

# **THE GASTRO-INTESTINAL TRACT**

## GASTROINTESTINAL *tract*

- Oral cavity
- Pharynx
- Esophagus
- Stomach
- Small bowel
- Large bowel (Colon)
- Rectum

### **Accessory organs**

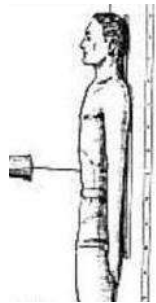
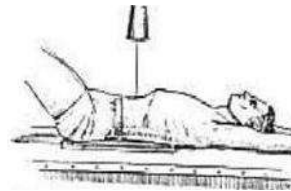
- ❖ Parotid glands
- ❖ Liver
- ❖ Gallbladder and biliary ducts
- ❖ Pancreas

## Imaging modalities

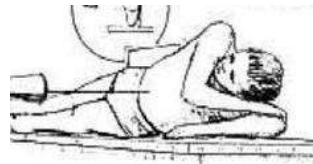
- 1. Plain Radiograph of the abdomen**
- 2. Barium study**
- 3. Fluoroscopy**
- 4. Ultrasonography**
- 5. Computerized tomography**
- 6. Radionuclide imaging**
- 7. Magnetic Resonance Imaging (MRI)**
- 8. Angiography (aorta, celiac trunk, mesenteric arteries)**

## Plain abdominal X-ray

- Anteroposterior (AP)



- Left lateral Decubitus (LLD)



- Semi recumbent



- Chest X-ray (CXR)



# Indications

- Bowel obstruction
- Perforation
- Renal pathology
- Acute abdomen
- Foreign body localization
- Toxic megacolon
- Aortic aneurysm
- Control or preliminary films for contrast studies
- Detection of calcification or abnormal gas collection

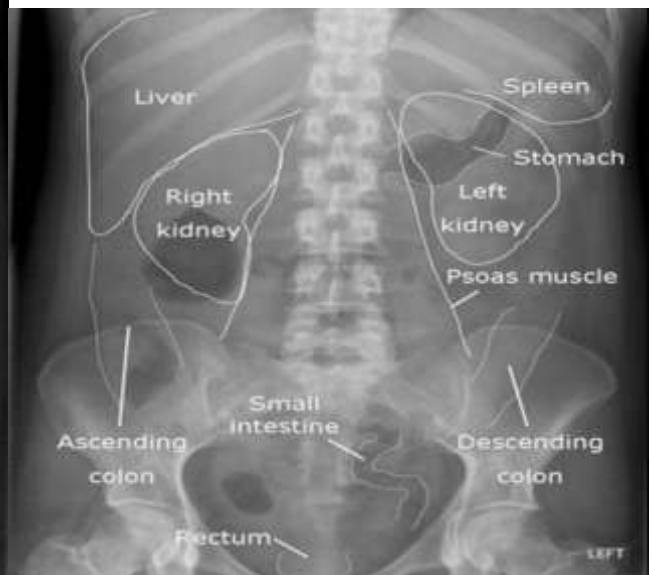
## 5 basic densities on x rays:

- Gas - - - - - > Black
- Fat - - - - - > Dark grey
- Soft tissue/fluid - - - - > Light grey
- Bone/calcification - - - > White
- Metal - - - - - > Intense white



# What to examine?

- Air (bowel gas)
- Bone density
- Calcifications
- Soft tissues



## Air:

- Look at the stomach:
  - If the stomach contains air it may be visible in the left upper quadrant of the abdomen. The lowest part of the stomach crosses the midline.
- Look at the diaphragms:
  - Are they raised or flattened?
  - Are the costophrenic angles clear?
- Is there any free intra-abdominal air?  
(better evaluated if erect or decubitus)



**Air:**



**Free air under the diaphragm → visceral perforation**

**Bone  
density:**

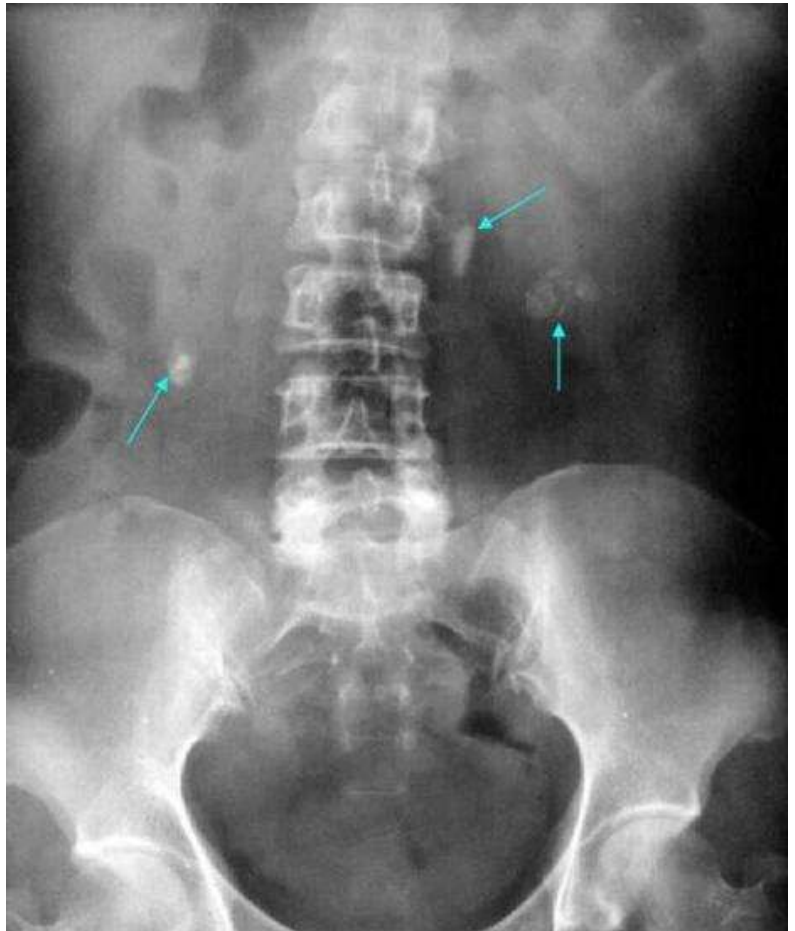


## **Calcifications:**



**Chronic calculous pancreatitis**

**Calcifications,  
stones**



## Targeted X-ray of abdomen

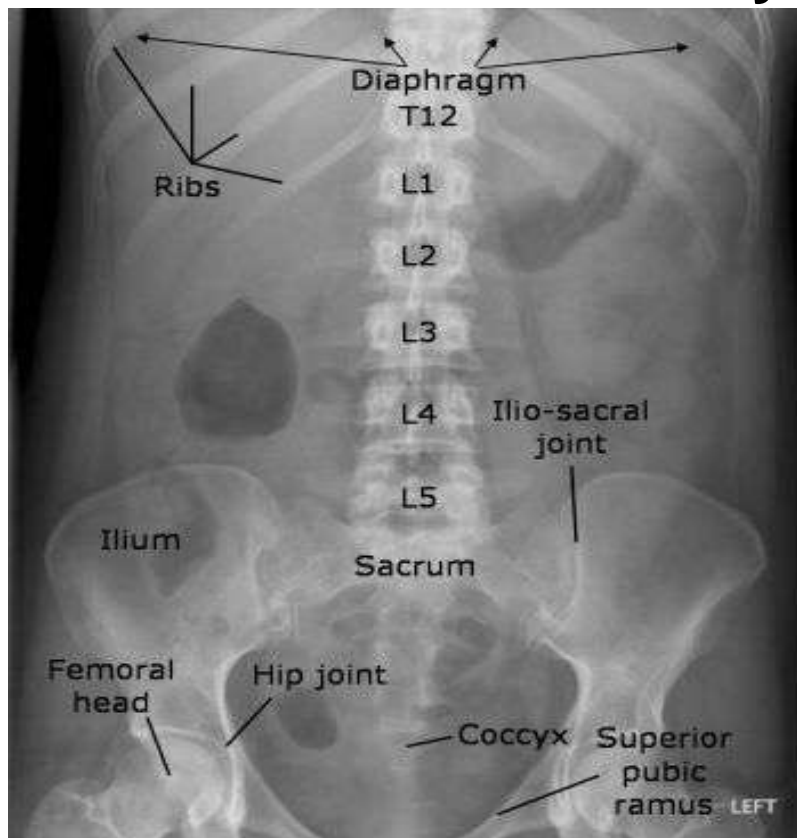
**Calcified  
gallbladder**



## Soft tissues

- Look at the liver:
  - Is it enlarged, shrunk or displaced?
  - Are there any calcifications?
- Look at the spleen:
  - Is it enlarged, shrunk or removed?
  - Are there any calcifications?
- Look at the kidneys, ureters and bladder:
  - Are they enlarged, shrunk or displaced?
  - Are there any calcifications?

## Structures seen on X-ray



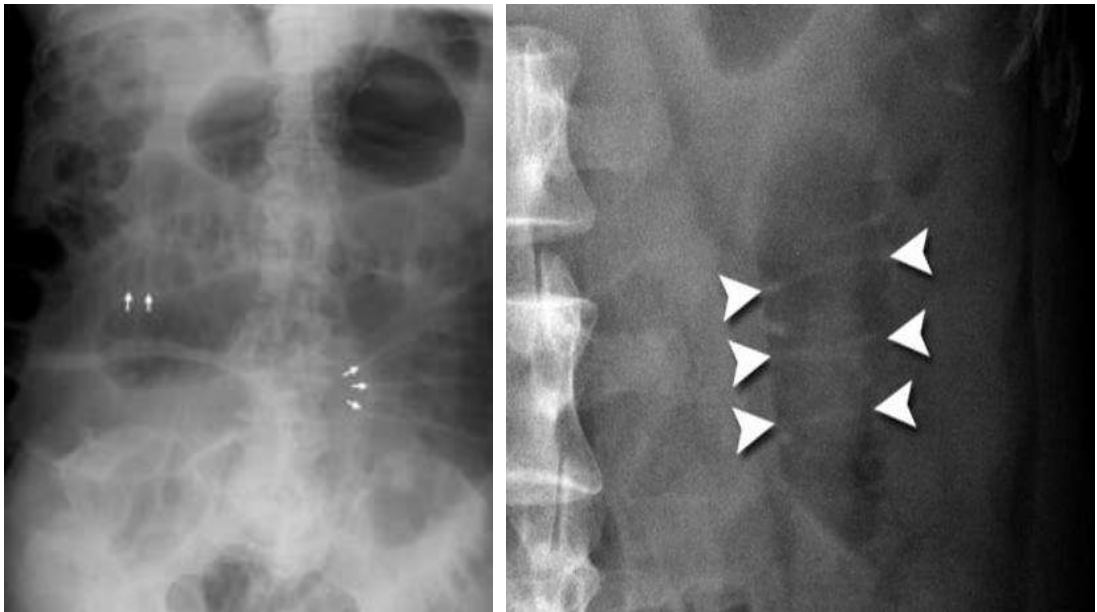
## Bowel gas pattern

- Look at the bowel gas pattern:
  - Where are the bowel loops located (central vs. peripheral)?
  - What is the distribution of the gas in the abdomen?
  - Is there too much intraluminal gas?
- What is the intraluminal caliber of the small and large bowel?
- Are there any dilatations of the small and/or large bowel?
- Are there any air-fluid levels?



# Small bowel

- Central position in the abdomen
- Valvulae conniventes - mucosal folds that cross the full width of the bowel. Usually they become visible when the small bowel is more distended, particularly in the jejunum.



