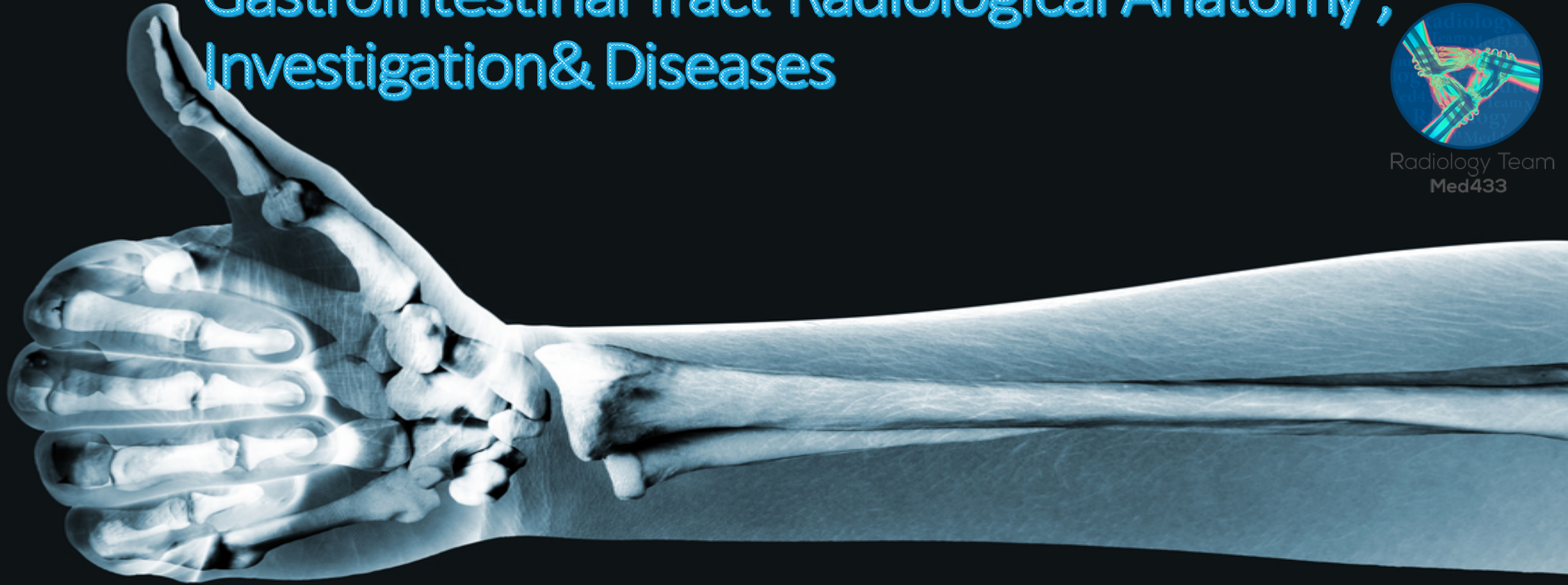


Lecture 10:
Gastrointestinal Tract Radiological Anatomy,
Investigation & Diseases



Radiology Team
Med433



● Slides

● Explanation

● Notes

● Additions

● Important

Radiological anatomy of the GIT:

- Esophagus
 - Stomach: Fundus, body, antrum, Lower and greater curvatures.
 - Duodenum: 1st to 4th part.
 - Small intestine: jejunum at LUQ, ileum at RLQ
 - Colon: cecum, appendix, Ascending, transverse, descending colon, rectum.
-
- Upper GIT
 - Lower GIT

Radiological studies of the GIT:

- Plain radiograph of abdomen (KUB)
- Barium study
- US
- CT
- MRI
- Angiography

Abdominal X-ray (AXR)

AP (supine)



General Assessment:

- Basic details (name, age, gender ...etc)
- Projection of the film (AP or PA) and position weather erect¹ or supine².
(erect position characterized by lower position of bowels gas due to pressure of solid organs and gas at stomach fundus)
- Right or left
- Check bone, soft tissue/Solid Organs, calcification and gas pattern & Artefacts
- An AXR should include the lower anterior ribs and Ideally patients should have empty bladders

- 1: Erect films are used to show any fluid levels (suspects either obstruction or ileus)
- 2: AXR are usually done with the patient lying down (supine film)

Assessment of gas: Before you start, check if there is gas under the diaphragm* (if it is visible)

Small bowel

Gas outline is often broken up into many small pockets, because of peristalsis.

Central in the abdomen

- Jejunum has “**valvulae conniventes**”
- Ileum is characteristically **featureless**

The calibre **should not exceed 2.5–3 cm**

If it is visible at all, it suggests that it is abnormal

Large bowel

- The caecum normally **contains semifluid material containing multiple pockets of gas.**
- Much of the right side of the bowel, has a granular appearance on X-rays, creating **mottled areas of gas** seen best against the background of the **iliac bone.**
- When visible, the haustral folds of the colon may be seen, only partially visualised across part of the large bowel lumen.
- Peripheral in the abdomen

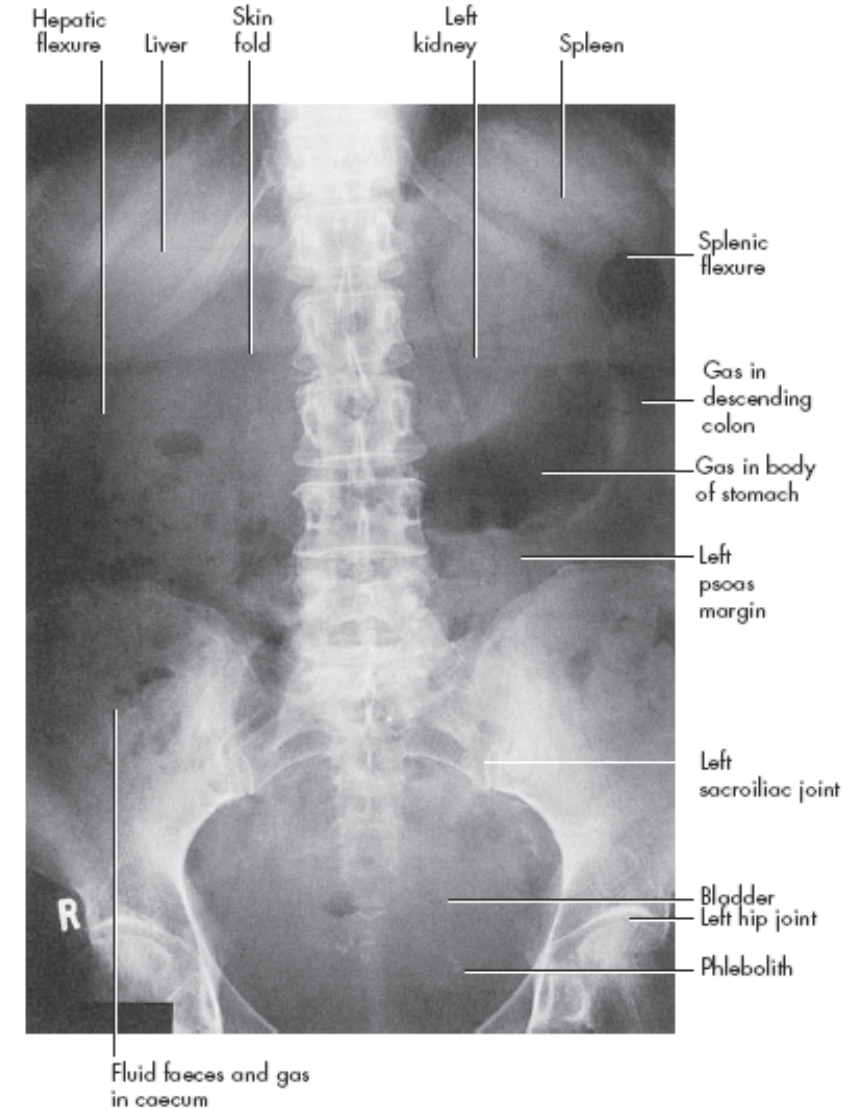
- If you are given a CXR and an AXR, the clinician is probably interested in **air under the diaphragm** and so suspect diseases that feature **perforation as a complication such as (IBD & diverticular disease)**
- An AXR should include the lower anterior ribs
- Ideally, patients should have empty bladders for an AXR

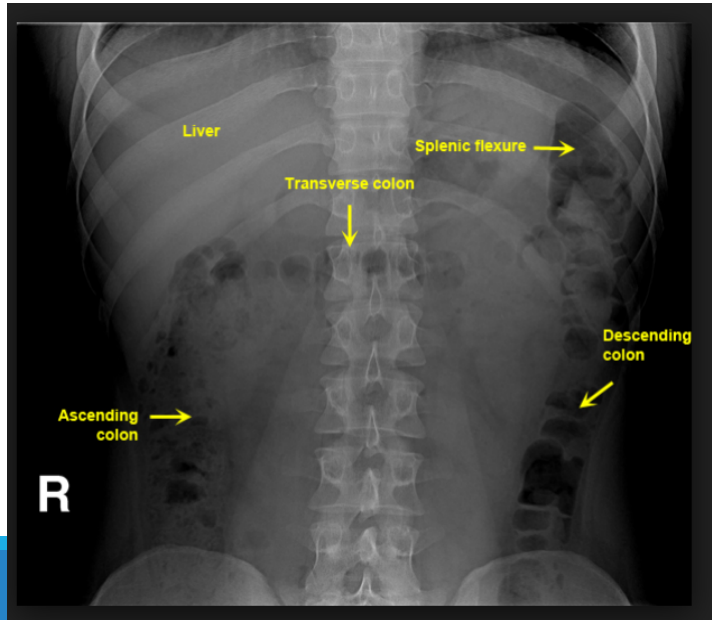
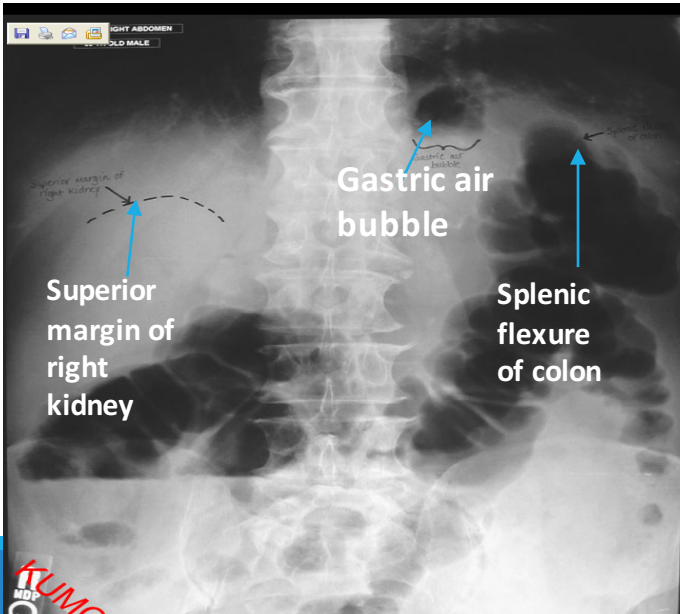
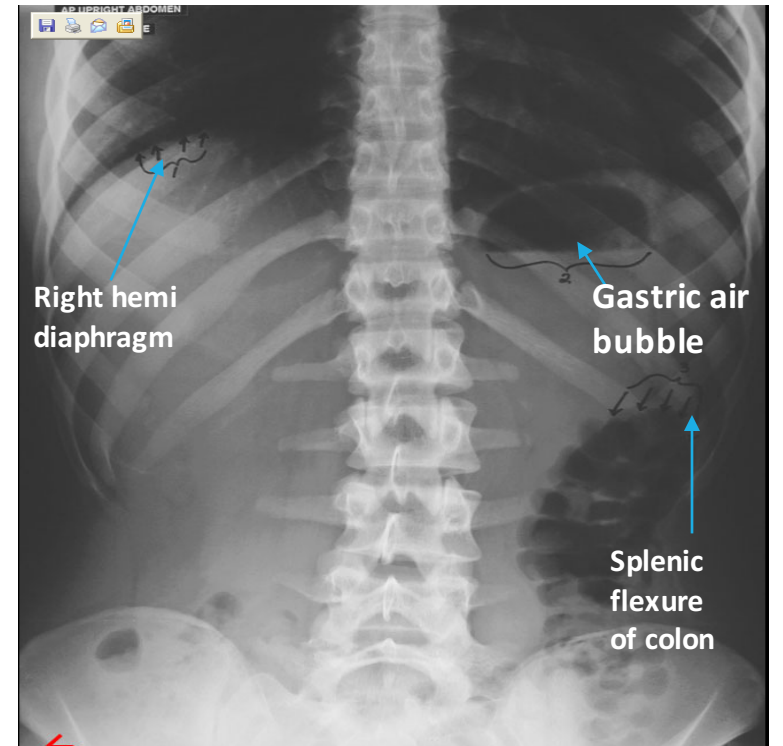
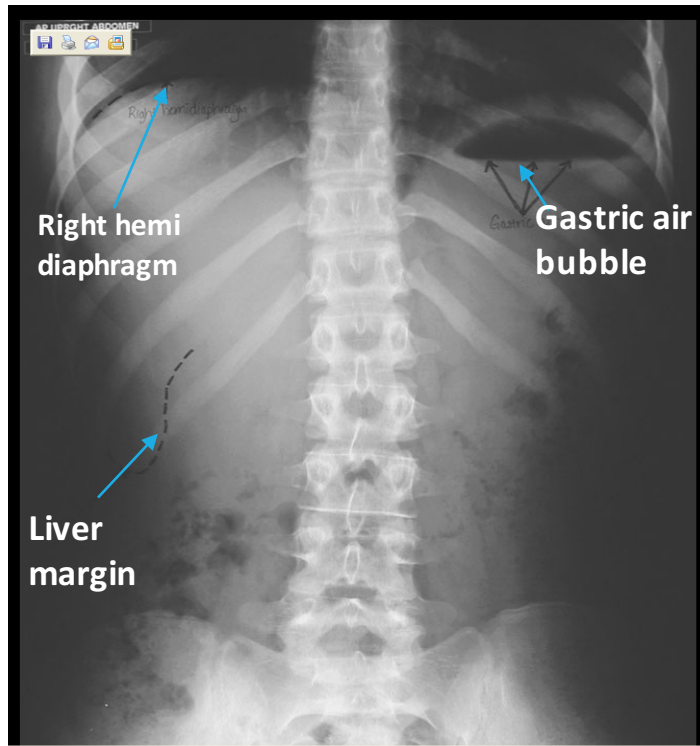
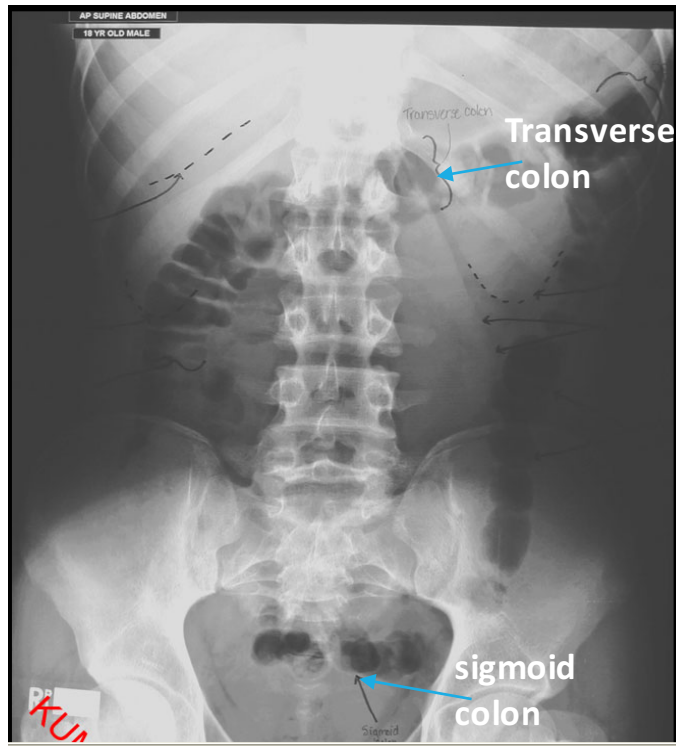
Assessment of Bones:

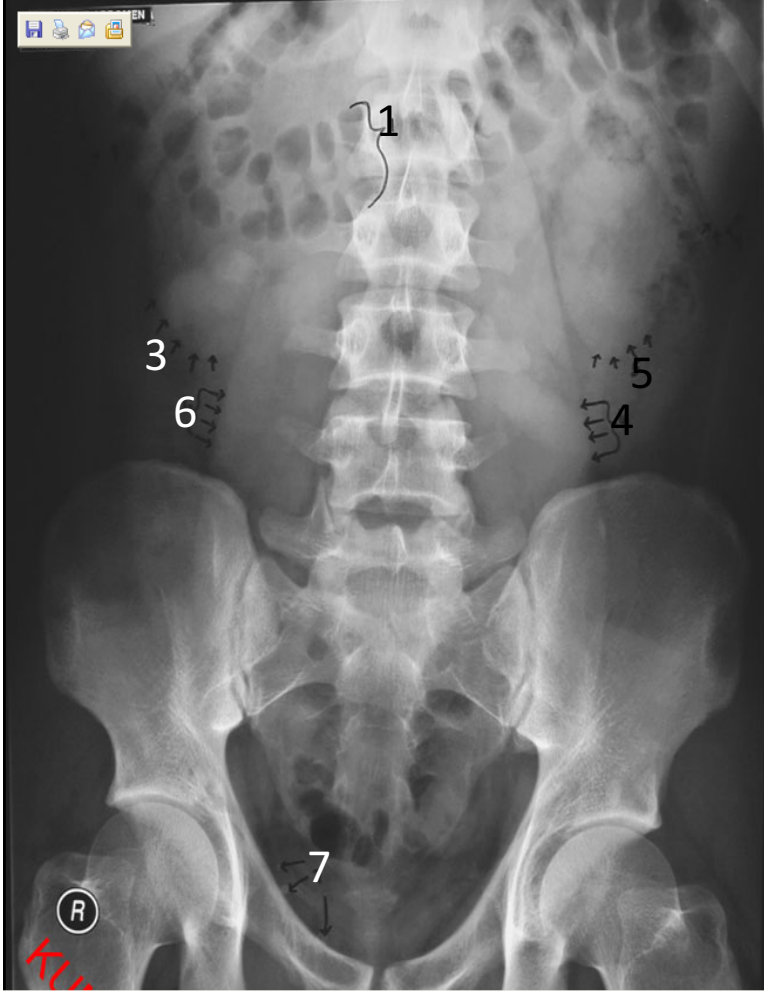
- Ribs, spine, sacrum, pelvis and hips.
- Bones may show evidence of **malignant disease**
- **Sacro-iliitis may be associated with intestinal problems such as Crohn's disease**
- **Excessively sclerotic** bones may hint at other diseases e.g. Paget's (which can present as abdominal pain) or GI ulcers (which are associated with sclerotic bone lesions)
- Don't forget to check the spine for conditions such as ankylosing spondylitis.

Assessment of Soft Tissue: look for

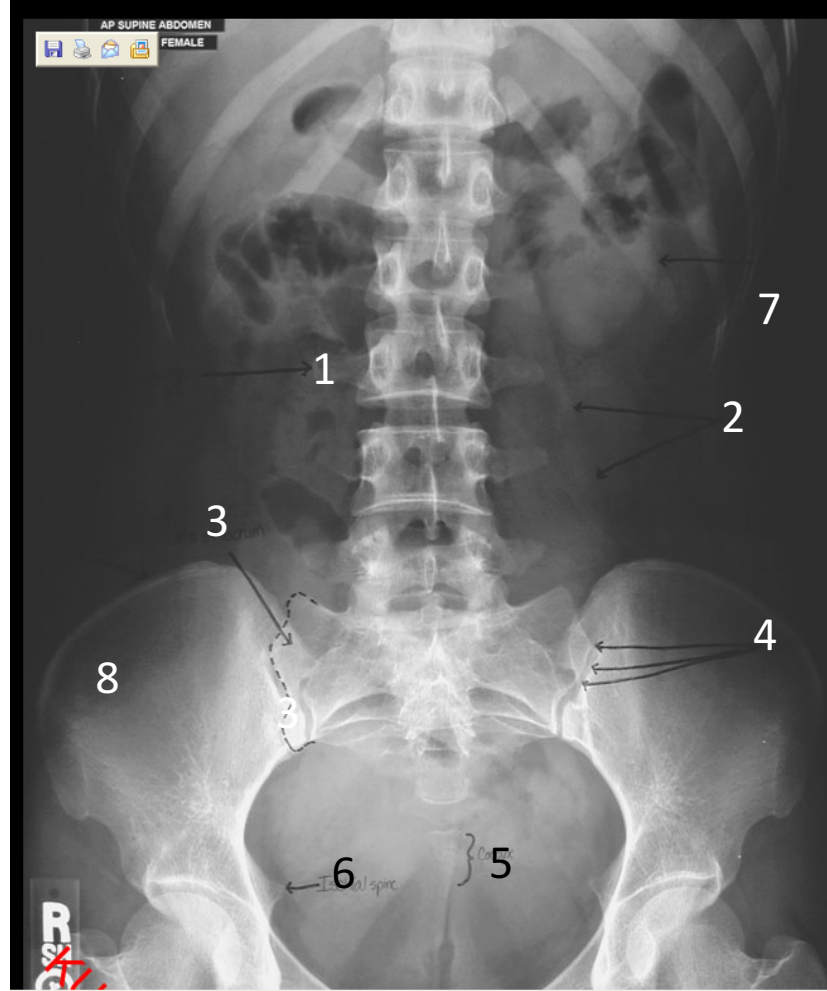
- Trace soft tissue outline for any clues as to pathology e.g. (obesity, trauma sites, abdominal drains ... etc)
- Psoas muscles
- Kidneys (**left is higher and slightly bigger than the right**)
- Liver (**difficult to see but may be identifiable by lack of bowel in RUQ**)
- Spleen (difficult to see)
- Bladder (**visible if full, not always visible if empty**)
=> A full bladder may hint for an acute problem, rather than a chronic one
- Uterus (causes a dent in the top of the bladder on IVU).







