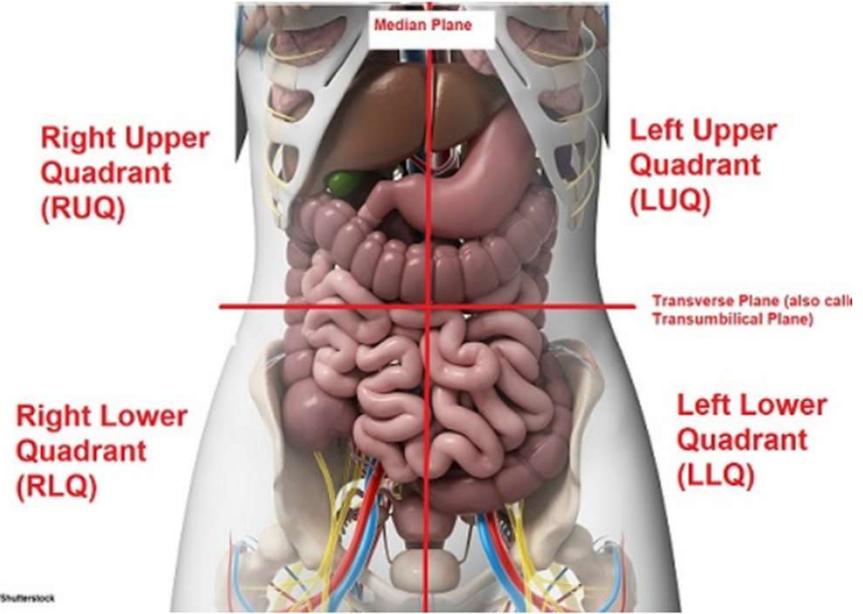
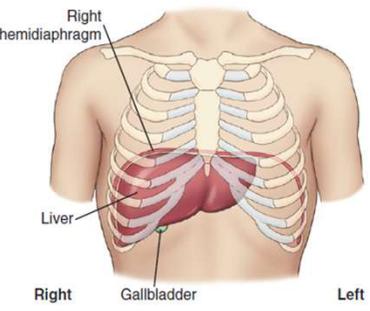
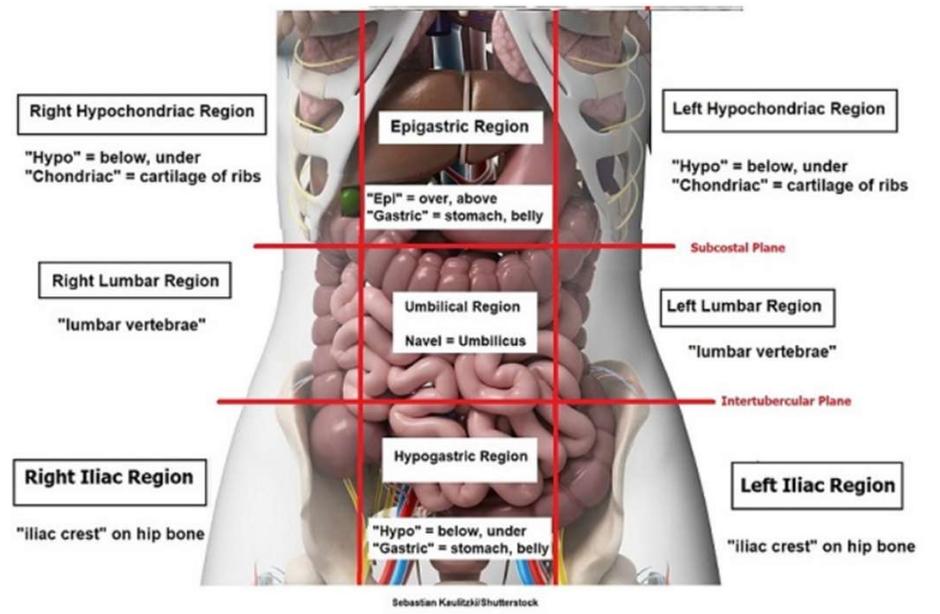


# Biliary Tract and Upper GI system

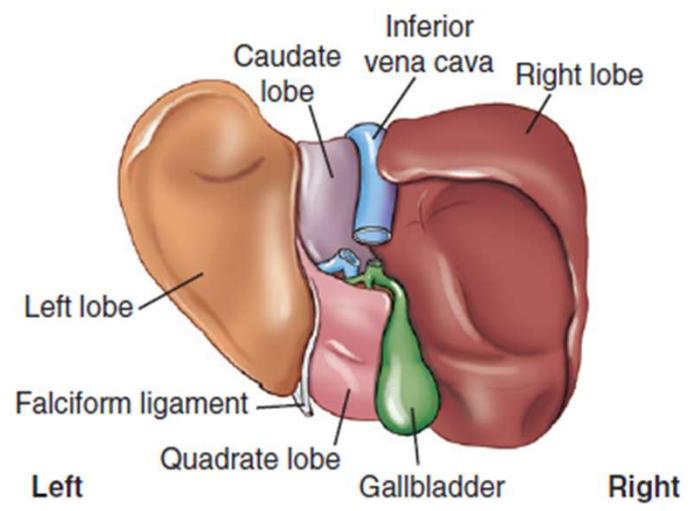
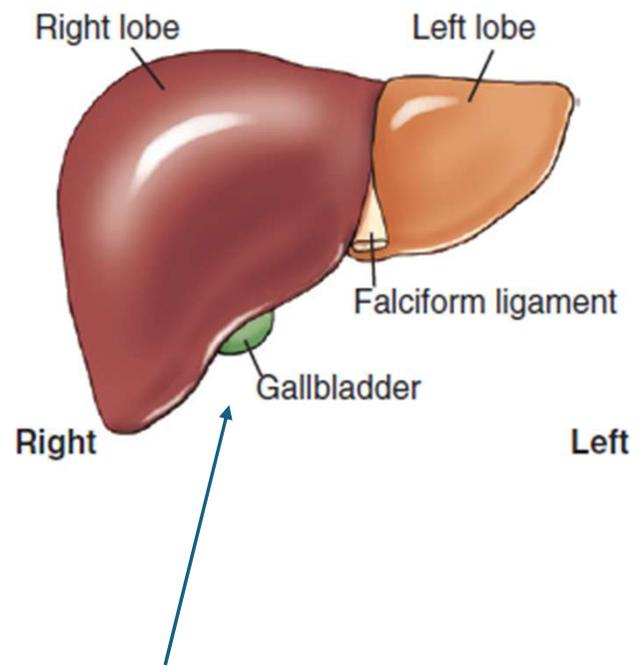
RADIOGRAPHIC ANATOMY



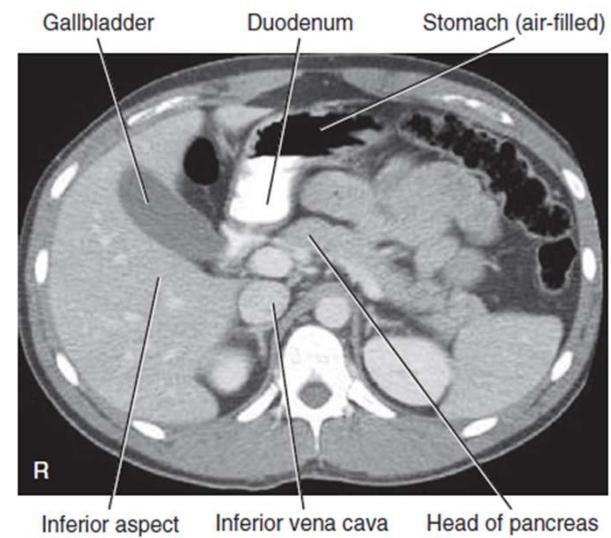
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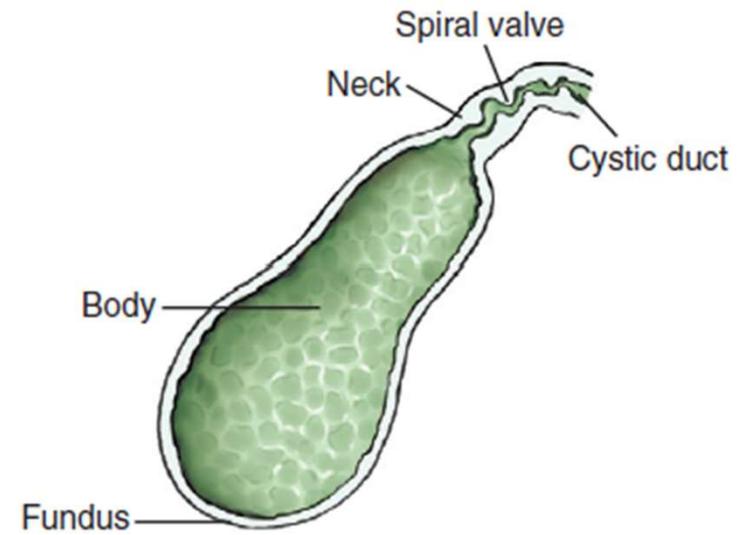
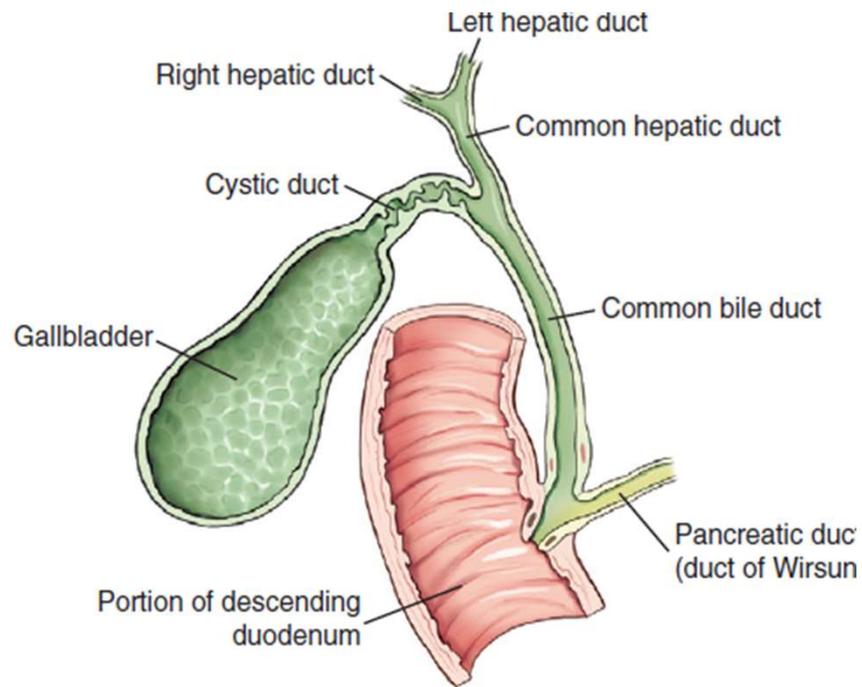
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- Liver secretes 800 to 1000 mL of bile per day.
- Bile aids in the digestion of fats by emulsifying (breaking down) fat globules and the absorption of fat
- Bile also contains cholesterol, which the bile salts make soluble in the bile.

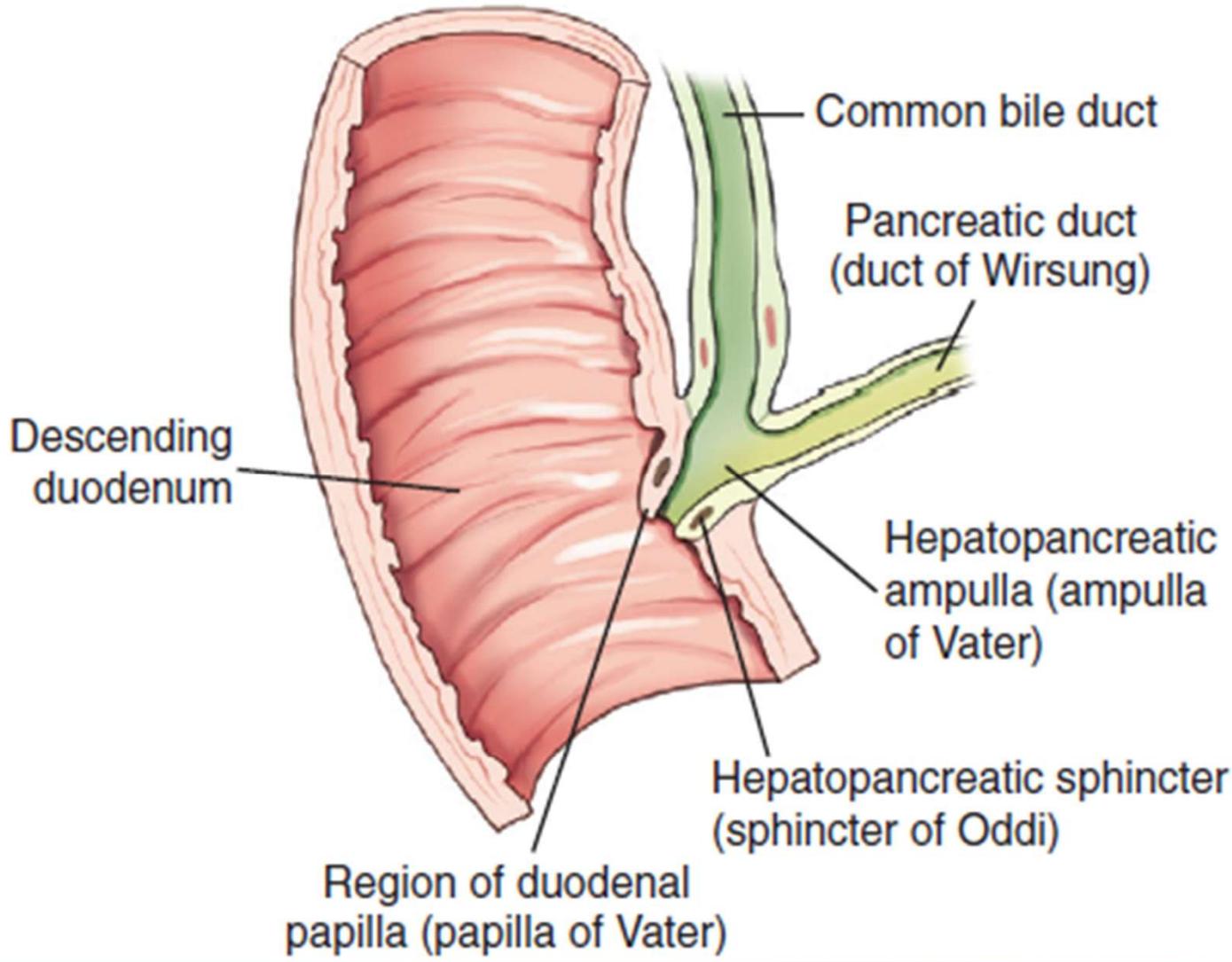


# Gallbladder and Biliary Ducts



# GB Functions

- The three primary functions of the gallbladder
  1. store bile: If bile is not needed for digestive purposes
  2. concentrate bile: as a result of hydrolysis
    - Too much water is absorbed → cholesterol becomes too concentrated → gallstones (choleliths) may form GB
  3. contract when stimulated:
    - foods stimulate the duodenal mucosa to secrete the hormone cholecystokinin
    - (CCK).
    - High levels of CCK in the blood cause the gallbladder to contract and the terminal opening of the common bile duct to relax.
    - CCK causes increased exocrine activity by the pancreas.



