Gastrointestinal disease: Can plain chest films provide any clues?

e-Poster: P-104

Congress: ESGAR 2009

Type: Educational Exhibit

Topic: Diagnostic / Liver / Other

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MeSH:

Gastrointestinal Diseases [C06.405]

Radiography, Thoracic [E01.370.350.700.730]

1. Learning objectives

1) To list the pathological processes of the gastrointestinal tract that can present with intrathoracic changes.
2) To describe and illustrate the spectrum of findings on the chest radiograph that can raise suspicion to the presence of gastrointestinal disease.

2. Background

Gastrointestinal diseases may produce radiographic changes in the thorax. In fact, an abnormal chest radiograph is often the initial clue to the diagnosis of several illnesses of the gastrointestinal tract.

Esophageal processes, such as benign and malignant tumors, achalasia, diverticula, duplication cysts and perforation, usually result in diagnostic changes on plain chest films. Extraesophageal gastrointestinal entities, including pancreatitis and intraabdominal abscesses are also associated with intrathoracic changes.

3. Imaging findings OR Procedure details

ESOPHAGEAL ABNORMALITIES

The esophagus is a well-known component of the posterior mediastinum, thus can be the cause of abnormalities on chest radiographs.

Radiologic anatomy basics

The esophagus lies posterior or posterolateral to the trachea, from the level of the thoracic inlet superiorly to the tracheal carina inferiorly.

Frontal radiographs

From the thoracic inlet to the level of the aortic arch, the visceral and parietal pleural of the posteromedial portion of the right and left upper lobes of the lungs meet behind the esophagus and immediately anterior to the spine to form the **posterior junction line** that appears as a vertical line through the tracheal air column on frontal radiographs (Fig.1; Fig.2). Inferiorly to this level they become separated by the forward arching of the superior intercostals veins and by the aortic and posterior azygos arches. Consequently, on the posteroanterior chest radiograph the posterior junction line is typically noted to end at about the level of the aortic knob.

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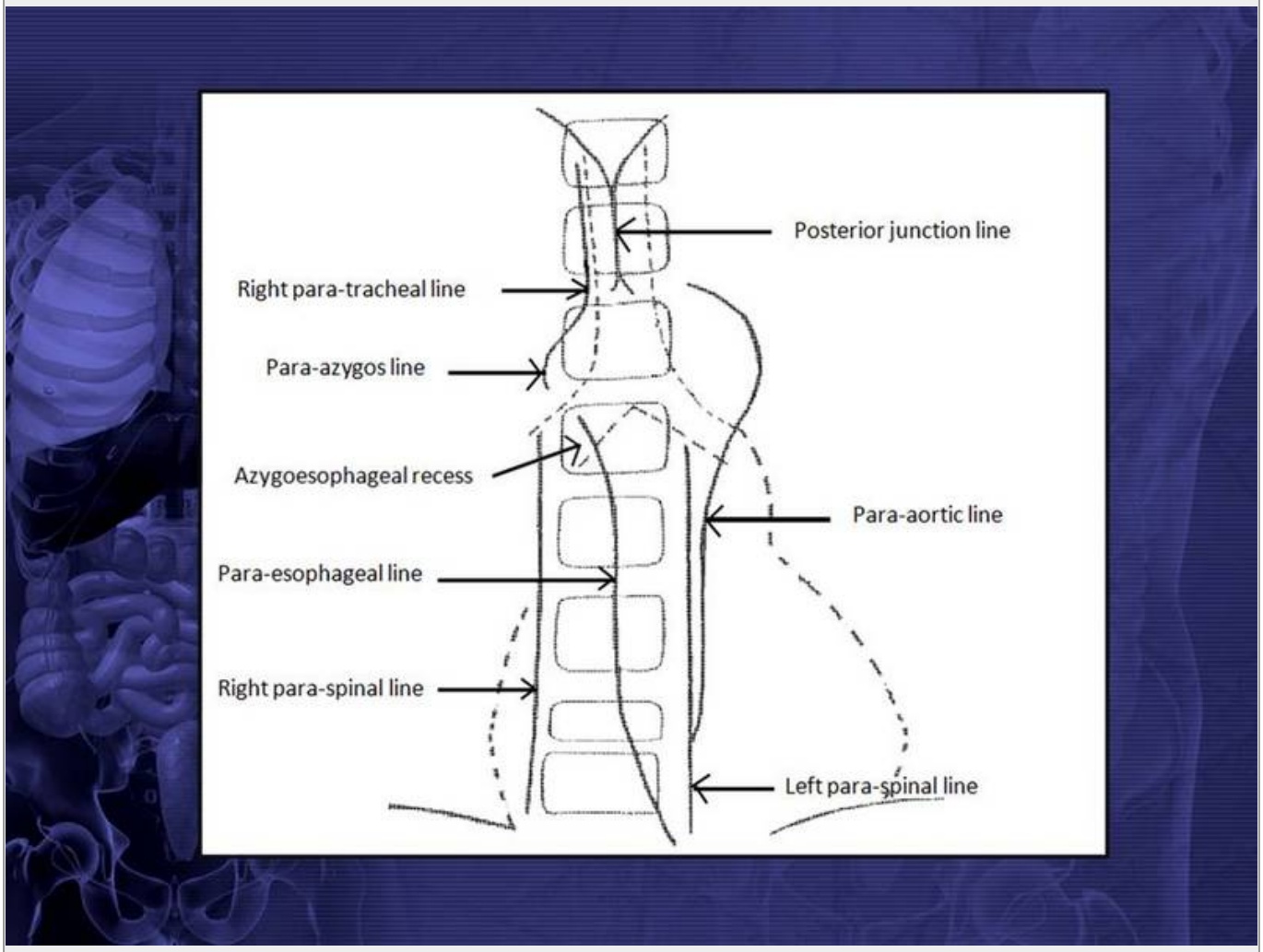

Figure 1. Lines in the posterior mediastinum. (adapted from Wright F. Radiology of the Chest and Related Conditions. p. 1.10)

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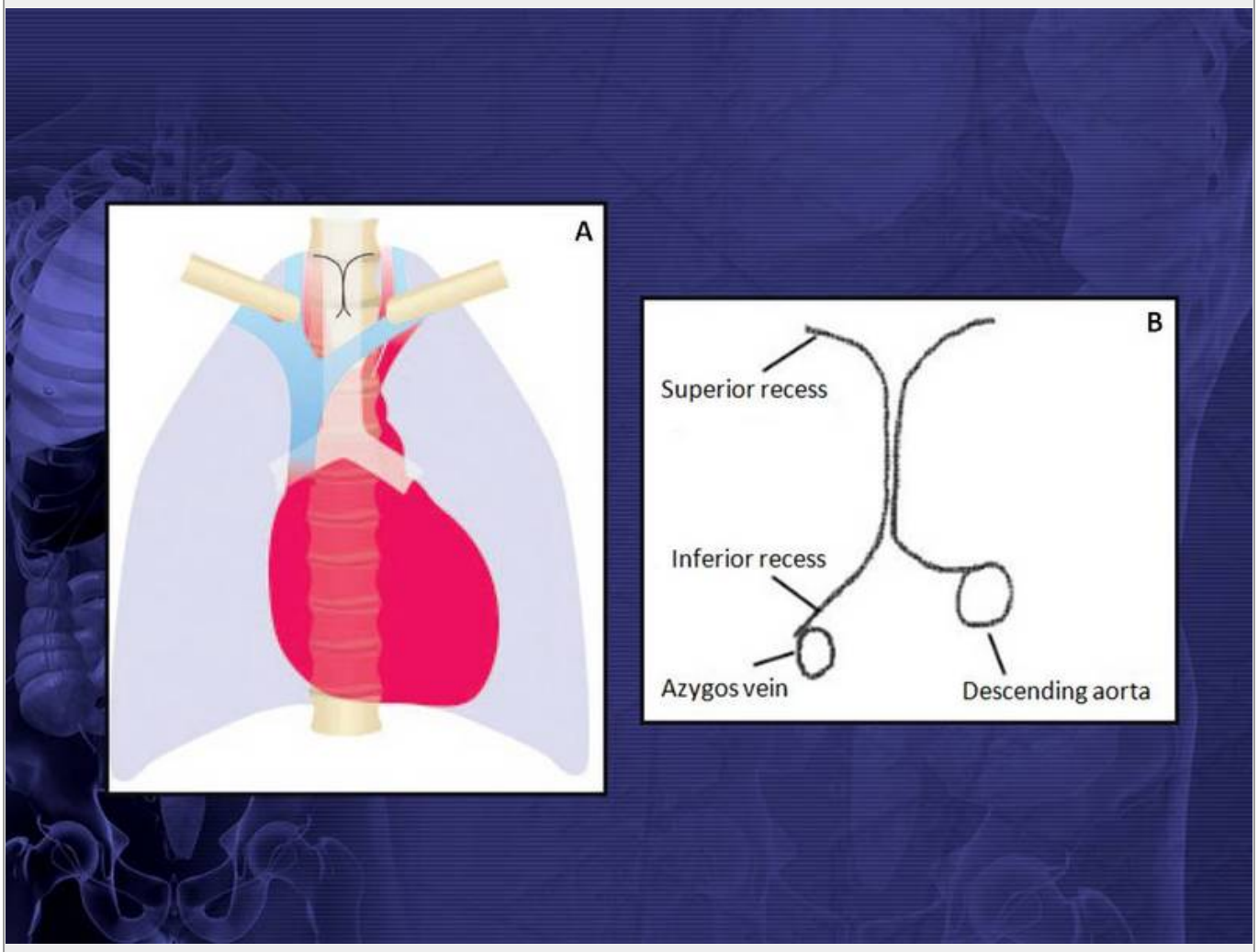

Figure 2. Illustration (A) and diagram (B) depicting the normal anatomy of the posterior junction line. (A. from Gibbs et al. Lines and Stripes: Where Did They Go – From Conventional Radiography to CT. RadioGraphics 2007; 27:33–48. B. adapted from Wright F. Radiology of the Chest and Related Conditions. p. 1.15)

Below the azygos and aortic arches, the esophagus maintains a constant relationship with the descending thoracic aorta, usually lying anteromedial to the aorta down to the level of the aortic hiatus, where the aorta is in a direct prevertebral position while the esophagus crosses the aorta anteriorly to exit the thorax via the esophageal hiatus.

At this level the medial lung surfaces again approach the midline. On the right, the posteromedial portion of the lower lobe of the lung contacts with the mediastinum, creating the **azygoesophageal recess**, which extends from the level of the anterior turn of the azygos vein to the level of the aortic hiatus inferiorly (Fig.1; Fig.3).

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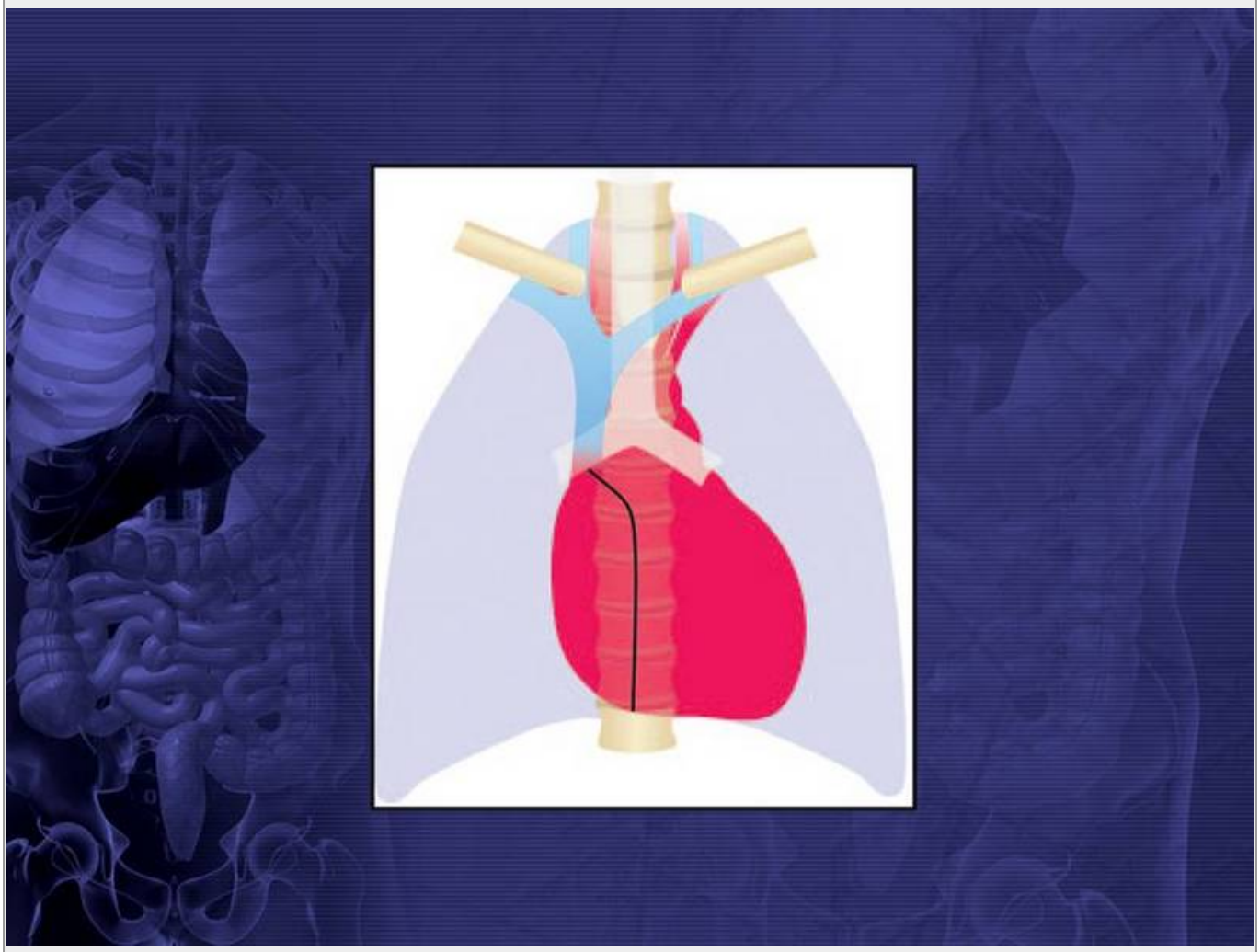

Figure 3. Illustration showing the normal azygoesophageal recess. (from Gibbs et al. Lines and Stripes: Where Did They Go – From Conventional Radiography to CT. RadioGraphics 2007; 27:33–48)

On the left, in a small percentage of normal individuals, the **preaortic recess** interface is seen as a reflection of the left lower lobe with the esophagus anterior to the descending aorta; it extends vertically from the underface of the aortic knob a variable distance towards the diaphragm (Fig.1; Fig.4).

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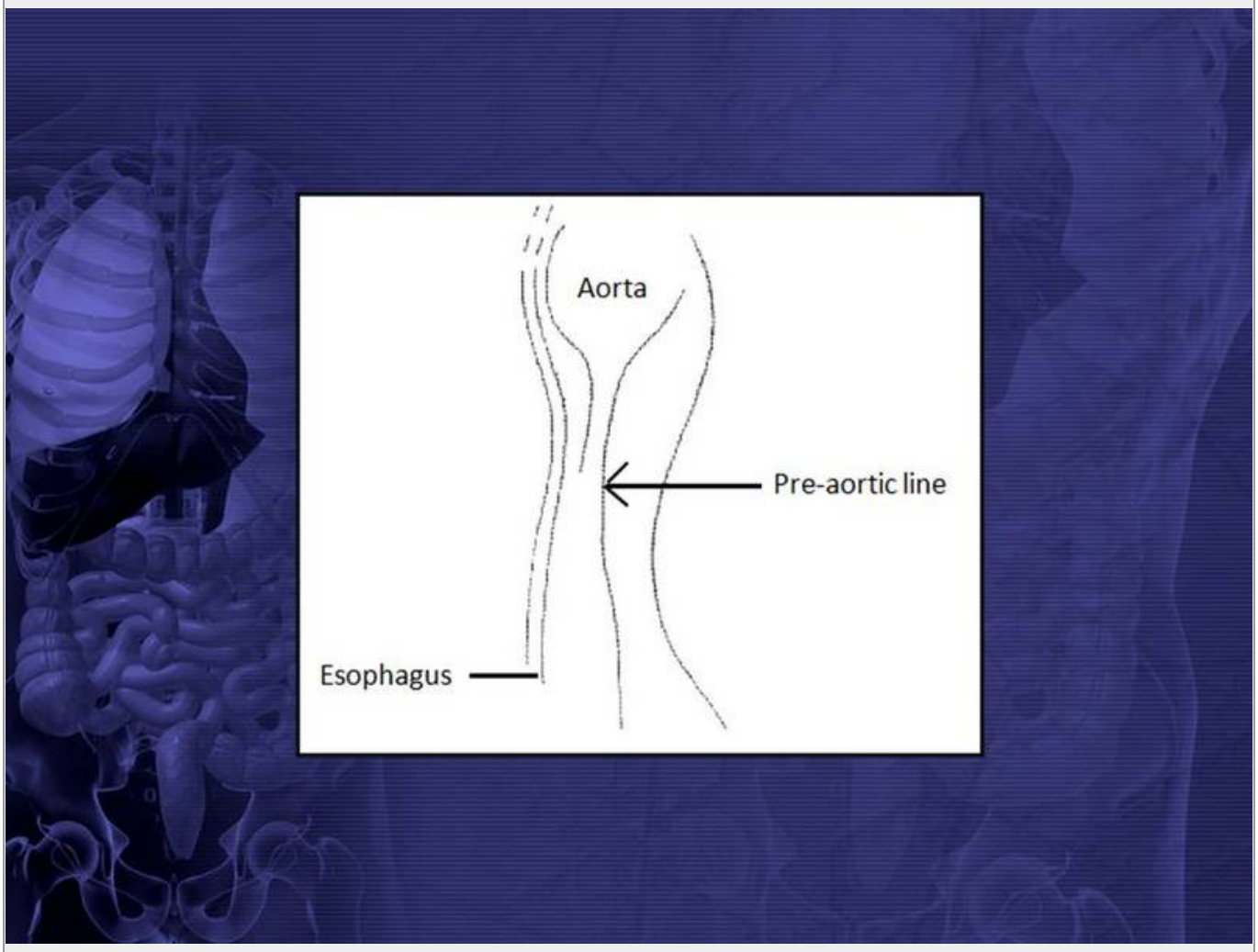

Figure 4. The pre-aortic line. (adapted from Wright F. Radiology of the Chest and Related Conditions: p. 1.19)

Occasionally the mediastinal anatomy causes the lung in the azygoesophageal recess and preaortic lung to meet to form a true posterior junction line in this area as well.

