

how to use the holistic concept of subperitoneal space to improve the CT diagnosis of acute abdomen.

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Subperitoneal space is constituted of subserous connective tissue beneath the peritoneal surfaces of abdomen and pelvis ,which belong either to parietal or to visceral peritoneum

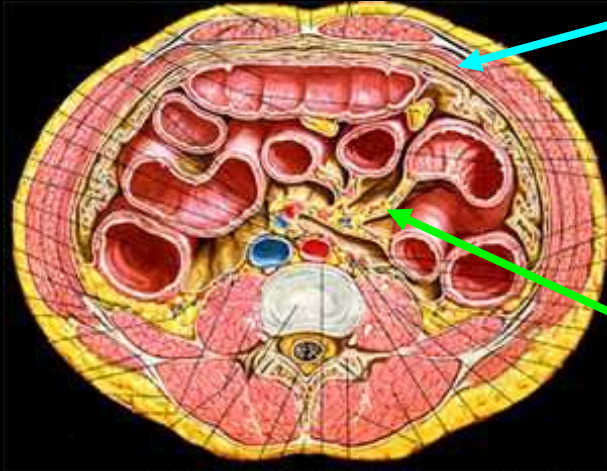
Subperitoneal space is a **preferential way of spreading** for inflammatory and tumoral diseases but also for diffusion of fluids such as gaseous and liquid effusions .

The **holistic concept** of subperitoneal space refers to the fact that all its components constitute an **anatomic continuum of connective tissue** joining pelvis, retroperitoneum and mesenteric perivascular extensions of the peritoneal cavity .Moreover possible transdiaphragmatic communications allow bidirectionnal migrations of gas from sub diaphragmatic areas to mediastinum and cervico thoracic regions .

These anatomic features are very useful in daily CT practice to better understand some intriguing clinical or radiological situations specially in abdomino-thoracic emergencies



subperitoneal anterolateral or properitoneal space



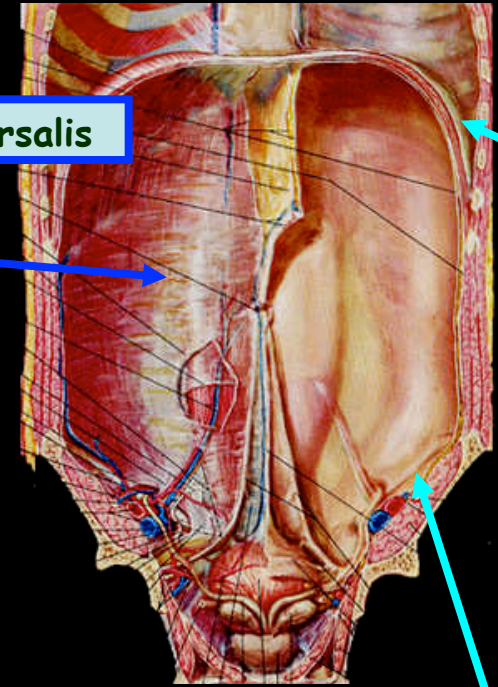
1. anatomical basis of subperitoneal space

subperitoneal perivascular mesenteric space

subperitoneal anterolateral or properitoneal space

retropubic (Retzius) subperitoneal space

fascia transversalis



anterior abdominal wall, dorsal view

subperitoneal anterolateral or properitoneal space

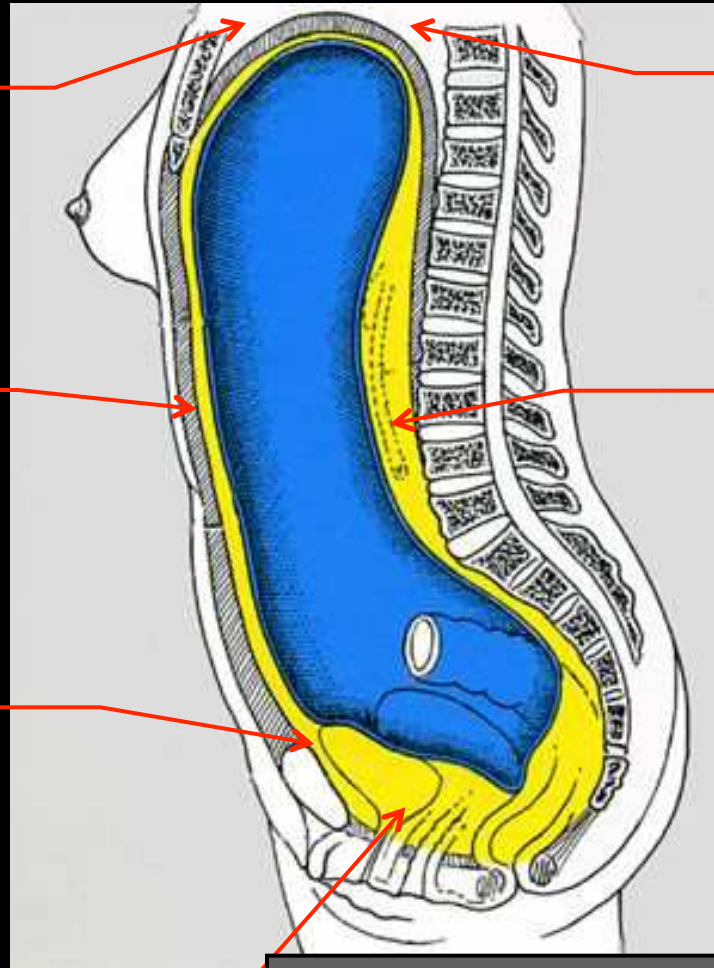
retroperitoneal compartments

anterior extrapleural space

properitoneal space

retropubic subperitoneal space (Retzius' space)

pelvic subperitoneal space



posterior mediastinal connective tissue

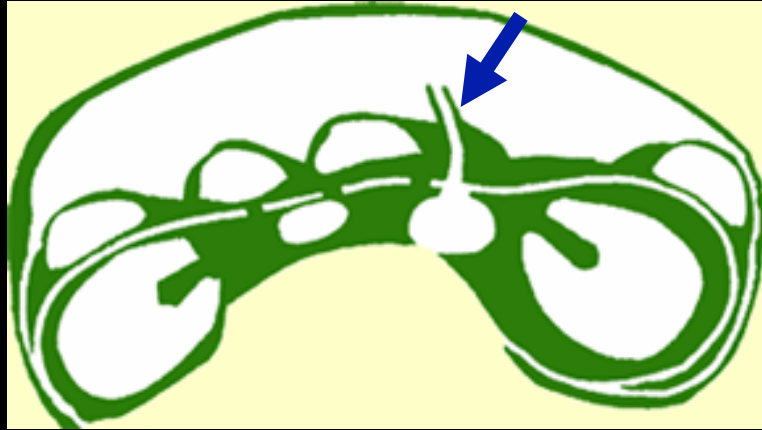
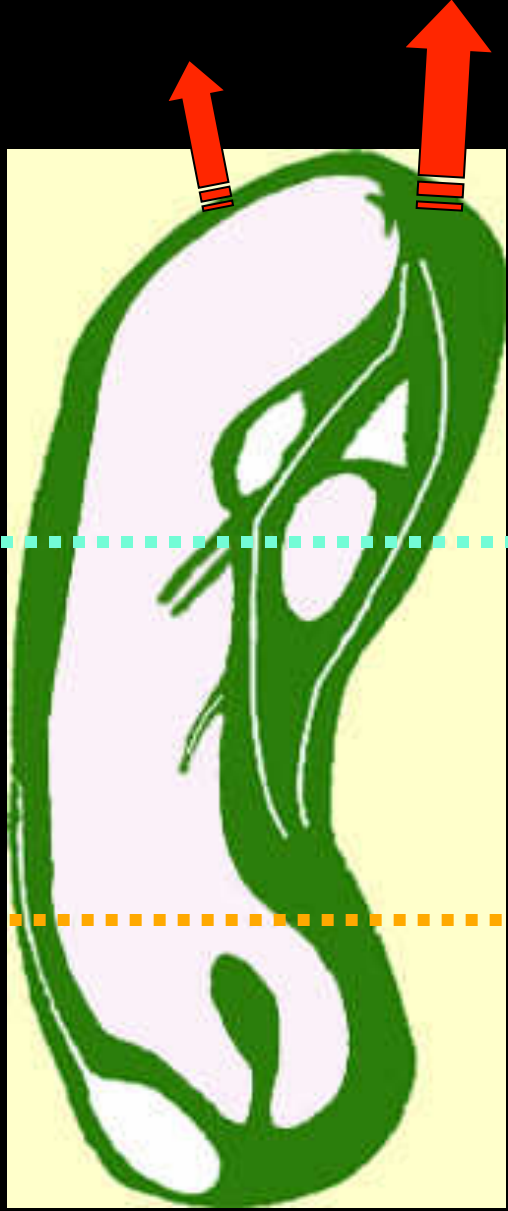
**retroperitoneal space
3 compartments:**

- anterior pararenal
- périrenal
- posterior para renal

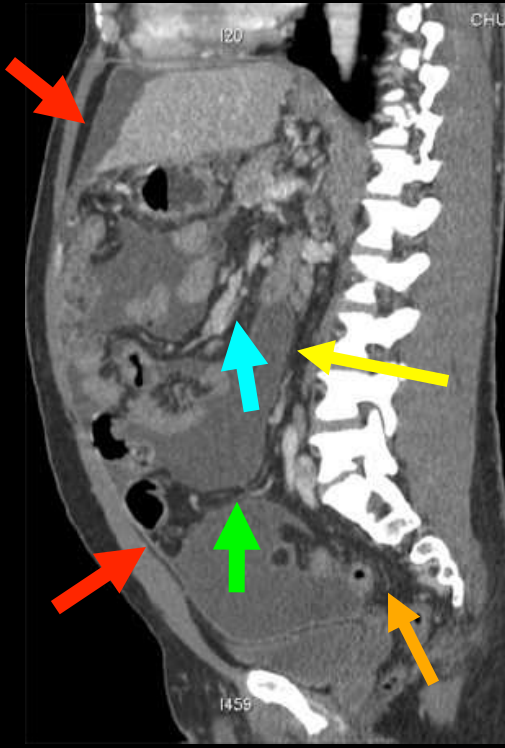
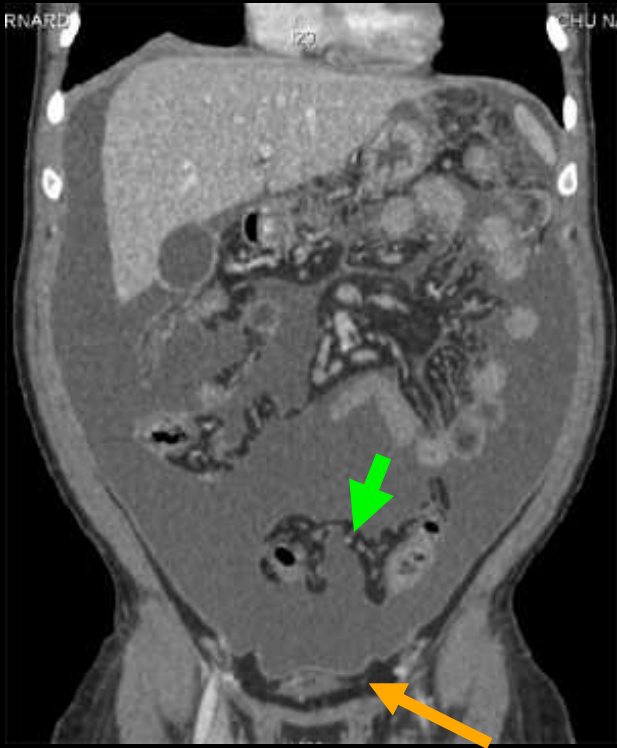
there is a continuum between subperitoneal connective tissue of anterior abdominal wall, pelvis and retroperitoneum (behind posterior parietal peritoneum)..

In the thorax, extra pleural space and mediastinum are also made of connective tissue with potential communications (oesophageal and aortic hiatus. between diaphragmatic anterior insertions)

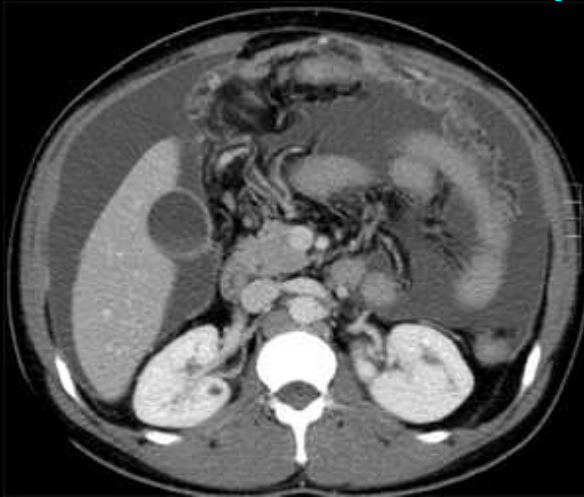
possible direct or inverse migration of gas from subperitoneal space to subpleural or mediastinal connective tissue








If connective tissue of subdiaphragmatic abdomen (peritoneal cavity and retroperitoneum) is extracted, the continuum is demonstrated. We have to consider that subperitoneal space extends along mesenteric vessels in the mesentery and the mesosigmoid (→), coeliac trunk and coronary ligament (→)