# Large bowel

- **Peripheral position in the abdomen** (although the location of the transverse and sigmoid colon may vary)
- **Haustra** - small pouches, giving the colon its segmented appearance. **Haustra don't reach around the entire circumference of the intestine, in contrast to circular folds of the small bowel (valvulae conniventes).**
- Loss of haustra is a sign of chronic ulcerative colitis.
- Large bowel also contains feces (in contrast to the small intestine)



# Psoas muscles

- **arise from the transverse processes of the lumbar vertebrae**
- **joins the iliacus muscle on each side to form the iliopsoas and attaches to the lesser trochanter of the femur.**

**An abdominal X-ray often demonstrates the lateral edge of the psoas muscles as a near straight line.**



Metallic  
foreign body



## *Barium studies*

- **Barium swallow**
  - **Barium meal**
  - **Barium follow-through**
  - **Barium enema**
- 
- Barium salts are radioopaque and show clearly on a radiograph. If barium is swallowed before radiographs are taken, the barium within the esophagus, stomach or bowel shows the shape of the lumina of these organs.
  - Barium sulfate - an inert particulate contrast agent most commonly used in GI tract evaluation.

## Barium swallow

- Used to examine upper GI tract, which includes the **esophagus** and to a lesser extent the stomach.

### The esophagus:

- Starts at the cricoid cartilage, courses through the posterior mediastinum and ends at the gastroesophageal junction.
- Normally has 3 sites of narrowing:
  - **superior:** junction site with pharynx at the level of cricoid cartilage
  - **middle:** cross site of aorta and left main bronchus (level of the aortic arch)
  - **inferior:** level of diaphragmatic sphincter





**THE GASTROINTESTINAL TRACT**

- **BARIUM SWALLOW EXAMINATION**





## Barium meal

- Also known as an upper gastrointestinal series
- The patient ingests **gas pellets** and **citric acid** to expand the stomach. Then about 3 cups (700 ml) of **barium** is ingested.
- Radiographs of the **esophagus**, **stomach** and **duodenum** are taken after Barium sulfate is ingested.
- The patient may move or roll over to coat the stomach and esophagus in barium.

With the advent of esophago-gastroduodenoscopy, the usage of barium meal studies has gradually declined.



## 2 types of Barium meal studies

### ■ **Single contrast Barium meal:**

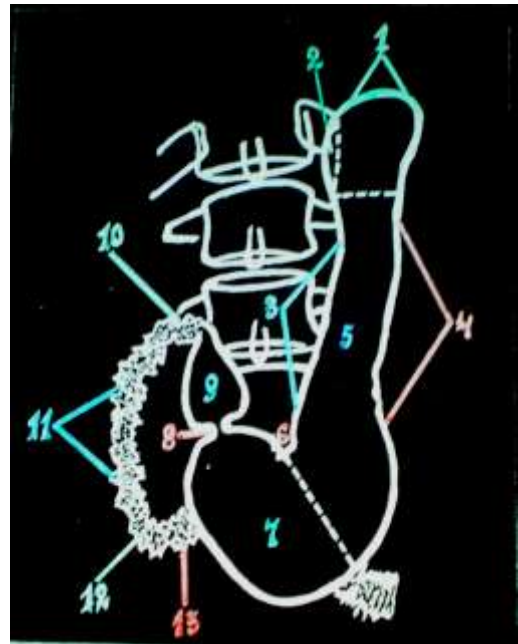
- uses only barium, a radioopaque (or positive) contrast medium, to image the upper GI tract.

### ■ **Double contrast Barium meal:**

- uses barium as well as a radiolucent (or negative) contrast medium such as air, nitrogen, or carbon dioxide.
- is more useful as a diagnostic test, demonstrating mucosal details and allowing the detection of small mucosal lesions such as diverticula or polyps.

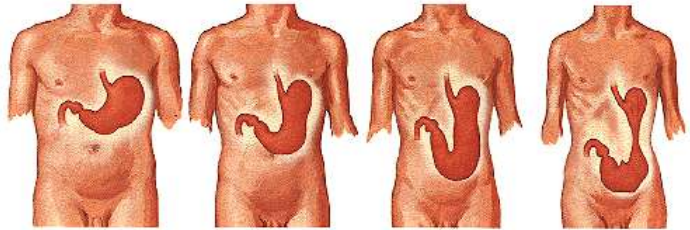
# RADIOLOGICAL ANATOMY STOMACH AND DUODENUM

1. Fundus
2. Cardia
3. Lesser curvature
4. Greater curvature
5. Body of the stomach
6. Angle of the stomach
7. Antrum
8. Pylorus
9. Duodenal bulb
10. D-1
11. D-2
12. D-3
13. D-4

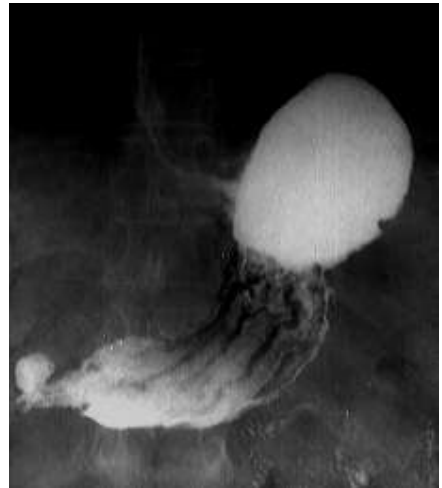


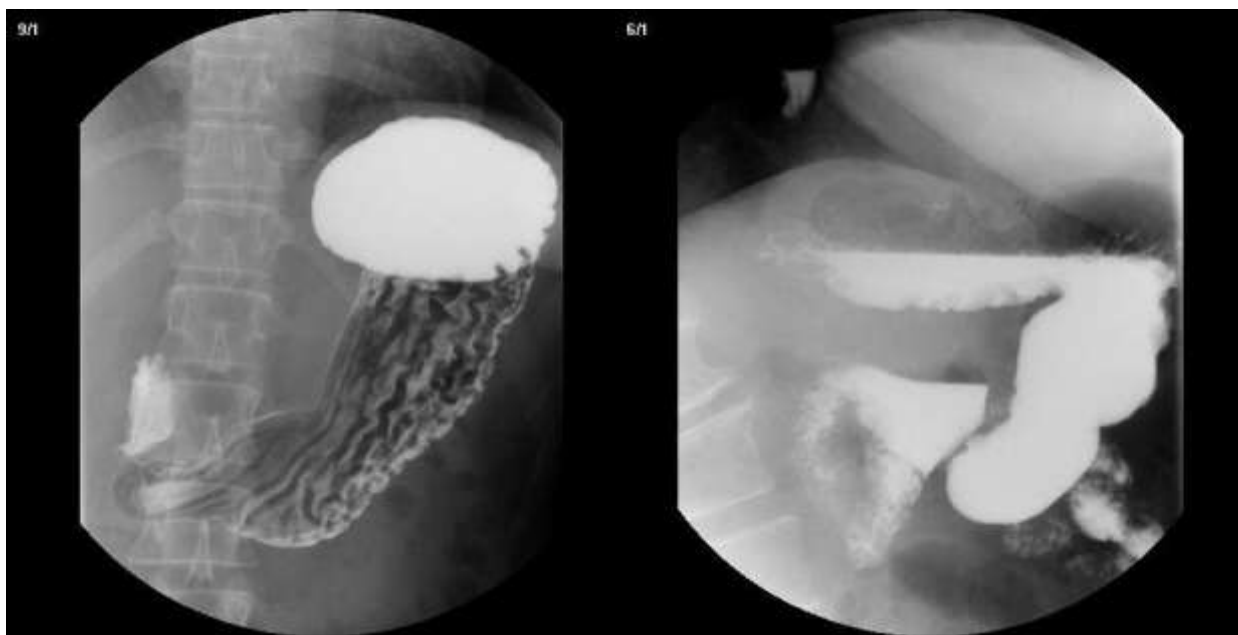
## Shape and position of the stomach related to the body type

- a. Normostenic
- b. Astenic
- c. Hiperstenic



**THE GASTROINTESTINAL TRACT**  
**SINGLE CONTRAST BARIUM MEAL**

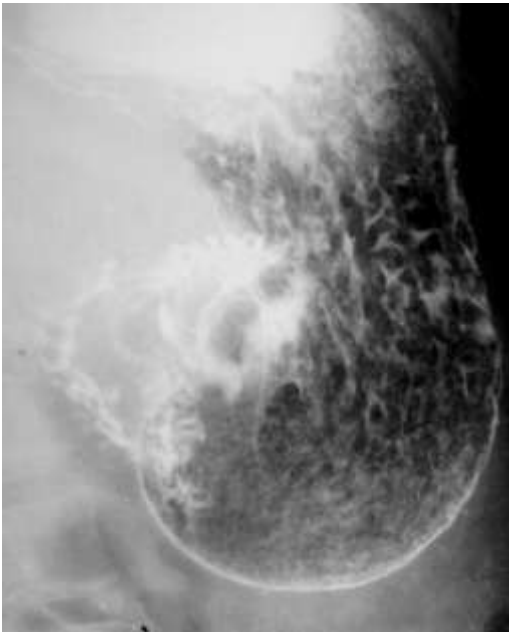




Pozitie de decubit dorsal (subst de contrast in fornix)

Ortostatism: stomac "in cascada"

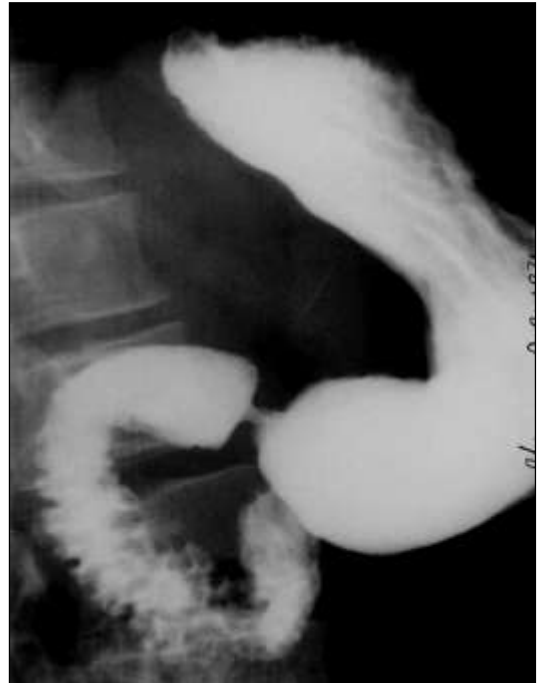
**THE GASTROINTESTINAL TRACT**  
**DOUBLE CONTRAST TECHNIQUE**



## THE GASTROINTESTINAL TRACT

### DUODENUM

#### – BARIUM MEAL TECHNIQUE





**THE GASTROINTESTINAL TRACT  
DUODENUM  
– HYPOTONIC DUODENOGRAPHY**



## HYPOTONIC DUODENOGRAPHY



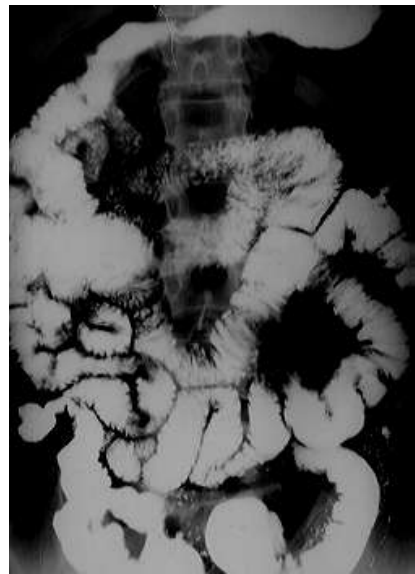
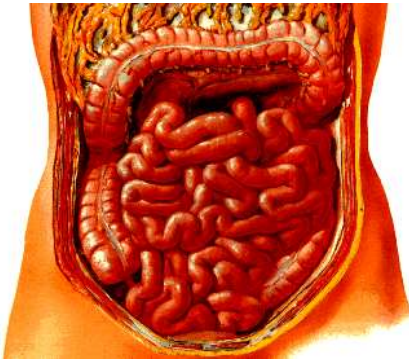
## Barium follow-through

- X-ray images are taken as the contrast moves through the intestine, commonly at 0 minutes, 20 minutes, 40 minutes and 90 minutes.
- The test is completed when the Barium is visualised in the terminal ileum and Caecum, which marks the beginning of the large bowel. This is one of the most common places for pathology of the bowel to be found, therefore imaging of this structure is crucial.
- The test length varies from patient to patient as bowel motility is highly variable.
- It is used to diagnose various conditions of the small bowel such as Crohn's disease, ulcerative colitis, bowel cancer. For example, Crohn's disease shows up as intermittent sections of strictured bowel.