## BILIARY TERMINOLOGY

### TERM

### MEANING

Chole- (*ko'-le*)

Prefix denoting relationship to bile

Cysto- (*sis'-to*)

Prefix denoting sac or bladder

Cholangiogram (*ko-lan'-je-o-gram''*)

Radiographic examination of biliary ducts

Cholecystocholangiogram  
(*ko''-le-sis''-to-ko-lan'-je-o-gram*)

Study of both the gallbladder and the biliary ducts

Choleliths (*ko'-le-liths*)

Gallstones

Cholelithiasis (*ko''-le-li-thi'-ah-sis*)

Condition of having gallstones

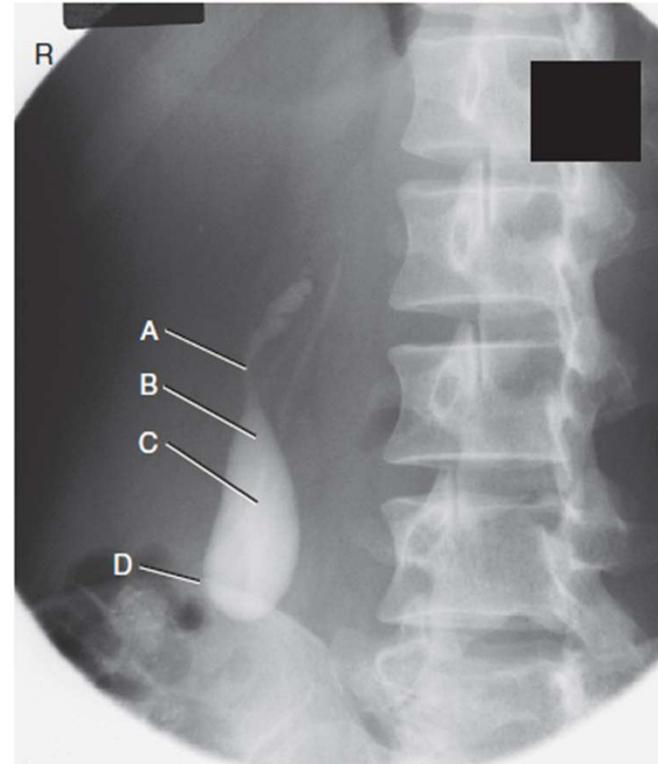
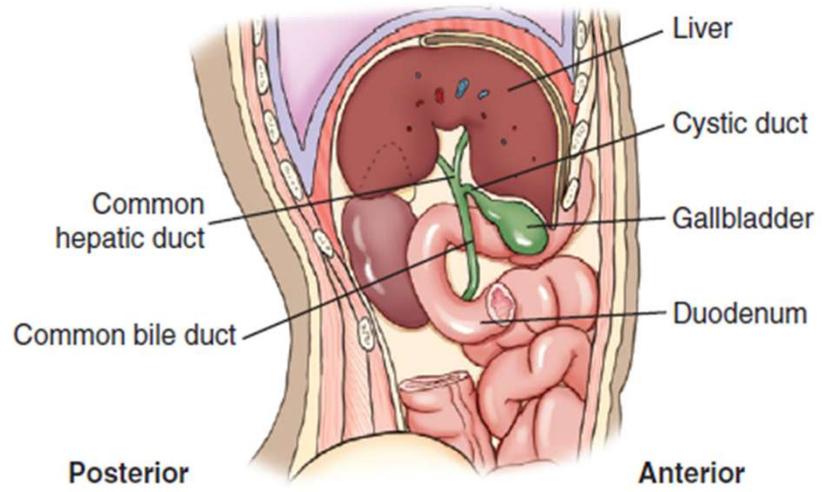
Cholecystitis (*ko''-le-sis-ti'-tis*)

Inflammation of the gallbladder

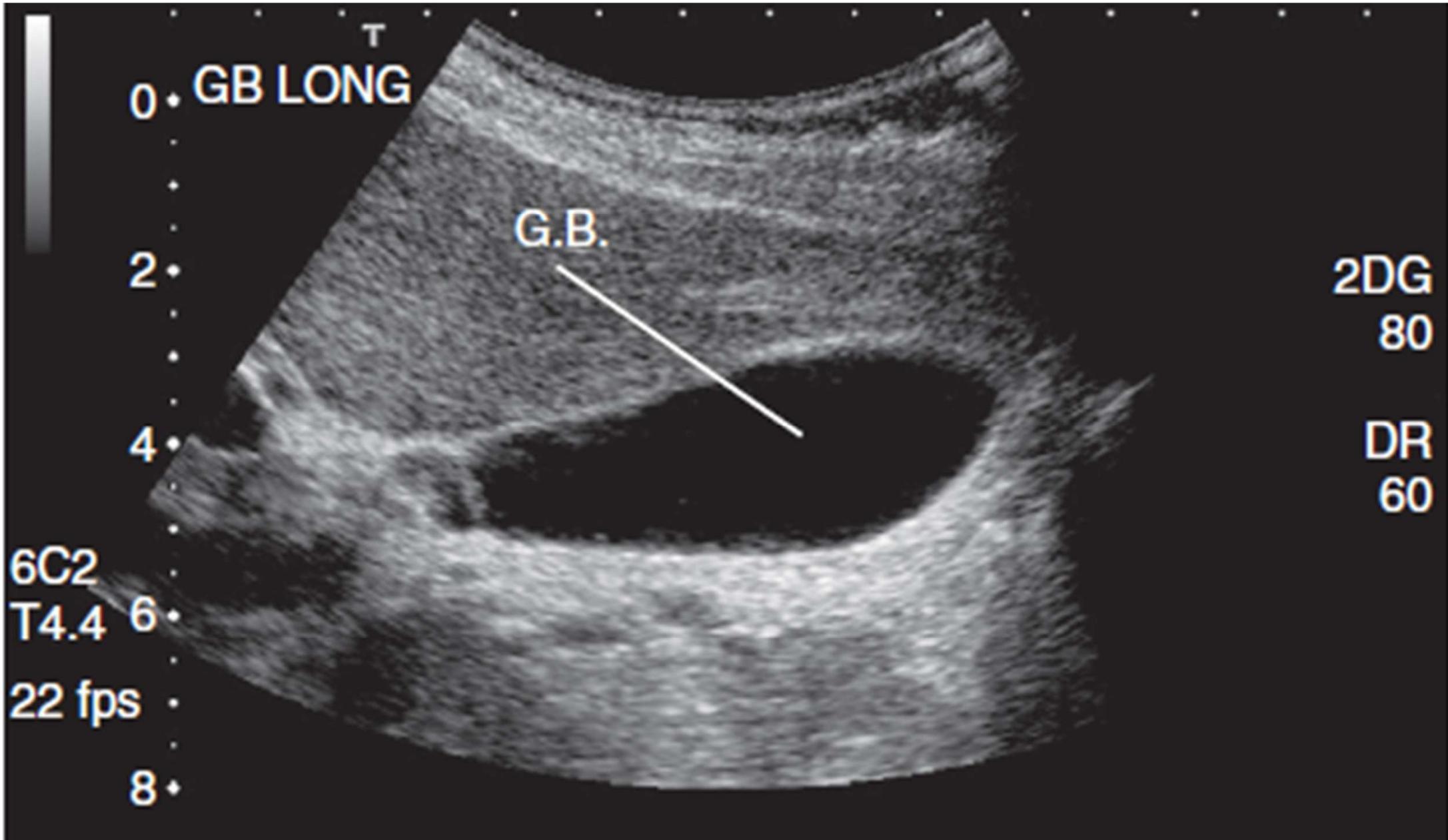
Cholecystectomy  
(*ko''-le-sis-tek'-ta-me*)

Surgical removal of gallbladder

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Oral cholecystogram; 35° to 40° LAO position.



0 • GB LONG

G.B.

2DG  
80

DR  
60

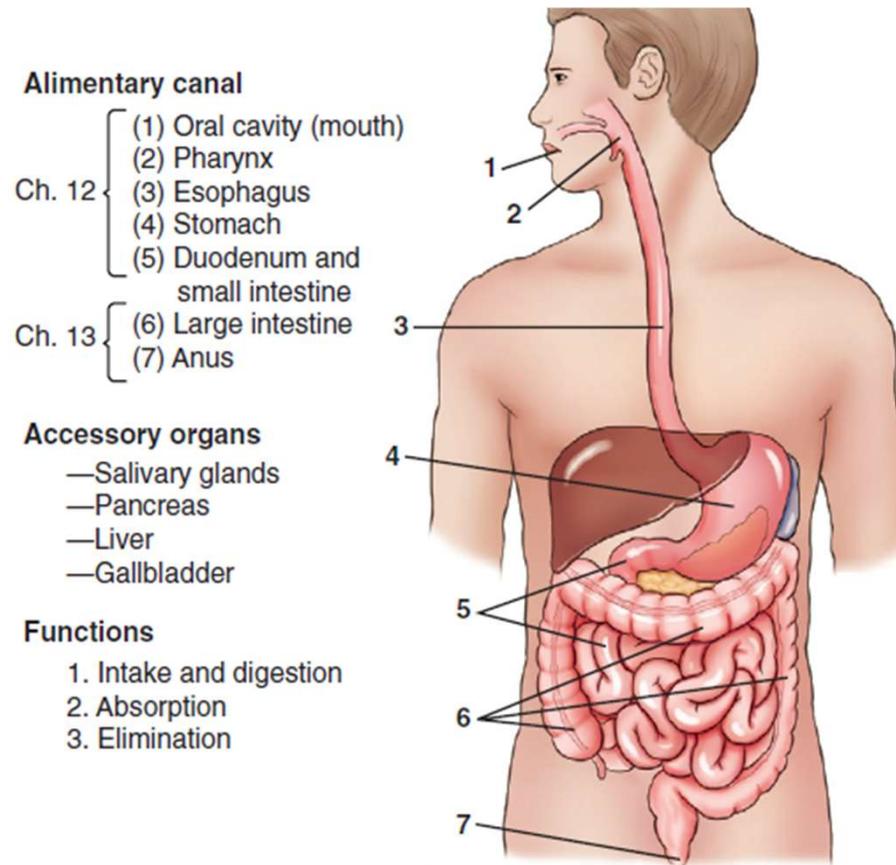
6C2  
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**SUMMARY OF CLINICAL INDICATIONS—GALLBLADDER AND BILIARY TRACT RADIOGRAPHY**

| <b>CONDITION OR DISEASE</b>              | <b>MOST COMMON RADIOGRAPHIC EXAMINATION</b>           | <b>POSSIBLE RADIOGRAPHIC APPEARANCE</b>   | <b>EXPOSURE FACTOR ADJUSTMENT</b> |
|--|---|---|-----------------------------------|
| Cholelithiasis (stones in gallbladder)   | Sonography  | Both radiolucent and radiopaque densities seen in the region of the gallbladder; "shadowing" effect with ultrasound; failure to accumulate radionuclide within gallbladder <sup>†</sup> | None                              |
|  | ERC   |   |                                   |
|  | Operative cholangiography                             |   |                                   |
| Cholelithiasis (stones in biliary ducts) | Sonography  | Enlargement or narrowing of biliary ducts owing to presence of stones   | None                              |
|  | Cholescintigraphy (radionuclide studies) <sup>†</sup> |   |                                   |
| Acute cholecystitis                      | Sonography  | Thickened wall of gallbladder with ultrasound; failure to accumulate radionuclide within gallbladder <sup>†</sup>   | None                              |
|  | Cholescintigraphy (radionuclide studies) <sup>†</sup> |   |                                   |
| Chronic cholecystitis                    | Sonography  | Calcified plaques or calcification of wall of gallbladder   | None                              |
| Neoplasms                                | Sonography  | Mass seen within gallbladder, liver, or biliary ducts; extensive calcification of gallbladder wall  | None                              |
|  | CT  |   |                                   |
| Biliary stenosis                         | Operative cholangiogram<br>ERC                        | Elongation, tapering, and narrowing of common bile duct   | None                              |

# Digestive system



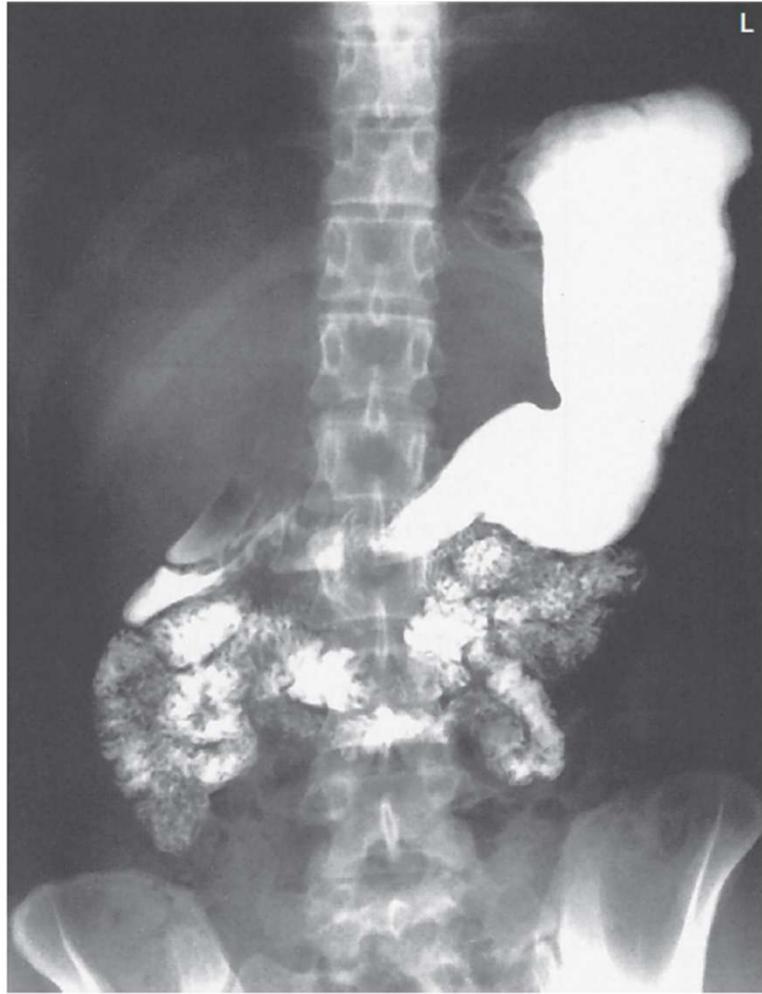
## COMMON RADIOGRAPHIC PROCEDURES

### ➤ Esophagogram or Barium Swallow (Study of Pharynx and Esophagus)

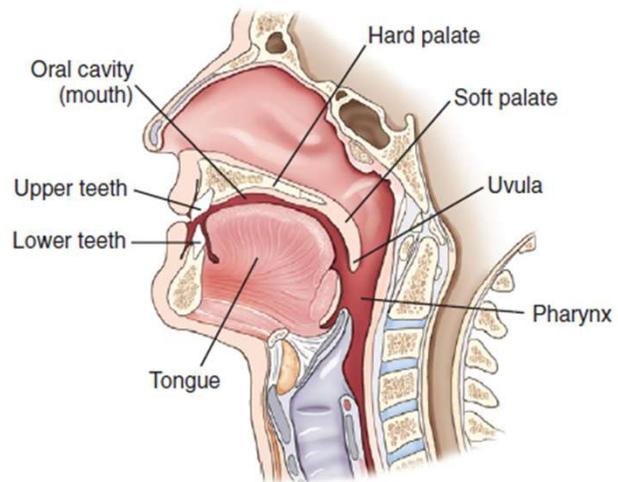
- A radiographic examination specifically of the pharynx and esophagus
- is termed an esophagogram, or barium swallow.
- studies the form and function of the swallowing aspect of the pharynx and esophagus.

### ➤ Upper Gastrointestinal Series (Study of Distal Esophagus, Stomach, and Duodenum)

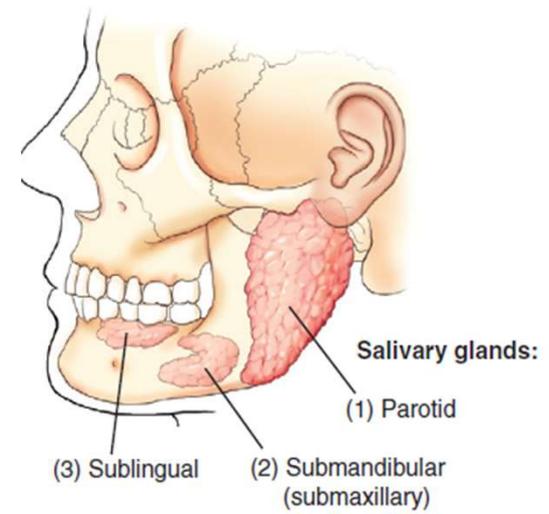
- The procedure designed to study the distal esophagus, stomach, and duodenum in one examination (UGI, upper GI).
- Barium sulfate mixed with water is the preferred contrast medium for the entire alimentary canal



PA—upper GI series (barium in stomach and duodenum).



