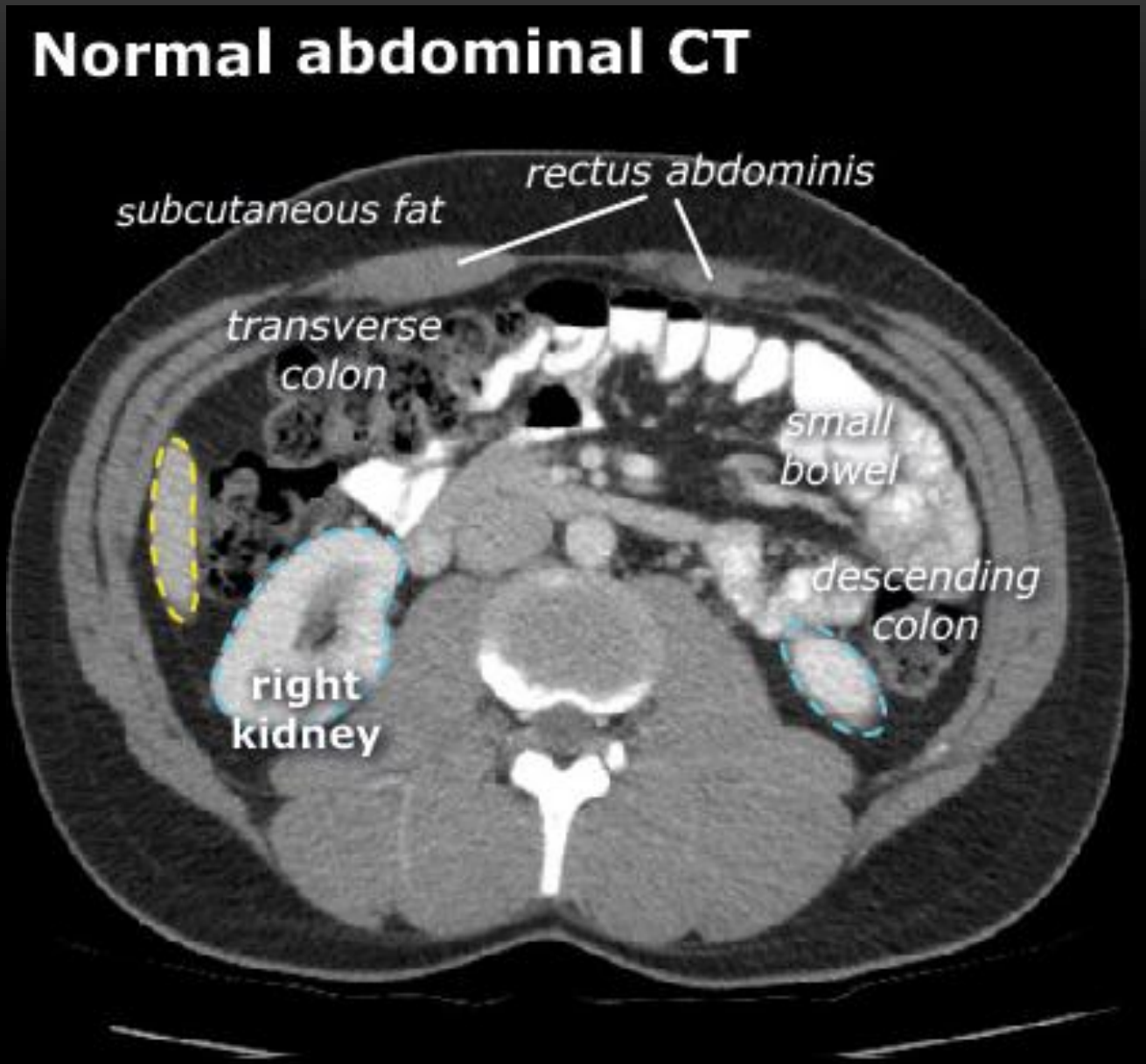

Normal abdominal CT
portal vein (confluence)
stomach
splenic vein
gallbladder
body
pancreas
tail
liver
spleen
left kidney
right adrenal gland
inferior vena cava

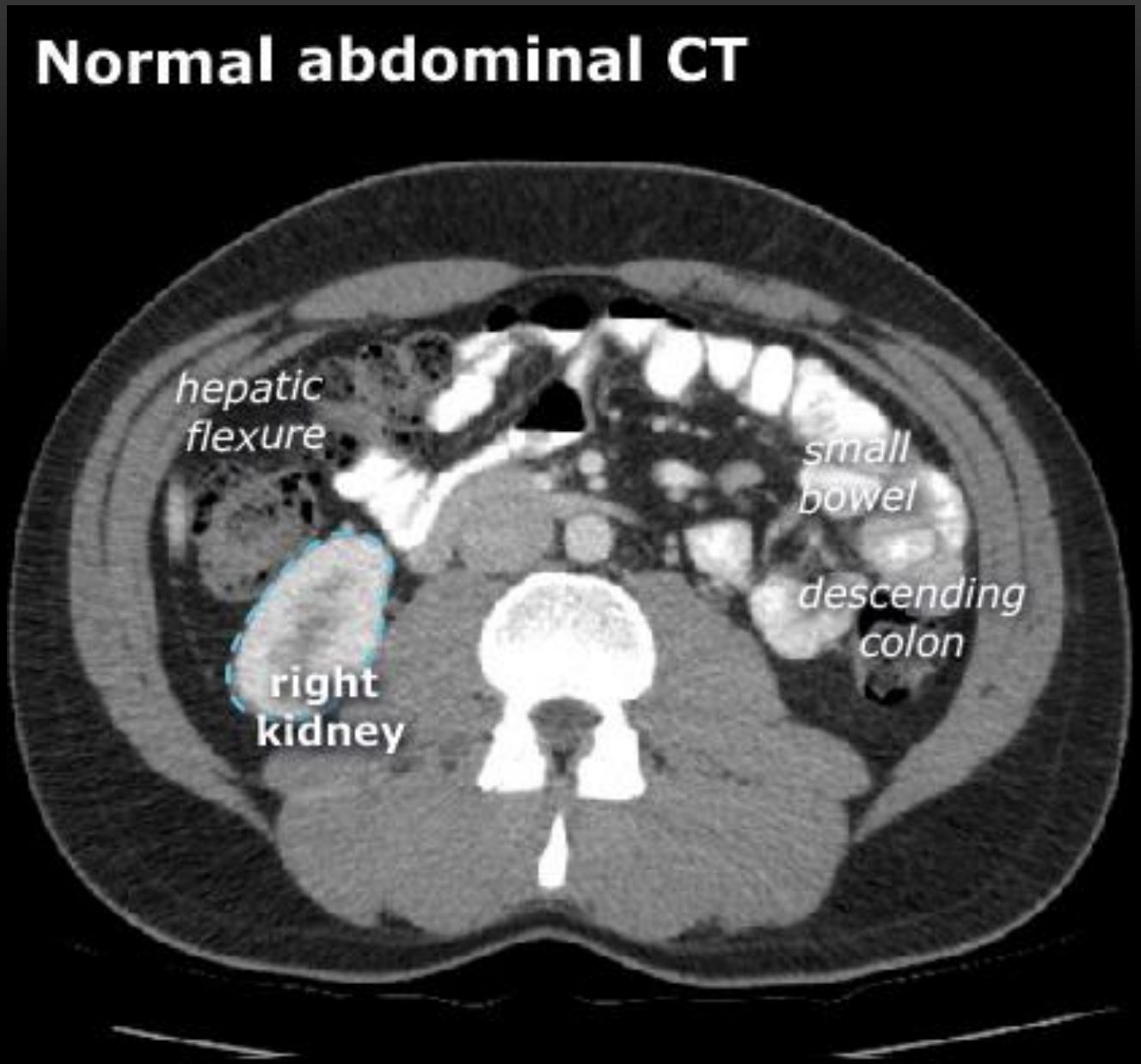

Normal abdominal CT
portal vein
(confluence)
splenic
vein
gallbladder
liver
spleen
left
kidney
inferior
vena cava

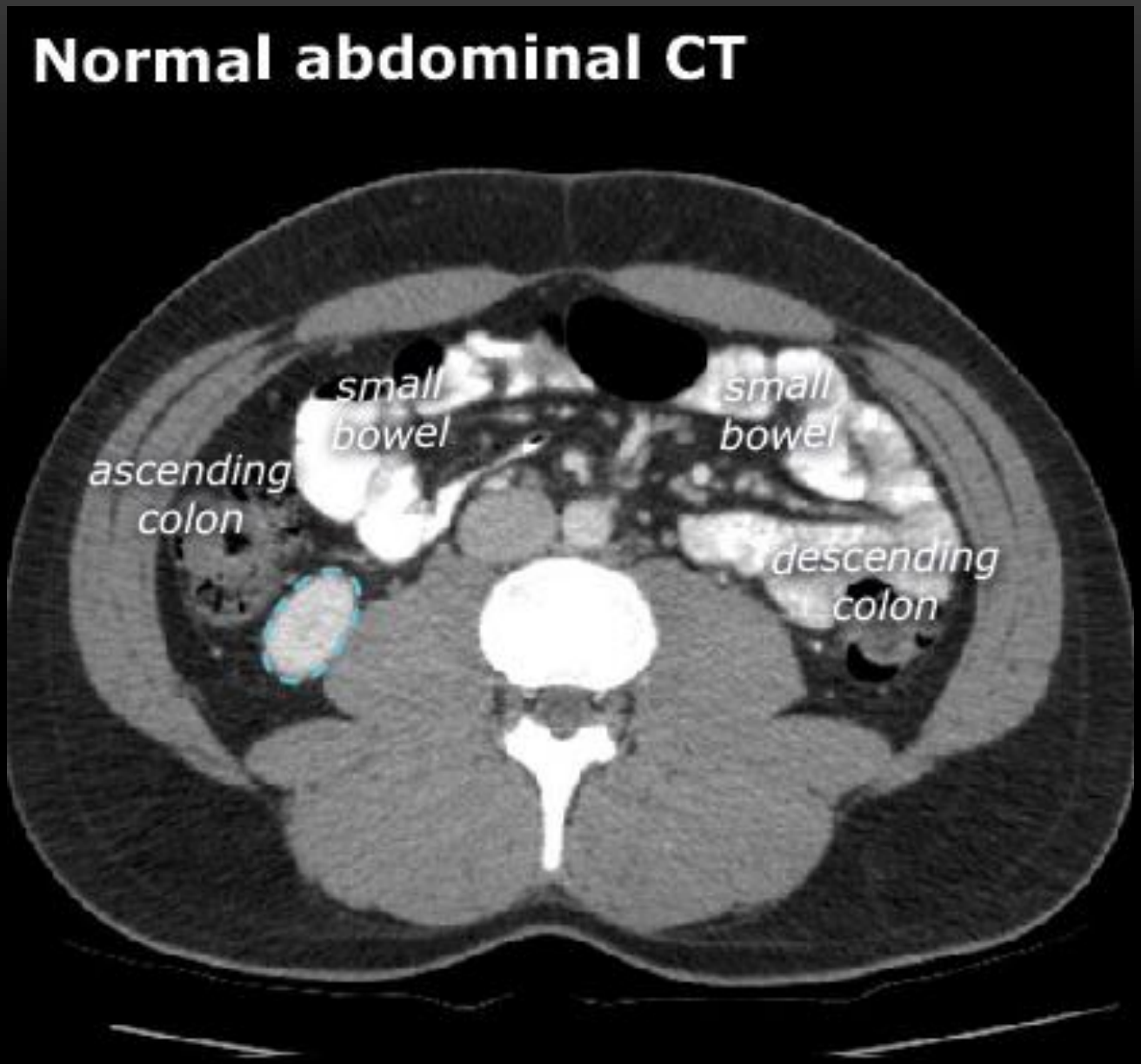

Normal abdominal CT
duodenum
superior
mesenteric vein
gallbladder
head
liver
right
kidney
left
kidney
inferior
vena cava

