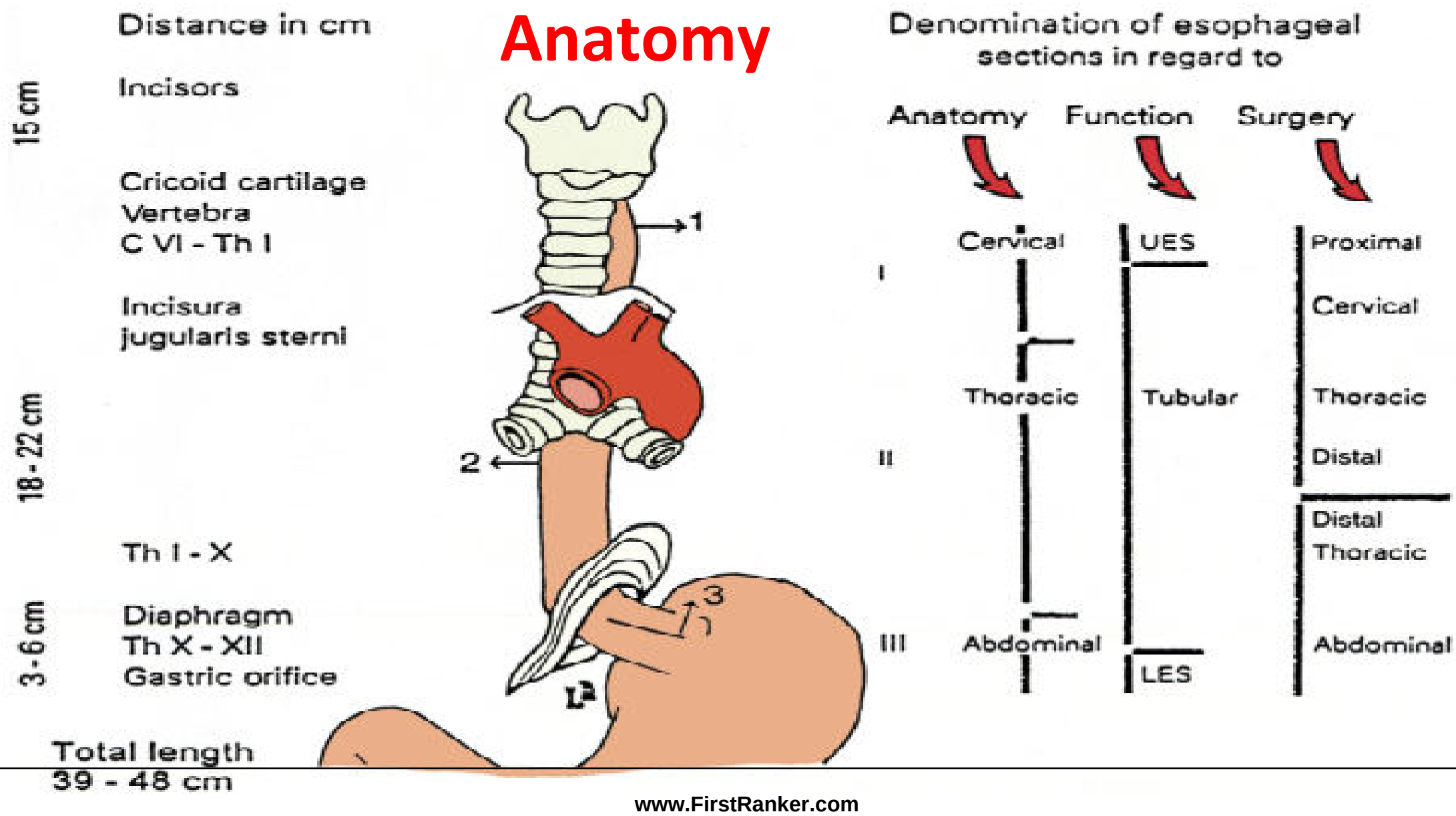
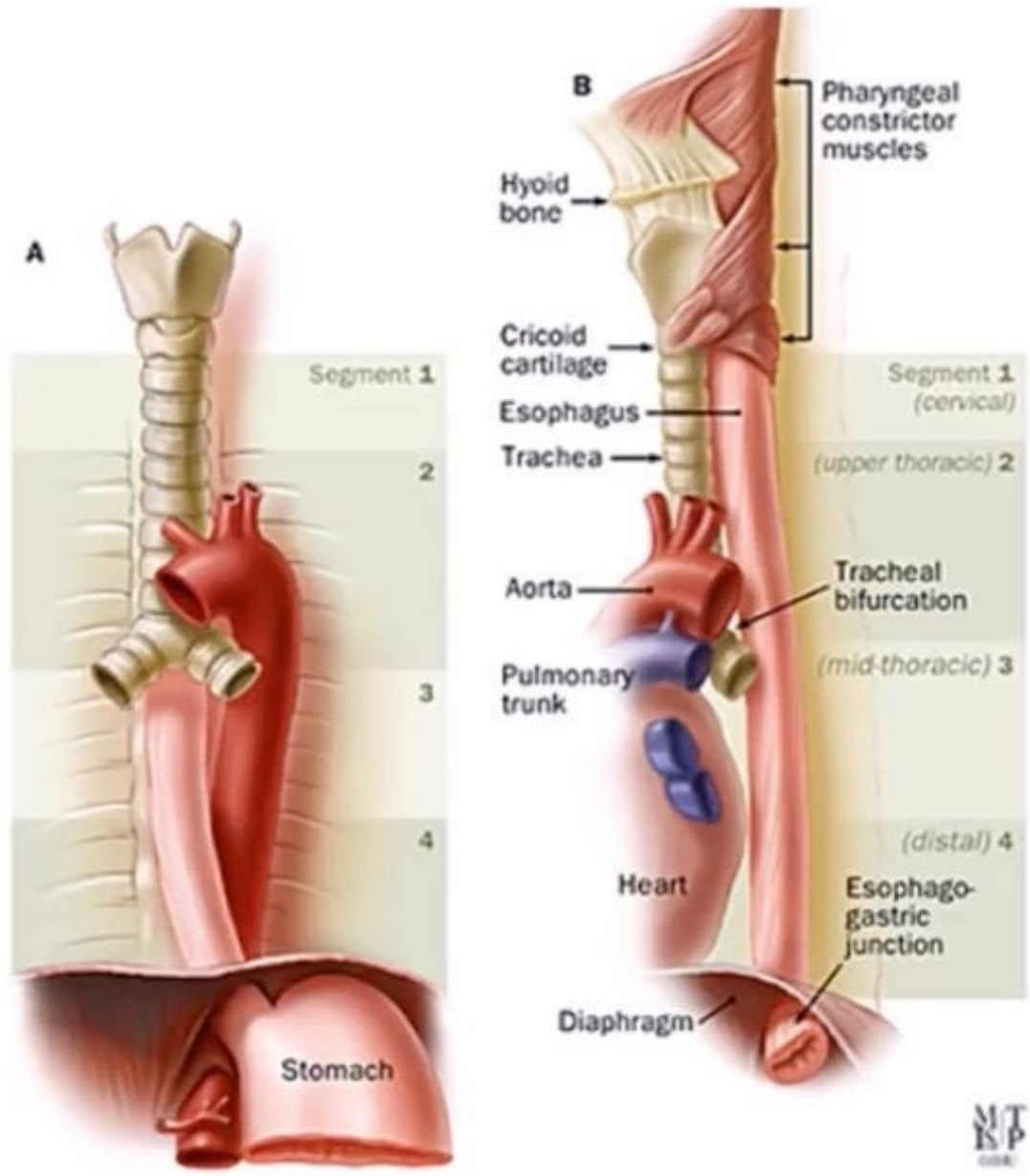
Esophagus- surgical anatomy