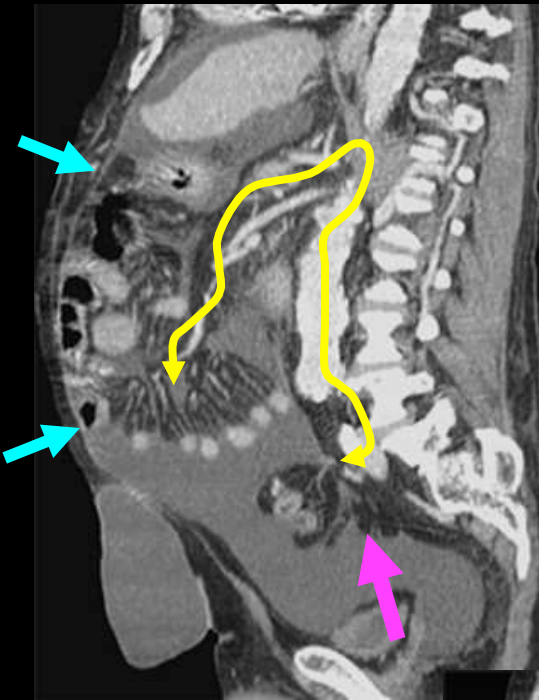


tuberculous ascites in a 43 yo african man

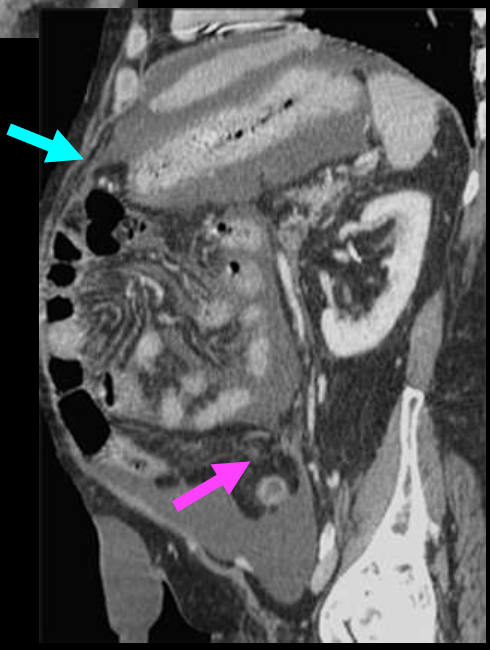
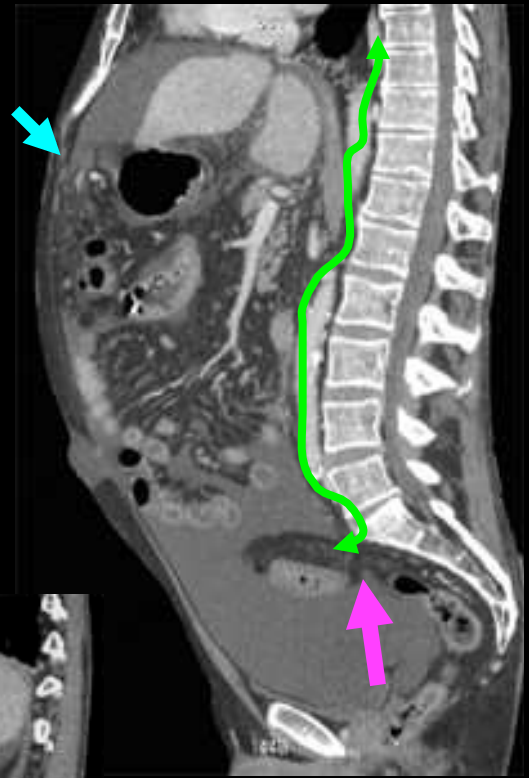


continuum between:

- subperitoneal perivascular space (mesentery  mesosigmoid )
- retroperitoneal space 
- subperitoneal pelvic space 
- properitoneal space 






two cases of cirrhotic ascitis to depict the potential road for gaseous diffusion from subperitoneal perivascular space of the mesosigmoid to its mesenteric counterpart (**yellow road**) or to posterior mediastinal connective tissue (**green road**), through aortic and/or oesophageal foramens



cirrhotic ascitis in a 57 yo man



properitoneal space 
 subperitoneal mesosigmoid space 
 great omentum floating in the supra mesocolic area 

cirrhotic ascitis in a 48 yo man

2. fluid diffusion through connective subserous spaces of the trunk

2a. gaseous migrations in subserous spaces of the trunk

they are the most important and fortunately the easiest images to see and to analyse on CT of acutely ill patients but they can be confusing if they are misdiagnosed.

The first step is to learn how to recognize the exact **anatomic** situation of these gaseous images

- how can we identify **pro peritoneal** gaseous images ?

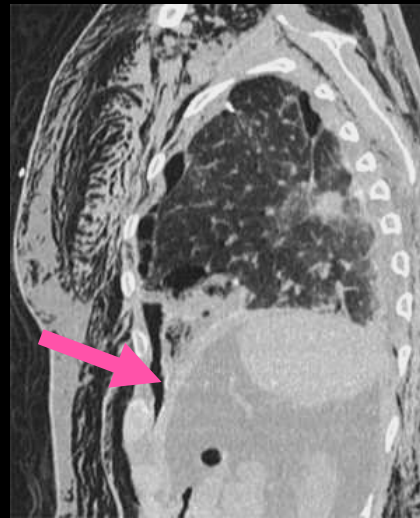
the easiest way to avoid misinterpretation of pro peritoneal gaseous images is to consider situations in which nothing has been done in the abdomen !

-massive subcutaneous thoracic emphysema

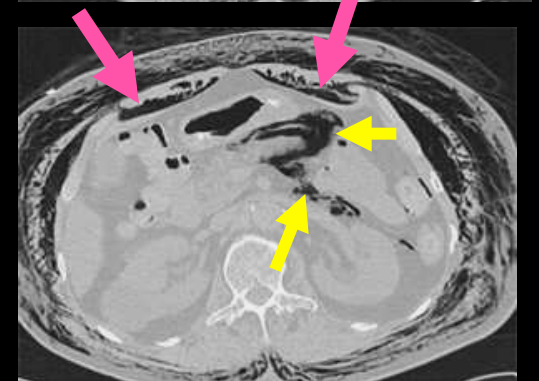
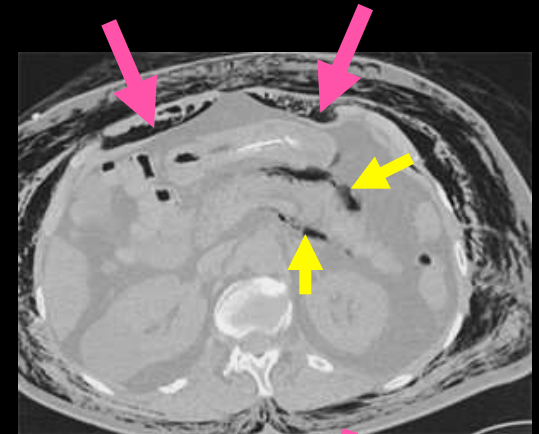
-typical images of properitoneal gas (→)
(symmetrical linear collections of gas sparing the median region)

-retropneumoperitoneum (→)

-no pneumoperitoneum !



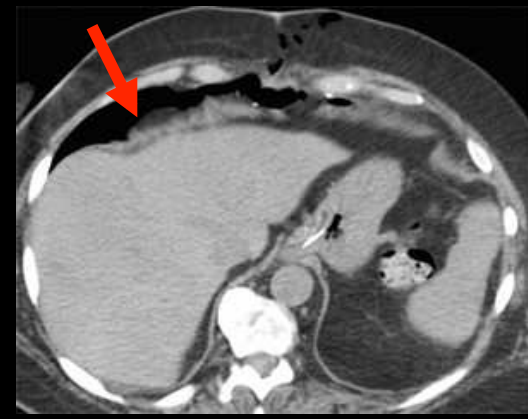
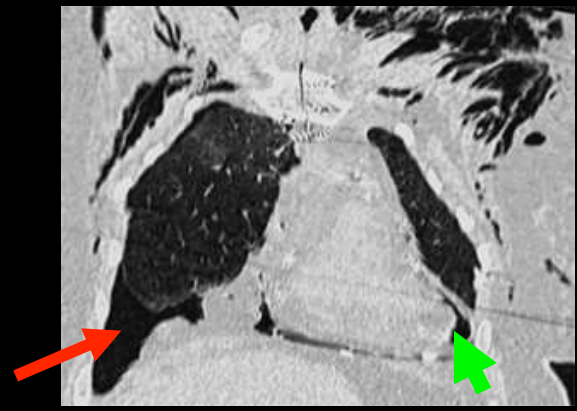
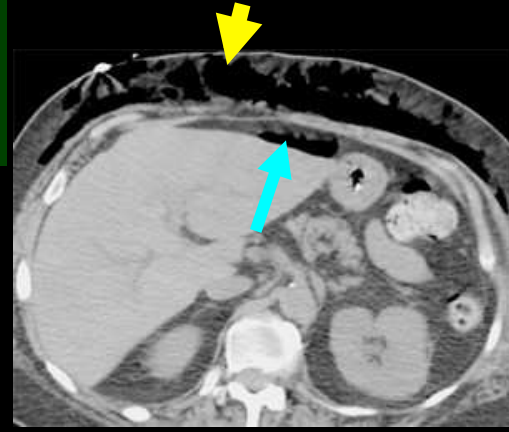
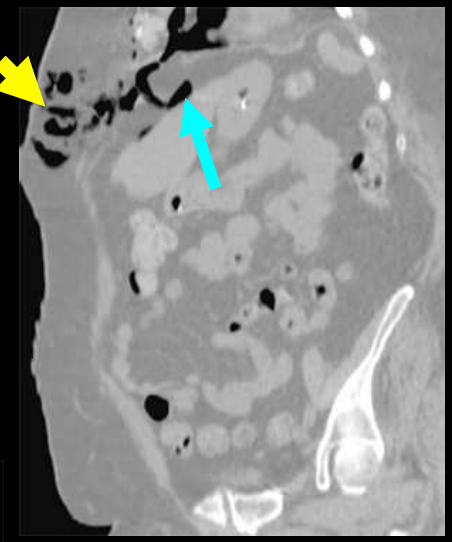
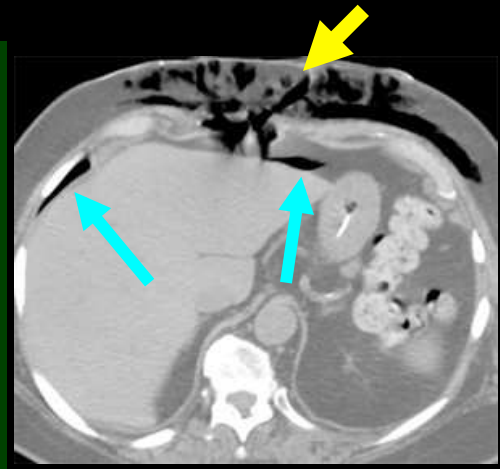
massive subcutaneous cervico thoracic emphysema after surgical lung biopsy



-pneumothorax (→), pneumopericardium (→) and subcutaneous anterior thoraco-abdominal emphysema (→)

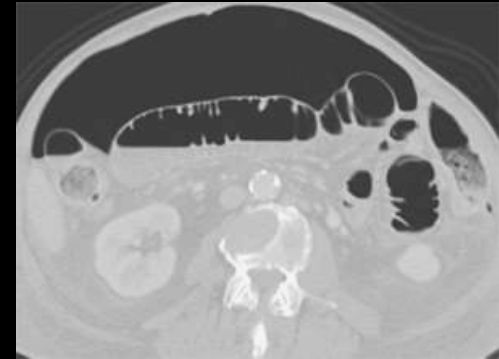
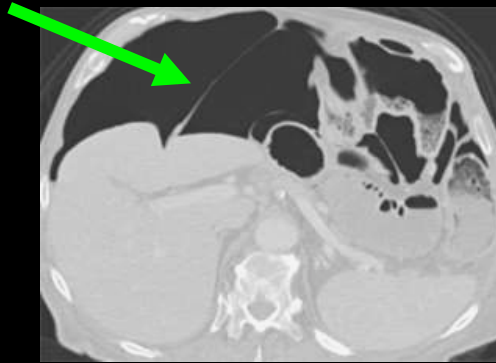
-properitoneal gas is seen ,lining the anterior edge of the liver , thus mimicking pneumoperitoneum (→) ,however these images are fixed in their position and are not situated at the apex of the peritoneal cavity as in pneumoperitoneum .

-pneumothorax in the anterior costo-diaphragmatic recess (→) lies before the diaphragm and also need to be differentiated from pneumoperitoneum




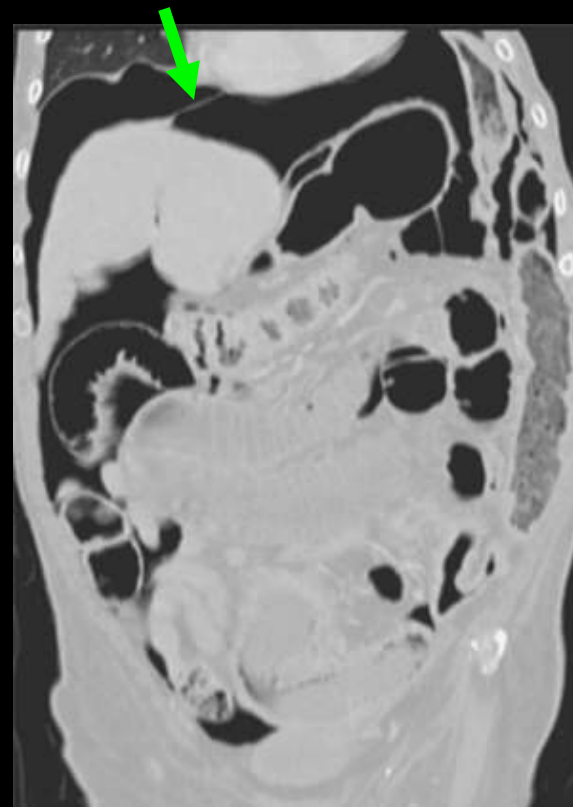
massive subcutaneous emphysema of the antero superior thoracic wall and the cervic thoracic junction after a difficult transjugular implantation of a Port-a Cath.

- how can we identify intra peritoneal gaseous images ?



-identifying a pneumoperitoneum on CT scan is generally very easy specially with large peritoneal gaseous effusions (ulcer perforation, caecal diastatic perforation, bowel wall endoscopic perforation...) are present .