- 1 Transverse colon
- 2 Inferior margin of the liver
- 3 Inferior margin of right kidney
- 4 Splenic margin
- 5 Inferior margin of left kidney
- 6 Psoas major muscles
- 7 Phleboliths



- 1- Right transverse process of L3
- 2- Psoas major muscle
- 3- Ala of sacrum
- 4- Left sacroiliac joint
- 5- Coccyx
- 6- Ischial spine
- 7- Left 12th rib
- 8- Iliac crest

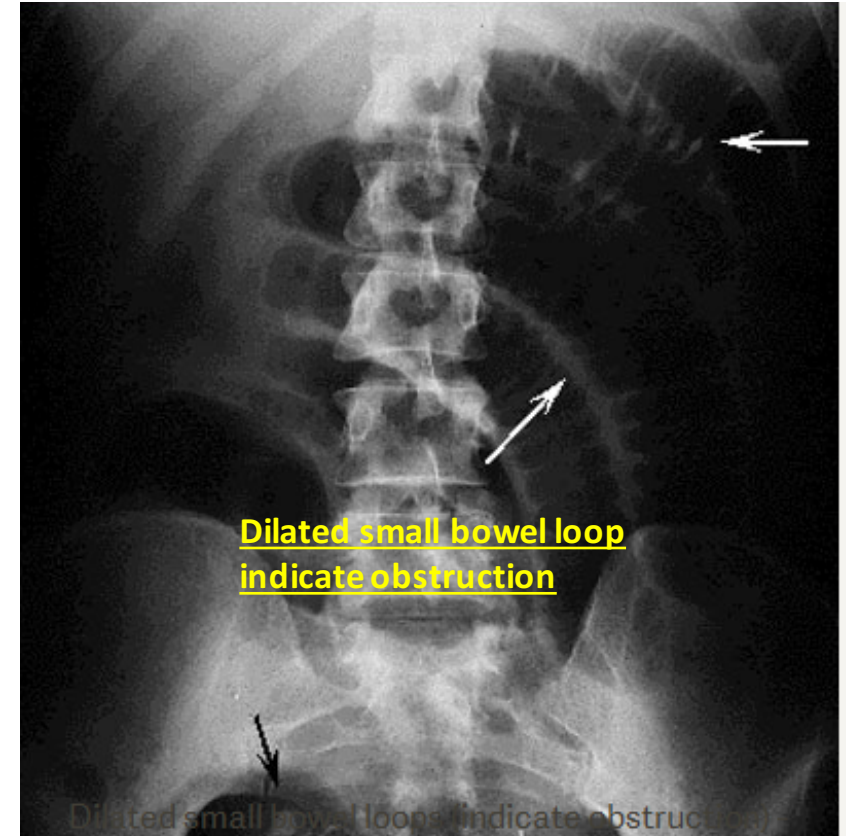
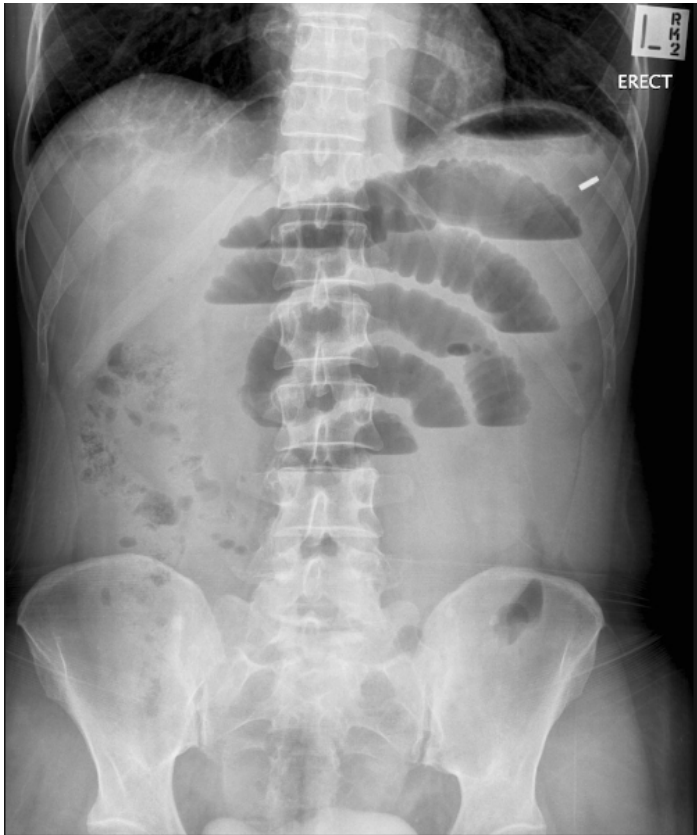


- A Lateral margin of the psoas muscle
- B Inferior pole of the left kidney
- C Left L5-S1 facet joint
- D Left sacroiliac joint

Bowel Obstruction

1- Small Bowel Obstruction:

- More in the **center**
- Diameter DOES NOT exceed 5cm
- Distended bowel loops are better seen on supine abdominal film



1- Small Bowel Obstruction:



Any suspicion of intestinal obstruction, we have to go for erect (standing x-ray). Because we want to see the bowel lobes and if there's any air-fluid levels.

Air-fluid levels: 3 and more, each is 3cm or more, this is abnormal.

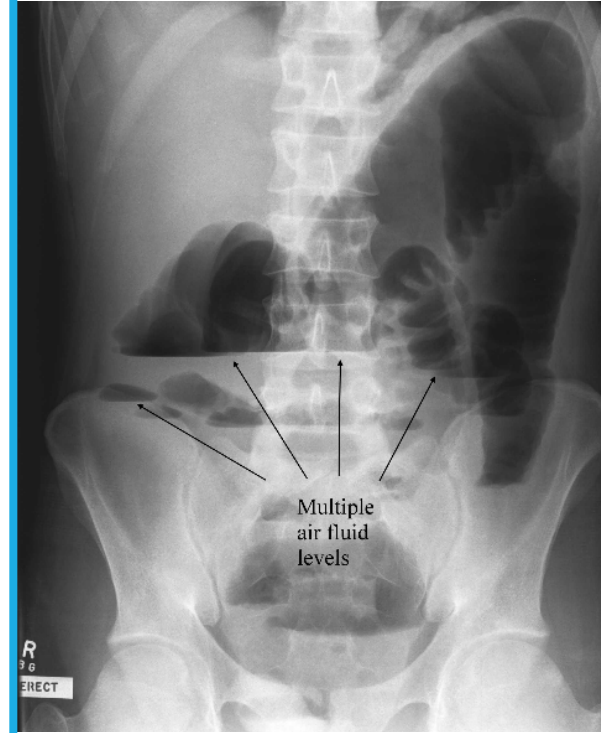


Small bowel obstruction on upright film.

*Note the multiple air-fluid levels.

2- Large Bowel Obstruction:

- More in the **peripheral** area
- Diameter DOES NOT exceed 8cm



Pneumoperitonium

- ❖ Presence of air in the peritoneal cavity.
- ❖ Indicate perforation of duodenal ulcer or post-op complication



Assessment of Calcification on Abdominal X-ray

Calcification occurs in:

Lymph nodes

Appendicoliths

Phleboliths

Calculi

Aortic calcification

caused by faeces in appendix, may suggest appendicitis.

usually within pelvis, look like silt

look in kidney, ureters & bladder

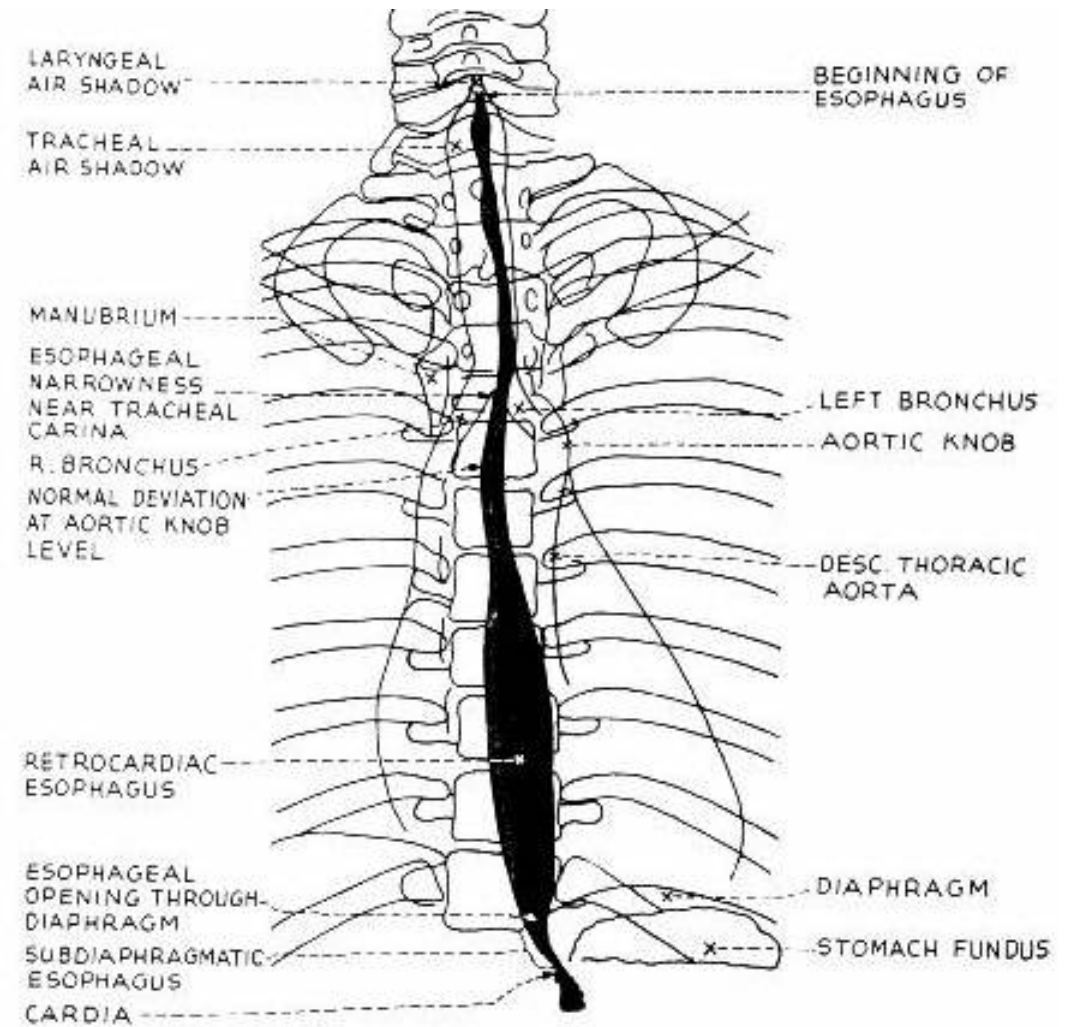
It is normal as age increases but you must check the aorta as **asymmetry of the walls suggests aortic aneurysm.**



Barium Swallow

- **Single contrast study**, used mainly to look at the oesophagus
- Liquid barium is swallowed in an upright and prone position and radiographs are taken during the oesophageal phase of transit.
- Has two techniques: Single & Double.

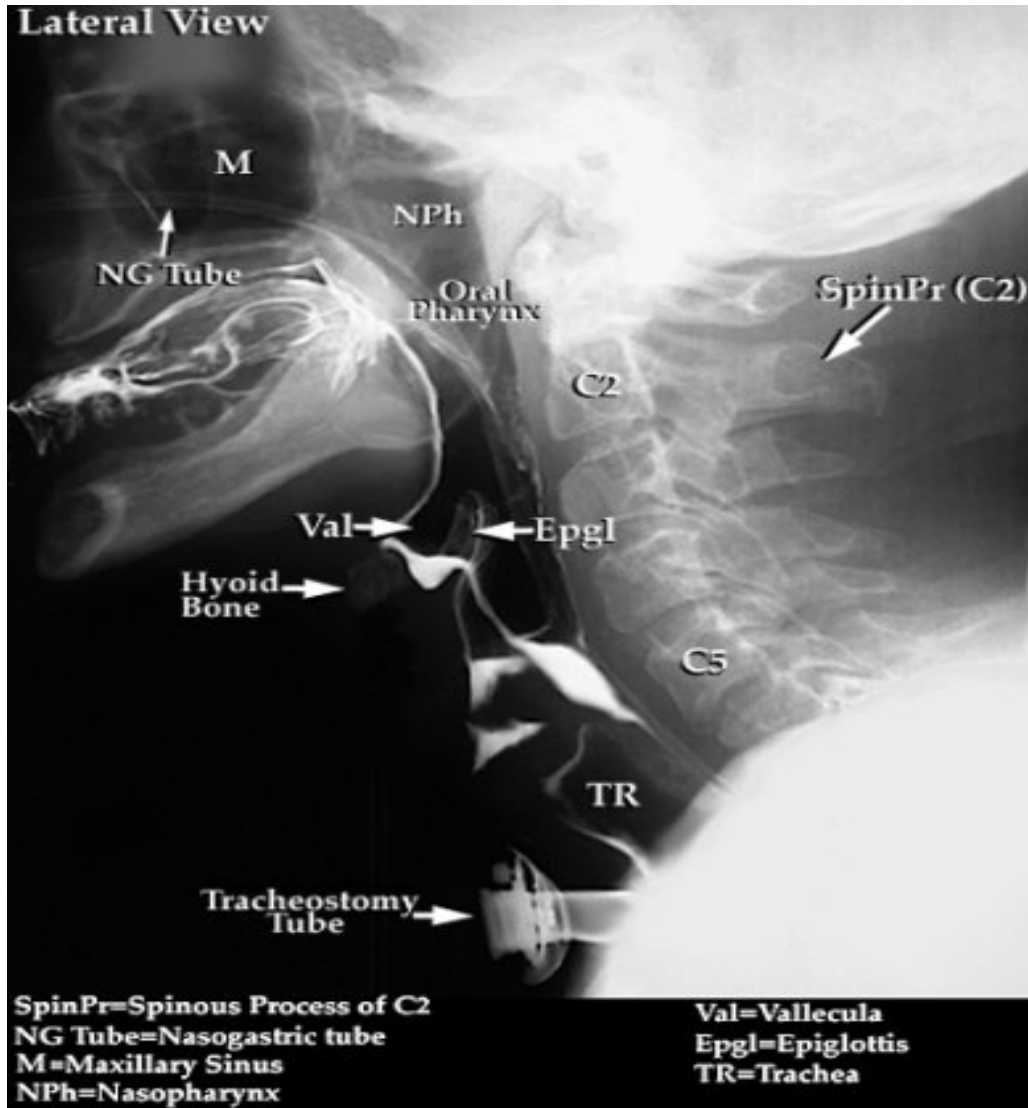
Upper gastrointestinal tract radiography, also called an upper GI, is an x-ray examination of the pharynx, esophagus, stomach and first part of the small intestine (also known as the duodenum) that uses a special form of x-ray called fluoroscopy and a contrast material called barium.



1- Single Contrast Study:

The main indication is **DYSPHAGIA**.

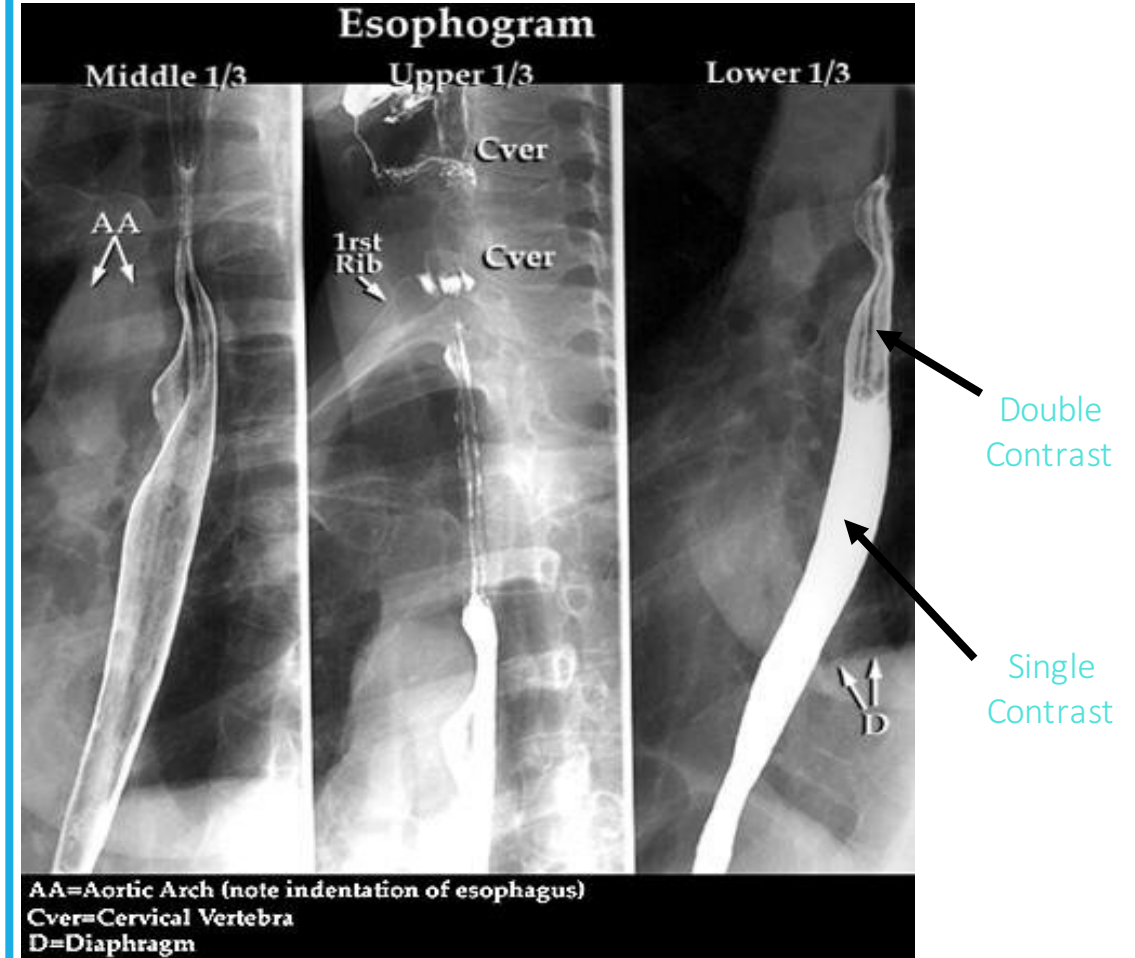
(Used for evaluation of gross structures)



2- Double Contrast Study:

Barium contrast followed by air.

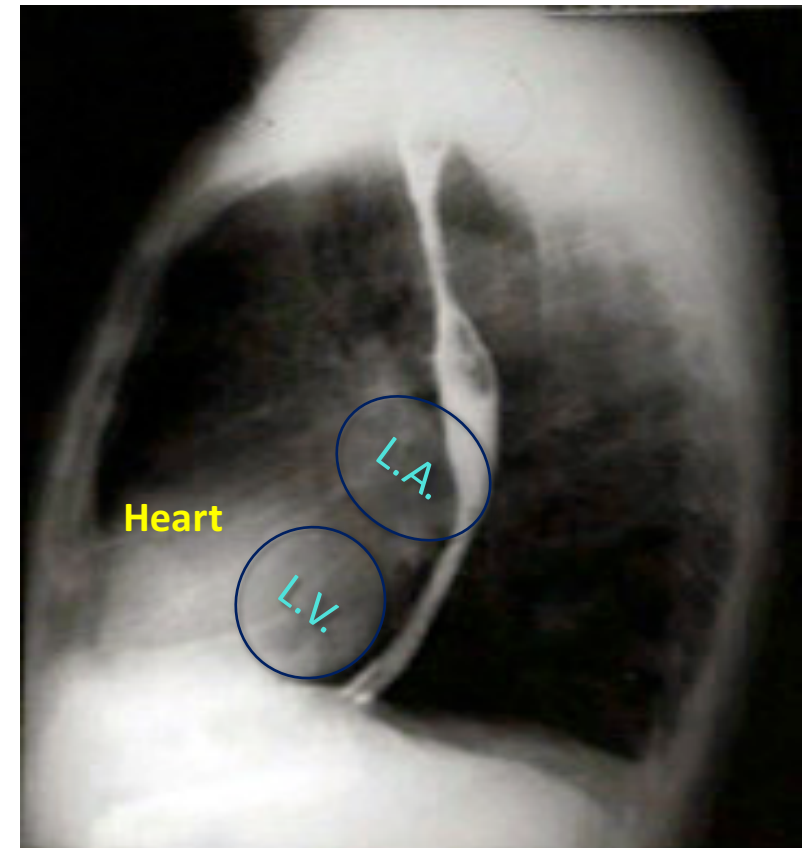
(Used for more details (mucosa)).



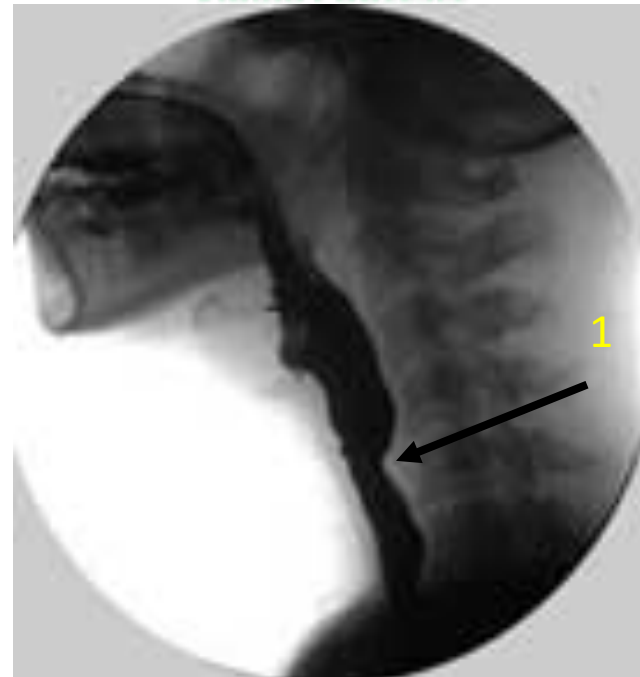
The 5 Indentations of the Esophagus

- 1- Indentation of Cricopharyngeus Muscle: At level of C5-C6, Part of upper esophageal sphincter (UES).
- 2- Indentation of the aortic arch (AA).
- 3- Indentation of Left main bronchus.
- 4- Indentation of the left atrium.
- 5- Indentation of the left ventricle.