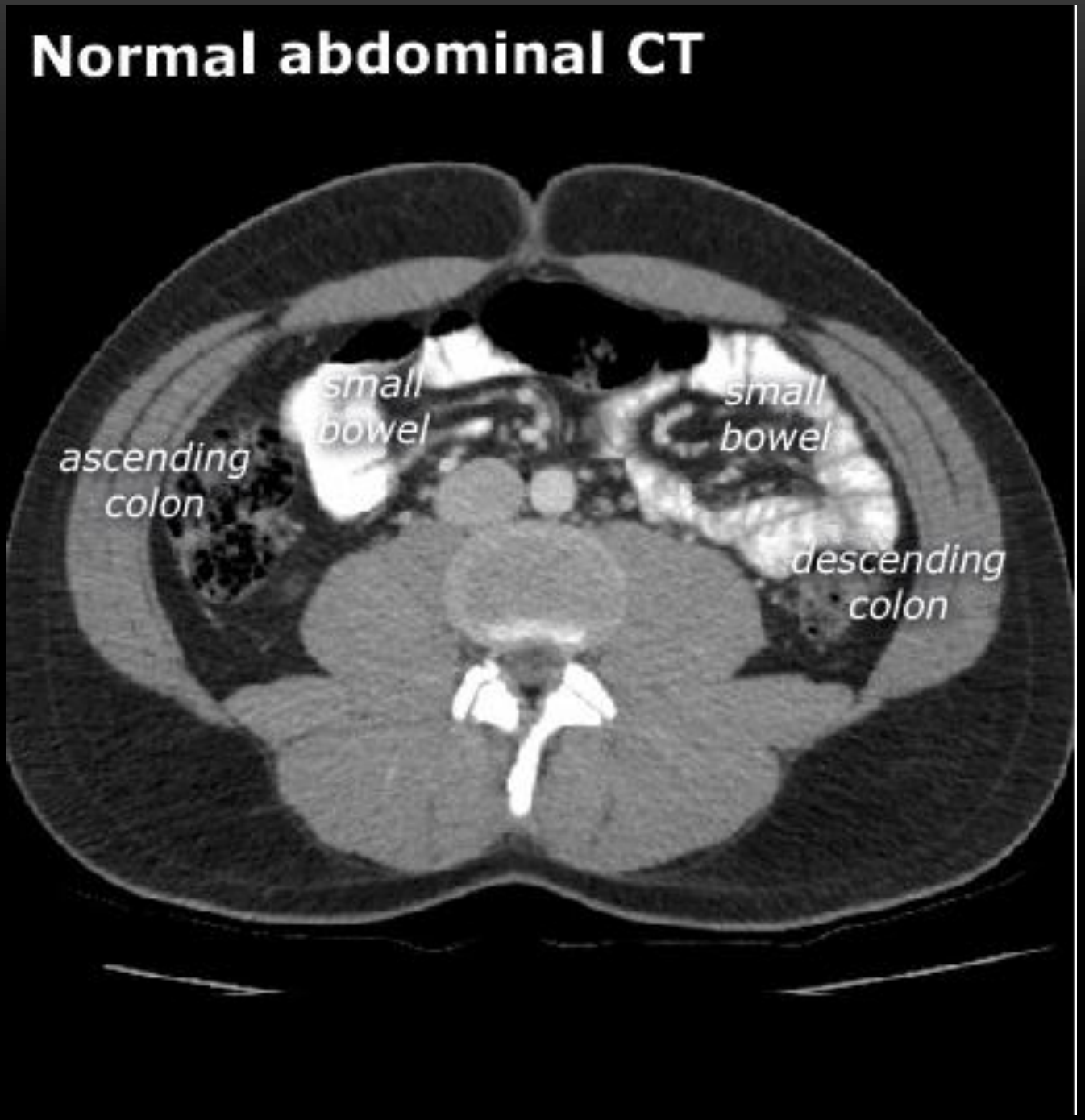

Normal abdominal CT
duodenum
superior mesenteric vein
superior mesenteric artery
left renal vein
liver
aorta
right kidney
left kidney
inferior vena cava


Normal abdominal CT
transverse colon
small bowel
liver
descending colon
right kidney
left kidney


Normal abdominal CT
rectus abdominis
subcutaneous fat
transverse colon
small bowel
descending colon
right kidney


Normal abdominal CT
hepatic flexure
small bowel
descending colon
right kidney


Normal abdominal CT
small bowel
small bowel
ascending colon
descending colon


Normal abdominal CT
small bowel
small bowel
ascending colon
descending colon

ACUTE ABDOMEN - PRACTICAL APPROACH

Natural history of frequent causes of an acute abdomen

Life-threatening		Self-limiting
Aortic aneurysm rupture	Appendicitis	Gastroenteritis
Pancreatitis	Cholecystitis	Lymphadenitis
Bowel ischemia	Sigmoid diverticulitis	Epiploic appendagitis
Perforated peptic ulcer	Salpingitis	Omental infarction
Perforated diverticulitis		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

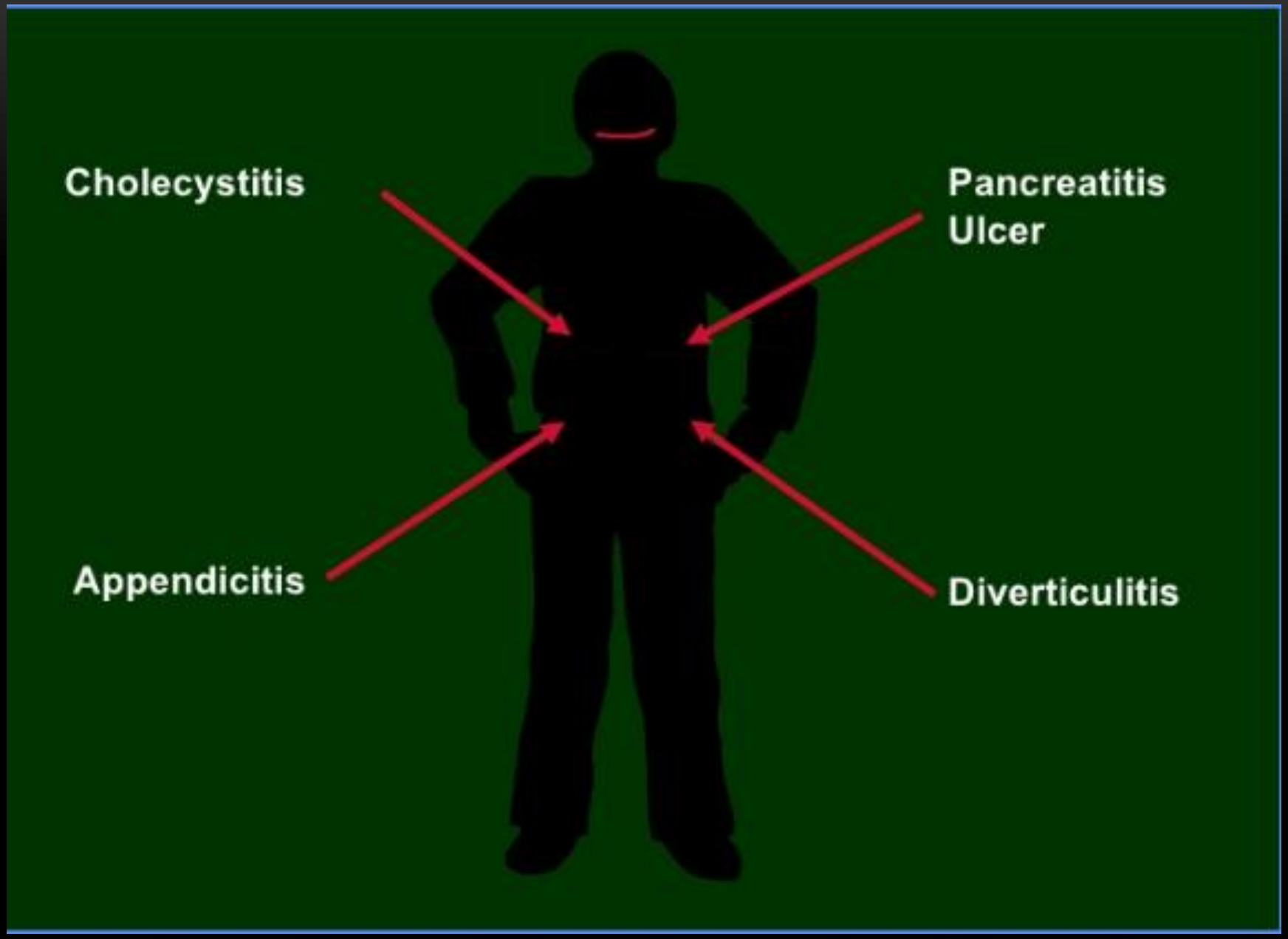
- The clarity of outlines of structures depends, on the differences between these densities.