Anatomy

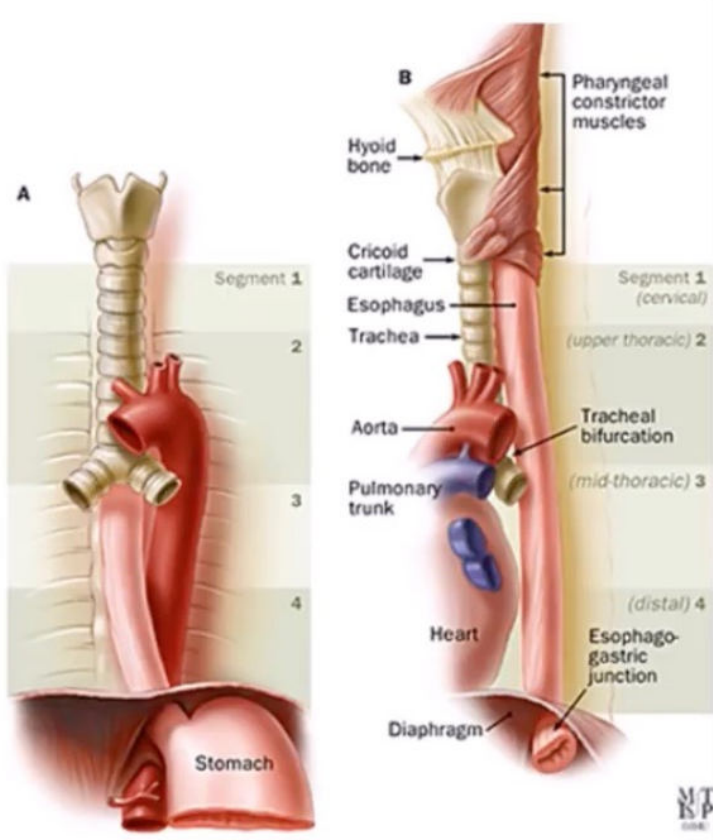


Relations of thoracic part of esophagus:

- Anteriorly: Trachea & left recurrent laryngeal nerve, left principal bronchus (constricts it)
- Posteriorly: Bodies of thoracic vertebrae, thoracic duct, azygos veins, right posterior intercostal arteries & descending thoracic aorta (at its lower level)