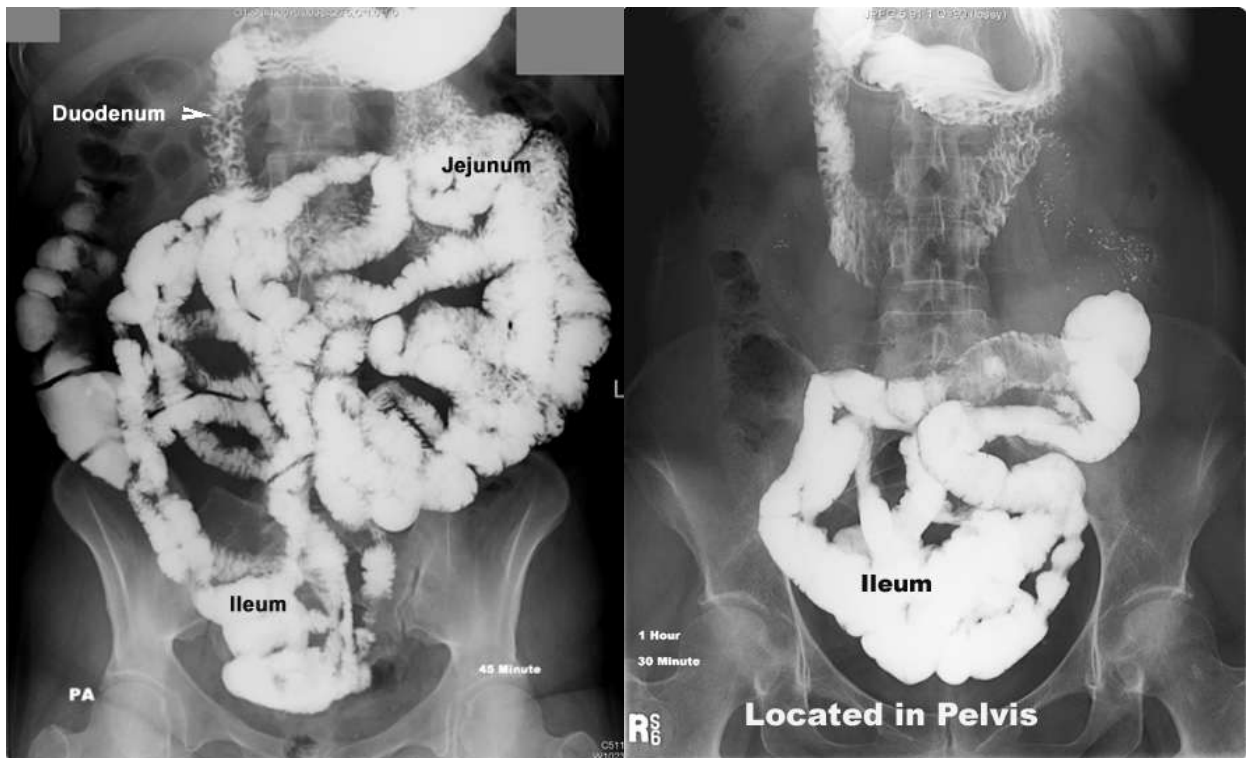
## THE GASTROINTESTINAL TRACT

### JEJUNUM and ILEUM

- **SMALL BOWEL FOLLOW – THROUGH MEAL:**  
observation of the barium passage over several hours



# Barium follow-through



## **Digestive Tube artificial contrast (barium passage)**



## **Digestive Tube artificial contrast (barium passage)**

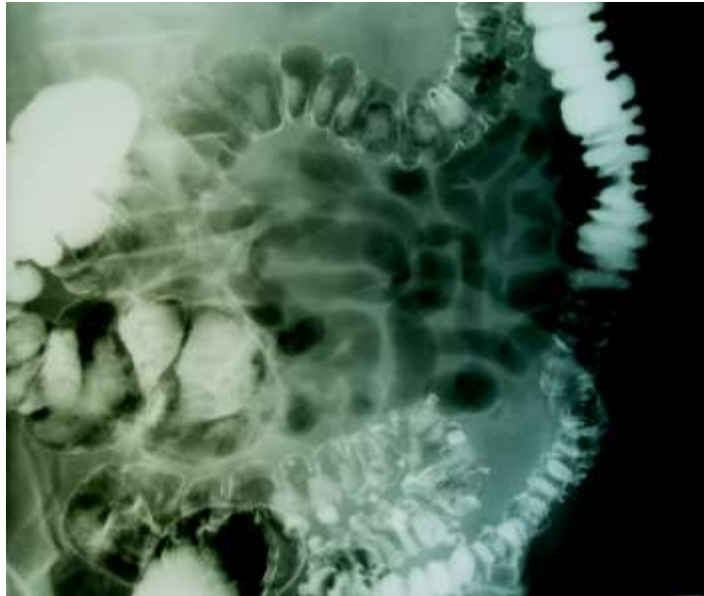


## Digestive Tube artificial contrast (barium passage)





# BARIUM ENEMA

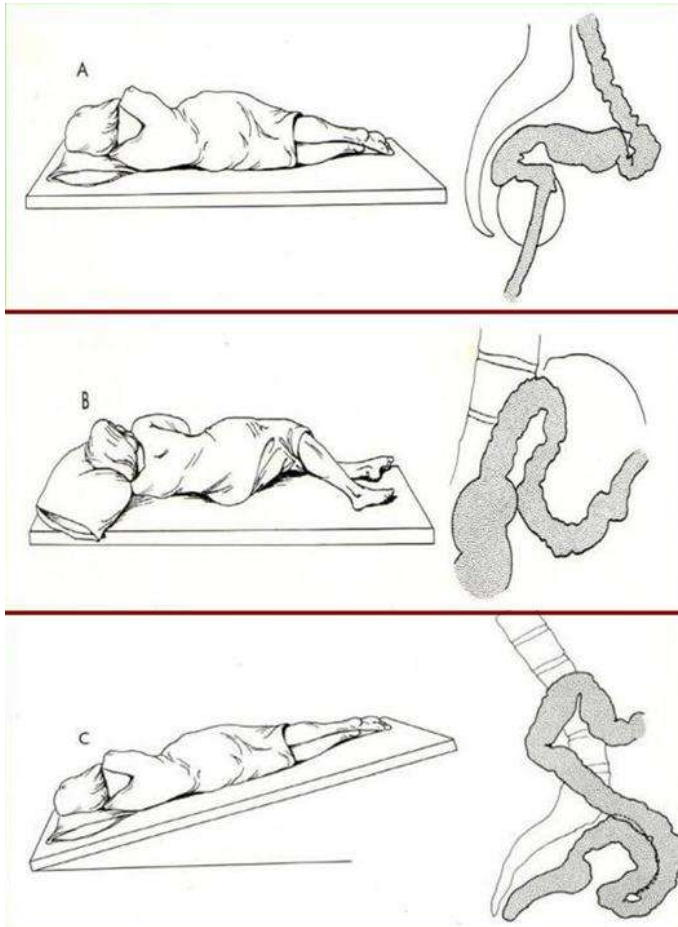


## Barium enema (Irrigoscopy)

- Also known as a **lower gastrointestinal series**
- X-ray pictures are taken while barium sulfate fills the colon via the rectum.
- A large balloon at the tip of the enema tube may be inflated to help keep the barium sulfate inside.
- The flow of the barium sulfate is monitored by the health care provider on an X-ray fluoroscope screen (like a TV monitor).

## Barium enema (Irrigoscopy)

- **Single contrast Barium enema** - The colon is filled with barium, which outlines the intestine.
- The flow of the barium sulfate is monitored by the health care provider on an X-ray fluoroscope screen.
- **Double contrast Barium enema** - the colon is first filled with barium; then the barium is drained out, leaving only a thin layer of barium on the wall of the colon.
- The colon is then filled with air. This provides a detailed view of the inner surface of the colon, making it easier to see strictures, diverticula, or inflammation.



■ **A - Left lateral position:**

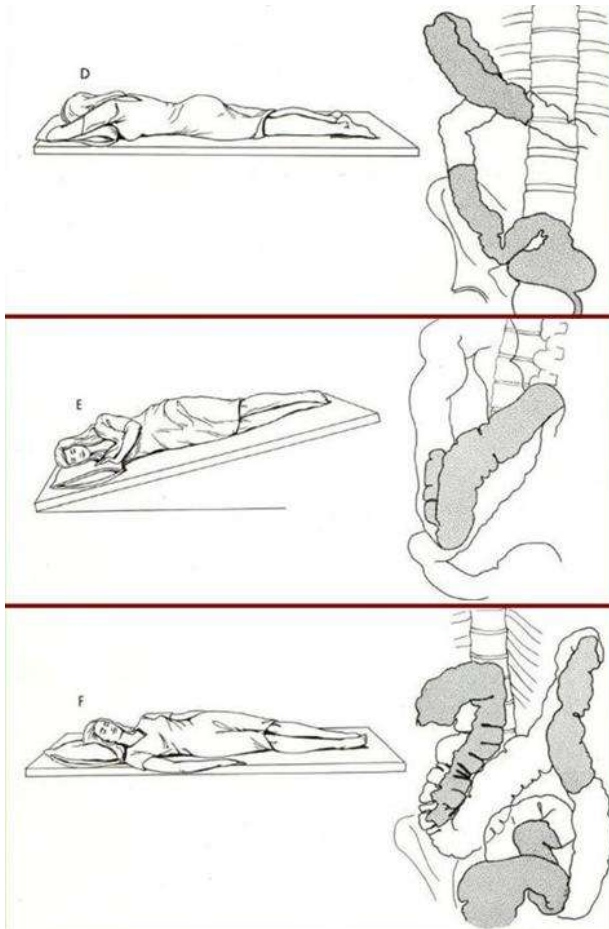
contrast filling of the **rectum**  
and **rectosigmoid**

■ **B - Left posterior oblique position:**

contrast filling of the **sigmoid**

■ **C - Left lateral with 15° Trendelenburg position:**

contrast flow to **descending colon** and **splenic flexure**



■ **D - turning clockwise from C to prone position:**

contrast filling of the **transverse colon**

■ **E - turning clockwise from D to right lateral with 15°**

**Trendelenburg position :**

contrast filling of the **hepatic flexure**

■ **F - turning clockwise from E to supine position:**

contrast filling of the **hepatic flexure and ascending colon**

# Indications

- **Single contrast Barium enema:**
  - Intussusception
  - Hirschprung's disease (congenital aganglionic megacolon)
  - Fatigue / old patient
  - Suspected pelvic metastases
  
- **Double contrast Barium enema:**
  - Melena (bloody stools)
  - Suspected colonic polyps or colon cancer
  - Family history of colonic polyps or colon cancer
  - Chronic diarrhea / bowel habit change
  - IBD (inflammatory bowel disease)
  - Abdominal pain and discomfort
  - Diverticulosis

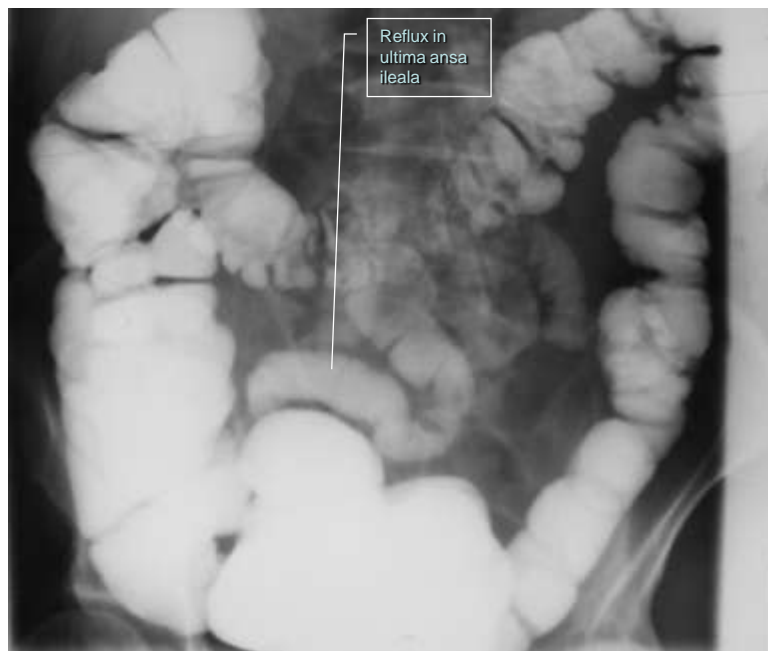
## **Barium enema contraindications**

- Suspected bowel perforation
- Toxic megacolon
- After colonic biopsy
- Pregnant patient