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

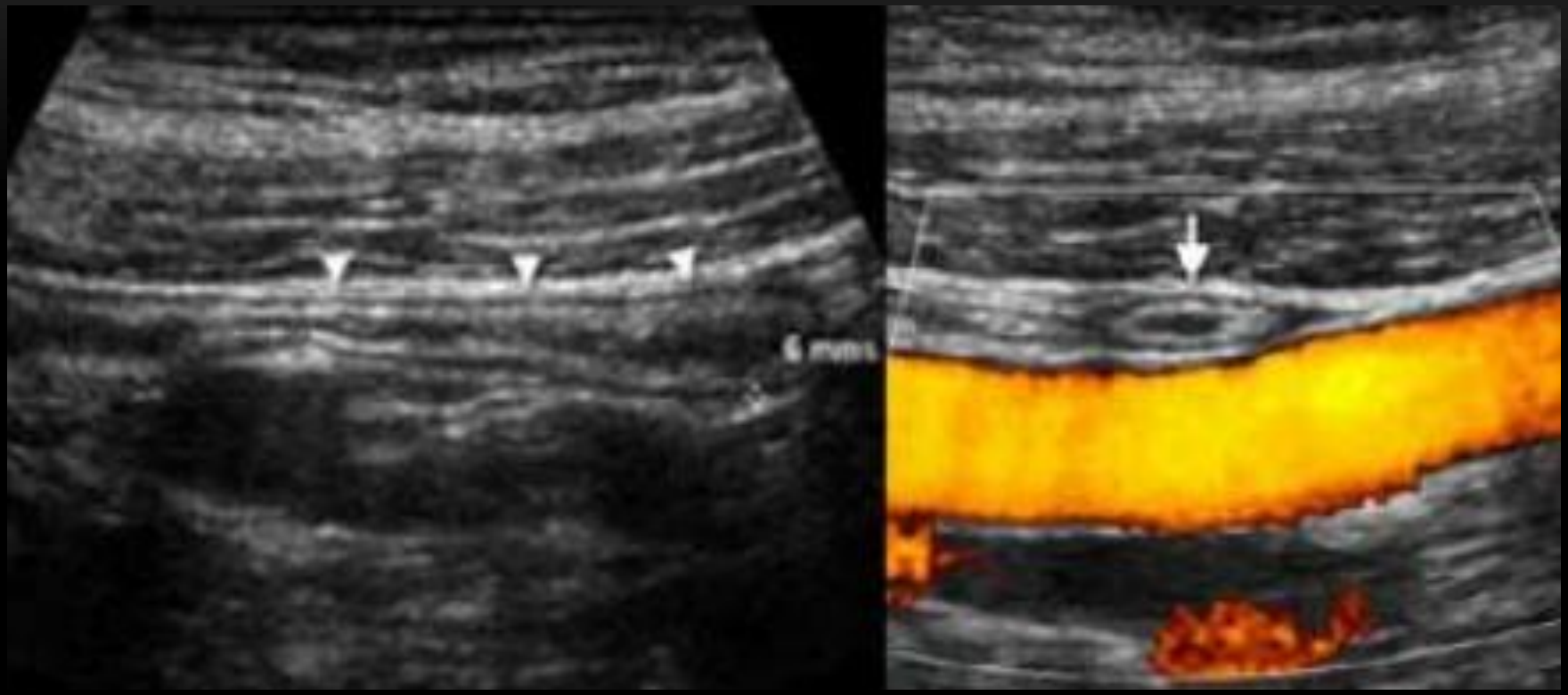

Cholecystitis
Pancreatitis
Ulcer
Appendicitis
Diverticulitis

RLQ : Appendicitis

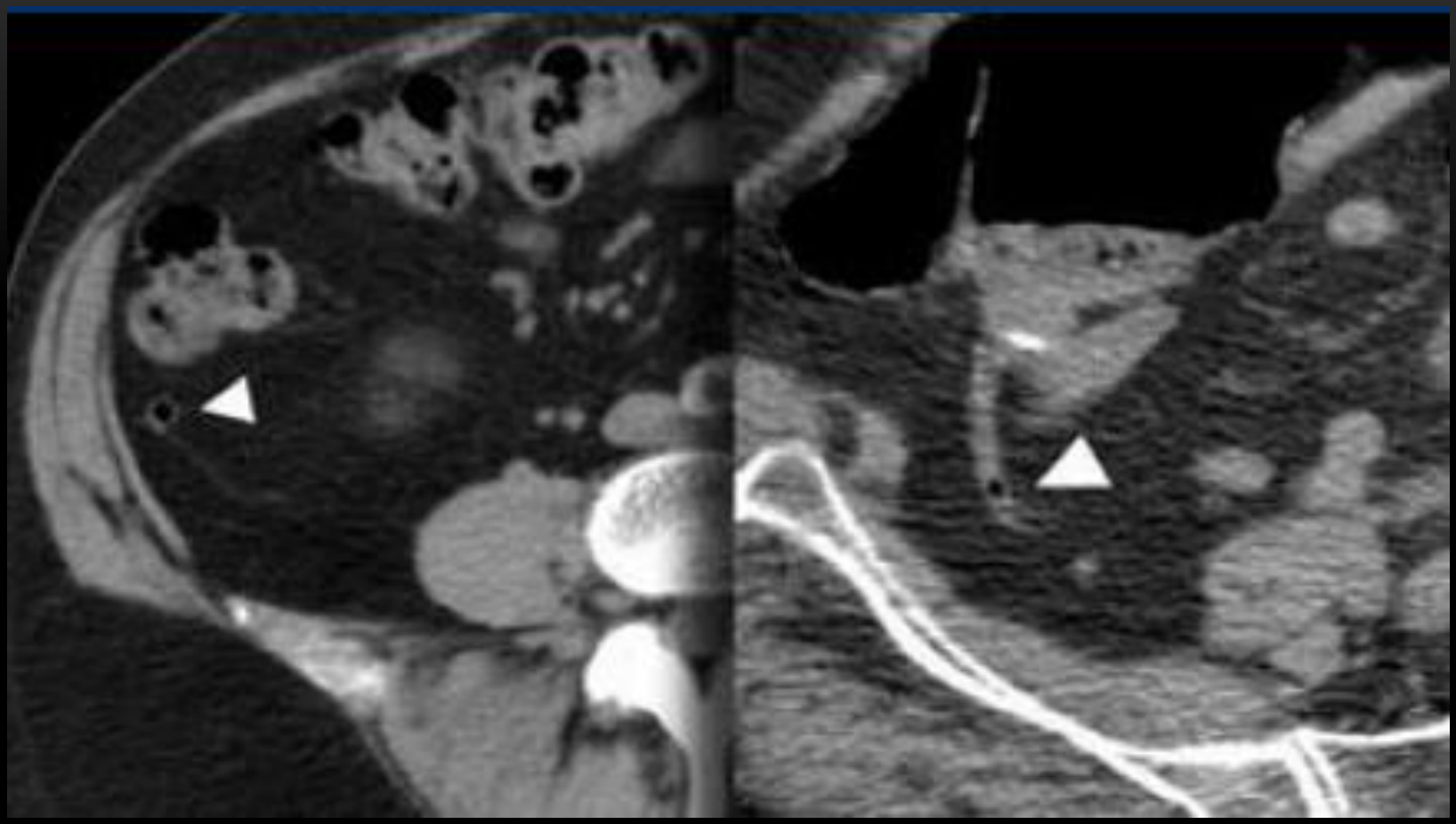
Pain in the RLQ, regardless of any other symptom or laboratory results, should be considered to be appendicitis until proven otherwise.
If you are unable to find the appendix you cannot rule out the diagnosis of appendicitis unless a good alternative diagnosis is found.
If you do not find the appendix and there is no altermative diagnosis call the results of the examination indeterminate. Do not call it:' no appendicitis'.

Signs of appendicitis

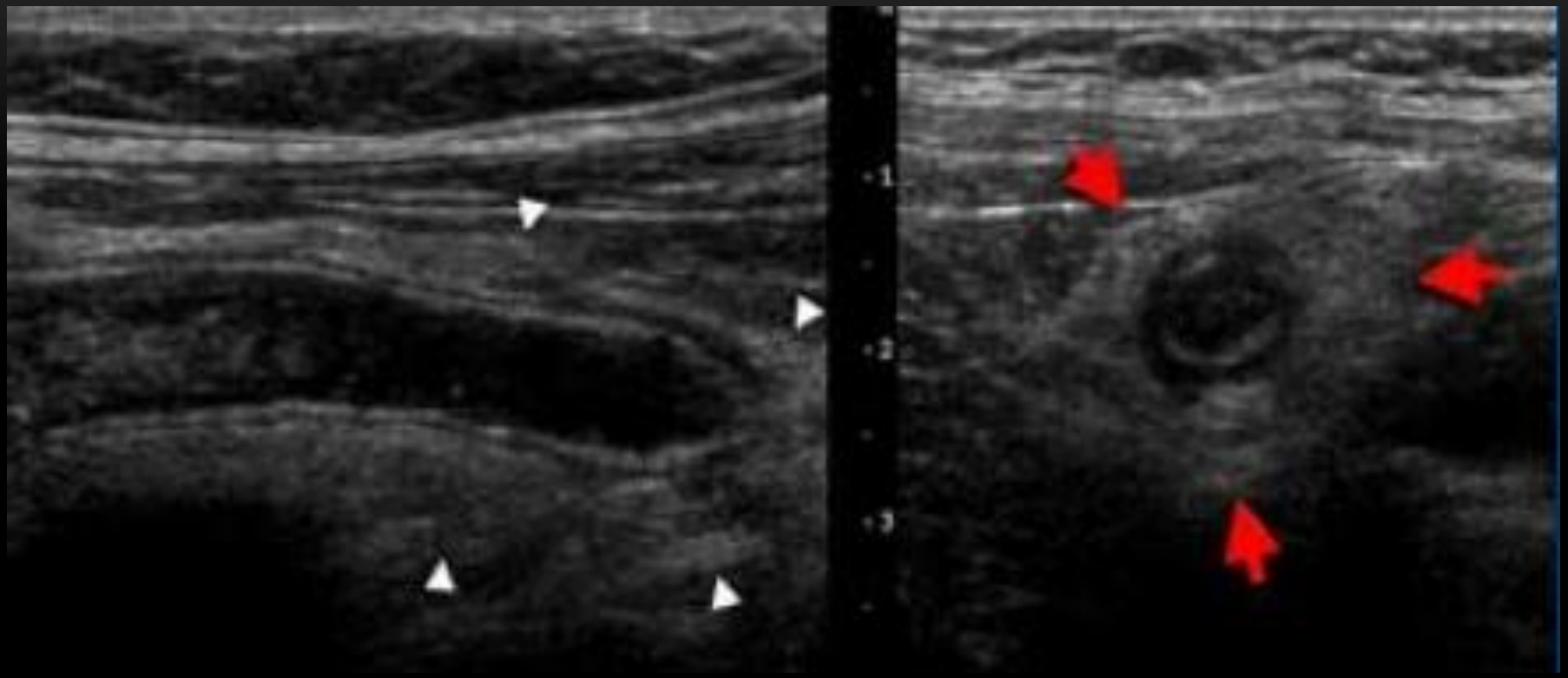
- Outer-to-outer diameter >6mm
- Inflamed periappendiceal fat
- Fecolith
- Hypervascularity on power Doppler



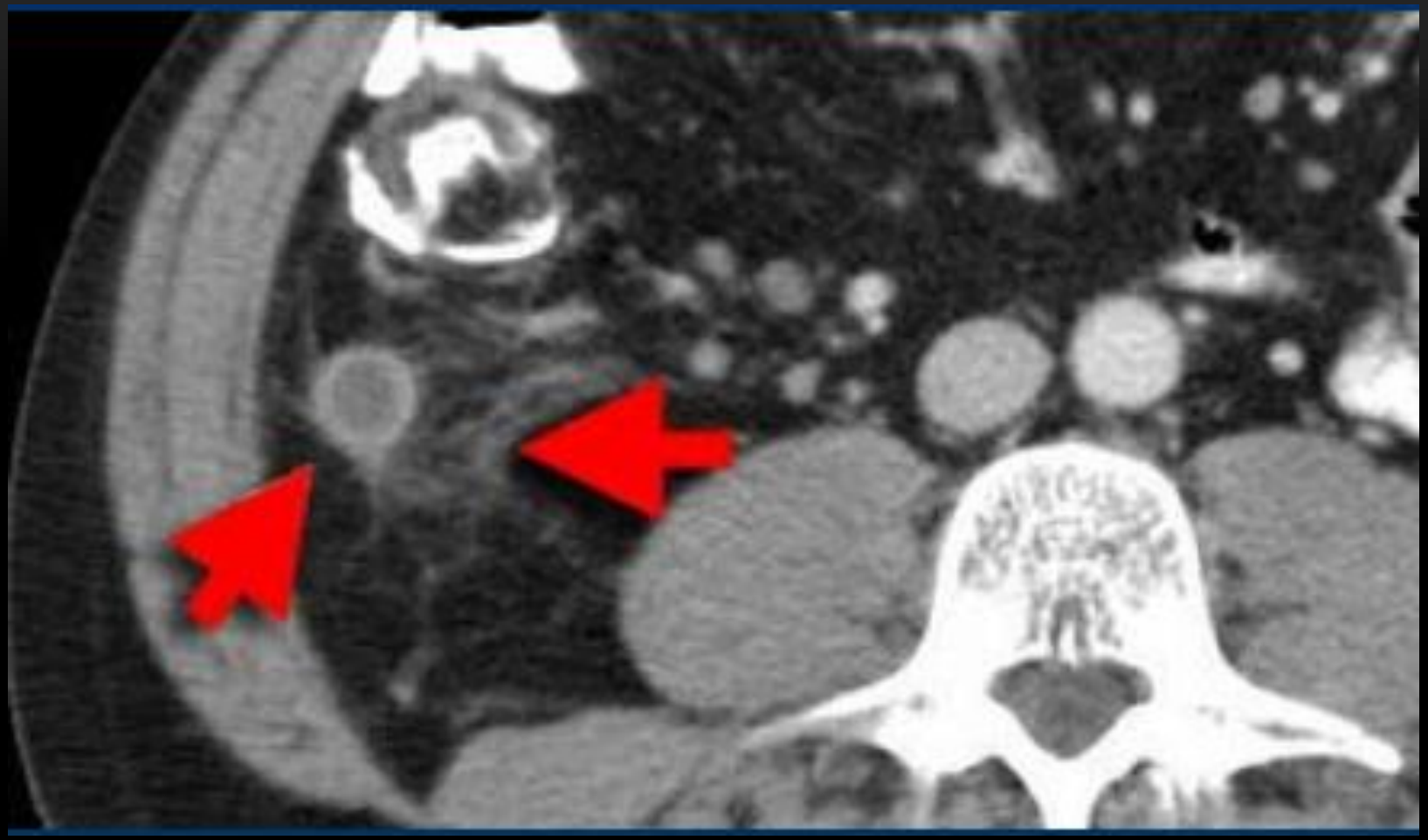
Normal appendix : Longitudinal (A) sonogram depicts a blind-ending tubular structure (arrowheads) with 'gut-signature', with a maximum outer diameter of 6 mm, with noninflamed surrounding fat. On an axial view (B) the appendix can be compressed crossing the iliac vessels.



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 bij hyperechoic inflamed fat (arrowheads).

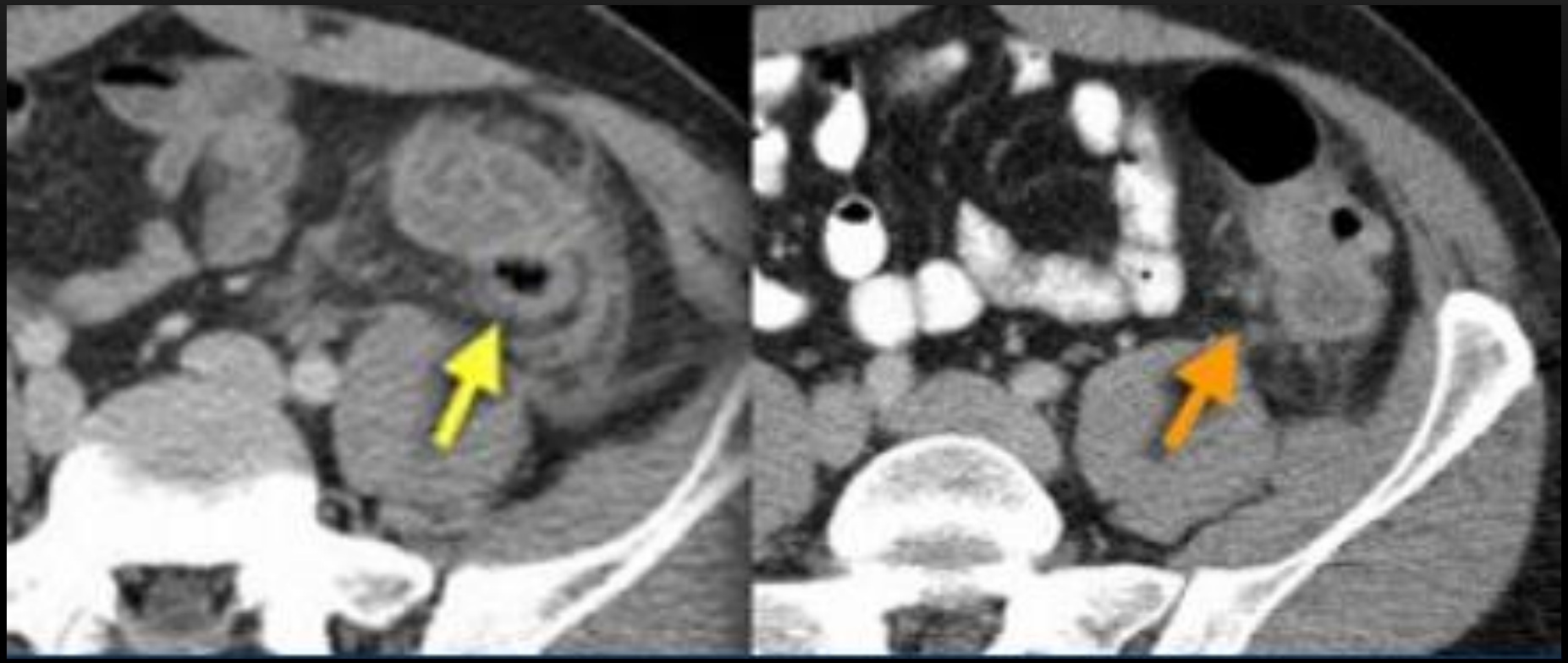


Inflamed appendix at CT. The appendix (arrows) is fluid-filled and distended with periappendiceal fat-stranding.