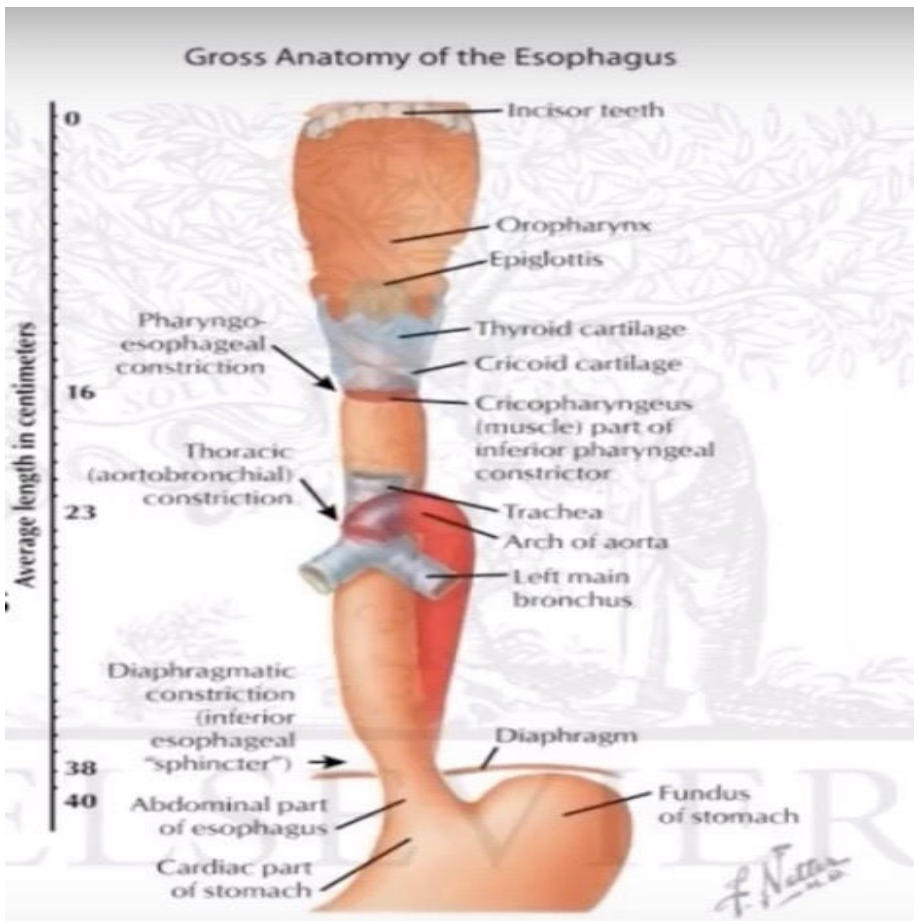
Relations...



- Right side- mediastinal pleura & terminal part of azygous vein
- Left side- left subclavian artery, aortic arch, thoracic duct, mediastinal pleura

- When esophagus pierces the diaphragm, it is accompanied by two vagi, branches of left gastric artery & lymphatic vessels.
- In abdomen – left lobe of liver anteriorly & left crus of diaphragm posteriorly.

Constrictions



I – Pharyngo-esophageal junction -15cm from incisor teeth.

II- Aortic arch and left bronchus crosses esophagus anteriorly- 25cm from incisor teeth.

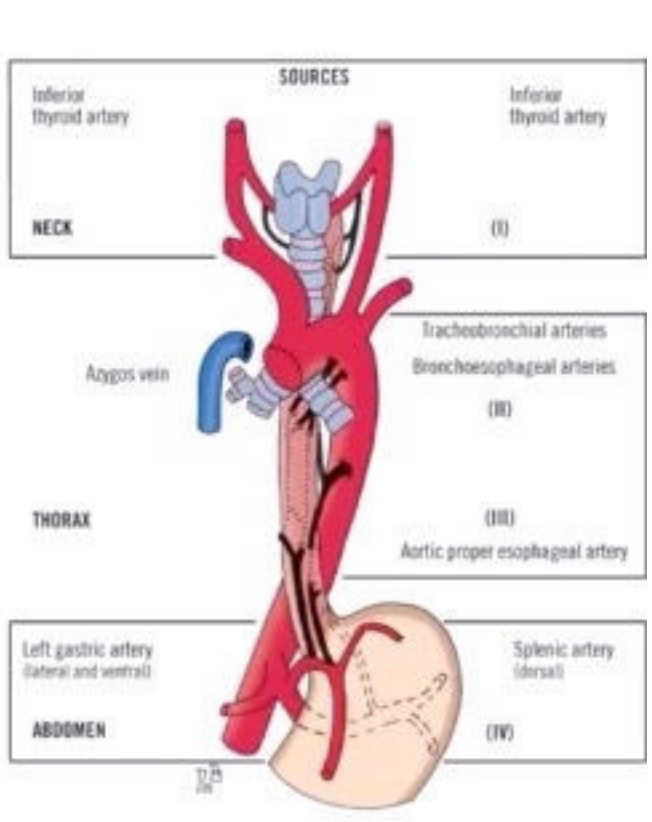
Clinical importance of constrictions of esophagus

- Common site for lodgment of foreign body
- Common site for stricture formation after corrosive ingestion
- Common site for carcinoma of esophagus
- Difficult sites for passage of esophagoscope.

Length of the Esophagus

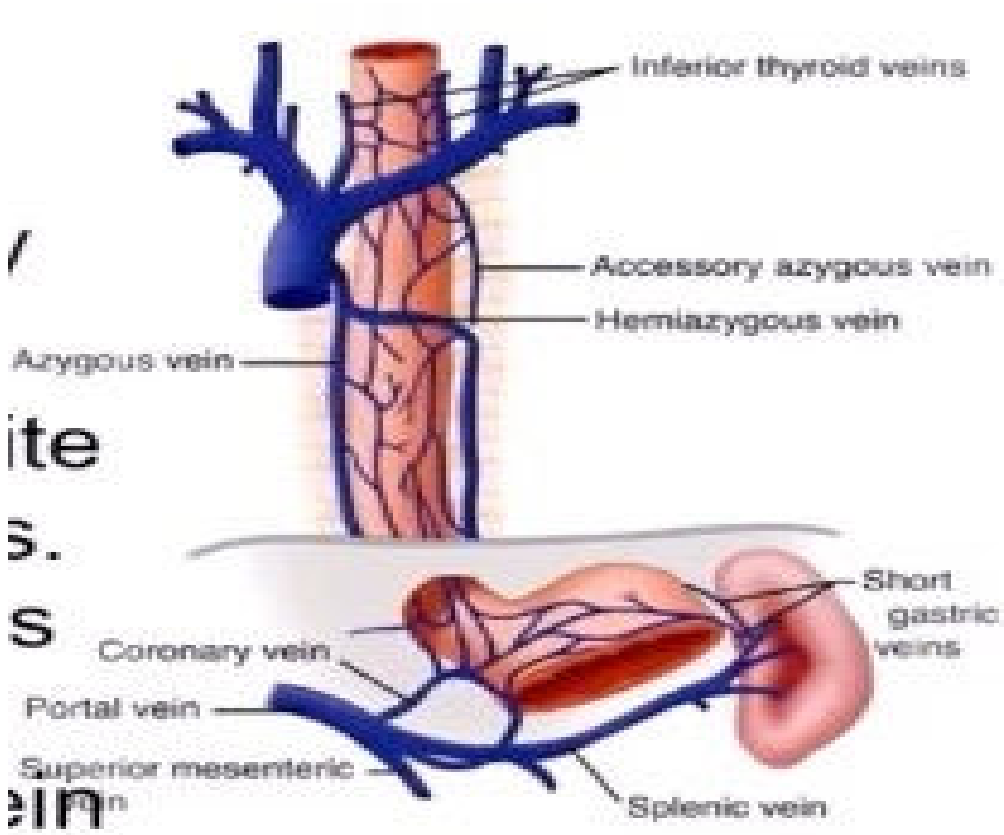
- The distance between the cricoid cartilage and the gastric orifice.
- In adults, it ranges from 22 to 28 cm, 3 to 6 cm of which is located in the abdomen.
- length of the esophagus is related to the subject's height rather than sex.
- Cervical – 5cm
- Thoracic -18-20cm
- Abdomen – 2-4cm