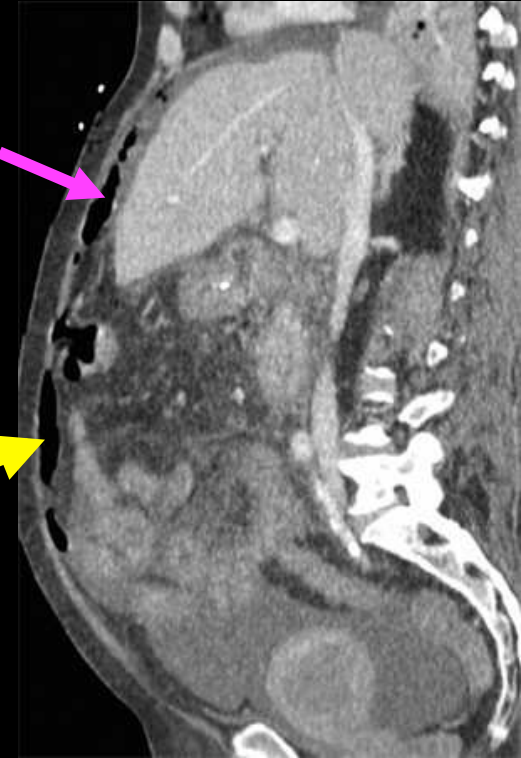
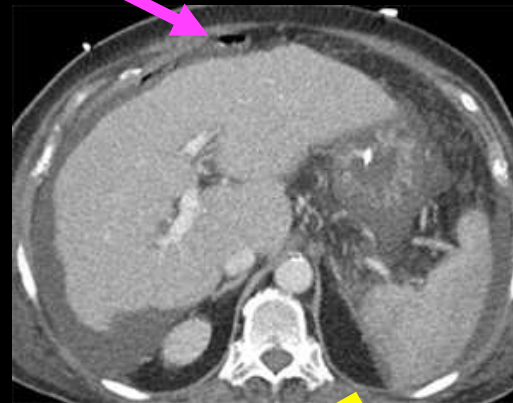
- when you are in doubt (specially with small gaseous collection of the subphrenic space) ,remember that the only sign which will never fail you is the outlining of the falciform ligament by free intra peritoneal gas () !!!



anterior gastric wall perforated ulcer



-when confronted with juxta abdominal wall gaseous images , you hesitate between pro or intra peritoneal gas (→)

-look at the highest point of the peritoneal cavity which is always located in the median zone and you will see gas bubbles lining anterior parietal peritoneum (→) in case of true pneumoperitoneum




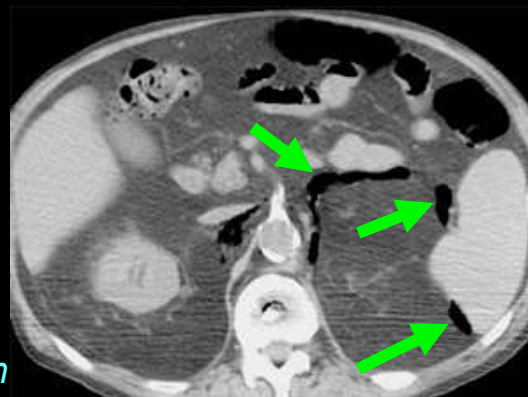
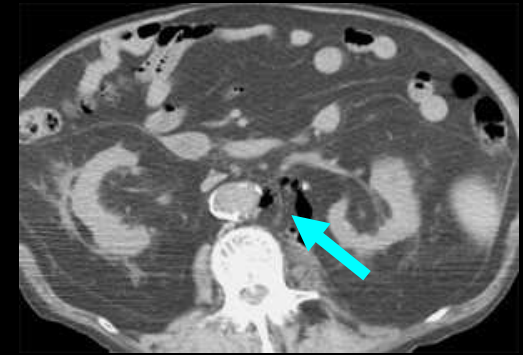
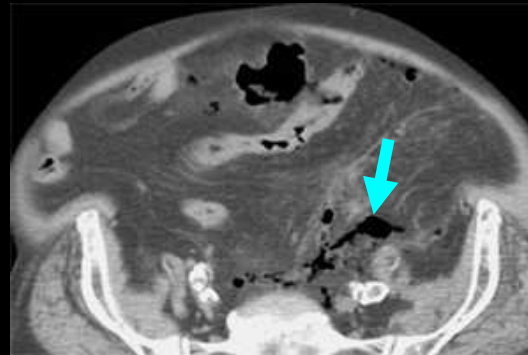
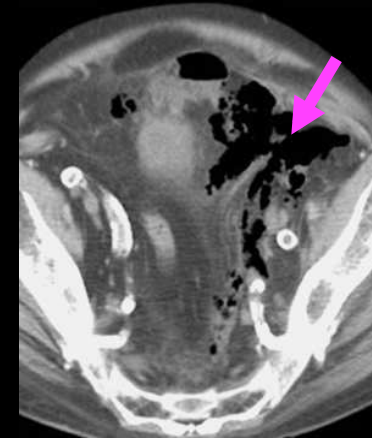
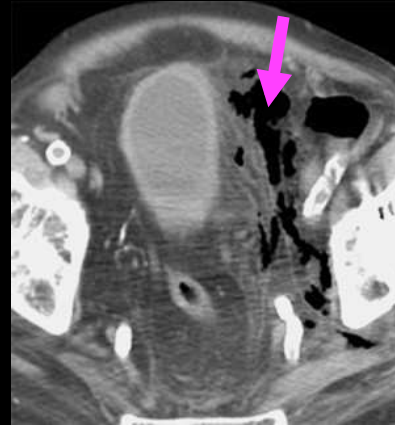
perforated anterior duodenal ulcer ; alcoholic cirrhosis with ascitis , in a 62 yo woman


• how can we identify retro peritoneal gaseous images ?

-propagation of gas from cellulitis through subperitoneal pelvic space () to retroperitoneum ()

-no free gas is observed in the peritoneal cavity

-gaseous retropancreatic and juxta splenic images () belong to retroperitoneal space !!!



juxta splenic gaseous images () belong to retro-pneumoperitoneum as they stay between splenic capsule and visceral splenic peritoneum

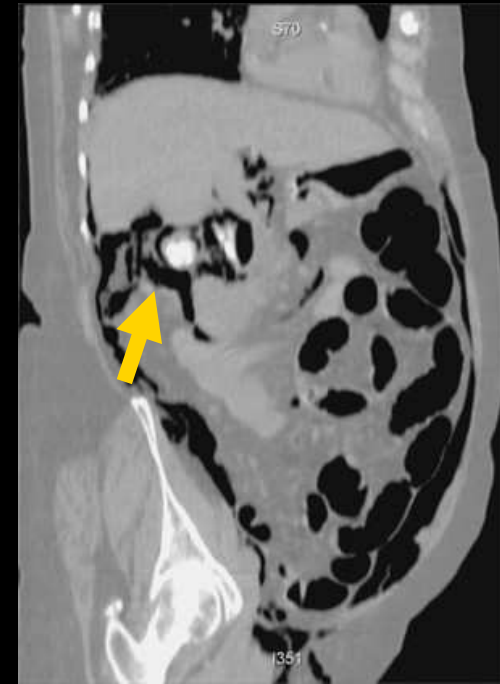
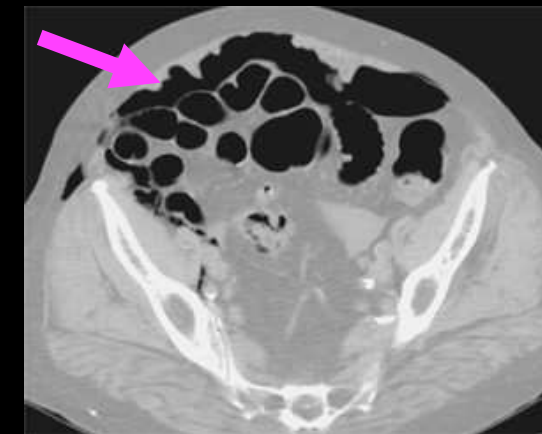
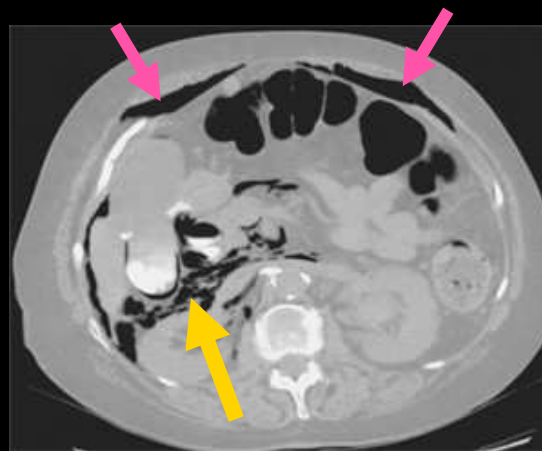


*rheumatoid arthritis ,diabetic ,
corticotherapy ,sepsis of the ischiatic region
(cellulitis after skin disruption),i, a 58 yo man*

-iatrogenic retro-pneumoperitoneum secondary to instrumental rupture of the posterior duodenal wall ,at the level of the major duodenal papilla (**→**) (extra hepatic biliary tree has been opacified before sphincterotomy).




-the interesting fact is the presence of gas in antero lateral properitoneal space (**→**) and Retzius space (**→**).


-**no pneumoperitoneum** is observed despite the volume of gas visible on these images !!! and this situation may theoretically be managed without surgery....




acute abdomen after endoscopic extraction of a choledcolithiasis in a 66 yo woman .

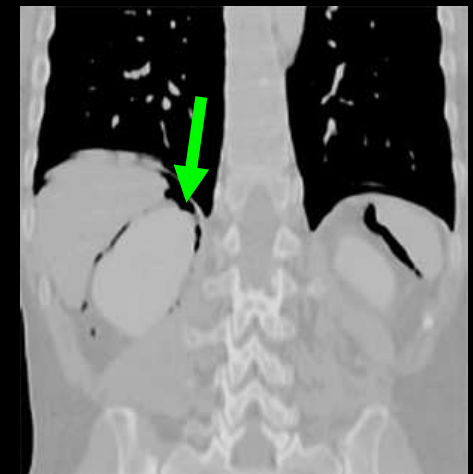
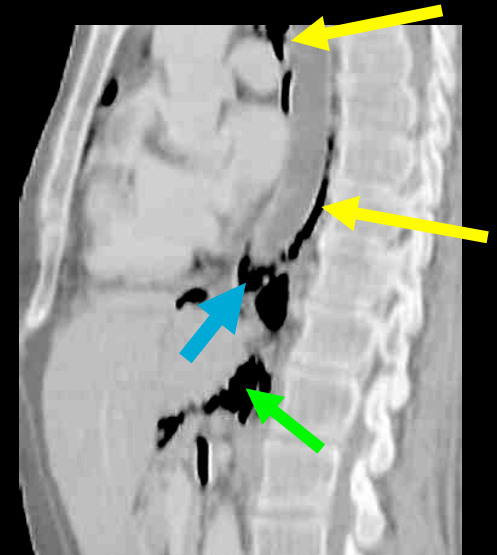
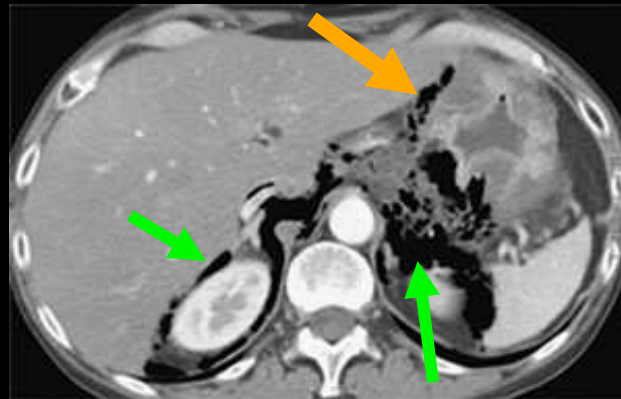
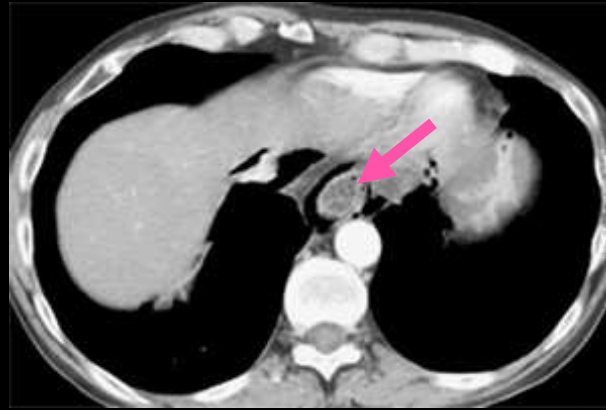
• don't be afraid when you see a lot of gas on CT of acute abdomen and make a thorough analysis! !

-posterior pneumomediastinum () and retro-pneumoperitoneum () due to lower oesophageal mechanical rupture after a failed attempt to extract a piece of impacted meat ().

-gas migrated to posterior mediastinum via peri oesophageal hiatus () ;

-no gas migrated around IVC due to a circular continuous fibrous membrane joining venous wall and diaphragm that prevent transdiaphragmatic road at this point .