Lateral radiographs

On lateral chest radiographs one can further see the **posterior tracheal stripe** (or tracheoesophageal stripe), which is a vertical band that is formed by air within the trachea and right lung outlining the posterior tracheal wall or the juxtaposed posterior tracheal and anterior esophageal walls. It may measure up to 3-4 mm; esophageal lesions (most often achalasia and esophageal carcinoma), among others, may cause abnormal thickening of the posterior tracheal stripe (Fig.5).

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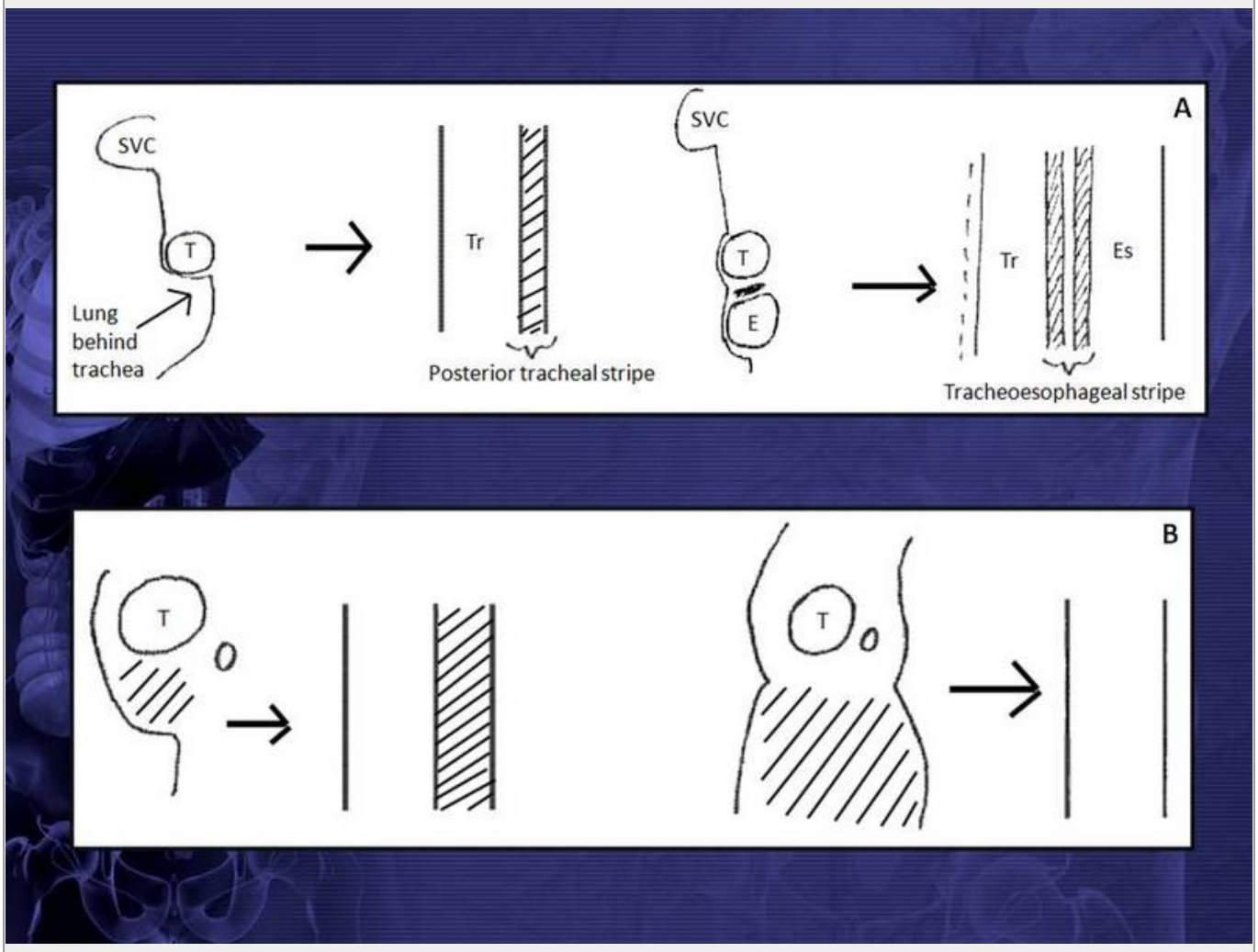

Figure 5. (A) Retrotracheal and retroesophageal stripes. (B) Tumor, nodes and esophageal mass thickening the retrotracheal stripe. When there are very large nodes or a tumor obliterating the retrotracheal space, the stripe will be completely lost, since no air-filled lung will project behind the trachea. (adapted from Wright F. Radiology of the Chest and Related Conditions. p. 1.23-1.24)

Achalasia (and other esophageal motility disorders)

The chest plain film is usually normal in the early phase of achalasia.

As the esophagus dilates, it can readily be observed in chest radiographs, since it creates new interfaces with the lung (Fig. 6-8).

· Widening of the mediastinum, air-fluid levels (retained fluid and food debris) and absence of the gastric fundus gas bubble can be detected on frontal radiographs obtained with the patient in the upright position.

· The azygoesophageal recess, which is normally straight or slightly concave to the right, becomes more convex to the right as the esophagus dilates and is seen as an opacity behind the right border of

the heart, which is wavy and irregular.

· Acute or chronic aspiration associated with poor esophageal emptying may lead to pulmonary disease, which may also be seen.

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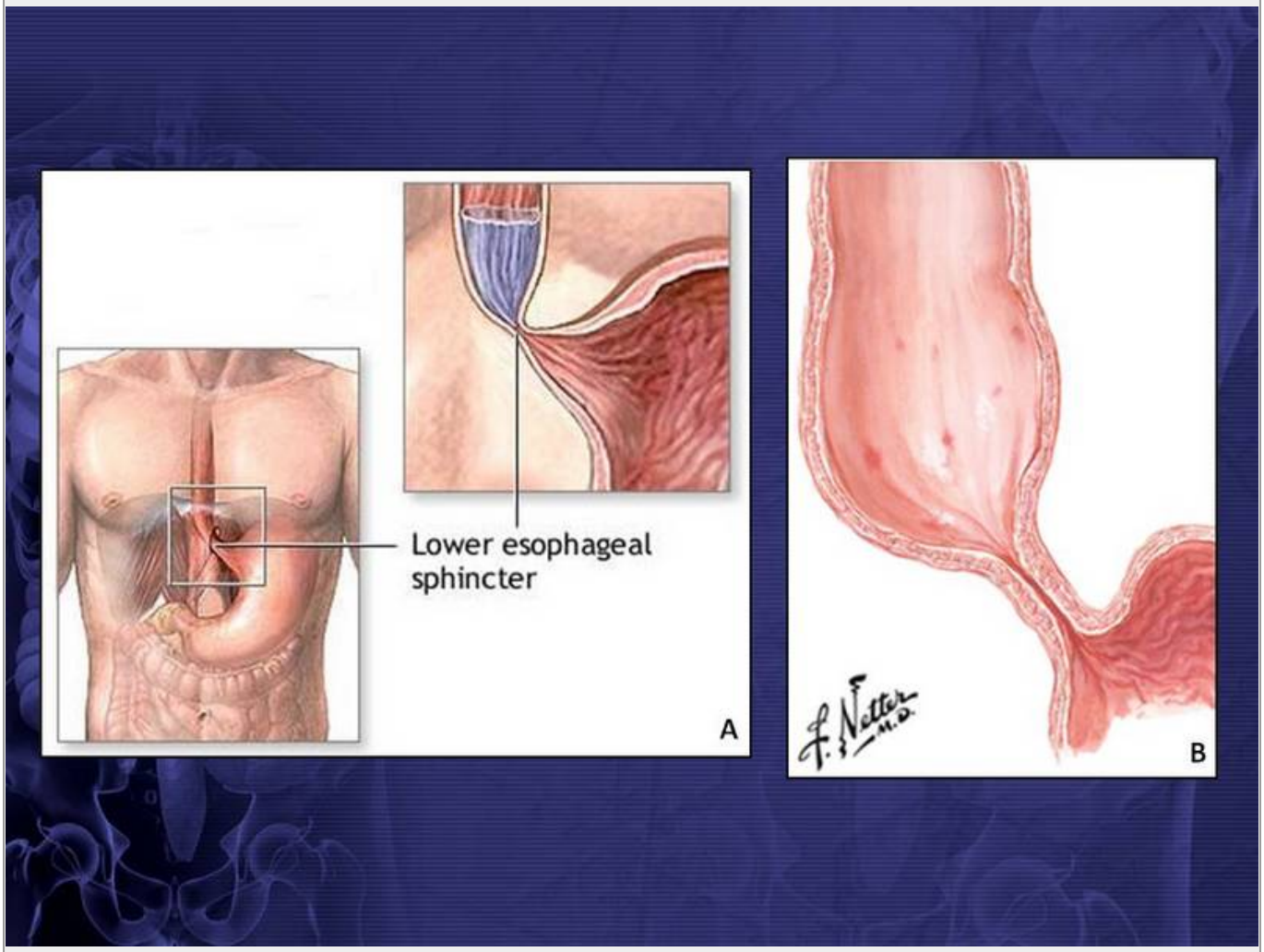

Figure 6. Achalasia. In advanced disease, the esophagus becomes dilated and filled with food residues. The esophageal wall is thickened and the lower esophageal sphincter fails to relax properly in response to swallowing. (A. adapted from http://adam.about.com/surgery/Achalasia-series.htm. B. adapted from Netter F. Netter's Illustrated Human Pathology.)

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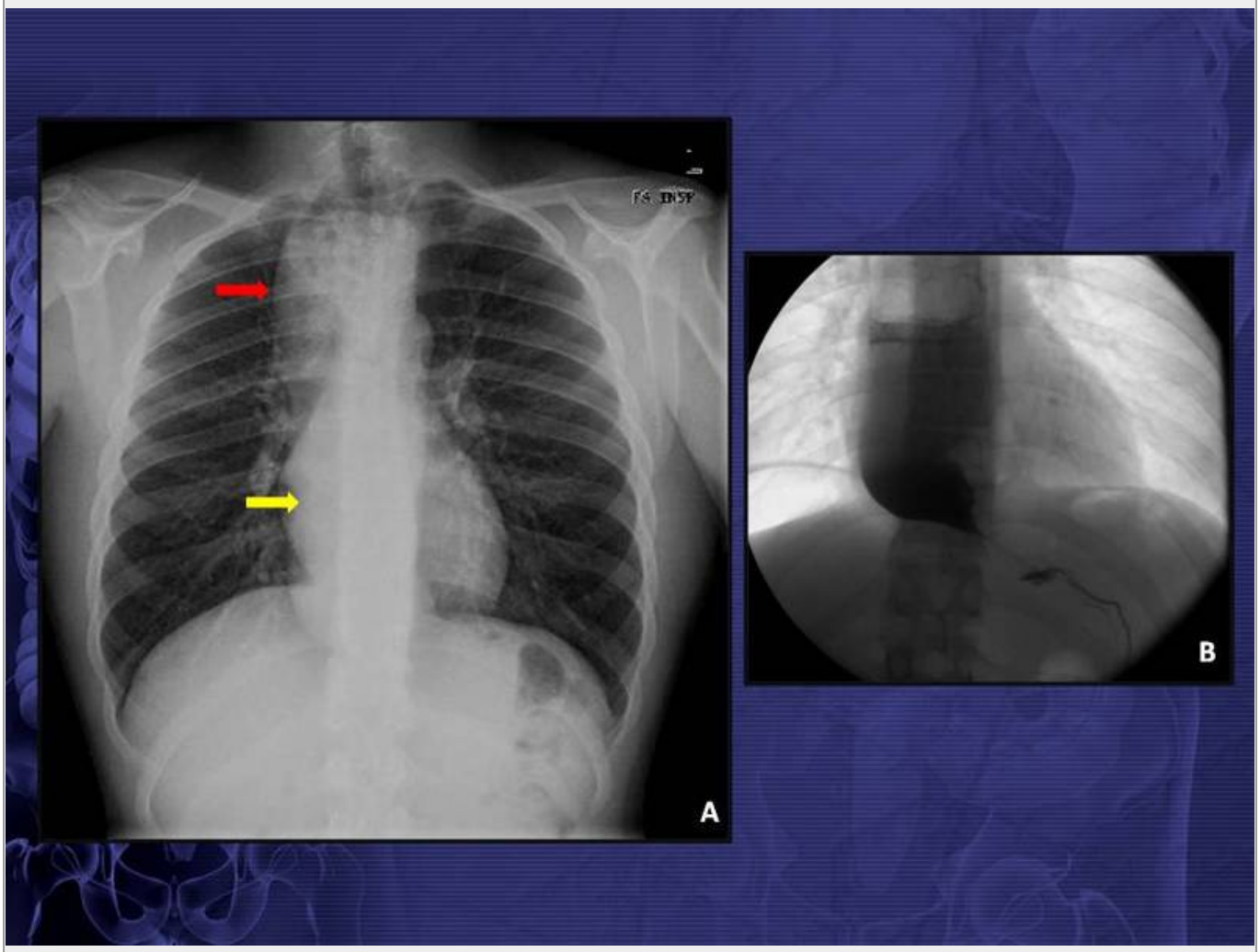

Figure 7. (A) Frontal chest radiograph of a 18-year-old patient showing widening of the superior mediastinum (red arrow), with some air lucencies patent on the right (debris-filled dilated esophagus). Note also the right convexity of the azygoesophageal recess (yellow arrow), secondary to the opacity of the dilated esophagus behind the right heart border. (B) Frontal esophagogram in the same patient confirmed the diagnosis of achalasia.

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Figure 8. (A) Frontal chest film reveals widening of the superior mediastinum secondary to massive dilatation of the esophagus, which protrudes into the right hemithorax, with an air-fluid level (arrow). (B) The esophagogram shows the typical findings of achalasia, confirming the diagnosis.

The lateral film allows identification of an abnormal posterior soft-tissue mass that may obliterate the posterior cardiac contour as well as bow and deviate the trachea anteriorly; clear delineation or thickening of the posterior tracheal stripe may also indicate excessive gas in the esophagus.

Other causes of esophageal motility disorders that may produce similar findings on chest x-rays include presbyesophagus, diffuse esophageal spasm, and collagen-vascular disorders (including scleroderma – Fig.9).

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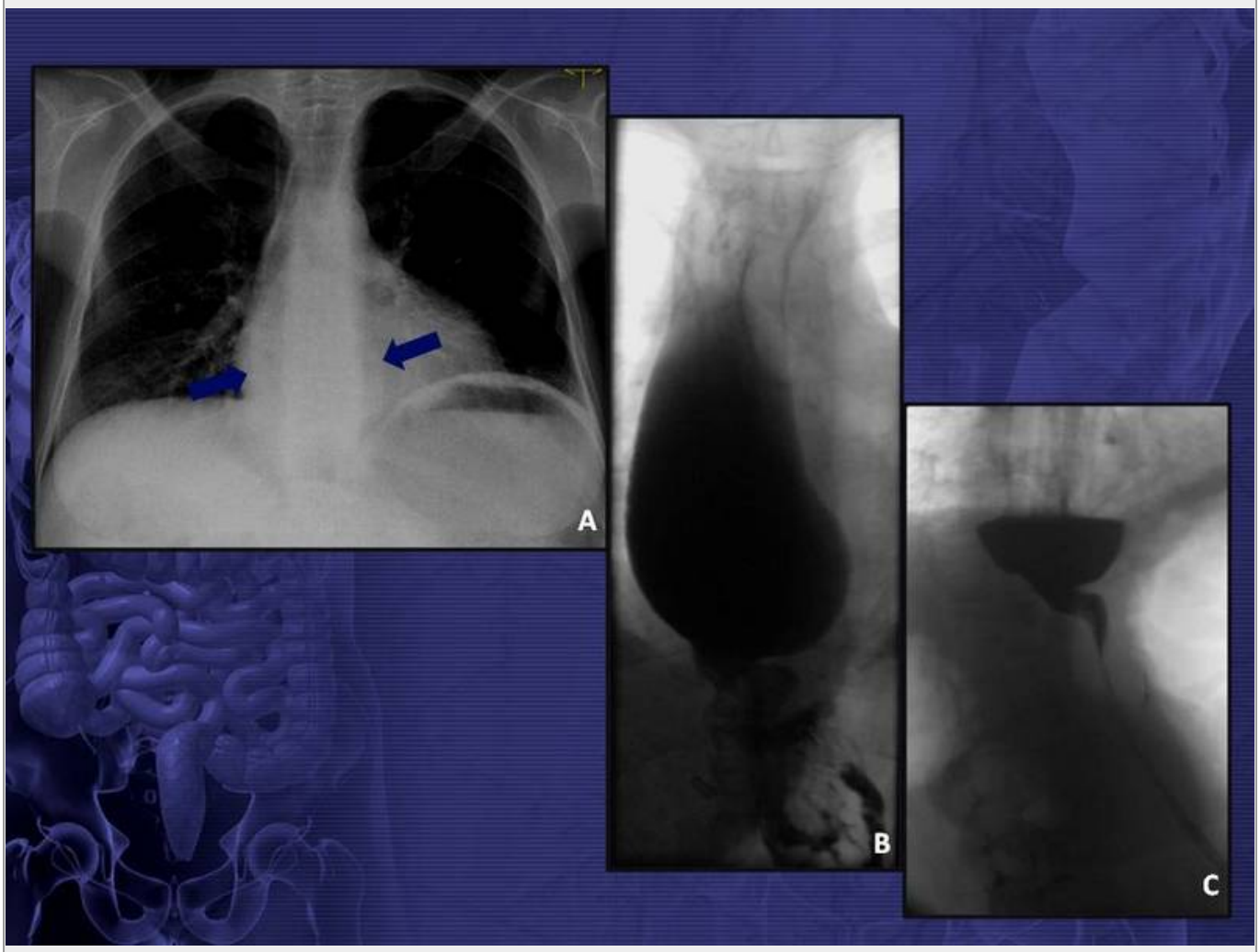

Figure 9. Scleroderma. (A) Frontal chest radiograph of this 45-year-old female demonstrates a well-defined opacity behind the heart shadow (arrows). (B) and (C) Barium swallow X-rays show dilated distal esophagus with aperistalsis and a stricture at the lower end of esophagus.