Blood supply



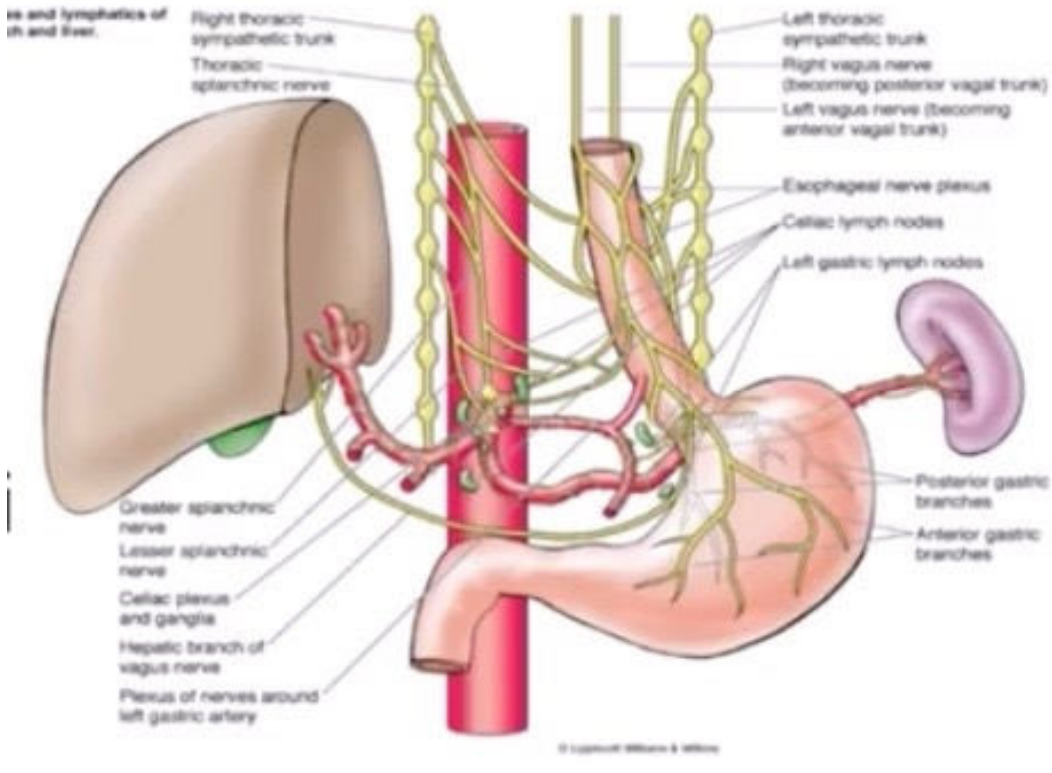
- Upper 1/3 – inferior thyroid artery
- Middle 1/3 – direct branches from aorta.
- Lower 1/3 – left gastric artery

Venous drainage



- Upper 1/3 – inferior thyroid vein
- Middle 1/3 – Azygous and hemi-azygous vein.
- Lower 1/3- left gastric vein

Nerve supply (Extrinsic)



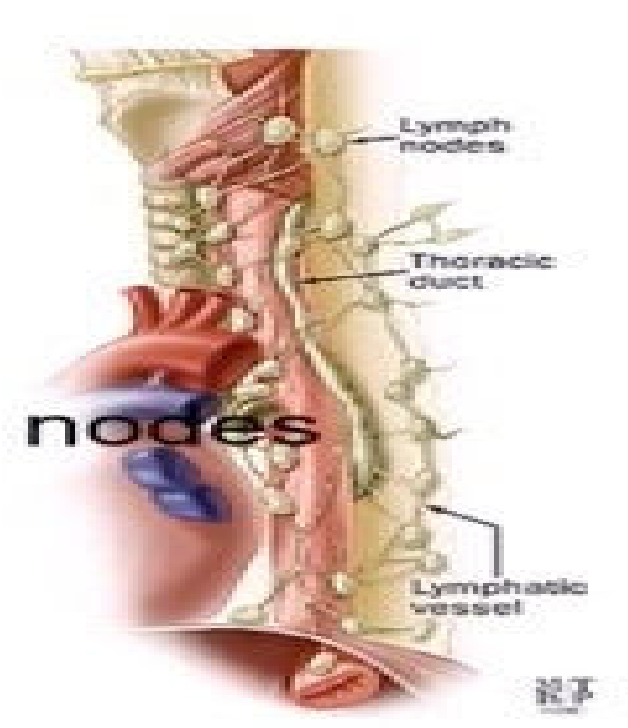
- Esophageal plexus – formed by vagus nerves by joining with sympathetic nerves below the root of lungs.
- LARP- left vagus anteriorly
    - Right vagus posteriorly

Nerve suply

- Extrinsic –vagus
- Intrinsic –
  - Auerbach /myentric plexus - between longitudinal and circular muscle
    - Peristalsis
  - Meissner's plexus- at submucosal level – for secretion
    - Meissner's submucosal plexus is sparse in the esophagus.