## **Barium enema complications**

- Gas pain
- Colonic perforation
- Intramural barium
- Stool impaction
- Bacterial contamination
- Allergy / hypersensitivity

## Time I





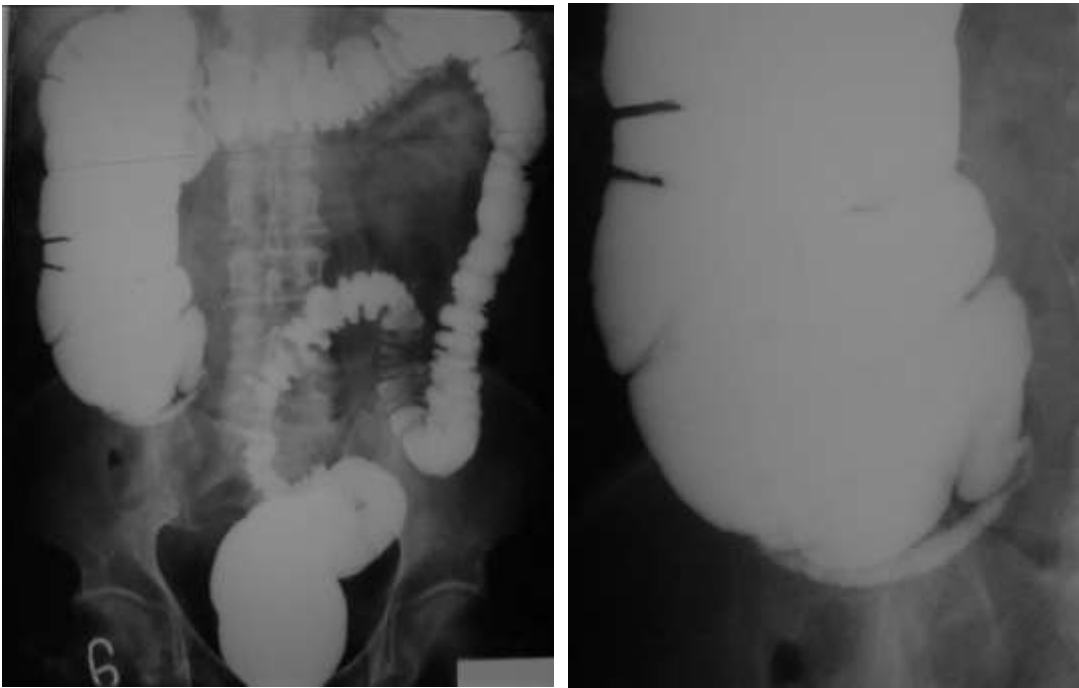
## Time II – barium evacuated



## Time III – double contrast



## Appendix



## Appendix



# Radionuclide Imaging



## Abdominal Ultrasonography

- Uses transmission and reflection of ultrasound waves to visualize internal



## Common indications for abdominal ultrasound

- In patients with **abdominal pain** can diagnose a variety of conditions such as cholecystitis, appendicitis, gallbladder or bile duct diseases, cholestasis, tumors, etc.
- In patients with **abnormal kidney function** or **pancreatic enzymes** for evaluation of renal and pancreatic pathology
- Evaluation of abdominal aortic and other **vascular aneurysms**
- It is very useful **for detecting stones**, for example kidney stones or gallstones, because they create a clearly visible ultrasound shadow behind the stone.
- It is used **to guide procedures** such as extracorporeal shock wave lithotripsy, needle biopsies or paracentesis.

### **Advantages:**

- can be performed quickly, including at the bed-side
- involves no exposure to X-rays, making it also useful in pregnant patients
- inexpensive compared to other imaging modalities such as CT or MRI-based techniques

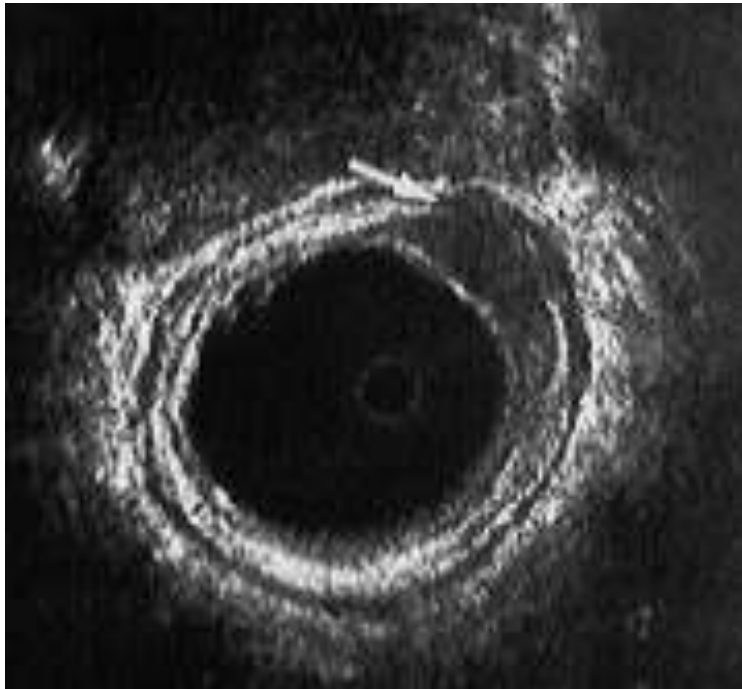
### **Disadvantages:**

- troublesome imaging if a lot of gas is present inside the bowels or if there is a lot of abdominal fat
- Is highly operator-dependent (i.e. the quality of the imaging depends on the experience of the person performing it).



THE GASTROINTESTINAL TRACT

- **ENDOSCOPIC ULTRASONOGRAPHY**



## Computed tomography (CT)

- **is a sensitive method for diagnosis of abdominal diseases**
- **the first line for detecting solid organ injury after trauma.**
- **useful for investigating acute abdominal pain** (especially of the lower quadrants, whereas ultrasound is the preferred first line investigation for right upper quadrant pain), **i.e. renal stones, appendicitis, pancreatitis, diverticulitis, abdominal aortic aneurysm, bowel obstruction etc.**
- **frequently used to determine stage of cancer and to follow its progress.**

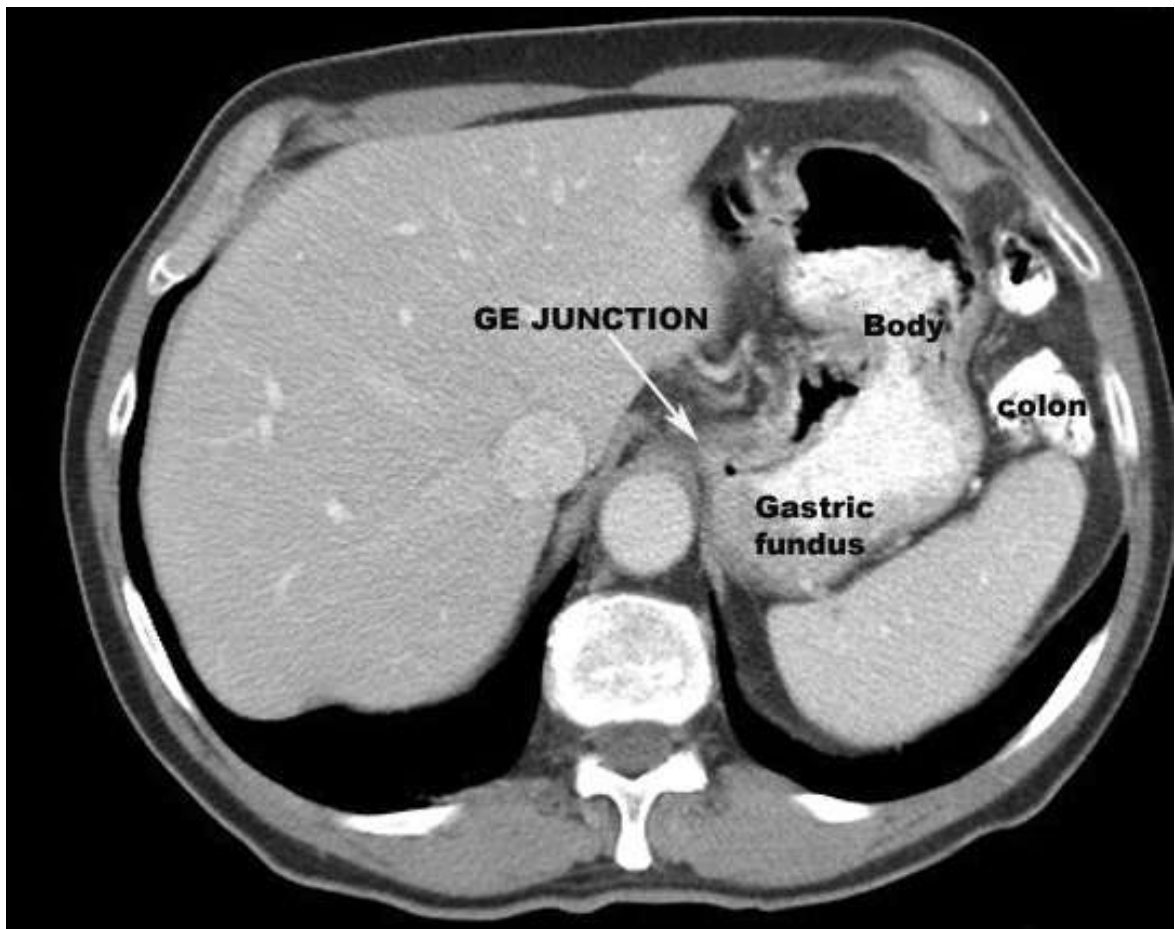
- Spatial resolution ability to resolve small objects in an image
- Contrast resolution ability to differentiate **small density differences** in an image

