Radiological Anatomy and Investigation of The GIT

Objectives

1 .To know various radiological investigations used for GIT.

2. To understand step wise approach in requesting GIT radiology investigations.

3. To be familiar with radiological appearance (anatomy) seen in various imaging modalities.

4. To interpret plan x-ray radiograph of abdomen with common pathologies.

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Color Coding

Important | Notes | Extra

Editing File

Introduction:

What is peculiar about GIT? (GIT Characteristics):

1. Hollow viscus (Not solid). 2. Usually filled with gas. 3. Motility.

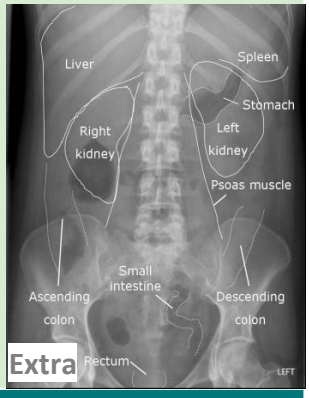
Radiological Modalities						
Plain X-ray	**Fluoroscopy**	**CT**	**Angiography**	**Nuclear Medicine**	**MRI**	**Ultrasound**
Ionizing Radiation				Minimal Radiation	Non-Ionizing Radiation	

Angiogram and nuclear medicine are not used in GIT imaging

X-ray (Plain radiography):

- 1895.
- Often used as first imaging modality
- A screening modality.
- Cheap.
- Fast.
- Can be done bedside (portable).
- Useful for free gas and bowel obstruction

We are able to know different types of tissues by seeing different densities:
Bone → High density/molecular weight (white).
Gas → Low density (black).
Soft Tissue → Medium density (gray).
We look for bowel obstruction or free gas outside the lumen of the bowel.



Fluoroscopy (Contrast Study):

- Can be used as first imaging modality.
- Cheap.
- Use of contrast (fluoroscopy = X-ray + contrast).
- Recently replaced by CT & MRI due to patient discomfort, contrast, radiation.
- Useful for intraluminal pathology.
- Can give clue about motility (function).

Different terminology and assessments:
In esophagus → Barium swallow.
Stomach → Barium meal.
Small bowel → Barium follow through.
Large bowel → Barium enema.

Ultrasound:

- Discovered after world war II, started in medical field in 1950.
- Relatively cheap.
- No radiation.
- Limited use in gas filled structures (abdominal distention) and it is of limited use in the GI tract (bowels) but very useful for solid organs like the liver and gallbladder.
- Used in pediatrics and pregnant ladies.
- Cannot be used to assess bone/gasses.
- Acute abdomen/acute appendicitis and pyloric stenosis is an indication to use ultrasound.

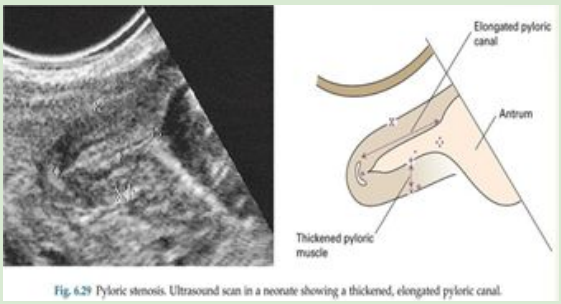


Fig. 6.29 Pyloric stenosis. Ultrasound scan in a neonate showing a thickened, elongated pyloric canal.

Pyloric stenosis. Ultrasound scan in a neonate showing a thickened, elongated pyloric canal. In babies, 4 weeks old, males with swelling in epigastric area and projectile vomiting.

CT:

- Started in 1970 in London.
- Expensive.
- More radiation.
- Fast, less than 1 minute from head to toe.
- Contrast (IV, Oral, rectal) usually used.
- Used in emergency department.

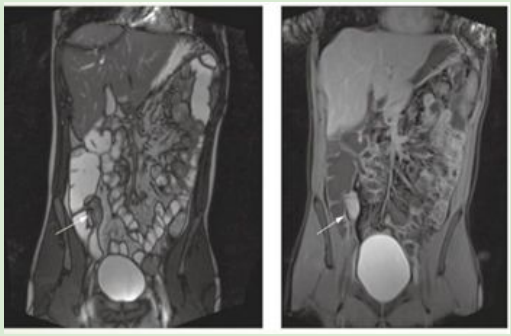
How to differentiate between Bone, soft tissue, fat and air in CT?

By different densities (Same as X-ray).

We don't use barium in CT because it'll cause artifacts (errors that can mimic pathology).

MRI:

- Started at the beginning of 1980.
- More expensive than CT.
- No radiation.
- Slow and affected by artifacts (Like motion or bowel movements).
- Excellent for soft tissue.
- Can't be reformatted.
- It takes a long time so can't be used for unstable patient, unlike CT which can be used in emergency (for unstable patient).
- Hydrogen ions moves to radiofrequency and will give a reaction to radiofrequency that can be interpreted by a computer then it can be reflected as an image according to the hydrogen ions.

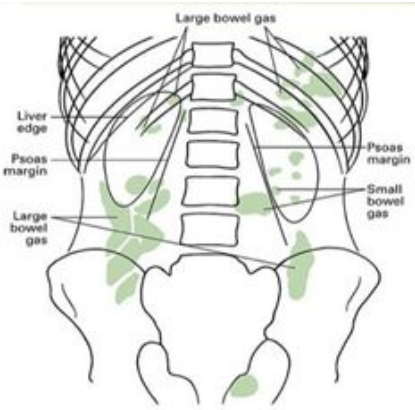


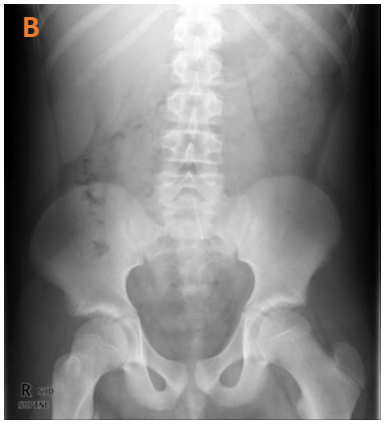
MRI of Crohn's disease coronal T2 (the picture on the left) and coronal T1 post contrast right picture) images demonstrating mucosal thickening and enhancement involving the terminal ileum (arrows), characteristic of Crohn's disease.