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).



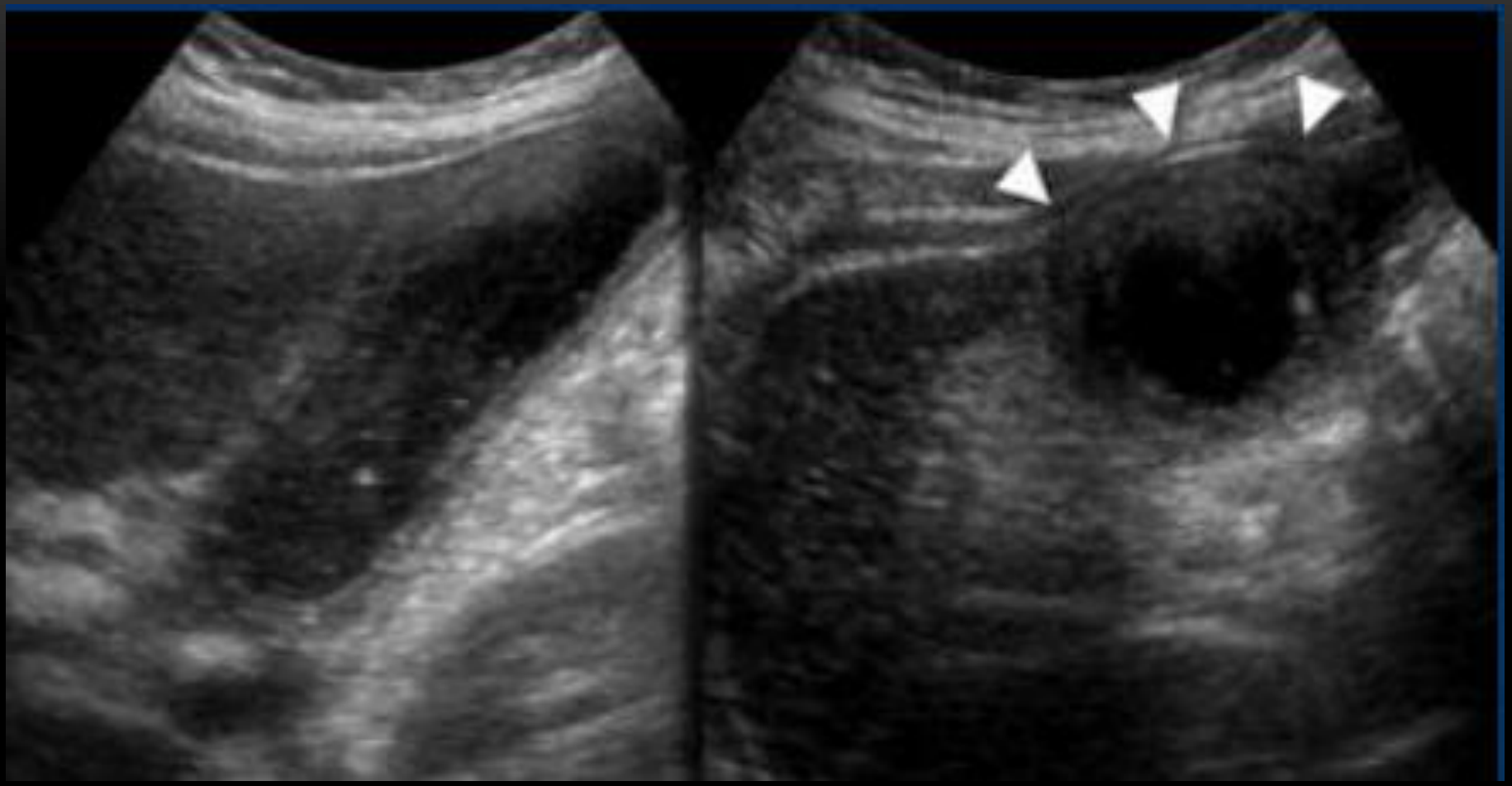
LEFT: Sigmoid diverticulitis. Diverticulum (arrow) is surrounded by hyperattenuating fat. The sigmoid wall is thickened. RIGHT: Sigmoid carcinoma with limited fat stranding.

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 compressiblity 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.

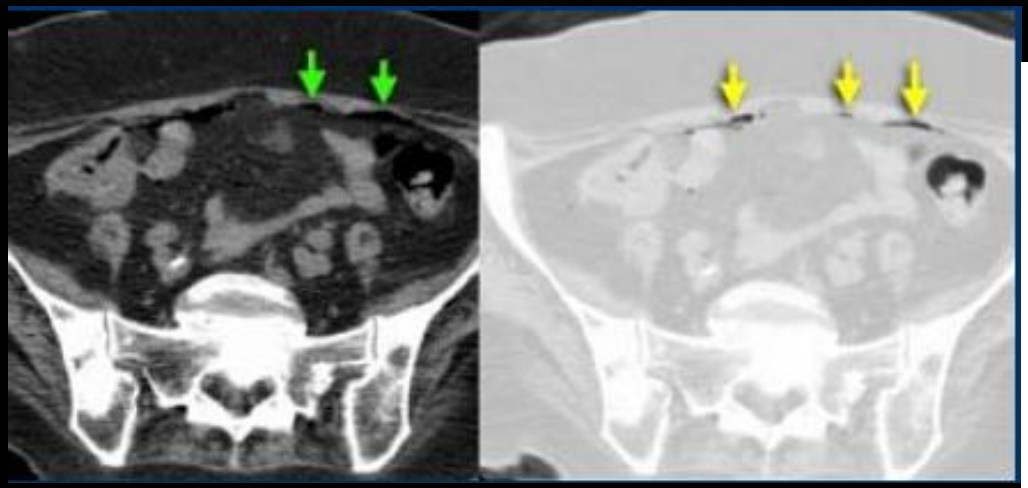
Pain in LUQ

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.



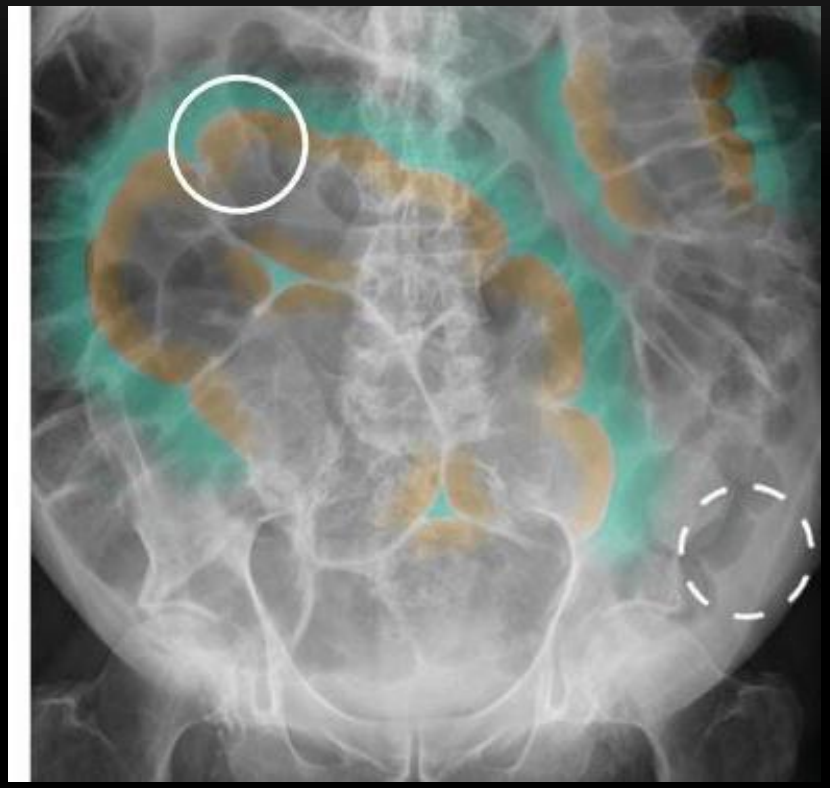
Free air

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

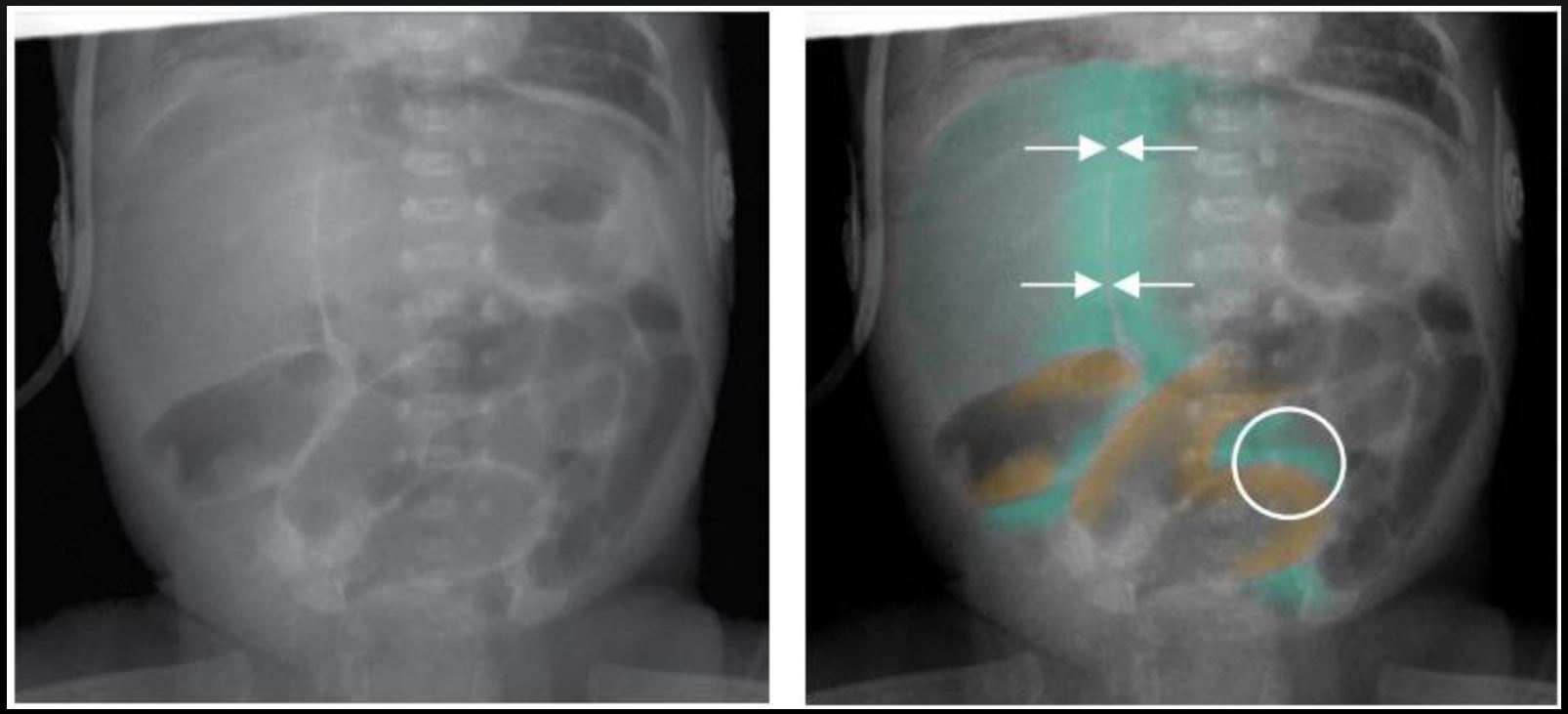
Free air is usually not seen in perforated appendicitis).
Always examine the images in lungsetting for better detection of free intraabdominal air (figure).