-perivisceral gas bubbles correspond to migration in subperitoneal perivascular spaces ()



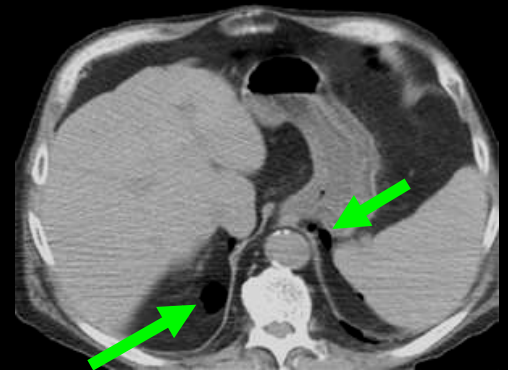
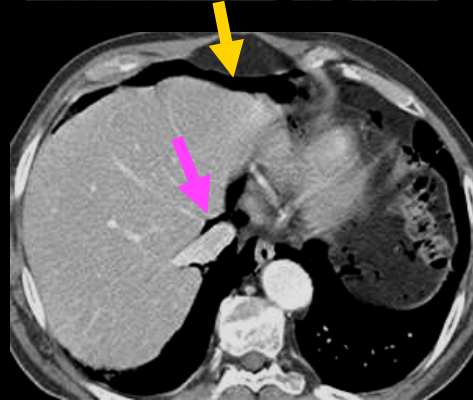
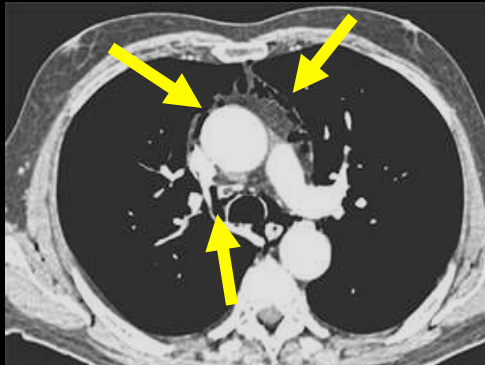
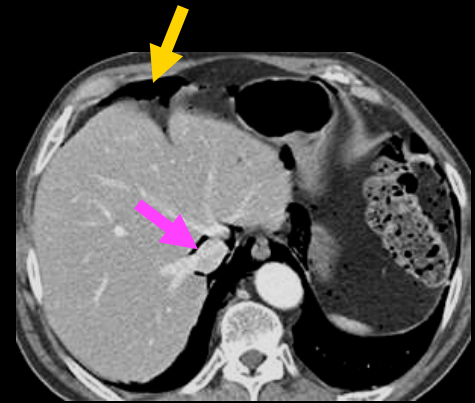
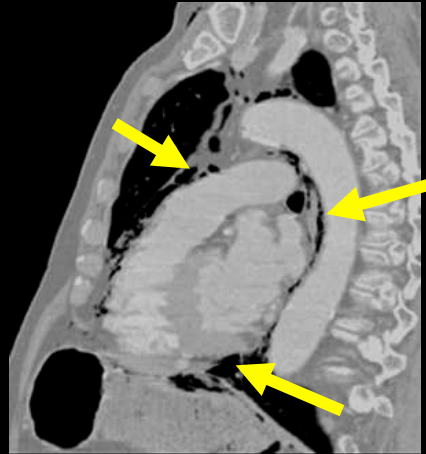
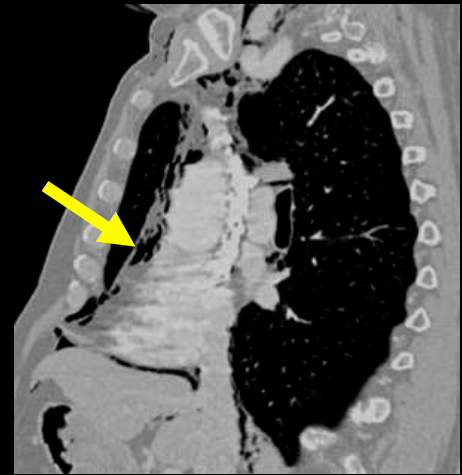
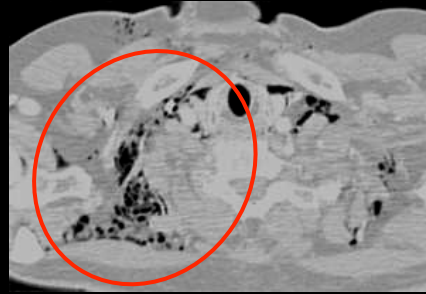
painful aphagia after a failed attempt to extract an impacted piece of meat in the lower oesophagus

fever, subcutaneous emphysema of the right axilla in a 71 yo man (1)

emphysema (red circle) and pneumomediastinum with total homogeneous gaseous dissection of mediastinal connective tissue ,from top to bottom (—>)

-we can see gas around the IVC (—>) and in the retroperitoneum (—>)

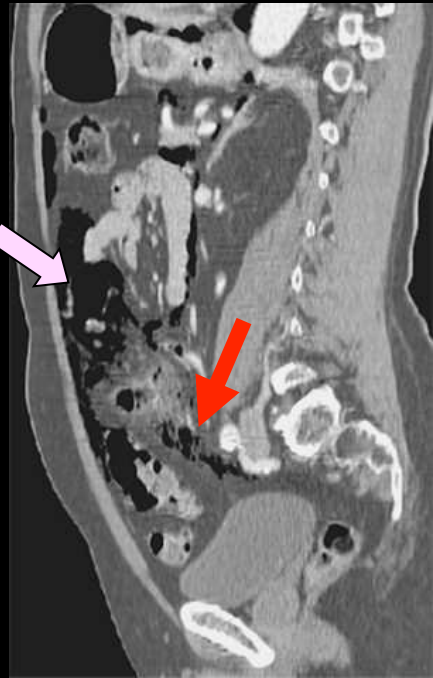
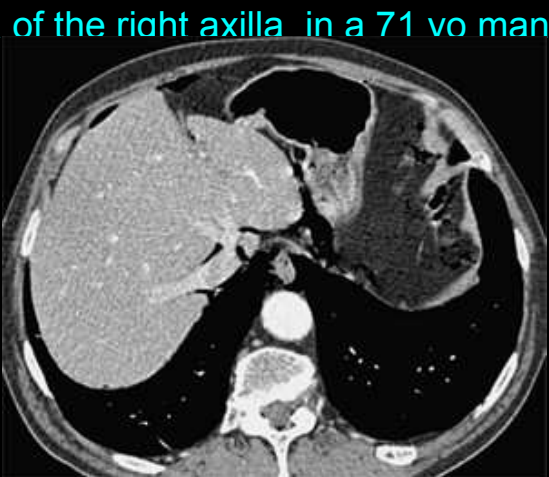
-in front of the liver it is difficult to determine the exact location of the gaseous images (—>) (anterior pleural recess? pro peritoneal gas? pneumoperitoneum?)



fever, subcutaneous emphysema of the right axilla in a 71 yo man (2)

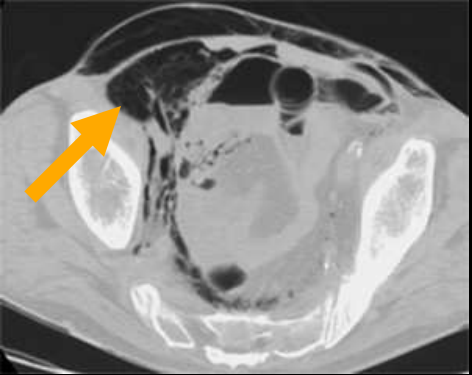
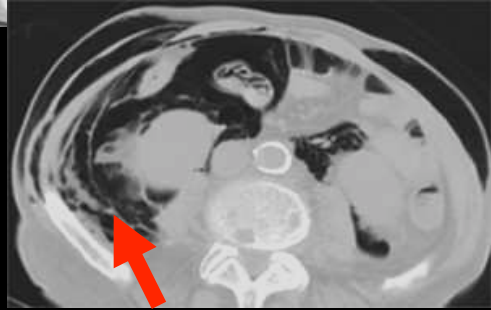
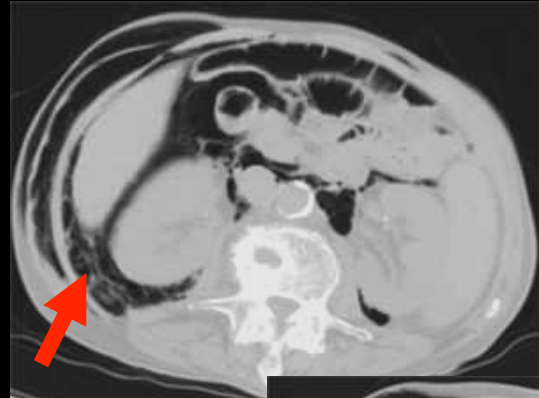
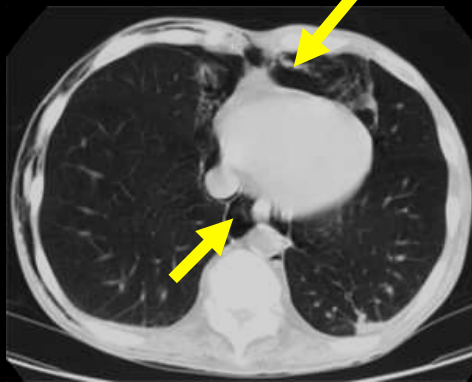
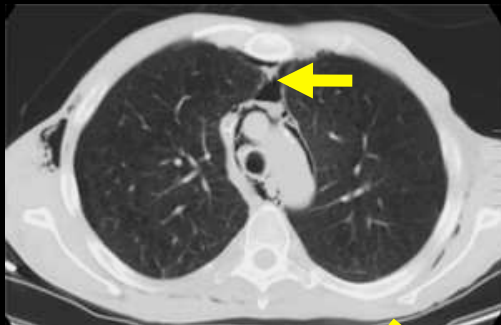
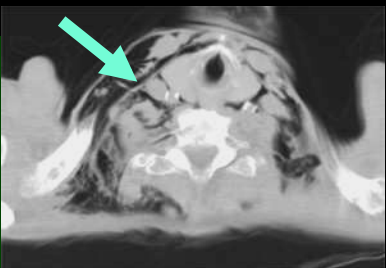
-the retro-pneumoperitoneum is obvious (→) with gas around caudal pancreas and sagittal reformation shows that this gas is coming from mesosigmoid (→) following a ruptured sigmoid diverticula

-a subsidiary question concern a large amount of gas behind anterior abdominal wall (→) .Laparoscopy confirm a **pneumo-omentum** with gaseous infiltration of epiploic and pericolic appendages.

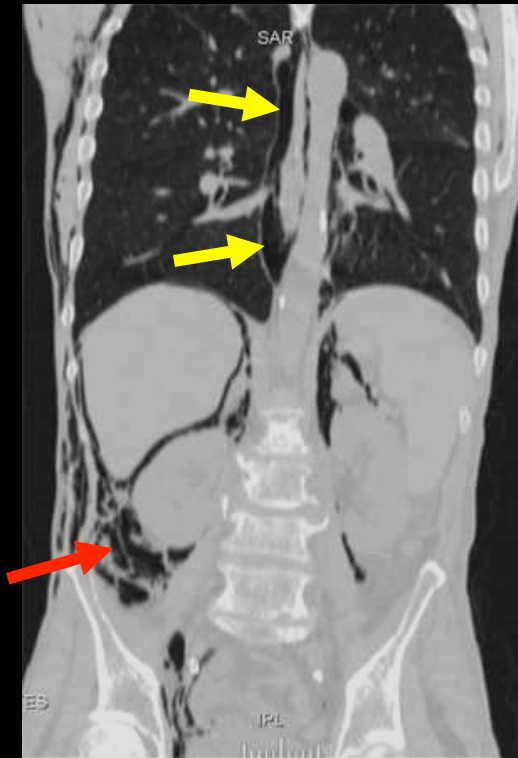



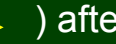
59 yo man ,returning from an endoscopic resection of recto-colic polys ;a nurse of the post anesthesia care unit is puzzled by an aspect of the penis she is not familiar with...; clinical examination reveals subcutaneous cervuco-thoracic emphysema (1)

-CT confirms subcutaneous cervical emphysema, (), and pneumomediastinum ()
 -extensive retro-pneumoperitoneum (),
 -pneumopenis () and gaseous dissection ()
 -groin subcutaneous connective tissue ()





59 yo man ,returning from an endoscopic resection of recto-colic polyps ;a nurse of the post anesthesia care unit is puzzled by an aspect of the penis she is not familiar with...; clinical examination reveals subcutaneous cervuco-thoracic emphysema (1)

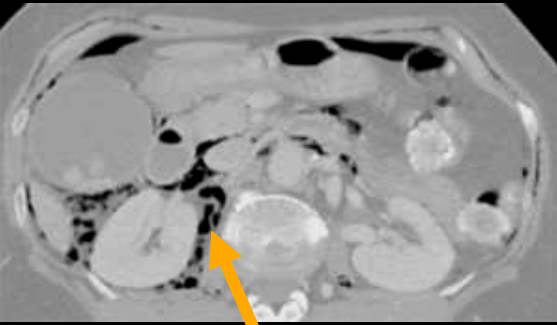
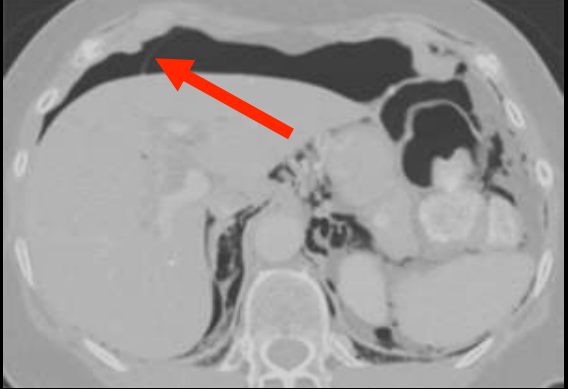
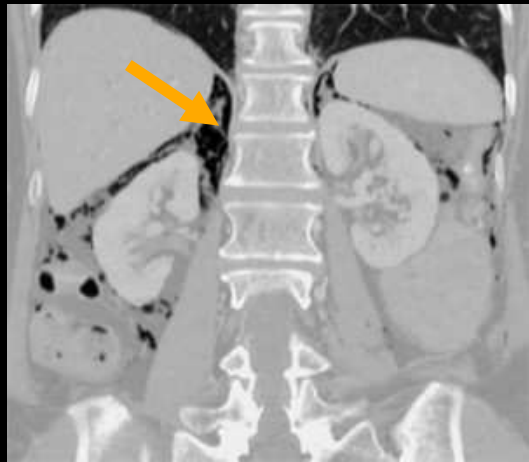


this very impressive "total body" gaseous dissection of retroperitoneum () and mediastinum () after a common endoscopic resection of a pediculated recto-sigmoid polyp give us a good illustration of the holistic concept of subperitoneal space and its relations with mediastinal connective tissue . Note the gaseous dissection of the fascia of Treitz with "floating" duodeno pancreas (orange circle).