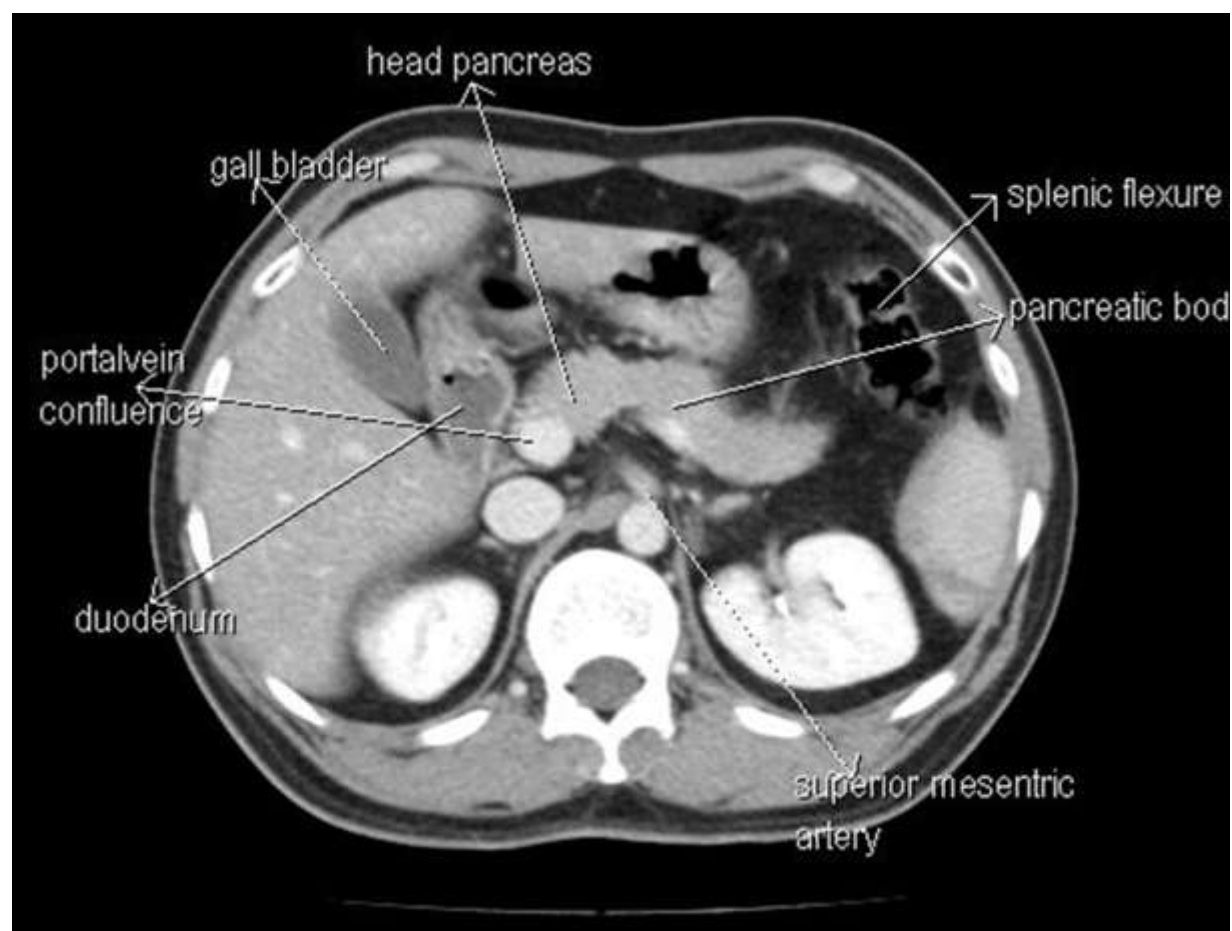
Non contrast CT of the abdomen include

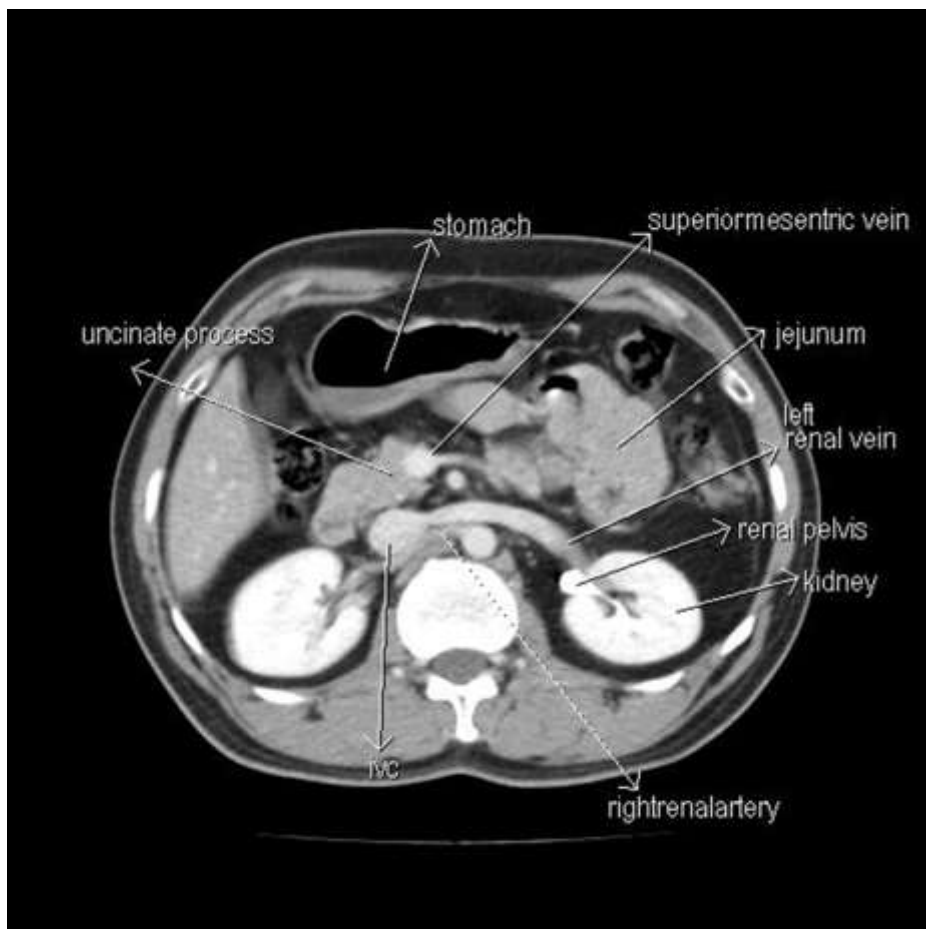
- Urinary tract evaluation ( stone protocol )
- Emergency CT for appendicitis
- Abdominal trauma

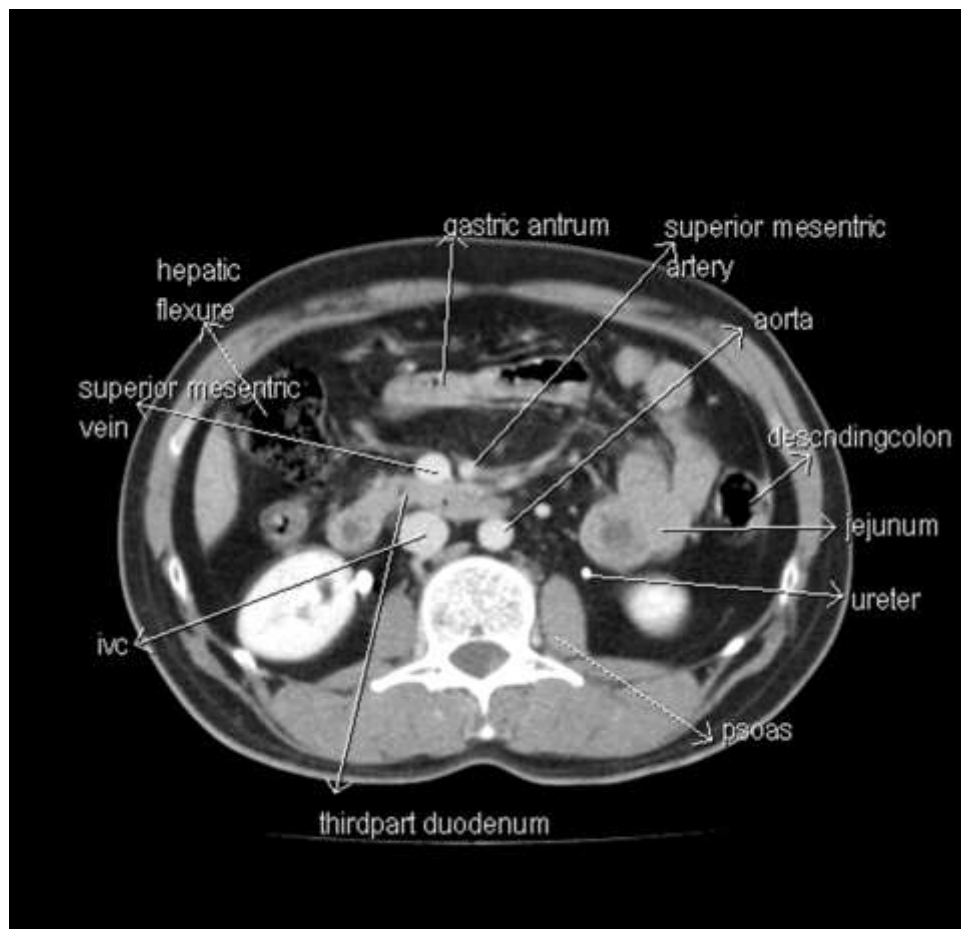
## Contrast enhanced CT

- **Intravenous iodinated contrast** is used in CT to help highlight blood vessels and to enhance the tissue structure of various organs such as the liver, kidneys, spleen.
- **Oral and/or rectal contrast** may be used to help highlight GI system. A dilute (2% w/v) suspension of Barium sulfate is most commonly used for this purpose. The concentrated barium sulfate preparations used for fluoroscopy, e.g., barium enema, are too dense and cause severe artifacts on CT.
- Iodinated contrast agents may be also used *per os* if barium is contraindicated (for example, suspicion of bowel injury).