T1 T2 are usually seen in brain where you see fluid.

Bright fluid in T2.

Dark in T1.



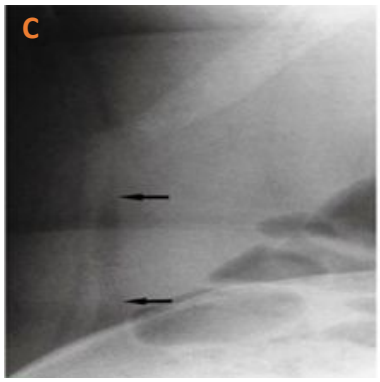


Normal plain abdominal film.

(a) Normal abdomen. The arrows points to the lateral borders of the psoas muscles. The renal outlines are obscured (overcast) by the overlying colon.

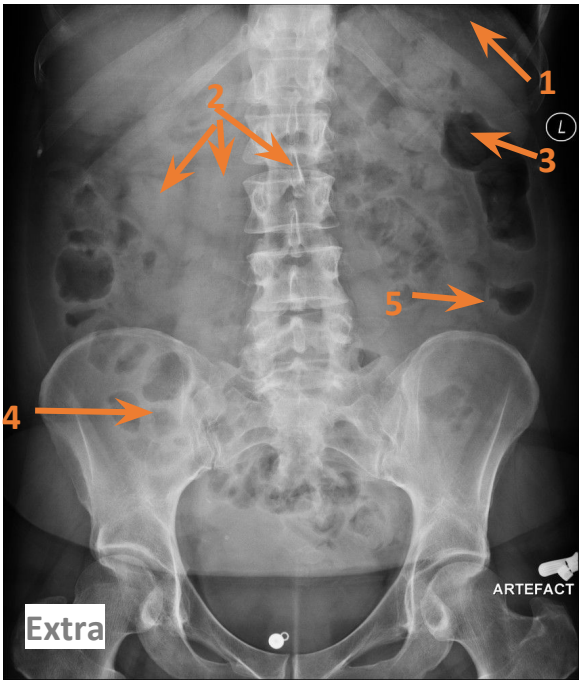
(B) The white line (metal density) is umbilical piercing. Liver edges can be seen (contrast between fat and liver).

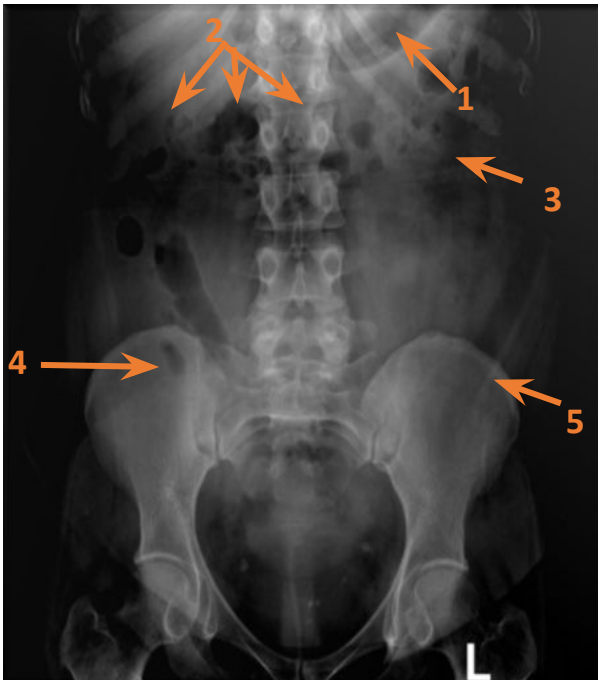
(c) Normal extraperitoneal fat stripe. Part of the right flank showing the layer of extraperitoneal fat (arrows), which indicates the position of the peritoneum.



Extra pic, team 434

a. Abdominal X-ray





1- Stomach, known as gas in left upper abdomen.

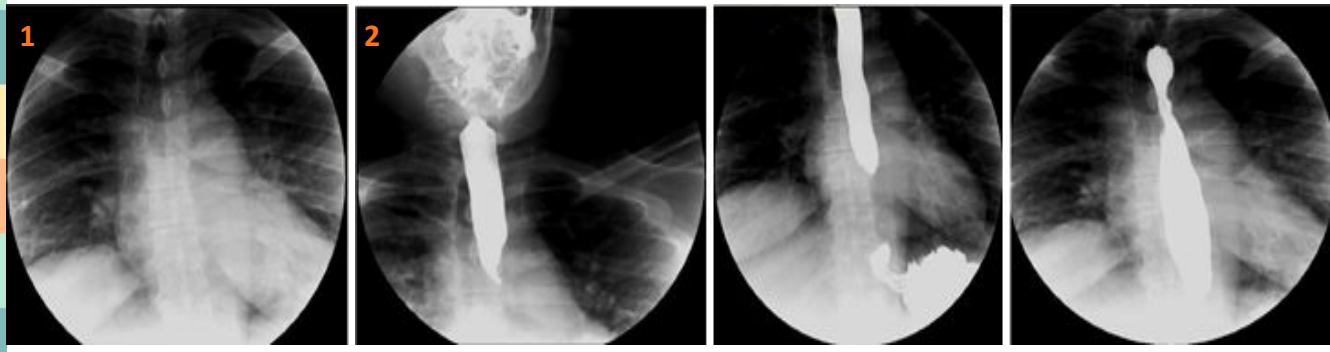
2- Transverse Colon. **3-** Small bowel.