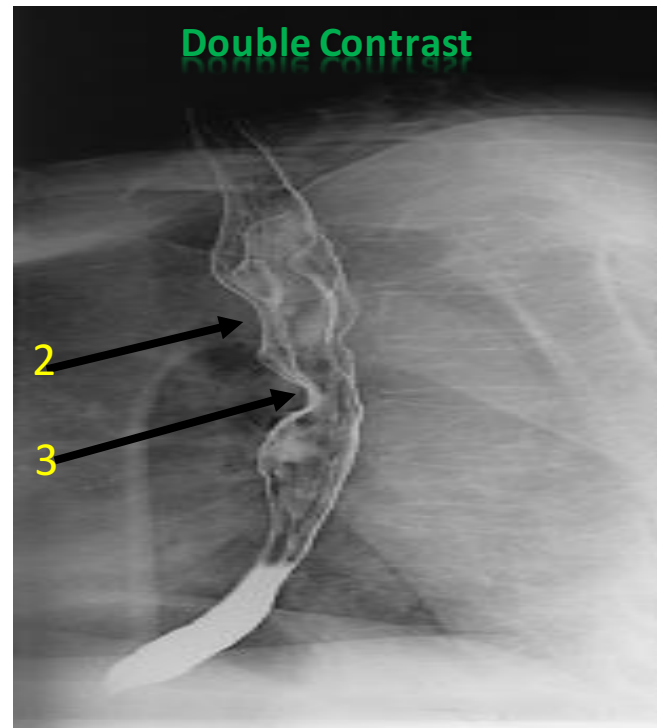
Single Contrast



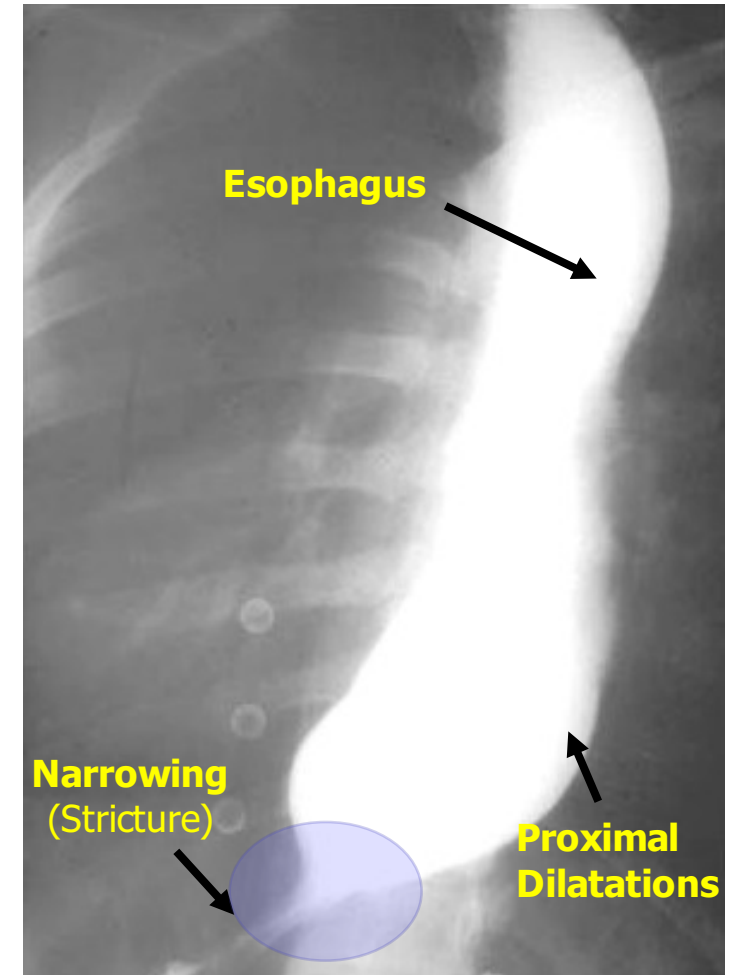
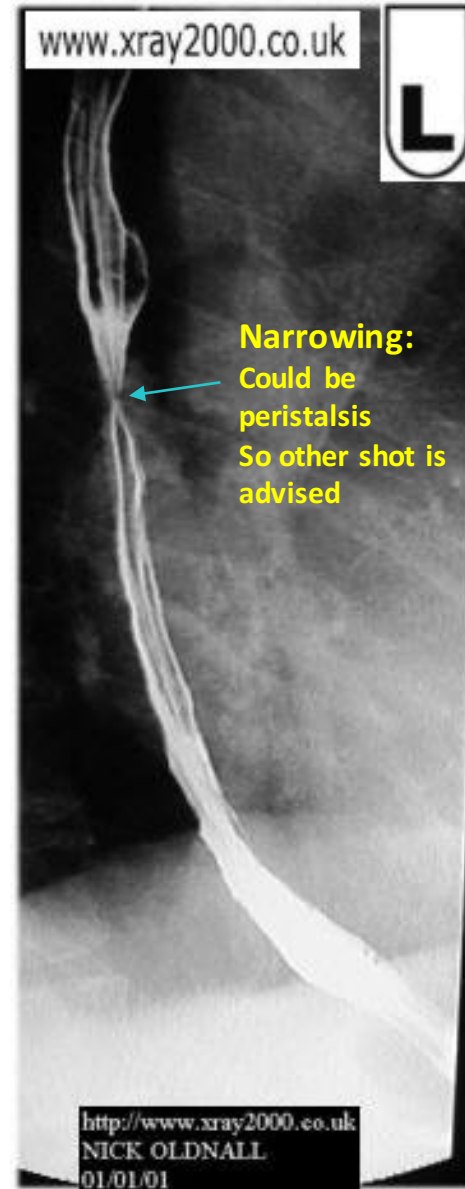
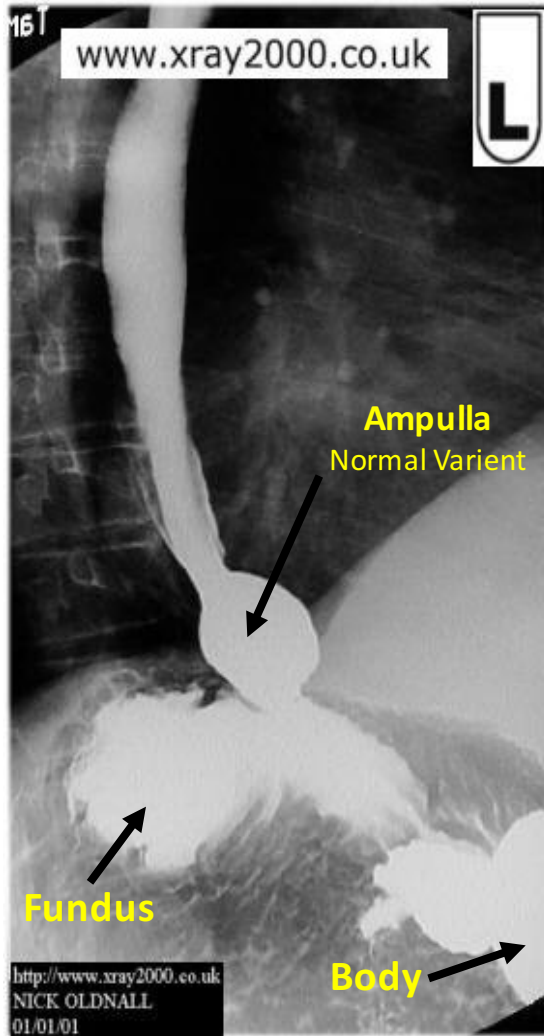
Single Contrast



Double Contrast

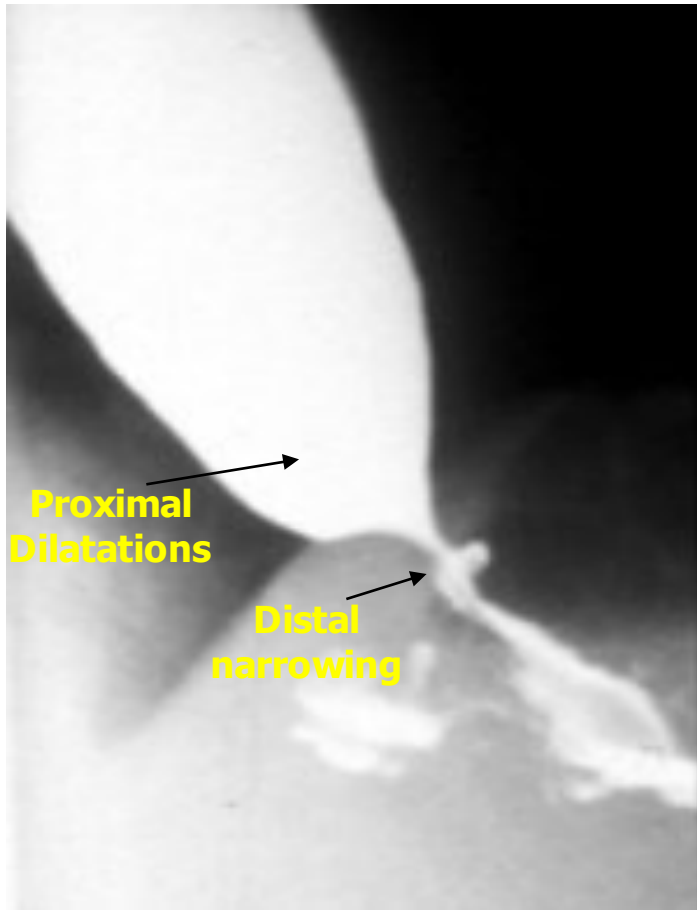


Single Contrast



Bird peak sign
Differential diagnosis: **Achalasia**

Lower Esophagus

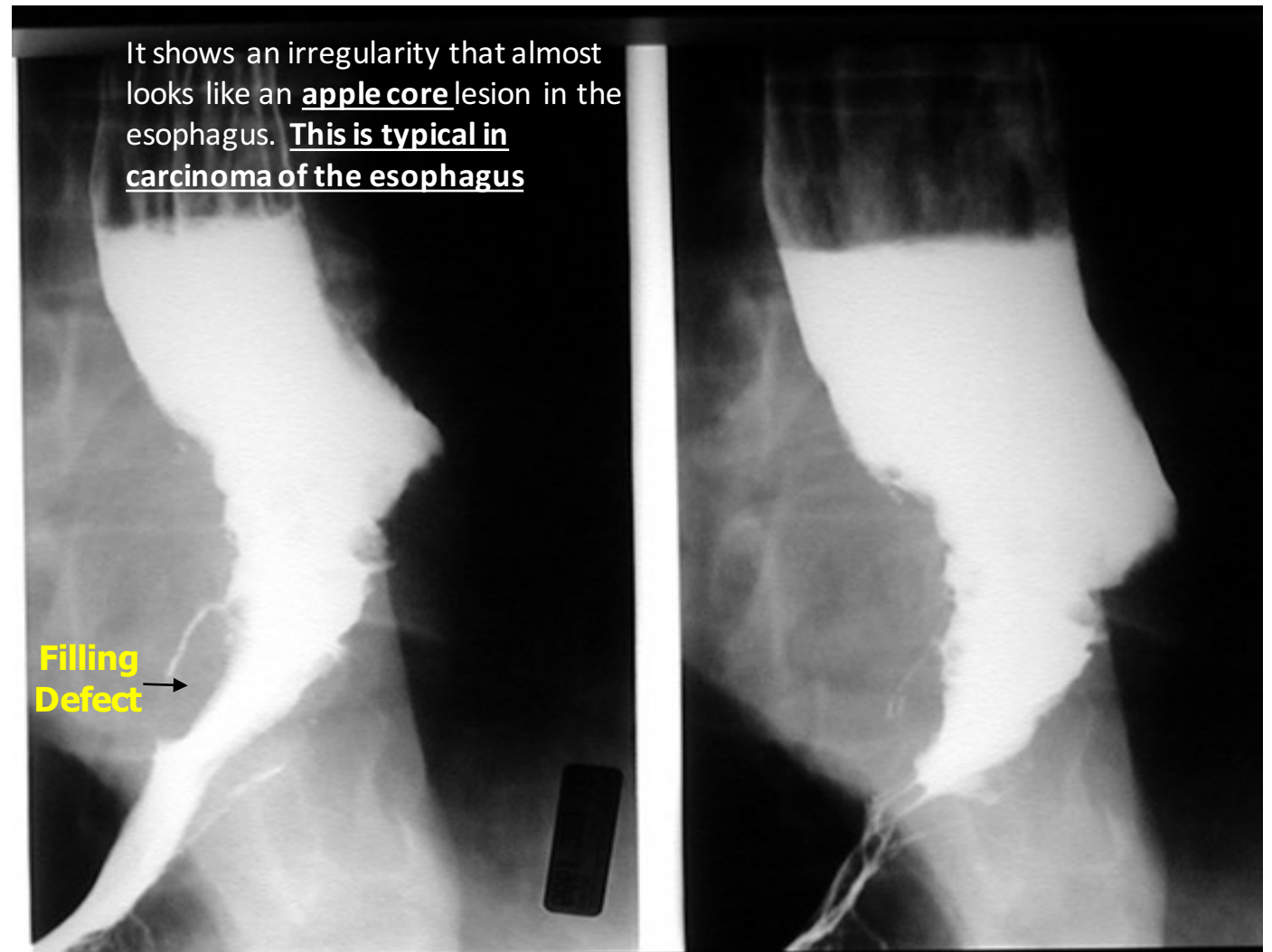


Proximal Dilatations

Distal narrowing

Benign Stricture:

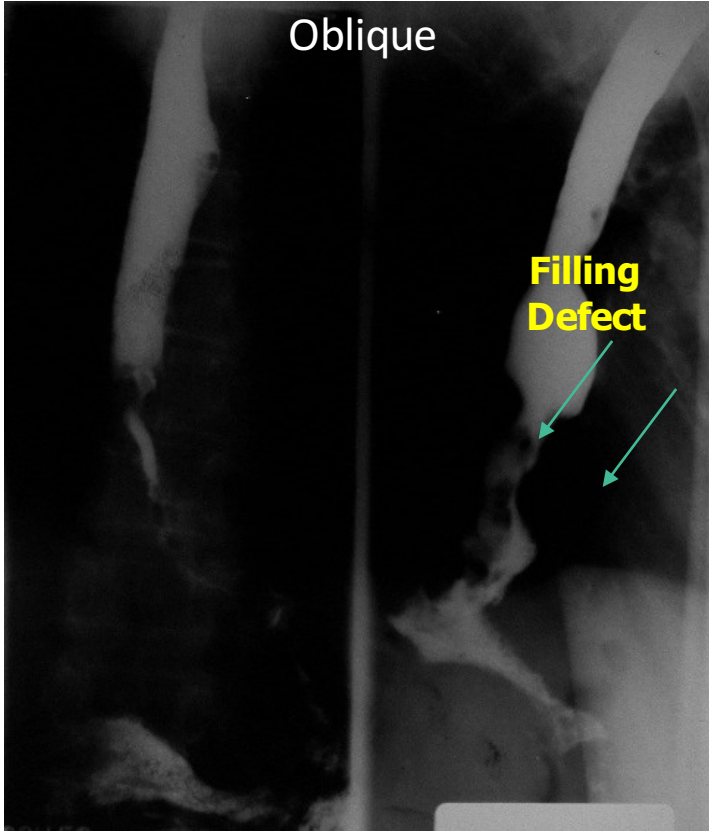
The transitional Zone looks smooth and free of filling defects.



Filling Defect

Malignant Stricture:

- The transitional Zone looks Irregular & ill defined
- Differential diagnoses: **Adeno CA & Squamous Cell CA**

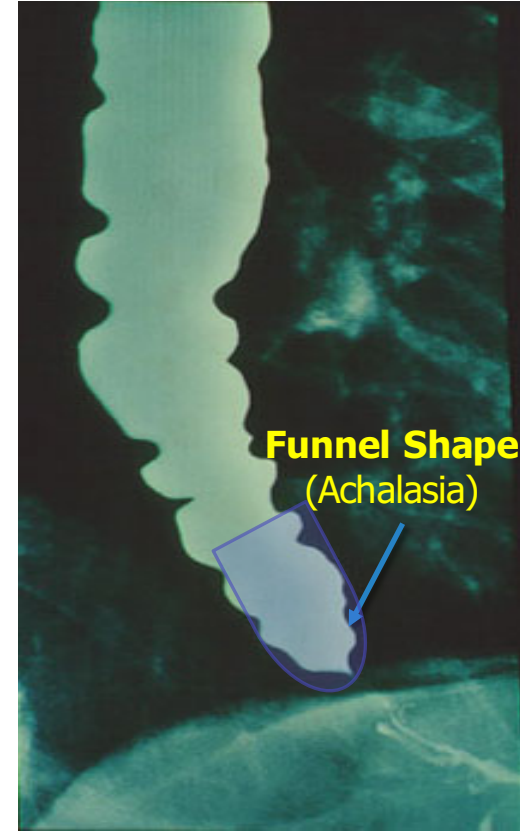


Malignant Stricture

Malignant Stricture:

It shows an irregularity that almost looks like an apple core lesion in the esophagus. This is typical in carcinoma of the esophagus

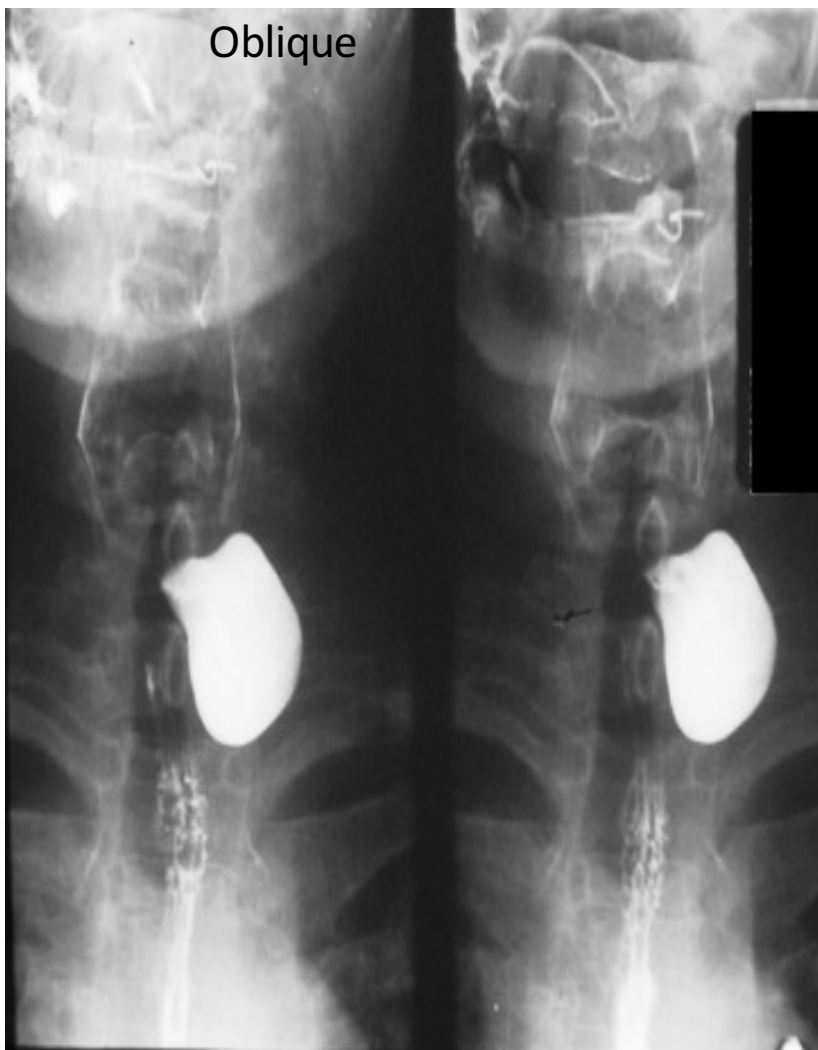
Long irregular narrowing



Irregular Wall & Dilatation: Tertiary Contraction (Pathological non-propulsive Contraction)

The barium swallow reveals:

- 1- Smooth distal tapering caused by the hypertensive lower esophageal sphincter that straddles the diaphragm
- 2- Multiple non-Peristaltic (non-propulsive) contractions throughout the body of the esophagus.
- 3- This appearance is called "vigorous achalasia".

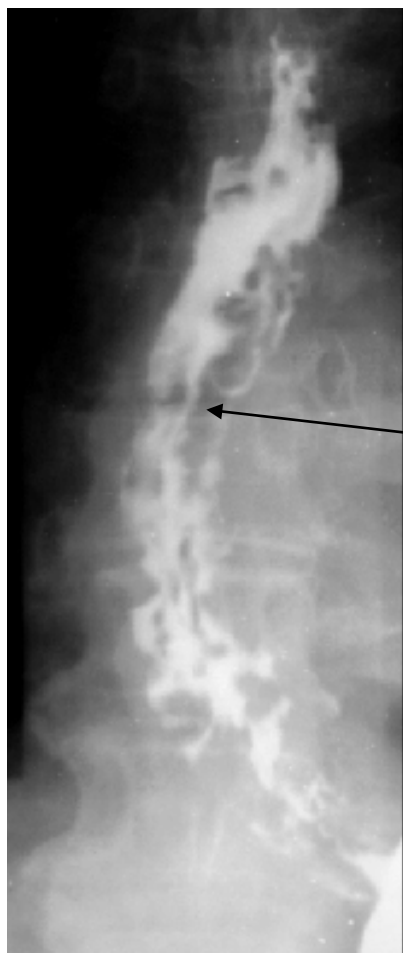


Well Defined Contrast Filled left cervical level sac

NOTE: Opposite to diverticulum, polyps pouch inside and they will not be filled with contrast.



Pharyngeal Pouch (Zenker's Diverticulum):
occurs in an area of anatomic weakness known as **Killian's dehiscence.**



Irregular Multiple Filling Defects

Differential Diagnosis of Multiple Esophageal Filling Defects:

1. Fungal Infx
2. Polyps
3. Esophageal Varices
4. Food Particles

(Esophageal Varices)

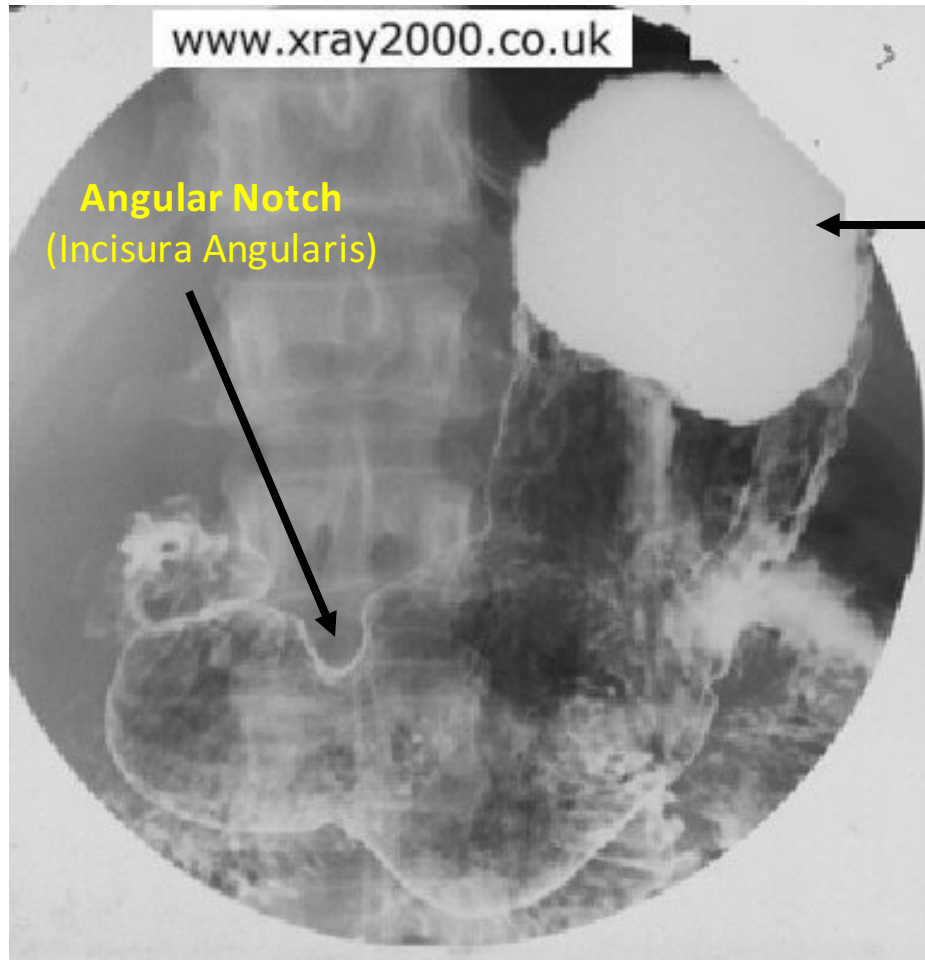


Irregular Multiple Filling Defects

- Numerous rounded and elongated smooth-contoured filling defects are present in the inferior two thirds of the esophagus.
- The contour of the esophagus is irregular and spiculated.