- The parasympathetic nerve supply is mediated by branches of the vagus nerve
  - that has synaptic connections to the **myenteric (Auerbach's) plexus**.

Lymphatic drainage

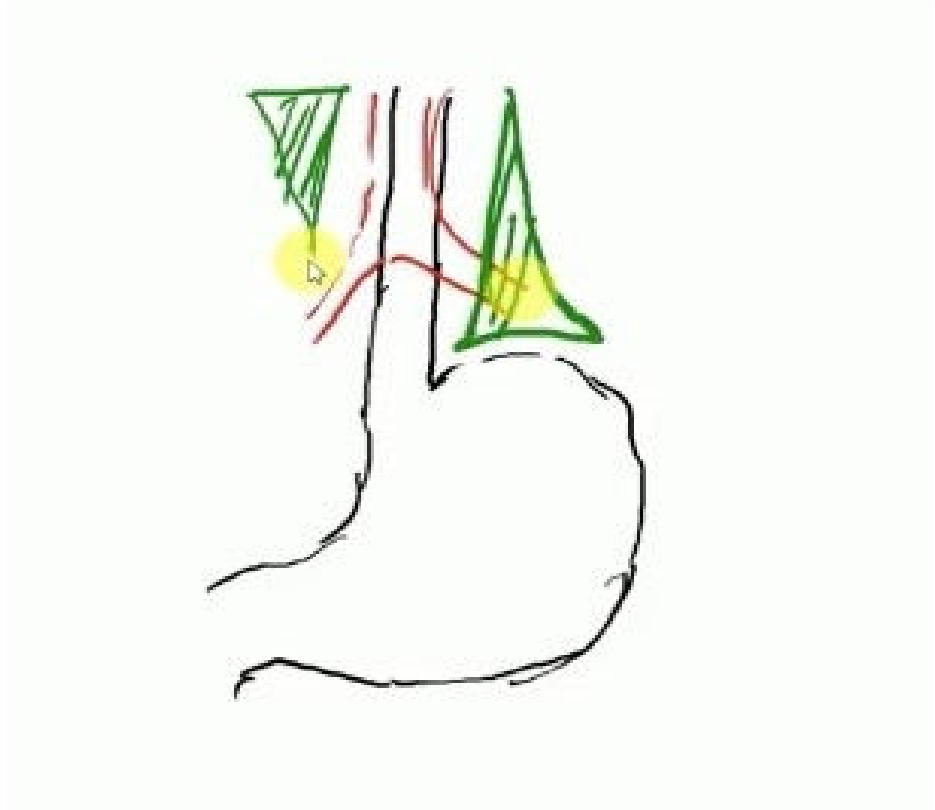


- Upper 1/3-
  - deep cervical nodes.
- Middle 1/3-
  - superior & posterior mediastinal nodes
- Lower 1/3-
  - celiac nodes

Diameter of the Esophagus

- The esophagus is the narrowest tube in the intestinal tract.
- At rest, the esophagus is collapsed; it forms a soft muscular tube .
- Flat in its **upper and middle** parts, with a diameter of **1.6 cm.**
- The **lower** esophagus is rounded, and its diameter is **2.4 cm.**

Musculature



- The musculature of the upper esophagus & UES is **striated**.
- This is followed by a **transitional zone** of both striated and smooth muscle.
- proportion of the smooth muscle. progressively increasing.
- In the **lower half** of the esophagus, there is only **smooth muscle**.
- It is lined throughout with **squamous epithelium**.

Layers

1. Mucosa –
   - epithelium
   - Basement membrane
   - Lamina Propria
2. Submucosa- **strongest layer**
3. Muscular propria-
   - Inner circular
   - Outer longitudinal
4. Adventitia –visceral peritoneum

Periesophageal Tissue, Compartments, and Fascial Planes

- Unlike the general structure of the digestive tract, the esophageal tube has **neither mesentery nor serosal coating**.