4- Cecum. **5-** Descending Colon. Colon is usually in the periphery.

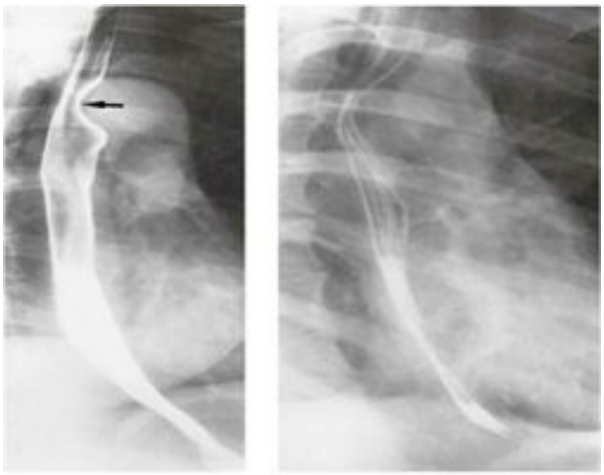
b. Esophageal Barium Swallow:

To study the upper GI (esophagus, stomach and first part of duodenum). We used contrast x-ray (fluoroscopy), and we ask the patient to swallow a barium (contrast). This imaging can be used to evaluate upper GI by:

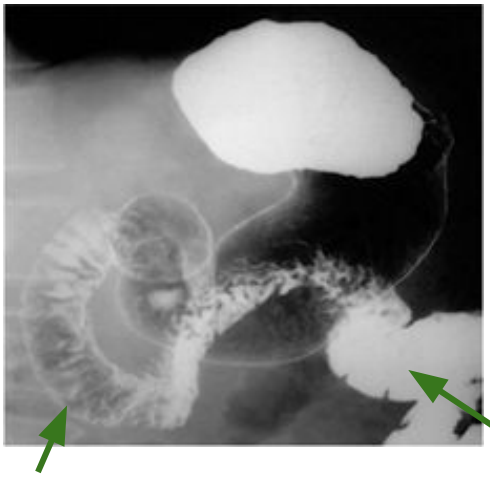
➔ evaluating the motility of the esophagus.
➔ evaluating the transit time of the contrast.
➔ evaluating obstruction / stricture.



In this image (1) we can't see the esophagus because we didn't use contrast you can only see trachea and heart, but if we fill it with contrast, it'll appear denser (like in the other images (2)).



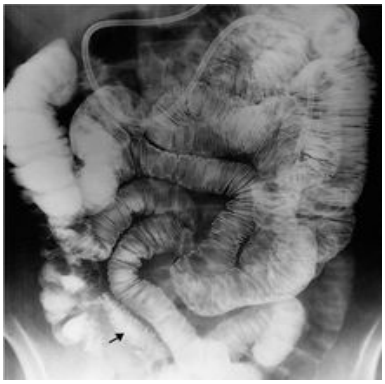
Single contrast is used in the image on the left: Only barium.
Double contrast is used in the image on the right: barium and gas.
We add gas to see the mucosal lining which should be linear, straight no irregularity.
Esophagus: the arrow is pointing to a normal narrowing due to the aortic arch (anteriorly). There is no bulging or any other abnormalities like strictures.



Stomach: The contrast is shown in the fundus smooth mucosa, no filling defect (Barium meal).

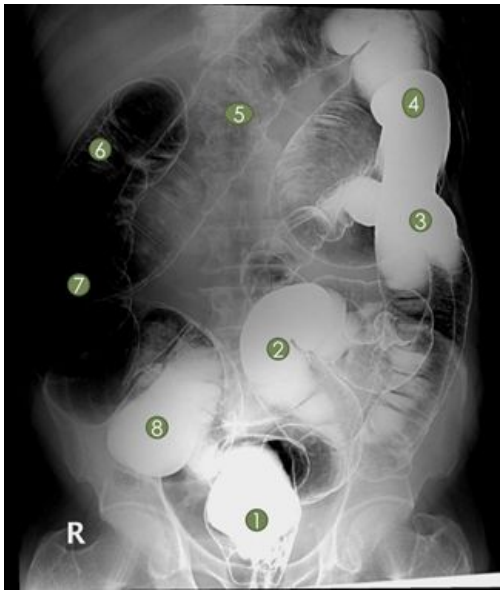
C. Barium follow through (rare):

Normal barium follow-through. The small intestine, ascending and transverse colon are filled with barium. The small intestine, ascending and transverse colon are filled with barium and it is called barium enema, it appears feathery. The jejunum in the left side of the abdomen has a much more marked mucosal fold pattern than the ileum, which is lying in the pelvis. When a peristaltic wave contracts the bowel, the mucosal folds lie longitudinally (arrows). Note the way of measuring the diameter of the bowel. In the pelvis the loops overlap and details of the bowel become hidden.



They do this study by inserting a tube into the stomach, duodenum and then when it reaches the jejunum they will inject a contrast + fluid. Normal enteroclysis (small bowel enema). This technique gives good mucosal detail. The arrow points to the terminal ileum. Note that a tube has been passed through the stomach into the jejunum.
Not done anymore, almost replaced by CT and MRI.

- Large bowel will be seen in the lateral side of the picture frame while in the center we can see the small bowel.
- The contrast in large bowel will fill the whole diameter. On the other hand, the contrast in small bowel will fill part of the diameter.



