



كلية المأمون الجامعة
قسم تقنيات الأشعة

المرحلة الثانية

Special radiological procedures of gastrointestinal tract and bones

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MSc Medical Imaging / MRI Applications

1st
Semester

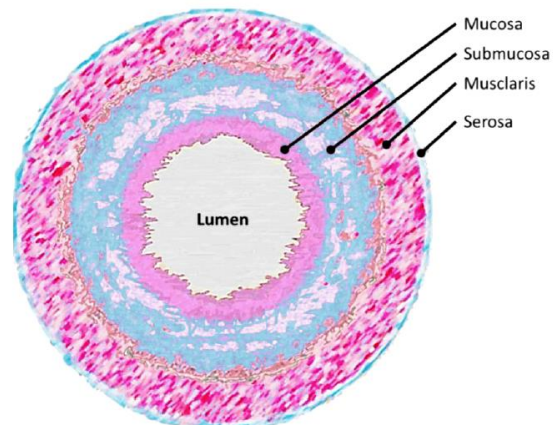
Lecture (2,3)

Methods of imaging of Gastrointestinal tract (GIT)

Part one (Anatomy)

The intestine **wall** consists of four main layers:

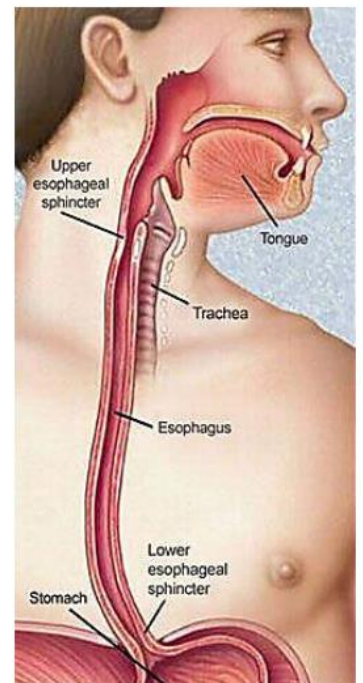
- 1- **Lumen**: The hollow cavity inside the intestine where food passes through.
- 2- **Mucosa**: The innermost layer, in direct contact with the lumen, involved in nutrient absorption and secretion.
- 3- **Submucosa**: A supportive layer containing blood vessels, nerves, and glands that nourish surrounding tissues and help in secretion.
- 4- **Muscularis**: Responsible for peristalsis, it consists of two muscle layers (circular and longitudinal) that move food along the digestive tract.
- 5- **Serosa**: The outermost protective layer, providing structural support and reducing friction with surrounding organs.



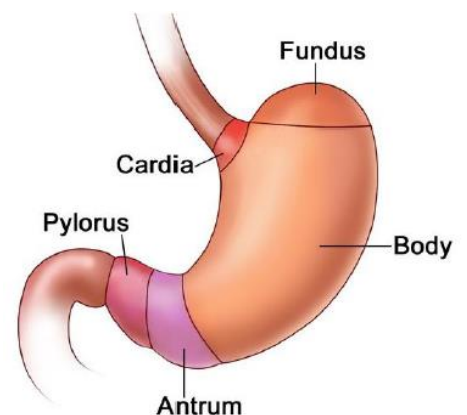
In radiology, the **mucosa and submucosa** are particularly important when assessing the gastrointestinal tract. Changes in the mucosa (such as **thickening, inflammation, or ulceration**) can indicate conditions like Crohn's disease, ulcers, or tumors. The submucosa is essential for detecting pathologies like edema or vascular abnormalities. In contrast studies (e.g., with barium or iodine), visualization of the mucosal pattern helps identify abnormalities in the intestinal lining.