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



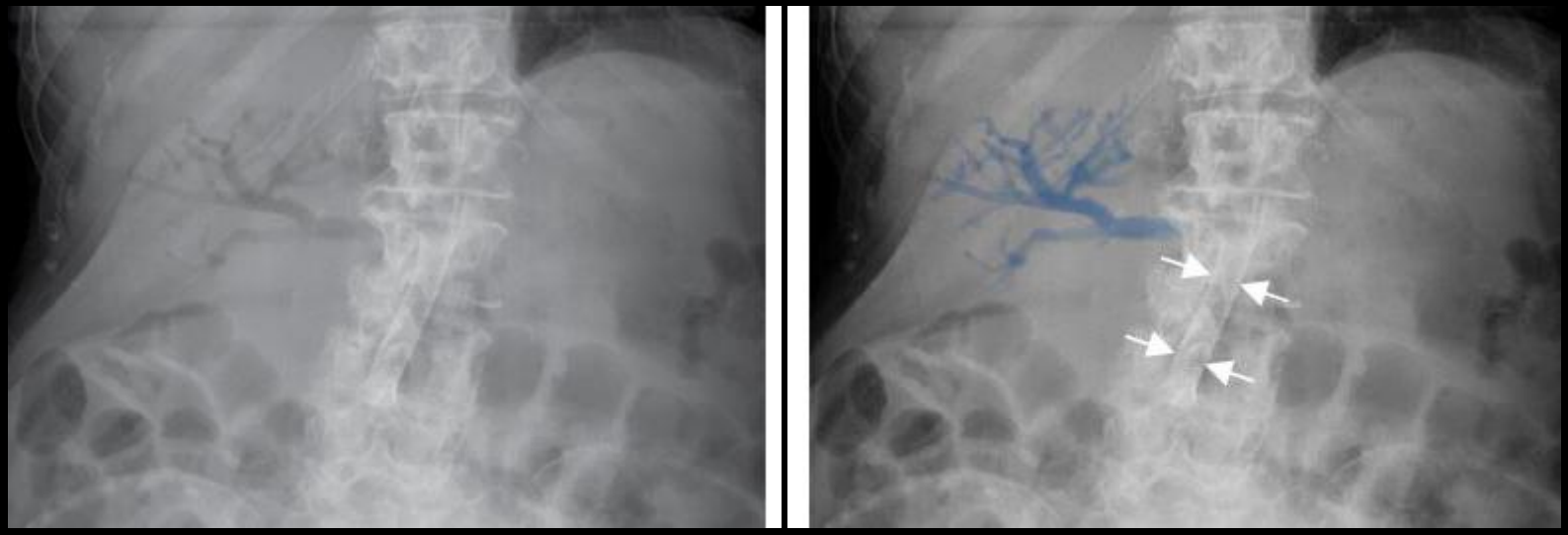
استرواح بريتوان كبير

علامة الرباط المنجلي

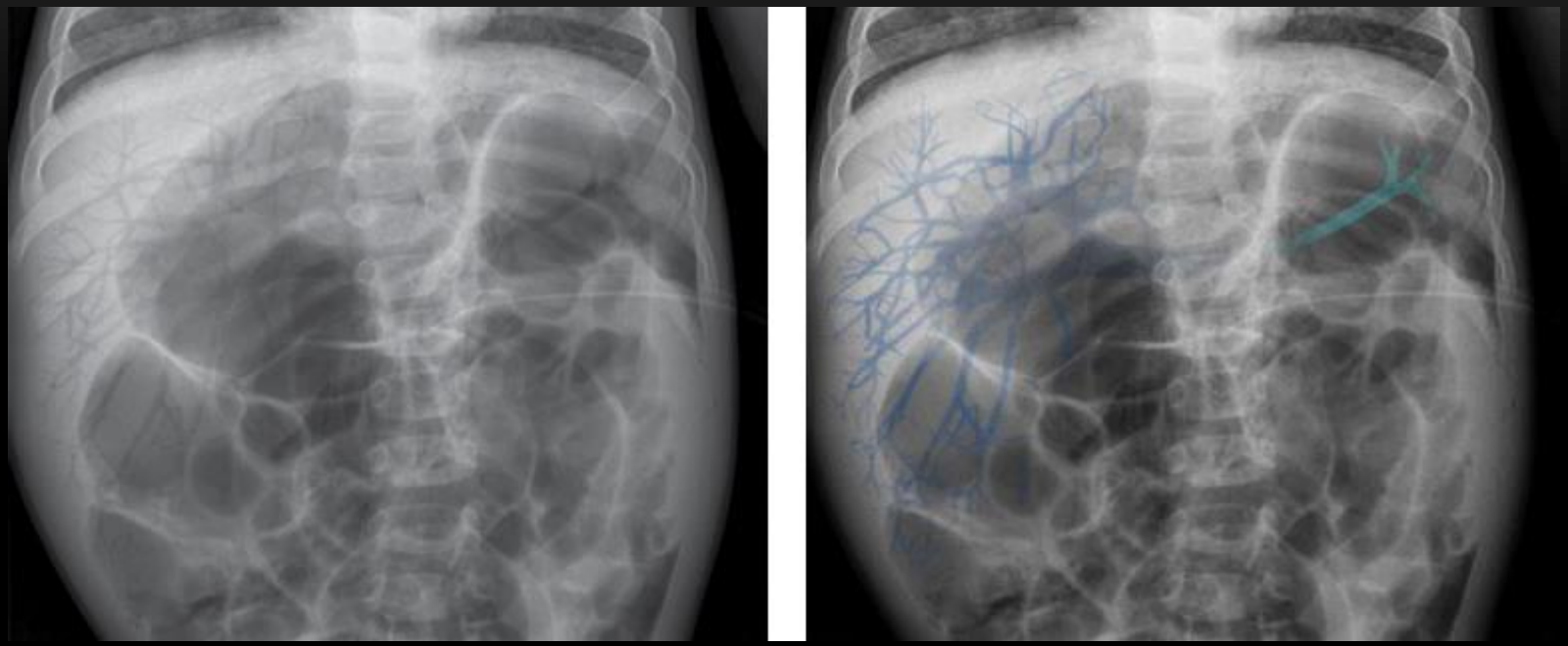


FOOTBALL SIGN علامة كرة القدم الأمريكية

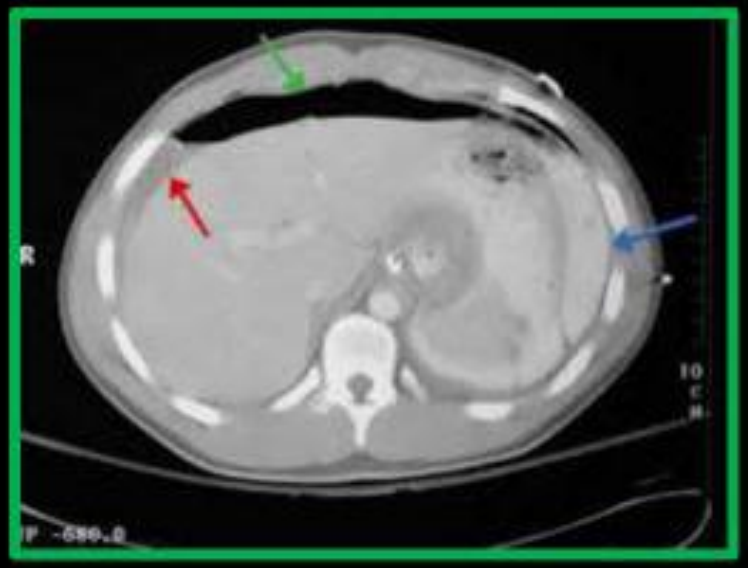
استرواح في الجهاز الصفراوي

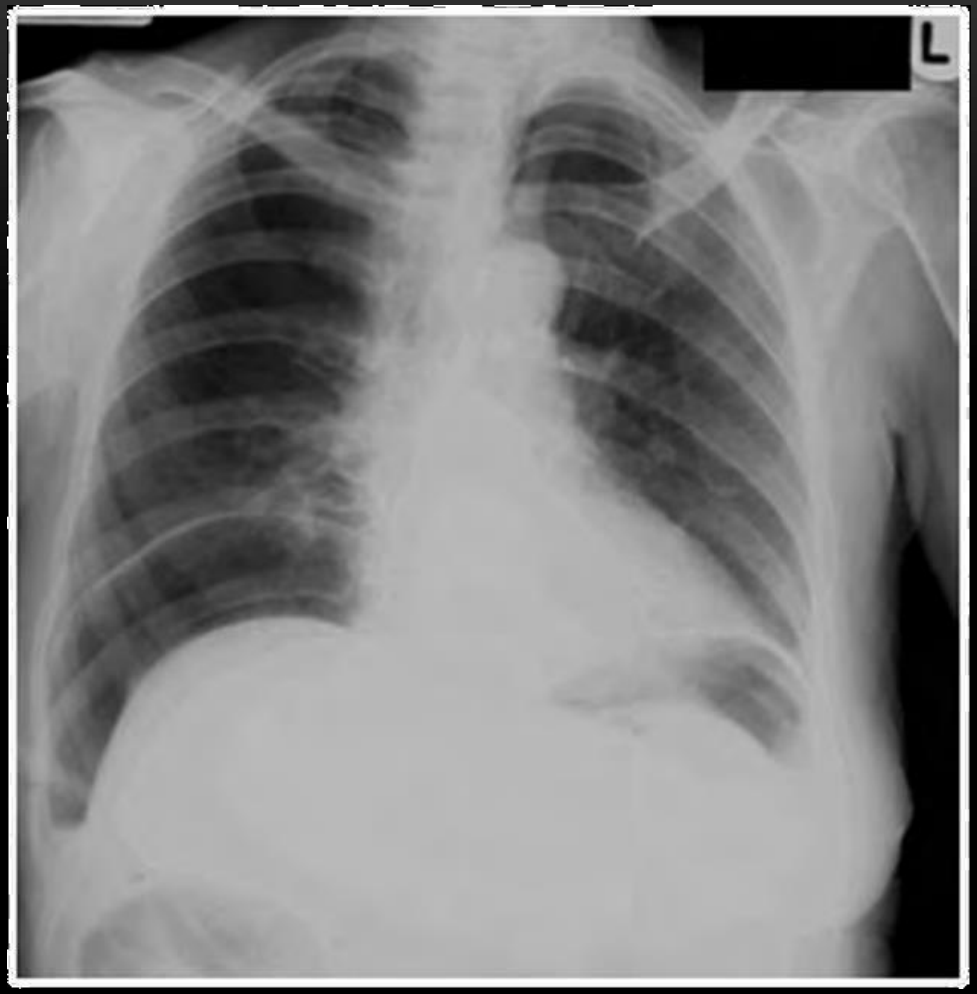


غاز في وريد الباب



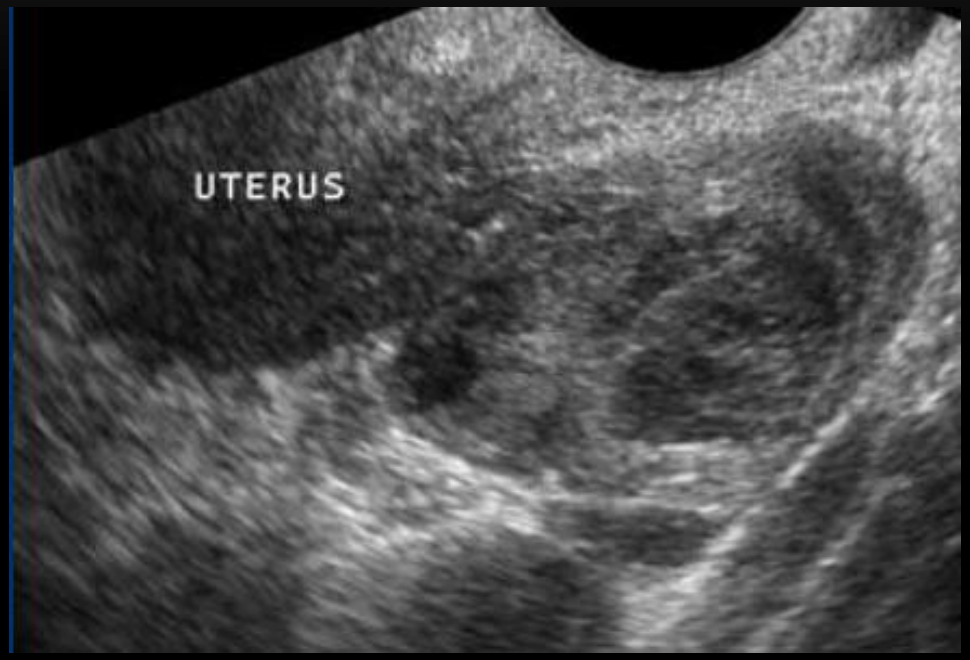
pneuoperitoneum





صورة صدر بسيطة خلفية أمامية: تظهر هلالين هوائيين تحت قبتي الحجاب وتهوي البريتوان.