Barium meal: To evaluate the stomach and duodenum

Barium meal, double contrast



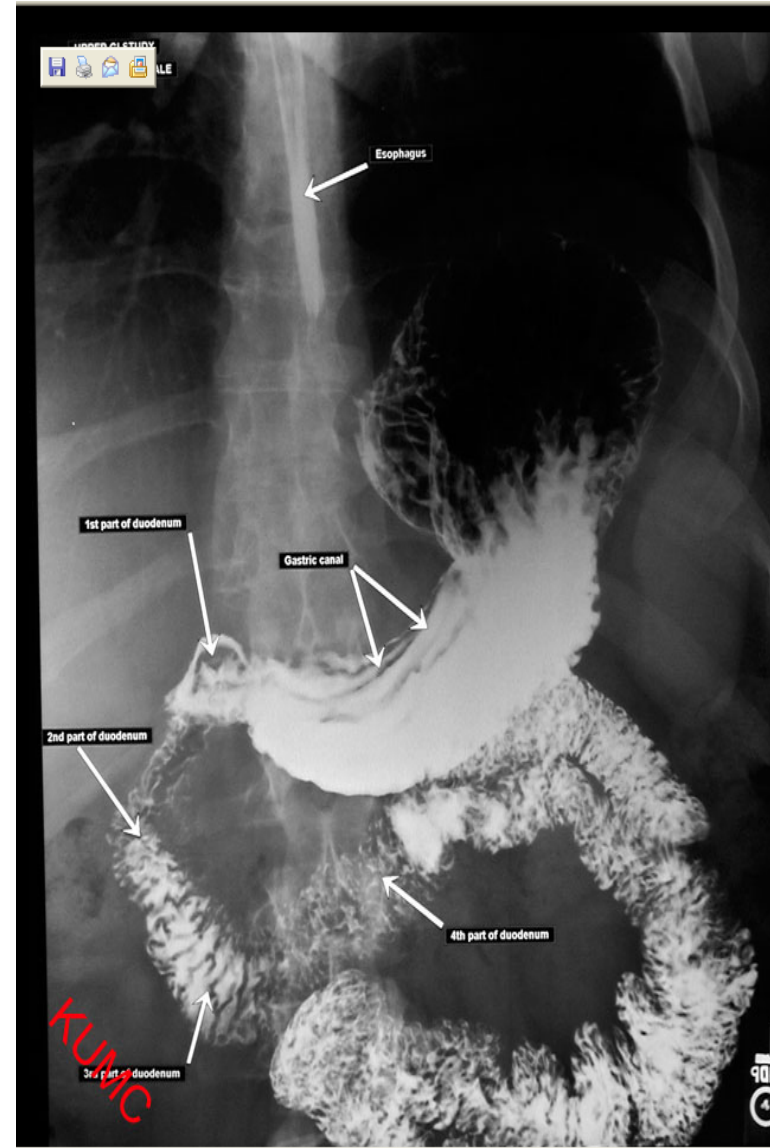
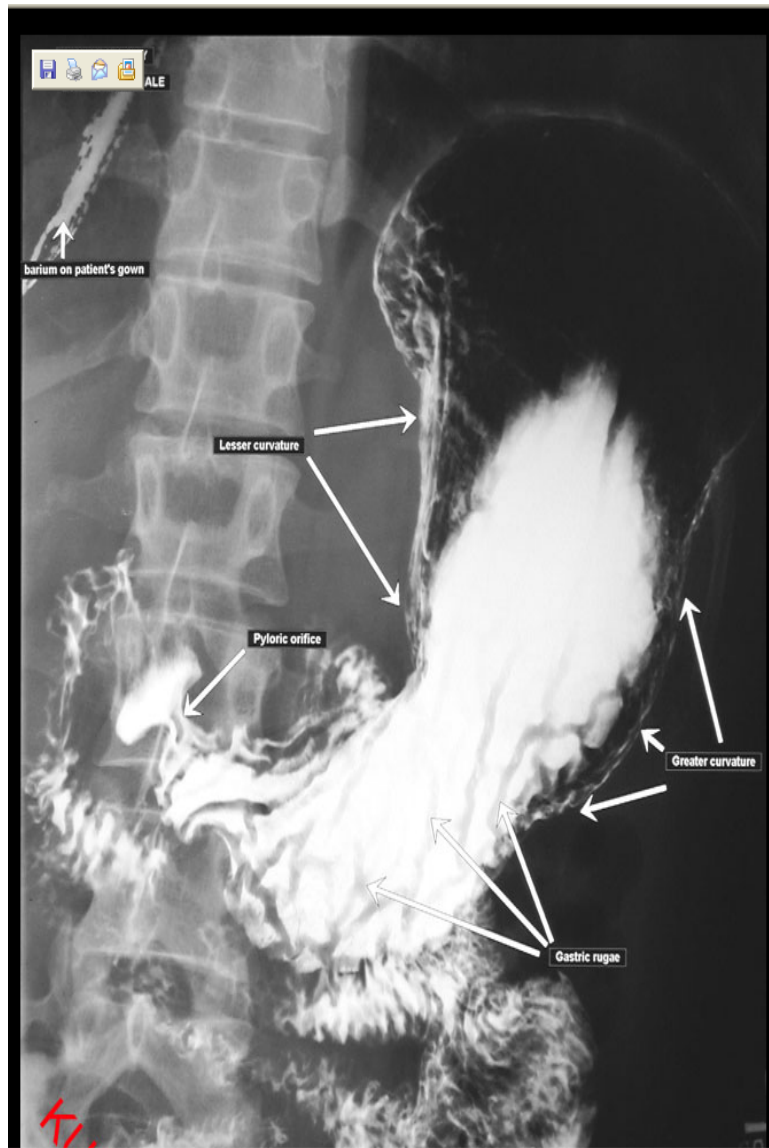
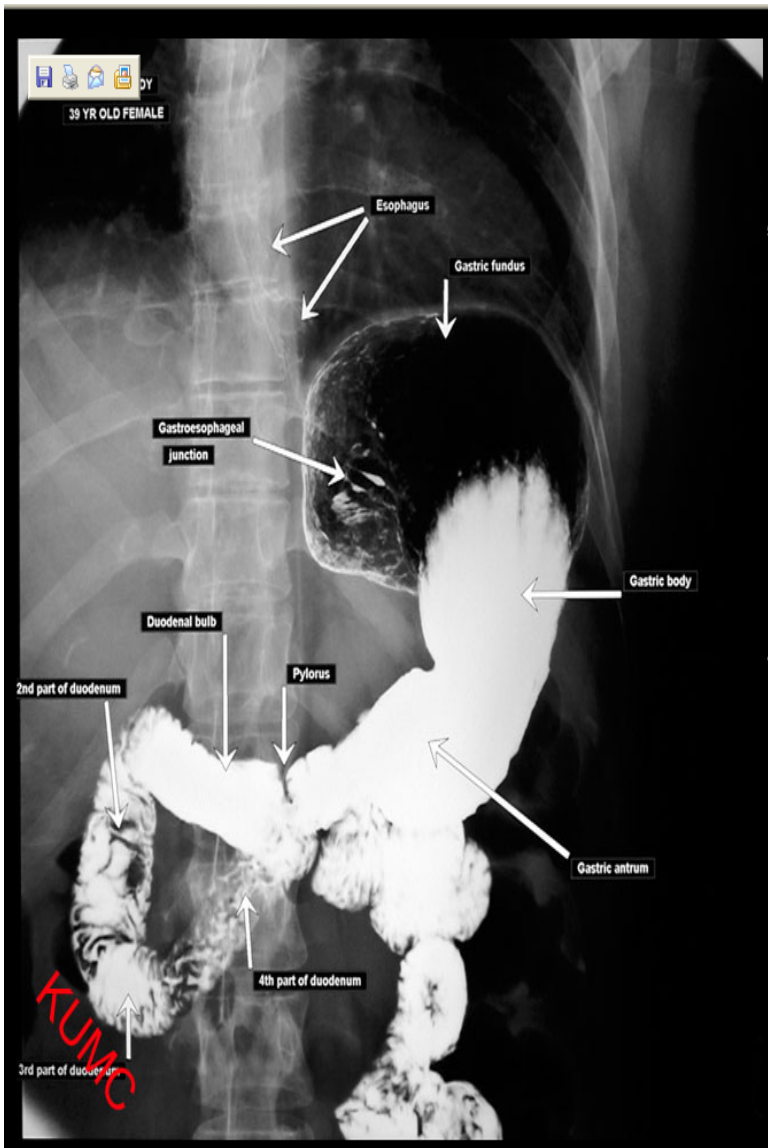
www.xray2000.co.uk

Angular Notch
(Incisura Angularis)

The patient is in supine Position. WHY?

=> Because the contrast is highly distributed
(concentrated) in the Fundus due to gravity

← **Antrum** → ← **Body** →



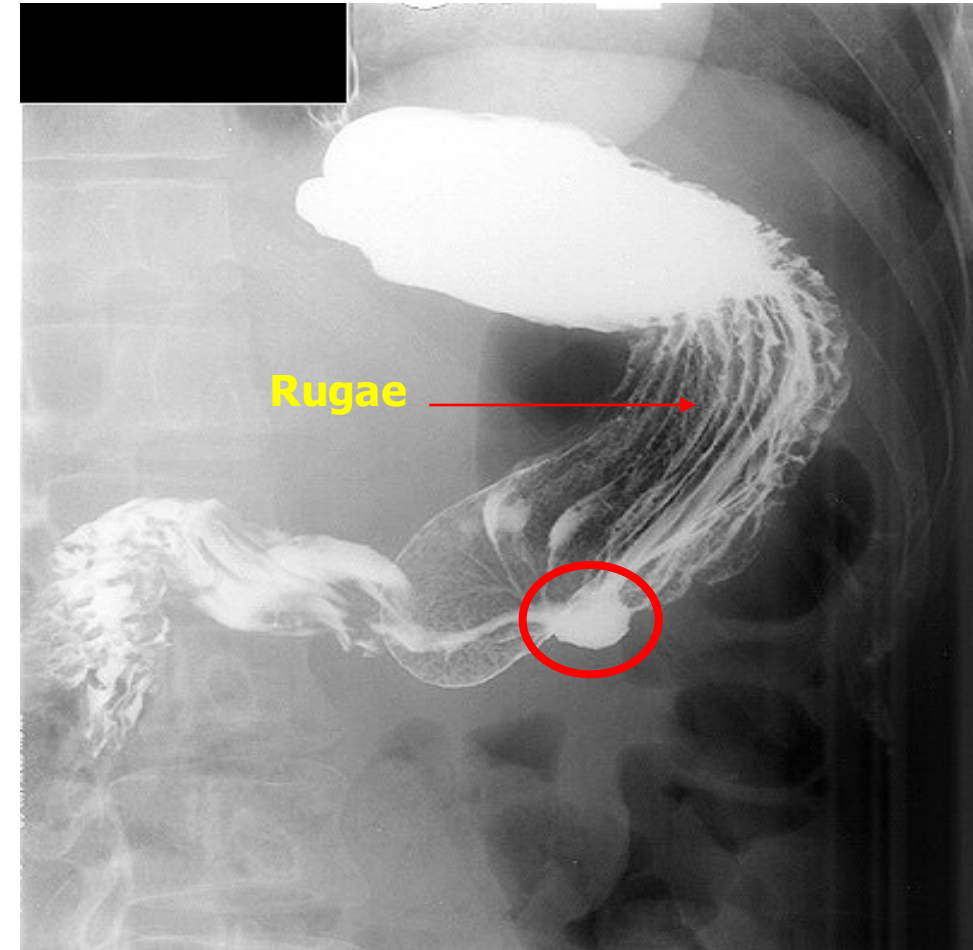
Standing position because the fundus is filled with air.

Barium Meal, Double Contrast



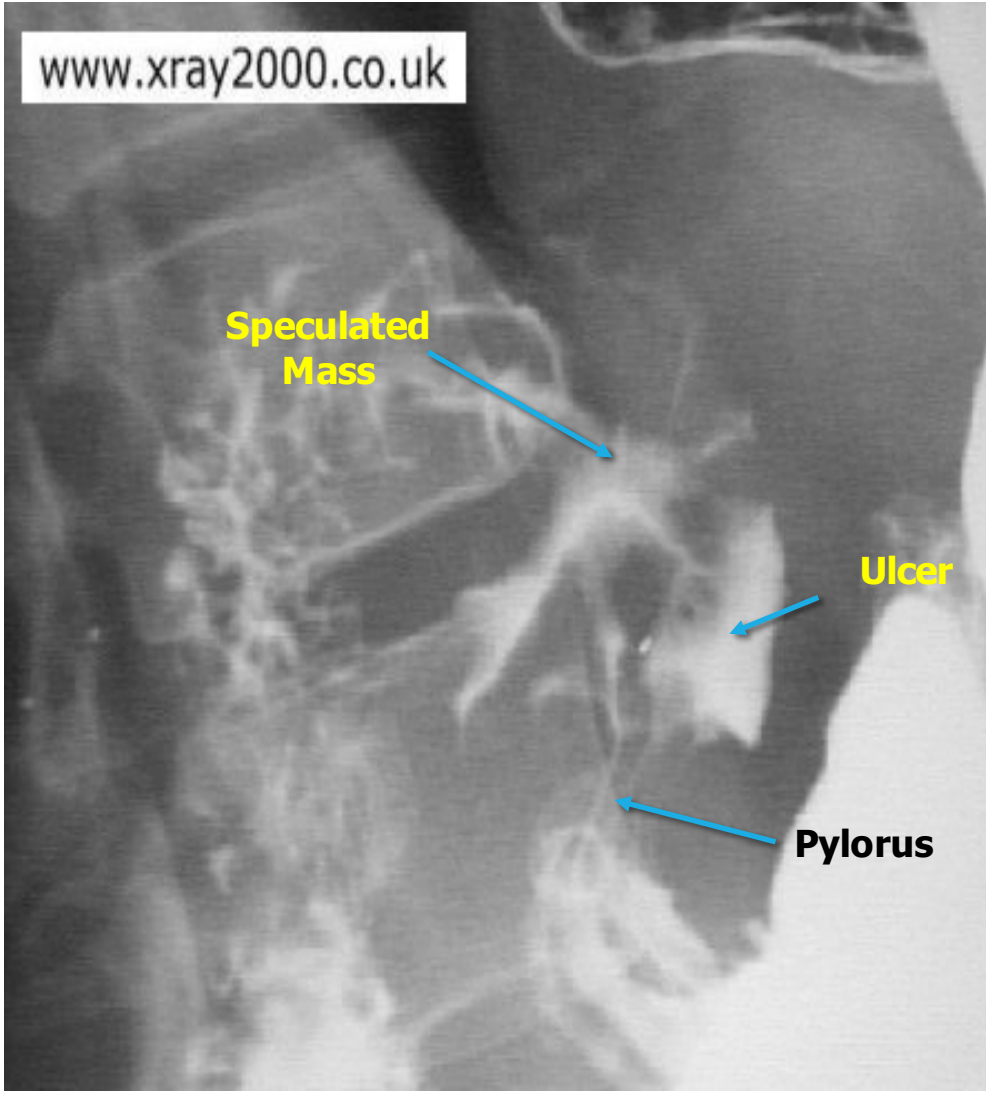
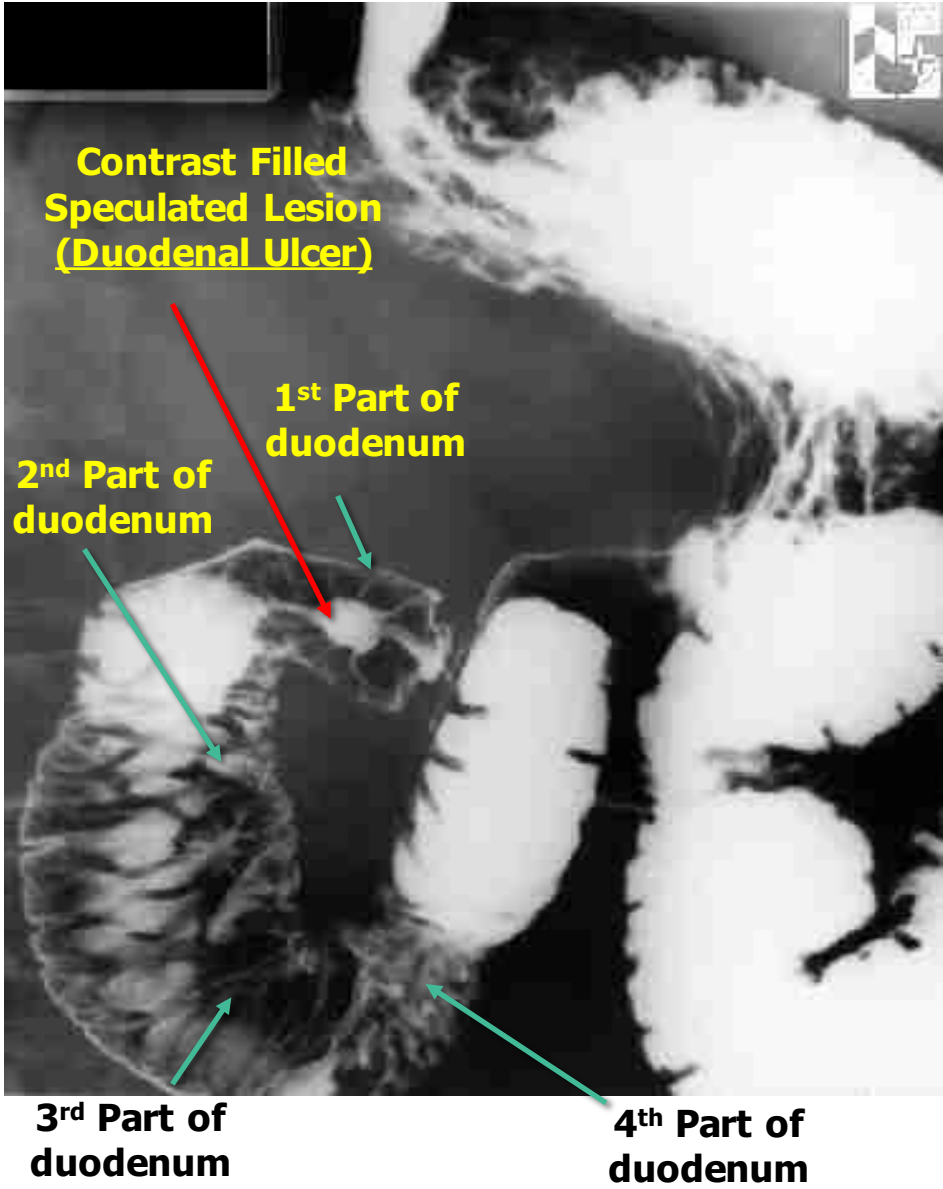
Contrast Filled Speculated Lesion

(Benign Gastric Ulcer)

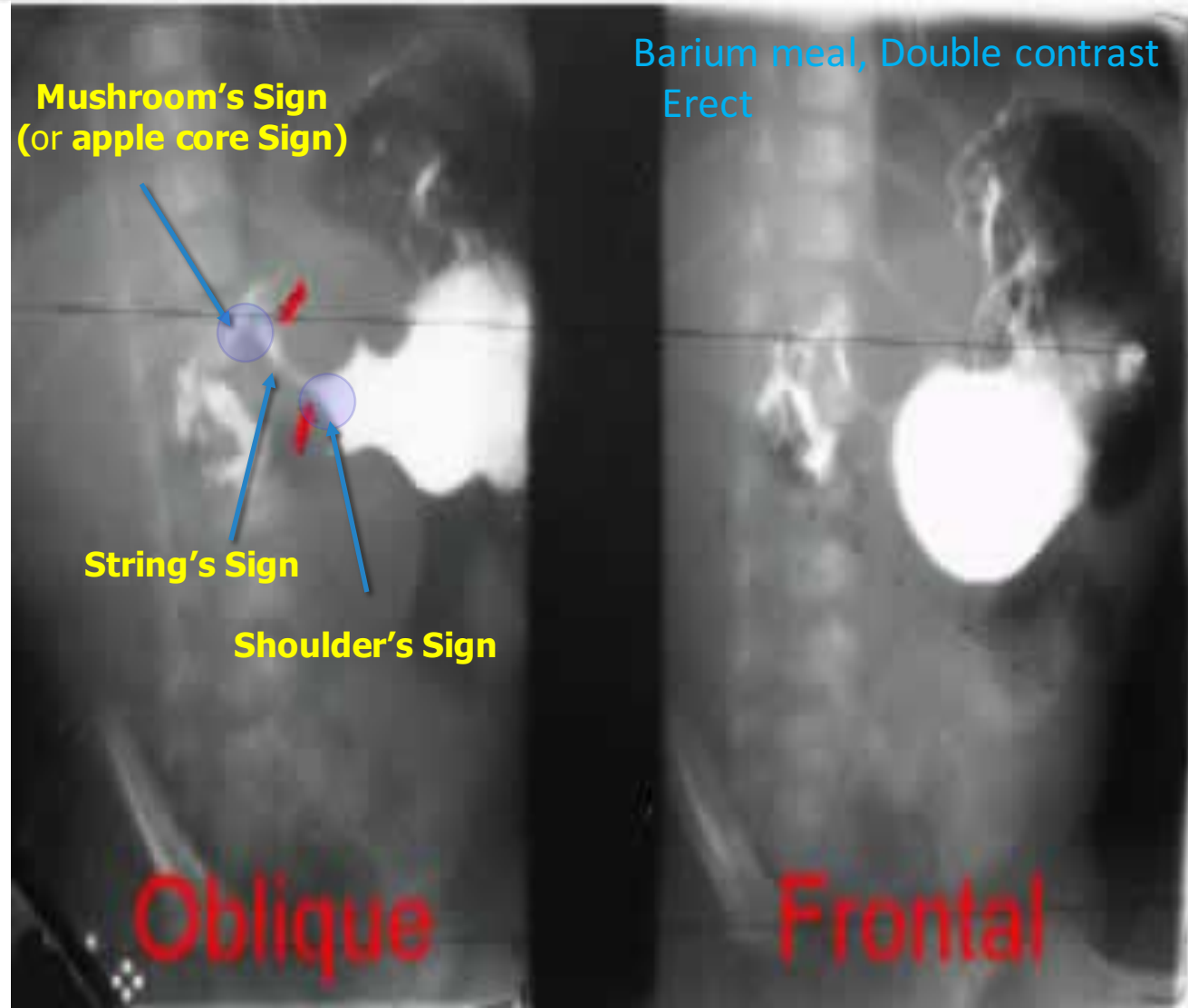
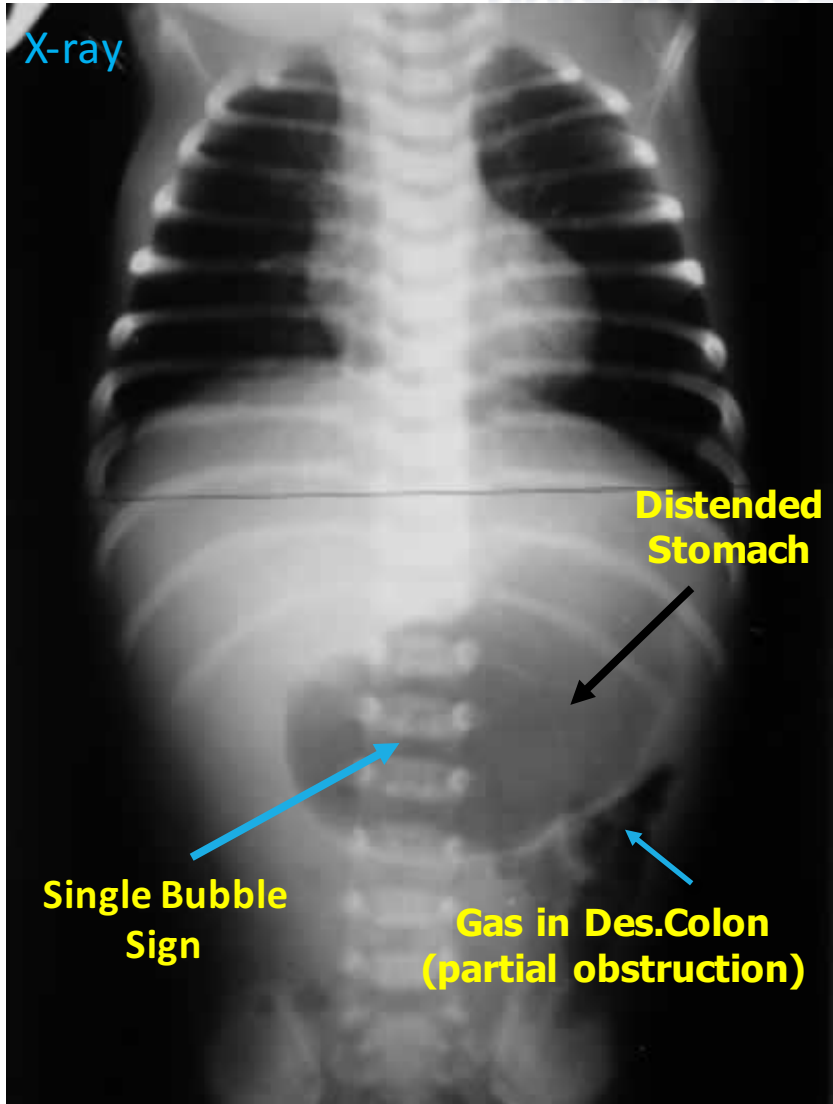