1- Rectum.
2- Sigmoid Colon.
3- Descending Colon.
4- Splenic Flexure.
5- Transverse Colon.
6- Hepatic Flexure.
7- Ascending Colon.
8- Cecum.

In this image the contrast has been given per rectum (Barium enema).

C. **Barium follow through** double contrast picture (rare):

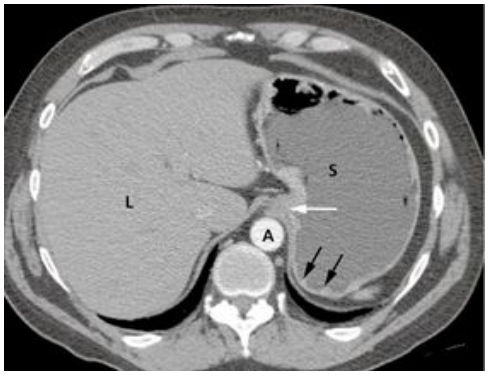
- **The light green line** is the **Hustra.**

This is a double contrast of the large bowel: first they inject the barium and the barium will make the outline clear. After that the patient will pass the barium out then we will inflate gas which will make the outline more clear. Haustra can be missing or diminished in the left side of the colon normally. But in right and transverse it MUST be present. Absent haustra in right or transverse is pathological.

CT scan:

CT + angio contrast because the aorta is bright
- **S**tomach
- **L**iver
- **A**orta

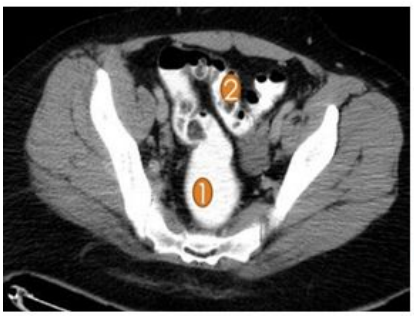
And the use of an intravenous smooth muscle relaxant. Some normal rugal folds are still visible (black arrows). Note the gastroesophageal junction (white arrow).

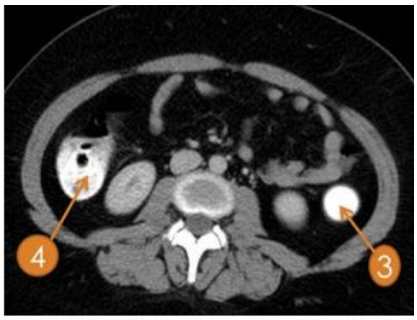


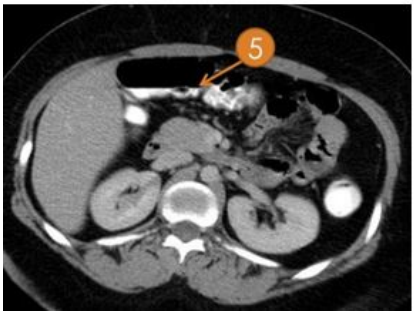
Post surgery with SOB, tachycardia, low saturation and arrest?

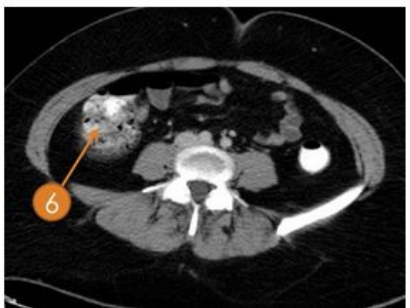
Pulmonary Embolism (so we need to see the pulmonary artery by CT with contrast, CT pulmonary angio within 9-12 seconds after injection).

We give the patient I.V. contrast and we wait to see: after 9-12 seconds to see the pulmonary trunk (right and left), Aorta 15-20 second, Abdominal organs artery phase 30-35 seconds, portovenous phase 60-70 seconds, kidney excretion 3 min, bladder and ureter 7 minutes.









1- Rectum.

2- Sigmoid Colon.

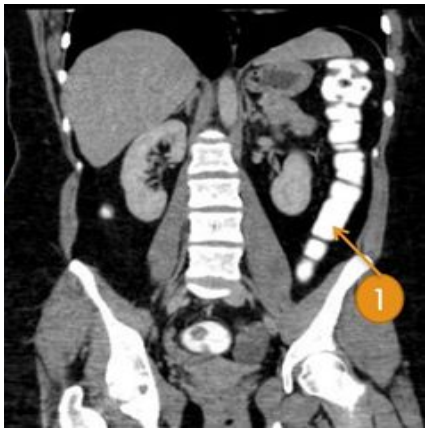
3- Descending Colon.

4- Ascending Colon.

5- Transverse Colon.

6- Cecum.

Coronal CT scan:

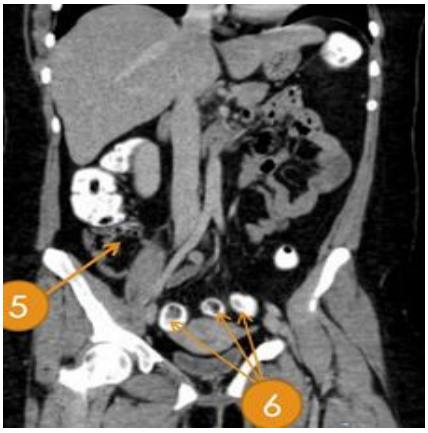


1- Descending Colon.

2- Splenic Flexure.

3- Hepatic Flexure.