Esophageal Diverticula

The appearance of esophageal diverticula in plain chest radiographs is variable, depending on size, contents and position. Little diverticula are unlikely to become visible on plain films, whereas large diverticula may be detected as large air-filled or fluid-filled sacs close to the esophagus and predispose patients to the occurrence of aspiration pneumonias.

Diverticula arising at the cervicothoracic esophageal junction (hypopharynx) – **Zenker diverticula** – are acquired pulsion diverticula and they may appear on frontal chest films as a superior mediastinal mass or superior mediastinal widening. The diverticulum sac most often projects into the left hemithorax and may contain an air-fluid level on upright radiographs (Fig.10; Fig.11). On lateral radiographs, the diverticulum may be seen as retrotracheal mass with anterior tracheal bowing. Evidence of aspiration pneumonia may also be seen associated to this type of diverticula.

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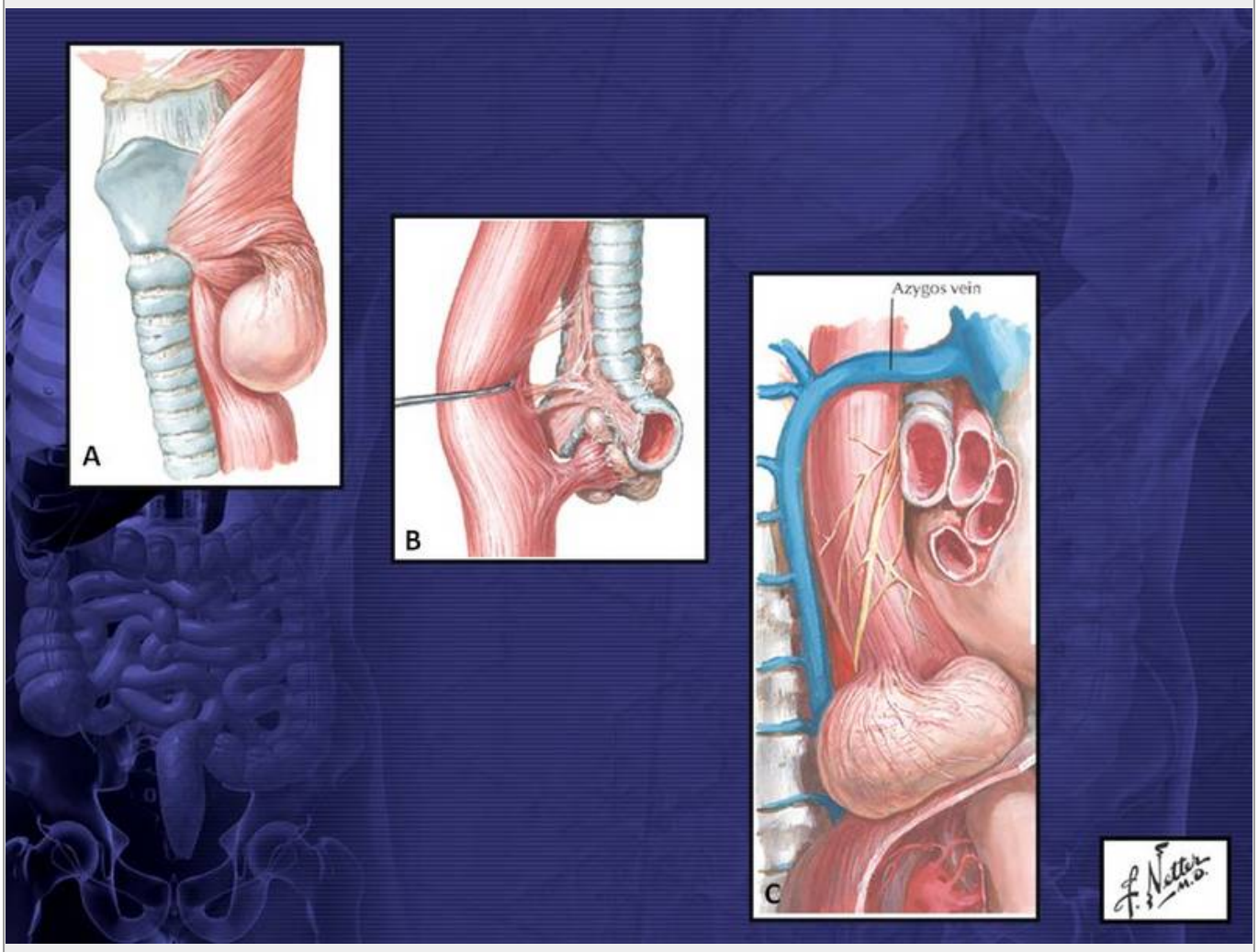

Figure 10. Esophageal diverticula. (A) Zenker diverticulum. (B) Midesophageal diverticulum. (C) Epiphrenic diverticulum. (adapted from Netter F. Netter's Illustrated Human Pathology.)

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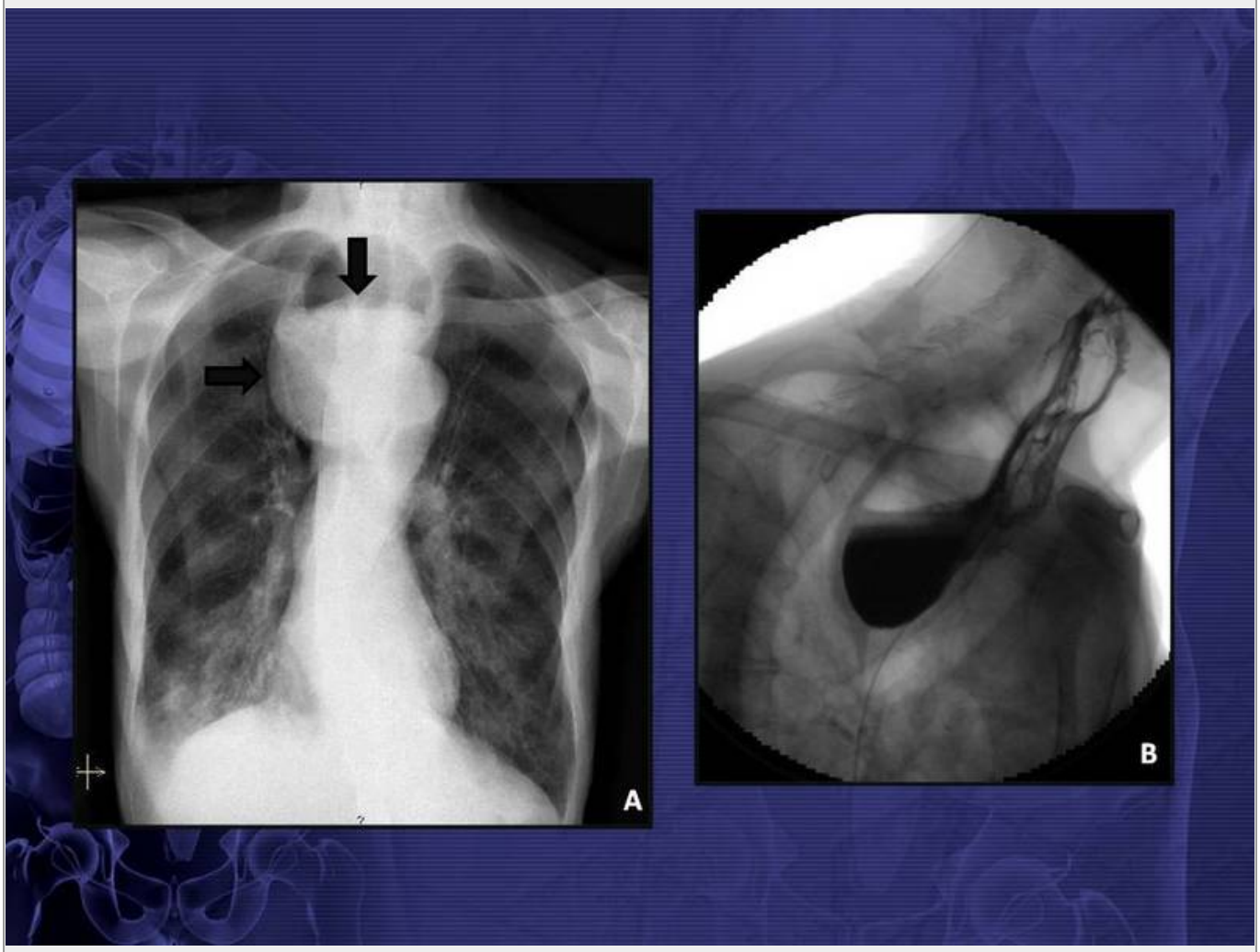

Figure 11. (A) Frontal chest film in the upright position shows an opacity in the superior mediastinum with an air-fluid level (arrows). (B) Esophagogram performed afterwards was consistent with a large Zenker diverticulum.

Diverticula of the body of the esophagus are divided into midthoracic (parabronchial) and epiphrenic diverticula (distal esophagus).

Midesophageal diverticula are most often caused by traction from contiguous mediastinal inflammation and adenopathy, resulting from previous granulomatous disease, such as pulmonary tuberculosis and histoplasmosis. They are usually asymptomatic and have a small diameter, thus are unlikely to cast a discernible shadow on plain radiographs (Fig.10).

Epiphrenic diverticula, arising near the gastroesophageal junction, represent pulsion diverticula, and are most likely caused by a motility disorder, leading to incoordination between the lower esophageal sphincter and the primary esophageal peristaltic wave. Findings on chest radiographs include a juxtadiaphragmatic, retrocardiac, paraesophageal mass, usually projecting to the right of midline behind the right atrium with or without a gas-fluid level (Fig. 10; Fig. 12).

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Figure 12. (A) Chest frontal radiograph shows an air-fluid level within a mass in retrocardiac location, on the right. (B) Barium esophagogram demonstrates a large epiphrenic diverticulum.

Esophageal Tumors

Malignant

The majority of esophageal malignant tumors, excluding lesions that arise at the esophagogastric junction (adenocarcinomas), are squamous cell carcinomas (95%). Fifteen percent occur in the upper third, 50% in the middle third, and 35% in the lower third.

Most patients with esophageal carcinoma have abnormal plain radiographic findings, including:

· an abnormal azygoesophageal interface;

· widening of the mediastinum (resulting from the tumor itself or a dilated esophagus proximal to the obstructing lesion);

· abnormal thickening of the tracheoesophageal stripe;

· retrotracheal, subcarinal, or retrocardiac mass;

· tracheal deviation;

· accompanying paratracheal or hilar lymph node enlargement;

· esophageal air-fluid level;

· an abnormal air bubble.

Thickening of the posterior tracheal stripe deserves special attention, as this can be seen as an early finding, often before symptoms develop. As it was previously referred, the posterior tracheal stripe is seen on the lateral chest radiograph and thickness greater than 4 mm is considered abnormal. Thickening of the posterior tracheal stripe may be secondary to paratracheal and paraesophageal lymphatic engorgement due to obstruction or direct invasion by tumor. Masses in the **upper one-third** of the esophagus may cause thickening of the posterior tracheal stripe, and the right paratracheal stripe, normally less than 4 mm, may also thicken (Fig.13).

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Figure 13. Frontal (A) and lateral (B) chest radiographs of a patient with carcinoma of the esophagus. Note in (B) the thickened posterior tracheal stripe, with a soft-tissue mass with irregular borders producing a slight posterior tracheal indentation.

One of the more common findings is an **abnormal azygoesophageal recess**, identified in approximately 30% of patients with esophageal carcinoma. It becomes widened and convex towards the right lung in distal and midesophageal carcinomas.

A major complication of esophageal carcinoma is extension to involve adjacent organs. Tracheoesophageal fistulas develop in 5%-10% of patients. Chest radiographs in these patients show evidence of repeated aspiration pneumonia or pulmonary abscesses (Fig.14).

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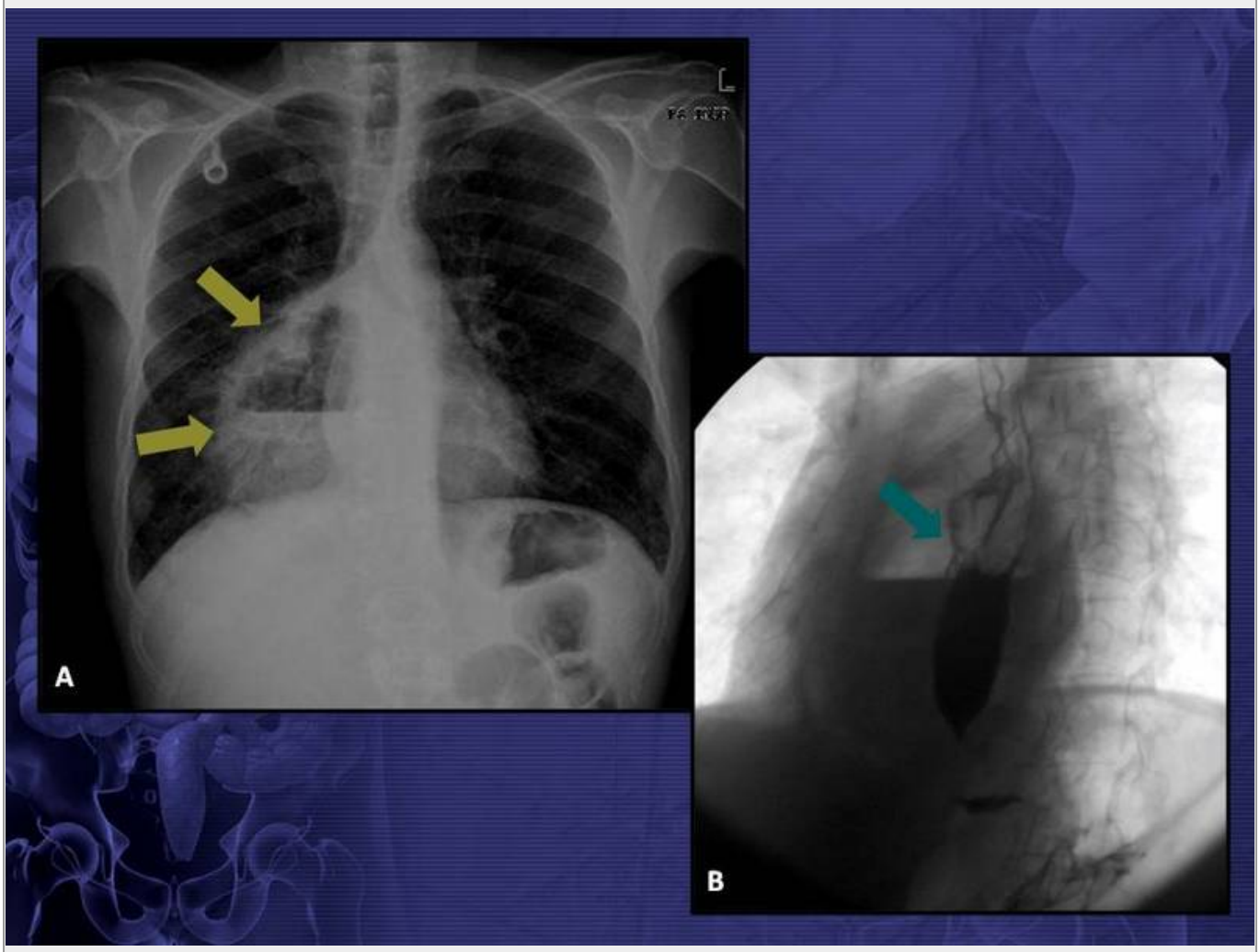

Figure 14. Frontal chest radiograph (A) and esophagogram (B) of a patient with known esophageal carcinoma, who developed a fistulous tract (arrow in B) between the ulcerated neoplasm and the right lung, leading to abscess formation (arrows in A).

Benign

Benign tumors of the esophagus are rare lesions that constitute less than 1% of esophageal neoplasms. Nearly two thirds of benign esophageal tumors are leiomyomas, which represent the most common variety.

Most benign tumors are asymptomatic and usually present as intramural masses, being detected only on esophagogram or CT. Large benign neoplasm may become visible on chest radiographs as smooth soft-tissue solitary mediastinal masses projecting laterally from the posterior mediastinum, adjacent to the course of the esophagus on frontal chest radiographs. Although often large, benign tumors are nonobstructive, therefore the absence of esophageal dilatation above the mass helps distinguishing them from carcinoma.

Esophageal Duplication Cysts

Duplication cysts of the esophagus represent 25% of all gastrointestinal tract duplication cysts and are one of the two most common types of foregut malformations (along with bronchogenic cysts). They occur very rarely and are most frequently located in the right lower posterior mediastinum. The cysts become symptomatic in early childhood in 80% of cases, but in adults they are often asymptomatic. Thus, they are frequently first detected on routine chest films or on radiographs performed for other reasons. Radiographic findings generally include a rounded or oblong well-defined mass adjacent to the esophagus that usually does not communicate with the esophagus (though exceptions occur), therefore not opacifying with the use of contrast material on an esophagogram (Fig.15).