**Fig. 12-13** Midsagittal section of mouth (oral or buccal cavity).



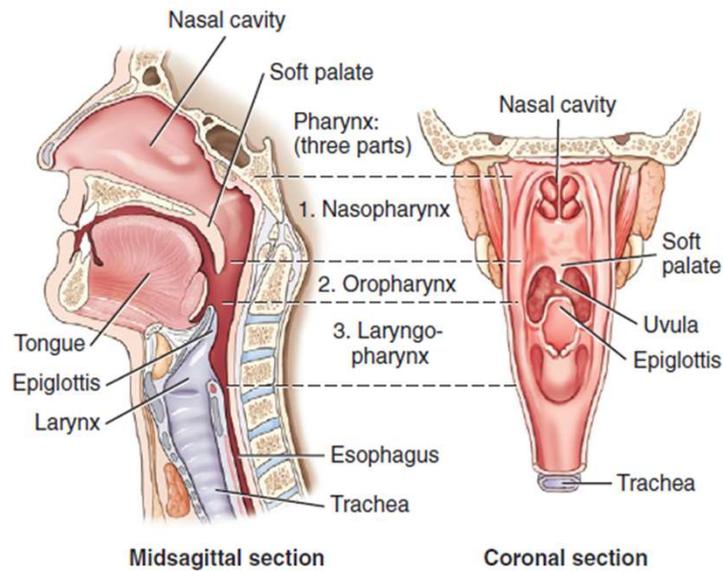
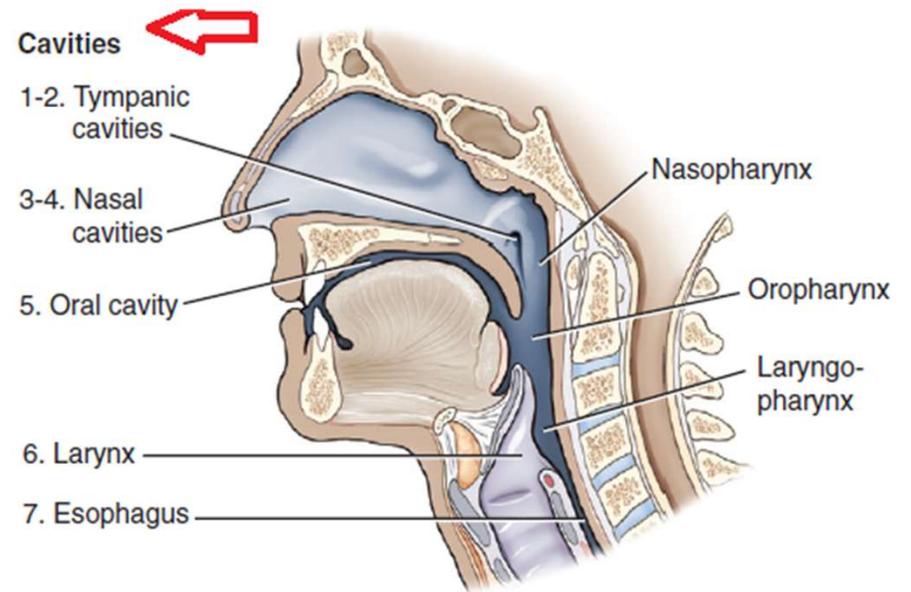
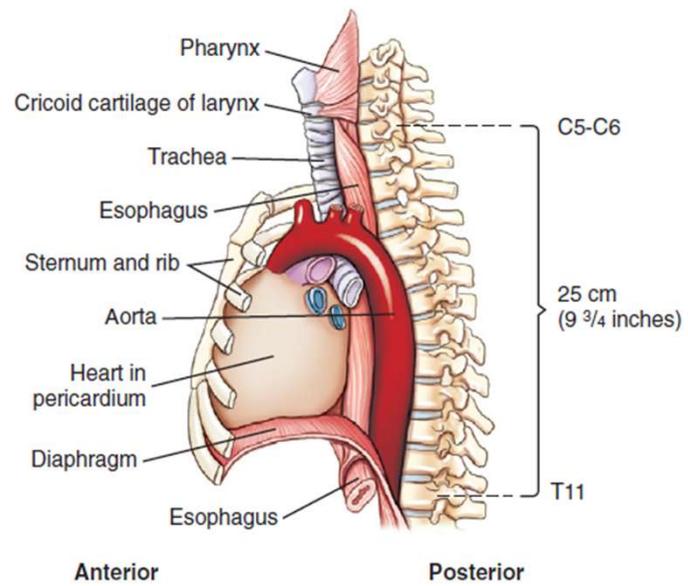


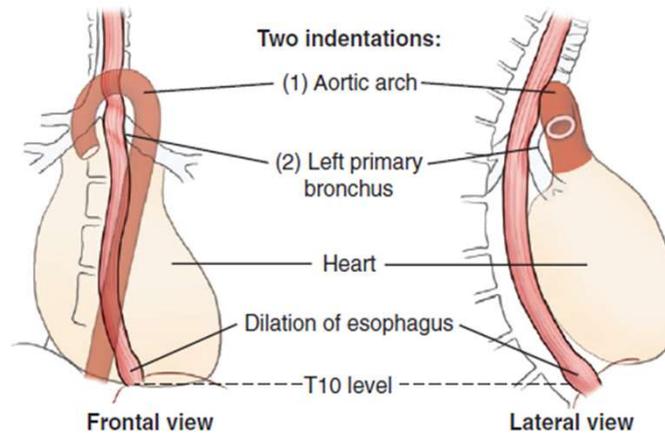
Fig. 12-15 Pharynx.

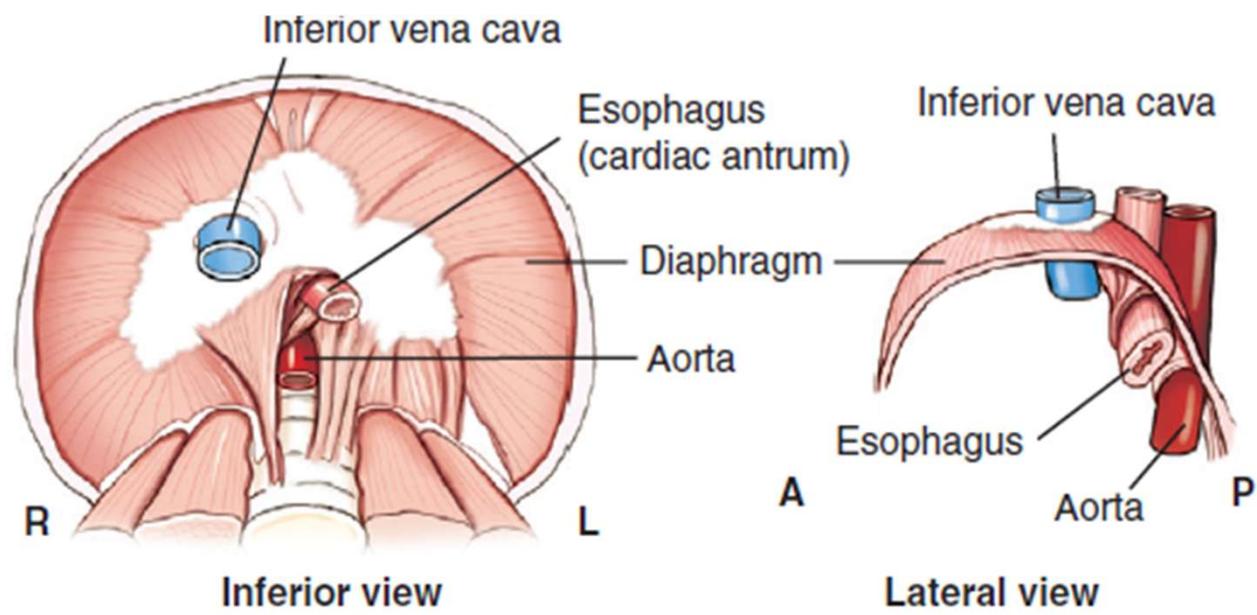


Seven cavities, or openings, communicate with the pharynx.



**Fig. 12-17** Esophagus in mediastinum—lateral view.



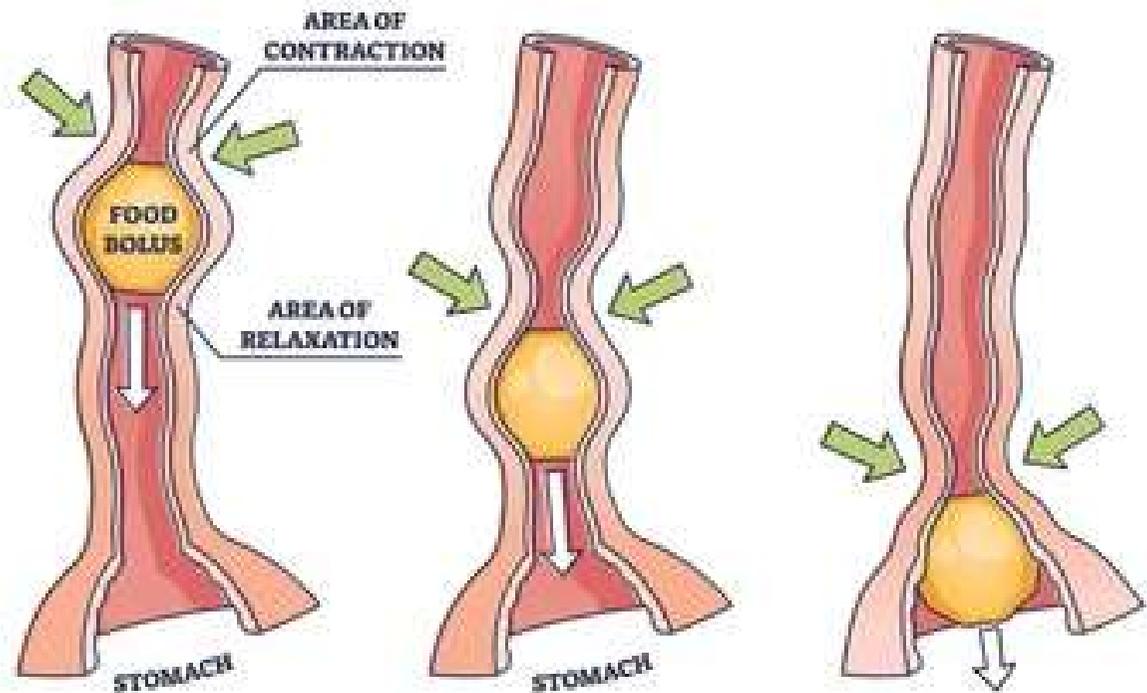


# PERISTALSIS

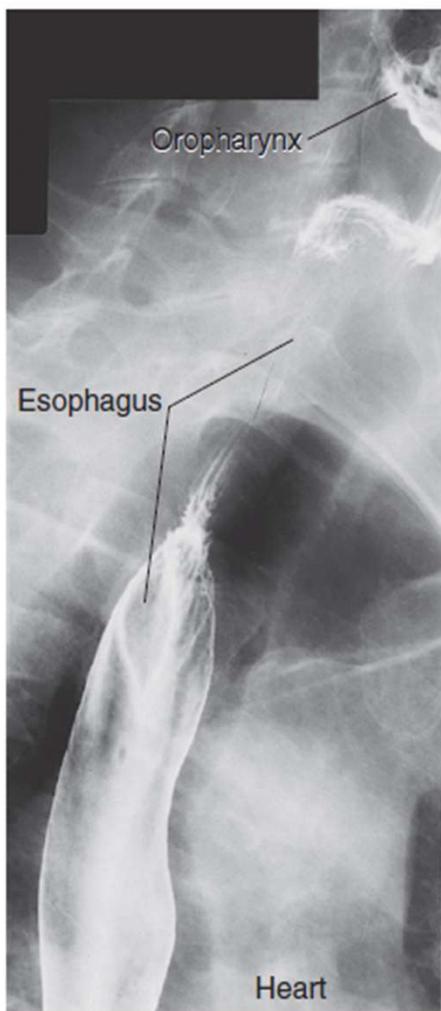
## Peristalsis

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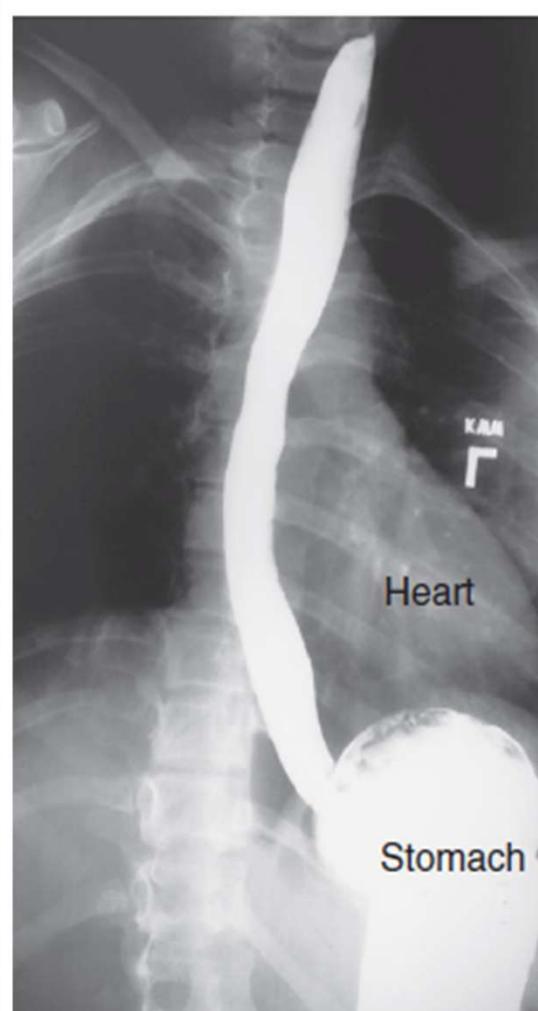
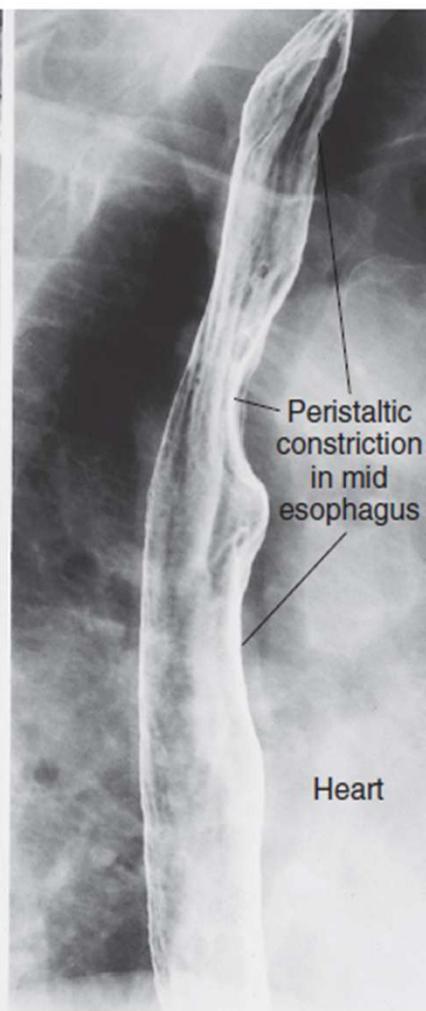
- Peristalsis is a wavelike series of involuntary muscular contractions
- propel solid and semisolid materials through the tubular alimentary canal.