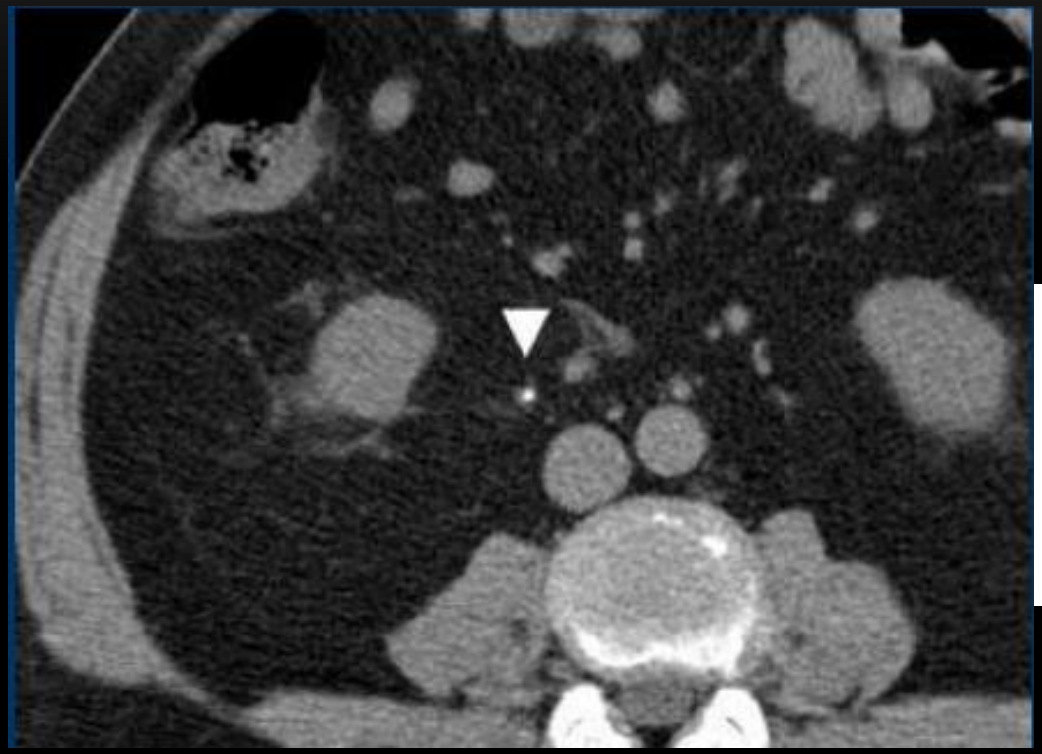
صورة بطن بسيطة: تظهر علامة ريغلر (المشار إليها).



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

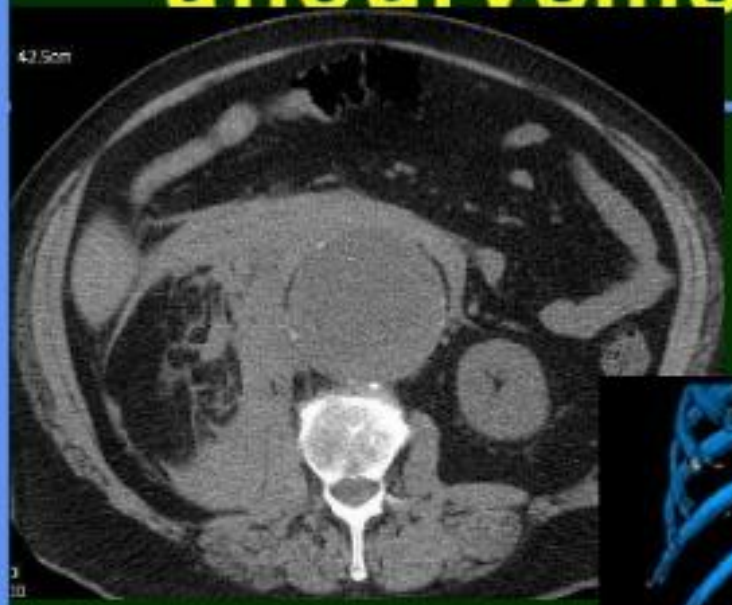
Urolithiasis often causes flank pain, but an ureteral stone (arrowhead) may occasionally present with clinical signs simulating appendicitis, cholecystitis or diverticulitis. Appendicitis on the other hand may cause hematuria, pyuria and albuminuria in up to 25% of patients because of ureteral inflammation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

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

Renal Colic

Renal stone right sided hydronephrosis

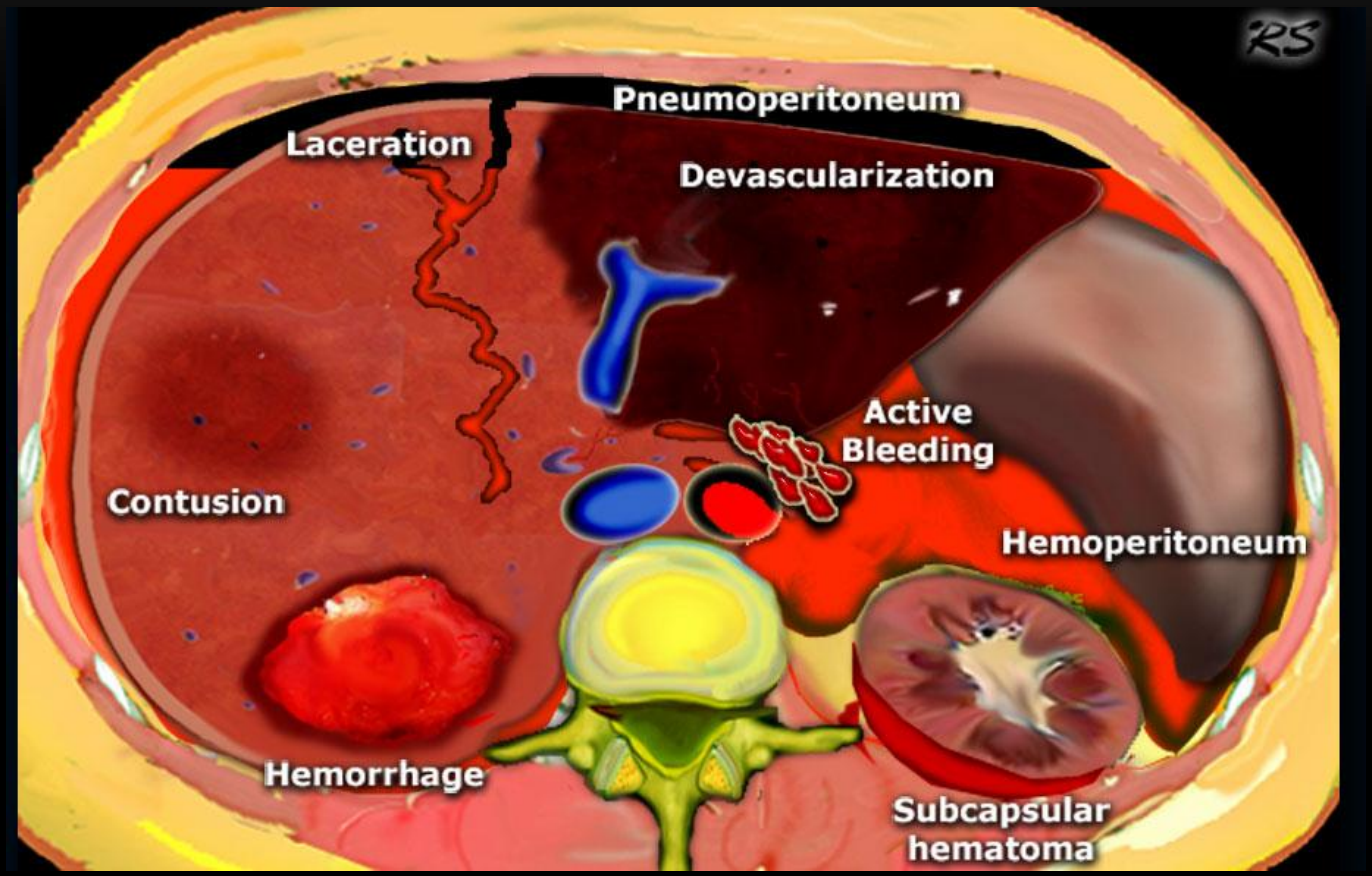
Aortic aneurysms

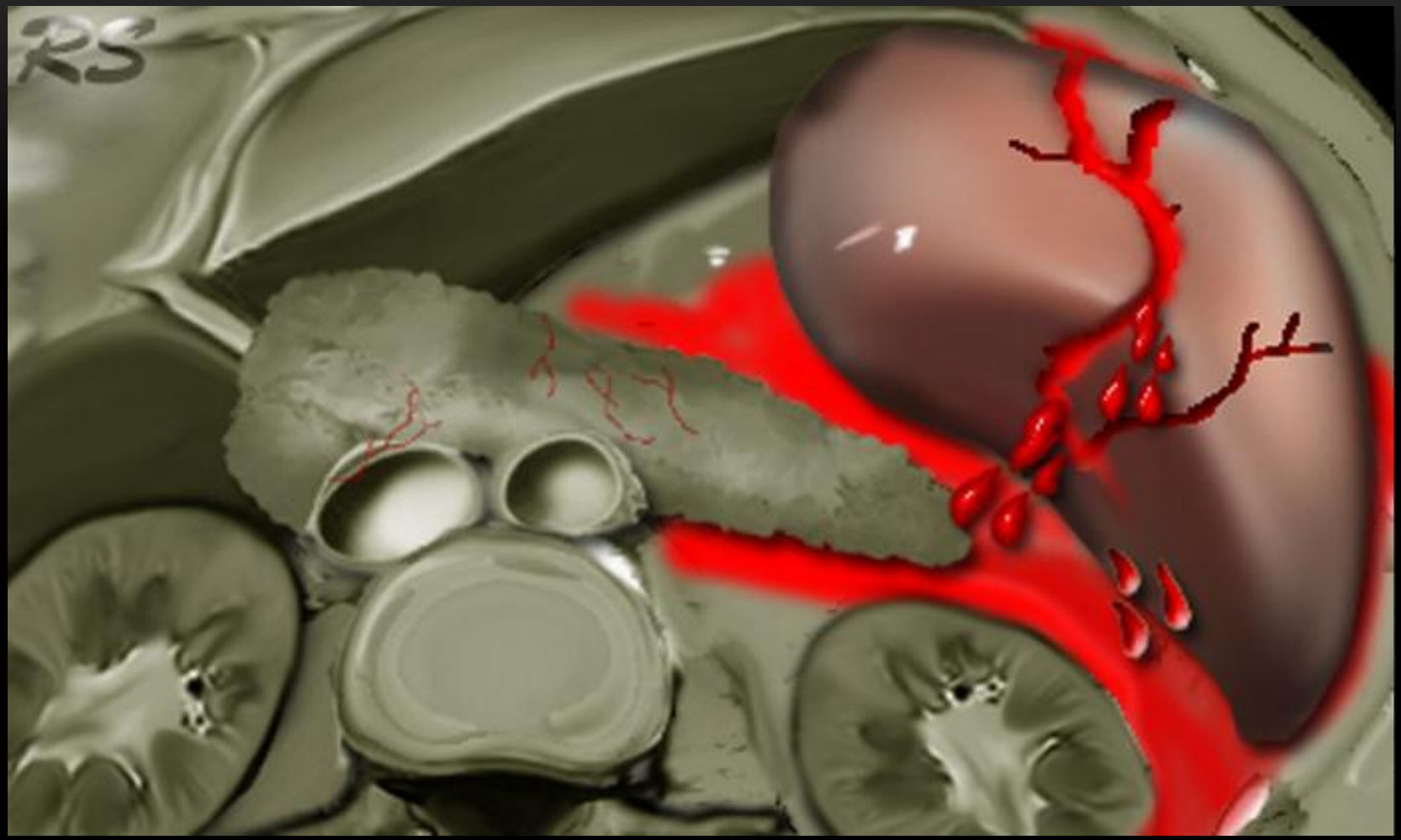


Left retroperitoneal fluid collection due to ruptured aneurysm.

Pancreas surrounded by fat stranding due to exsudative pancreatitis.