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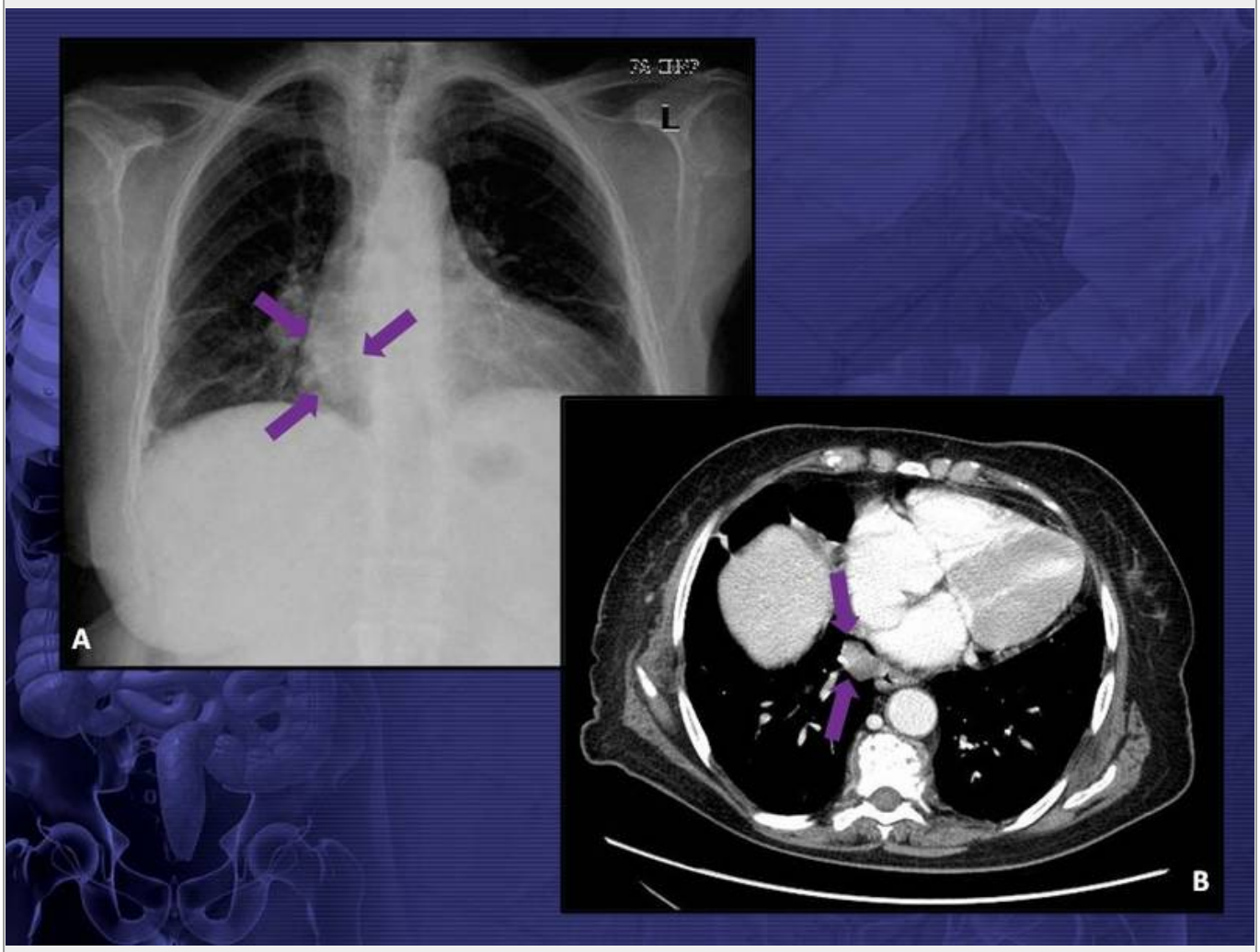

Figure 15. Esophageal duplication cyst. (A) Routine frontal chest radiograph in this 78-year-old female demonstrates a rounded well-defined mass adjacent to the distal esophagus, on the right (arrows). (B) Enhanced CT scan reveals a low attenuation, rounded, well-defined mass adjacent to the esophagus that doesn't seem to communicate with its lumen. The right-sided location is typical.

Esophageal Varices

Esophageal varices only become visible on plain radiographs in approximately 5%-8% of the cases. They may produce round or lobulated retrocardiac, paraesophageal or paraspinal masses on chest films and an abnormal contour of the azygoesophageal recess may also be seen. These findings may be accentuated after sclerotherapy.

Dysphagia Aortica

Dysphagia aortica describes swallowing difficulty caused by external compression from an ectatic, tortuous or aneurysmal aorta as a result of age related degeneration. It is a rare condition usually associated with hypertension and old age and is classically seen in elderly women of short stature. Low sternal dysphagia is caused by the diseased aorta pushing the esophagus anterolaterally against the crural slings of the diaphragm or compressing the esophagus against the posterior aspect of an enlarged left ventricle. Compression at the arch of the aorta is less common.

On standard chest radiography the typical findings in dysphagia aortica are an unfolded aortic arch below which lies a tortuous dilated aorta, the course of which is variable (Fig.16).

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Figure 16. Frontal (A) and lateral (B) chest radiographs of a patient with an aortic aneurysm and prominent ectasia of the thoracic aorta. Unfolding of the aortic arch and a tortuous dilated aorta are seen. This patient sought medical attention due to dysphagia and vague chest pain. The diagnosis of aortic dysphagia should always be considered in differential diagnosis when these atypical symptoms are present.

Barium swallow may demonstrate focal narrowing of the distal esophagus; a flattened contour of the left margin of the esophagus and pulsatile movement of the barium synchronous with aortic pulsation may also be objectivated.

Esophageal Perforation

Esophageal perforation is a life-threatening condition in which early detection is crucial and highly dependent on interpretation of plain chest radiographs.

The most common cause of esophageal perforation is iatrogenic esophageal injury during instrumentation, either esophageal dilation ([diapositivo26.jpg] Fig.26) or endoscopy. Spontaneous

rupture (Boerhaave syndrome) is the other large category of esophageal rupture and it occurs secondary to a sudden increase in intraluminal pressures, usually due to violent vomiting or retching, and often follows heavy food and alcohol intake. Ingestion of foreign bodies can also cause esophageal perforation, as well as trauma (blunt or penetrating).

The most common site of iatrogenic rupture is in the cervical esophagus at the level of the cricopharyngeus muscle, the narrowest portion of the esophagus. More distal iatrogenic esophageal perforations are often associated with biopsy or dilation of strictures. In spontaneous rupture of the esophagus, the usual site of perforation is the left posterolateral wall of the distal esophagus (where the wall is thinnest).

Plain radiographic findings are highly suggestive of perforation in 90% of cases, but they may sometimes (in 9%-12% of cases) be normal.

Chest radiographic findings indicative of perforation, medistinitis and mediastinal abscess formation include (Fig.17):

· pneumomediastinum;

· deep cervical emphysema;

· subcutaneous air;

· mediastinal widening;

· effacement of mediastinal soft-tissue planes;

· poorly defined mediastinal masses;

· mediastinal air-fluid level.

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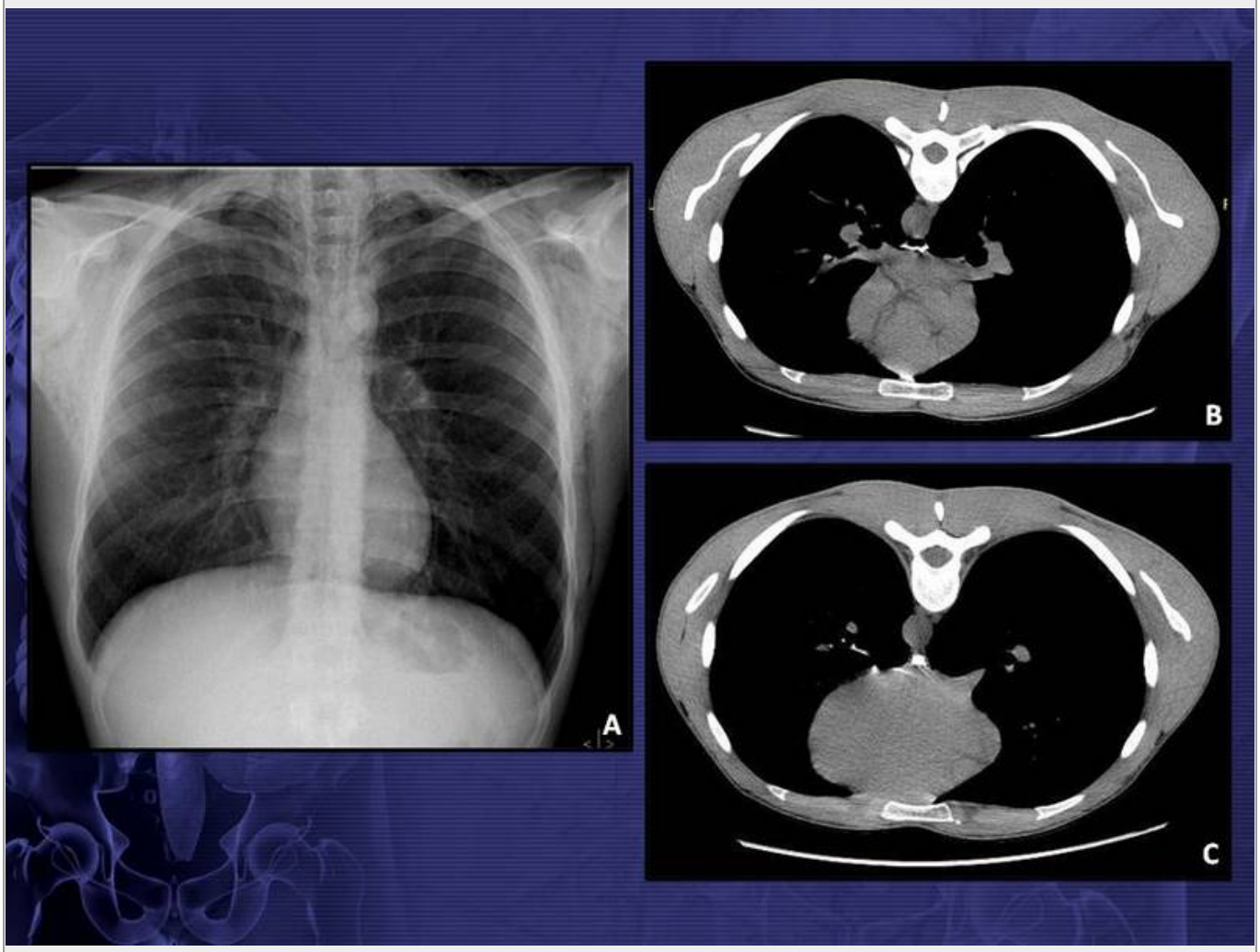

Figure 17. Boerhaave syndrome. (A) Chest frontal radiograph of a 18-year-old patient admitted in our emergency room for abdominal pain, nausea and persistent vomiting after heavy alcohol ingestion. It shows pneumomediastinum as well as deep cervical and subcutaneous emphysema. (B) and (C) show that the CT scan obtained in prone position after oral ingestion of water-soluble contrast medium demonstrate a small accumulation of contrast in the mediastinum, which suggest rupture of the esophagus.

If the mediastinal pleura does not contain the rupture, an esophageal-pleural fistula may occur, leading to:

· pleural effusions;

· pneumothorax;

· hydropneumothorax;

· atelectasis.

The site of perforation can be suggested by the plain radiographic findings. The midthoracic

esophagus lies beneath the right pleura. The distal esophagus returns to the left and passes anteriorly in front of the aorta. It is, thus, apparent that rupture of the distal esophagus will result in leftsided pleural effusion or hydropneumothorax, whereas perforation of the midesophagus tends to produce pleural effusion or hydropneumothorax on the right side.

Postoperative Esophagus

A wide range of surgical procedures are available for either benign and malignant disease of the esophagus. Some patients undergo demolitive intervention, characterized by resection and replacement of the esophagus with an intrathoracic stomach. Colon (usually right side) or jejunum can also be used, although less frequently.

On chest radiographs, the transplanted stomach or intestine appears as a widened mediastinum, usually on the right side (Fig.18). Air-fluid levels can be identified on upright images.

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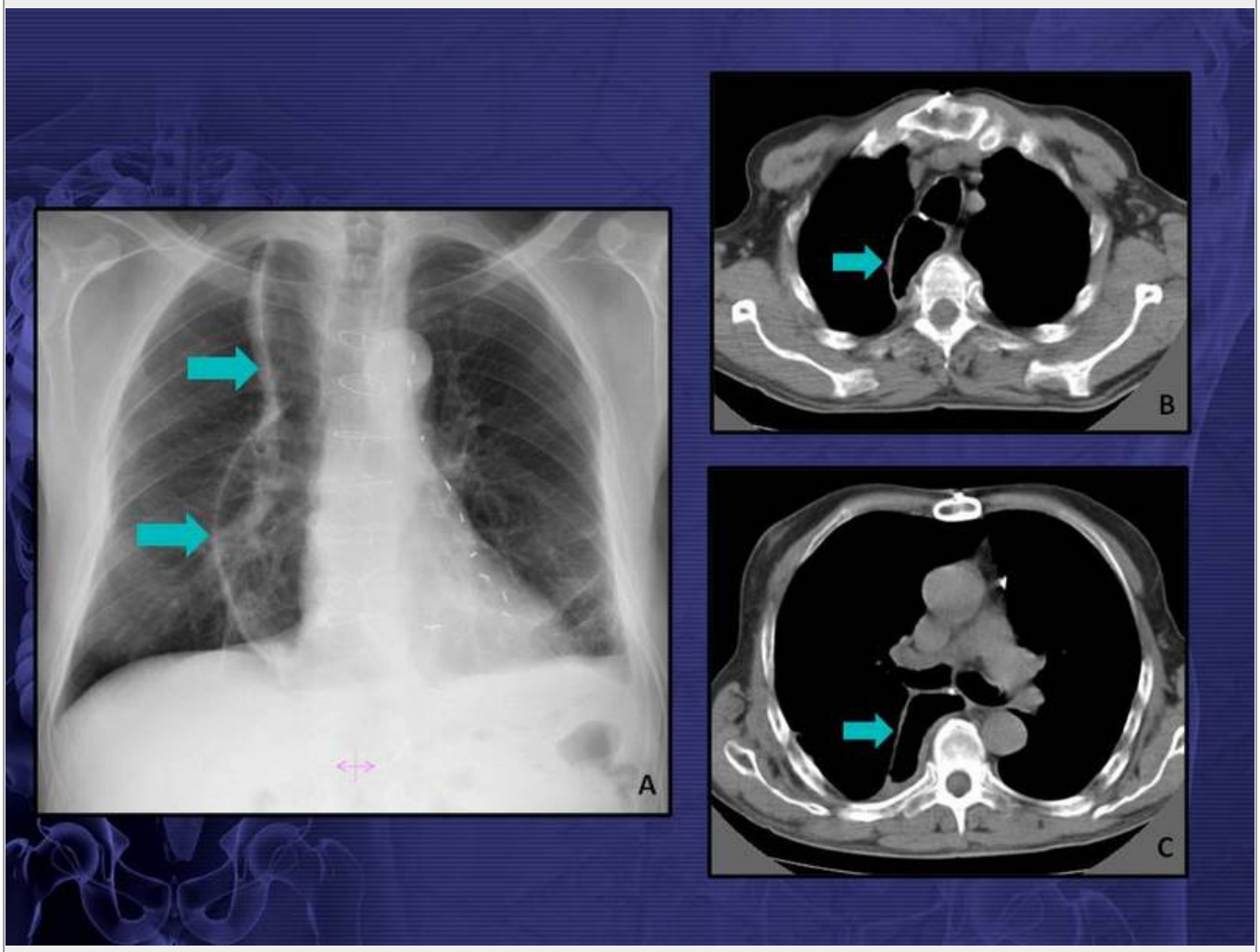

Figure 18. Postoperative esophagus. (A) Frontal chest radiograph of a patient who underwent resection and replacement of the esophagus with an intrathoracic stomach. The transplanted stomach produces mediastinal widening (arrows). (B) and (C) CT scan confirms that this widening is due to the intrathoracic stomach.

EXTRAESOPHAGEAL GASTROINTESTINAL ABNORMALITIES

The standard chest radiograph includes a portion of the upper abdomen. Chest radiographic findings may be the first indication of upper abdominal gastrointestinal disease; therefore, a careful assessment of the upper abdomen should be included as a routine part of chest radiographic interpretation.

Pancreatitis

Pancreatitis, in common with many other upper abdominal diseases, often leads to pleuro-pulmonary complications. Up to a half of cases of pancreatitis present with abnormalities on chest radiographs. The most common findings include leftsided plate-like atelectasis and pleural effusion. Other features such as basilar parenchymal infiltrates, pulmonary infarction, pulmonary edema, empyema, elevation of the left hemidiaphragm, mediastinal abscess formation, mediastinal pseudocyst, bronchopancreatic fistula formation, bronchopleural fistula, and pericardial effusion have also been reported (Fig.19).