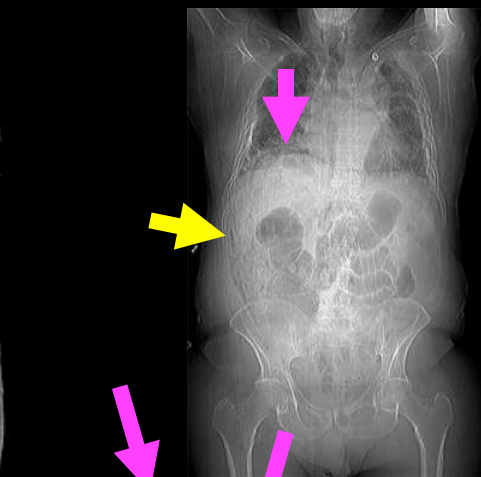
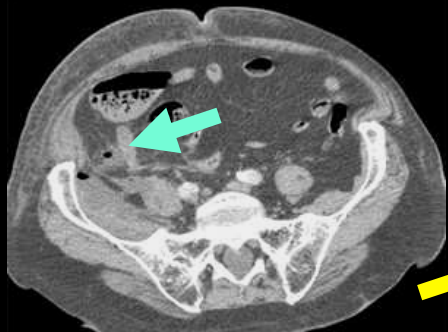
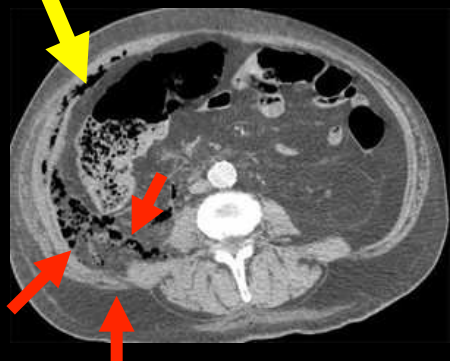
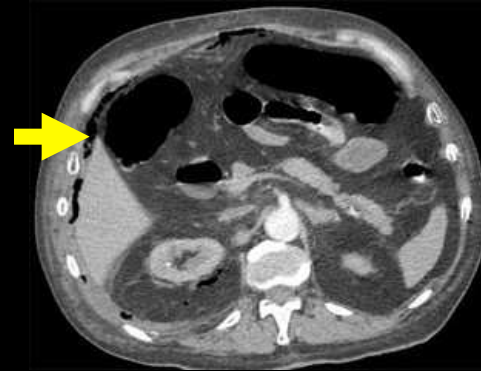
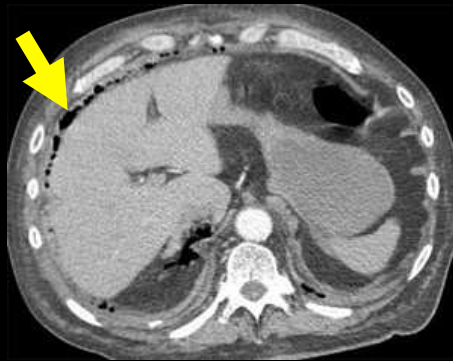
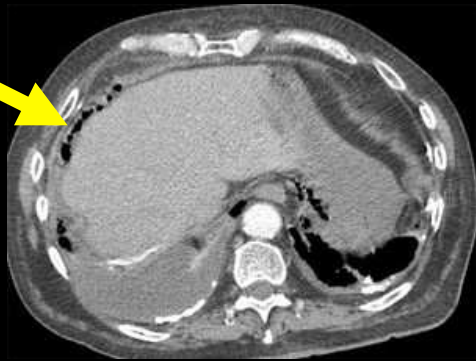
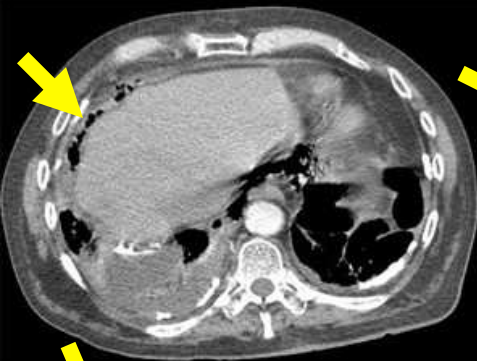
endoscopic sphincterotomy and transpapillary extraction of biliary stones of the main bile duct in a 72 yo woman ; increasing pain with abdominal guarding

-CT confirms the retro-pneumoperitoneum () due to posterior rupture of the juxta papillary duodenal wall.



-but dont forget to look for the sign of associated pneumoperitoneum : free pre hepatic gas outlining the falciform ligament () which indicate surgical treatment .




pain and tenderness of the right iliac fossa; ; moderate fever in a 80 yo man



-no pneumoperitoneum! !

-retroperitoneal abscess () due to retrocaecal appendicitis ()

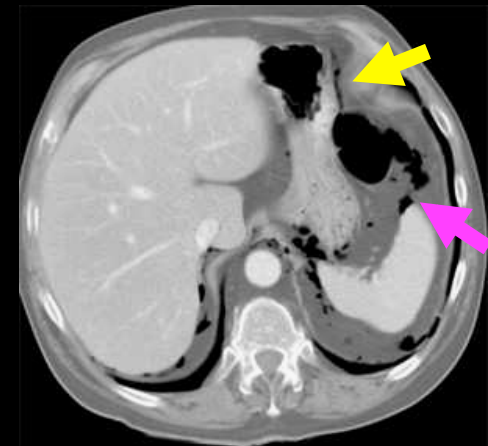
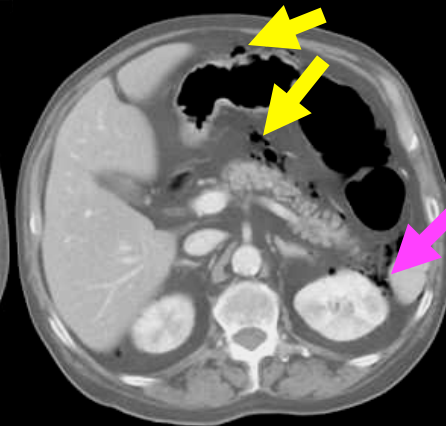
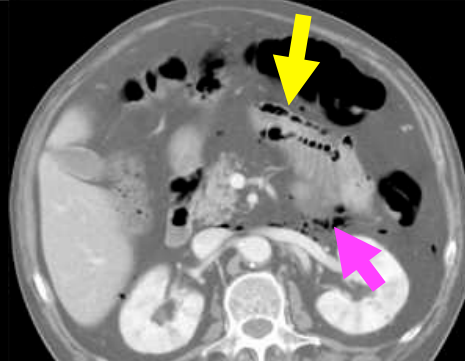
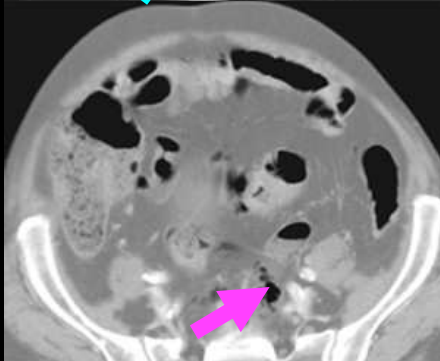
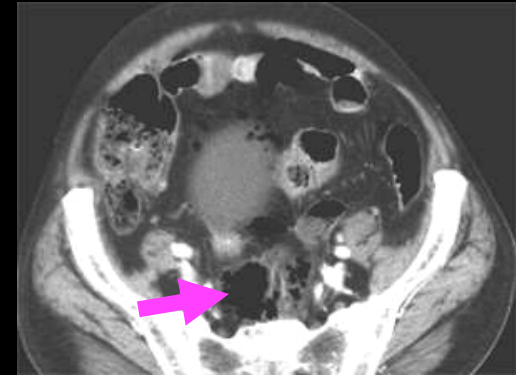
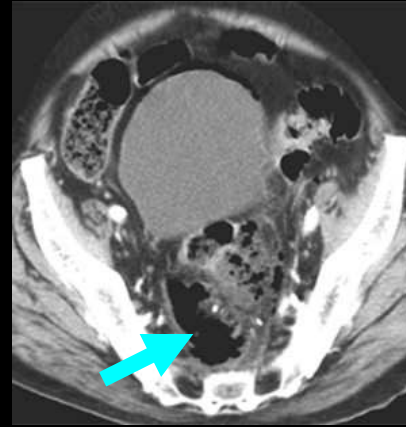
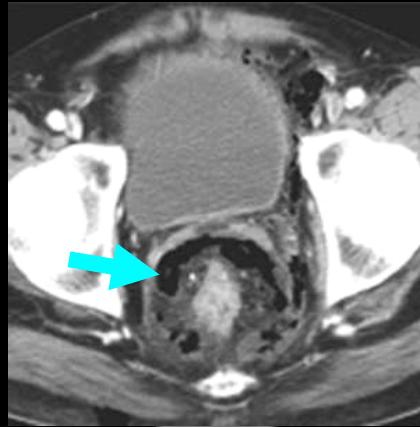
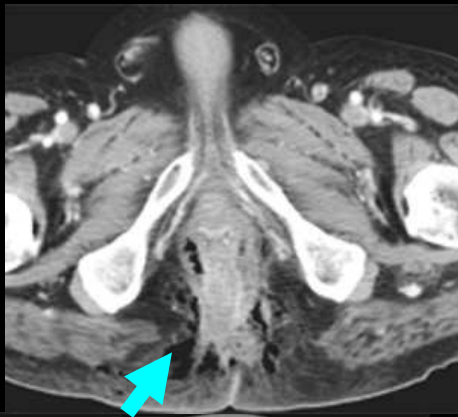
-gaseous diffusion in properitoneal space ()

and in subperitoneal space of the diaphragm ()





*courtesy of M Lamrani MD
Les Sables d'Olonne*

peri rectal abscess operated 3 days ago in a 69 yo man ; recurrent fever and persistant local sepsis

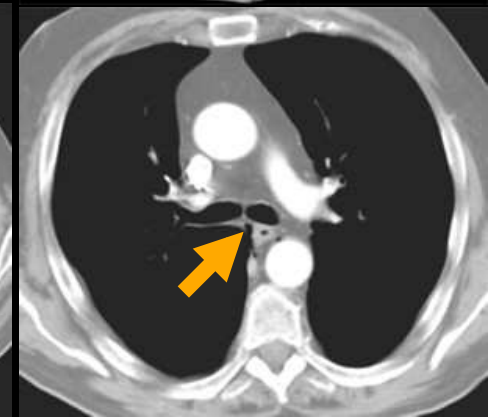
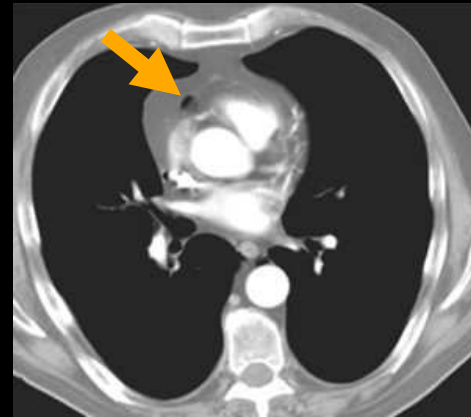


-be careful ! there is no pneumoperitoneum

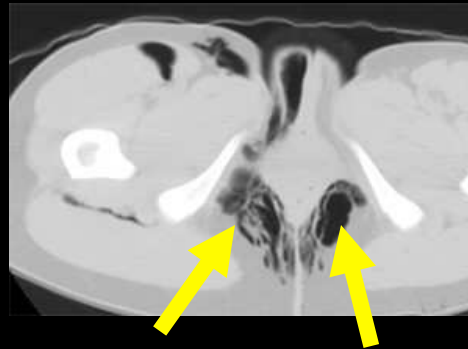
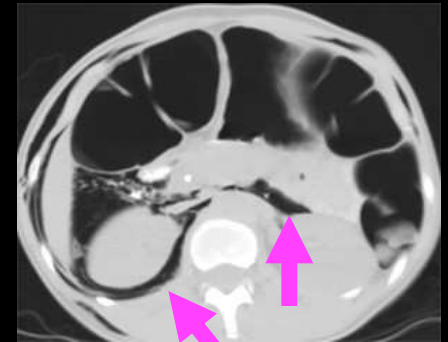
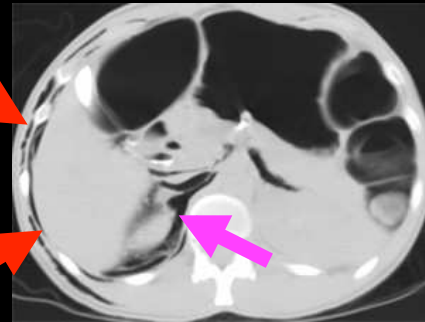
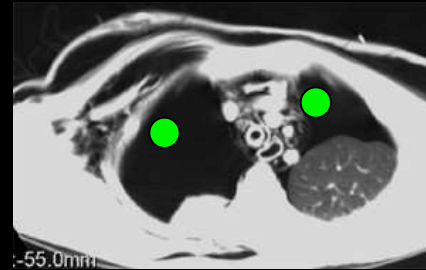
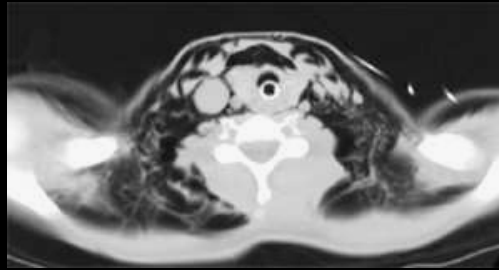
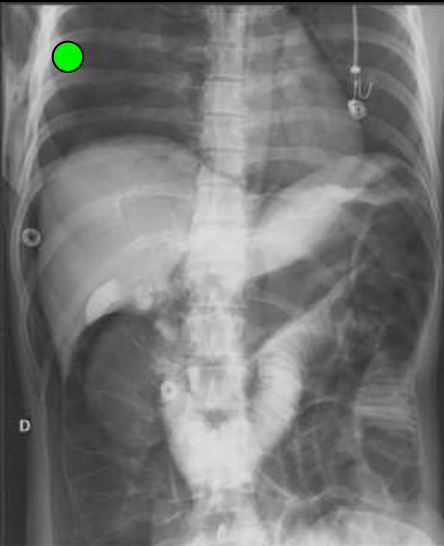
-all visible gaz bubbles belong to retropneumoperitoneum () or to mesenteric subperitoneal space ()


-small pneumomediastinum ()

-peri rectal abscess ()



respiratory distress during a tough endoscopic extraction of a main bile duct stone in a young 39 yo woman ; subcutaneous cercico-thoracic emphysema