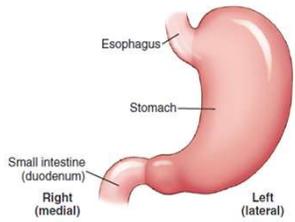
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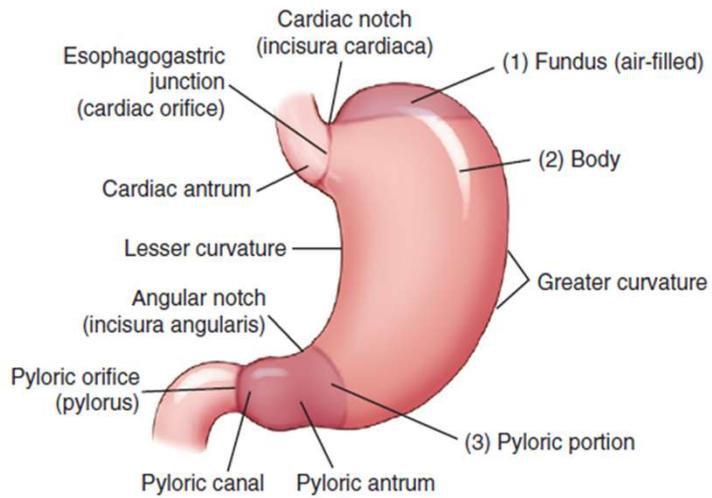
RAO esophagogram—upper esophagus. Midesophagus and lower esophagus are just above diaphragm.



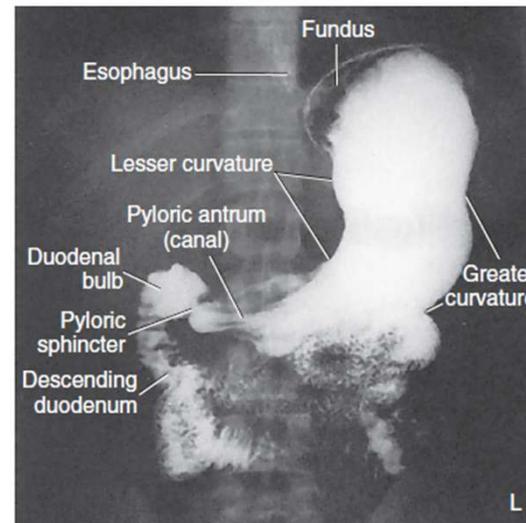
RAO esophagogram (slightly obliqued).



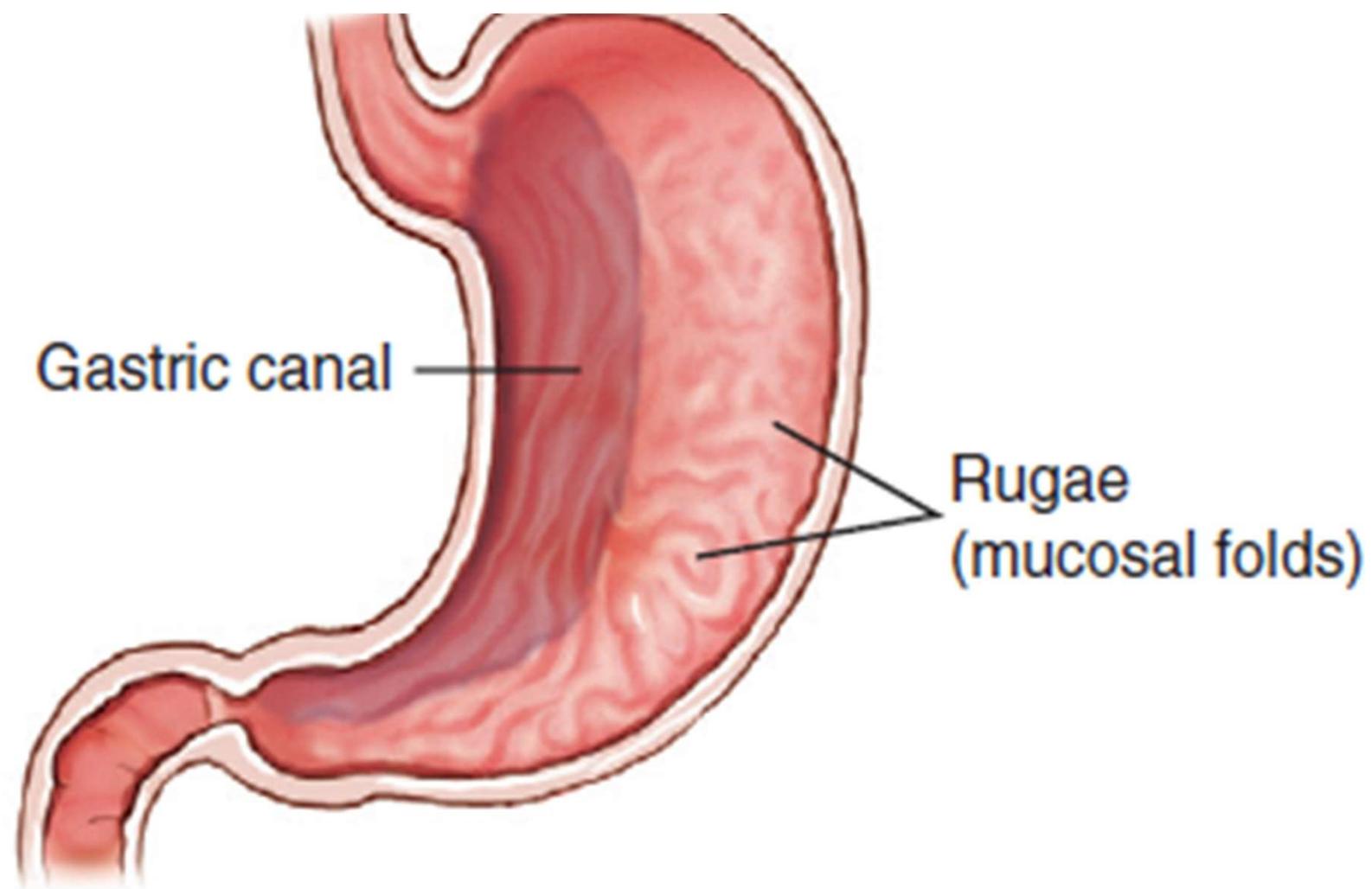
# Stomach



**Fig. 12-23** Stomach—openings, greater and lesser curvatures, and subdivisions.

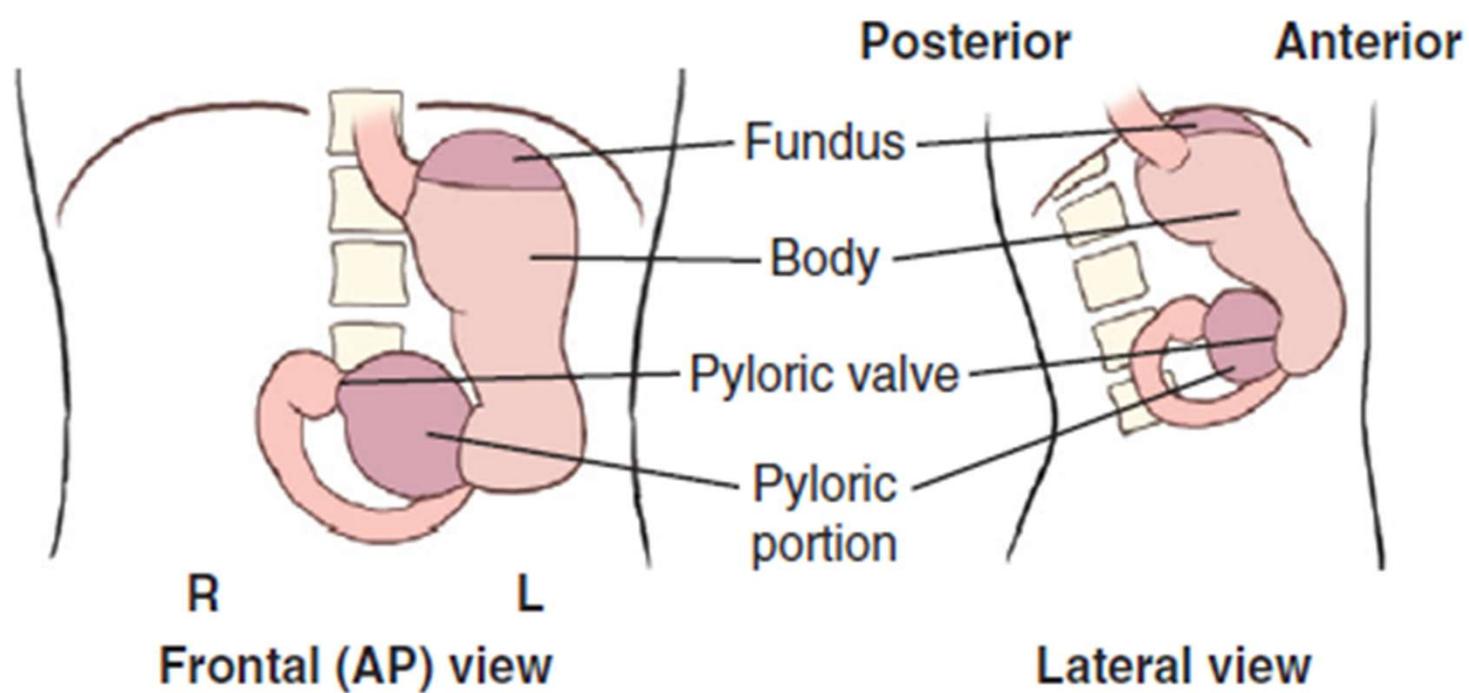


**Fig. 12-24** Barium-filled stomach and duodenum.

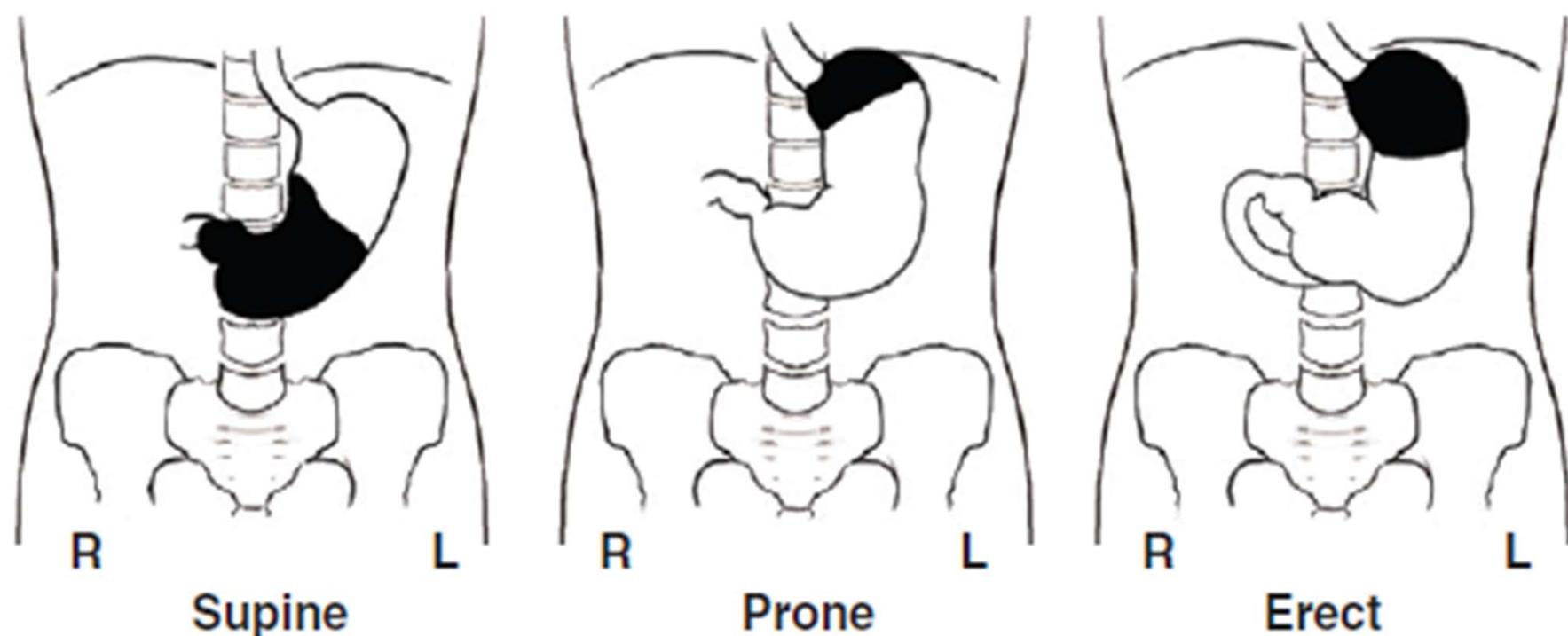


Gastric canal

Rugae  
(mucosal folds)

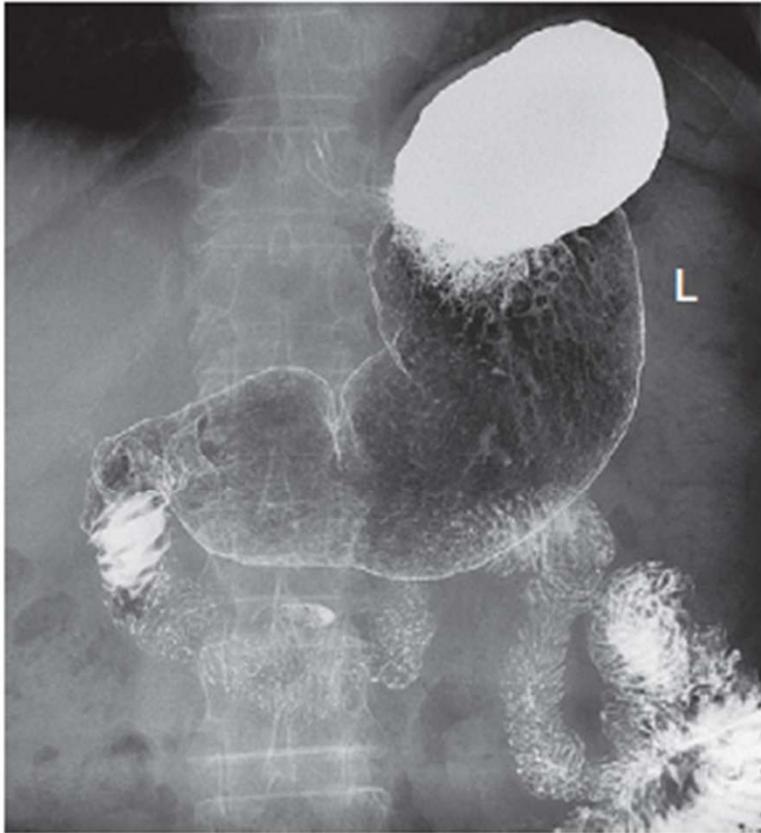


**Fig. 12-26** Average empty stomach orientation.



**Fig. 12-29** Air/gas-barium distribution in the stomach—frontal views in various body positions. Air/gas = *black*; barium = *white*.

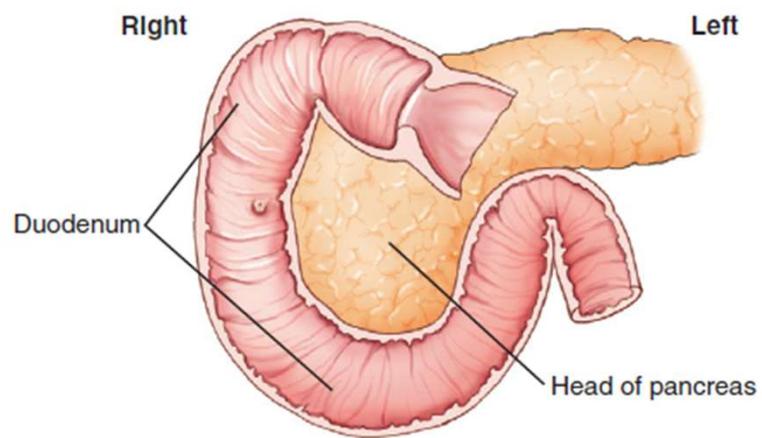
AIR/GAS-BARIUM DISTRIBUTION IN STOMACH



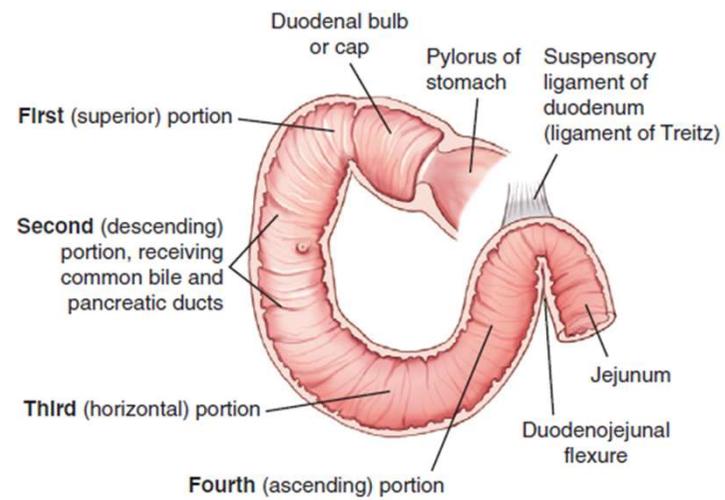
**Fig. 12-27** AP—supine position (barium in fundus).