Contrast Filled Outpouching at the Greater Curvature

(Malignant Gastric Ulcer)



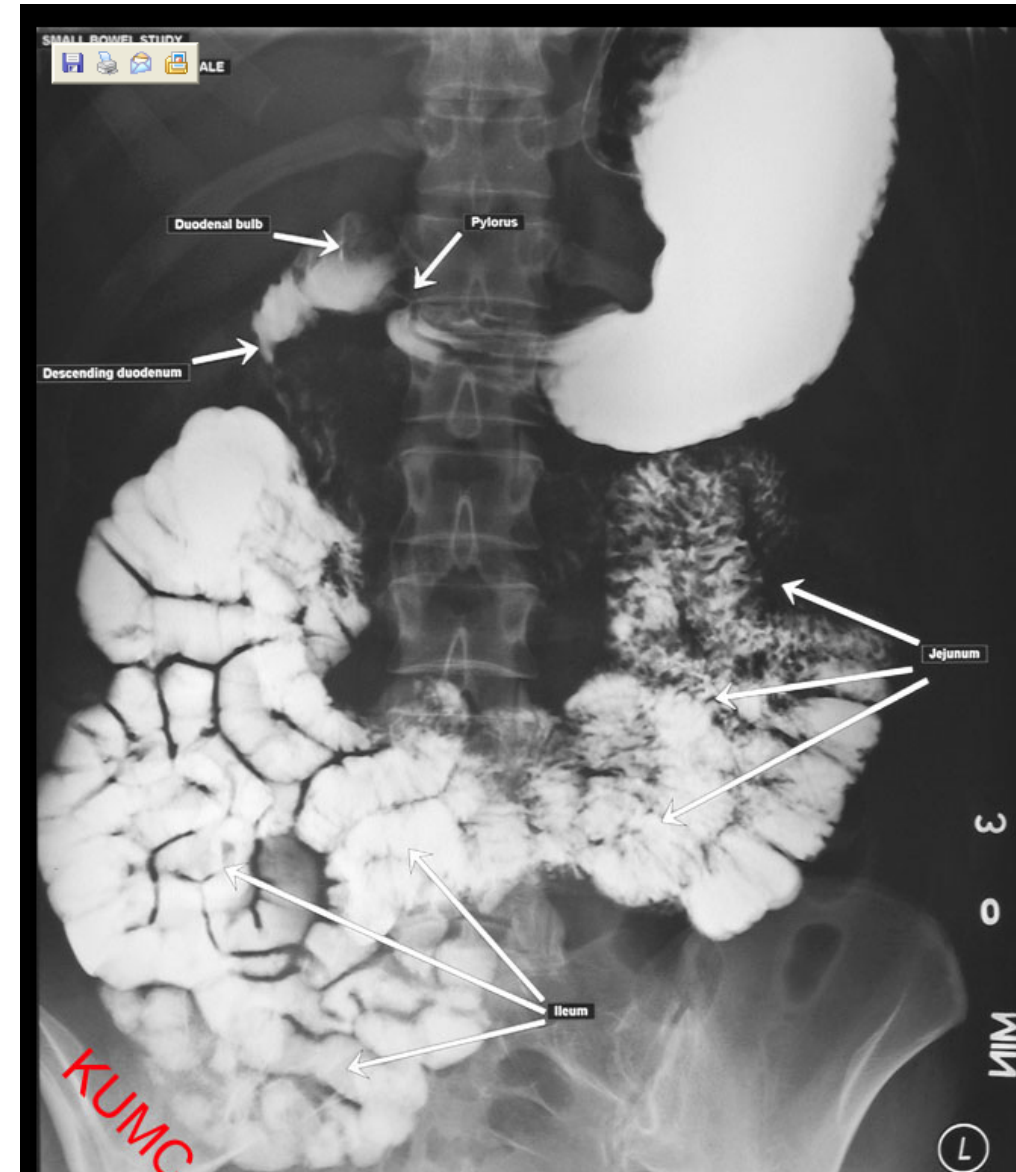
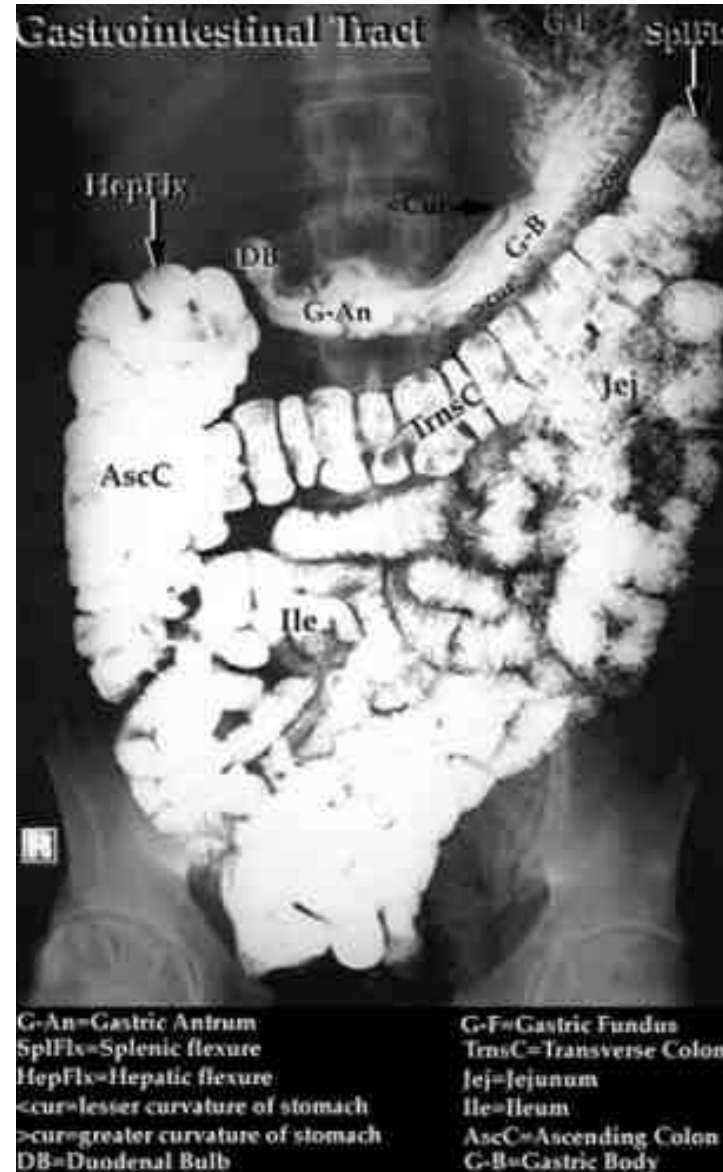
Pyloric stenosis: scenario of newborn with repeated vomiting

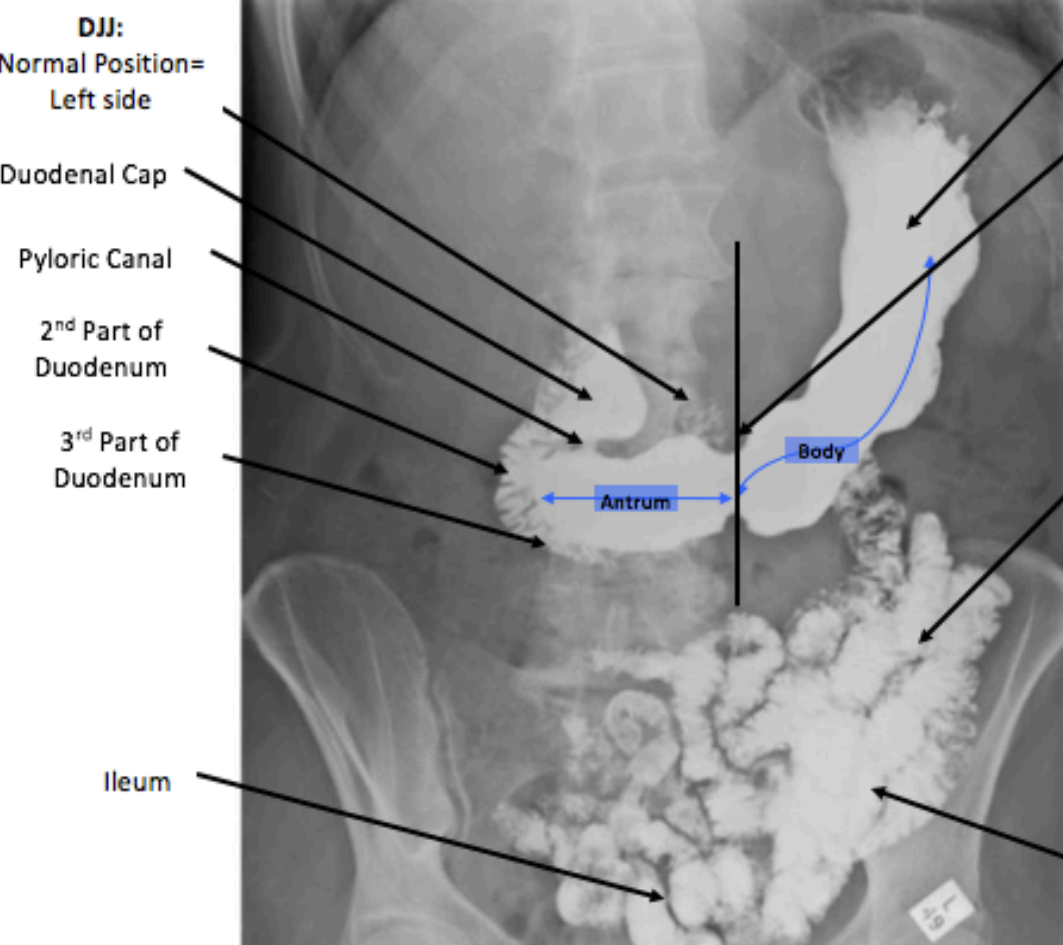


Differential diagnosis: Gastric Output Obstruction (Pyloric Stenosis)

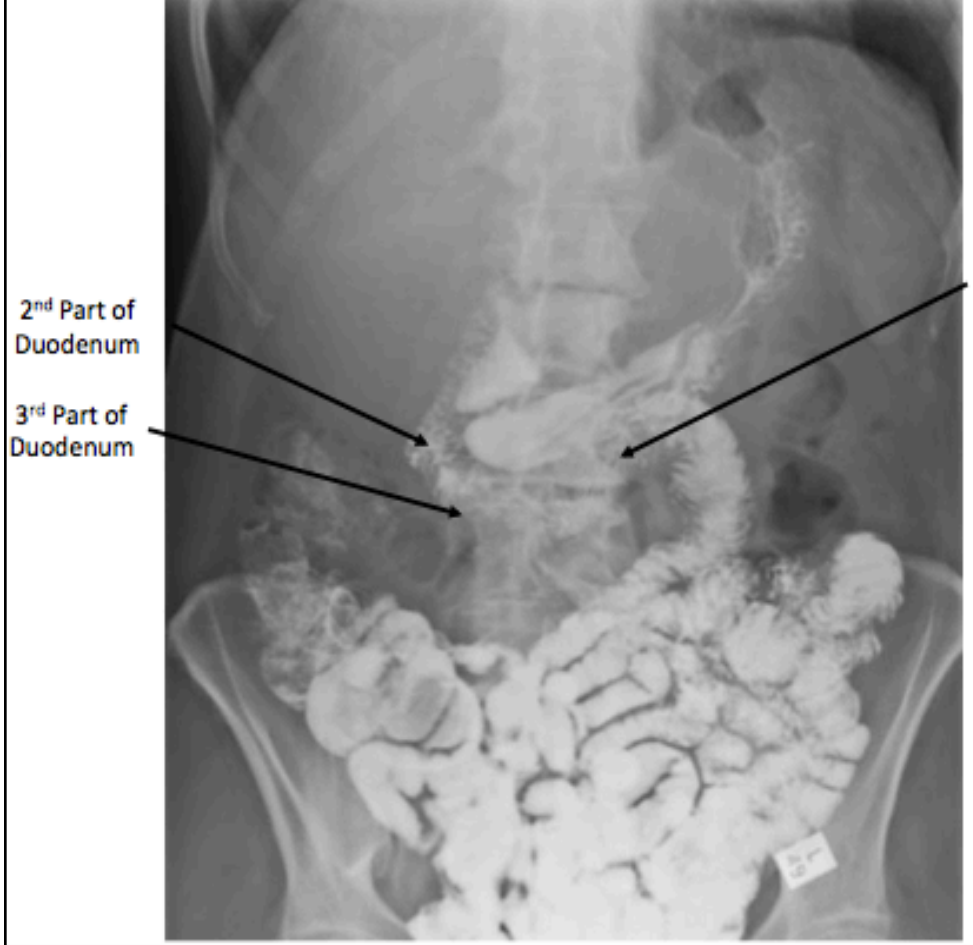
Barium Follow-Through

- Used to examine small bowel (duodenum, jejunum and ileum).
- Like a barium swallow patient drinks the contrast, but images taken every 20 minutes or so for 2-3 hours until we reach terminal ileum.
- Small bowel follow-through may reveal evidence of disorders such as Crohn's disease, coeliac disease or small bowel tumours.
- Normal Jejunum has feathery appearance.





Barium Meal + Follow-Through (Erect Position)



Barium Follow-Through to Cecum (Erect Position)

Small Bowel Enema

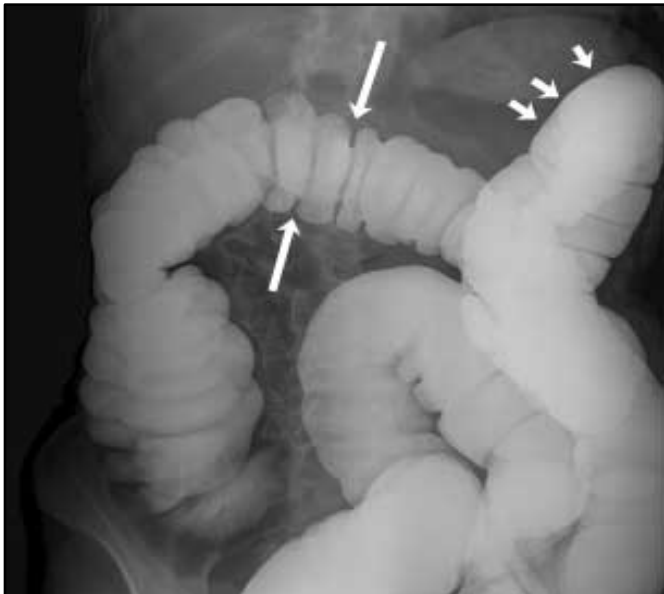
- This procedure involves **inserting a thin tube** through the mouth, esophagus and past the stomach to inject barium, methylcellulose and water into the small bowel.
- This allows for **better visualization** of the small bowel than can be seen during a small bowel follow-through.



A Modified Follow-Through which is called **Small Bowel Enema**. Note that the bowel is more distended here.

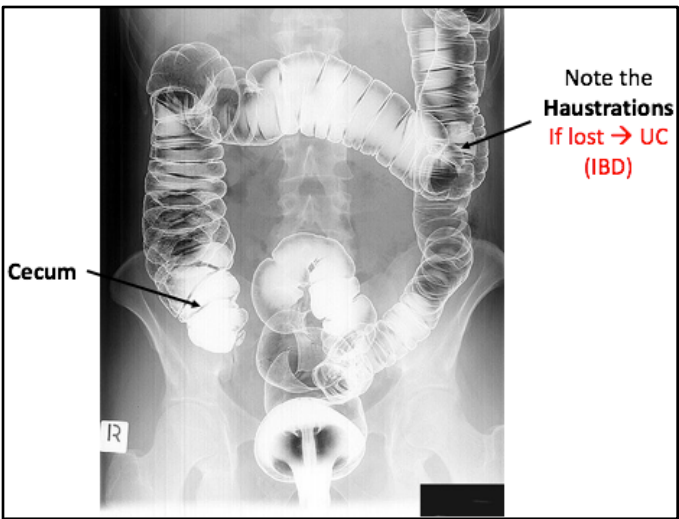
Barium Enema

- **Single or double** contrast study.
- Double contrast means **air fired up after barium** – pictures may show coating on the outline of the bowel rather than a white bowel.
- Patient has to have:
 1. low residue diet for three days before the procedure
 2. laxatives 24hr before
 3. bowel prep just before
- Barium up the bum, patient has to move into different positions to coat to the whole colon. Often the table moves about to help the passage of barium. Serial X-rays are taken.
- Films can be small and only cover a small area of bowel.



This is normal, despite the arrows!

Ascending Colon Cecum Terminal Ileum	A single contrast barium enema X-ray showing the large intestine. Blue dashed lines point from labels on the left to the corresponding parts of the bowel: Ascending Colon, Cecum, and Terminal Ileum. On the right, blue dashed lines point to the Transverse Colon, Descending Colon, and Sigmoid.	Transverse Colon Descending Colon Sigmoid	Hepatic Flexure Note the effect of gravity	A double contrast barium enema X-ray in the right lateral decubitus position. The barium coats the inner surface of the bowel, and air is visible in the lumen, creating a double-contrast effect. A blue dashed line points to the hepatic flexure. The text 'Note the effect of gravity' is present.
<p>Barium Enema, Single Contrast Haustra and semilunar folds can be seen. This is normal large bowel enema.</p>		<p>Barium Enema, Double Contrast (Right Lateral Decubitus) We inject contrast into large bowel > let the patient evacuate the contrast > after that we pump air inside the large bowel.</p>		

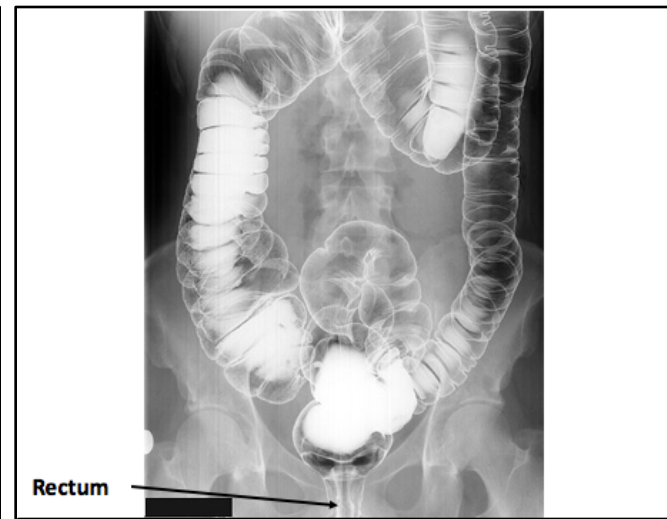


Note the **Haustrations**
If lost → UC
(IBD)

Cecum

R

**Barium Enema, Double Contrast
(Prone Position)**



Rectum

**Barium Enema, Double Contrast
(Supine Position)**



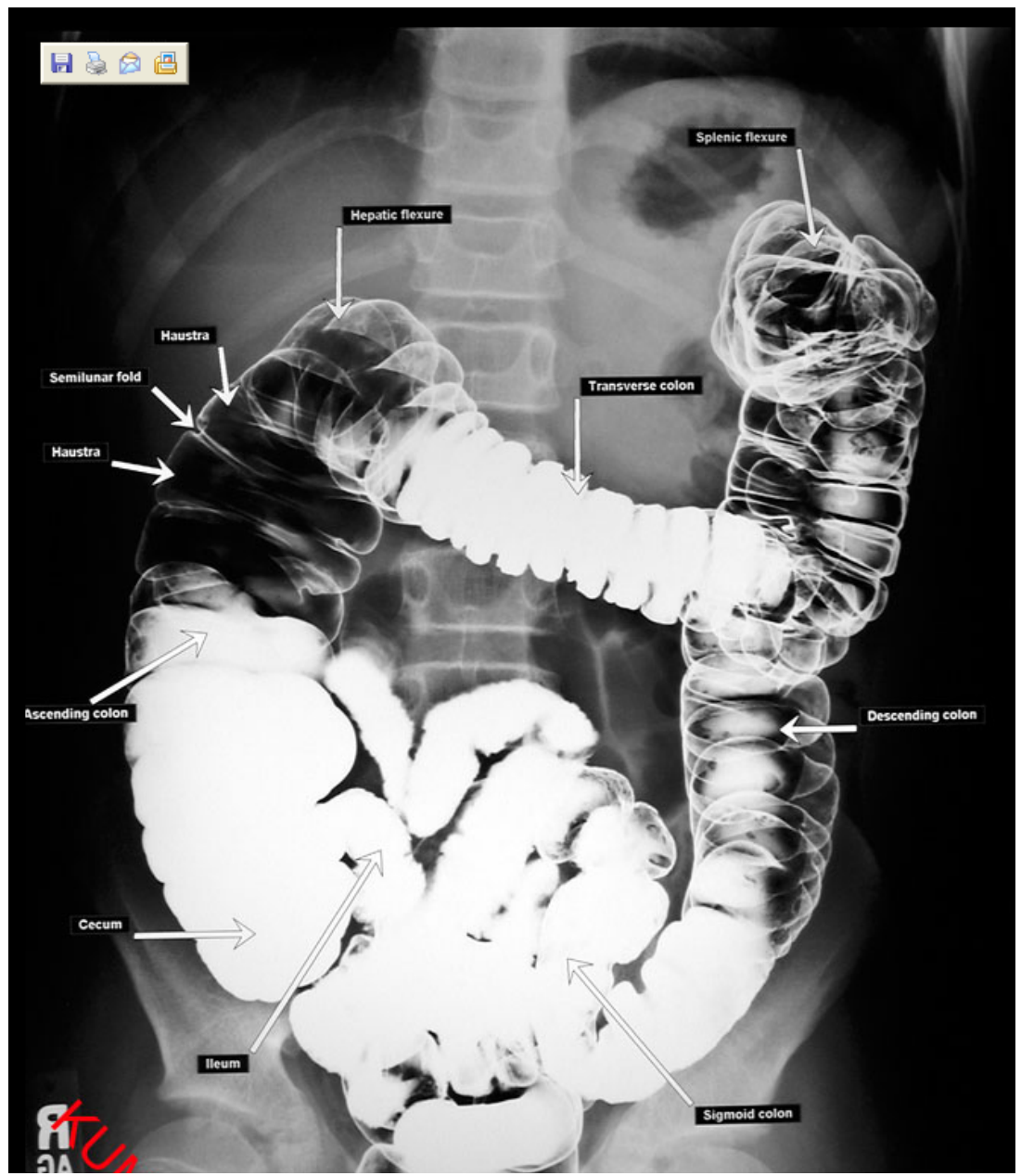
The terminal ileum is **narrowed** and **featureless**. **No** visible thickening or ulceration

Differential Diagnosis of Terminal Ileum Narrowing:

1. Tumor → Lymphoma
2. Iatrogenic → Adhesion (can be post op)
3. Inflammatory (IBD)

In these cases terminal ileum is featureless, narrowed and sometimes **elongated**.