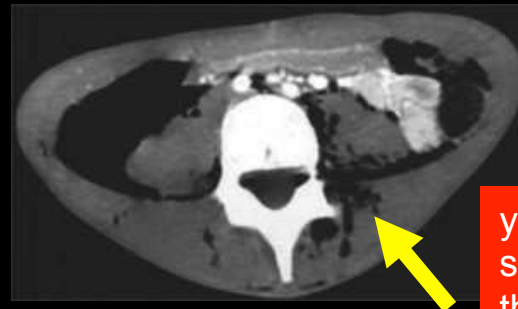
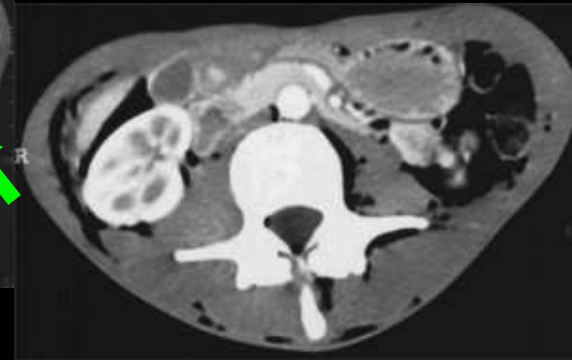
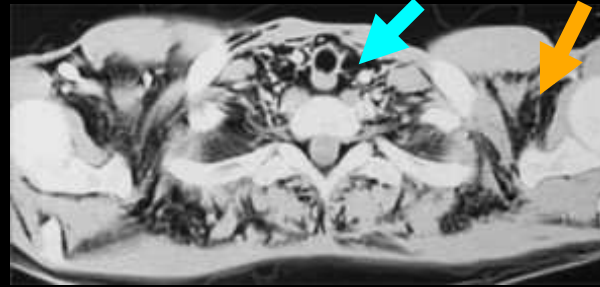
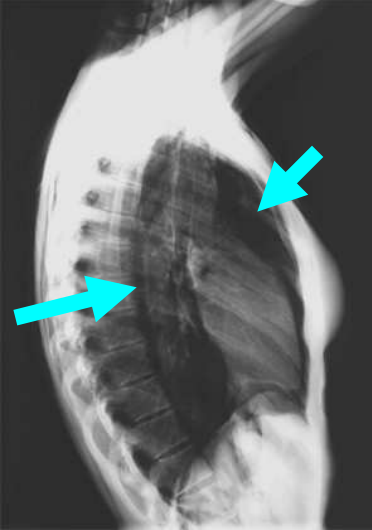
-retropneumoperitoneum () due to traumatic tear of the juxta papillary posterior duodenal wall

-gas in the properitoneal space () and in subperitoneal pelvic space and deep perineal connective tissue ()

-bilateral large gaseous subpleural effusion ()

-no pneumoperitoneum and no pneumothorax are noticed !!!

young teenager , coming to emergency room for giant subcutaneous emphysema without any other complaint



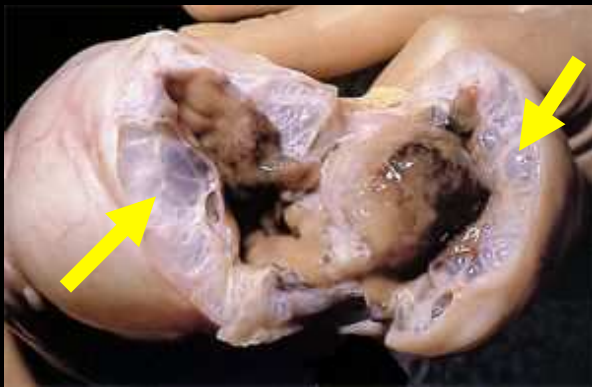
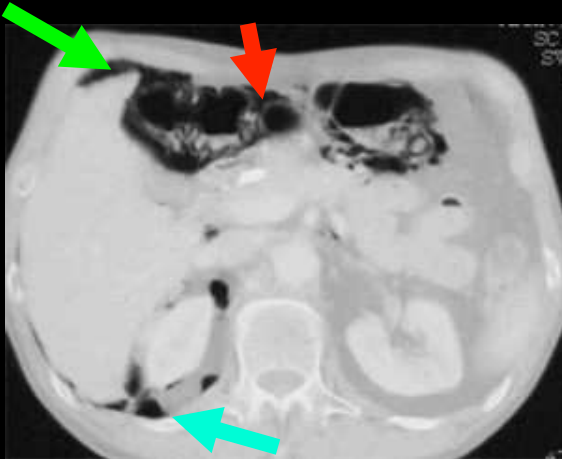
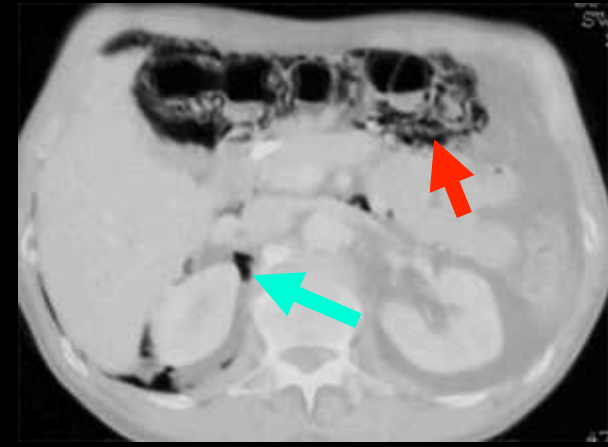
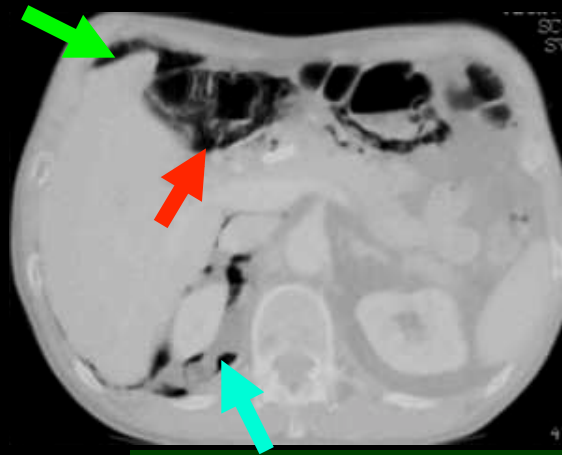
CT confirms X ray plain films : huge extensive retroperitoneum (→)

a global and harmonious pneumomediastinum (→) and subcutaneous emphysema (→)

can you guess the origin with this last picture

young girl with psychological problems , who auto-injected syringes of air in her back (→); you might also suggest that she is probably right-handed!!!

59 yo man, heavy smoker , laryngeal cancer two years ago, intermittent abdominal pain. COPD and severe emphysema



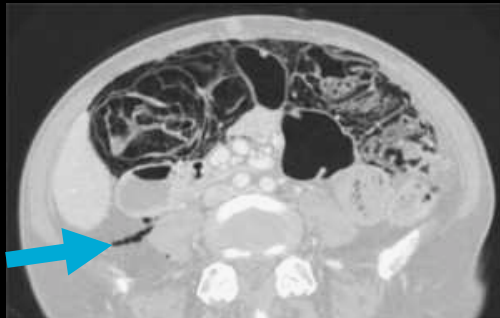
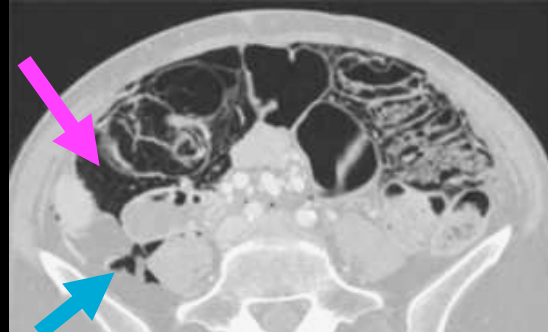
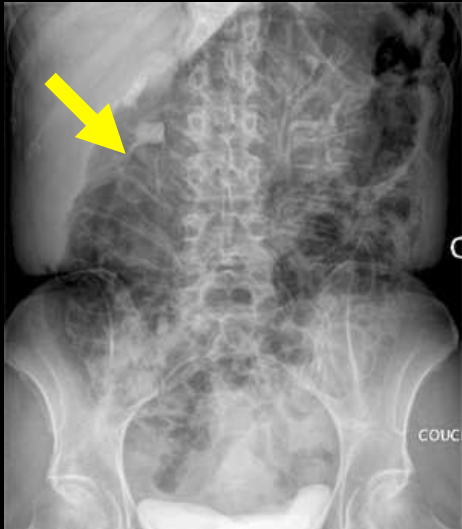
-cystic chronic pneumatosis coli is a condition very often observed in association with chronic hypoxemia , specially heavy smokers with COPD . Excess gas is coming from bowel lumen ,due to modified bacterial population secondary to chronic hypoxemia and insufficient methane degradation.

-cystic gaseous lesions are generally developed in submucosa but ,as in this case, also in subserous connective tissue (→);.

-a retroperitoneum (→) is very frequently associated and always in the right side. It corresponds to migration of gas from parietal lesions through subperitoneal space of right Toldt's fascia or of the right transverse mesocolon .

-pneumoperitoneum (→) secondary to spontaneous rupture of subserosal gaseous cyst is also frequent

chronic mild abdominal pain , heavy smoker ; severe hypoxemia at arterial blood gas sampling in a 52 yo woman



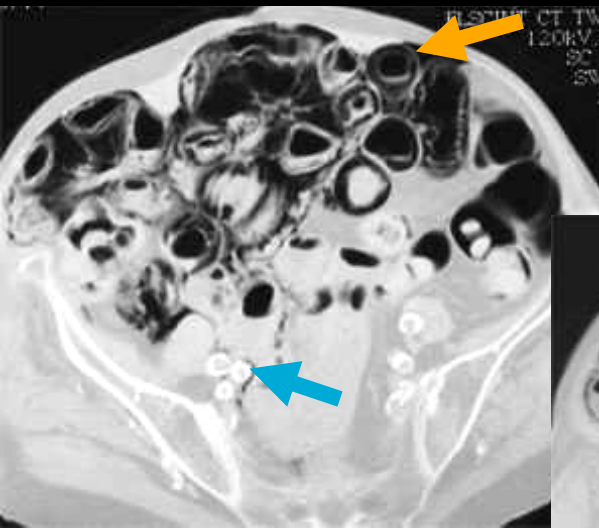
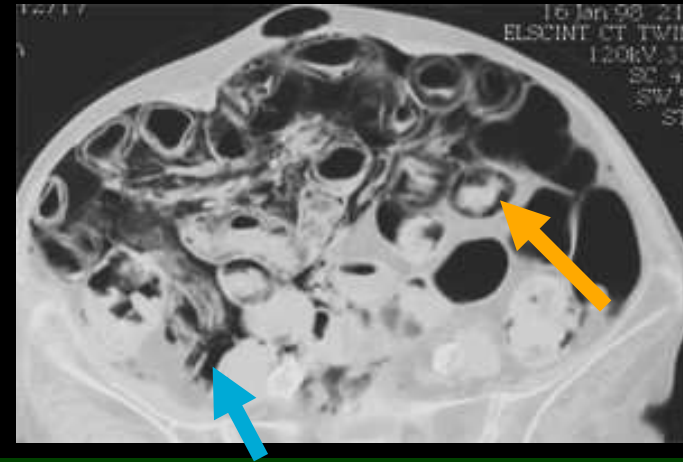
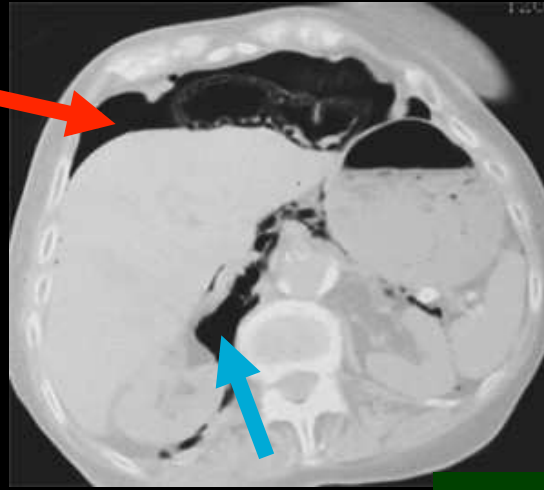
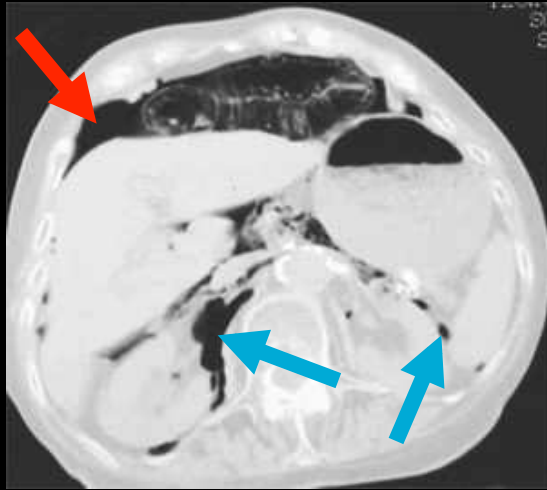
-typical chronic cystic pneumatosis coli linked to chronic hypoxemia (→).

-massive gaseous dissection of the right Toldt's fascia (→)

-right retroperneumoperitoneum (→) with diffusion of gas bubbles up to diaphragmatic subperitoneal space (→).

courtesy of A Rodde MD Luxembourg

53 yo man , heavy smoker with mild abdominal pain , operated after discovery of a pneumoperitoneum on CT ;
no intestinal perforation at surgery !