Acute Abdomen - Role of CT in Trauma

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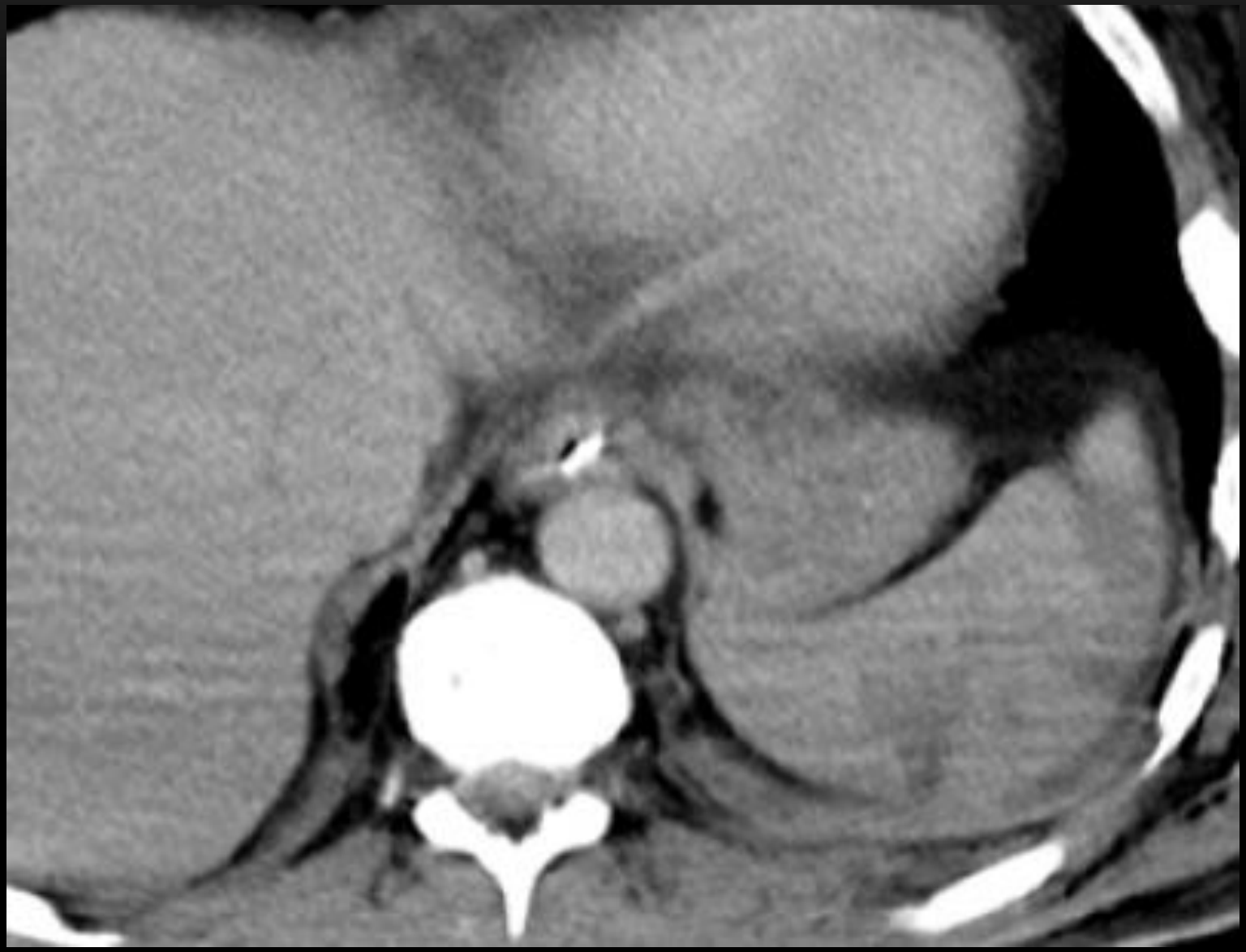
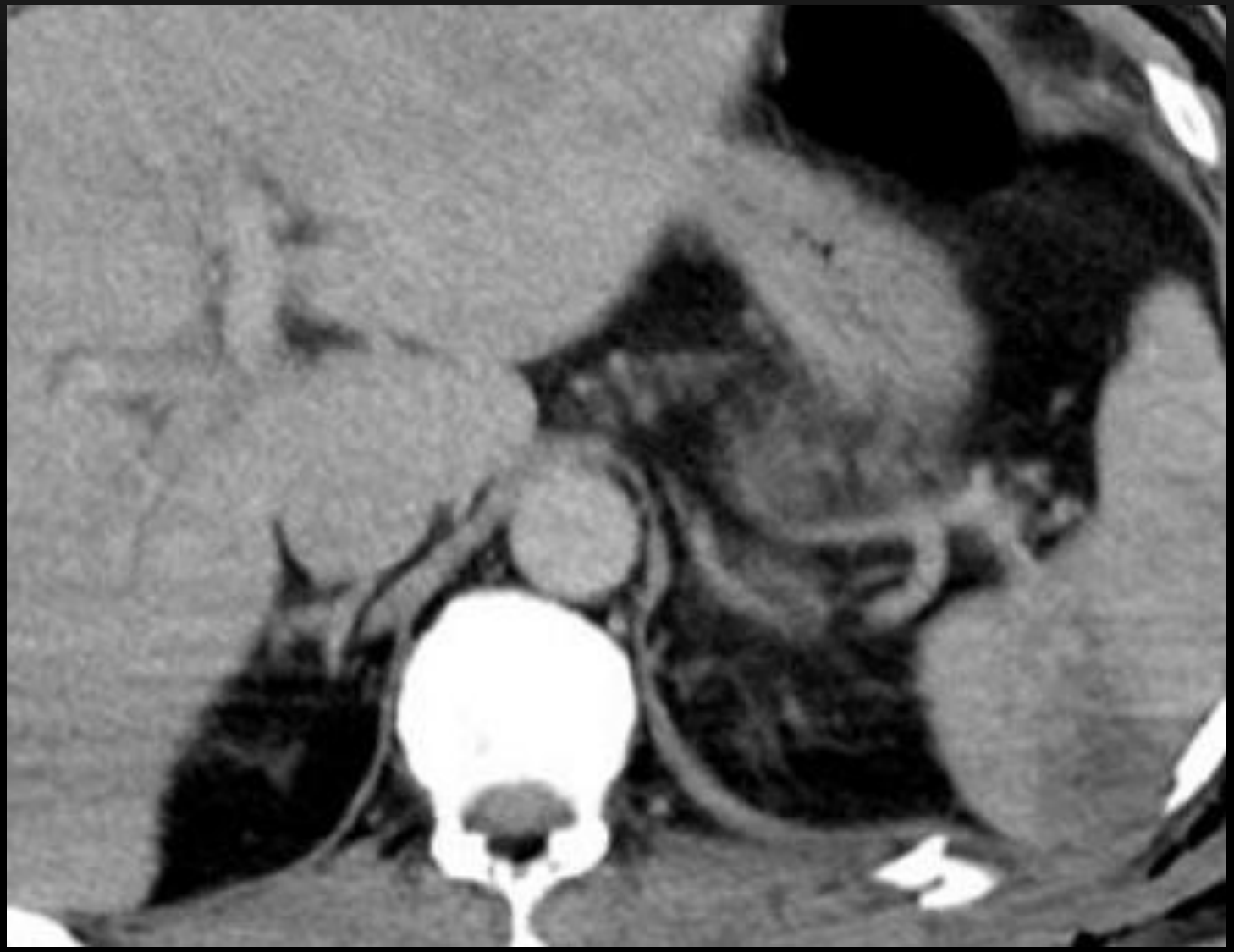
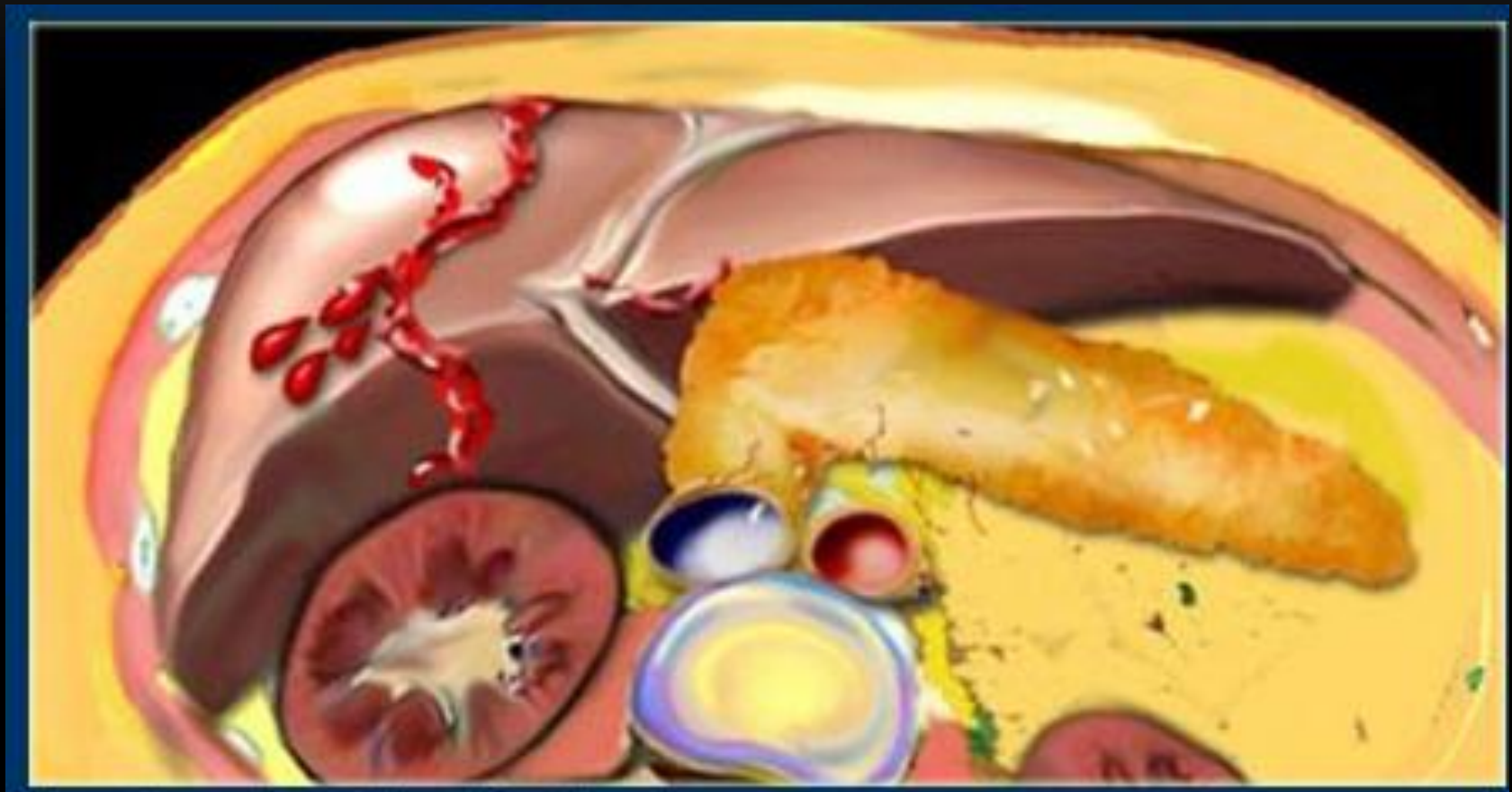