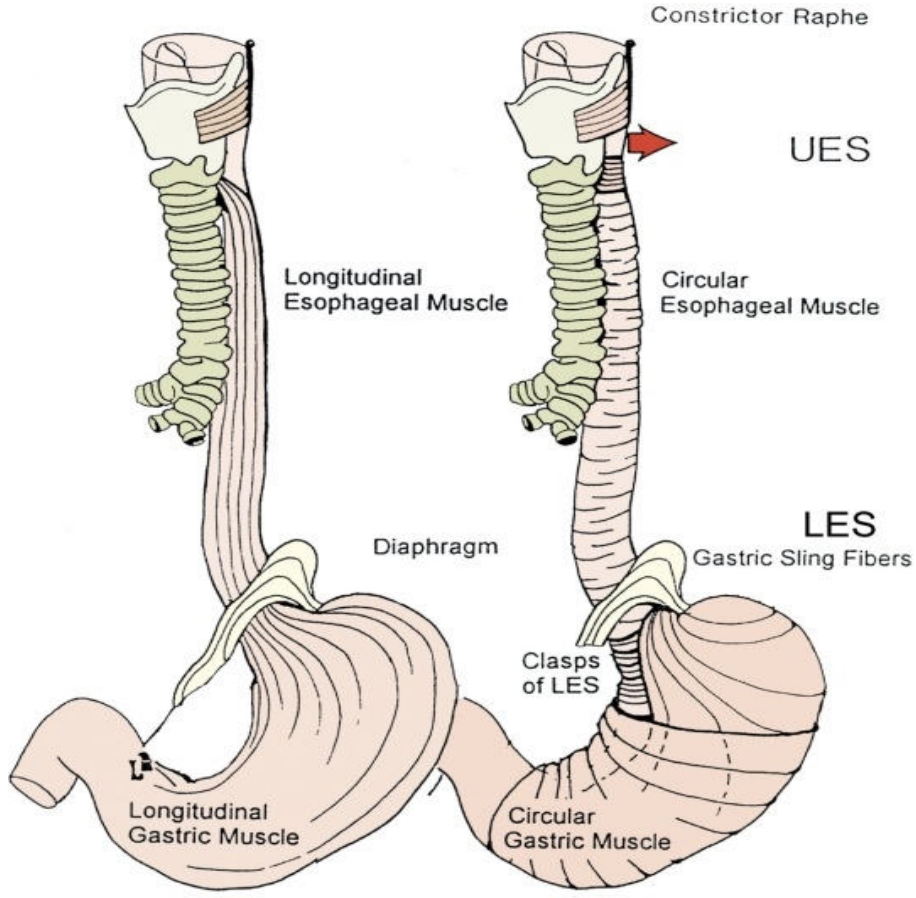
- Its position within the mediastinum and a **complete envelope of loose connective tissue** allow the esophagus extensive transverse and longitudinal mobility.

- The esophagus may be subjected to easy blunt stripping from the mediastinum.

Clinical relevance

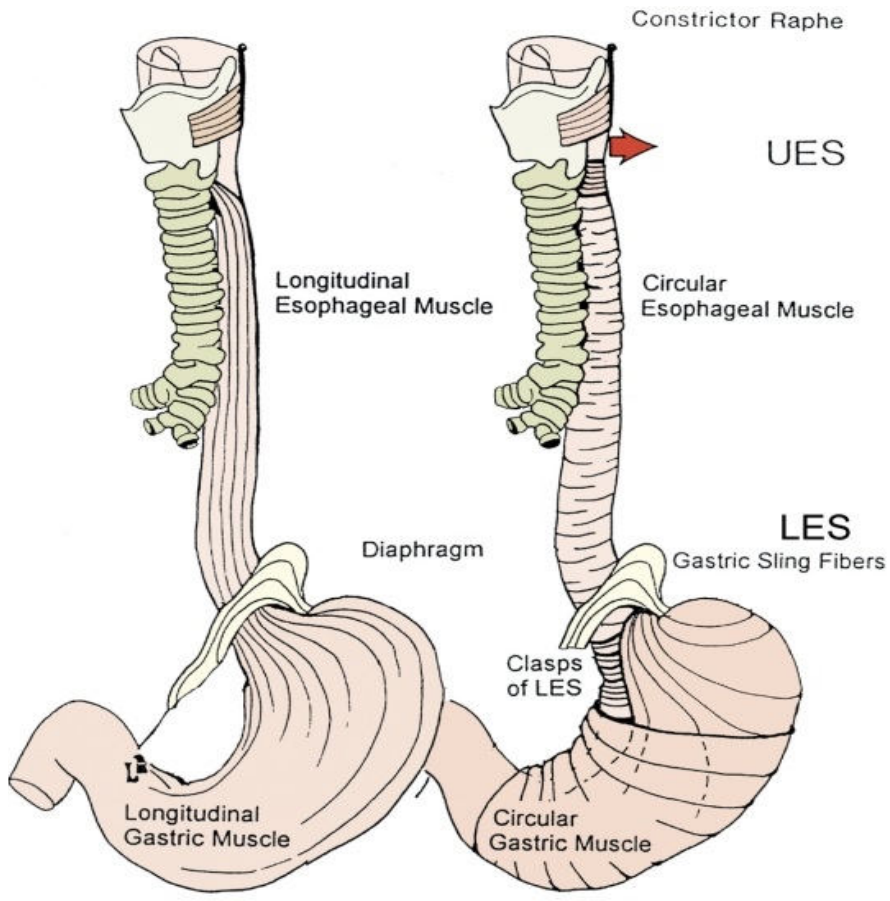
- The connective tissues in which the esophagus and trachea are embedded are bounded by fascial planes,
  - the pretracheal fascia anteriorly and
  - the prevertebral fascia posteriorly.
- In the upper part of the chest, both fascia unite to form the **carotid sheath.**

Tunica Adventitia



- This thin coat of **loose connective tissue envelops** the esophagus.
- connects it to adjacent structures,
- contains small vessels, lymphatic channels, and nerves.

Tunica Muscularis



- The tunica muscularis coats the lumen of the esophagus in two layers :
- the **external** muscle layer parallels the **longitudinal** axis of the tube,
- the muscle fibers of the **inner** layer are arranged in the **horizontal** axis.
- For this reason, these muscle layers are classically called longitudinal and circular, respectively.