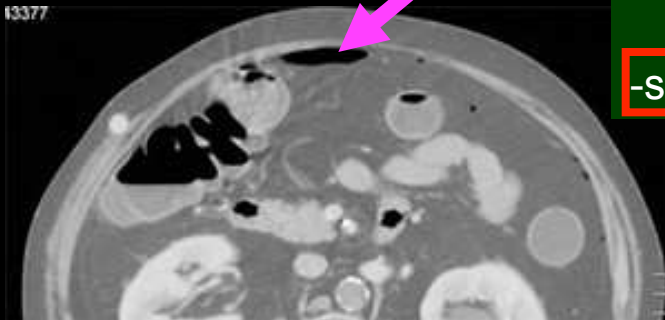
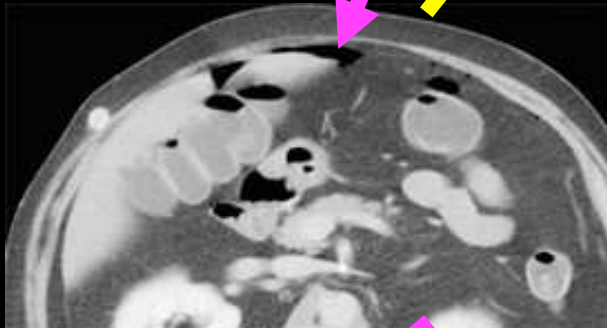
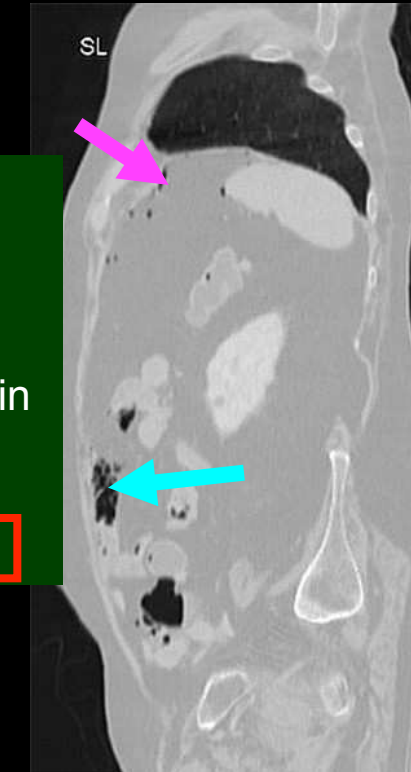
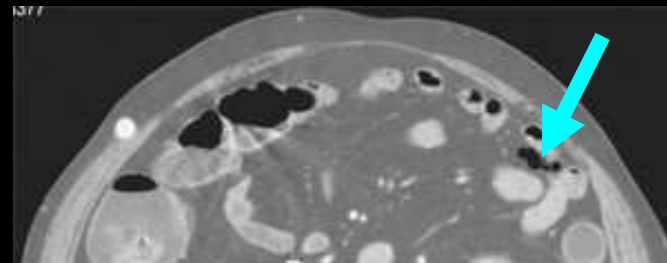
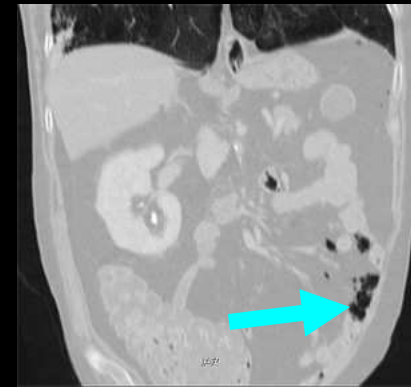
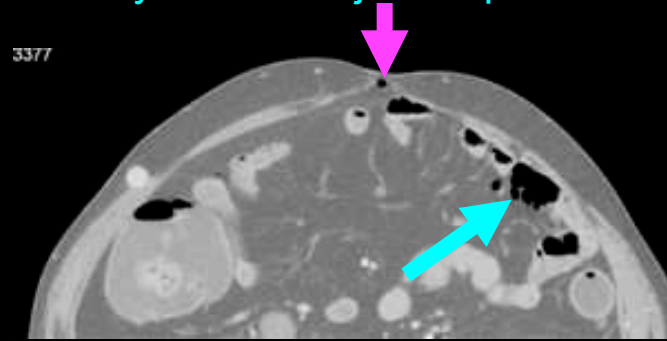
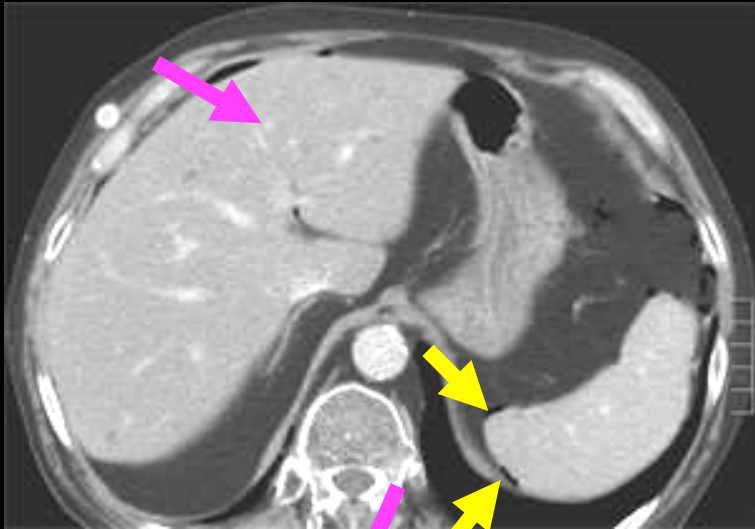
-typical case of chronic cystic pneumatosis (→) of the small bowel due to chronic anoxemia (COPD)

-small bowel chronic cystic pneumatosis is preferentially located in subserosis .Thus it represents the main cause of "medical" or "non surgical" pneumoperitoneum (→)


-large retroperitoneum is an excellent diagnostic argument (→)

-remember:"don't operate images !!!"

58 yo man with chronic respiratory insufficiency due to major biapical tuberculous sequellae .



-asymptomatic pneumoperitoneum ()
and retropneumoperitoneum ()

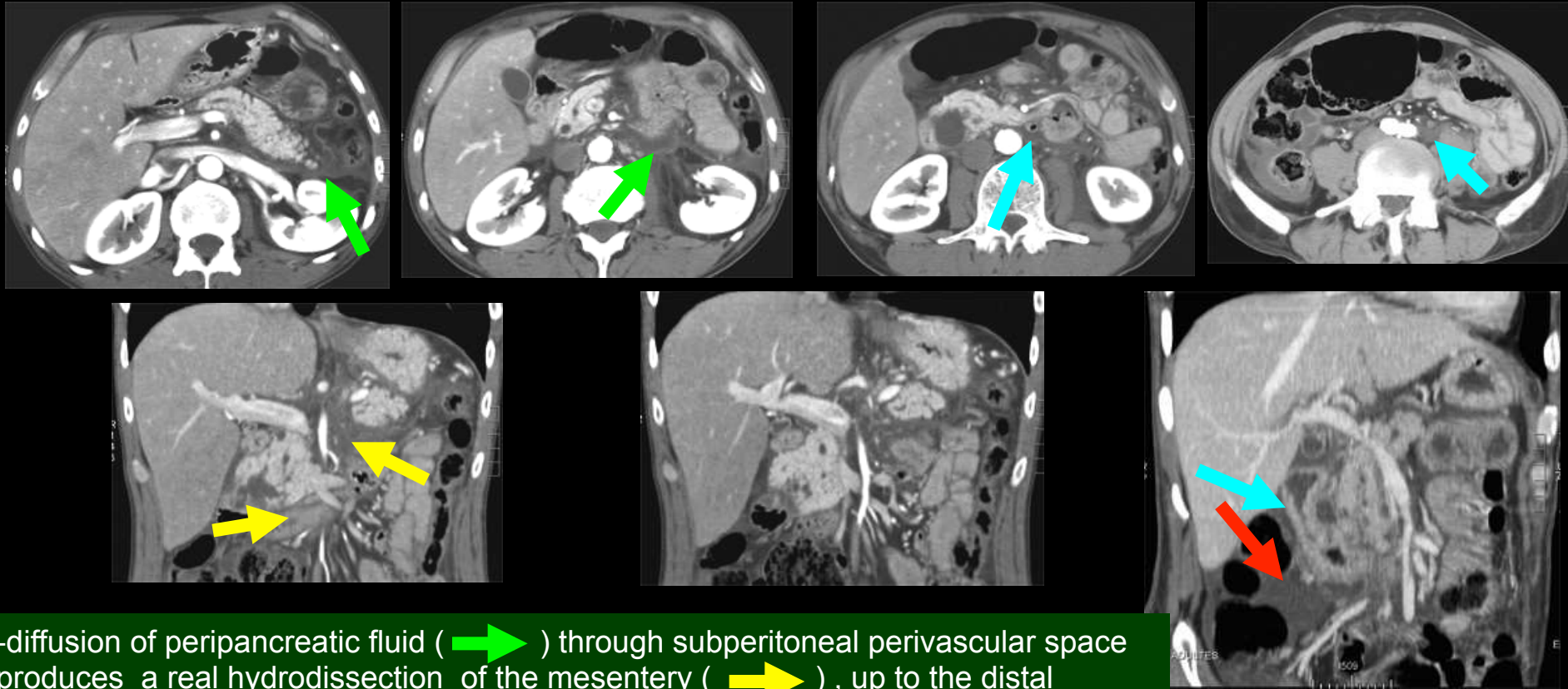
-small cluster of jejunal chronic cystic
subserous pneumatosis () at the origin
of gaseous migration

-subtle details but big diagnostic impact !!!



2a. liquid migrations through subperitoneal space of the trunk

Instances of loco-regional liquid fluid diffusion are more commonly seen,, for exemple in acute exsudative pancreatitis and in diffusion of retro peritoneal or intra peritoneal infectious processes.

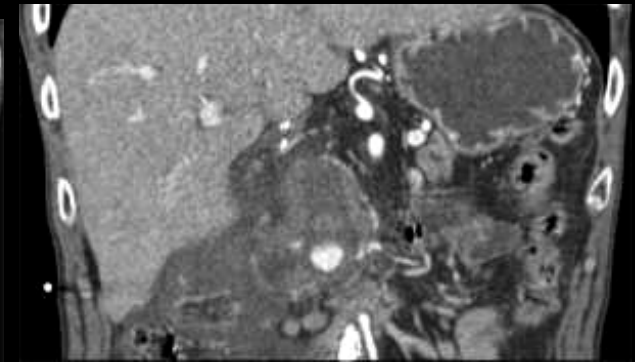
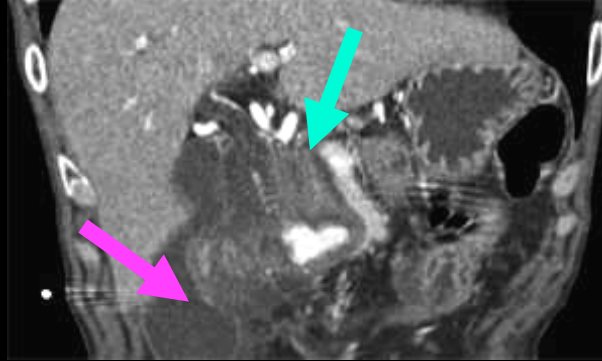
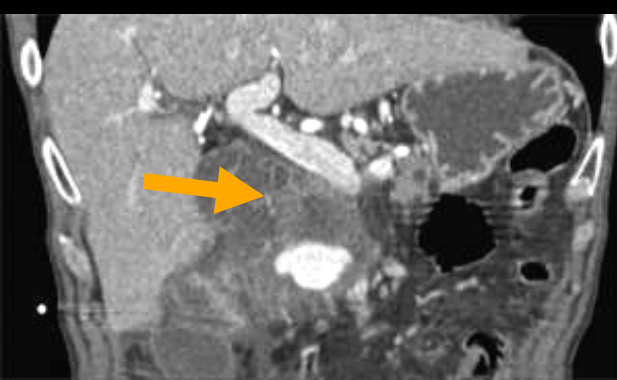
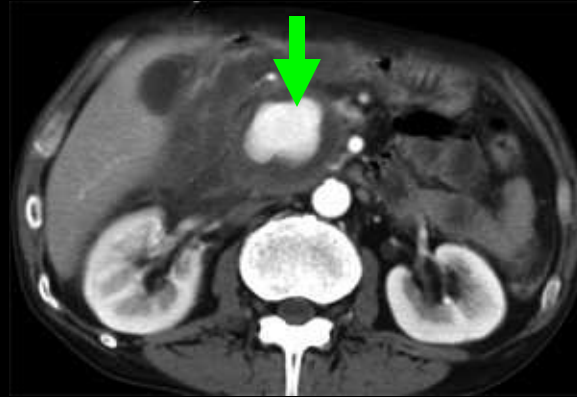
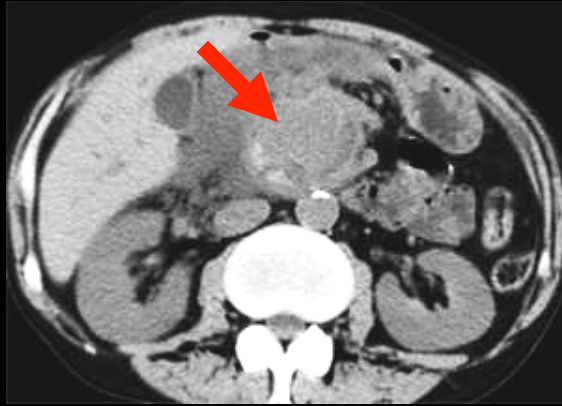


-diffusion of peripancreatic fluid (→) through subperitoneal perivascular space produces a real hydrodissection of the mesentery (→), up to the distal segment of the superior mesenteric artery and right Toldt's fascia (→)..