GIT Parts:

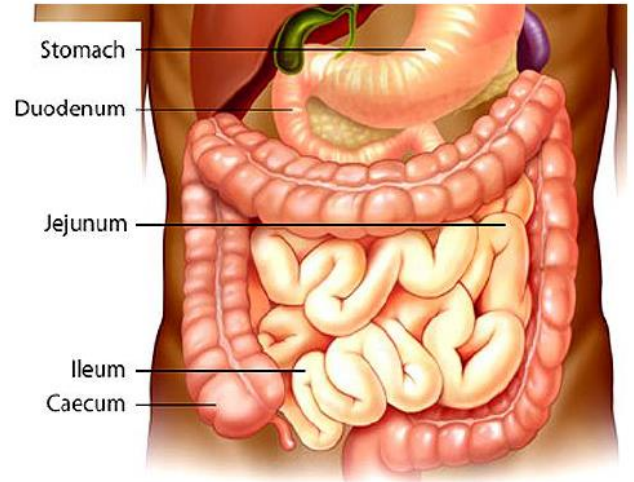
1- **The esophagus** is a muscular tube, about 25 cm long, connecting the throat (pharynx) to the stomach. It is located behind the heart and trachea and passes through the diaphragm before reaching the stomach. The esophagus has two muscular sphincters: the upper esophageal sphincter (UES) at the top, preventing food from entering the trachea, and the lower esophageal sphincter (LES) at the bottom, which prevents stomach acid from refluxing. It consists of three parts: cervical, thoracic, and abdominal.



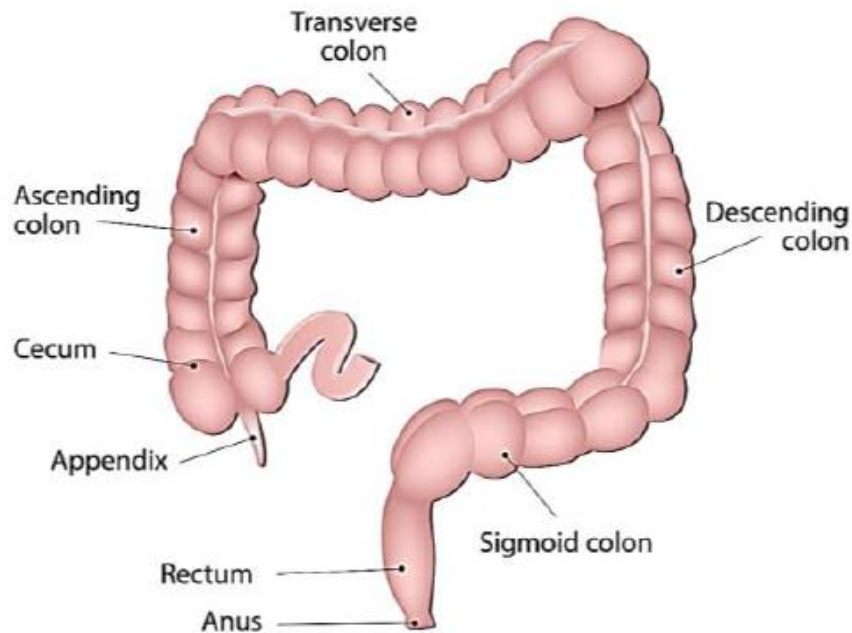
2- **The stomach**, a J-shaped intraperitoneal organ between the esophagus and duodenum, is located in the epigastric and umbilical regions. It has four main divisions: the cardia (T11 level), the gas-filled fundus, the large central body, and the pylorus, which connects to the duodenum via the pyloric sphincter.



3- The small intestine, the longest part of the digestive system, connects the stomach to the large intestine and consists of the duodenum, jejunum, and ileum. It completes digestion and absorbs nutrients. The duodenum receives digestive juices, the jejunum has rapid peristalsis, and the ileum has slower movements with a narrower lumen.



4- The colon, or large intestine, plays a crucial role in the digestive system by reabsorbing water, maintaining fluid balance, absorbing vitamins, processing undigested food, and storing waste. It extends from the cecum to the anus and consists of four regions: the ascending colon, transverse colon, descending colon, and sigmoid colon, which connects to the rectum for waste elimination.