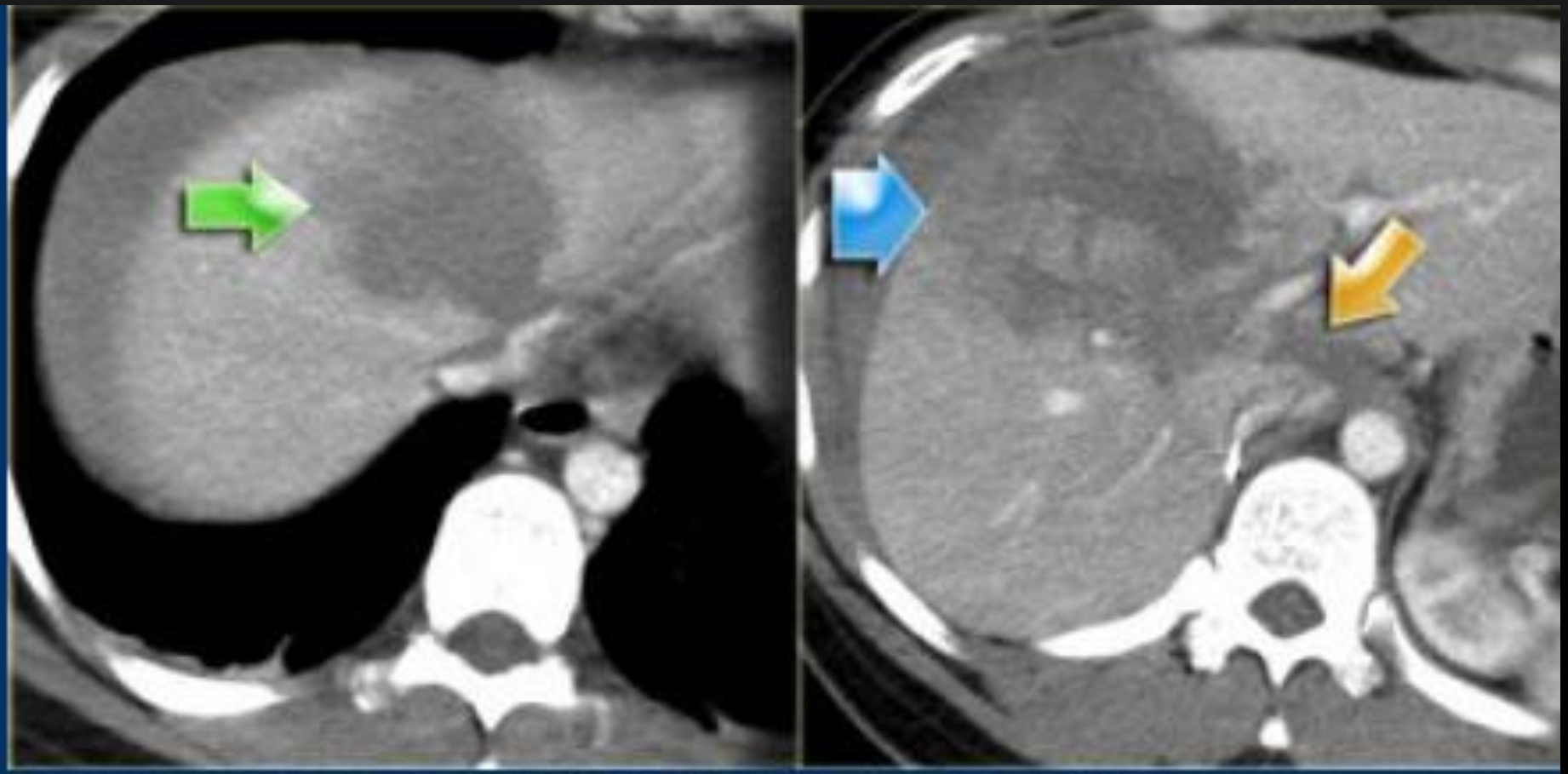


Splenic CT Injury Grading Scale

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



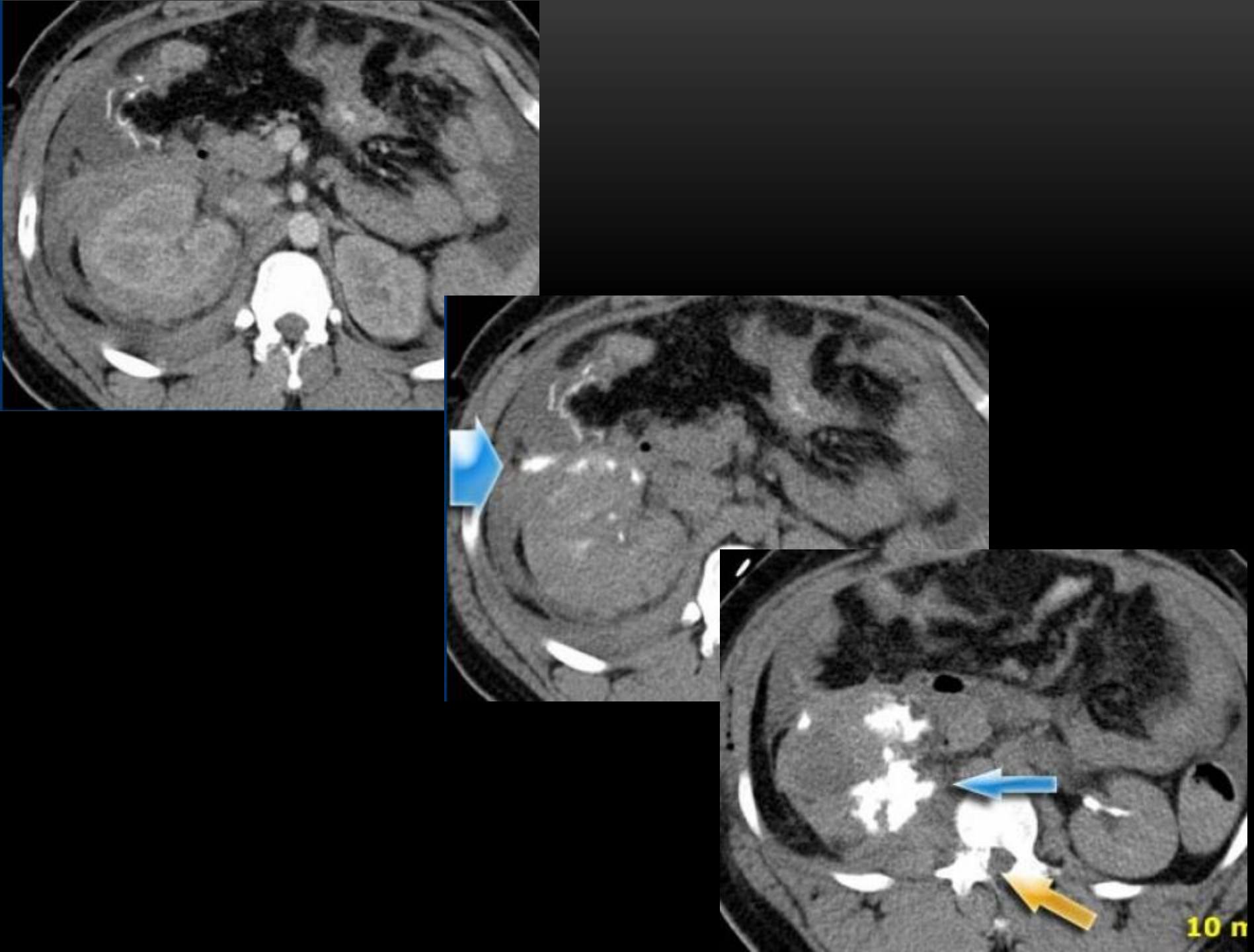
Liver laceration with active bleeding



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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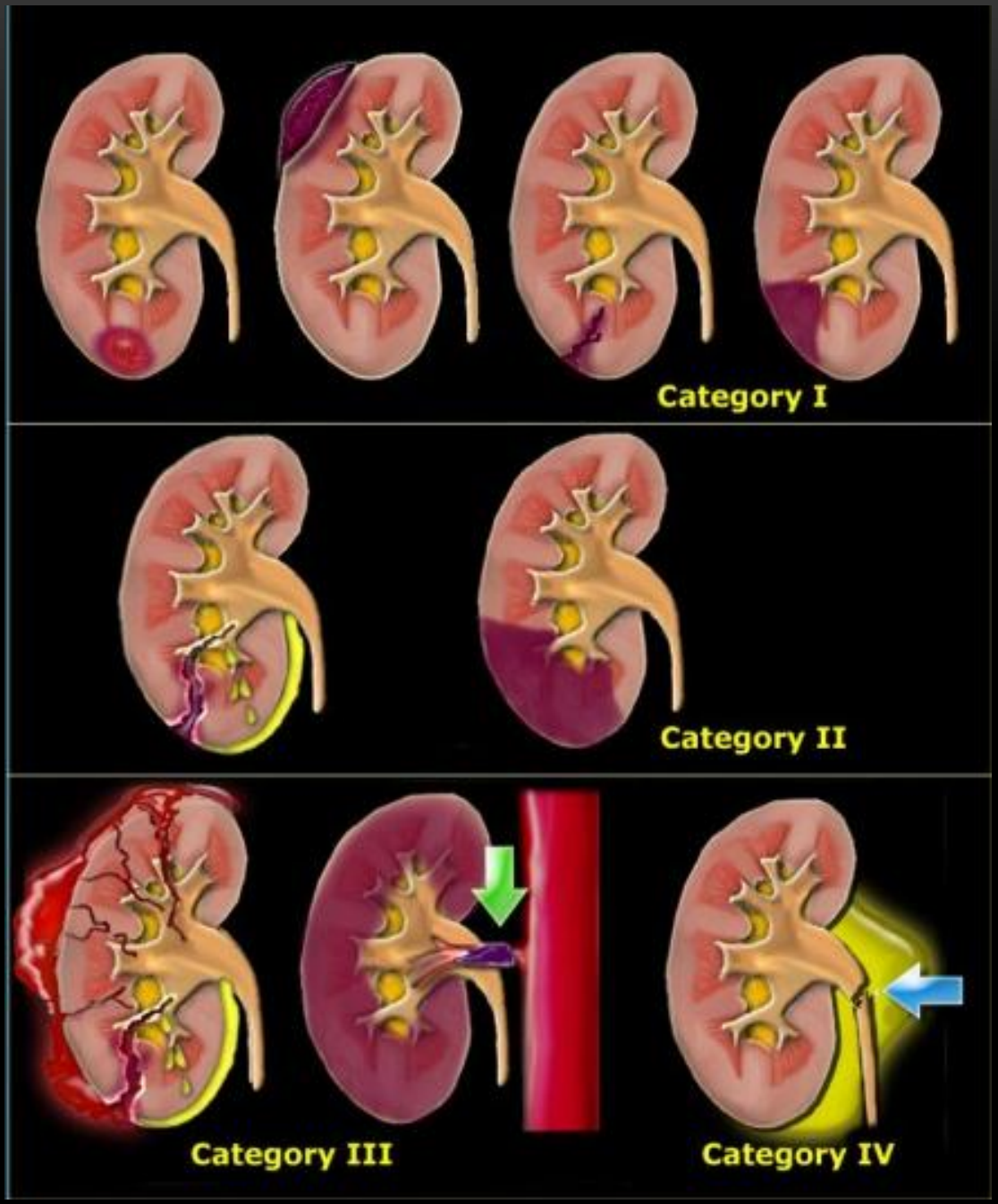

Category I
Category II
Category III
Category IV

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

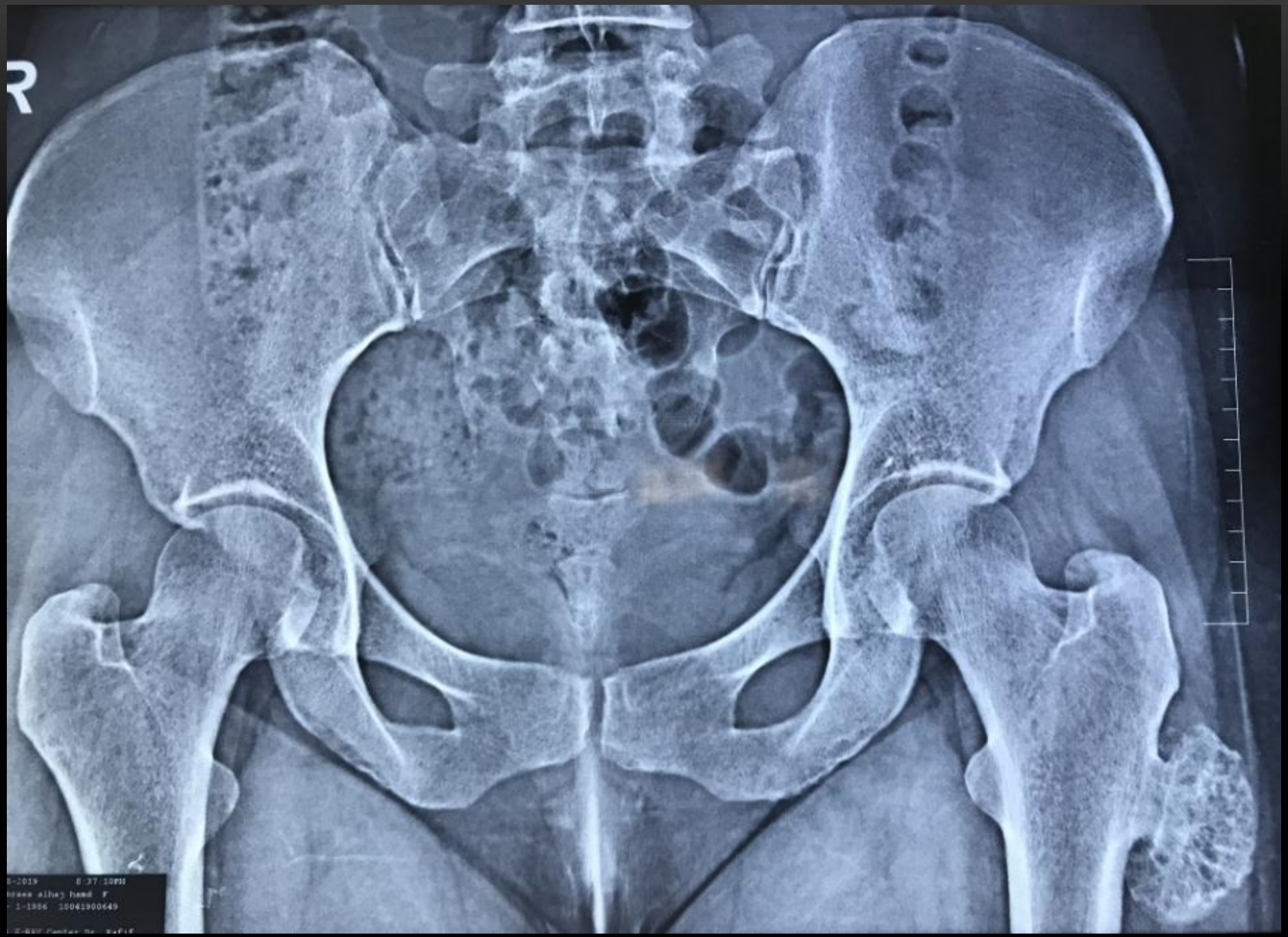
Grade I	Contusion / Subcapsular hematoma No parenchymal laceration
Grade II	Laceration < 1 cm depth of renal cortex No urinary extravasation
Grade III	Laceration > 1 cm depth of renal cortex No urinary extravasation
Grade IV	Laceration extending through renal cortex, medulla and into collecting system 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.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