-para renal anterior compartment of the retroperitoneal space is also involed (→)

acute pancreatitis of unknown origin , without pancreatic necrosis in a 34 yo man

54 yo alcoholic man with , acute pancreatitis and spontaneous hyperdense pseudocyst (→); CT confirms a pseudo aneurysm of a pancreatico-duodenal artery (→).



peripancreatic migration of fluid follows subpleural space of ligaments and mesos to reach :

-right transverse mesocolon via duodeno colic ligament (→)

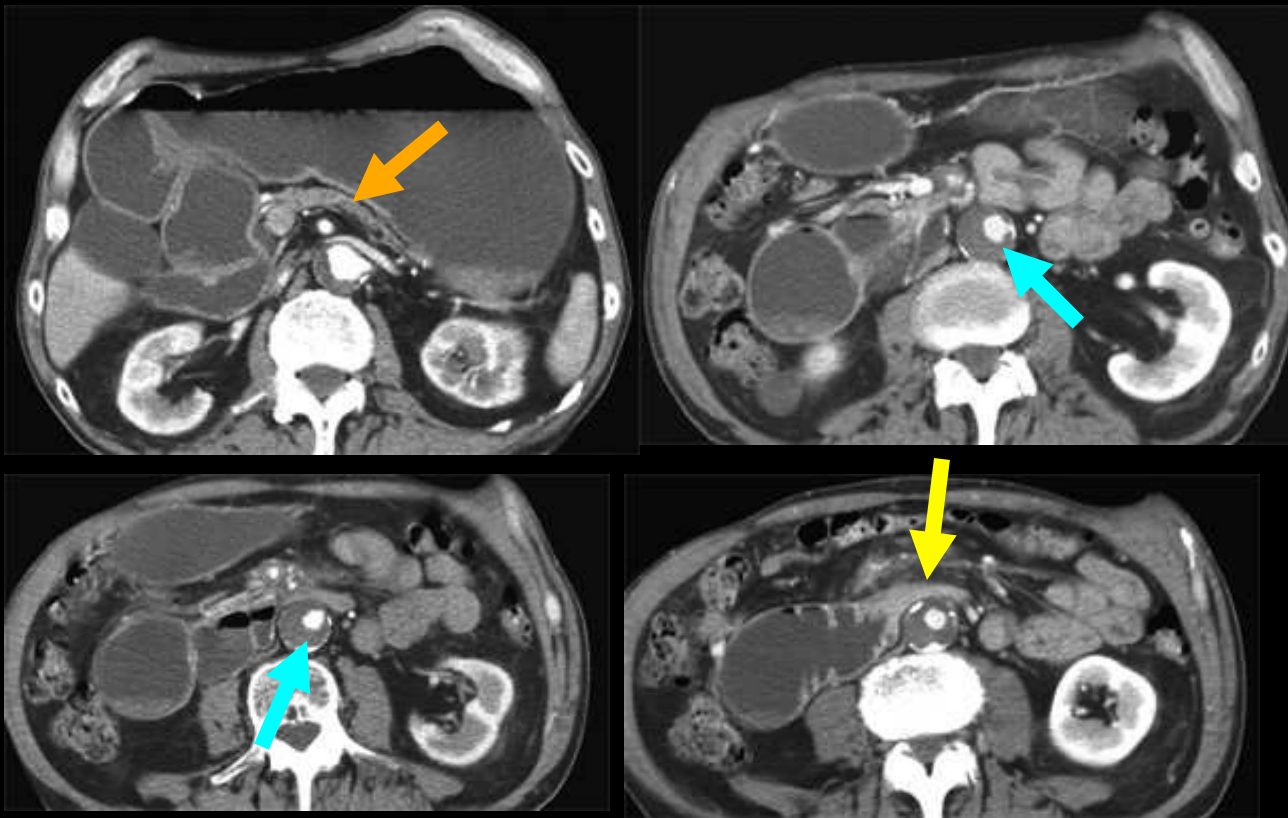
-right Toldt's fascia and ascending colon (→)

-pars pediculosa of gastro hepatic ligament (lesser omentum) (→)

2. inflammatory and tissular spreading through connective subserous spaces of the trunk

considerable work has been done to show the importance of subserosal space to understand the spread of tumoral and inflammatory diseases in abdomino-pelvic cavity. We would like to show 2 pertinent didactic examples

64 yo man ,heavy smoker with weight loss , postprandial epigastric pain and vomiting ;clinically suspected of acutizing chronic mesenteric ischemia

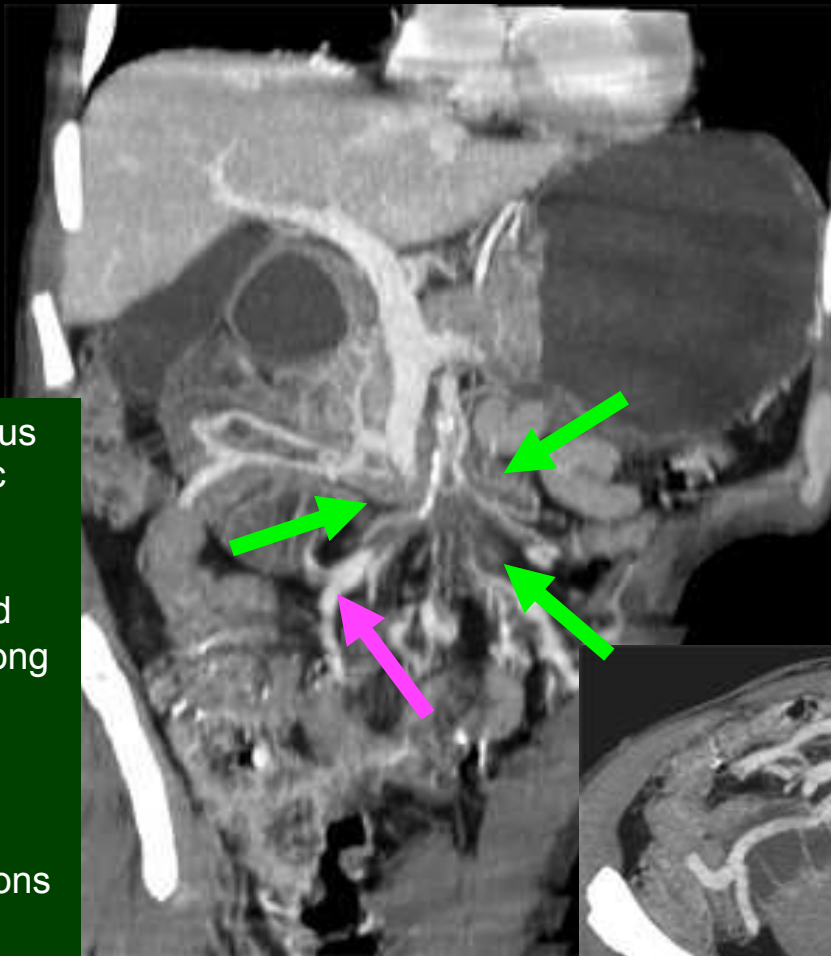
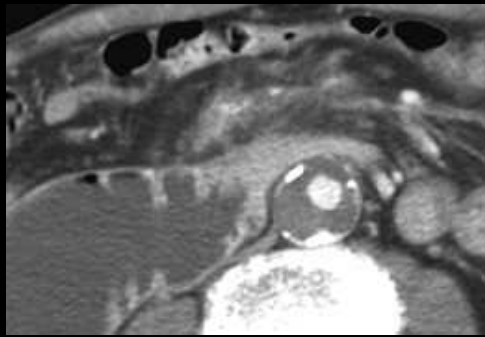
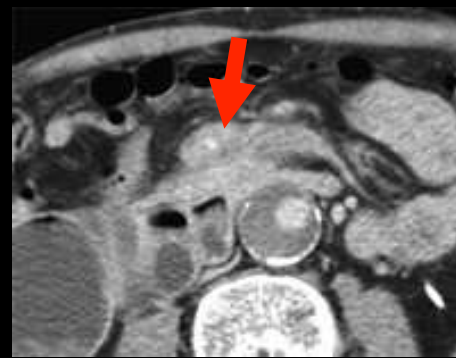
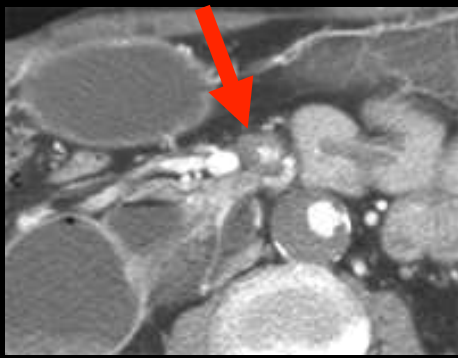


-high grade stenosis of the third portion of the duodenum (→)

-coexisting with thick mural thrombus of an atheromatous abdominal aorta (→)

-no main pancreatic duct dilatation was observed (→) .

-next slide will show more detailed images

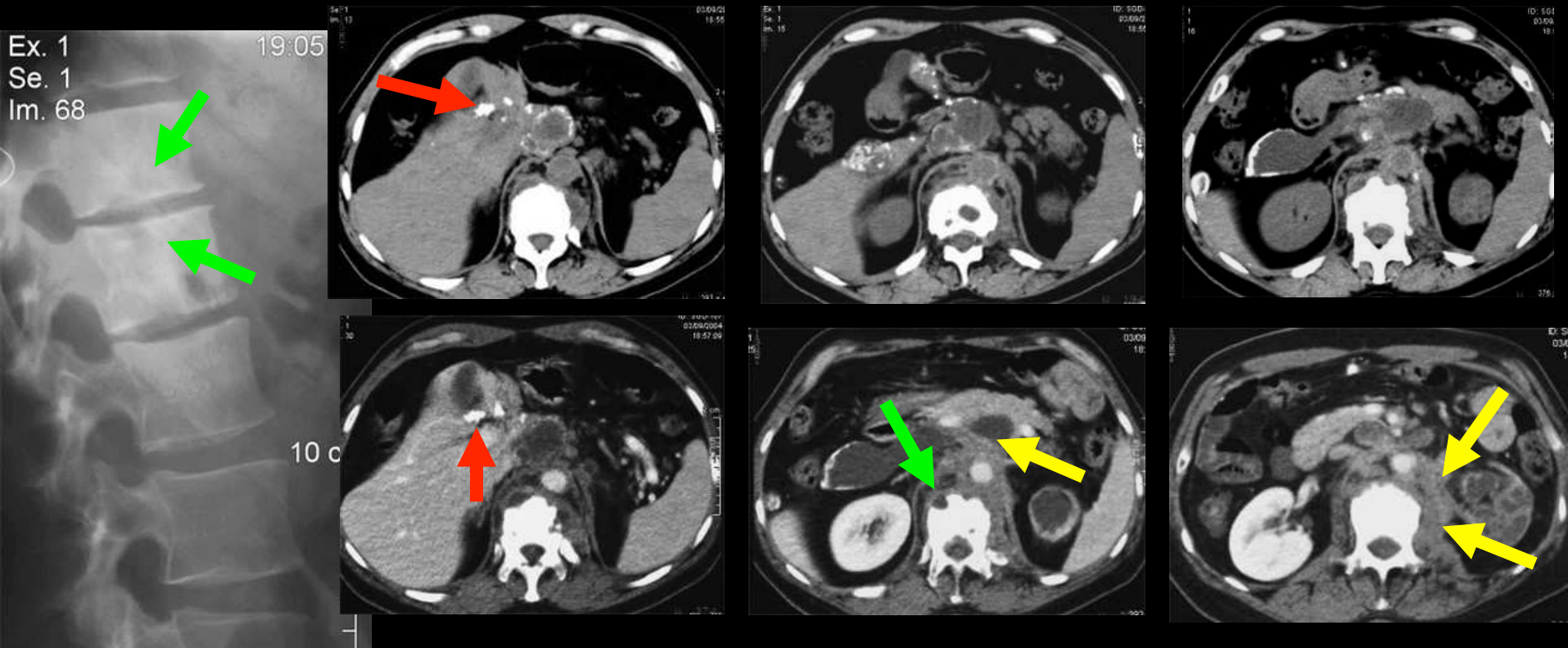


-we can see a typical aspect of fibrous periaxial extension of a pancreatic ductal adenocarcinoma (→)

-the pancreatic lesion has developed from the uncus and spread down along the mesenteric perivascular subperitoneal space (→)

-dilatation of mesenteric distal veins upstream fibrotic mesenteric expansions are highlighted on MIP coronal and axial images (→).

56 yo man ,misdiagnosed and treated for 16 years for tuberculosis , with liver and spine(L1-L2)locations.



diagnosis of **echinococcosis multilocularis** was finally established after surgery for medullary compression

-initial calcified lesion of the left liver (→) migrated through the subpleural space of the lesser omentum to retroperitoneum (para renal anterior and para renal posterior compartments) (→)

-this parasitic fibrous aggressive reaction extended to lumbar spine determining the "pseudo Pott" aspect (→)

3 conclusions and take home messages

- becoming more familiar with the **holistic concept of subperitoneal space** is very helpful to read CT images of acute abdomen , particularly for **exact determination of the localisation of gaseous images** .

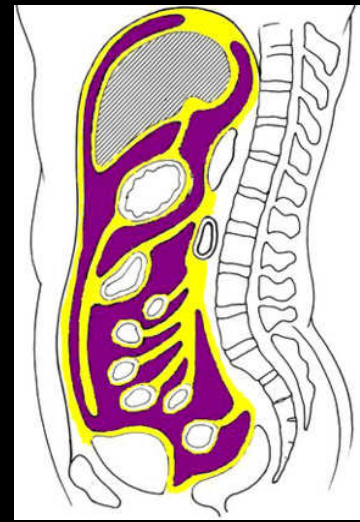
-it is often necessary to have readily available CT **thoraco - abdomino-pelvic examination** in order to avoid heavy consequences of misinterpretation in fluid migrations (specially gaseous) in subperitoneal space

-don't forget to thoroughly analyse and identify gaseous images of **properitoneal space** and don't misinterpret them as pneumoperitoneum

-always look for **retropneumoperitoneum** when you have problems with gaseous bubbles anywhere in the trunk ; it is a very important item to take into account for correct diagnosis

-**subperitoneal space is an Ariane's thread** that helps the radiologist to recognize fluid migration roads through the labyrinth of abdomino thoracic anatomy

-thank you for showing interest in this poster



[holistic concept of subperitoneal space in yellow !](#)

from ref 8.Pickhardt PJ , Bhalla S
Usual nonneoplastic peritoneal and subperitoneal conditions : CT findings
RadioGraphics 2005 ;25 : 719-730



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Amer J Roentgenol AJR 1996 ; 167 :1433-1439
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The subperitoneal space: mechanism of tumor spread in the peritoneal cavity, mesentery and omentum
Cancer Imaging 2003 ; 4 : 25-29
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Usual nonneoplastic peritoneal and subperitoneal conditions : CT findings
RadioGraphics 2005 ;25 : 719-730