Part two (GIT Pathology aspects)

- 1- **Inflammatory bowel disease:** conditions such as ulcerative colitis and Crohn's disease can affect the colon, and also increase the risk of developing colon cancer.
- 2- **Diverticulitis** (pronunciation: Diver-tic – lytis): tiny sacs called diverticula can develop along the colon .
- 3- **Bowel obstruction:** can either be loss a mechanical or functional of the small or large intestines. The obstruction occurs when the lumen of the bowel becomes either partially or completely blocked.
- 4- **Dysphagia:** the peristalsis in the esophagus is affected, with difficult in swallow.
- 5- **Gastric ulcer** (stomach ulcer): An erosion in the lining of the stomach, often causing pain and/or bleeding. Gastric ulcers are most often caused by Non-steroidal anti-inflammatory drug or *H. pylori* infection.
- 6- **Peptic ulcer:** common term to describe the ulcer in duodenum.
- 7- **Gastritis:** Inflammation of the stomach. - **Hiatus hernia:** is when part of stomach moves up into chest through the diaphragm.
- 8- **Gastro esophageal reflux:** stomach contents, including acid, can travel backward up the esophagus.
- 9- **Gastro esophageal reflux disease (GERD):** When symptoms of reflux become bothersome or occur frequently, they're called GERD.
- 10- **Dyspepsia:** Another name for stomach upset or indigestion. - **Irritable bowel syndrome (IBS):** is hyper motility, hypo motility, or both in succession in bowel. Symptoms can include diarrhea or constipation.
- 11- **Helicobacter pylori (*H. pylori*):** is a type of bacteria that causes infection in the stomach. It is the main cause of peptic ulcers, and it can also cause gastritis and stomach tumor.

Part three GIT X- ray Imaging

Imaging of the gastrointestinal tract (GIT) using barium and water-soluble contrast agents provides detailed visualization of various segments of the digestive system. Here's an overview of the primary imaging methods used, categorized by the type of contrast agent employed:

1. Barium-based Contrast Agents:

Barium sulfate is a radiopaque substance commonly used to visualize the GIT in X-ray or fluoroscopy examinations. Barium provides excellent contrast in imaging due to its high density, which helps in outlining the structures of the GIT.

a. Barium Swallow:

- Purpose: Used to evaluate the esophagus, detecting abnormalities like strictures, tumors, ulcers, and motility disorders (e.g., achalasia).*
- Procedure: The patient swallows a barium solution, and a series of X-rays or fluoroscopic images are taken as the contrast passes through the esophagus.*

b. Barium Meal:

- Purpose: Imaging of the stomach and duodenum to assess for conditions such as peptic ulcers, tumors, and hiatal hernia.*
- Procedure: After ingesting barium, fluoroscopic images are taken as the contrast passes through the stomach and upper duodenum.*

c. Barium Follow-through (Small Bowel Follow-through):

- Purpose: Used to visualize the small intestine and diagnose conditions like Crohn's disease, small bowel obstructions, or tumors.*
- Procedure: After swallowing barium, X-rays are taken at intervals to track the passage of contrast through the small intestine.*

d. Barium Enema:

- Purpose: This technique is used to evaluate the large intestine (colon) for conditions such as tumors, diverticulosis, polyps, and inflammatory bowel diseases.*

- *Procedure: Barium is introduced into the colon through a rectal enema, and X-ray images are taken to visualize the contours and abnormalities in the colon.*

2. Water-soluble Contrast Agents:

*Water-soluble contrast agents, such as Gastrografin or Omnipaque, are iodinated contrast media used when there's a risk of **perforation** or when barium is contraindicated (e.g., suspected bowel perforation or risk of aspiration).*

a. Water-Soluble Swallow Study:

- *Purpose: Similar to the barium swallow, but used when there's a concern for esophageal perforation or aspiration.*

- *Procedure: The patient swallows a water-soluble contrast agent, and fluoroscopic images are taken to assess the esophagus and stomach.*

b. Water-Soluble Contrast Enema:

Purpose: Used to evaluate the colon in cases where barium is contraindicated, particularly when a bowel perforation is suspected.

Procedure: Water-soluble contrast is introduced into the colon via an enema, and images are obtained to assess the colon.

c. Gastrointestinal Follow-through with Water-Soluble Contrast:

- *Purpose: Water-soluble contrast agents are sometimes used in place of barium for small bowel imaging, particularly in patients with a risk of perforation or post-operative leaks.*

- *Procedure: The contrast is administered orally or through a nasogastric tube, and X-rays are taken to visualize the flow through the intestines.*

3. Double-Contrast Studies:

In some cases, both barium and air or gas are used in combination to provide a more detailed view of the mucosal surfaces.

a. Double-Contrast Barium Enema:

- Purpose: Provides more detailed imaging of the large intestine by using both barium and air, enhancing mucosal detail for detecting polyps, tumors, or diverticula.