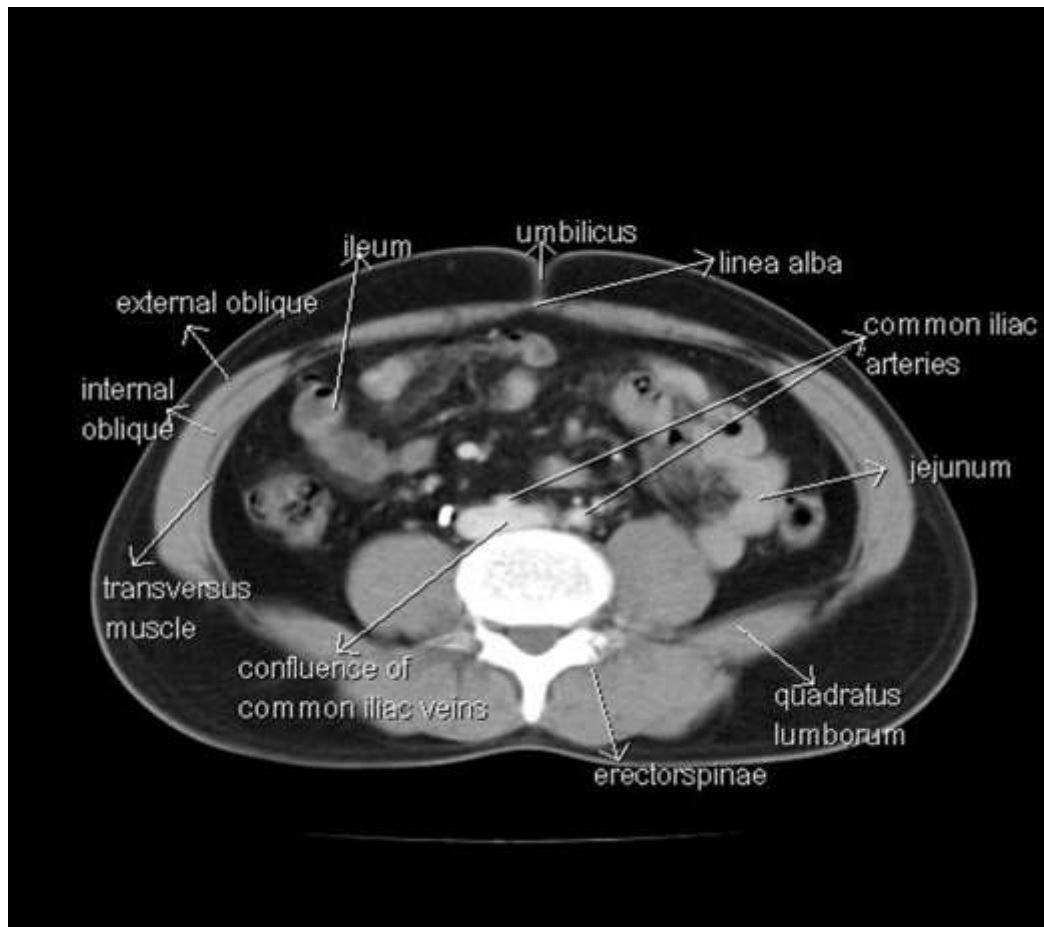




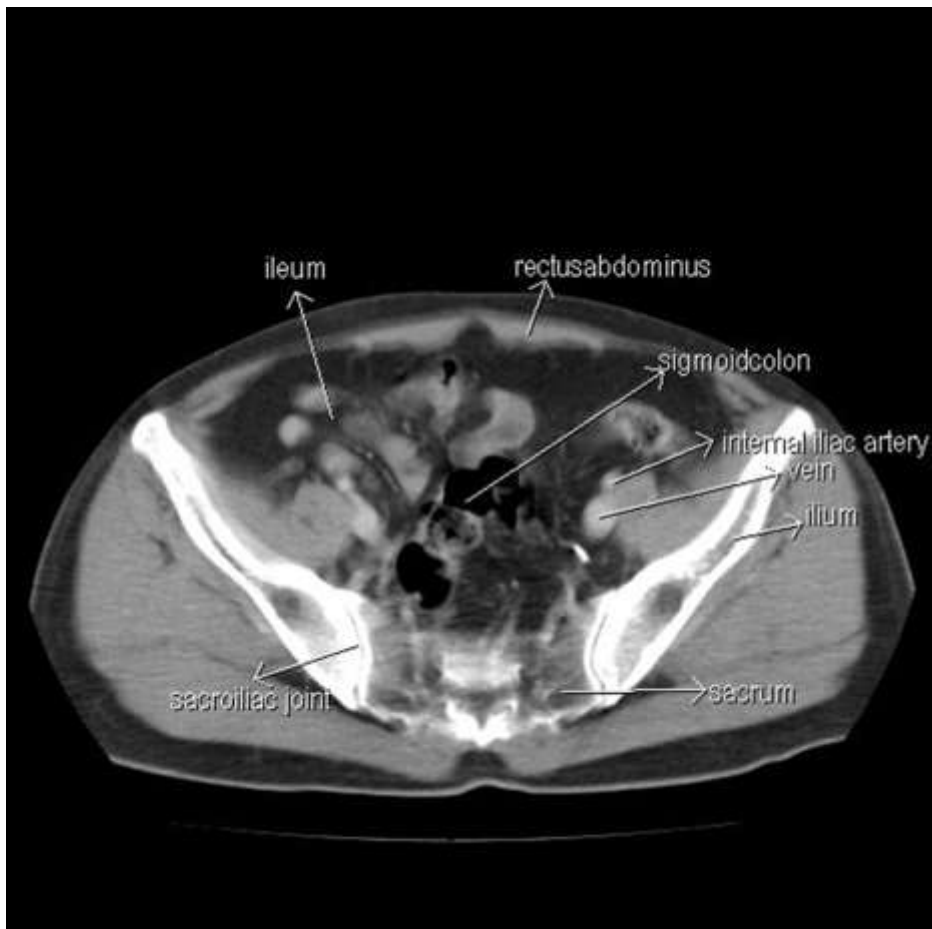


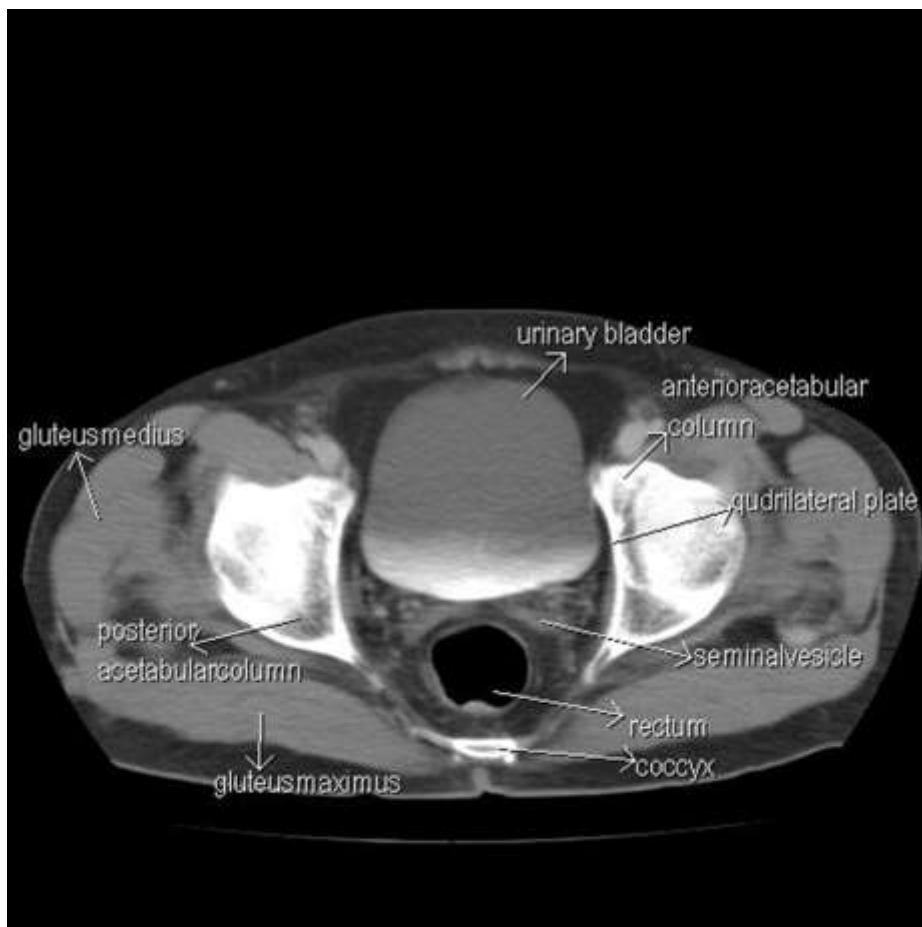


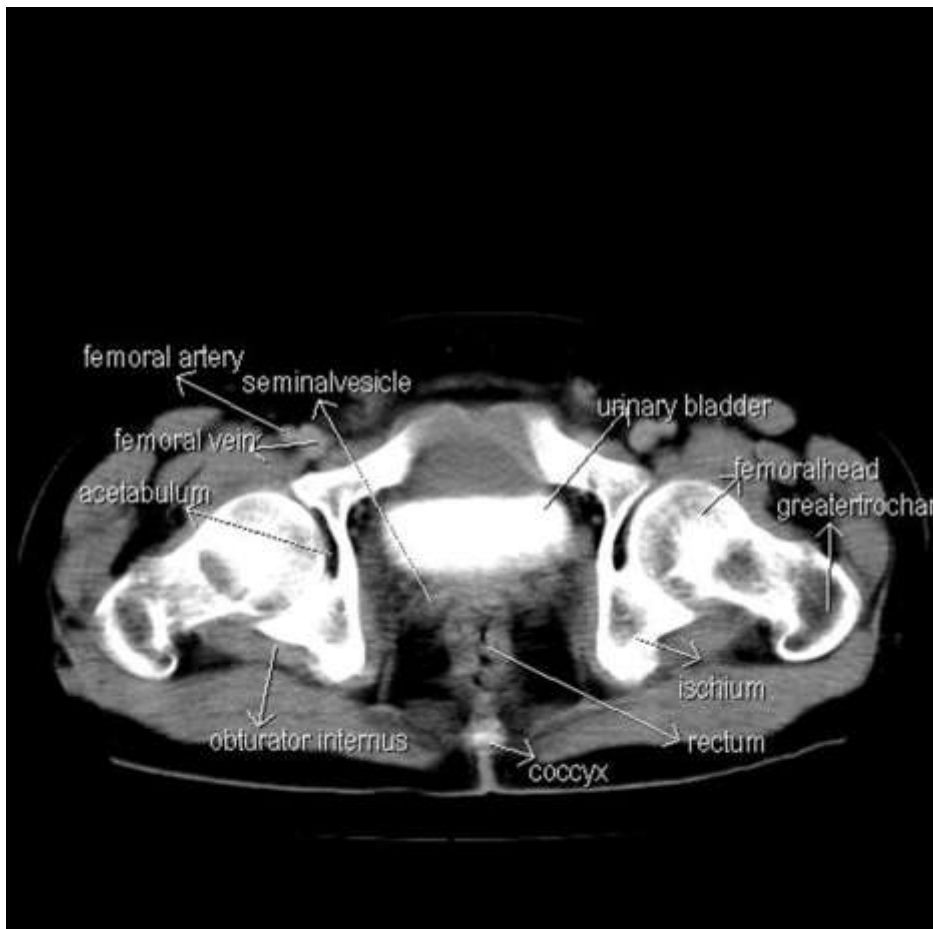


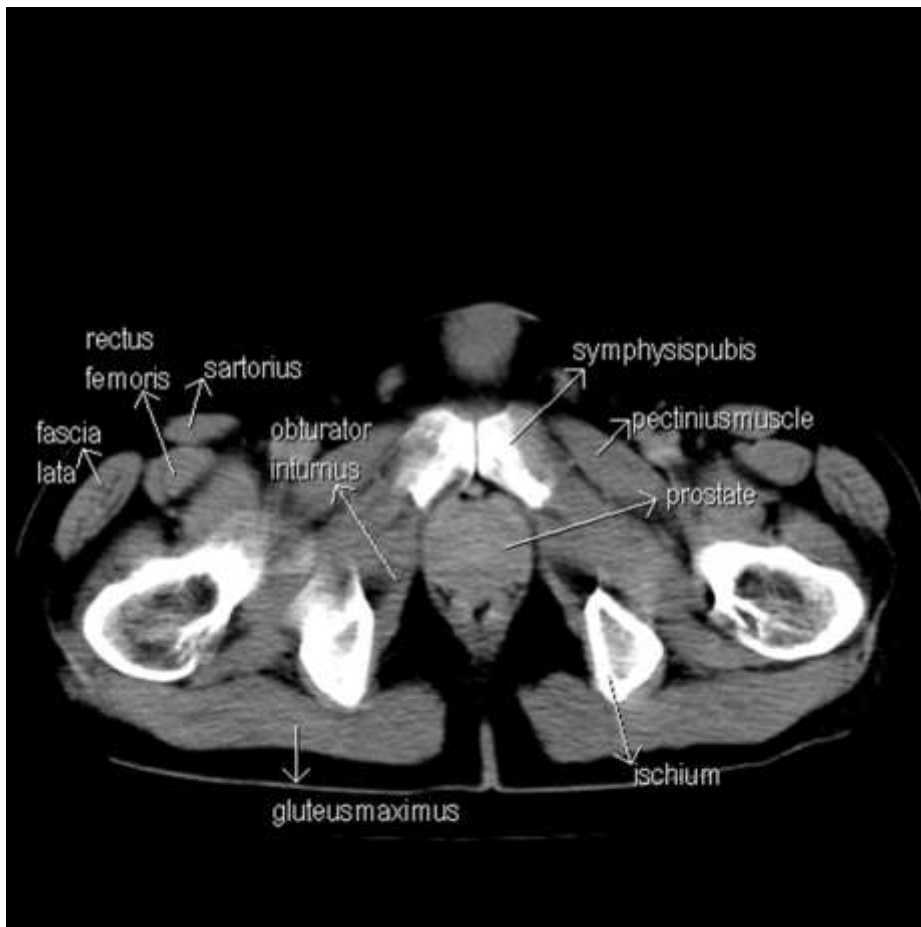




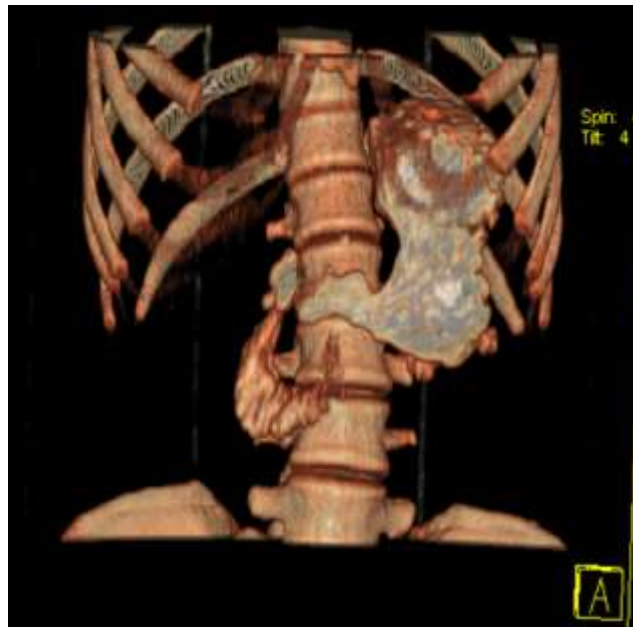


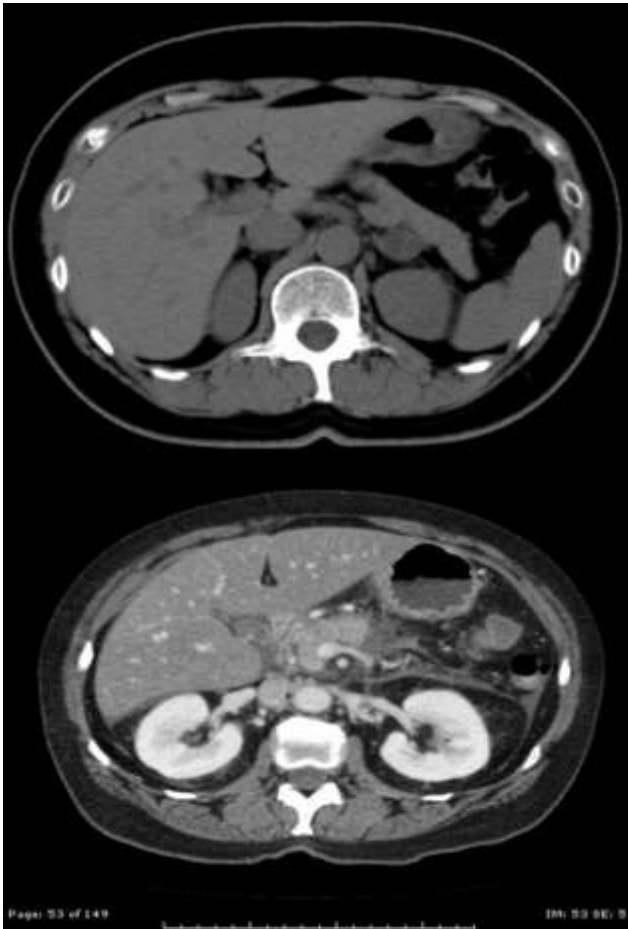






### ***CT 3D reconstruction***





CT of abdomen **without contrast**. Note the lack of distinction between abdominal organs.

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CT scan of abdomen **with intravenous contrast**.

Notice how much better you can see the kidneys and blood vessels.

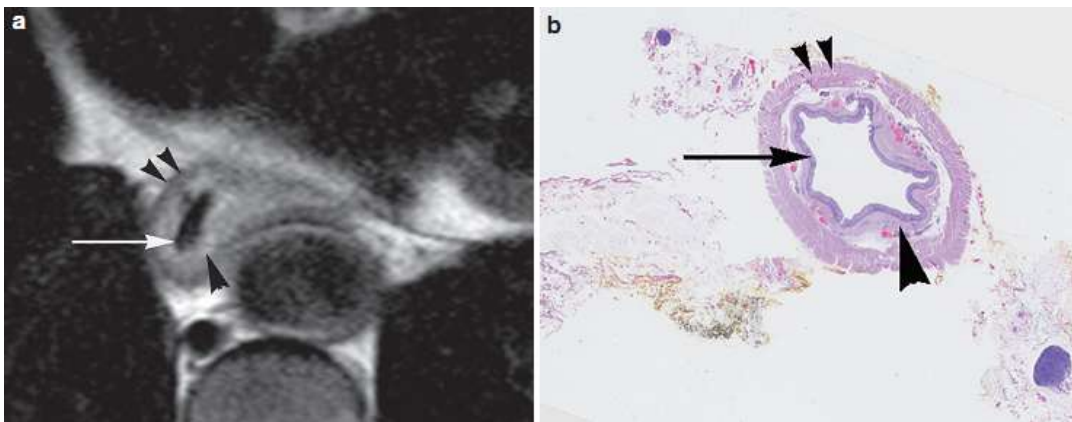


# MRI

Small/large bowel indications for MRI include:

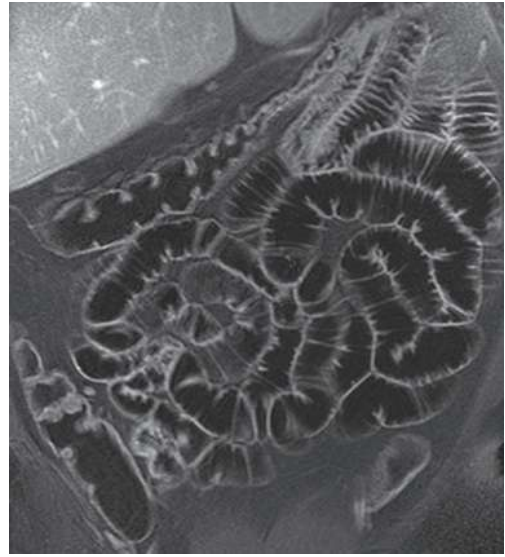