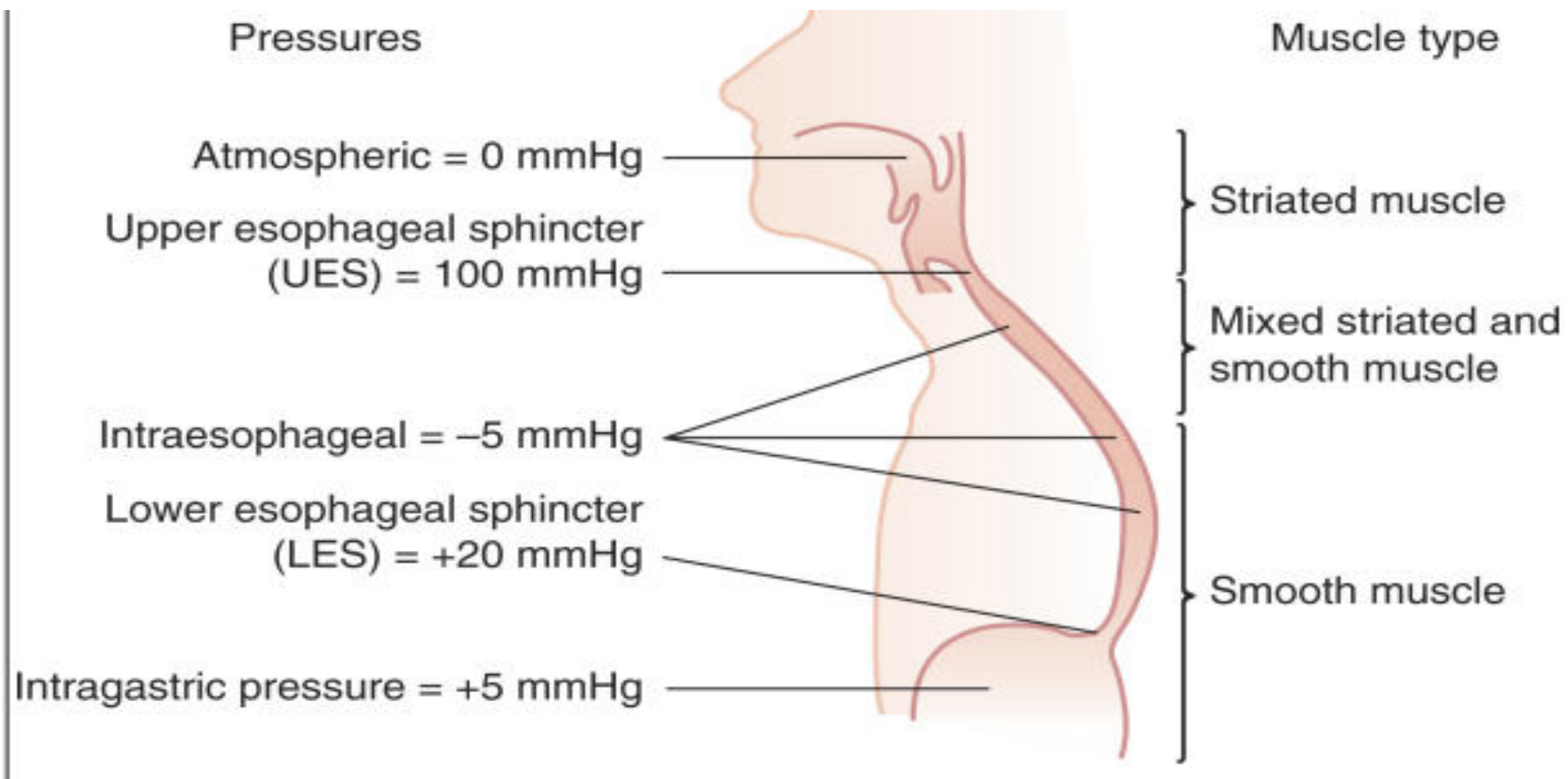
Tela Submucosa

- The submucosa is the connective tissue layer that lies between the muscular coat and the mucosa.
- It contains a meshwork of small blood and lymph vessels, nerves, and mucous glands.
- The duct of deep esophageal glands pierce the muscularis mucosae.

Tunica Mucosa

- The mucous layer is composed of three components:
  - the muscularis mucosae,
  - the tunica / lamina propria, and
  - the inner lining of nonkeratinizing stratified squamous **epithelium** .

Physiology of the Esophagus and Its Sphincters



Physiology

- The musculature of the esophagus = predominantly striated at the level of the UES and proximal 1 to 2 cm of the esophagus.

- mixed striated = smooth muscle transition zone spanning 4 to 5 cm

- Entirely smooth muscle structure = in the distal 50% to 60% of the esophagus, including the LES

SWALLOWING PROCESS

- Normal human subjects swallow on average 500 times a day.
- The act of swallowing can be divided into three stages:
  1. the oral (voluntary) stage,
  2. the pharyngeal (involuntary) stage, and
  3. the esophageal stage.

- These stages are a continuous process closely coordinated through the medullary swallowing centers.

Esophageal Stage

- The esophageal stage of swallowing starts once the food is transferred from the oral cavity through the UES into the esophagus.

- This active process is achieved by contractions of the circular and longitudinal muscles of the tubular esophagus and coordinated relaxation of the LES.

- Esophageal peristalsis is controlled by afferent and efferent connections of the medullary swallowing center via the **vagus nerve** (cranial nerve X).

- The vagus nerve carries both stimulating (cholinergic) and inhibitory (noncholinergic, nonadrenergic) information to the esophageal musculature.

- In addition to the central nervous system control, the myenteric (Auerbach) plexus
  - plays a major role in coordinating peristalsis in the smooth muscle portion of the distal esophagus.

Esophageal peristalsis

- Esophageal peristalsis is the result of sequential contraction of the circular esophageal muscle.
- Three distinct patters of esophageal contractions have been described:
  1. Primary peristalsis
  2. Secondary peristalsis
  3. Tertiary contractions.

Primary peristalsis

- Primary peristaltic contractions are the usual form of the contraction waves of **circular muscles** that progress down the esophagus;

- they are initiated by the **central mechanisms** that follow the voluntary act of swallowing.

- During primary peristalsis, the LES is relaxed, starting at the initiation of swallowing and lasting until the peristalsis reaches the LES.