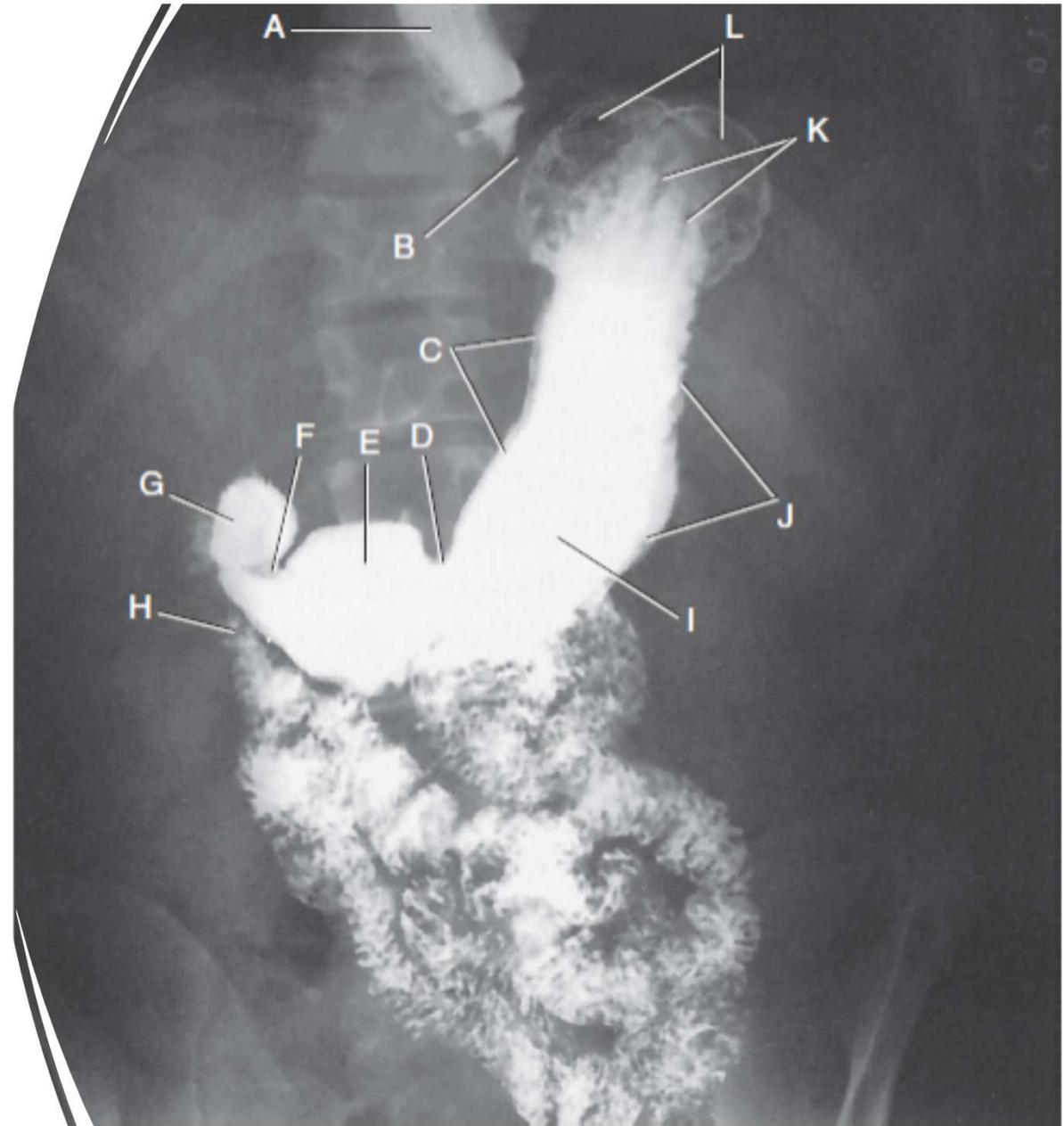
**Fig. 12-28** RAO—prone position (air in fundus).



**Fig. 12-30** Duodenum and pancreas.



- A. Distal esophagus
- B. Area of esophagogastric junction (cardiac orifice)
- C. Lesser curvature of stomach
- D. Angular notch (incisura angularis) of stomach
- E. Pylorus of stomach
- F. Pyloric valve or sphincter
- G. Duodenal bulb (cap)
- H. Second (descending) portion of duodenum
- I. Body of stomach
- J. Greater curvature of stomach
- K. Mucosal folds, or rugae, of stomach
- L. Fundus of stomach



## SUMMARY OF CHEMICAL DIGESTION

### Substances Ingested, Digested, and Absorbed

1. Carbohydrates (complex sugars) → simple sugars (mouth and stomach)
2. Proteins → amino acids (stomach and small bowel)
3. Lipids (fats) → fatty acids and glycerol (small bowel only)

### Substances Ingested but *not* Digested

4. Vitamins
5. Minerals
6. Water

### Enzymes (Digestive Juices)

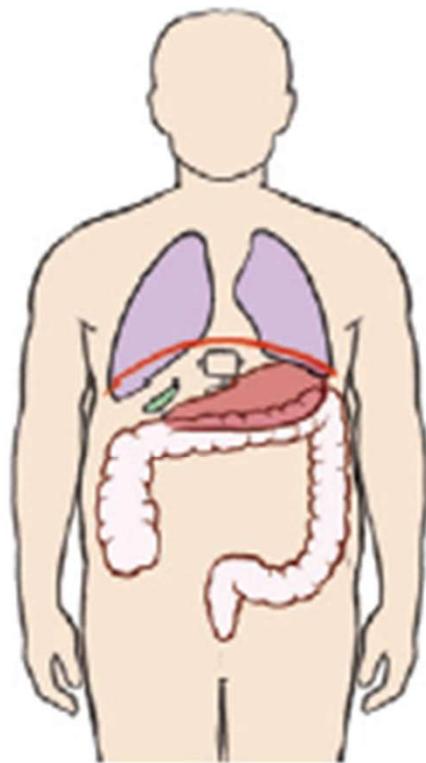
Biologic catalysts

### Bile (from Gallbladder)

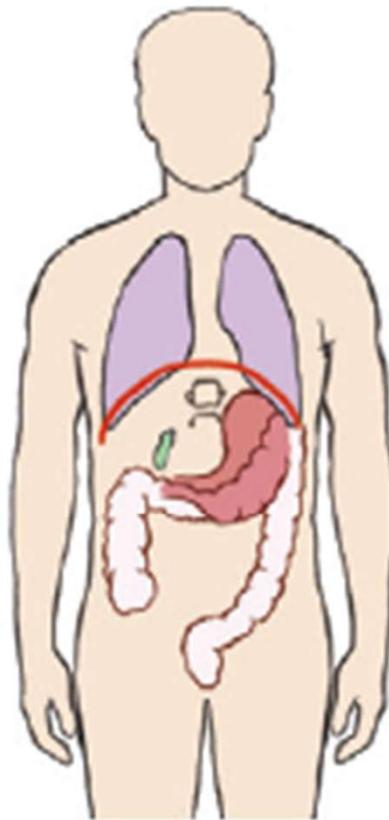
Emulsification of fats

## SUMMARY OF MECHANICAL DIGESTION

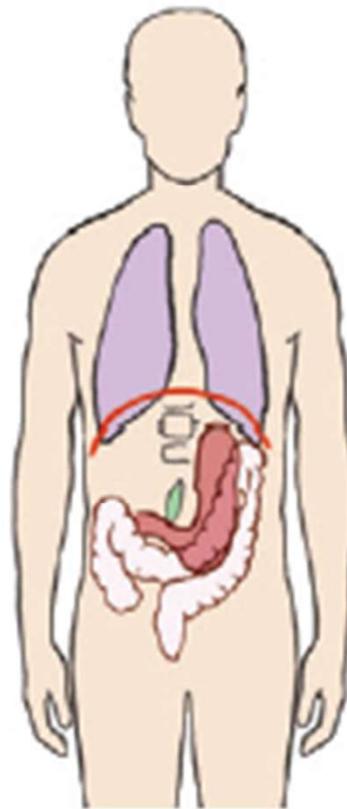
|                                |  |
|--------------------------------|--|
| Oral cavity (teeth and tongue) | Mastication (chewing)<br>Deglutition (swallowing)                    |
| Pharynx                        | Deglutition  |
| Esophagus                      | Deglutition<br>Peristalsis (waves of muscular contraction) (1-8 sec) |
| Stomach                        | Mixing (chyme)<br>Peristalsis (2-6 hr)                               |
| Small intestine (small bowel)  | Rhythmic segmentation<br>Peristalsis (3-5 hr)                        |



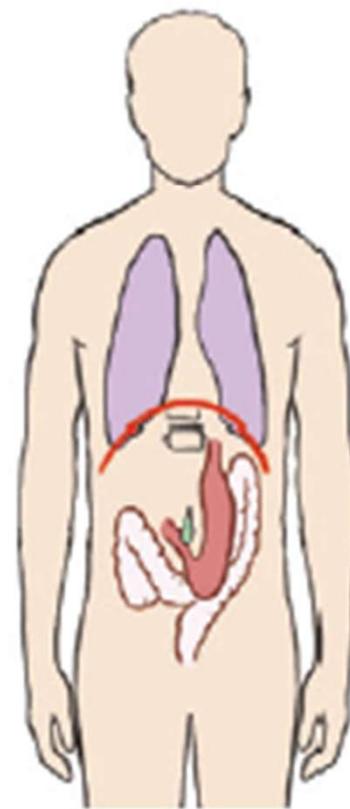
1. Hypersthenic  
(massive)  
5%



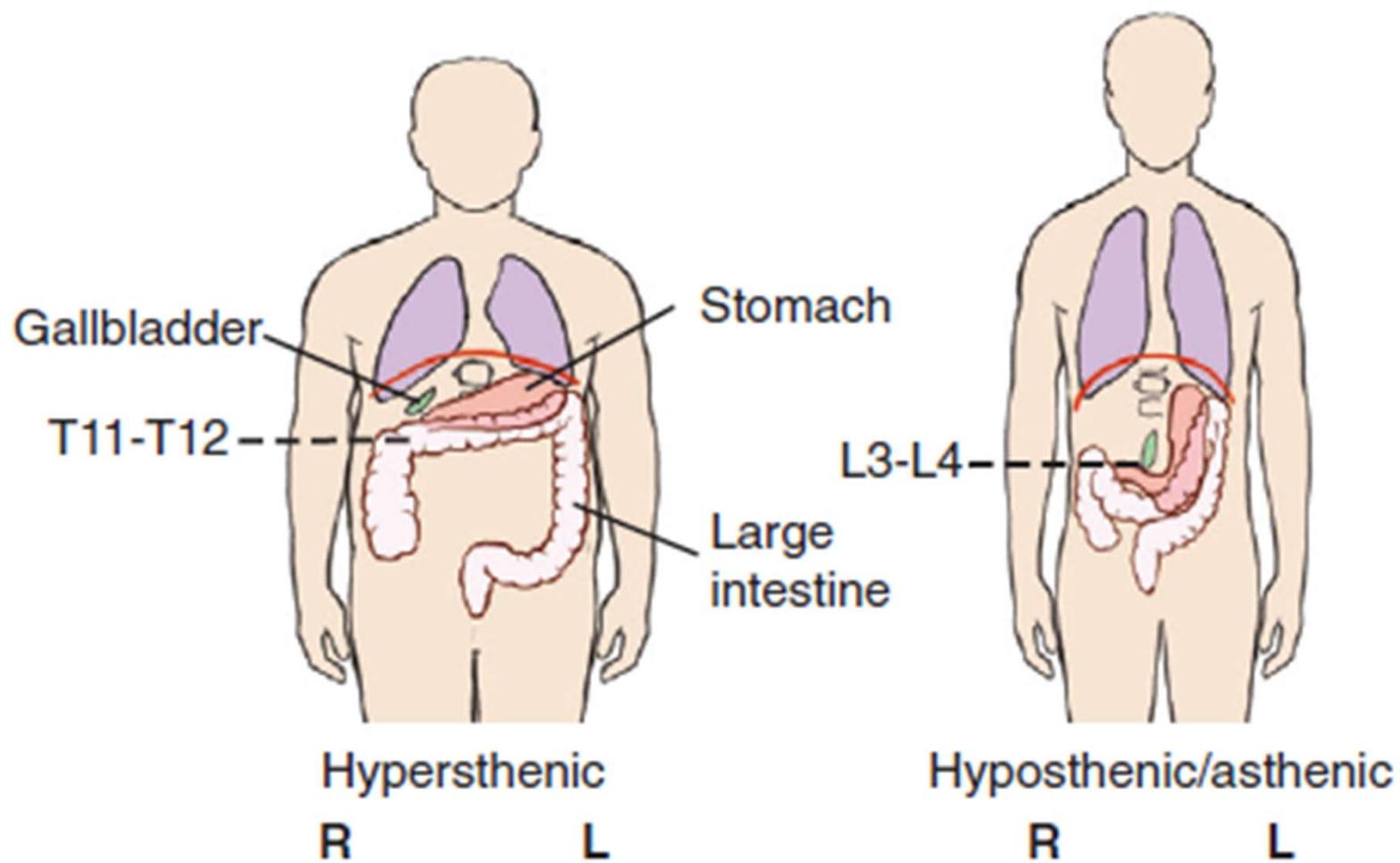
2. Sthenic  
(average)  
50%

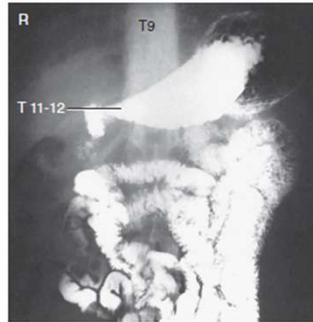


3. Hyposthenic  
(slender)  
35%

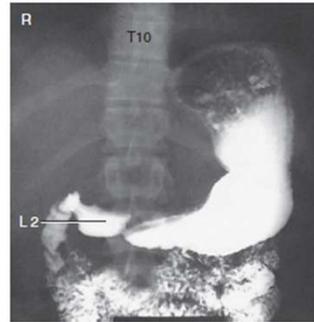


4. Asthenic  
(very slender)  
10%

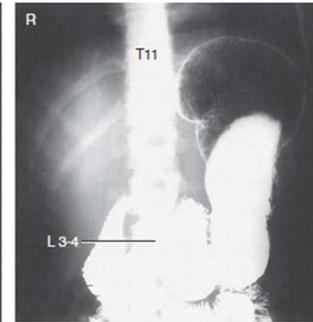




**Fig. 12-36** Hypersthenic. General stomach—high and transverse, level T9 to T12. Pyloric portion—level T11 to T12, at midline. Duodenal bulb location—level T11 to T12, to right of midline.



**Fig. 12-37** Sthenic. General stomach—level T10 to L2. Pyloric portion—level L2, near midline. Duodenal bulb location—level L1 to L2, near midline.