To evaluate terminal ileum, **barium follow-through** should be done. Because the terminal ileum is not always clearly visible with barium enema (sometime the contrast does not reach the small bowel).

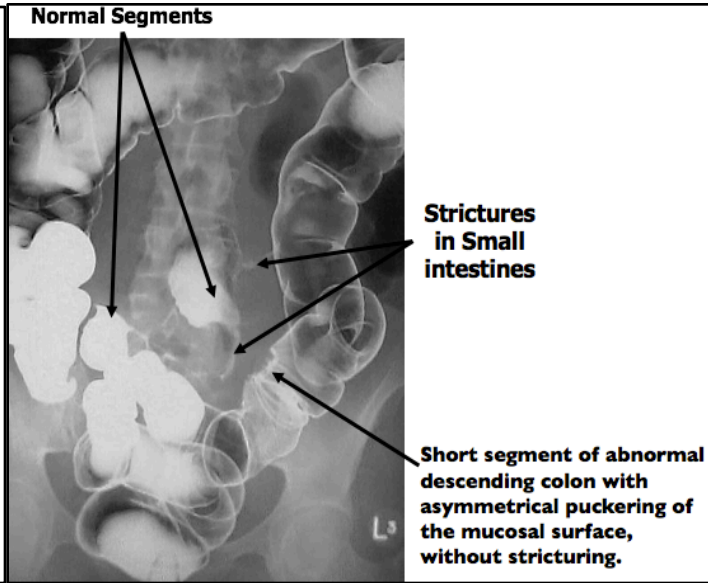


Hepatic flexure
Splenic flexure
Transverse colon
Ascending colon
Descending colon
Sigmoid colon
Cecum
Ileum
Haustra
Semilunar fold



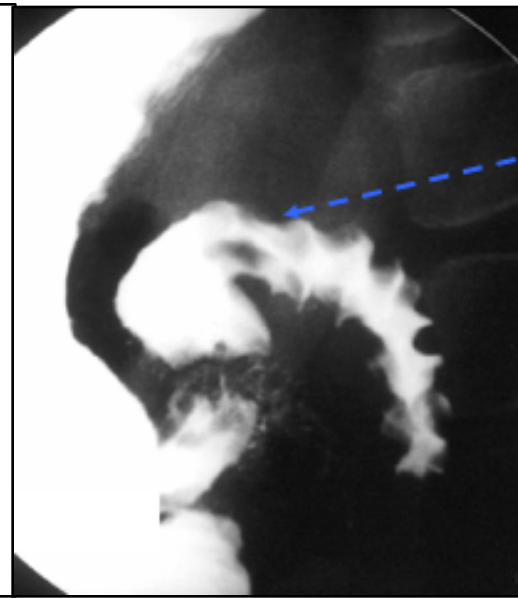
Barium Enema, Double Contrast (Prone Position)

Skip Lesions & narrowing in Small intestines **DDx: Crohns' Disease**. Note that contrast has refluxed into the terminal ileum and small bowel, and there are several strictures present within it. Sometimes the terminal ileum is featureless and narrowed.



Barium Enema

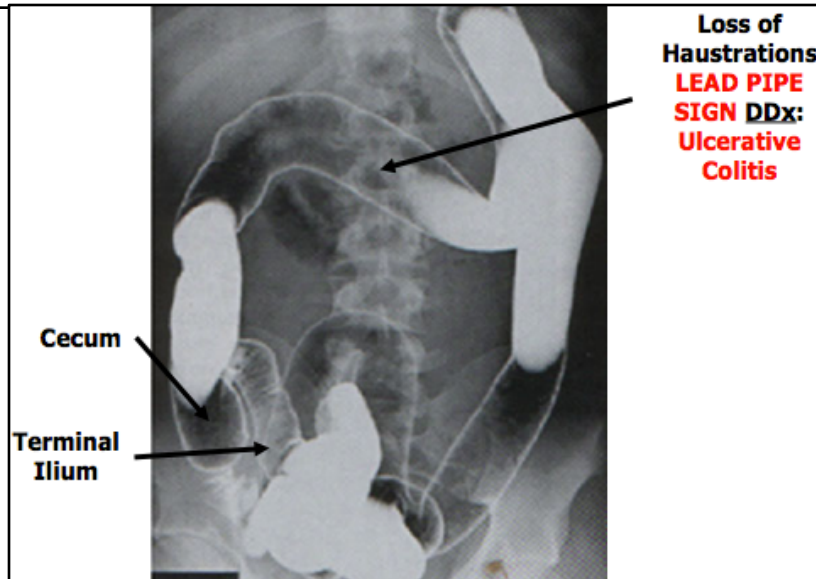
There is abnormal wall thickening, luminal narrowing, and cobblestoning involving a long segment of the distal ileum including the terminal ileum.



Multiple Filling Defects
Cobble Stone appearance
DDx: Crohn's Disease

Barium Enema, Double Contrast

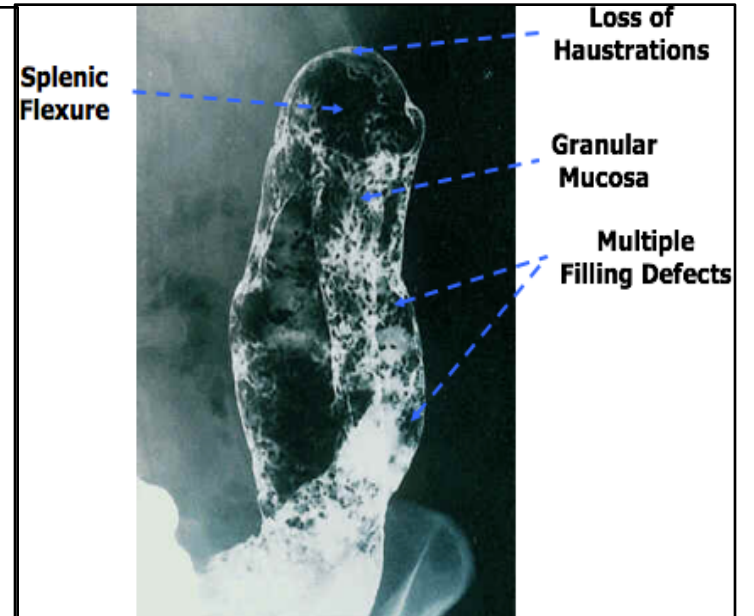
Featureless, lead pipe sign. **DDx: Ulcerative Colitis (Pancolitis)**



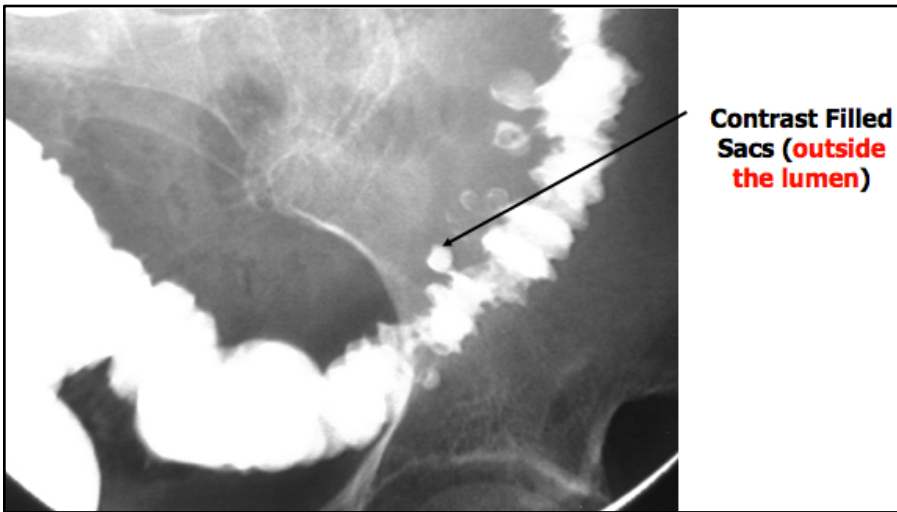
Loss of Haustrations
LEAD PIPE SIGN **DDx: Ulcerative Colitis**

Barium Enema, Double Contrast

Multiple filling defects, granular mucosa and complete absence of haustra which confirm total colitis. **DDx: Ulcerative Colitis**



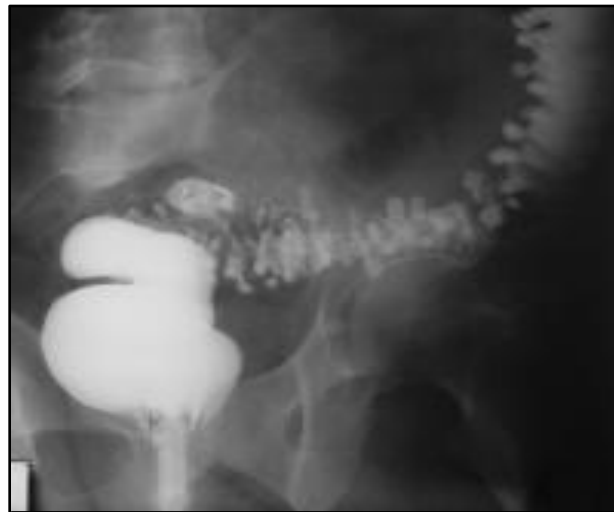
Loss of Haustrations
Granular Mucosa
Multiple Filling Defects



Contrast Filled Sacs (outside the lumen)

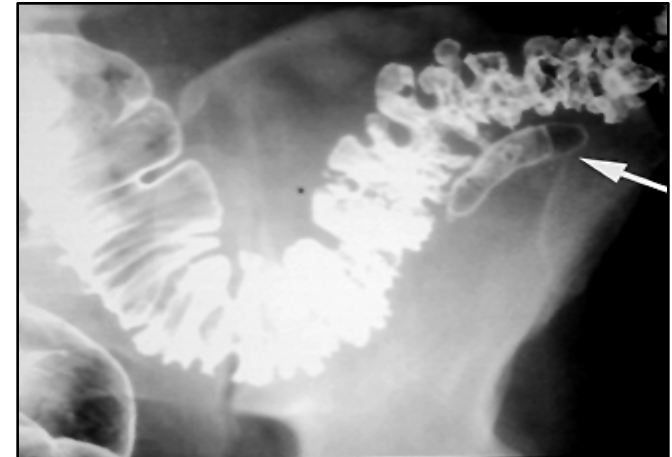
Barium Enema

Diverticulosis in Descending & Sigmoid Colon

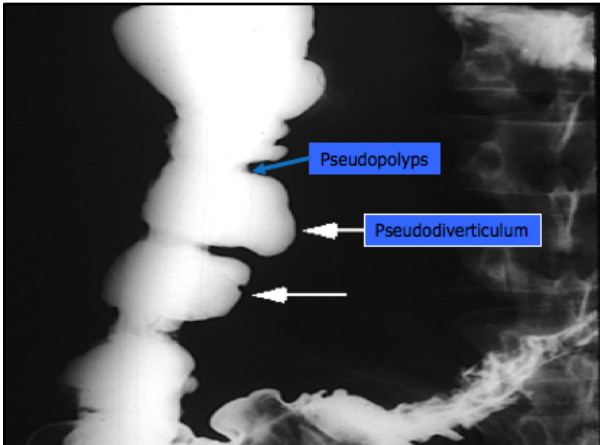


Barium Enema

Diverticulosis



Intramural diverticular abscess Double contrast barium enema in a patient with numerous sigmoid colon diverticulae demonstrates an air-containing intramural abscess cavity (arrow). Courtesy of Jonathan Kruskal, MD, PhD.



Pseudopolyps

Pseudodiverticulum

Chronic Crohn's colitis Barium enema demonstrates sacculations along the medial border of the ascending colon (arrows) produced by scarring and fibrosis in a patient with Crohn's disease. Courtesy of Jonathan Kruskal, MD, PhD.

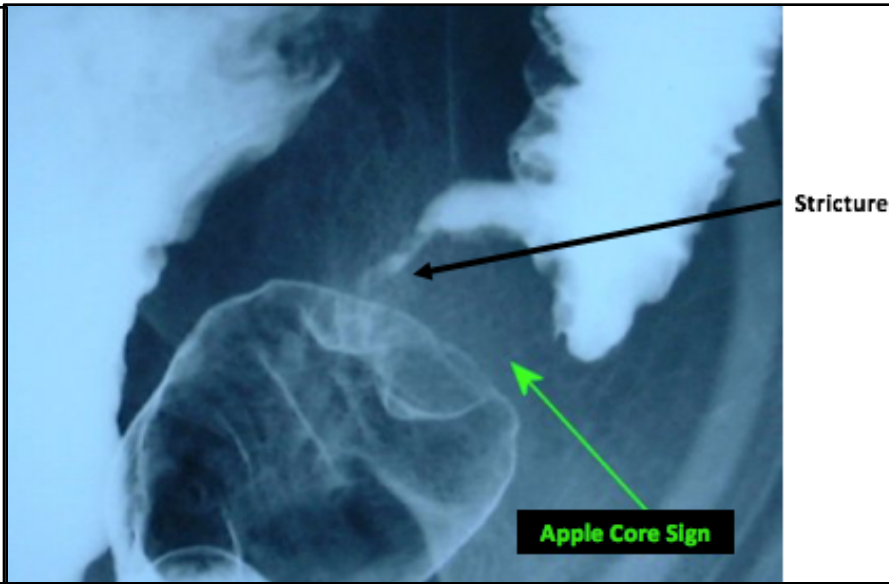
Barium Enema, Double Contrast
Multiple Small & Round Filling Defects **DDx:**
Multiple Polyps



*Polyps are like the **opposite** of diverticulosis.

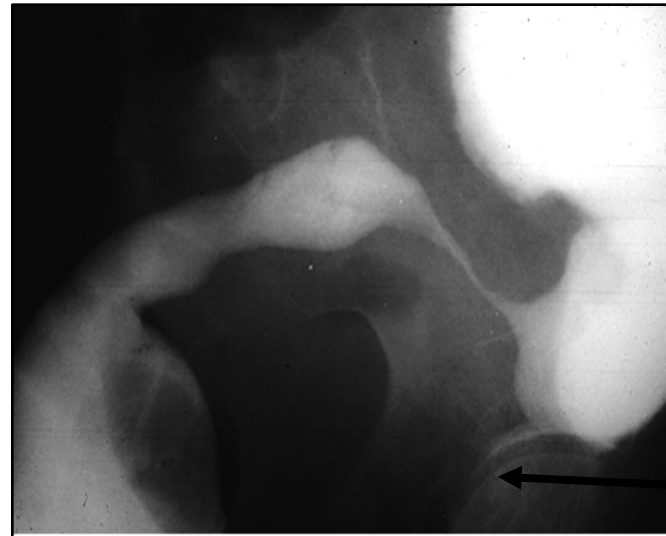
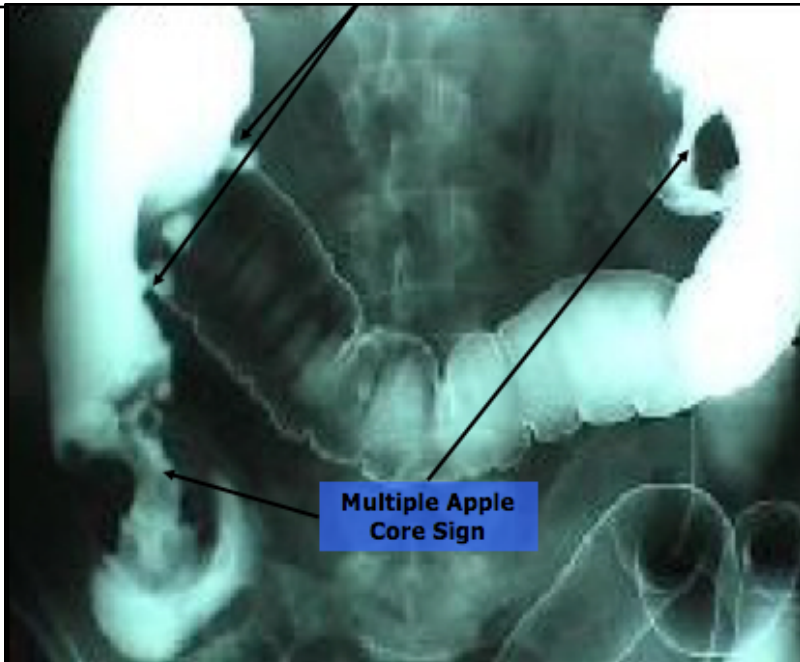
*Infected diverticulum is an emergency because it could perforate and the patient develops peritonitis.

Barium Enema
DDx:
Sigmoid
Colon CA

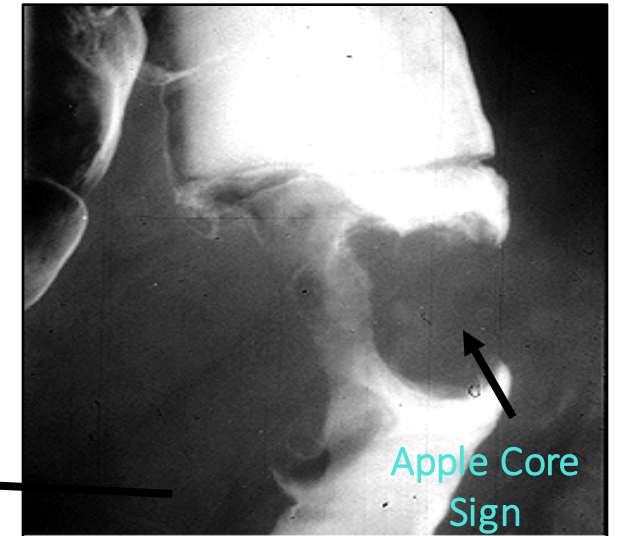


Barium Enema, Double Contrast

Apple core appearance DDx:
Colon CA.
Most common colon cancer is adenocarcinoma.



Sigmoid cancer developing in ulcerative colitis Barium enema study demonstrates a focal stricture in the sigmoid colon caused by an infiltrating cancer. The adjacent bowel is featureless and folds are absent, findings characteristic of chronic ulcerative colitis. Courtesy of Norman Joffe, MD.



Cancer of the colon Double contrast barium enema shows an apple-core lesion surrounding the lumen of the descending colon. Courtesy of Jonathan Kruskal, MD.

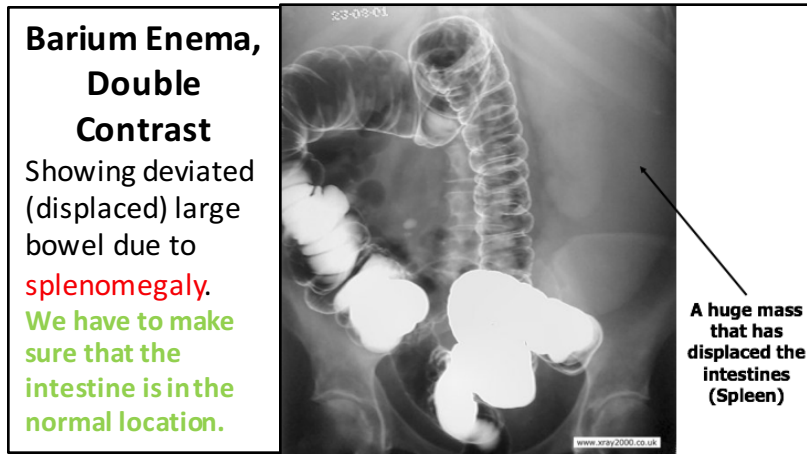
A Sigmoid Stricture is always considered **malignant** until proven otherwise.



A huge right indirect hernia in the scrotum

Barium Enema, Double Contrast

Enlarged scrotum with herniated small bowel filled with contrast. **We have to make sure that the intestine is in the normal location.**



A huge mass that has displaced the intestines (Spleen)

Barium Enema, Double Contrast

Showing deviated (displaced) large bowel due to **splenomegaly**. **We have to make sure that the intestine is in the normal location.**

Filling defects & dilated Descending & Sigmoid Colon

Transition Zone: is the term applied to the region in which a marked change in caliber occurs, with the dilated, normal colon above and the narrowed, aganglionic colon below.

According to the Transition Zone:

Rectum > **Ultra Short**

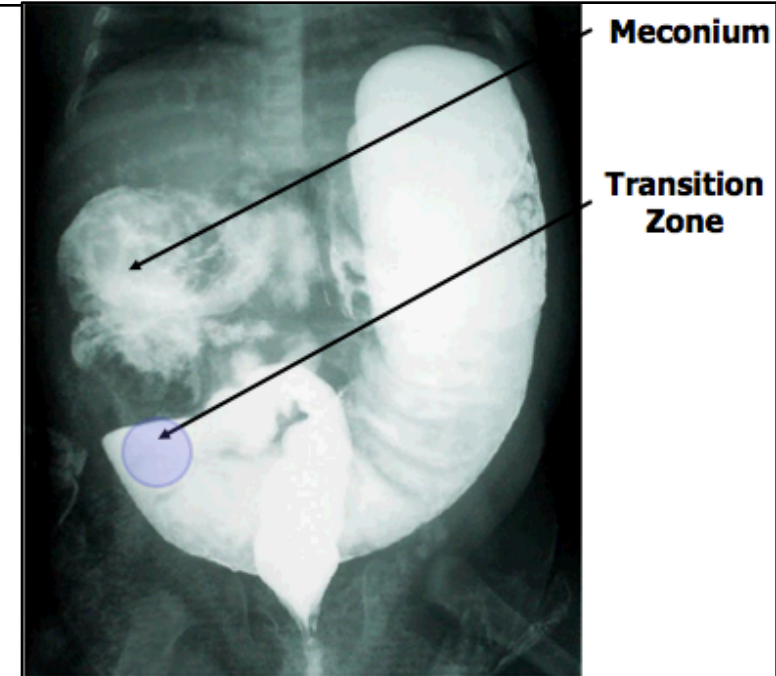
Rectosigmoid > **Short**

Transverse Colon > **Long**

Beginning of the Colon > **Total** (microcolon)

DDx: Hirschsprung disease (HD) which is more definitively diagnosed by means of contrast enema, which can show the presence of a transition zone, irregular contractions, mucosal irregularity, and delayed evacuation of contrast material, among other findings. Although the hallmark of the diagnosis is the presence of transition zone but it's absence exclude the disease.