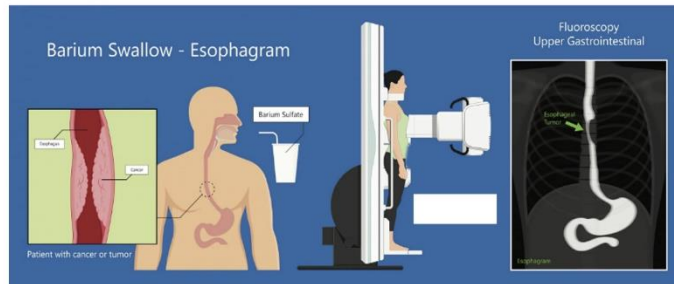
- Procedure: After administering barium, air is introduced into the colon to distend it, allowing for clearer imaging of the mucosa.

Advantages of Barium and Water-Soluble Contrast Agents:

Barium Contrast: Preferred for routine imaging of the GIT because it provides excellent contrast and detail, especially for detecting structural abnormalities. However, barium should not be used if there is a suspicion of perforation.

b. Water-Soluble Contrast Agents: *These are safer in cases where there's a risk of perforation or aspiration, as they are absorbed and excreted safely by the body if they leak into the peritoneum or are aspirated into the lungs.*

BARIUM SWALLOW



► **Barium swallow** is a dedicated test of the pharynx, esophagus, and proximal stomach, and may be performed as a single or double contrast study. It is often useful to evaluate the entire pathway from the lips to the gastric fundus. Barium swallow have two types :

- 1- Conventional Ba. Swallow .
- 2- Modified Ba. Swallow .

► **Modified Barium Swallows** a fluoroscopic procedure designed to determine anatomical and physiological structures of pharynx, epiglottis and larynx (dysphasia assessment , dysphagia disorders evaluation) .

► **Indications**

- ✓ high or low dysphagia.
- ✓ gastro-esophageal reflux disease (GERD).
- ✓ assessment of a hiatus hernia.
- ✓ generalized epigastric pain.
- ✓ persistent vomiting.
- ✓ assessment of fistula (use iodine CM replace of Barium)
- ✓ Achalasia.
- ✓ Ulcer.
- ✓ Structural problems, such as pouches (diverticula), narrowing (strictures), or growths (polyps)

▶ **Contrast media**

Because the thin-walled alimentary canal does not have sufficient density to be shown through the surrounding structures, demonstration of it on radiographic images requires the contrast medium. Barium sulfate, which is a water-insoluble salt of the barium. The barium sulfate used for this purpose is a specially prepared, chemically pure product to which various chemical substances have been added. Barium sulfate is available as a dry powder or as a liquid. The powdered barium has different concentrations and is mixed with plain water. The concentration depends on the part to be examined and the preference of the physician.

▶ **Barium media consecration :**

- Thin liquid : general examination .
- Thick liquid : mucosa pattern assessment and mass ; tumor evaluation .

▶ **Pre Examination technique:**

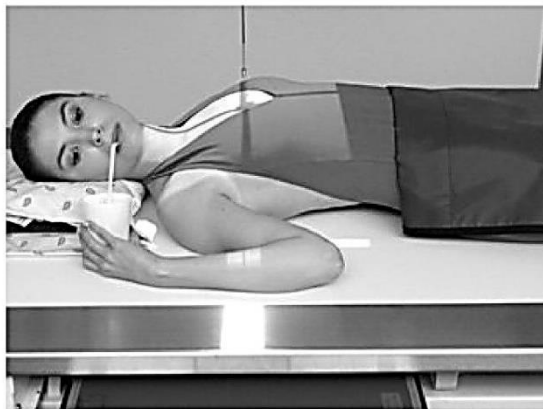
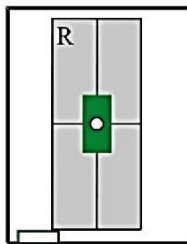
depends on the indication of the study. Preparation needed for study is fasting (4- 6 hours), avoiding smoking or chewing gum to decrease the secretions in the oral cavity and pharynx.