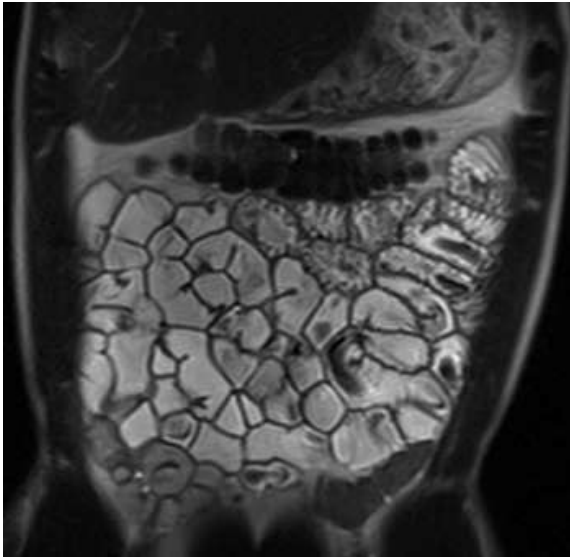
- inflammatory bowel disease,
- infectious disease including abscess evaluation or for appendicitis,
- ischemia,
- obstructions,
- neoplasm search,
- perianal fistulas
- pathology of the liver and gall bladder, pancreas, spleen, kidney

## The appearance of normal esophageal wall layers

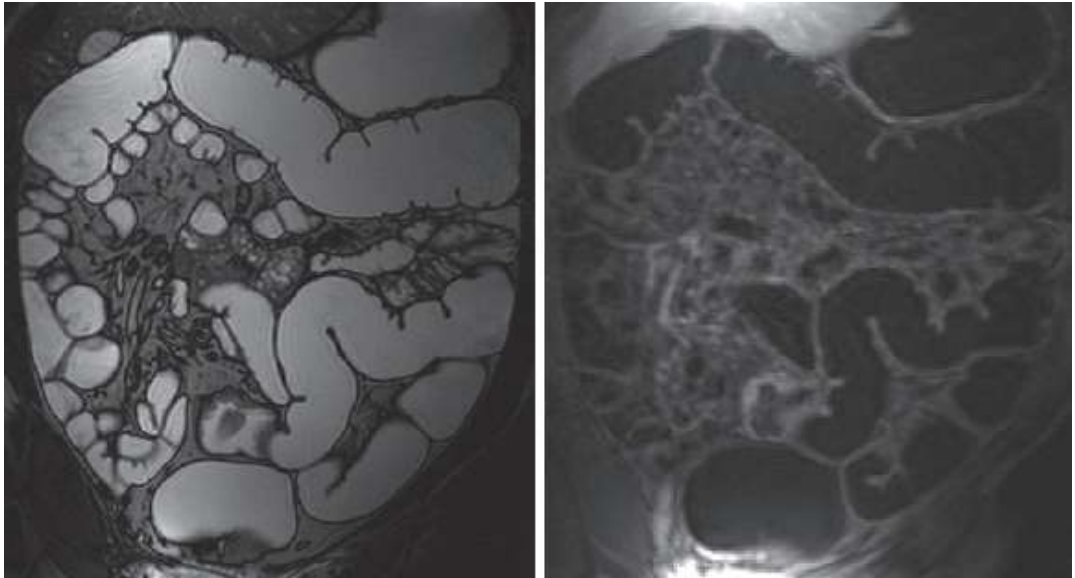


- a) The axial T2-weighted MRI image
- b) The layers on the corresponding histological section
  - The intermediate signal mucosa (arrow), the high signal submucosa (single arrow head) and the outer muscularis propria layer (double arrow heads)

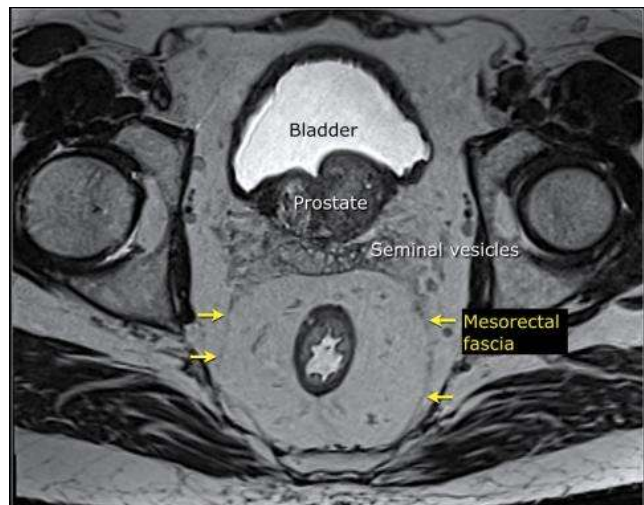
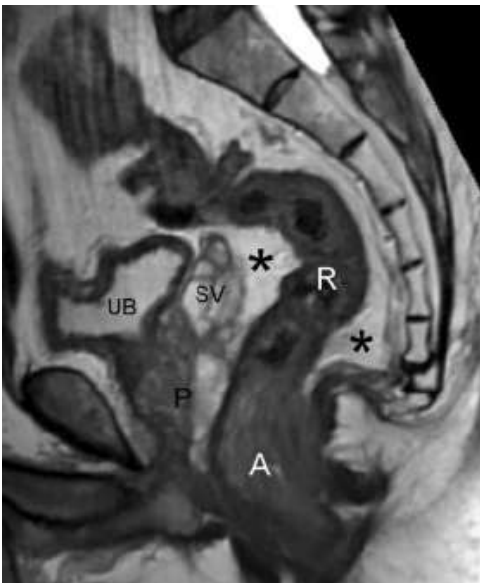
# MRI of the Small Bowel: Enterography