Example: An infant weeks or months old presents with constipation. Barium enema reveal narrowing in the distal large bowel while the proximal is dilated. **DDx: Hirschsprung disease.**



Hirschsprung's disease Barium enema of an infant with Hirschsprung's disease showing the transition zone between the lower aganglionic bowel and the normal colon above. Courtesy of George D Ferry, MD.

Computed Tomography

CT provides cross-sectional images of abdominal organs and structures.

Multiple x-ray images are taken from many different angles, digitized in the computer, reconstructed, and then viewed on a computer monitor.

Indication

1- abdominal CT scanning include diseases of the liver, spleen, kidney, pancreas, and pelvic organs.

2- detecting and localizing many inflammatory conditions in the colon, such as appendicitis, diverticulitis, regional enteritis, and ulcerative colitis.

Notes

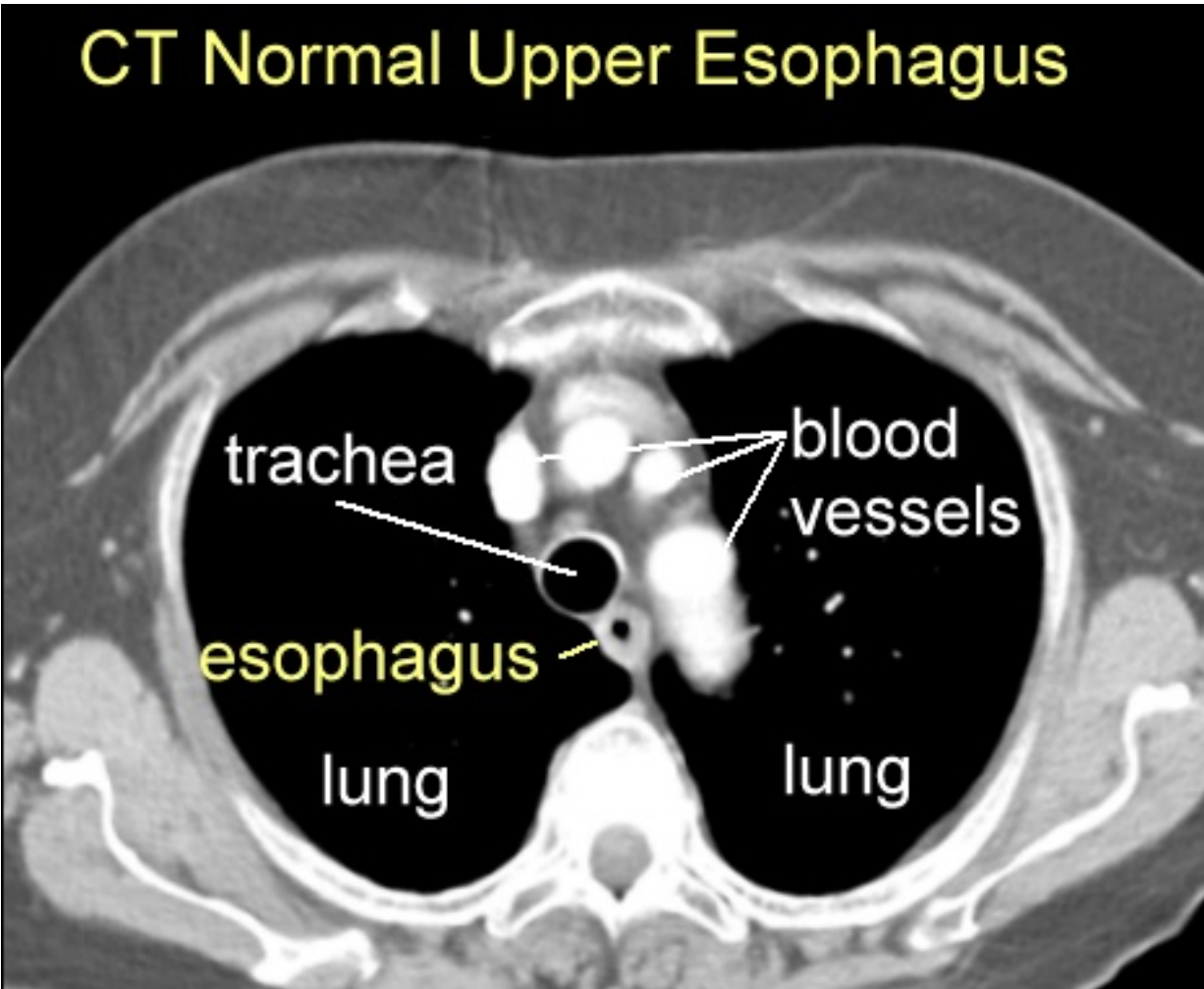
1- Instruct the patient not to eat or drink for 6 to 8 hours before the test.

2- If the patient is prescribed with intravenous or oral contrast agents, question the patient about contrast dye allergies.

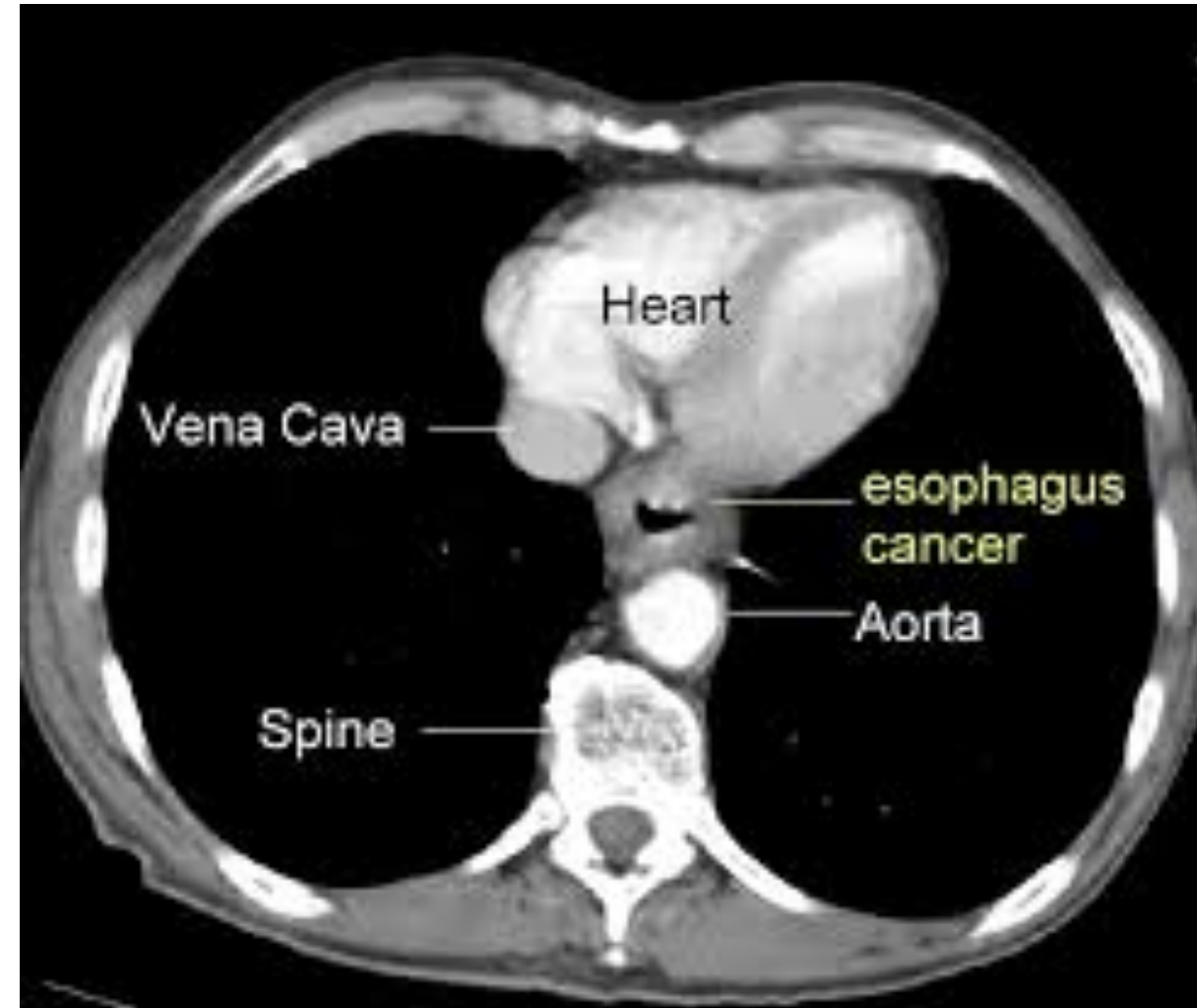
3- Schedule barium studies after CT scanning, so as not to interfere with imaging.

Normal Esophagus

CT Normal Upper Esophagus

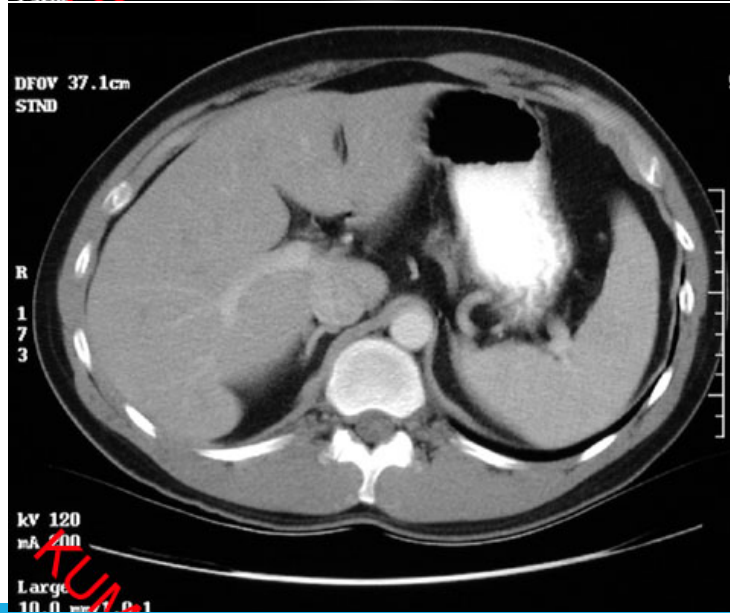
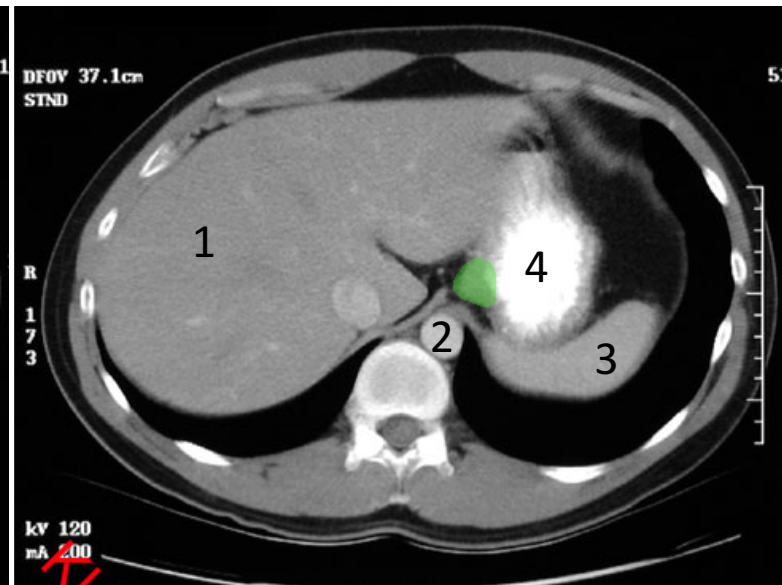
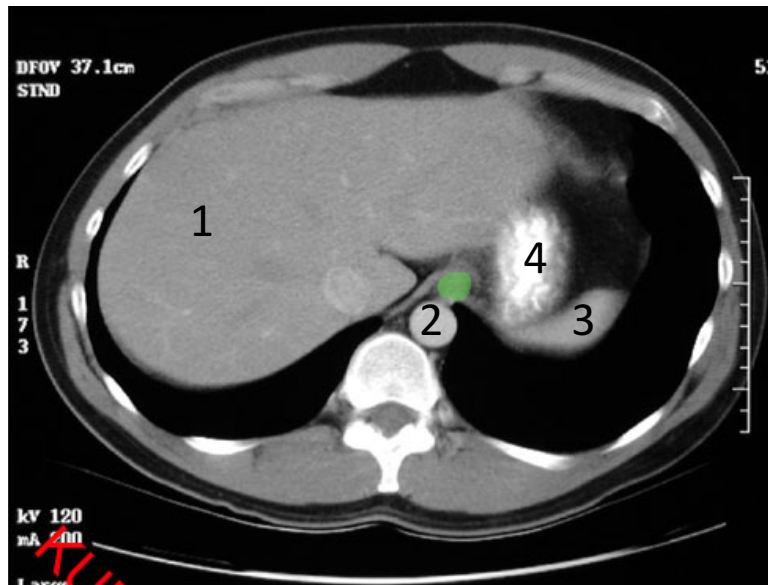


Esophagus Cancer



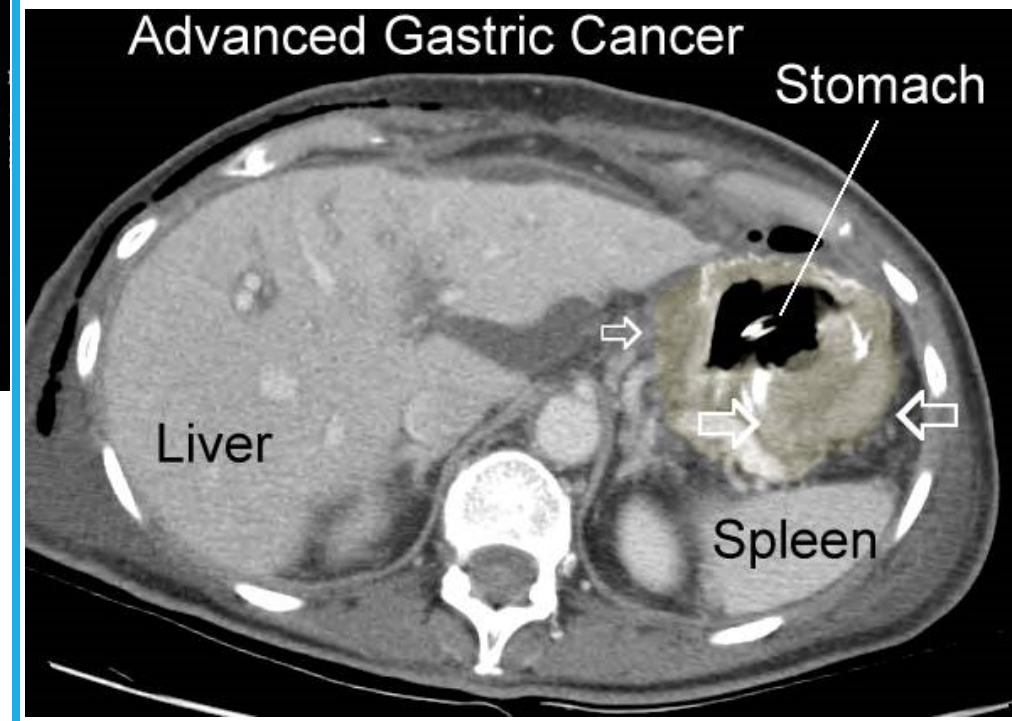
The wall is thickened which indicate Esophagus Cancer

Normal Stomach

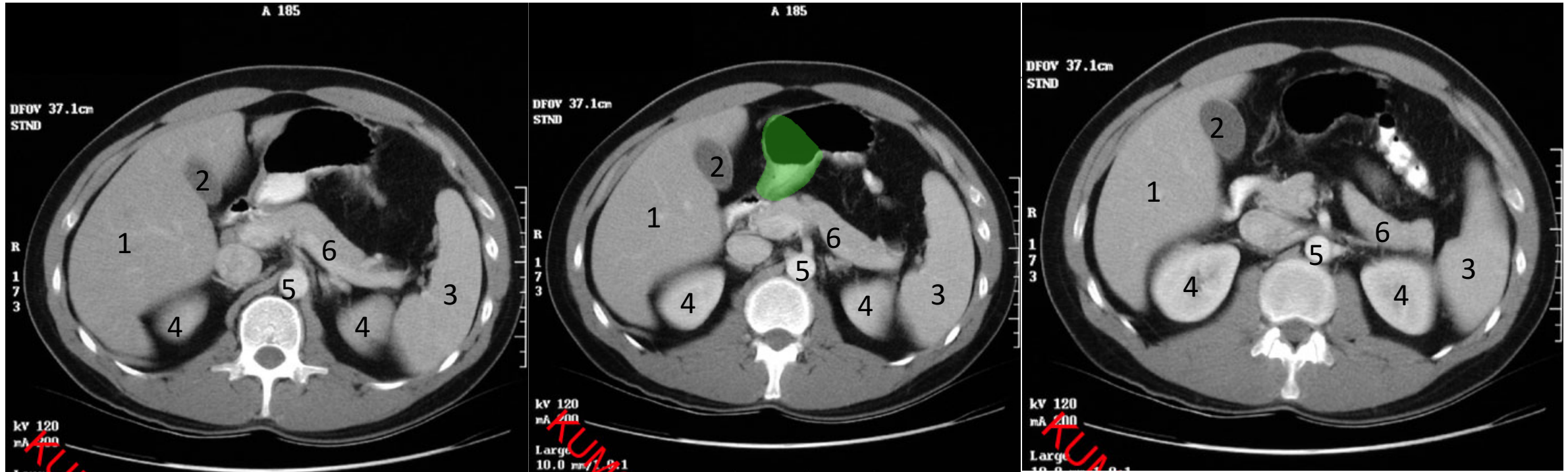


- 1- liver
- 2- aorta
- 3- spleen
- 4- stomach with contrast
- 5- with green highlight is esophagus

Gastric Cancer

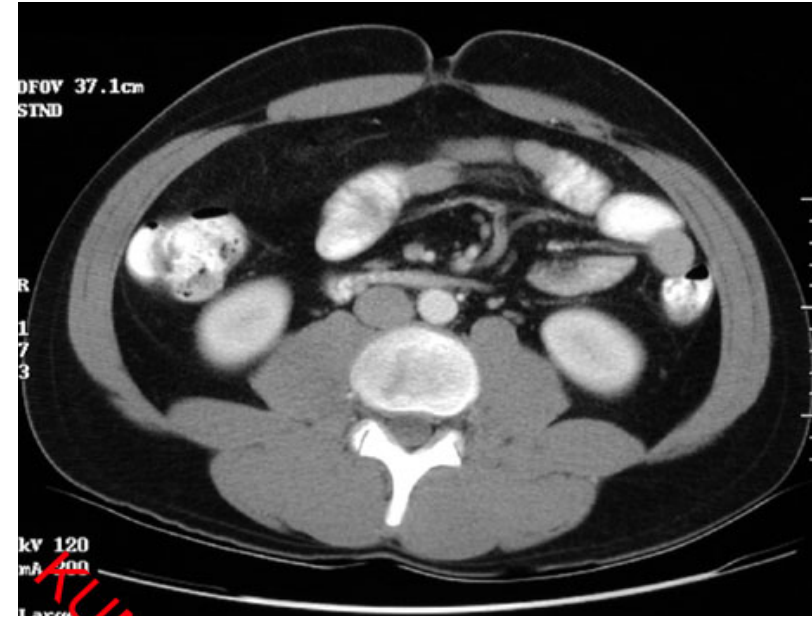
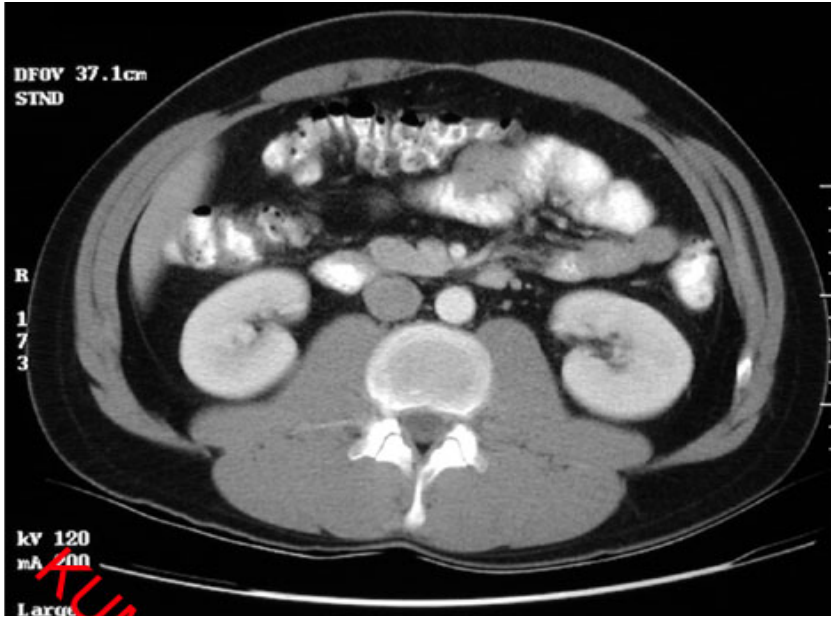