**Fig. 12-38** Hyposthenic/asthenic. General stomach—low and vertical, level T11 to L5. Pyloric portion—level L3 to L4, to left of midline. Duodenal bulb location—level L3 to L4, at midline.



**Fig. 12-39** Hypersthenic. Generally shorter in height, with broad shoulders and hips and short torso (less distance between lower rib cage and iliac crest). Abdominal cavity is widest at upper margin.

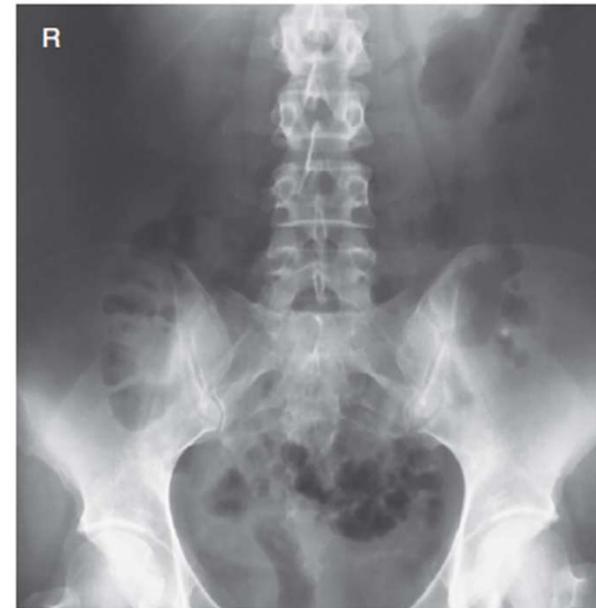


**Fig. 12-40** Sthenic. Near average in height, weight, and length of torso (may be heavier than average, with some hypersthenic characteristics).



**Fig. 12-41** Hyposthenic/asthenic. Generally tall and thin, with long torso. (This example is between hyposthenic and asthenic.) Abdominal cavity is widest at lower margin for a true asthenic.

- the only parts of the alimentary canal that can be easily identified on plain radiographs are the fundus of the stomach
- Parts of the large intestine, because of pockets of gas and collections of fecal matter.



**Fig. 12-42** Plain abdomen

# Fluoroscopy allows the radiologist to

- Observe the gastrointestinal tract in motion
- Produce radiographic images during the course of the examination
- Determine the most appropriate course of action for a complete radiographic examination.
- Radiographic images are recorded during and after the fluoroscopic examination
- Permanent record of the normal or abnormal findings



# Contrast Media

- Radiolucent and radiopaque contrast media are used to visualize GI tract radiographically.
- Radiolucent, or negative, contrast media include swallowed air, CO<sub>2</sub> gas crystals, and the normally present gas bubble in the stomach.
- Calcium and magnesium citrate carbonate crystals are frequently used to produce CO<sub>2</sub> gas.

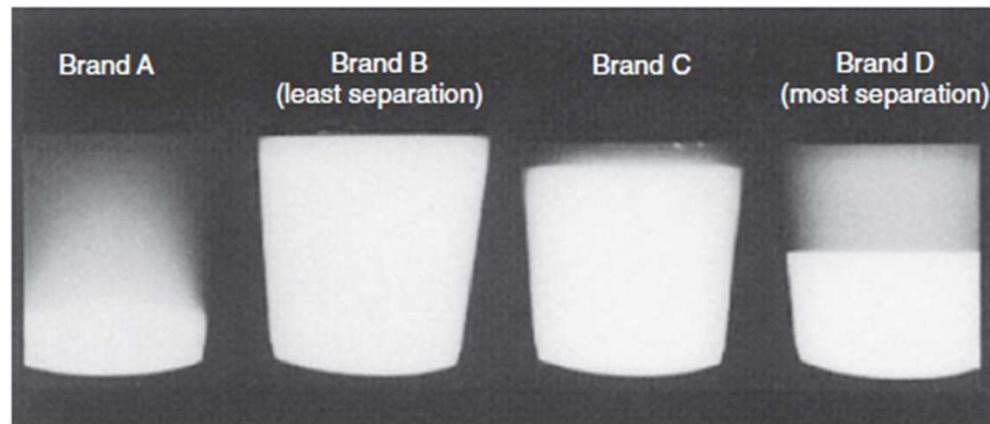
# barium sulfate (BaSO<sub>4</sub>)

- positive, or radiopaque, contrast medium
- barium sulfate is a powdered, chalklike substance
- The powdered barium sulfate is mixed with water before ingestion by the patient.
- chemically pure
- it does not interact chemically with the body
- it rarely produces an allergic reaction.
- Barium sulfate eventually is expelled rectally after the radiographic procedure
- Most barium sulfate preparations are prepackaged; water is added to the cup followed by mixing.
- Some barium sulfate preparations come in a liquid
- all barium suspensions must be mixed well just before use.



variety of smells and flavors  
palatable for the patient

- A mixture of barium sulfate and water forms a colloidal suspension, not a solution
- Barium sulfate never dissolves in water.
- In a colloidal suspension, the particles suspended in water tend to settle over time when allowed to sit.



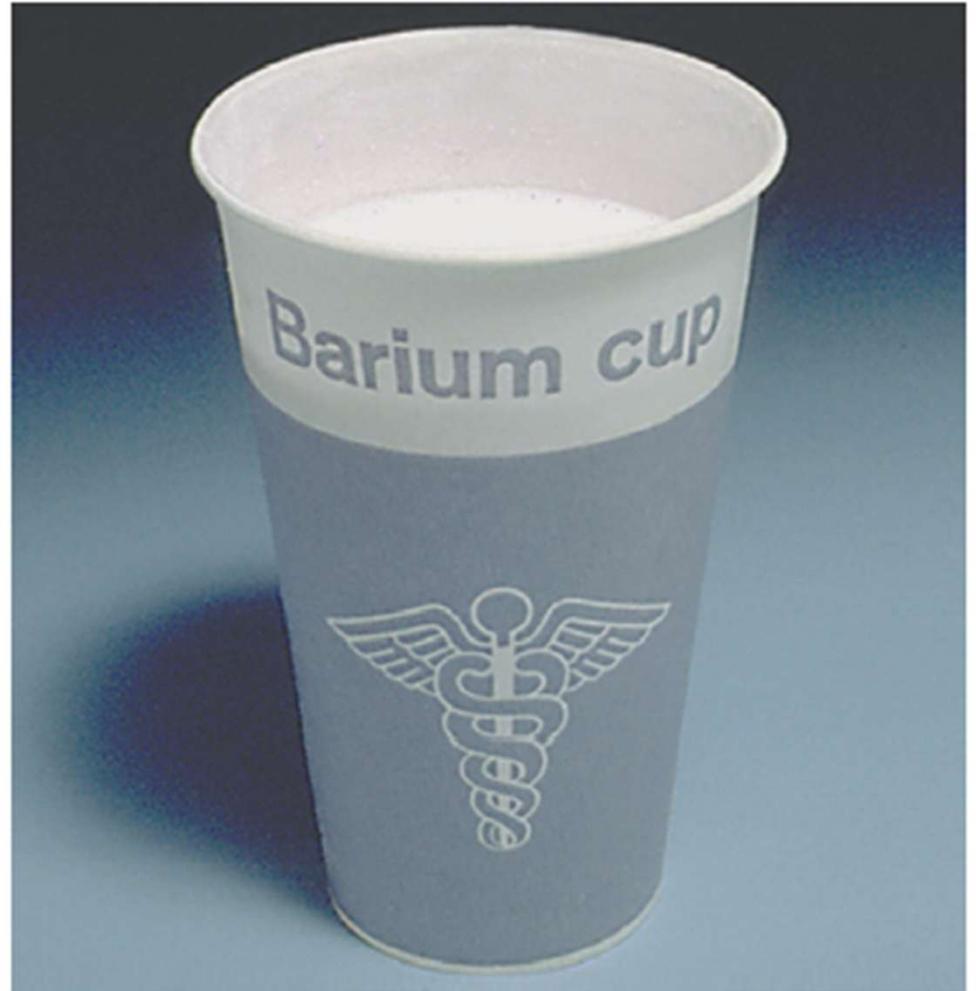
## Properties of Barium Sulphate – BaSO<sub>4</sub>

|                              |                       |
|------------------------------|-----------------------|
| BaSO <sub>4</sub>            | Barium Sulphate       |
| Molecular Weight/ Molar Mass | 233.38 g/mol          |
| Density                      | 4.5 g/cm <sup>3</sup> |
| Boiling Point                | 1,600 °C              |
| Melting Point                | 1,580 °C              |

# Thin Barium

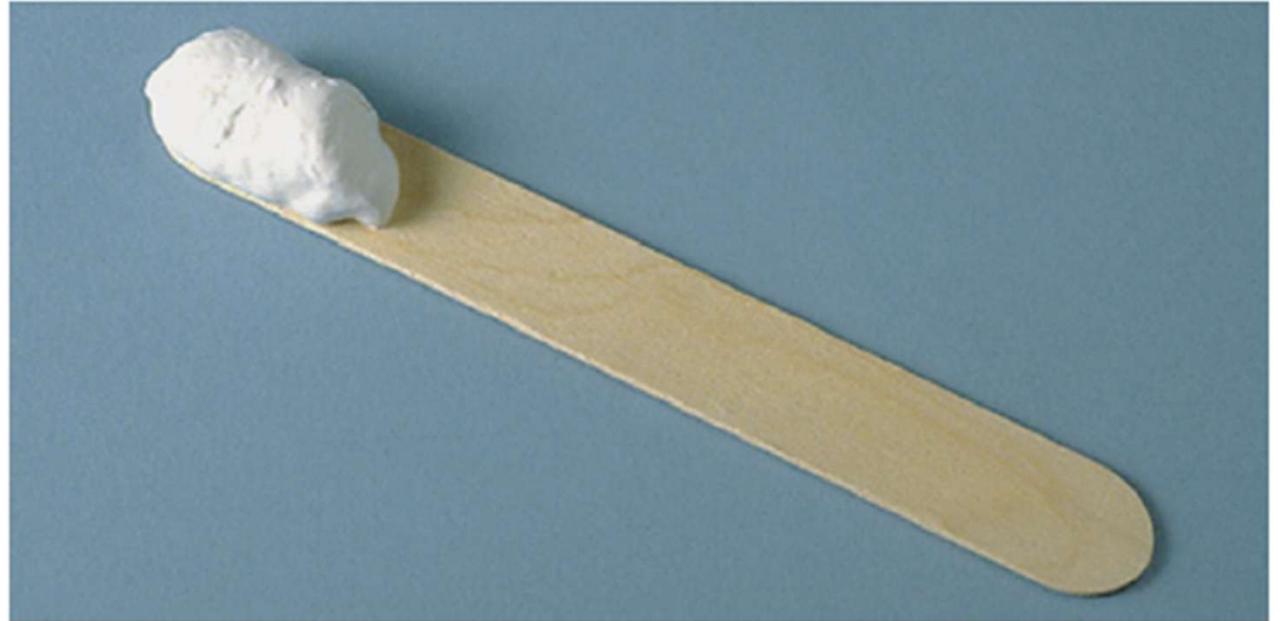
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- Barium sulfate may be prepared or purchased in a relatively thin mixture
- The thin barium sulfate and water mixture contained in a cup
- contains 1 part BaSO<sub>4</sub> to 1 part water.
- Thin barium has the consistency of a thin milkshake
- is used to study the entire gastrointestinal tract.
- Thin barium mixtures, on average, consist of 60% weight-to-volume (w/v) of barium sulfate to water.



- The motility, or speed depends on:
  - ✓ the suspending medium and additives,
  - ✓ the temperature
  - ✓ the consistency of the preparation
  - ✓ the general condition of the patient and the gastrointestinal tract.
- Mixing the preparation according to radiologist preferences and departmental protocol
- When the mixture is cold, the chalky taste is much less objectionable.

# Thick Barium



- Thick barium contains 3 or 4 parts  $\text{BaSO}_4$  to 1 part water
- should have the consistency of cooked cereal
- Thick barium is more difficult to swallow but is well suited for use in the esophagus

# water-soluble iodinated contrast media

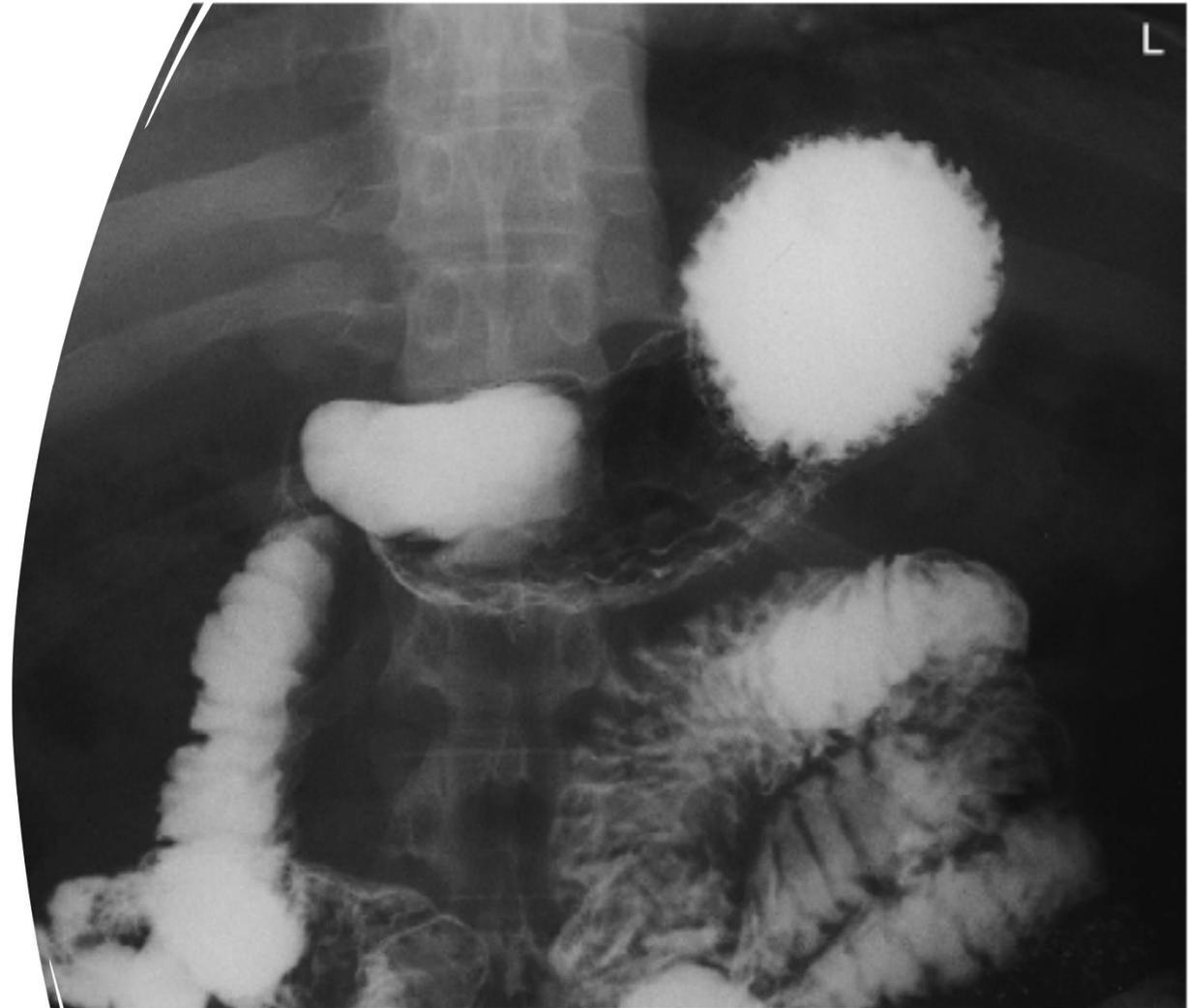
- Barium sulfate mixtures are contraindicated if escape into the peritoneal cavity
- water-soluble contrast agent contains 37% organically bound iodine, which opacifies the gastrointestinal tract
- Iodinated contrast media are sometimes mixed with carbonated soft drinks to mask the taste
- but they are often used "as is" or diluted with water
- should not be used if the patient is sensitive to iodine,