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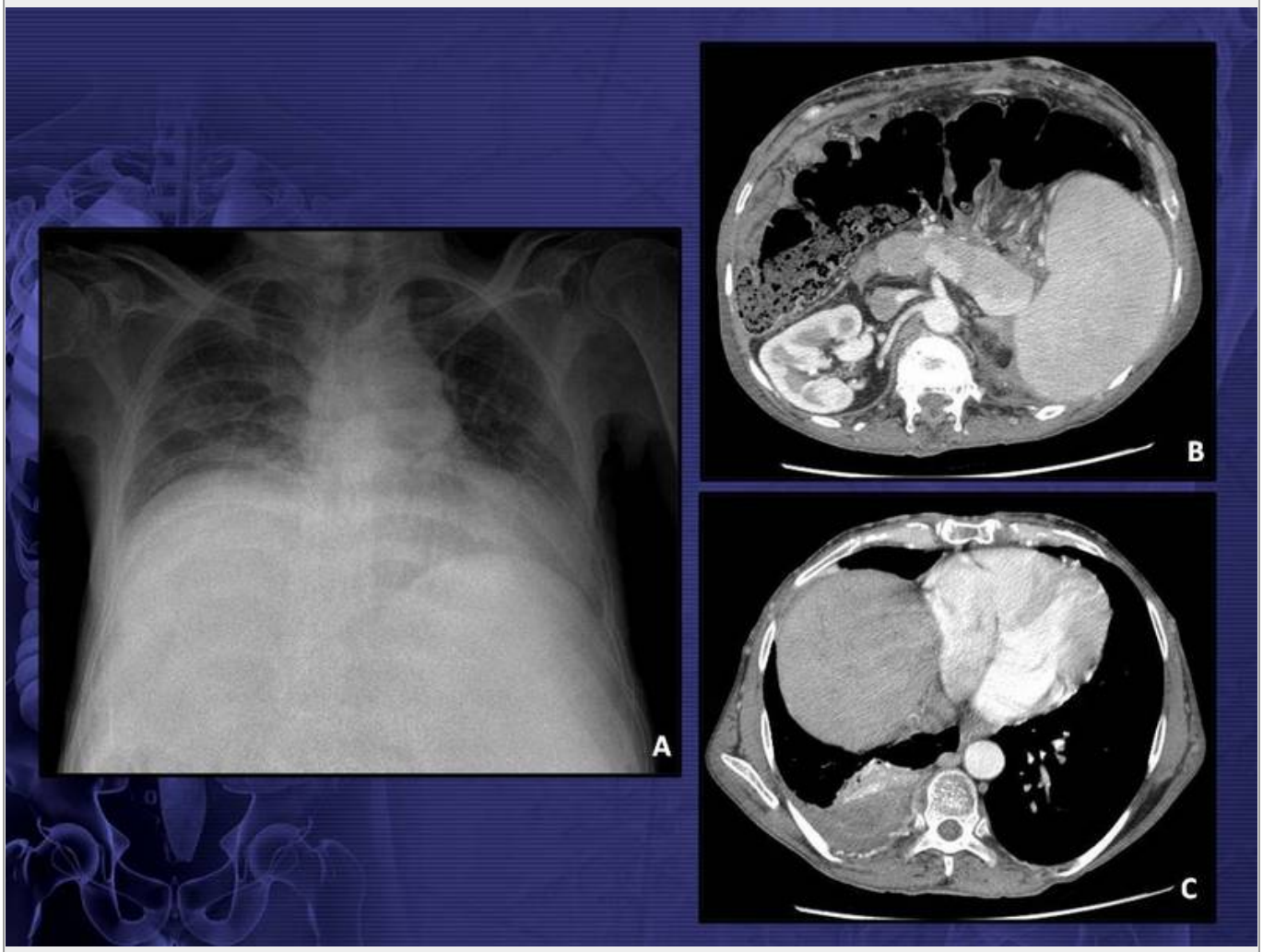

Figure 19. (A) Frontal chest film of a patient with pancreatitis. Note the elevated right hemicupula of the diaphragm. (B) CT confirmed the diagnosis and showed the presence of loculated right pleural effusion (C). The right-sided location is atypical.

Gastric and Colonic Abnormalities

Absence of the gastric air bubble on upright chest radiographs suggests esophageal obstruction. Its displacement may in turn be secondary to left upper quadrant mass lesions or splenomegaly.

A markedly distended gastric air bubble may be a hint to pyloric obstruction (Fig.20), gastric atony, or a malpositioned endotracheal tube.

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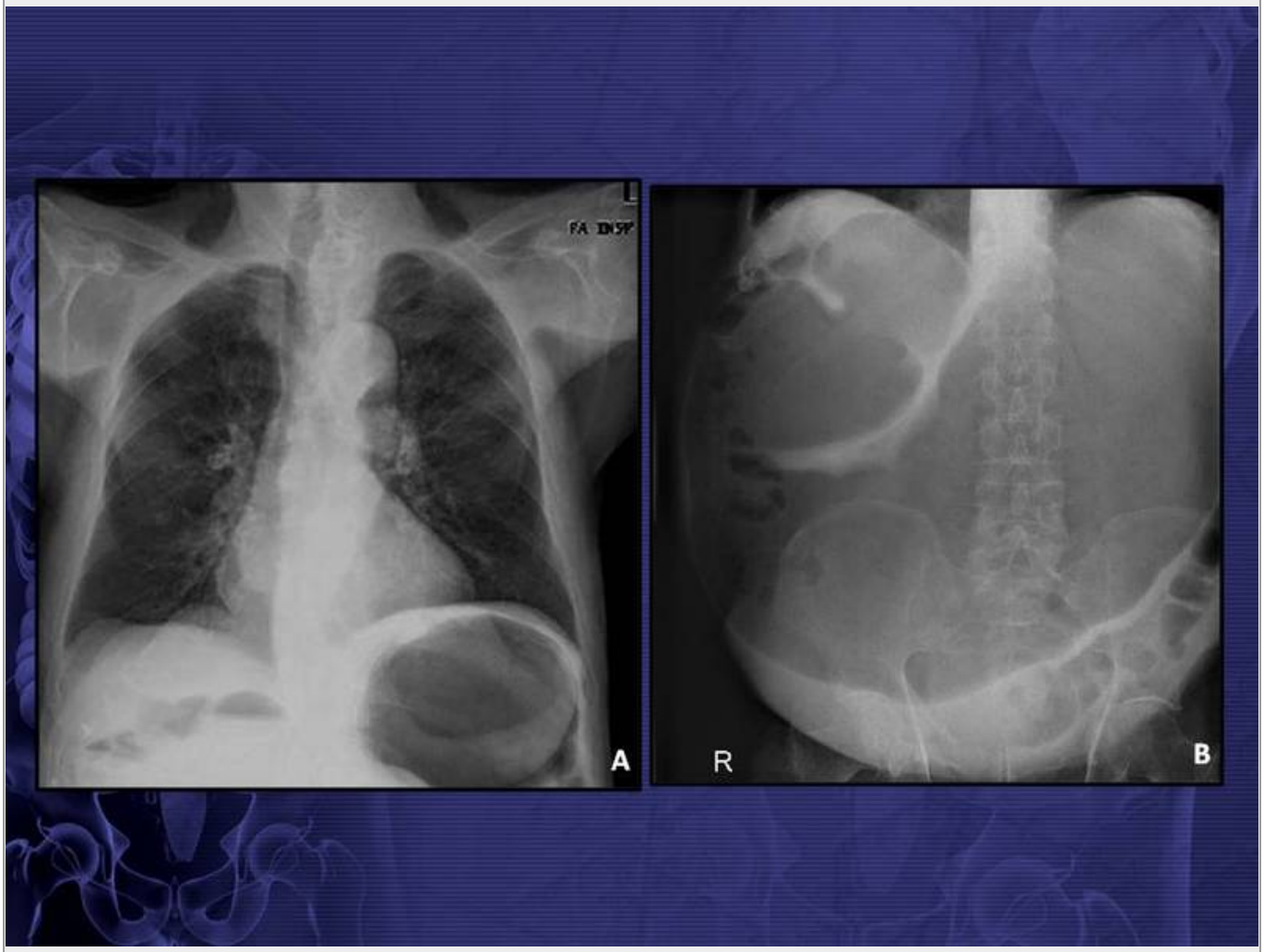

Figure 20. Pyloric obstruction. (A) Frontal upright chest radiograph of this 80-year-old patient shows a markedly distended gastric air bubble. (B) The supine abdominal film reveals an intensely dilated air-filled stomach due to gastric outlet obstruction.

Gastric volvulus is a relatively rare condition and it is produced when the stomach or part of it is twisted.

About 15-20 % of gastric volvulus appears in younger children associated with congenital diaphragmatic defects. The peak incidence in adults is the fifth decade, and gastric volvulus is commonly seen in association with paraesophageal hernias. Other causes are diaphragmatic traumatic hernia, eventration of the diaphragm due to nerve paralysis, mass in adjacent organs, abdominal adherences or laxity in one or more of the suspensory ligaments of the stomach.

Anatomically, gastric volvulus is classified based on the axis of rotation: organo-axial and mesentero-axial. The first type, the most common one, is produced when the stomach rotates on its long axis, anteriorly and superiorly, often in conjunction with diaphragmatic defects. The second type

involves a rotation of the stomach on its vertical axis, from the lesser curvature to the major one, and is frequently intermittent (Fig.21).

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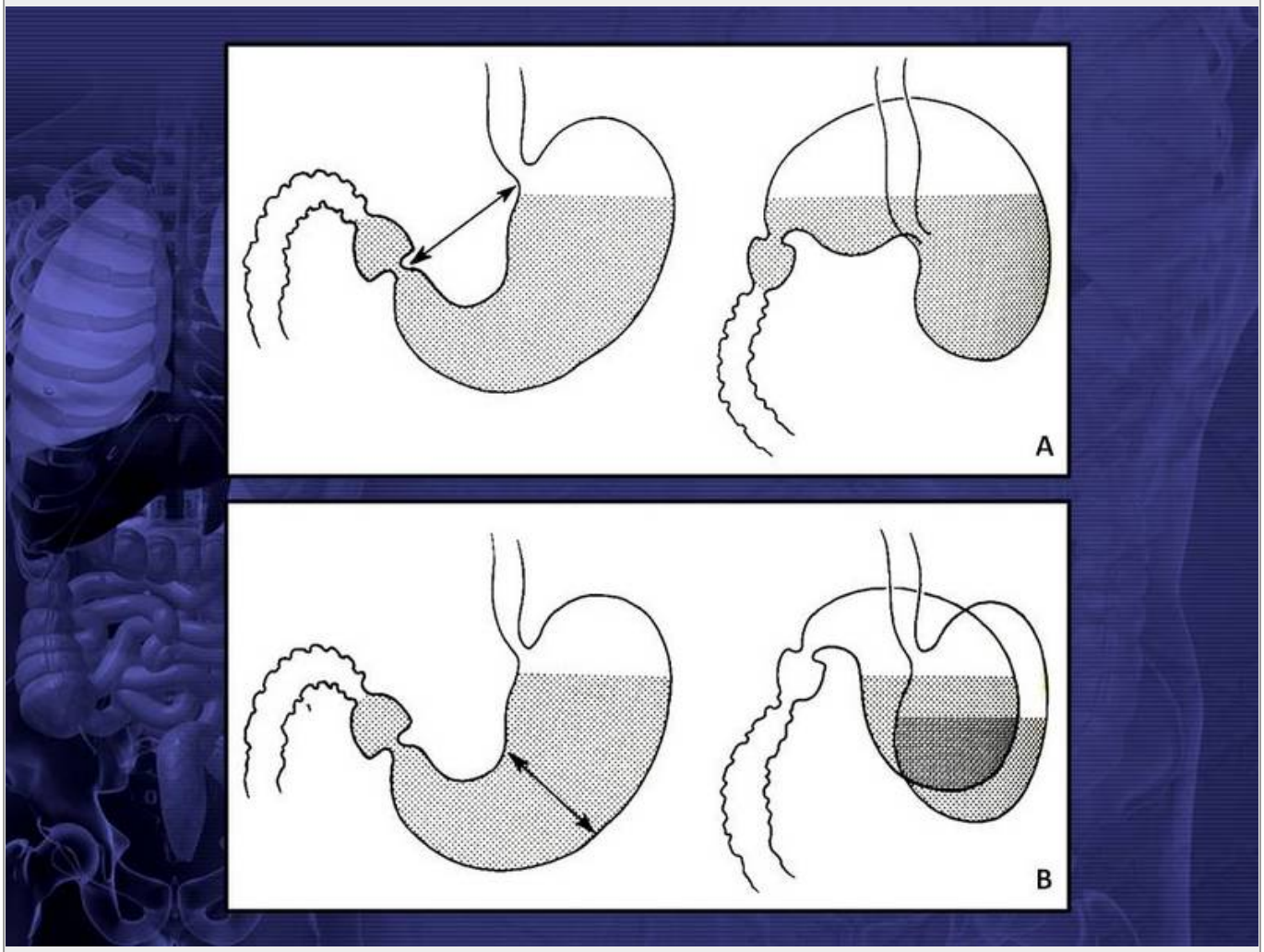

Figure 21. Gastric volvulus. (A) Organo-axial volvulus. (B) Mesentero-axial volvulus. (from Burgener FA, Kormano Martti. Differential Diagnosis in Conventional Radiology. 3nd ed. Stuttgart: Thieme; 1991: 592)

Plain radiographs may give a clue to suspect this condition.

Organoaxial volvulus may appear on upright films as a horizontally oriented stomach with a single air-fluid level (Fig.22; [oa gastric volvulus.avi] Video 1). Decreased air is noted within the remainding gastrointestinal tract.

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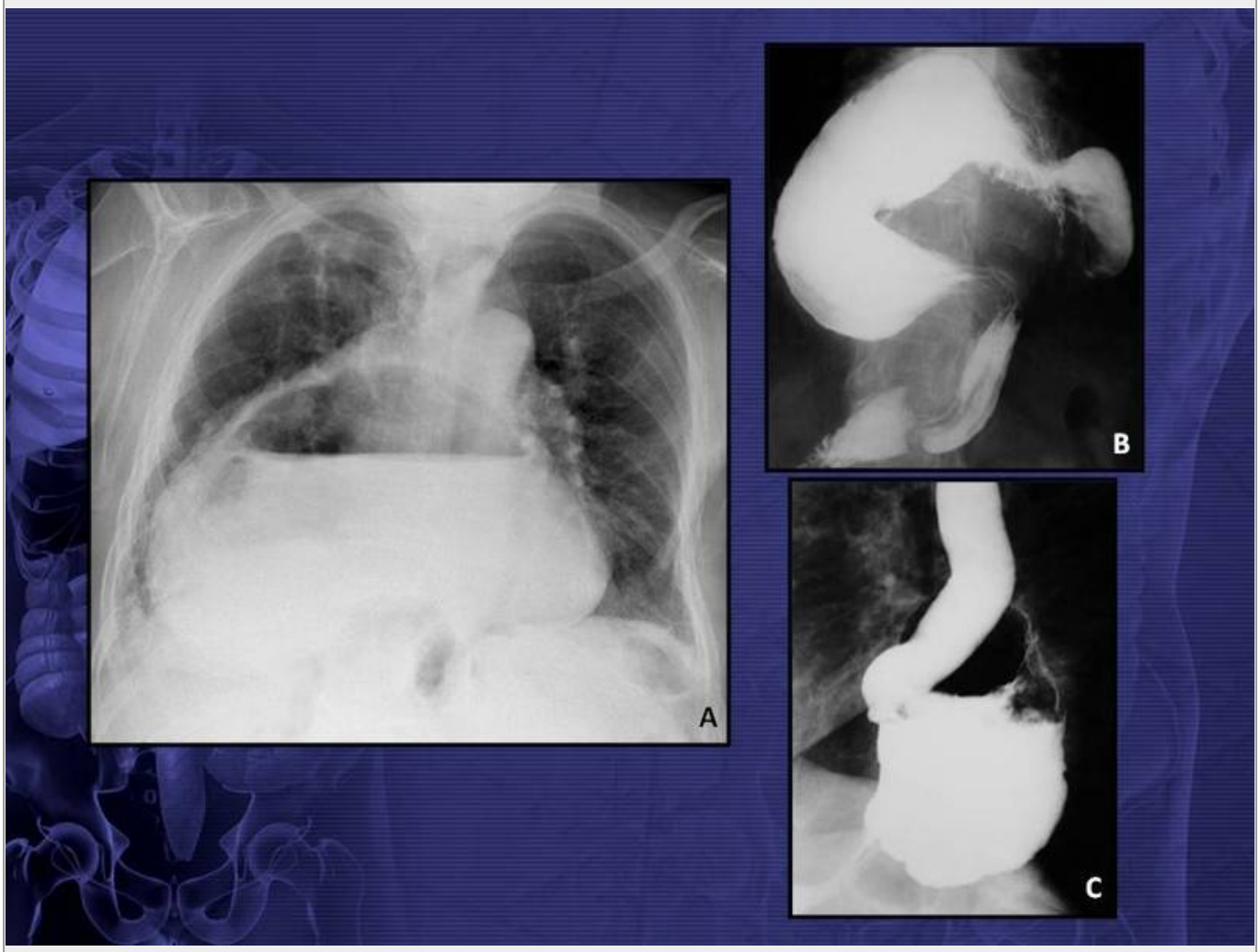

Figure 22. Organo-axial gastric volvulus. (A) Chest frontal radiograph shows a large retrocardiac opacity, consistent with the stomach, with an air-fluid level. (B) and (C) Barium x-rays demonstrate an organo-axial gastric volvulus in a sliding hiatal hernia.