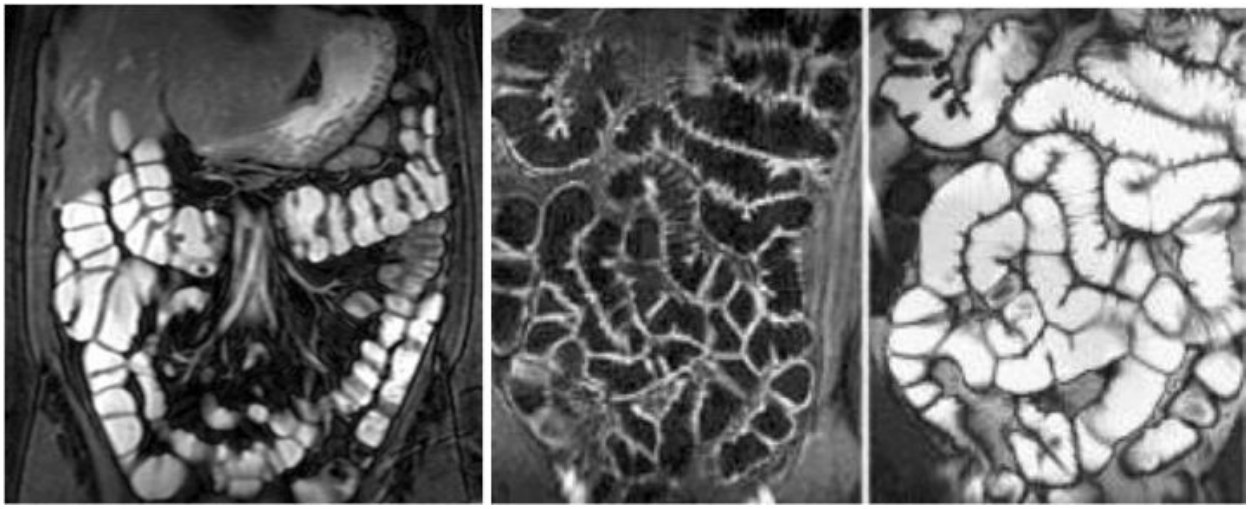
4- Ascending Colon.



5- Cecum.

6- Sigmoid Colon.

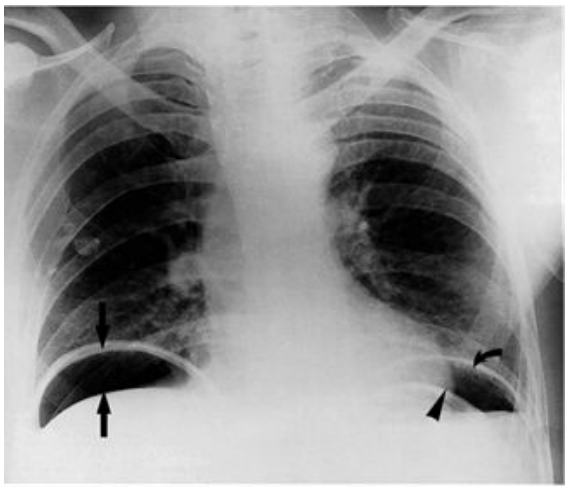
MRI Enterography:



Here there is contrast, but the radiology technologist reprogrammed MRI machine to wash it out.

- Used mainly to diagnose IBD (inflammatory bowel disease) and (Crohn's disease), which bowel is fibrosed and not moving, which area has a stricture or an abnormality.
- It is now replacing the fluoroscopy by doing functional study. Fluid is used to distend the intestine.

Common plain X-ray abdomen radiograph findings:

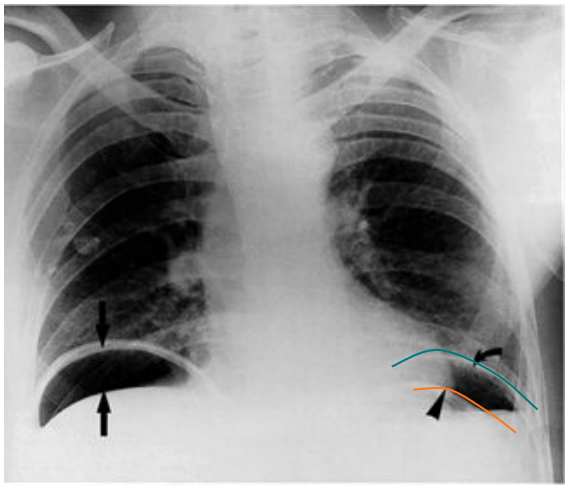


Free gas in the peritoneal cavity.

On this chest radiograph, air can be seen under the domes of both hemidiaphragms. The curved arrow points to the left hemidiaphragm and the arrow head to the wall of the stomach. The two vertical arrows point to the diaphragm and upper border of the liver.

"**Pneumoperitoneum**" due to perforation of viscus like peptic ulcer that give meniscus shaped free gas in abdomen.

Standing or erect position gas is not inside bowel it is under diaphragm. it is an emergency.



The green line represents the diaphragm, and the orange represents the stomach. The radiolucent (black) area between the two lines represents the abnormal free gas in peritoneum. And the radiolucency under the orange line represents normal gastric bubbles.

Why did the radiologist apply chest X-ray rather than abdominal X-ray?

- To exclude lower lobe pneumonia that caused by legionella which the abdominal pain is one of it's symptoms.

What are the findings?

- Black arrows pointing to the air bubbles.
- If the air bubble was at the site of stomach, it would be normal bubble (left side).
- While if it was on the right side, it indicates the perforation due to peptic ulcer.
- We can see normal air fluid level in the stomach and cecum as well as small intestines Sometimes when they're full (after meal), but without distension of the intestines (which would indicate small bowel obstruction).
- Stomach bubble is usually in the middle and doesn't extend to the periphery.