Secondary peristalsis

- **Secondary** peristaltic contractions are the contraction waves of the circular esophageal muscle occurring in response to esophageal distention.
- They are **not a result of central mechanisms**.
- The role of secondary peristaltic contractions is to clear the esophageal lumen of ingested material not cleared by primary peristalsis or material that is refluxed from the stomach.
- **Tertiary** contractions are primarily identified during barium x-ray studies and represent **non-peristaltic** contraction waves that leave segmental indentations on the barium column.

LES

- Normal LES resting pressure ranges from 10 to 45 mm Hg above the gastric baseline level.

- The function of the LES is to
  - prevent gastroesophageal reflux and
  - to relax with swallowing to allow movement of ingested food into the stomach.

Perforation of the oesophagus

- Causes -
  1. usually **iatrogenic** (at therapeutic endoscopy) or
  2. due to 'barotrauma' (**spontaneous** perforation).
  3. Pathological perforation- rare
  4. Penetrating injury

Barotrauma (spontaneous perforation, Boerhaave syndrome)

- This occurs classically when a person vomits against a closed glottis.
- The pressure in the oesophagus increases rapidly, and the oesophagus bursts at its weakest point in the **lower third**, sending a stream of material into the mediastinum and often the pleural cavity as well.

- The condition was first reported by Boerhaave , who reported the case of a grand admiral of the Dutch fleet who was a glutton and practised auto emesis.

Boerhaave syndrome…

- **Most serious type of perforation**
  - because of the large volume of material that is released under pressure.
  - mediastinitis
- Barotrauma has also been described in relation to other pressure events when the patient strains against a closed glottis (e.g. defaecation, labour, weight-lifting).

Diagnosis of spontaneous perforation

- history
  - severe pain in the chest or upper abdomen following a meal or a bout of drinking.
  - shortness of breath
- O/E-
  - rigidity on examination of the upper abdomen, even in the absence of any peritoneal contamination.
- D/D
  - myocardial infarction,
  - perforated peptic ulcer or
  - pancreatitis if the pain is confined to the upper abdomen.

Boerhaave syndrome…

1. Chest x-ray - confirmatory
   - air in the mediastinum, pleura or peritoneum.
2. A contrast swallow or
3. CT scan

Pathological perforation

- Free perforation of ulcers or tumors of the oesophagus into the pleural space is **rare**.
- Erosion into an adjacent structure with fistula formation is more common.
- Aerodigestive fistula is most common and usually encountered in primary malignant disease of the oesophagus or bronchus.

- Covering the communication with a self-expanding metal stent is the usual solution.

Penetrating injury

- Perforation by knives and bullets is uncommon

Instrumental perforation

- Instrumentation is by far the **most common cause of perforation**.
- Incidence - 1:4000 examinations /UGIE

Diagnosis of instrumental perforation

- History and physical signs may be useful pointers to the site of perforation.

1. **<u>Cervical perforation:</u>**
   - pain localised to the neck,
   - hoarseness,
   - painful neck movements and
   - subcutaneous emphysema.

2. Intrathoracic and intra-abdominal perforations, (more common),

- Immediate symptoms and signs
  - chest pain,
  - haemodynamic instability,
  - oxygen desaturation .
  - evidence of subcutaneous emphysema, pneumothorax or hydropneumothorax.

Treatment of oesophageal perforations

- Perforation of the oesophagus usually leads to mediastinitis.
- The loose areolar tissues of the posterior mediastinum allow a rapid spread of gastrointestinal contents.
- **Aim of treatment**
  - limit mediastinal contamination and
  - prevent or deal with infection.

Decision between operative and non-operative management rests on four factors

1. the site of the perforation (cervical versus thoraco-abdominal oesophagus);
2. the event causing the perforation (spontaneous versus instrumental);
3. underlying pathology (benign or malignant);
4. the status of the oesophagus before the perforation (fasted and empty versus obstructed with a stagnant residue).

Non-operative treatment of Instrumental perforations

- **Cervical** oesophagus - are usually small perforation and can nearly always be managed **conservatively**.

- The development of a local abscess is an indication for cervical drainage preventing the extension of sepsis into the mediastinum.

Indication for non-operative management (thoraco-abdominal perforation)

- when the perforation is detected early and prior to oral alimentation.
- **absence of**
  - crepitus,
  - diffuse mediastinal gas,
  - Hydro-pneumothorax or pneumo-peritoneum;

- mediastinal containment of the perforation with no evidence of widespread extravasation of contrast material;

- no evidence of ongoing luminal obstruction or a retained foreign body.

- patients who have remained clinically stable despite diagnostic delay.

Principles of non-interventional management

- nasogastric suction and
- broad-spectrum intravenous antibiotics

Indication of Surgical management

- unstable with sepsis or shock;
- have evidence of a heavily contaminated mediastinum, pleural space or peritoneum;
- have widespread intra-pleural or intra-peritoneal extravasation of contrast material.

Surgery

- direct repair,
- the deliberate creation of an external fistula or,
- rarely, oesophageal resection with a view to delayed reconstruction.

- **Direct repair**
  - if the perforation is recognised early (within the first 4–6 hours) and the extent of mediastinal and pleural contamination is small.
- After 12 hours, the tissues become swollen and friable , primary repair not possible.

MALLORY–WEISS SYNDROME

- Forceful vomiting may produce a mucosal tear at the cardia rather than a full perforation.
- In Boerhaave's syndrome, vomiting occurs against a closed glottis, and pressure builds up in the oesophagus.
- In Mallory– Weiss syndrome, vigorous vomiting produces a vertical split in the gastric mucosa, immediately below the squamo-columnar junction at the cardia in 90 per cent of cases.
- In only 10 per cent is the tear in the oesophagus.

MALLORY–WEISS SYNDROME…

- Clinical feature
  - Haematemesis

- Surgery is rarely required.