In mesenteroaxial volvulus, upright films often show a double air-fluid level, one inferior and left, representing the normally situated fundus, and the other superior and right, representing the displaced antrum. Occasionally the inferior air-fluid level is located in a normal position beneath the left hemidiaphragm while the upper one (herniated antrum) lies in the retrocardiac mediastinum, which is diagnostic of gastric volvulus herniating into the thorax. A helpful finding on chest x-ray is a nasogastric tube that is arrested at the gastroesophageal junction secondary to obstruction (Fig.23).

diapositivo 23.jpg

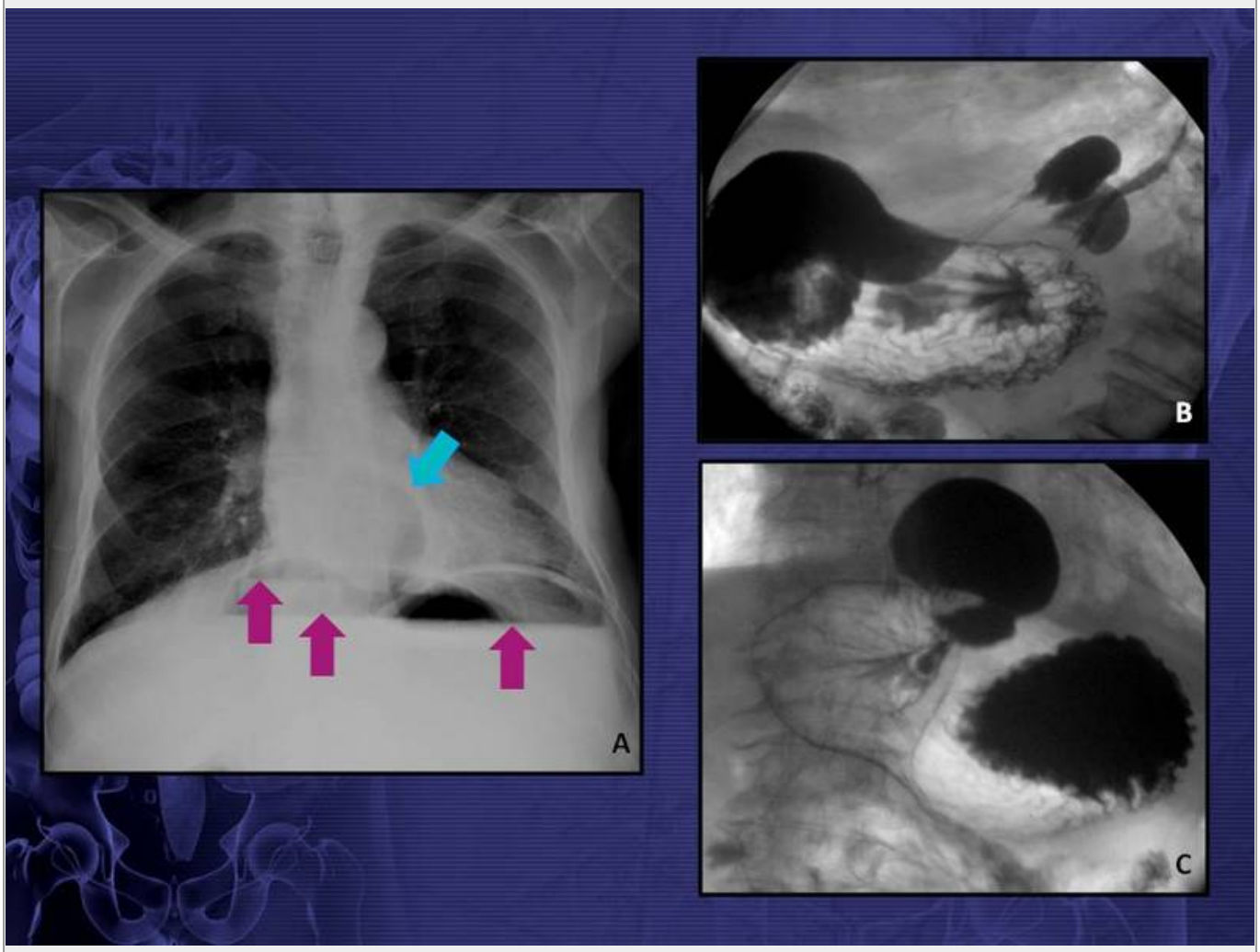

Figure 23. (A) Frontal chest radiograph of a patient with a previously known paraesophageal hiatal hernia demonstrates air-fluid levels in the upper abdomen (pink arrows) and a gas-filled structure in retrocardiac position (blue arrow). (B) and (C) The barium x-rays show torsion of the stomach at the level of the antrum, which herniates along with the duodenal bulb into the thorax, thus confirming the diagnosis of a mesentero-axial gastric volvulus. This type of gastric volvulus is less frequently associated to diaphragmatic defects than organo-axial volvulus.

Plain radiographic findings that are suggestive of gastric volvulus should be confirmed with a barium study or CT.

The hepatic and splenic flexures should be evaluated for dilatation (Fig.24), displacement, pneumatosis, and mass lesions.

diapositivo24.jpg

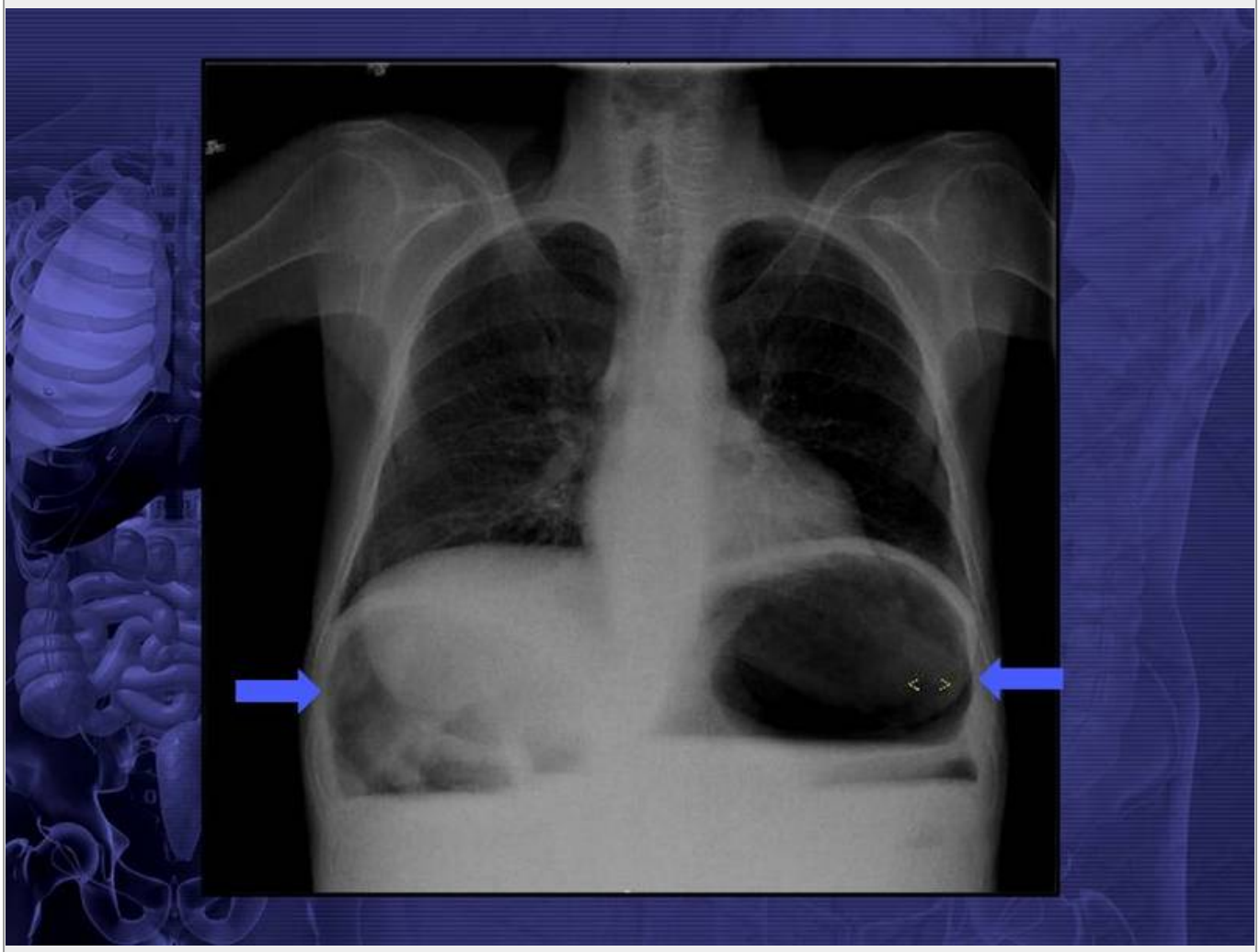

Figure 24. Chest frontal radiograph of a patient with scleroderma shows marked dilatation of the hepatic and splenic flexures of the colon.

Pneumoperitoneum

Intraperitoneal free gas nearly always indicates a perforated abdominal viscus that requires prompt surgical intervention.

Upright chest radiography is a sensitive tool for its detection, showing curvilinear air hyperlucencies beneath the domes of the hemidiaphragms (Fig.25-27).

diapositivo25.jpg

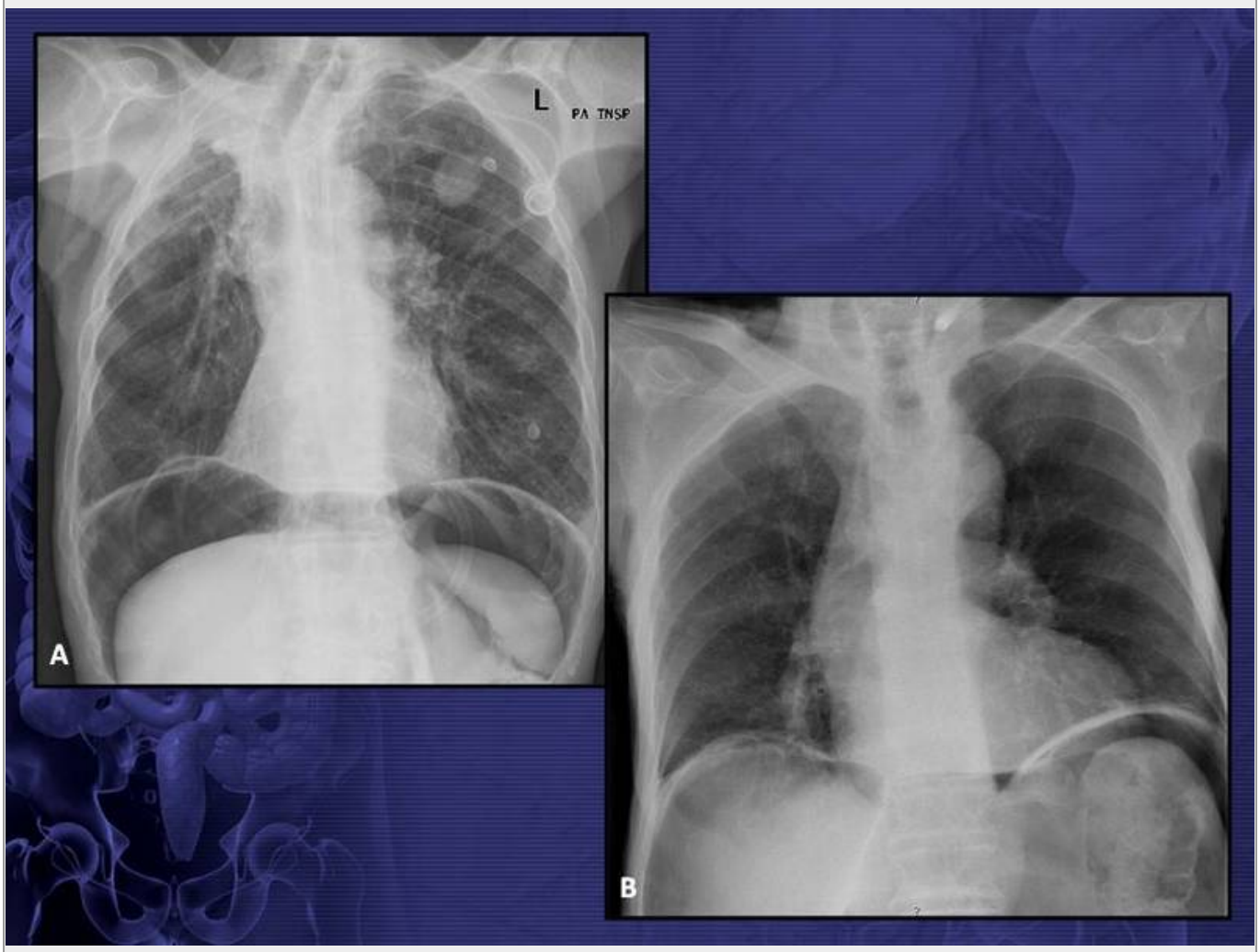

Figure 25. (A) Pneumoperitoneum after surgery in a patient with esophageal neoplasm. (B) This patient developed pneumoperitoneum after perforation of a duodenal ulcera.

diapositivo26.jpg

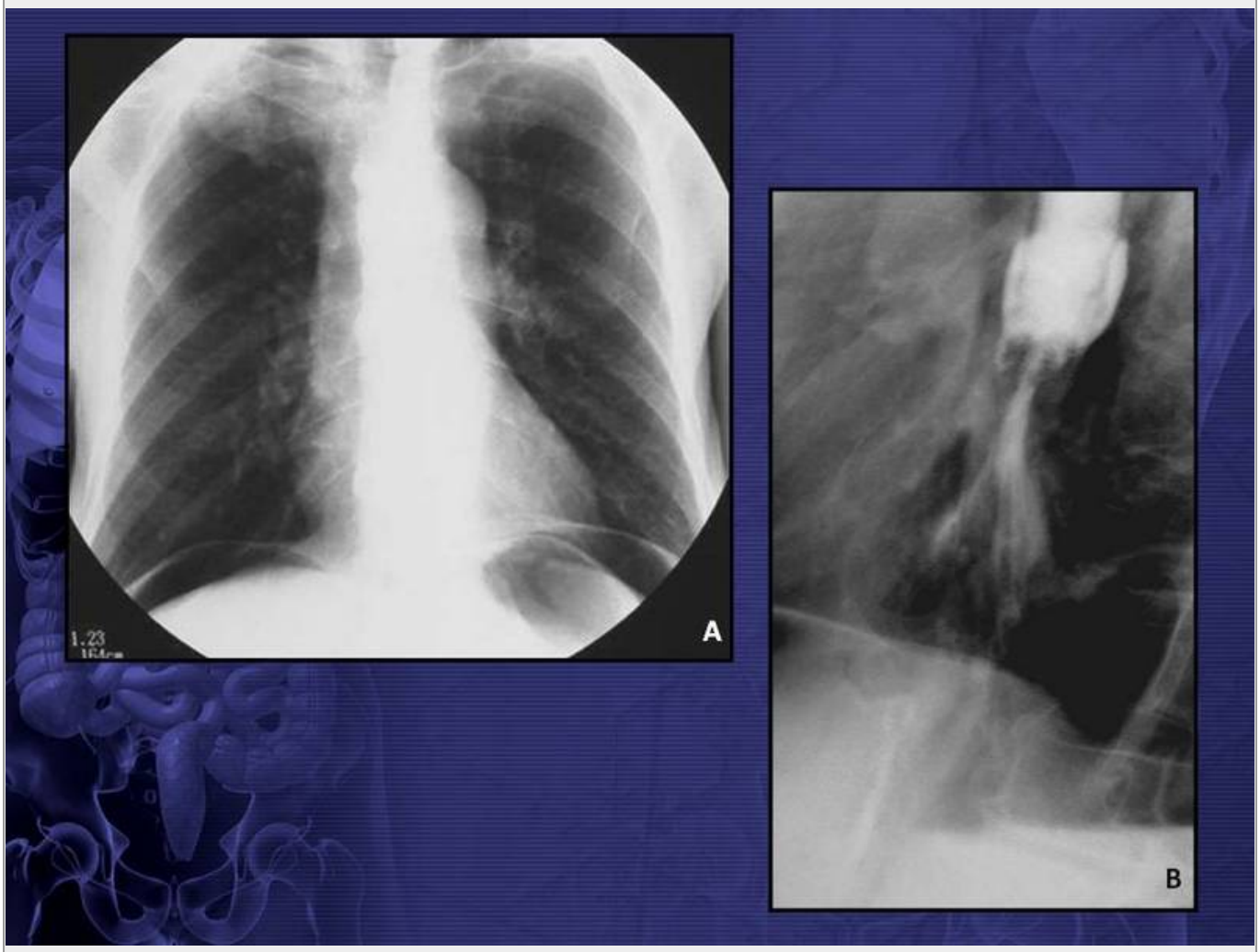

Figure 26. Pneumoperitoneum due to distal esophageal perforation after protesis placement in a patient with esophageal carcinoma.

diapositivo27.jpg

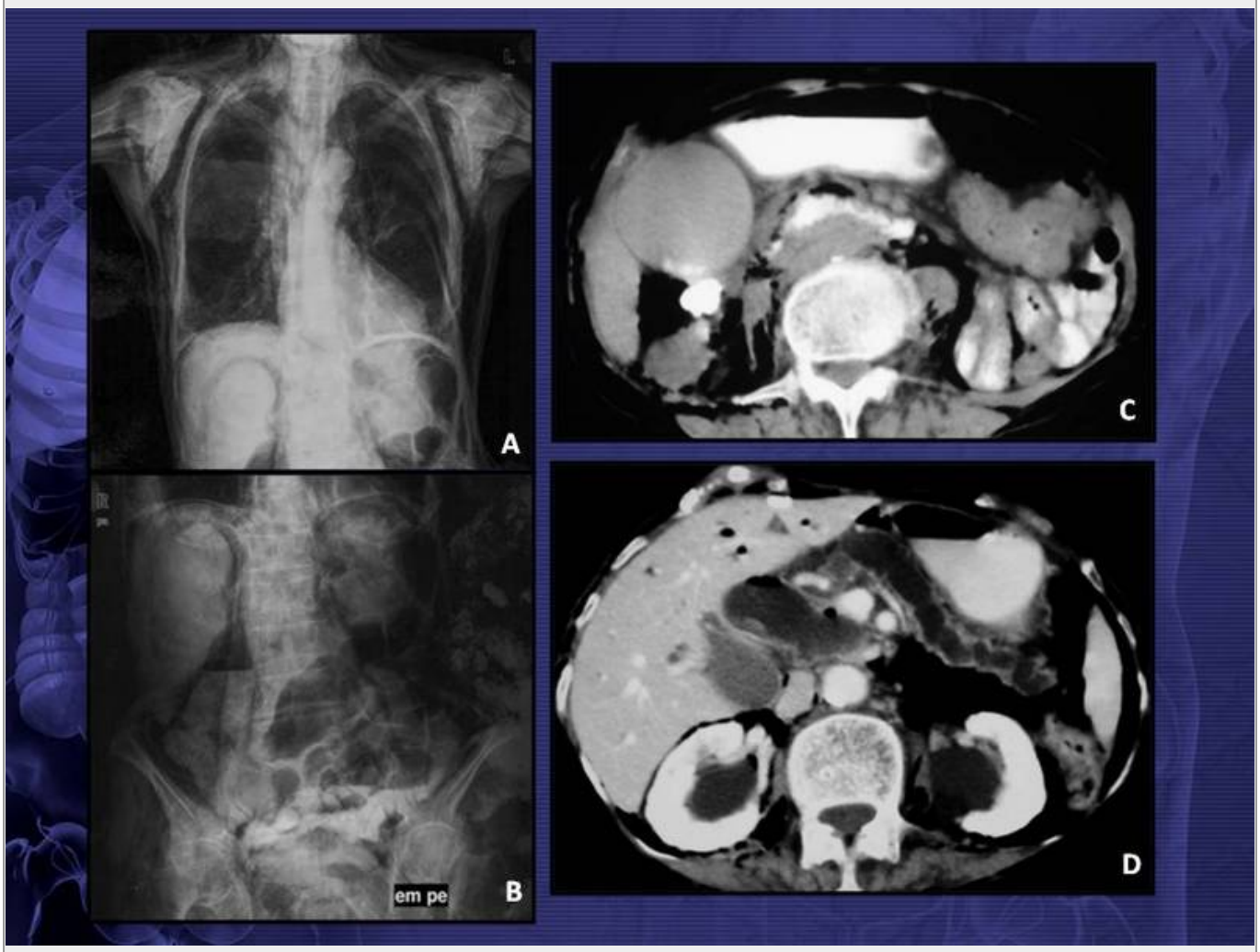

Figure 27. 85-year-old female submitted to ERCP with sphyncterothomy for biliary lythiasis. Chest (A) and abdominal (B) radiographs reveal the extent of gas collections, with pneumoretroperitoneum and mediastinal, deep cervical, and subcutaneous emphysema. (C) and (D) Contrast-enhanced CT performed with water-soluble positive oral contrast agent shows retroperitoneal extravasation to the right anterior pararenal space and abundant retroperitoneal gas.