## **MRI of the Colon (MR Colonography)**

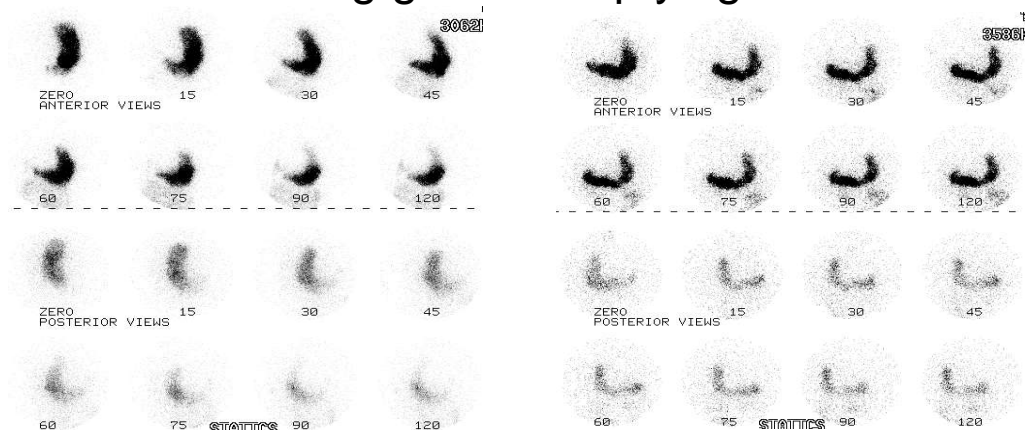


# MRI of the Rectum

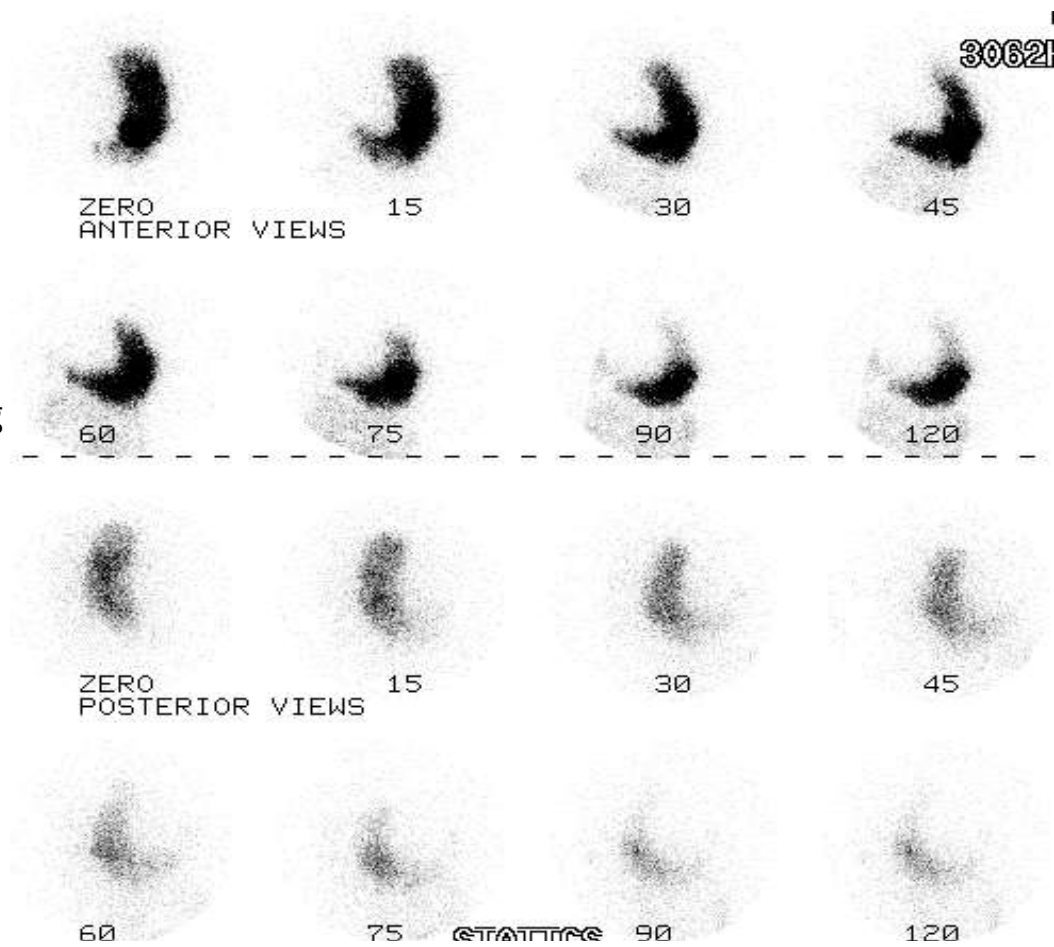


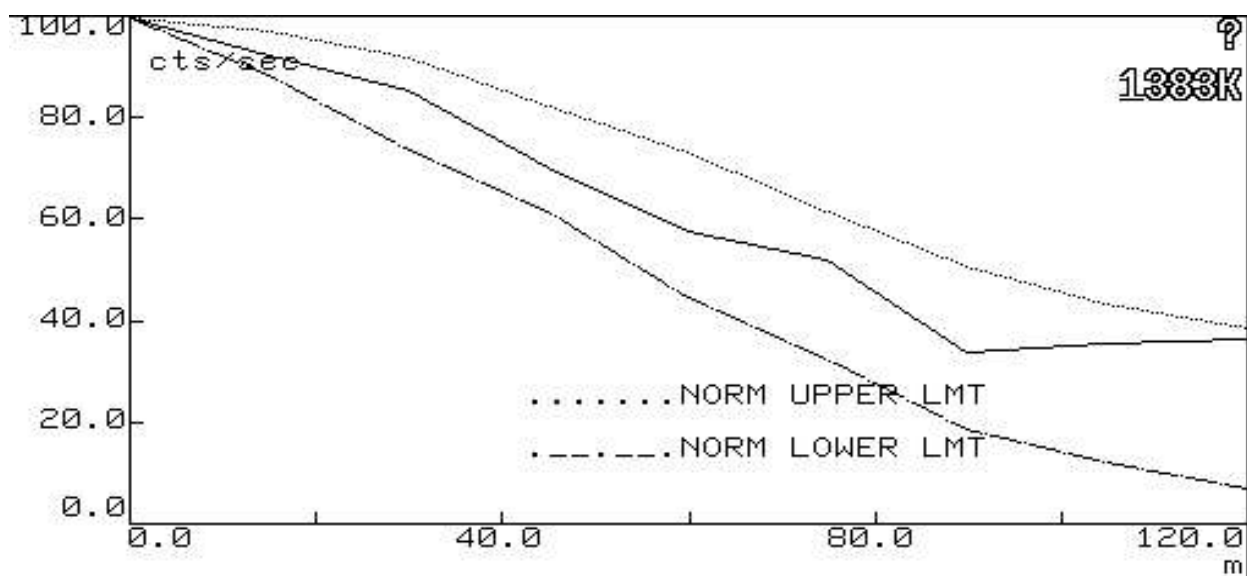
# Gastric emptying study

- **Scintigraphy with a radiolabeled test meal** represents the gold standard for evaluating gastric emptying in patients with dyspepsia, and evaluation of gastric function in various systemic diseases affecting gastric emptying.



# **Normal Gastric Emptying**





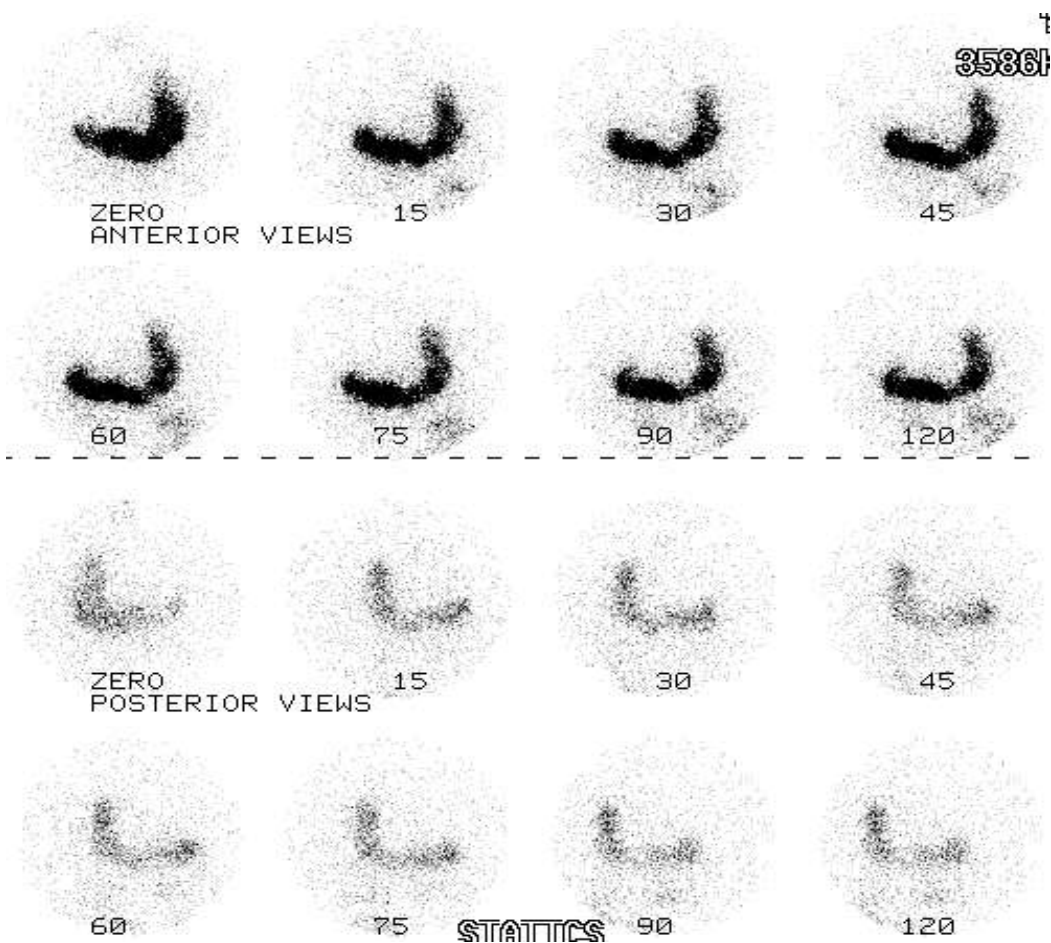
#### % EMPTYING

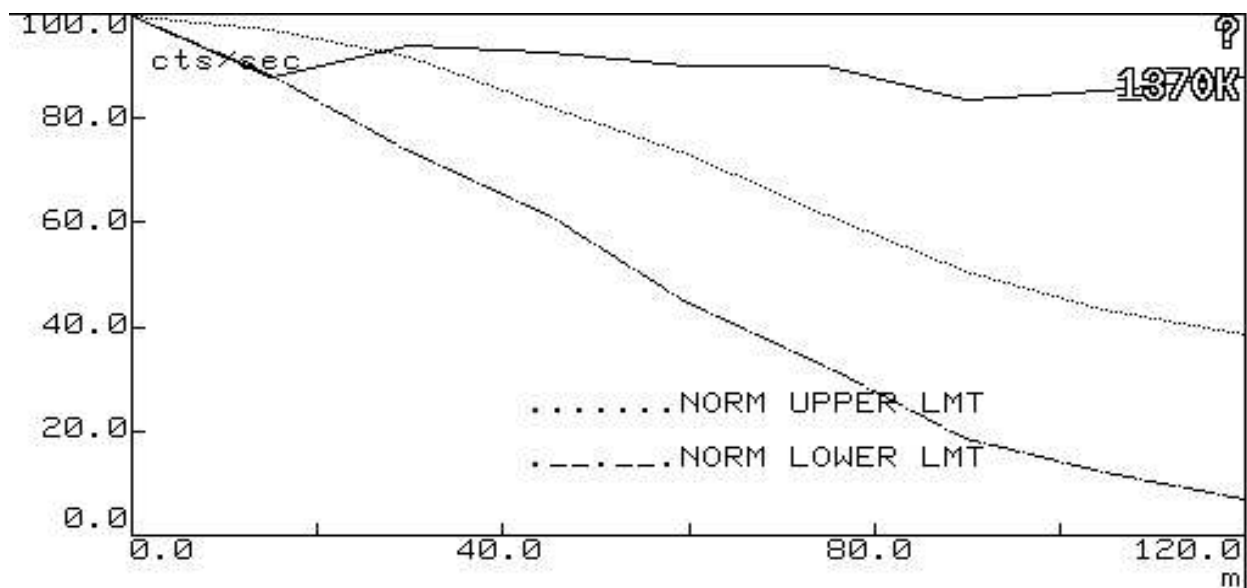
15 MIN:	7.4097
30 MIN:	14.508
45 MIN:	29.651
60 MIN:	42.068
75 MIN:	47.692
90 MIN:	66.172
105 MN:	64.466
120 MN:	63.468

Normal gastric emptying



# **Delayed Gastric Emptying**





#### % EMPTYING

15 MIN:	11.947
30 MIN:	6.0272
45 MIN:	7.1314
60 MIN:	9.7620
75 MIN:	9.6091
90 MIN:	16.379
105 MN:	14.630
120 MN:	12.000

**Delayed gastric emptying**