Common plain X-ray abdomen radiograph findings:

These two images are taken in two different positions, name them and tell the changes for each position. Both are "Small bowel obstruction due to adhesion":

Erect position:

The jejunal loops are markedly dilated and show air-fluid levels the air fluid level, air will be at the upper area while fluid will accumulate at the lower area due to gravity the jejunum is recognized by the presence of valvulae conniventes (Coins like structure).

Supine position:

There is no air fluid level (when the air rise above the fluid) because air is projecting over fluid the fluid accumulates posteriorly and the gas anteriorly.

- Stack of coin appearance.

Well demonstrated in the supine film. Note the large bowel contains less gas than normal.

- This is radiographic image shows gas filled structure (small bowl markedly dilated) in center of the abdomen and shows air-fluid levels in the erect film. And this presentation is due to small bowel obstruction.
- We do abdominal erect and supine film in bowel obstruction. But to investigate the cause of obstruction (e.g. mass, stricture), we do CT.
- **What is the difference between these 2 images?** Air-fluid level.
- **Why it's only seen in one image although it's the same patient at the same moment?** one of them erect and the other supine position. In supine air will be front and fluid go back, while in erect position air will be above and fluid go down so we will see air fluid level. it's there even in supine position but we can't see it.
- Signs of bowel obstruction can be diagnosed by x-ray, then do CT to know the cause

Large bowel obstruction (megacolon)
due to carcinoma at the splenic flexure. There is marked dilatation of the large bowel from the caecum to the splenic flexure.

Too much gas in large bowel it could be large bowel obstruction due to mass or could be paralytic ileus. anatomical or physiological obstruction you must correlate with clinical picture

Paralytic ileus
There is considerable dilatation of the whole of the large bowel extending well down into the pelvis. Small bowel dilatation is also seen.

Common plain X-ray abdomen radiograph findings:

الراديولوجستس شاعريين، يوصفون الشيء بإمعان قبل ما يعطون التشخيص النهائي.

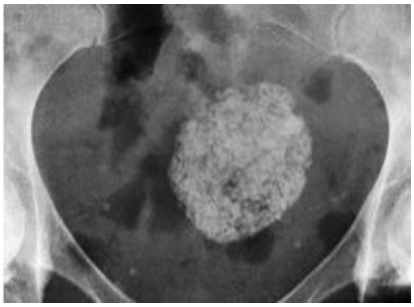
Abdominal x ray (erect position) shows markedly decreased gases (opacity)

Huge mass arising (originating) **from the pelvis (arrows),** displacing the bowel to the upper left side. This mass is cystadenocarcinoma of the ovary. (since the displacement is toward one side we know it is a mass not ascites).
The mass started at pelvic cavity (ovary) and then gradually increased in size and extended to the abdomen filling the intestinal space and displacing the intestines.

Ascites. Note how the gas in the ascending and descending colon (arrows) is displaced by the fluid away from the side walls of the abdomen.
Could be fluid or blood or ascites.
ascites goes everywhere, we see gas everywhere but decreased.
In ascites we can see scanty gas and the bowel is in it's same location.

Calcification of the abdomen:

Calcification within the pelvic base (phleboliths*) **Commonest**, benign, hollow structure inside like a ring (low density center), Could mimic ureteric stone, but stone is more medial.



Calcified large uterine fibroid (leiomyoma) in postmenopausal women

Calcification in the pancreas (chronic pancreatitis)

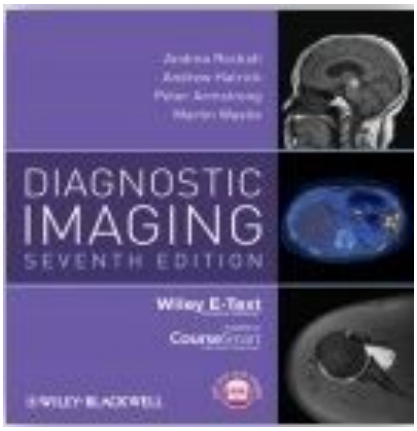
How did we know it is not a nodule?
Nodules mostly will contain soft tissue (less density).

* calcification within the venous system of the pelvis mimicking ureteric stone (common with aging).

Calcification of the abdomen:

This is **calcified abdominal aortic aneurysm**. The aneurysm measured 8 cm in diameter on the lateral view. Very dangerous and can be picked up by x-ray only.

Calcified mesenteric lymph nodes from old tuberculosis (arrows).



Dr.Sultan included the picture of the book in his slides and he said (this is the reference. I like it and i might ask from it)

*We **highly recommend** that you read the next part, it is very helpful.*

Click here to get a pdf version!

- The standard plain film of the abdomen is a supine antero-posterior (AP).
- Erect films offer little further diagnostic information at the expense of increased radiation exposure to the patient.
- Free intraperitoneal air can be seen on an erect chest radiograph (CXR), which is usually performed at the time of the abdominal x-ray.
- In patients who are unable to sit or stand, a lateral decubitus view (i.e. an AP film with the patient lying on his/her side) is performed using a horizontal x-ray beam as a means of detecting free intraperitoneal air.