However, pneumoperitoneum can also be detected on supine chest radiographs. The cupola sign was described by Mindelzun and McCort as an arcuate lucency overlying the lower thoracic spine and projecting caudad to the heart on supine radiographs, representing free intraperitoneal air within the median subphrenic space and beneath the central tendon of the diaphragm.

Liver Abnormalities

Portal venous gas and biliary gas can be detected on chest films as branching linear air hyperlucencies within the liver parenchyma (Fig.28).

diapositivo28.jpg

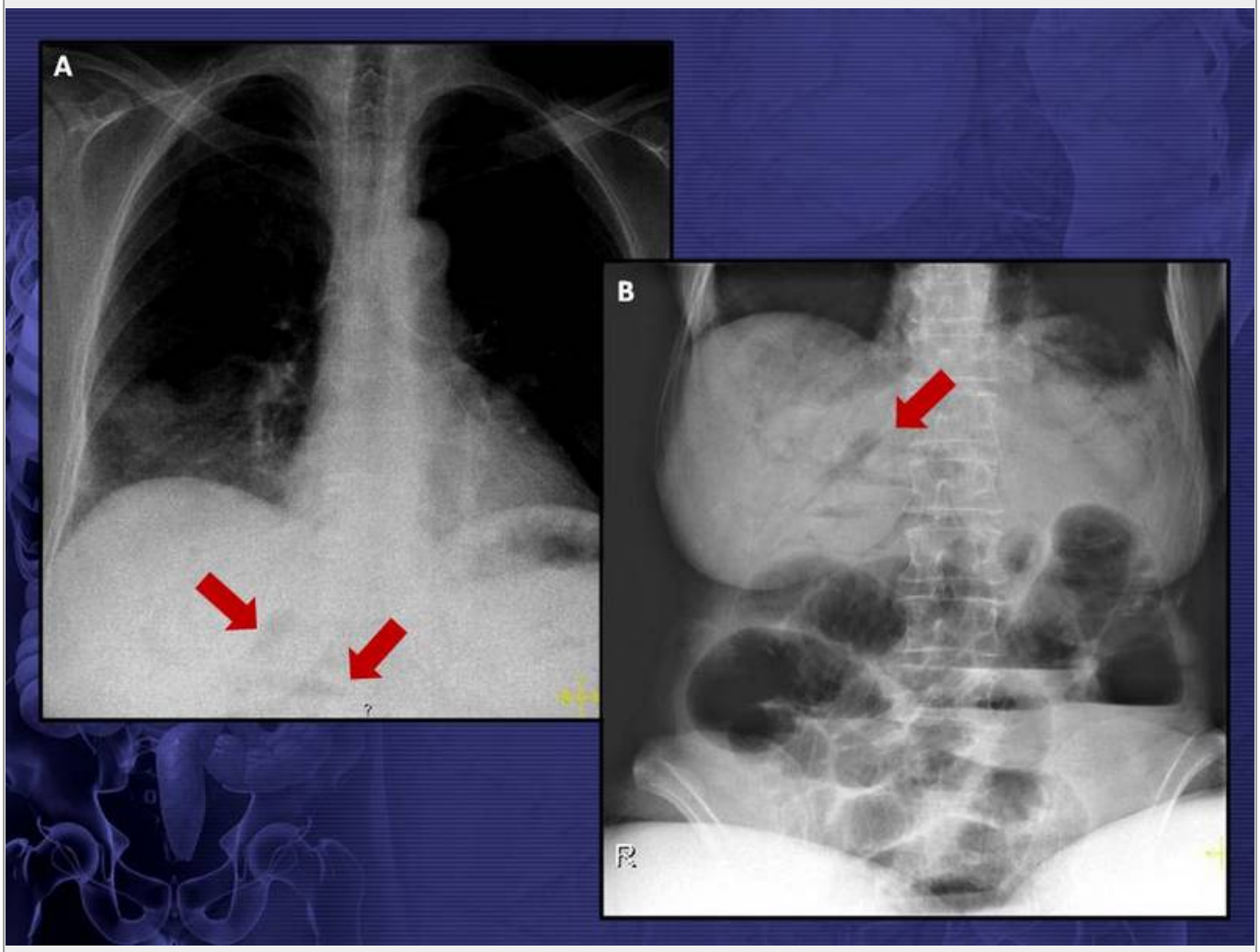

Figure 28. (A) Frontal chest radiograph of this 73-year-old lady raised the suspicion of portal venous gas. (B) Abdominal x-ray findings were even more suggestive. The patient was submitted to surgery, which confirmed acute mesenteric ischemia.

Intrathoracic herniation, congenital or acquired secondary to trauma, may appear on chest radiographs as a smooth, well-defined soft-tissue mass in the anterior aspect of the right cardiophrenic angle.

Upper Abdominal Abscesses

The mortality associated with upper abdominal abscesses remains quite high. Most cases occur after surgery in the upper abdomen and the most common location is in the subphrenic space.

Conventional radiography remains an effective method in the initial detection of upper abdominal abscesses. Plain chest radiographic findings are often suggestive of the diagnosis and include an elevated hemidiaphragm, pleural effusion, extraluminal gas, an abnormal soft-tissue mass or air-fluid level, and basilar platelike atelectasis (Fig 29; Fig.30).

diapositivo29.jpg

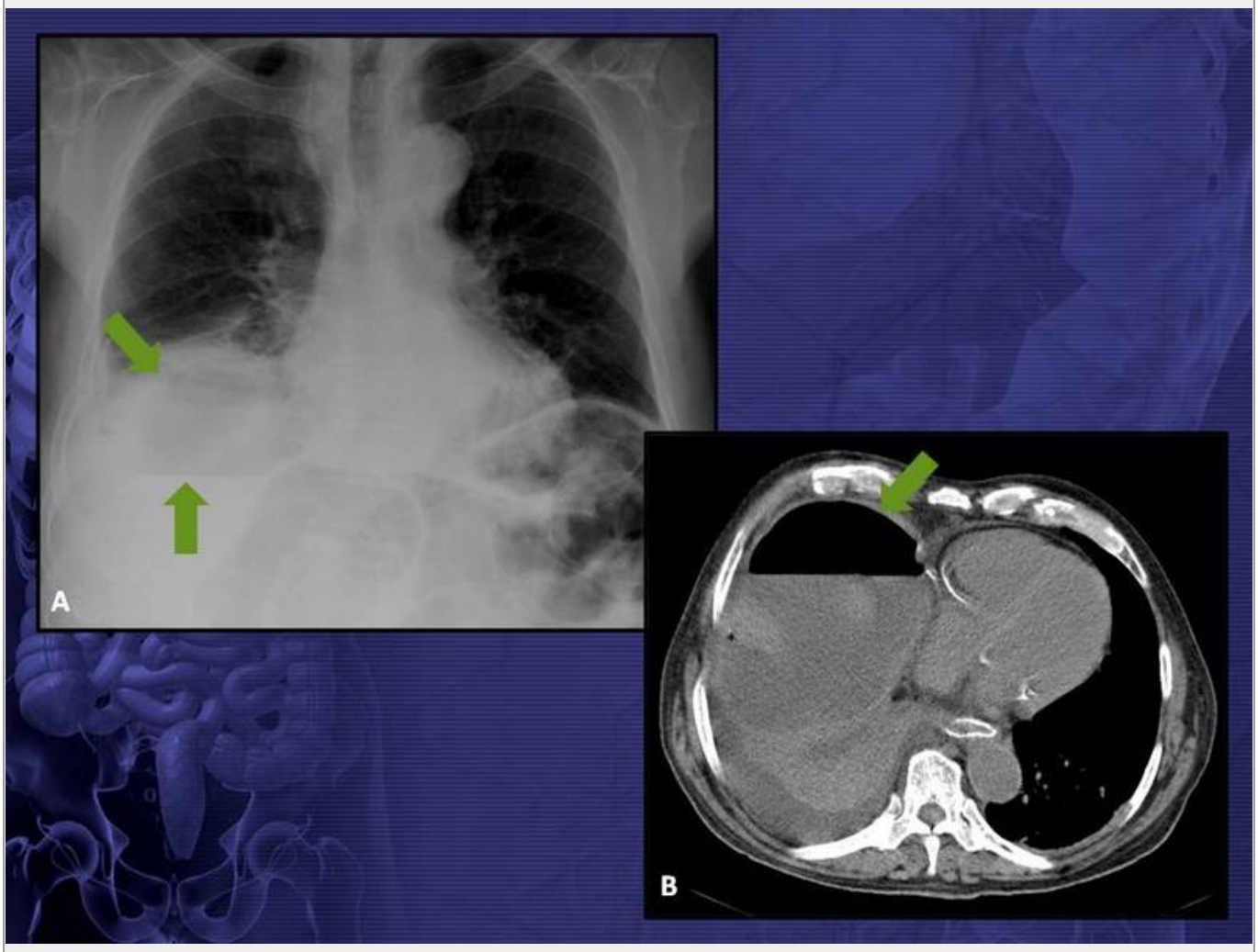

Figure 29. (A) Frontal chest radiograph reveals an elevated right hemidiaphragm, below which there is an air fluid level, projecting at the site of the liver (arrows). (B) CT scan confirmed the diagnosis of a liver abscess.

diapositivo30.jpg

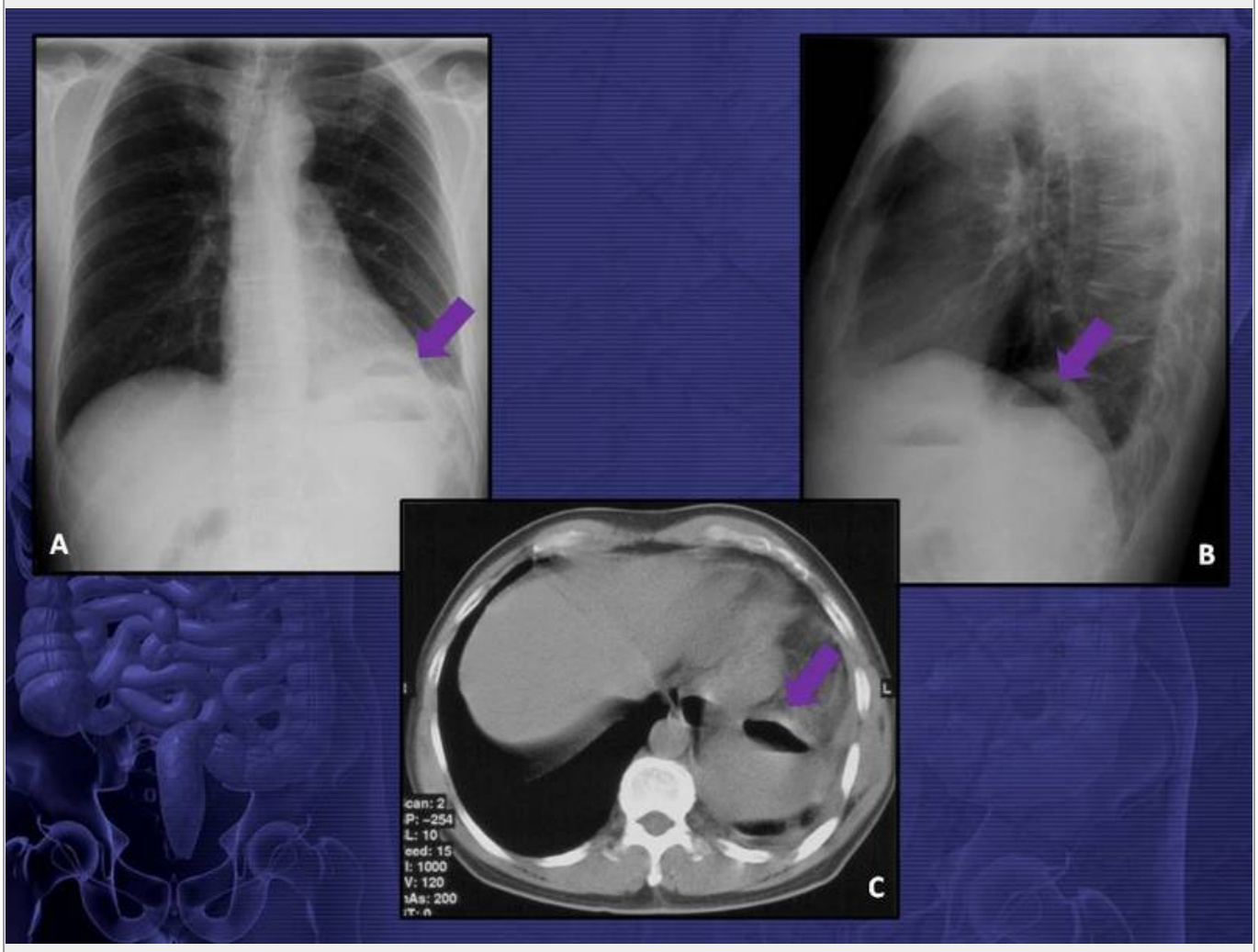

Figure 30. Frontal (A) and lateral (B) chest radiographs show an air-fluid level just below the elevated left hemidiaphragm. Note the normal gastric air bubble in its regular position. (C) CT scan was diagnostic for a left subphrenic abscess.

CT is often necessary to help confirm the diagnosis or to help direct drainage procedures.

Diaphragmatic Hernias

Congenital hernias

There are mainly two types of congenital diaphragmatic hernias: Bochdalek and Morgagni hernias (Fig.31).

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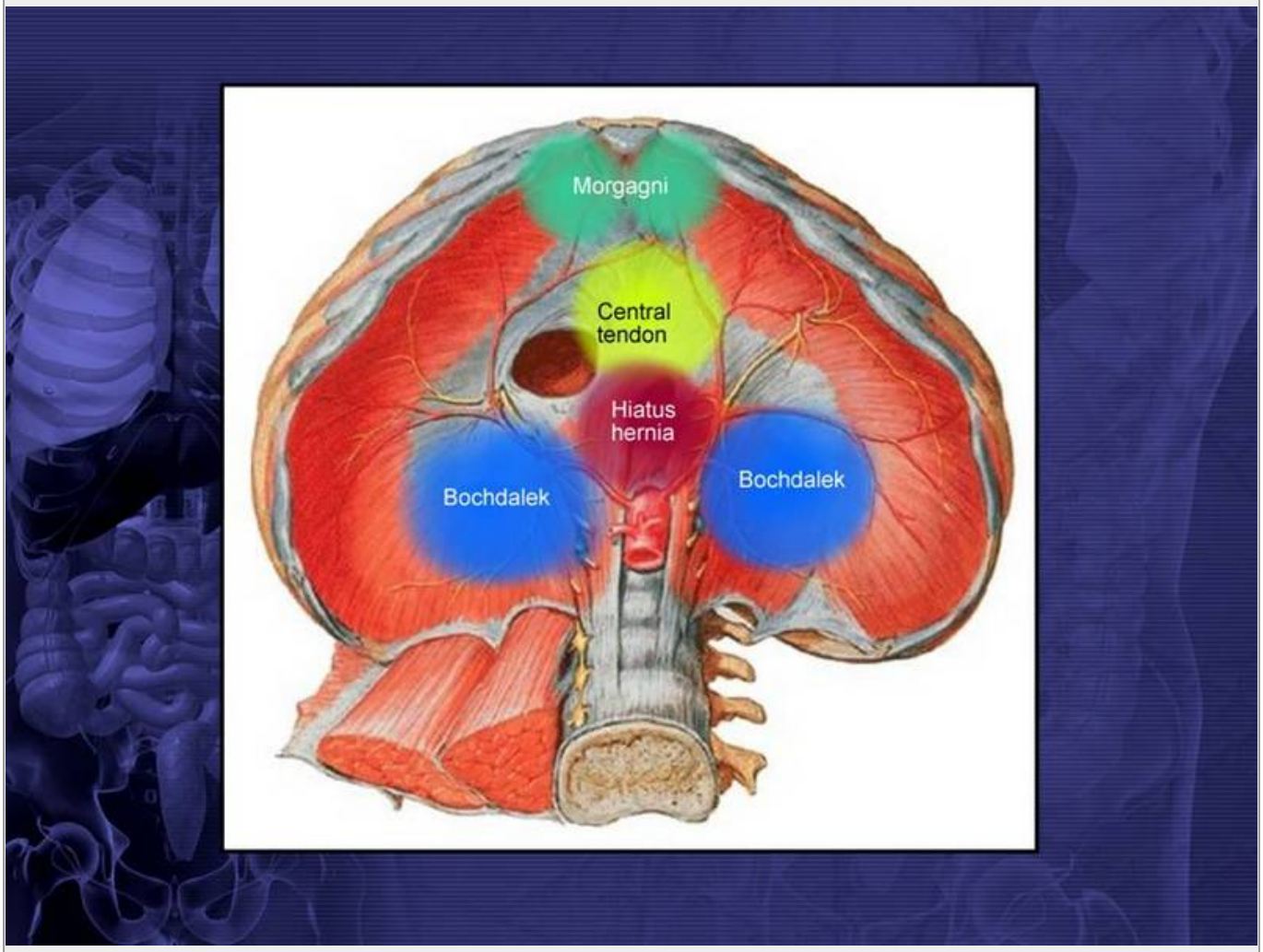

Figure 31. Types and sites of diaphragmatic hernias. (from www.med-info.nl)

Bochdalek Hernia – Bochdalek hernia results from a congenital defect in the diaphragm that occurs posterolaterally and on the left side in approximately 70-90% of cases. Although Bochdalek hernias can cause profound respiratory distress in the newborn, many cases go undiagnosed because affected adults are commonly asymptomatic. Bochdalek hernia is usually detected as a lung-base soft-tissue opacity lesion on the left side and seen posteriorly on lateral images. The herniated contents contain fat and omental tissue in a majority of cases, but other structures can infrequently be involved (e.g. kidney or liver) (Fig.32).