Abdominal CT in different levels

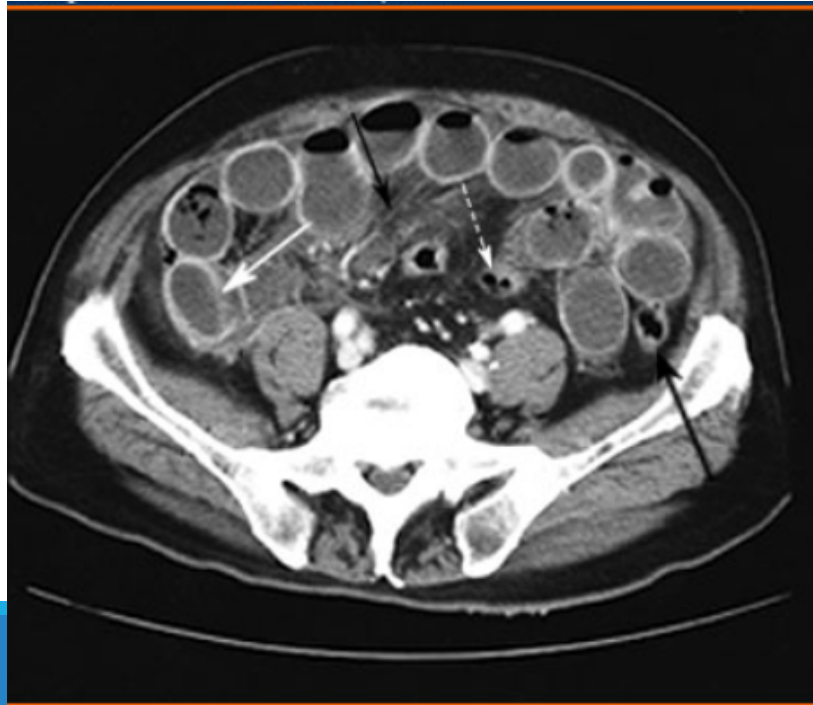


1- liver 2- gall bladder 3- spleen 4- kidney 5- aorta 6- pancreas 7- with green highlight gastric antrum

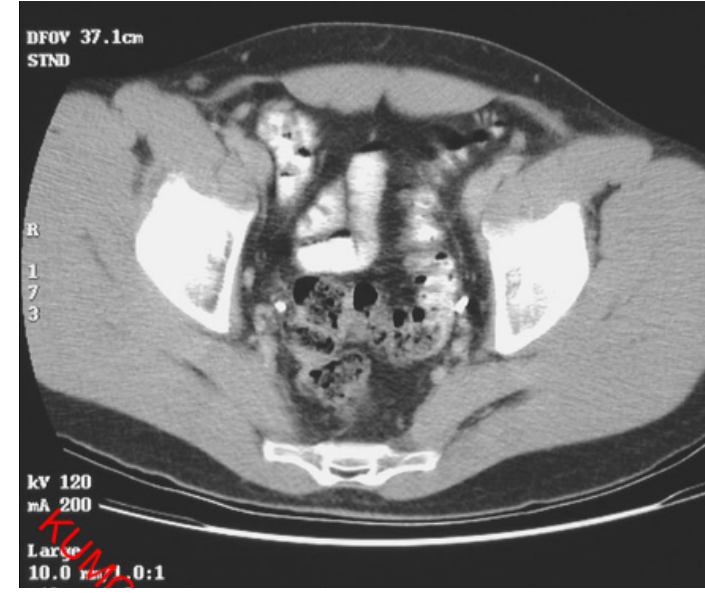
Normal Bowel



Small Bowel Obstruction



Colon Cancer



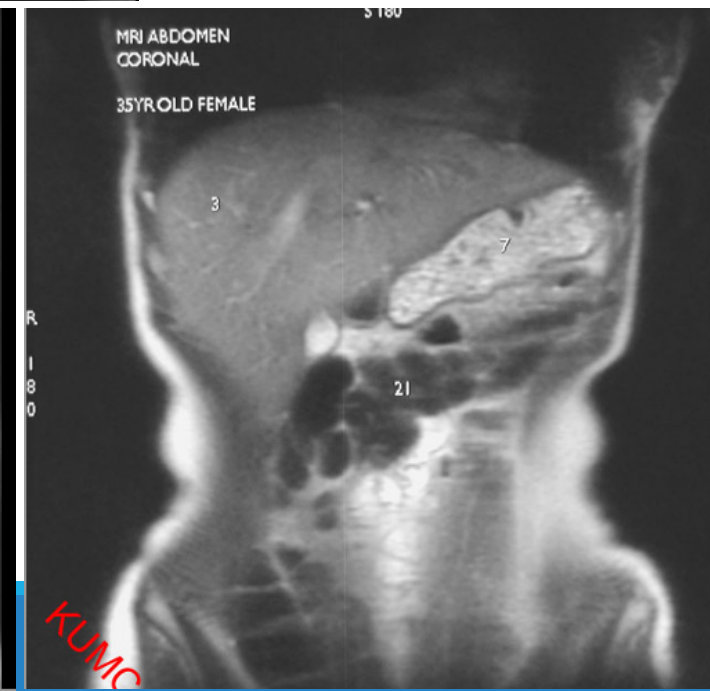
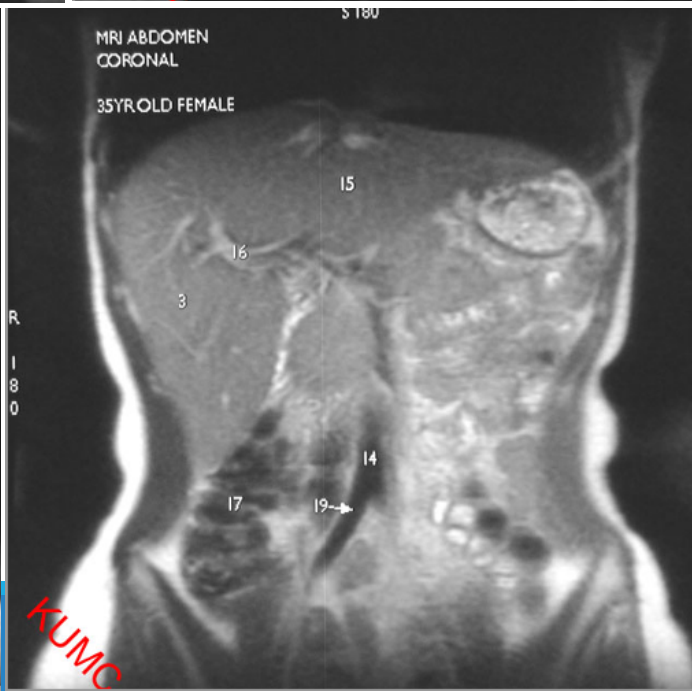
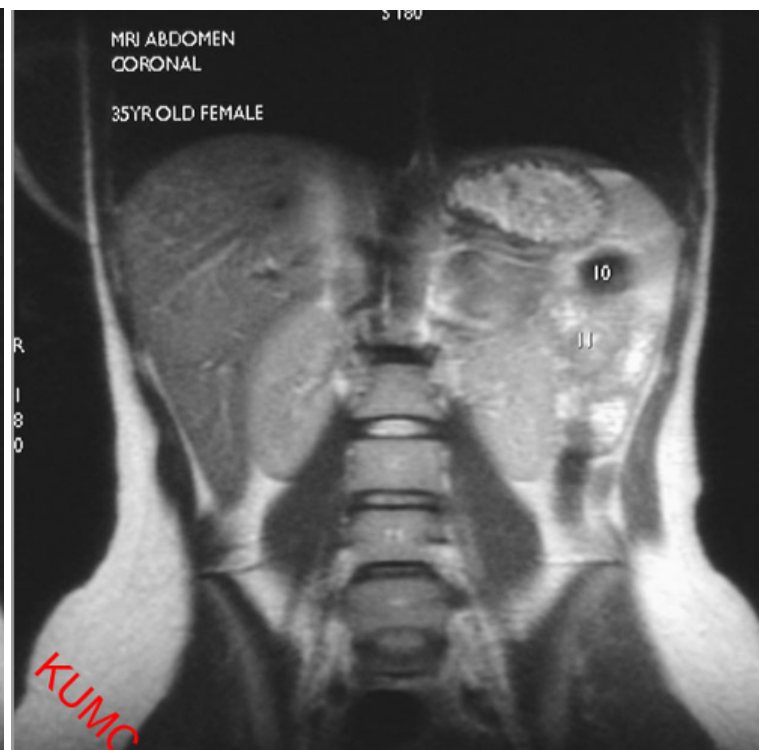
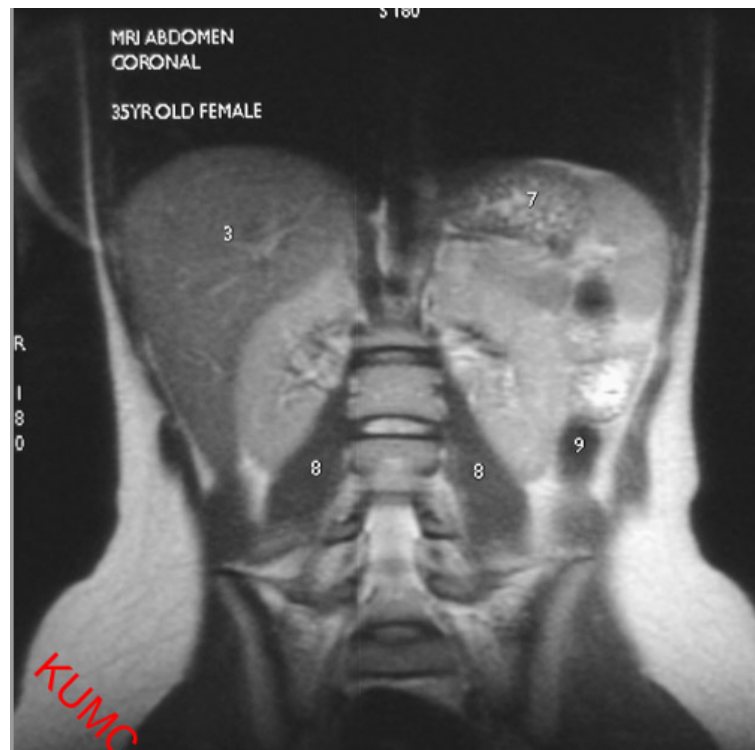
MAGNETIC RESONANCE IMAGING



- MRI is useful in evaluating abdominal soft tissues as well as blood vessels, abscesses, fistulas, neoplasms, and other sources of bleeding.
- Has not that much role in Bowel



4. Vagina
5. Urinary bladder
6. Pubic bone
7. Vertebral body-L5
8. Sacrum
9. Endocervical canal
10. Rectouterine pouch (cul-de-sac of Douglas)
11. Anal canal
12. Vesicouterine pouch
13. Urethra
14. Endometrium
15. Coccyx



ANATOMICAL FEATURES:

1. Erector spinae muscles
2. Spinal canal
3. Right lobe of liver
4. Spleen
5. Right kidney
6. Left kidney
7. Stomach
8. Psoas major muscle
9. Descending colon
10. Splenic flexure of colon
11. Jejunum
12. Hepatic veins
13. Inferior vena cava
14. Aorta
15. Left lobe of liver
16. Portal vein
17. Ascending colon
18. Left common iliac artery
19. Right common iliac artery
20. Ileum
21. Transverse colon

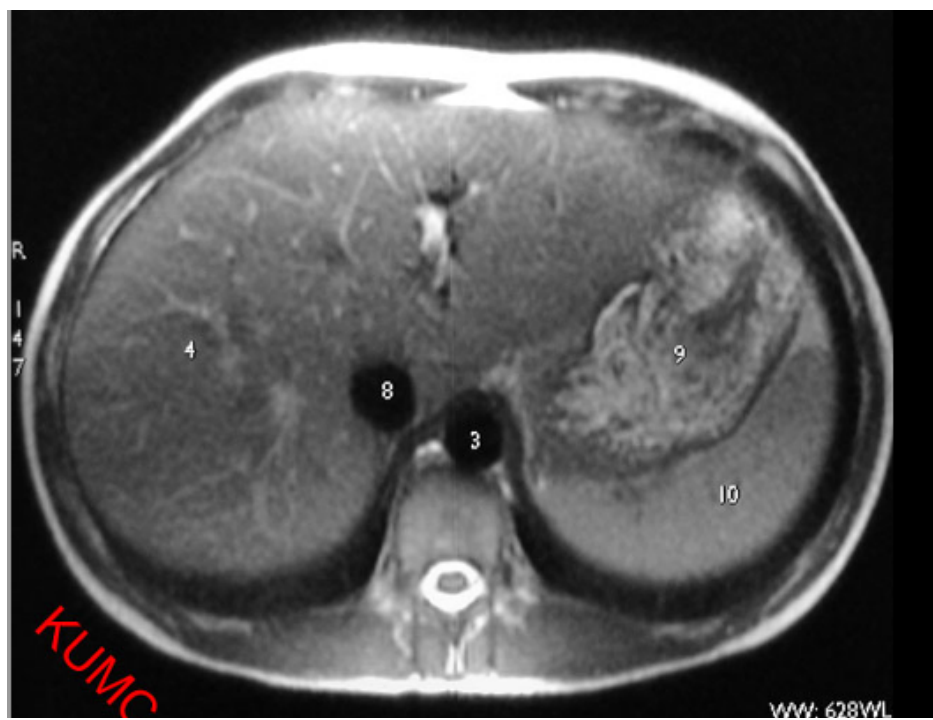
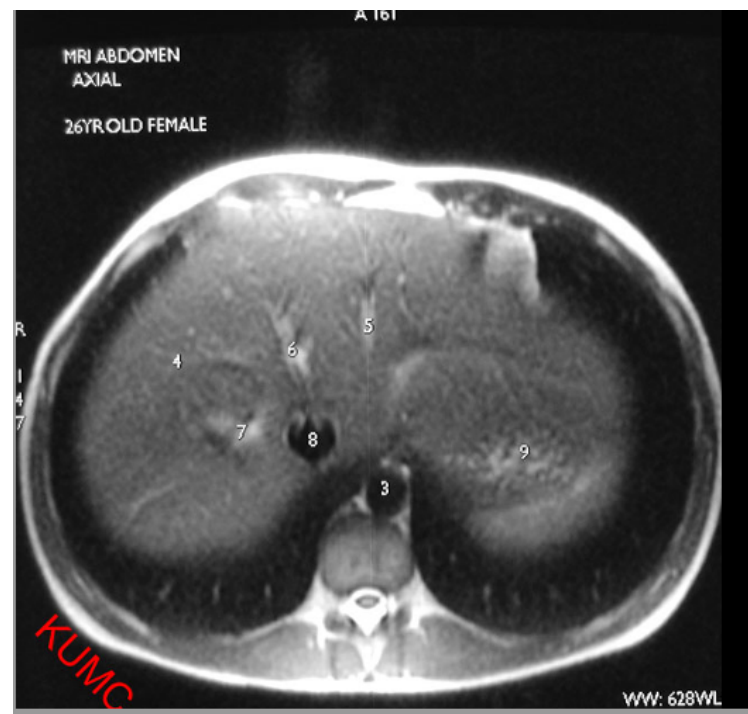




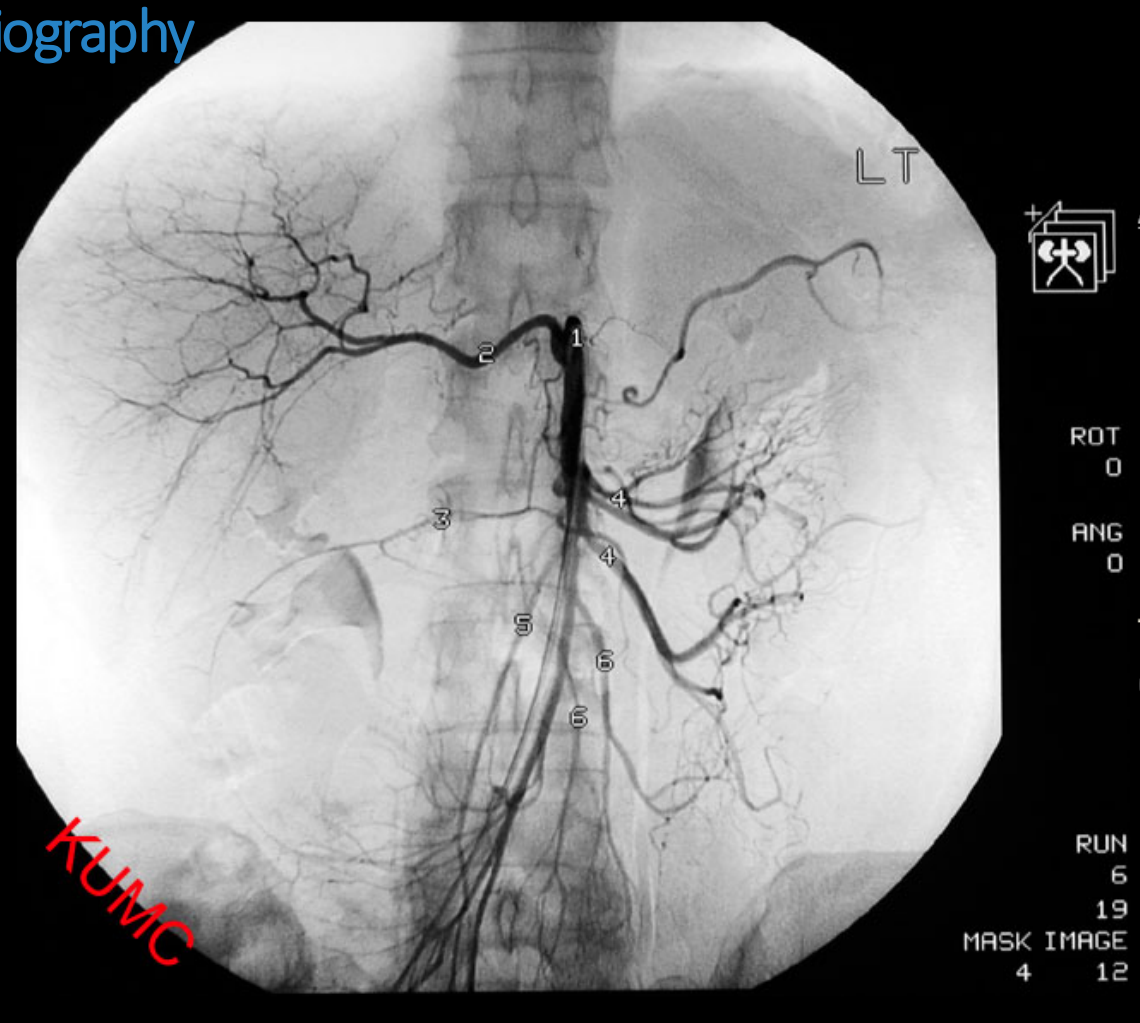
ANATOMICAL FEATURES:

1. Right ventricle
2. Left ventricle
3. Aorta
4. Liver
5. Left hepatic vein
6. Middle hepatic vein
7. Right hepatic vein
8. Inferior vena cava
9. Stomach
10. Spleen

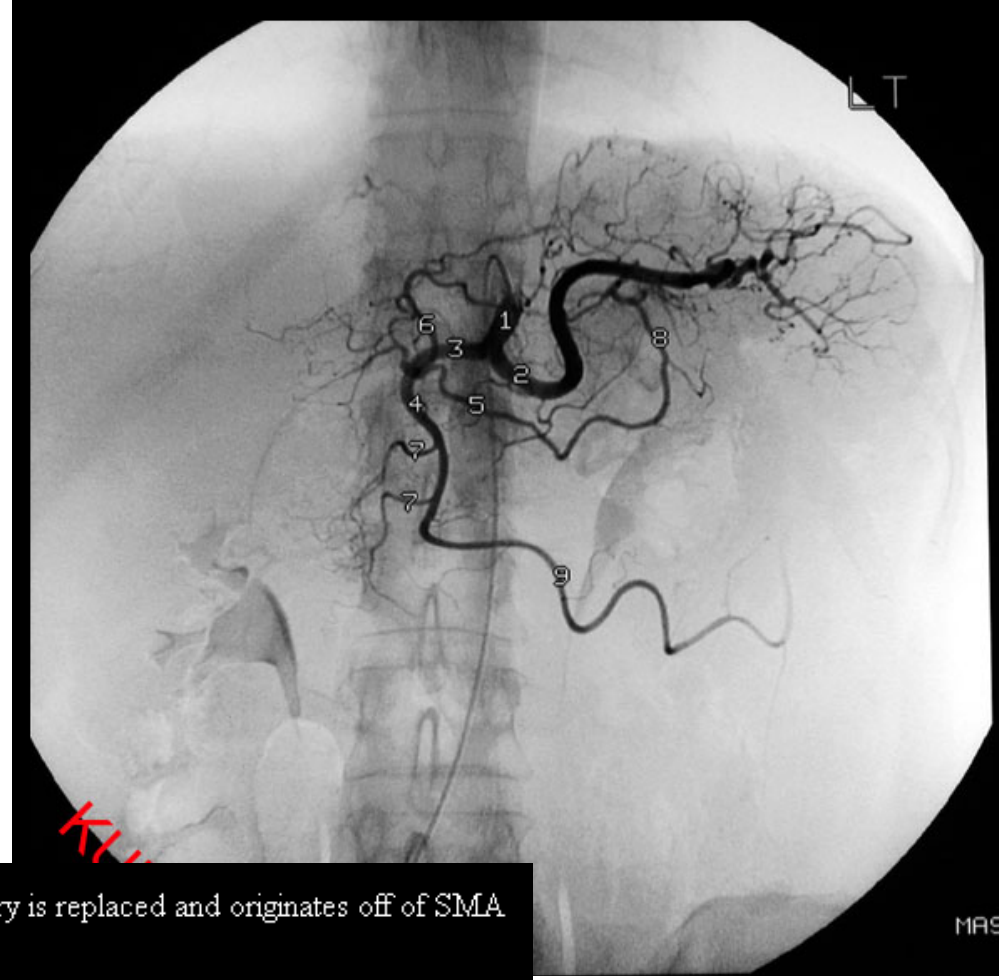
18. Right kidney
19. Left kidney
20. Head of pancreas
21. Jejunum



Angiography



- 1 Superior mesenteric artery (SMA)
- 2 Replaced right hepatic artery
- 3 Right colic artery
- 4 Jejunal (intestinal) arteries
- 5 Ileocolic artery
- 6 Ileal (intestinal) arteries



- Right hepatic artery is replaced and originates off of SMA (normal variant)
- 1 Celiac trunk
 - 2 Splenic artery
 - 3 Common hepatic artery
 - 4 Gastroduodenal artery
 - 5 Right gastric artery
 - 6 Left hepatic artery
 - 7 Pancreaticoduodenal arteries
 - 8 Left gastric artery (origin off celiac not visualized)
 - 9 Right gastroepiploic artery

Angiography

IMPORTANT



- 1 Abdominal aortal
- 2 Celiac trunk
- 3 Splenic artery
- 4 Common hepatic artery
- 5 Superior mesenteric artery
- 6 Inferior mesenteric artery
- 7 Catheter in lumen of aorta

RT

IMPORTANT



- 1 Abdominal aorta
- 2 Splenic artery
- 3 Common hepatic artery
- 4 Left renal artery
- 5 Right renal artery
- 6 Accessory right renal artery
- 7 Right hepatic artery
- 8 Inferior mesenteric artery
- 9 Left iliac artery
- 10 Right iliac artery
- 11 Catheter in lumen of aorta

Angiography



- 1 Celiac artery (trunk)
- 2 Left gastric artery
- 3 Common hepatic artery
- 4 Splenic artery
- 5 Hepatic artery proper
- 6 Left hepatic artery
- 7 Right hepatic artery
- 8 Gastroduodenal artery
- 9 Right gastroepiploic artery



- 1 Superior mesenteric artery
- 2 Middle colic artery
- 3 Right colic artery
- 4 Jejunal arteries
- 5 Ileocolic artery
- 6 Marginal artery
- 7 Colic branch of ileocolic artery
- 8 Ileal branch of ileocolic artery
- 9 Ileal arteries

Thank You!

We hope you found this helpful and informative.

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