Example of water-soluble iodinated contrast medium

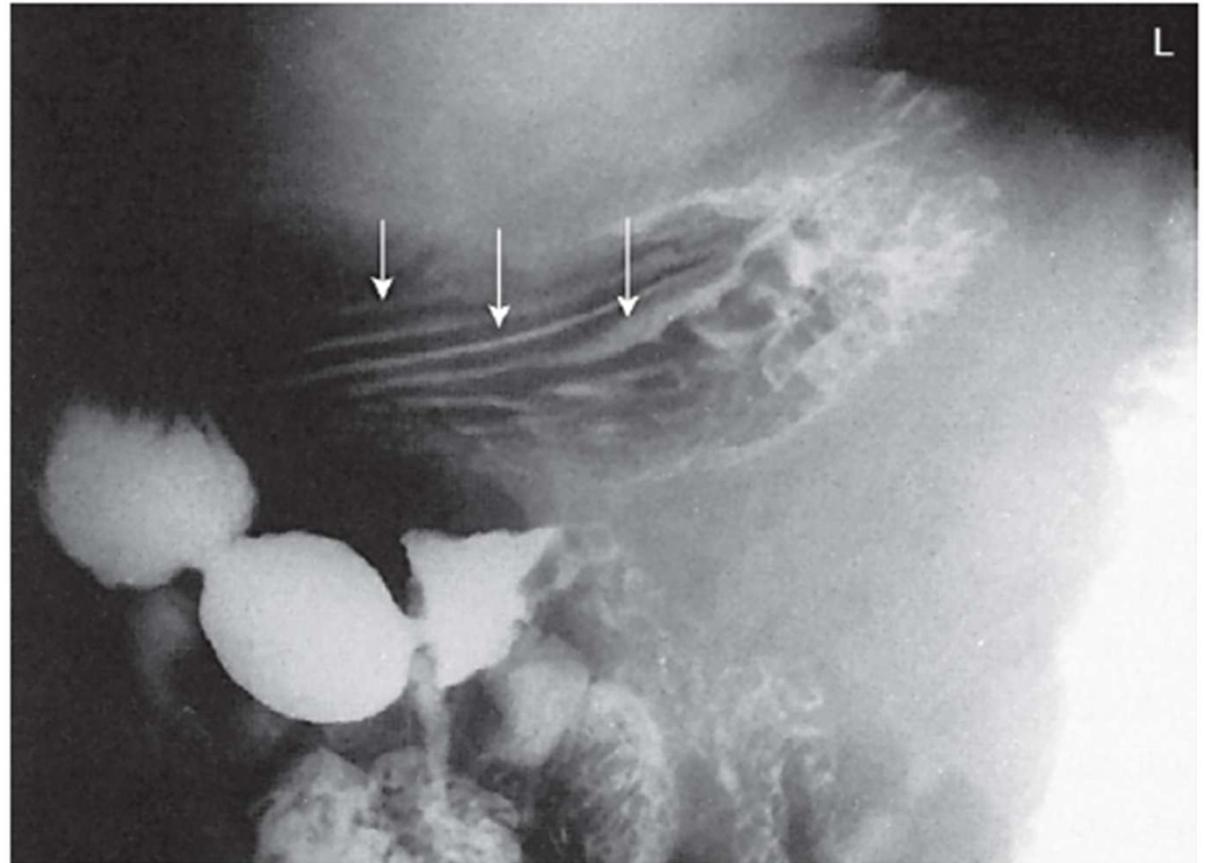
# DOUBLE CONTRAST

- Double-contrast procedures employing both radiolucent and radiopaque contrast media
- The radiopaque contrast medium is barium sulfate
- The radiolucent contrast medium is either room air or CO<sub>2</sub> gas.
- To introduce room air, small pinprick holes are placed in the patient's straw.
- As the patient drinks the barium mixture, air is drawn in with it.
- CO<sub>2</sub> gas is created when the patient ingests gas-producing crystals.



UGI—double contrast; demonstrates gas and barium-filled stomach.

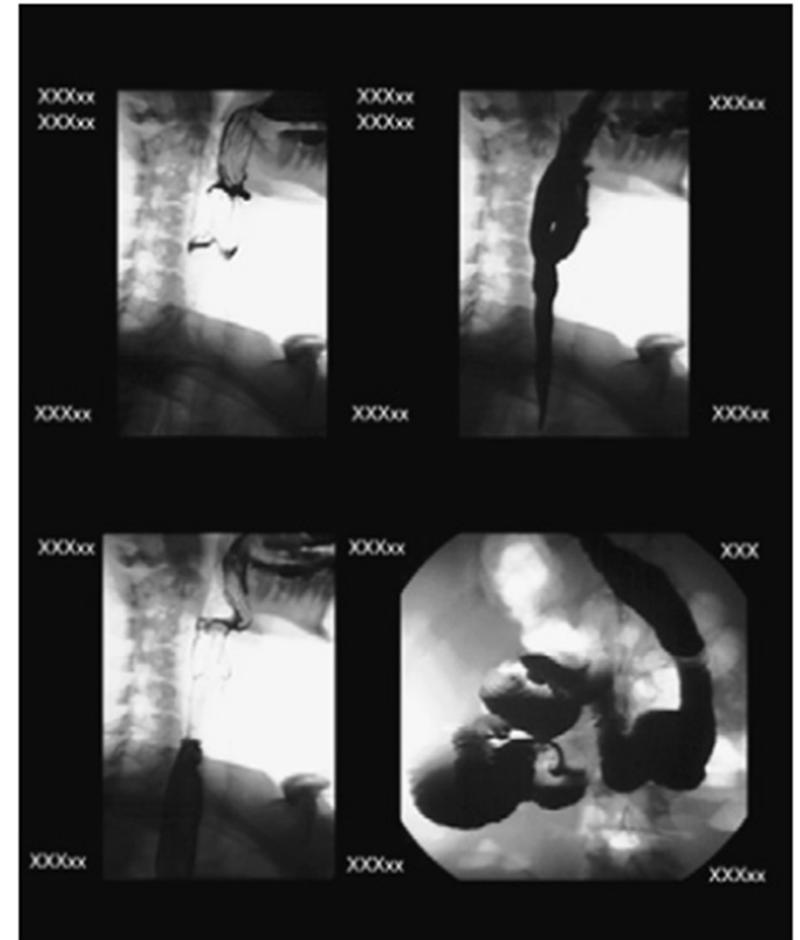
- 
- Two common forms of these crystals are **calcium and magnesium citrate**.
  - These crystals form a large **gas bubble**.
  - The gas mixes with the barium providing better coating to the mucosa and its patterns
  - Potential polyps, diverticula, and ulcers are better demonstrated with a double-contrast technique.



UGI—double contrast; demonstrates gas and barium-filled stomach, with mucosal folds lined with barium.

## Postfluoroscopy “Overhead” Images

- “Overhead” images routinely after fluoroscopy is decided by the radiologist or by departmental protocol
- No need if sufficient digital images are recorded
- decreased examination times and patient exposure for upper and lower GI series procedures
- multiple images can be formatted and printed on one piece of laser film.
- E.g : 4 on1, 6 on1, 9 on 1, 12 on 1
- “Hard-copy” films can be printed



# Cine Loop View

- displayed as moving or cine images.
- This feature is beneficial for certain studies
- such as an esophagogram for possible esophageal reflux or impaired swallowing mechanisms
- The technologist can play back the cine loop to demonstrate dynamic flow of barium through the esophagus or stomach.
- The radiologist can interpret the study from a monitor located in an office or reading room.



# Image Enhancement

- Manipulation with postprocessing tools
- edge enhancement
- window and leveling
- dynamic range control
- dual energy subtraction.
- Other options include inverting the image contrast
- motion artifact control
- smoothing



## WORKER PROTECTION SUMMARY CHART

### PROTECTIVE DEVICE

### BENEFIT

Fluoroscopy leaded tower drape

Greatly reduces exposure to fluoroscopy personnel

Protective lead apron  
(0.5 mm lead minimum)

Reduces exposure to torso

Lead gloves

Reduces exposure to hands and wrists

Bucky slot shield

Reduces exposure to gonadal region

Protective eyewear (Pb-Eq)

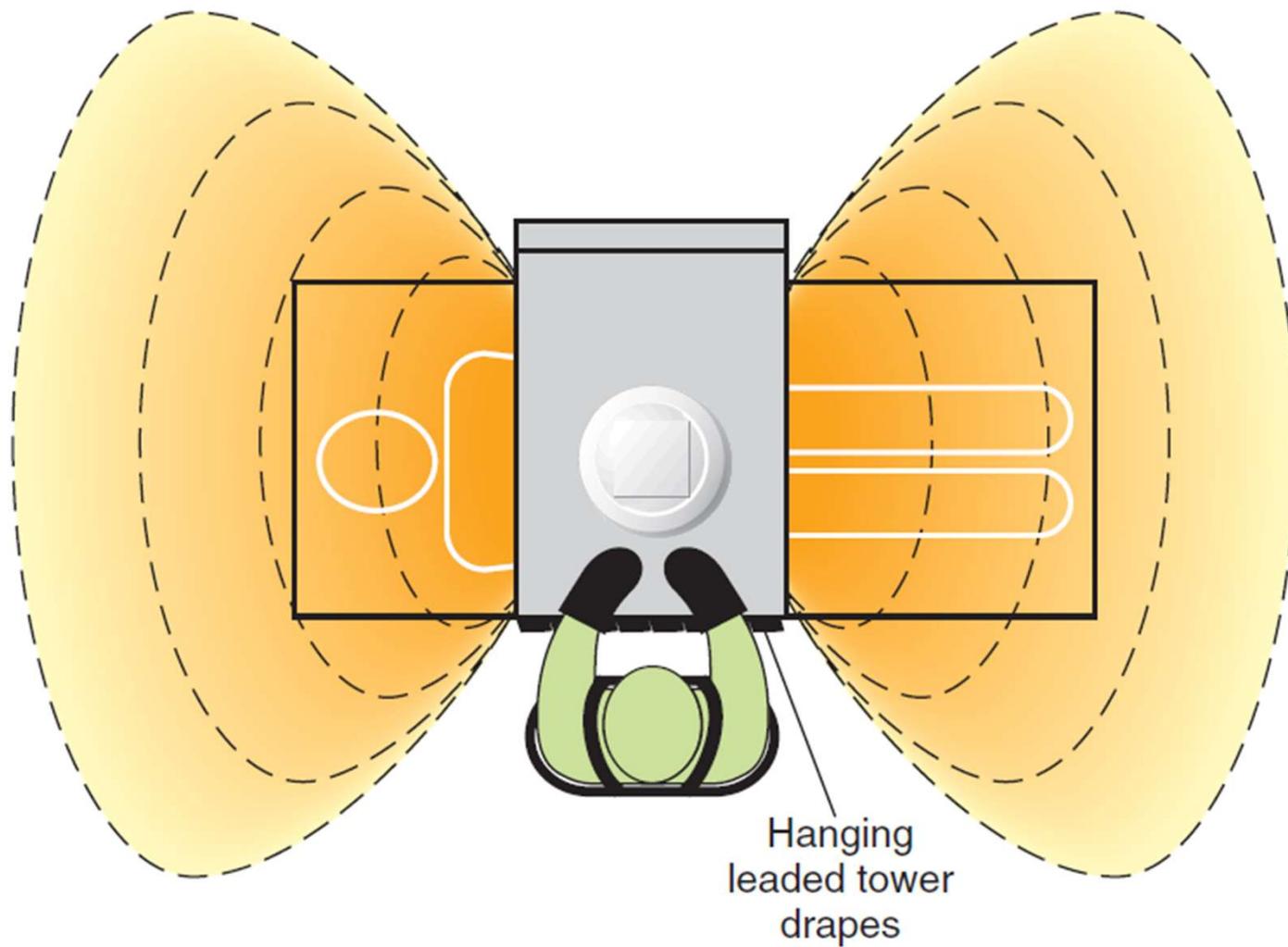
Reduces exposure to lenses of the eye

Thyroid shield

Reduces exposure to thyroid gland

Compression paddle

Reduces exposure to arm and hand of

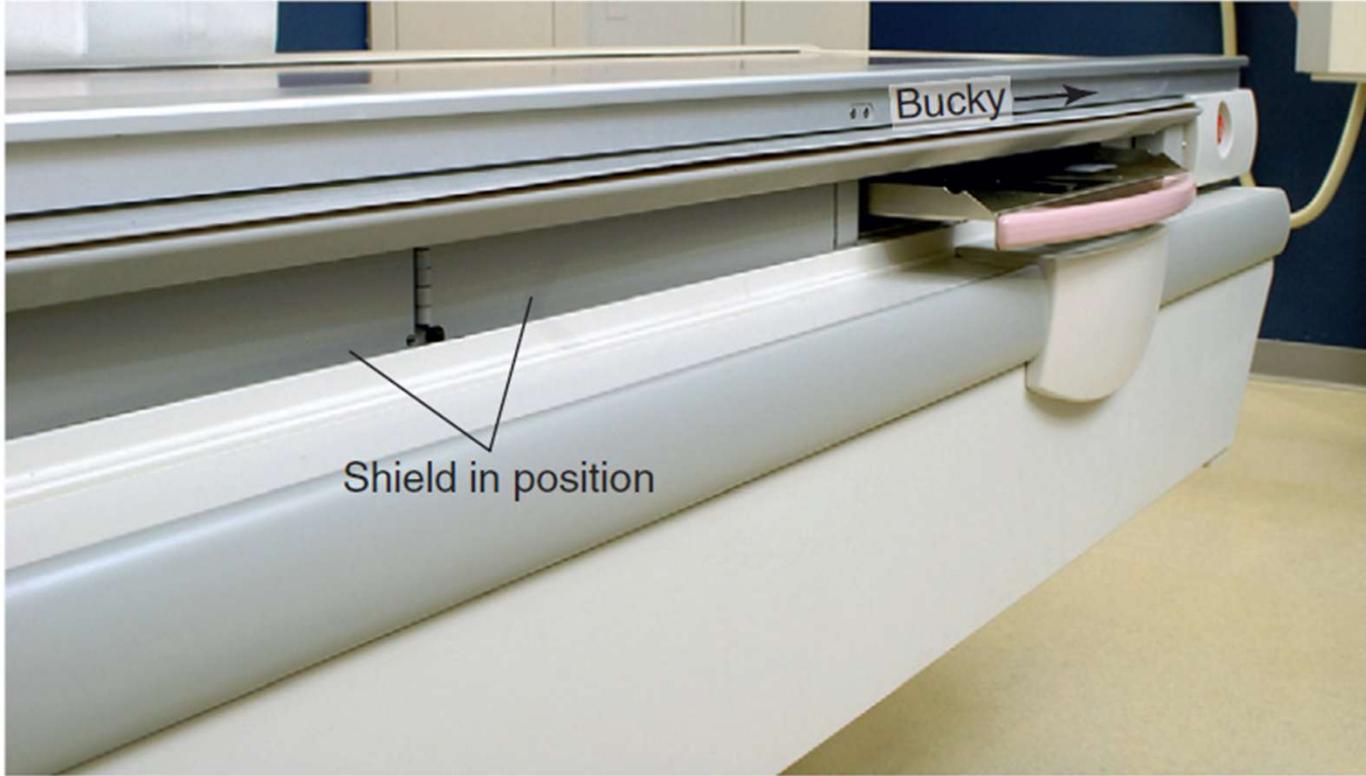


# Lead Drape Shield

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- ensure it is not damaged or improperly placed







Protective  
eyewear

Thyroid  
shield

Protective  
lead apron

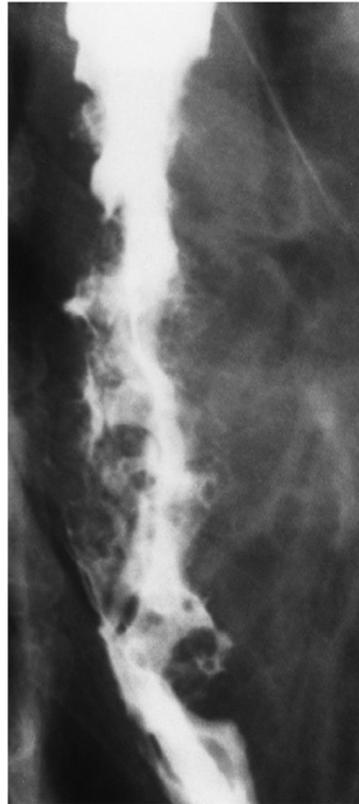
# Esophagogram Procedure

- Esophagogram (esophagram)
- or barium swallow
- upper GI series
- to demonstrate radiographically the form and function of the pharynx and esophagus.
- No major contraindications for esophagograms
- Possible sensitivity to the contrast media
- You should determine whether the patient has a history of sensitivity to barium sulfate or water-soluble contrast media.