There are a number of points to be considered when looking at a plain abdominal film:

- Analyze the intestinal gas pattern and identify any dilated portion of the gastrointestinal tract.
- Look for gas outside the lumen of the bowel.
- Look for ascites and soft tissue masses in the abdomen and pelvis.
- If there are any calcifications, try to locate exactly where they lie.
- Assess the size of the liver and spleen gas in the peritoneal cavity.

a. Intestinal gas pattern:

Relatively large amounts of gas are usually present in the stomach and colon in a normal patient. The stomach can be readily identified by its location above the transverse colon.

b. Dilatation of the bowel:

The pattern of dilatation is the key to the radiological distinction between small and large bowel obstruction.

c. Small bowel obstruction:

The small intestine is dilated down to the point of obstruction and the bowel beyond this point is either empty or of reduced caliber.

d. Large bowel obstruction:

The large bowel is dilated down to the level of obstruction.

e. Pneumoperitoneum :

- The radiological diagnosis of perforation of the gastrointestinal tract is based on recognizing free gas.
- The most common cause of spontaneous pneumoperitoneum is a perforated peptic ulcer.
- The largest quantities of free gas are seen after colonic perforation, and the smallest amounts with leakage from the small bowel.
- Pneumoperitoneum under the right hemidiaphragm is usually easy to recognize on an erect CXR as a curvilinear collection of gas between the line of the diaphragm and the opacity of the liver.
- Free gas under the left hemidiaphragm is more difficult to identify because of the overlapping gas shadows of the stomach and the splenic flexure of the colon.

f. Gas in an abscess:

- Gas in an abdominal or pelvic abscess produces a very variable pattern on plain films. It may form either small bubbles or larger collections of air, both of which could be confused with gas within the bowel.
- Fluid levels in abscesses may be seen on a horizontal x-ray.
- As abscesses are mass lesions, they displace the adjacent structures; for example, the diaphragm is elevated with a subphrenic abscess, and the bowel is displaced by pericolic and pancreatic abscesses.
- A pleural effusion or pulmonary collapse/consolidation are very common in association with subphrenic abscess.
- Ultrasound and CT are extensively used to evaluate abdominal abscesses.

g. Gas in the wall of the bowel:

- Numerous spherical or oval bubbles of gas are seen in the wall of the large bowel in adults in the benign condition known as pneumatosis coli.
- Linear streaks of intramural gas have a more sinister significance as they usually indicate infarction of the bowel wall.
- Gas in the wall of the bowel in the neonatal period, whatever its shape, is diagnostic of **necrotizing enterocolitis**, a disease that is fairly common in premature babies with respiratory problems.

h. Ascites:

- Small amounts of ascites cannot be detected on plain films. Larger quantities separate the loops of bowel from one another and displace the ascending and descending colon from the fat stripes.
- Indicate the position of the peritoneum along the lateral abdominal walls.
- Ascites is readily recognized at ultrasound or CT.

i. Abdominal calcification:

The pattern or shape of the calcification will usually limit the diagnosis to just one or two choices.

Calcifications in the abdomen are likely to be one of the following:

- Pelvic vein phleboliths are very common.
- Calcified mesenteric lymph nodes: caused by old tuberculosis.
- Vascular calcification: occurs in association with atheroma, and generally has a curvilinear appearance. Calcification is frequently present in the walls of abdominal aortic aneurysms, if suspected, further evaluation should be undertaken with ultrasound.
- Uterine fibroids: may contain numerous irregularly shaped, well-defined calcifications.

Causes of abdominal calcification:

- Pelvic vein phleboliths.
- Calcified mesenteric lymph nodes.
- Vascular calcification.
- Uterine fibroids.
- Soft tissue calcification.
- Ovarian masses.
- Adrenal calcification.
- Liver calcification.
- Gallstones.
- Splenic calcification.
- Pancreatic calcification.
- Faecoliths.
- Renal stones and other calcifications of the urinary tract.

Calcified mesenteric lymph nodes from old tuberculosis (arrows)

Adrenal calcification (arrow)

1. **Soft tissue calcification:**

In the buttocks may be seen following injection of certain medicines. These shadows can at times be confused with intra-abdominal calcifications.

2. **Malignant ovarian masses:**

Occasionally contain visible calcium. The only benign ovarian Lesion that is visibly calcified is the dermoid cyst, which may contain various calcified components, of which teeth are the commonest.

3. **Adrenal calcification**

Occurs after adrenal haemorrhage, after tuberculosis and occasionally in adrenal tumours. However, the majority of patients with adrenal calcification are asymptomatic healthy people in whom the cause of the calcification is unclear. Only a minority of patients with Addison's disease have adrenal calcification.

4. **Liver calcification:**

Occurs in hepatomas and rarely in other liver tumours. Hydatid cysts, abscesses and tuberculosis may also calcify over time.

5. **Splenic calcification:**

Is rarely of clinical significance. It is seen in cysts, infarcts, old haematomas and following tuberculosis.

6. **Pancreatic calcification:**

Occurs in chronic pancreatitis. The calcifications are mainly small calculi within the pancreas. The position of the calcification usually enables the diagnosis to be made without difficulty.

7. **Faecoliths. Calcified faecoliths:**

May be seen in diverticula of the colon or in the appendix. Appendiceal faecoliths are an important radiological observation, as the presence of an appendolith is a strong indication that the patient has acute appendicitis, often with gangrene and perforation. However, only a small proportion of patients with appendicitis have a radiologically visible appendolith.

8. **Liver and Spleen:**

- Substantial enlargement of the liver has to occur before it can be recognized on a plain abdominal film. As the liver enlarges it extends well below the costal margin, displacing the hepatic flexure, transverse colon and right kidney downwards and displacing the stomach to the left. The diaphragm may also be elevated.
- As the spleen enlarges, the tip becomes visible in the left upper quadrant below the lower ribs. Eventually, it may fill the left side of the abdomen and even extend across the midline into the right lower quadrant. The splenic flexure of the colon and the left kidney are displaced downwards and medially, and the stomach is displaced to the right.