▶ **Examination technique :**

The radiologist or technologist asks the patient to swallow several mouthfuls of the barium so that the act of deglutition can be observed to determine whether any abnormality is present. The radiologist instructs the patient to perform various breathing maneuvers under fluoroscopic observation so that spot images of areas or lesions which can't obtain from conventional procedure.

► **Examination positions :**

AP (PA): Esophagogram



- 35 × 43 cm (14 × 17") portrait
- Grid

Position

- Supine or erect; supine preferred (may be performed PA if erect)
- Center patient to midline of table
- Left arm at side, holding cup with right hand, straw in mouth
- (5 cm) above level of shoulder

Central Ray: at T6 level)

SID: (102 cm)

Collimation: To area of interest [12–15 cm] wide

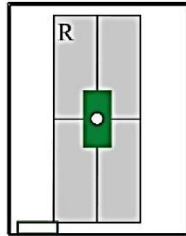
Respiration: With thin barium, expose while patient is swallowing (after 3 or 4 swallows). With thick barium, expose immediately after patient swallows

Fig. 9.25 AP esophagogram (barium swallow).

kV Range:

Analog and Digital Systems: 110–125 kV

Lateral : Esophagogram



- 35 × 43 cm (14 × 17") portrait
- Grid

Position

- Recumbent or erect; recumbent preferred
- Right lateral position, right arm and shoulder up and forward (holding cup)
- Center midcoronal plane to centerline
- (5 cm) above top of shoulder

Central Ray: at T6 level)

SID: (102 cm)

Collimation: To area of interest [12–15 cm] wide.

Respiration: With thin barium, expose while patient is swallowing (after 3 or 4 swallows). With thick barium, expose immediately after patient swallows. patient generally does not breathe immediately after a swallow.

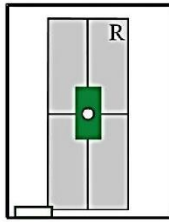


Fig. 9.22 R lateral esophagogram (barium swallow).

kV Range:

Analog and Digital Systems: 110–125 kV

RAO : Esophagogram



- 35 × 43 cm (14 × 17") portrait
- Grid

Position

- Recumbent or erect, recumbent preferred for more complete filling of esophagus
- Rotate 35°–40° from prone position onto right side, right arm down, left arm up; hold cup with left hand, straw in mouth
- Center thorax to centerline
- (5 cm) above level of shoulder

Central Ray: at T6 level)

SID: (102 cm)

Collimation: To area of interest [12–15 cm] wide

Respiration: With thin barium, expose while swallowing (after 3 or 4 swallows). With thick barium, expose immediately after swallowing. patient generally does not breathe immediately after a swallow.

kV Range:

Analog and Digital Systems: 110–125 kV



Fig. 9.21 35°–40° RAO for esophagus (barium swallow).

Comparison Esophagogram Positions / projections

AP Esophagogram

This position allows visualization of the esophagus from the front (or from the back when standing). The esophagus is imaged in a straight projection to obtain a clear alignment between the esophagus and the vertebral column. Advantages:

- Provides a comprehensive view of the esophagus from top to bottom.
- It is typically used to detect strictures, obstructions, or the presence of a hiatal hernia.

Lateral Esophagogram

This position provides a lateral view of the esophagus, allowing the surgeon or physician to observe the relationship between the esophagus, vertebral column, and other adjacent structures with greater precision. Advantages:

- *Primarily used to assess lateral changes in the esophagus, such as twists or strictures that may not be visible in anterior-posterior images.*
- *Allows for the evaluation of esophageal dilation or the presence of leakage.*

RAO (Right Anterior Oblique) Esophagogram

This position provides an oblique angle view of the esophagus, which helps to separate the esophagus from the vertebral column in the image. This results in a clearer visualization of structures that may be hidden behind the vertebral column in AP or PA positions. Advantages:

- *Excellent for revealing details not clearly visible in other positions, especially when there is overlap between the esophagus and other structures such as the aorta or vertebrae.*
- *Used to detect curvatures or issues related to esophageal motility or function during swallowing*