## ESOPHAGOGRAM—SUMMARY OF CLINICAL INDICATIONS

| CONDITION OR DISEASE                          | MOST COMMON RADIOGRAPHIC EXAMINATION   | POSSIBLE RADIOGRAPHIC APPEARANCE   | EXPOSURE FACTOR ADJUSTMENT |
|---|--|--|----------------------------|
| Achalasia                                     | Esophagogram with digital fluoroscopy  | Stricture or narrowing of esophagus  | None                       |
| Anatomic anomalies (including foreign bodies) | Esophagogram with digital fluoroscopy (functional study) endoscopy employed for foreign bodies | Abnormal peristaltic patterns<br>Various radiopaque and radiolucent foreign bodies | None<br>None               |
| Barrett's esophagus                           | Esophagogram or nuclear medicine scan  | Stricture or "streaked" appearance of distal esophagus                             | None                       |
| Carcinoma                                     | Esophagogram and CT scan   | Point of stricture, narrowing, or atrophic changes in mucosa                       | None                       |
| Dysphagia                                     | Esophagogram with digital fluoroscopy (functional study)                                       | Narrowing or enlargement of esophagus, depending on cause                          | None                       |
| Esophageal varices                            | Esophagogram (and endoscopy)   | Narrowing and "wormlike" appearance of esophagus                                   | None                       |
| Zenker's diverticulum                         | Esophagogram (and endoscopy)   | Enlarged recess or cavity in proximal esophagus                                    | None                       |

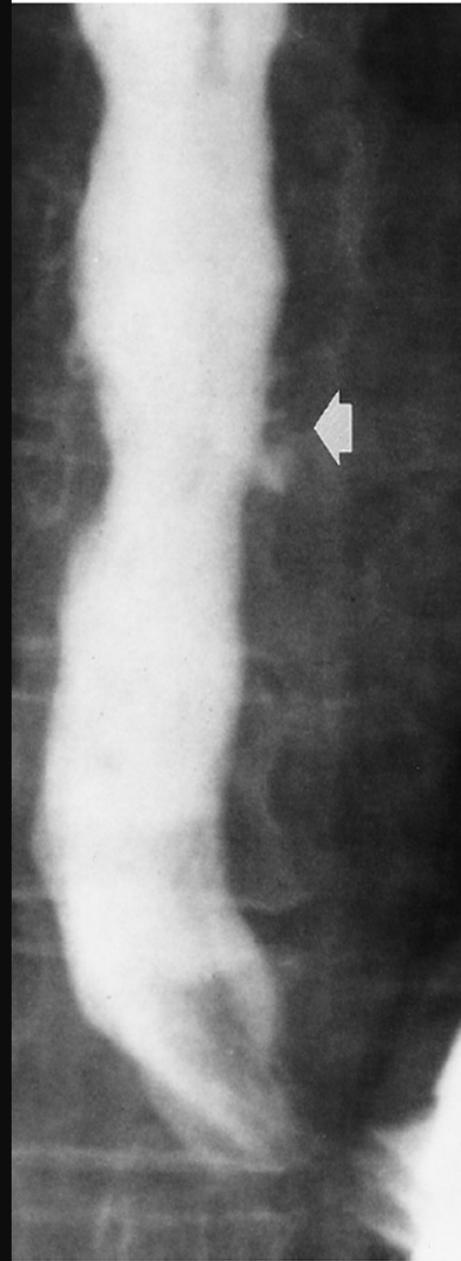
# Esophagogram— carcinoma of esophagus



## Barrett's esophagus, or *Barrett's syndrome*

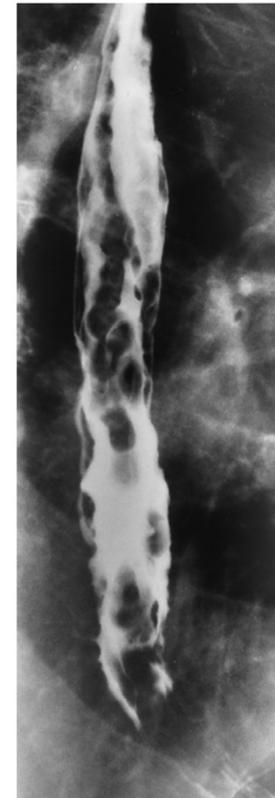
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- A stricture in the distal esophagus. In advanced cases
  - peptic ulcer may develop in the distal esophagus
- 



# Esophageal varices

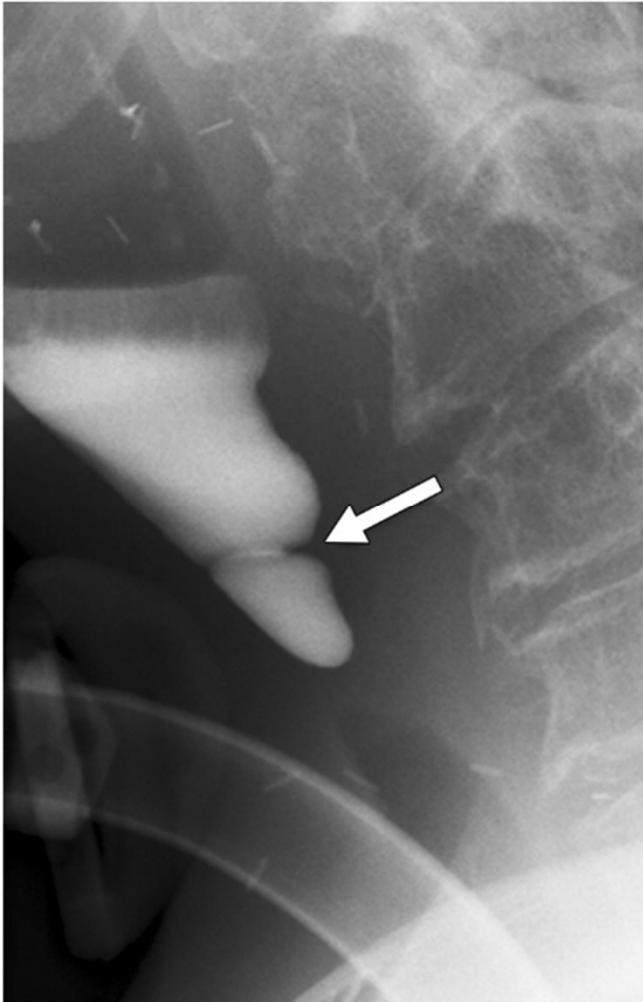
- Esophageal varices are characterized by dilation of the veins
- This condition is often seen with acute liver disease, such as cirrhosis
- Secondary to increased portal hypertension.
- With restriction in venous flow through the liver, the coronary veins in the distal esophagus become dilated, tortuous, and engorged with blood.
- Esophageal varices with diffuse round and oval filling defects.



# Foreign bodies

- patients may ingest include a bolus of food, metallic objects, and other materials lodging in the esophagus.
- Locations and dimensions may be determined during an esophagogram





**Fig. 10B**—78-year-old man with obstruction of cervical esophagus.

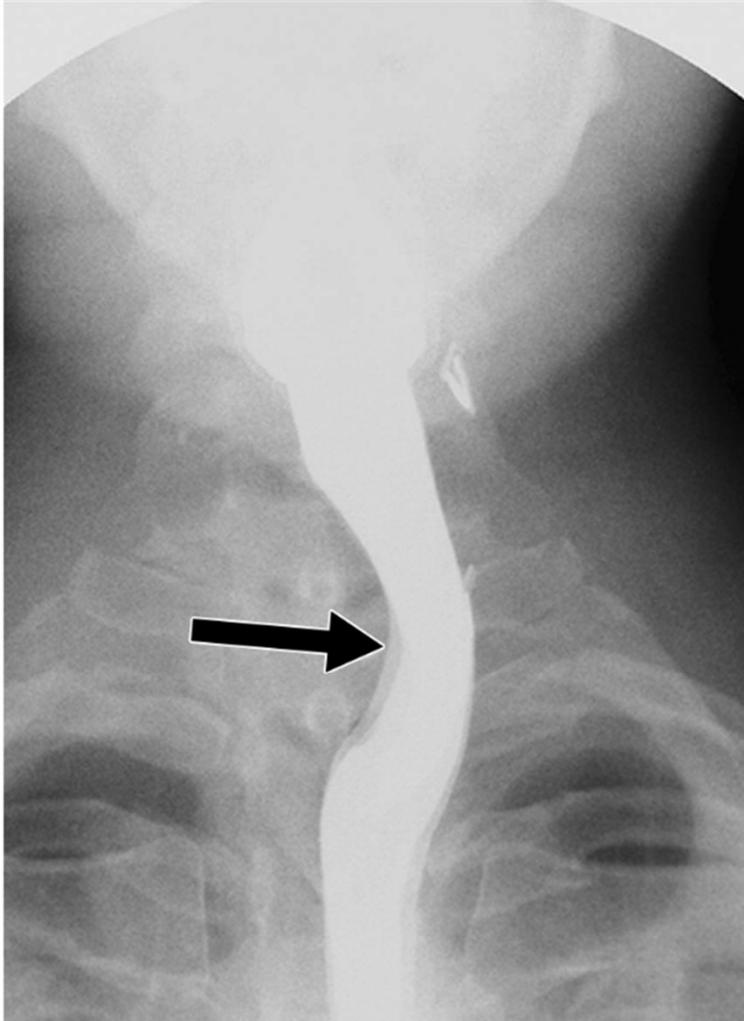
**B**, Anteroposterior (**A**) and lateral (**B**) views show complete obstruction (*arrow*) in cervical esophagus at C4–C5 level 2 years after laryngectomy and radiation therapy for laryngeal carcinoma. Postradiation mucosal web is evident in hypopharynx.



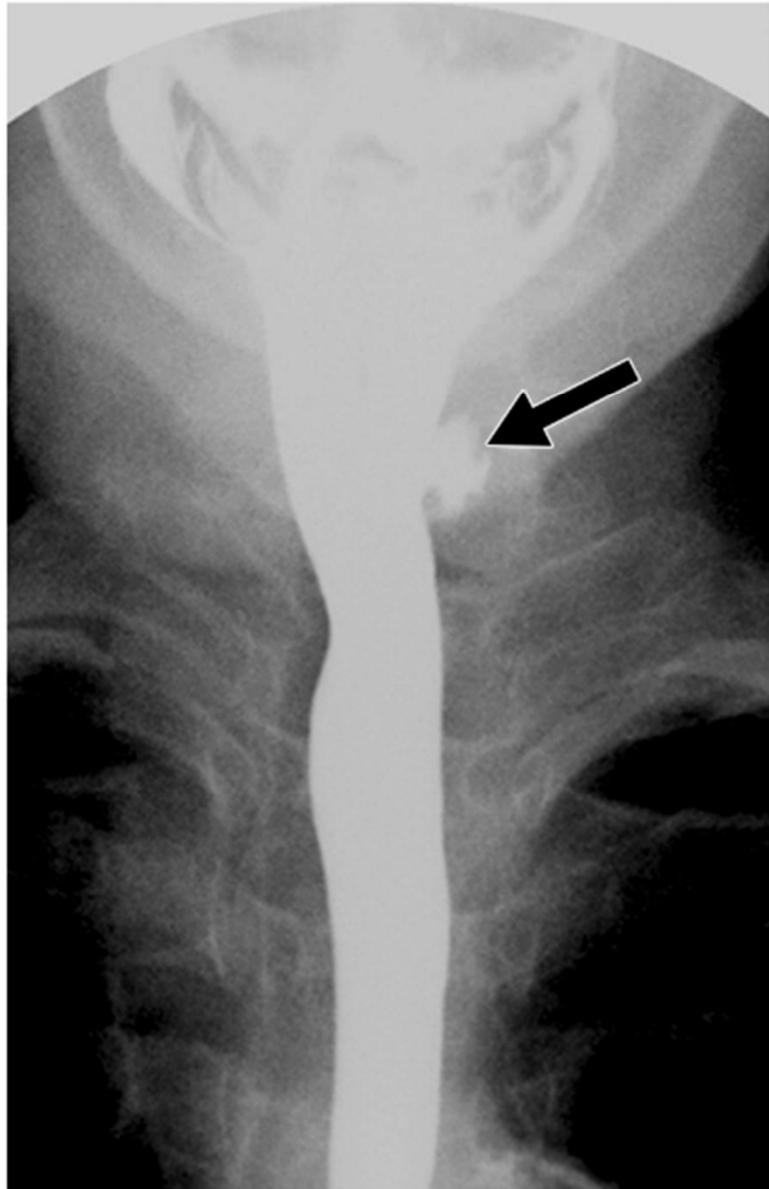
**Fig. 8**—69-year-old man with cervical osteophytes. Lateral fluoroscopic image shows anterior osteophytes (*arrows*) in region of C4–C6 causing narrowing of cervical esophagus.



**Fig. 9**—47-year-old man who has undergone laryngectomy. Left posterior oblique fluoroscopic image shows leak and fistula (*arrows*) from left lateral aspect of cervical esophagus.

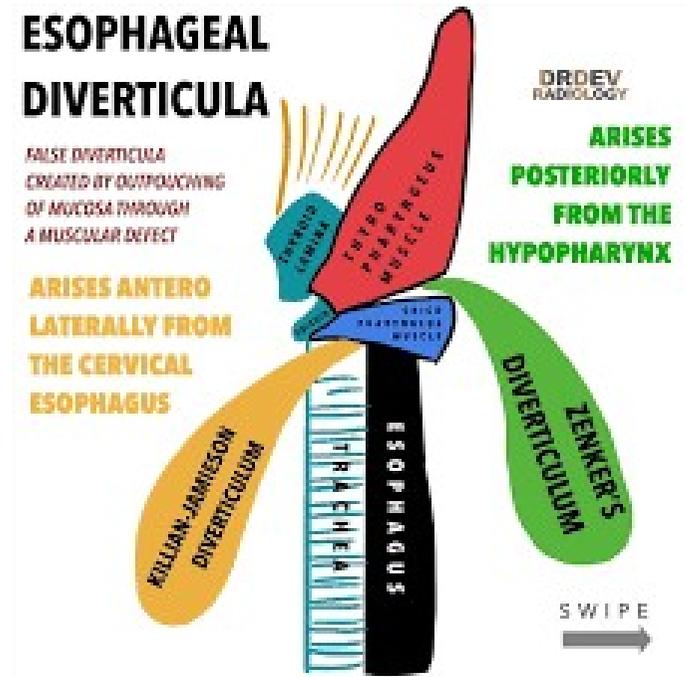


**Fig. 7**—40-year-old woman with enlarged thyroid. Anteroposterior fluoroscopic image shows enlarged right lobe of thyroid (*arrow*) causing compression and lateral displacement of cervical esophagus.



**Fig. 6A** —50-year-old man with left lateral Killian-Jamieson diverticulum.

**A**, Anteroposterior (**A**) and lateral (**B**) fluoroscopic images show diverticulum (*arrow, A*).





**Fig. 5B** —Three patients with Zenker diverticulum. Fluoroscopic images show Zenker diverticulum (*arrow*) extending anteriorly and compressing cervical esophagus.

**B**, 55-year-old man with moderate-sized Zenker diverticulum.