9. **Abdominal and Pelvic masses:**

- Attempting to diagnose the nature of an abdominal mass on a plain film is notoriously difficult, and ultrasound, CT or magnetic resonance imaging (MRI) are the appropriate imaging modalities.
- The site of the mass, the displacement of adjacent structures and the presence of calcification are important diagnostic signs but plain films are unable to distinguish between solid and cystic masses.
- An enlarged bladder can be seen as a mass arising from the pelvis, displacing loops of bowel. In females, uterine and ovarian enlargements also appear as masses arising from the pelvis.
- Ovarian cysts can become very large, almost filling the abdomen and displacing the bowel to the sides of the abdomen.

Summary

X-ray

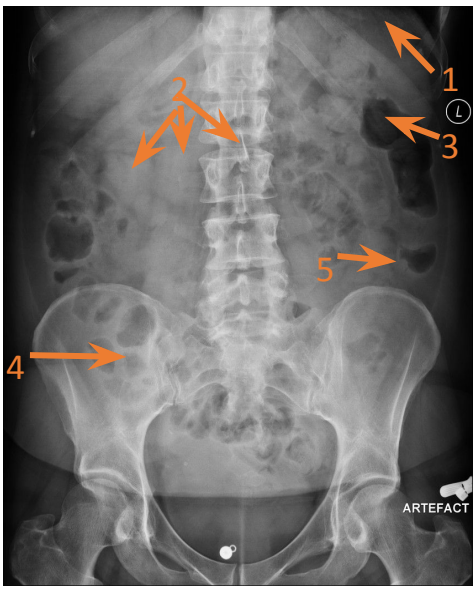
1- Stomach

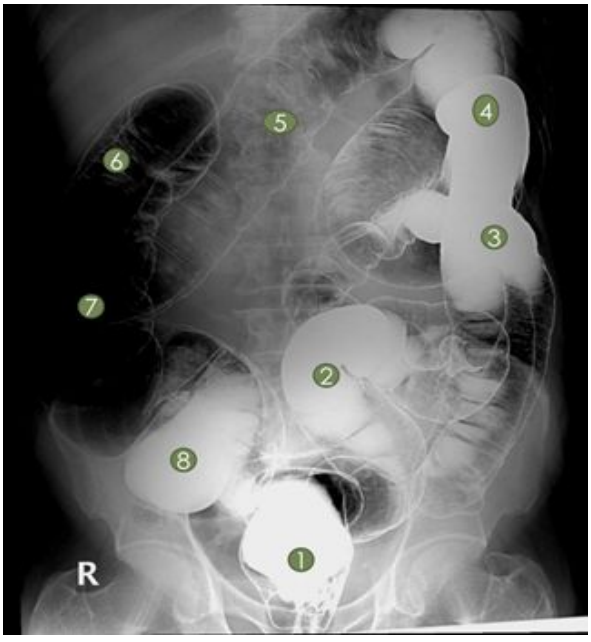
2- Transverse Colon

3- Small bowel

4- Cecum

5- Descending Colon





Barium follow through

1- Rectum.

2- Sigmoid Colon.

3- Descending Colon.

4- Splenic Flexure.

5- Transverse Colon.

6- Hepatic Flexure.

7- Ascending Colon.

8- Cecum.

CT

1- Rectum

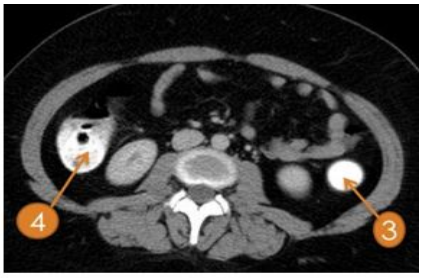
2- Sigmoid Colon

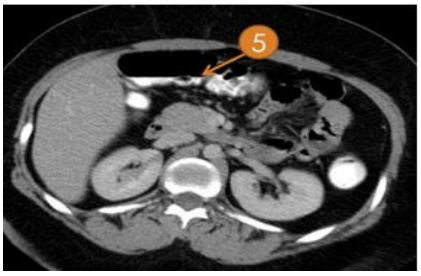
3- Descending Colon

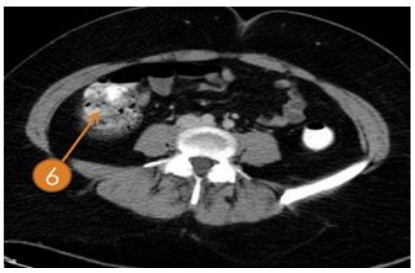
4- Ascending Colon

5- Transverse Colon

6- Cecum





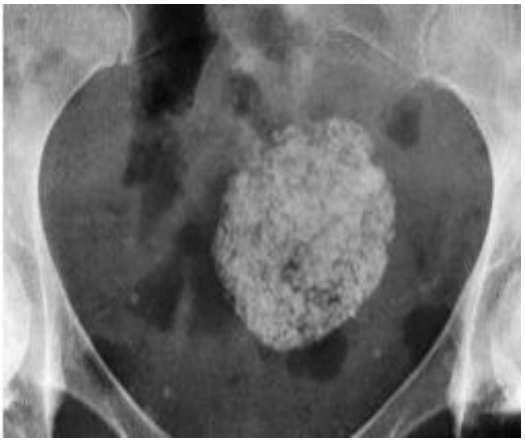


Questions

1. Abdominal X-ray was taken to a patient , which one of the following you think he has based on the X-ray:

A- Large bowel obstruction.
B- Perforation.
C- Scoliosis.
D- Normal abdominal X-ray.

2- Patient present to you complaining of an abdominal pain ,after you ordered an Abdominal X-ray you noticed that There is Calcification as shown Which statement below is true:



A- Calcification within the pelvic base.
B- Calcification in the pancreas.
C- Uterine fibroid.
D- Calcification within the head of femur.

3- Which of the following modalities can be initially used:

A- X-ray.
B-Fluoroscopy.
C-MRI
D-A&B

Answers :
1-A
2-C
3-D