diapositivo32.jpg

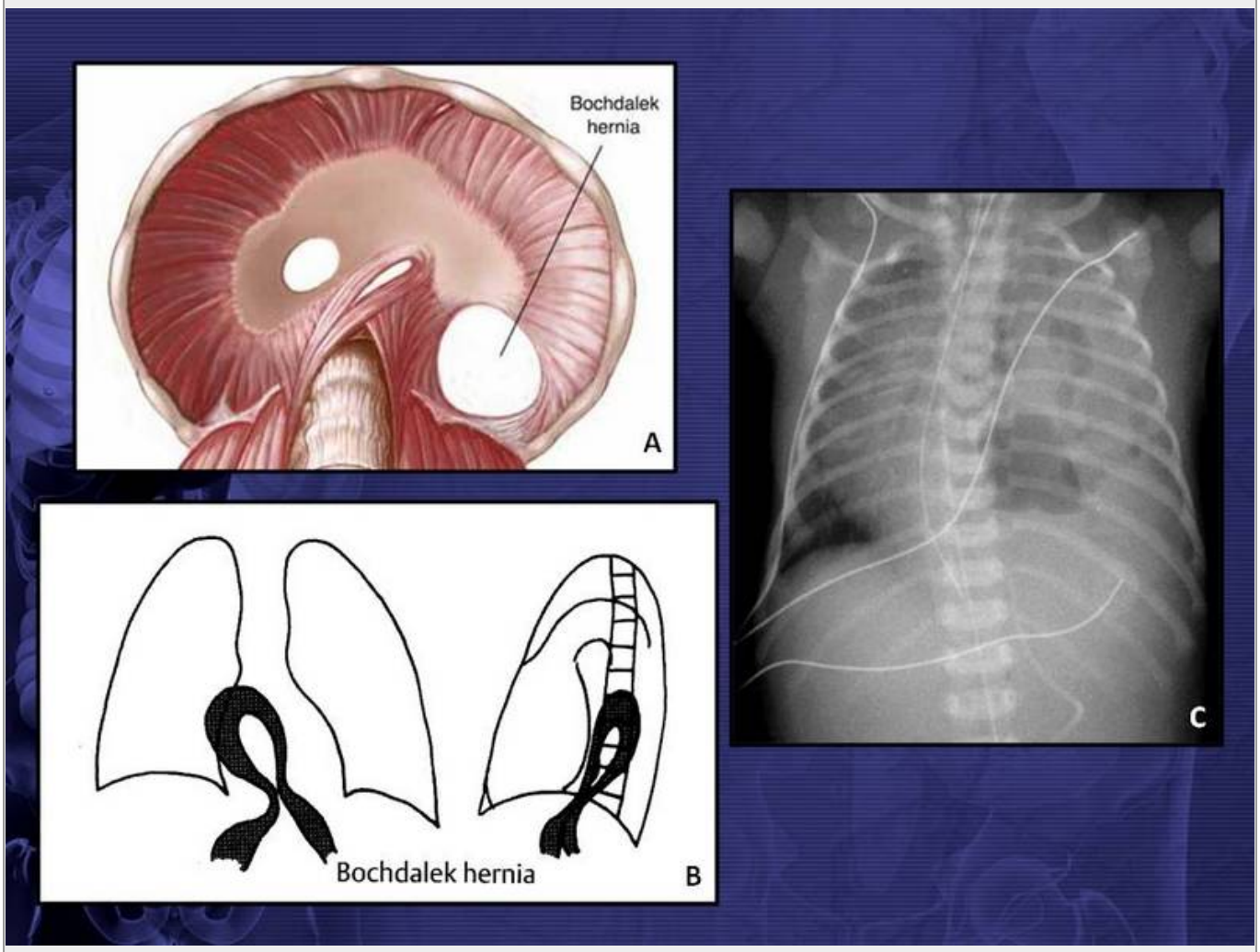

Figure 32. Bochdalek hernia. (A) and (B) Illustrations depicting the site of diaphragmatic defect (A) and the projection of the hernia on frontal and lateral radiographs (B). (C) Bochdalek hernia in a newborn with respiratory distress. (A. from www.vesalius.com. B. from Lange S, Walsh G. Radiology of Chest Diseases. 3rd ed. Stuttgart: Thieme; 2007: 231).

Morgagni Hernia – Much less common than Bochdalek hernia, Morgagni hernia results from a defect in the diaphragm between its attachment with the sternum and costal cartilages. The hernia most often is seen on the right side near the cardiophrenic angle. The radiographic appearance of the Morgagni hernia is variable depending on the contents of the hernia. Most often the hernia contains omental fat and transverse colon, but may also contain liver (Fig.33).

diapositivo33.jpg

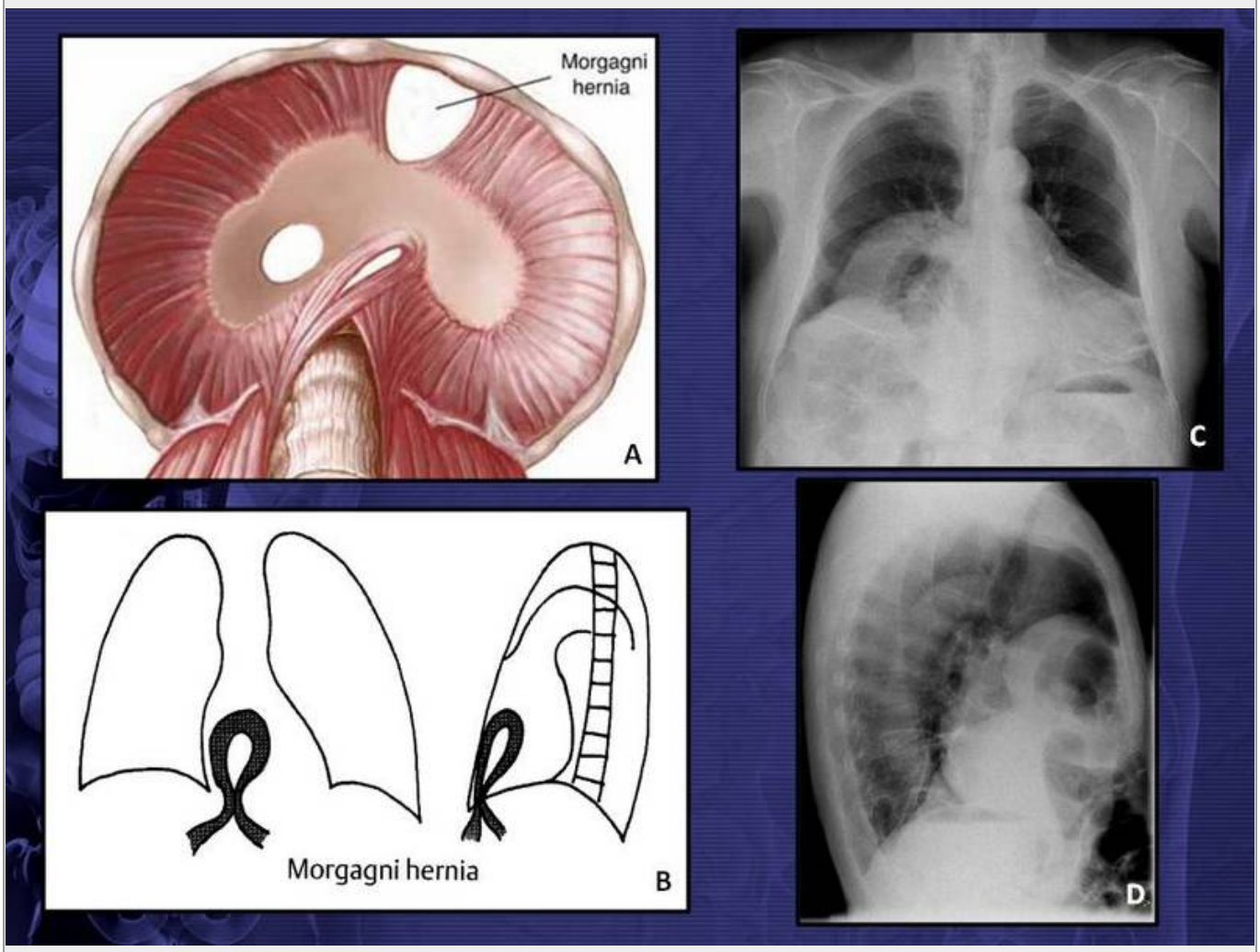

Figure 33. Morgagni hernia. (A) and (B) Illustrations depicting the site of diaphragmatic defect (A) and the projection of Morgagni hernia on frontal and lateral radiographs (B). Frontal (C) and lateral (D) chest radiographs show a Morgagni hernia in a 80-year-old man. Note that the hernia is seen on frontal radiographs in the right hemithorax, projecting anteriorly on lateral films. (A. from www.vesalius.com. B. from Lange S, Walsh G. Radiology of Chest Diseases. 3rd ed. Stuttgart: Thieme; 2007: 231).

Acquired hernias

Hiatal Hernia

Hiatal hernia is a common condition in which a portion of the upper stomach protrudes into the chest cavity through an enlarged and weakened esophageal hiatus, secondary to increased intraabdominal pressure.

There are two major types of hiatal hernia (Fig.34):

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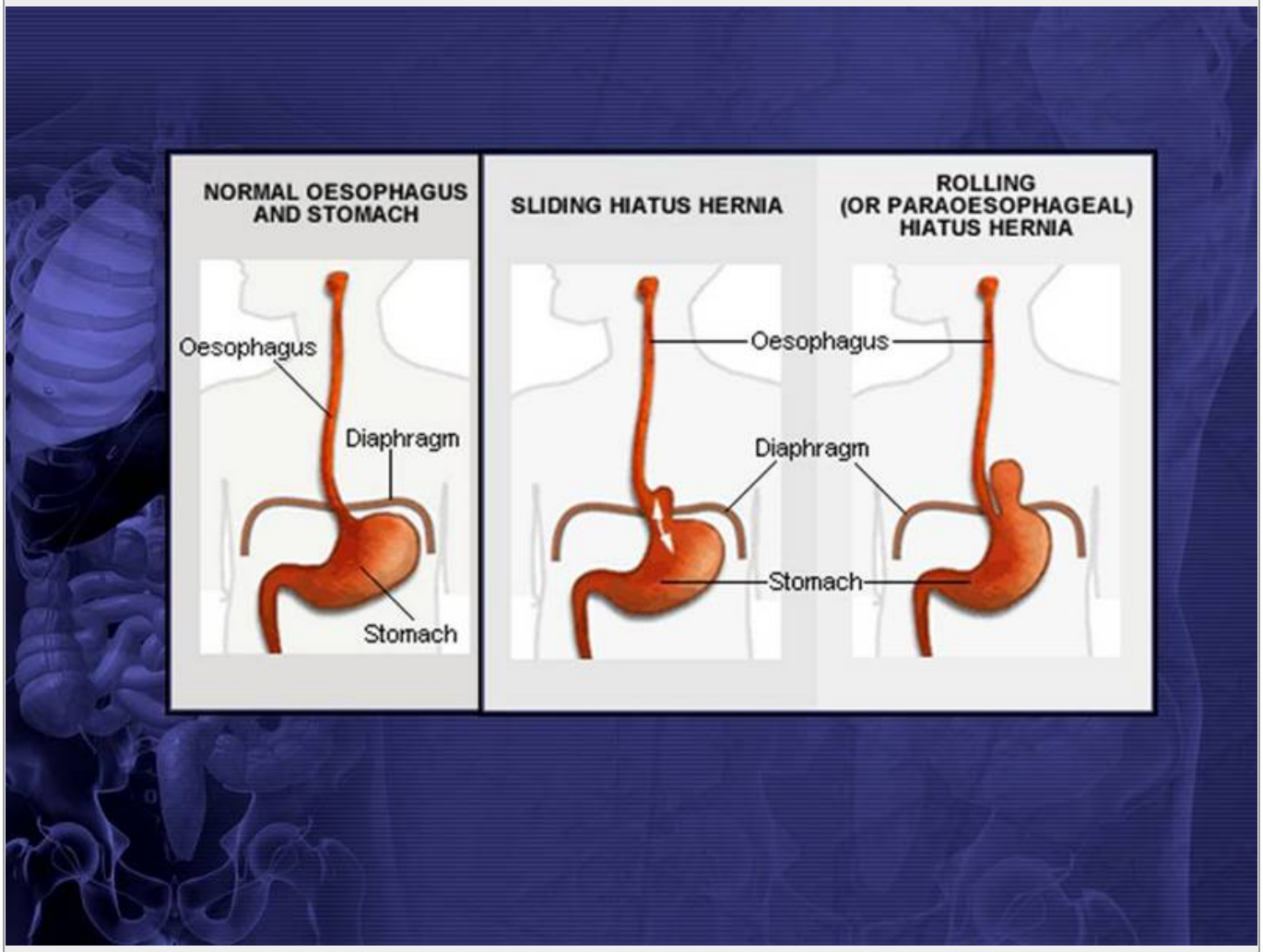

Figure 34. Types of hiatal hernias. (from hiatusherniasymptoms.com)

- The most common (95%) is the **sliding** type, where the gastroesophageal junction moves above the diaphragm together with some of the stomach (Fig.35).

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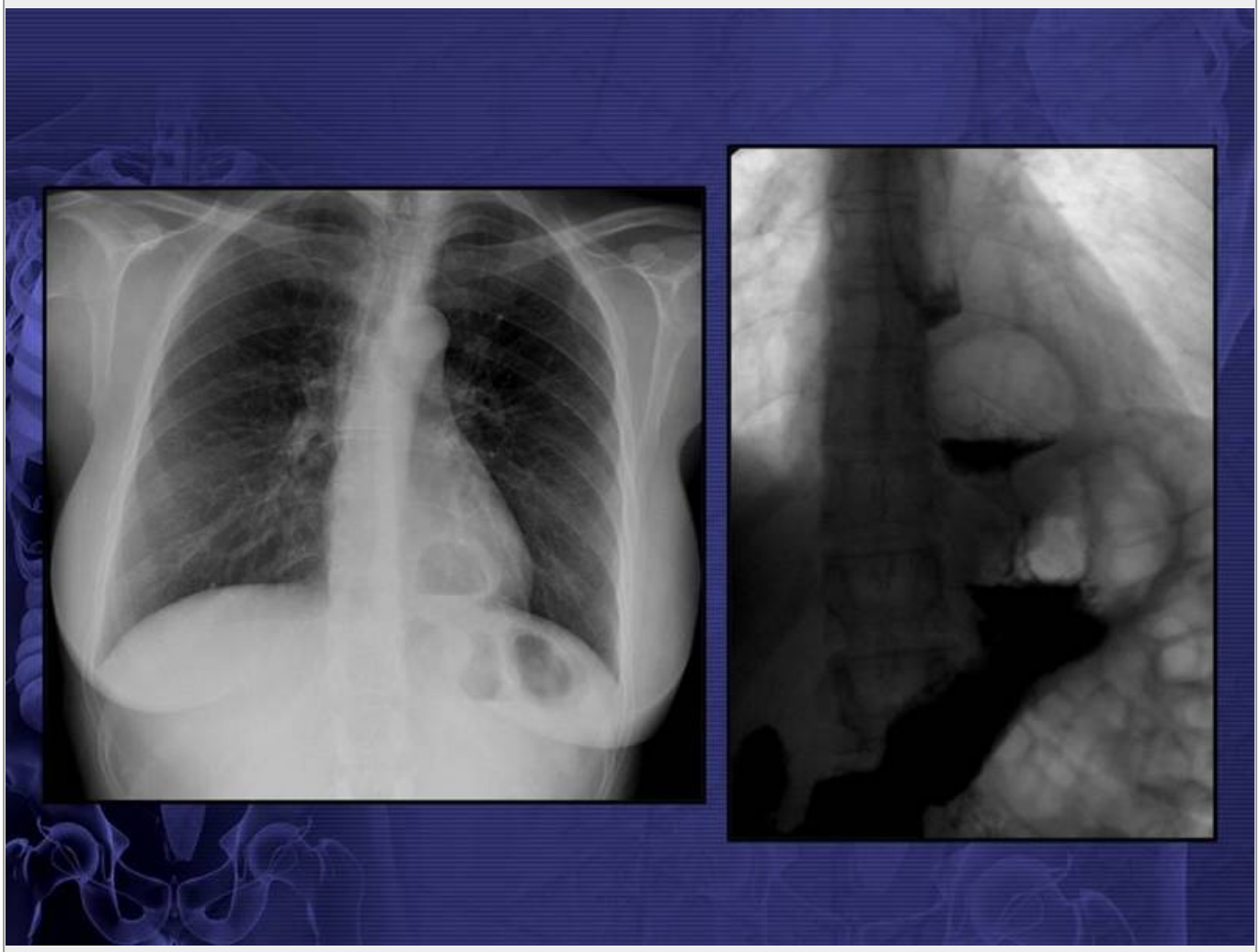

Figure 35. Chest radiograph (A) and barium swallow x-ray (B) showing a sliding hiatus hernia.

- The second type is **rolling** (or **paraesophageal**) hiatus hernia, when a part of the stomach herniates through the esophageal hiatus and lies beside the esophagus, without movement of the gastroesophageal junction (Fig.36). Gastric volvulus is the most common complication of paraesophageal hernias.

diapositivo37.jpg

Figure 36. (A) Frontal chest x-ray shows an opacity with an air-fluid level in retrocardiac location. (B) and (C) Barium swallow x-rays demonstrated that those radiographic findings corresponded to a paraesophageal hiatal hernia.

- A third type is also sometimes described, and is a combination of the first and second types.

On radiographs, a hiatal hernia is seen as a rounded soft-tissue opacity or an air-filled hyperlucency in the retrocardiac region, with or without an air-fluid level (Fig.37). When air is seen within the hernia, the stomach air bubble found below the diaphragm tends to be absent. In large hiatal hernias, the entire stomach rotates on its long axis and inverts into the hernia sac, ultimately resting above the diaphragm.

diapositivo36.jpg

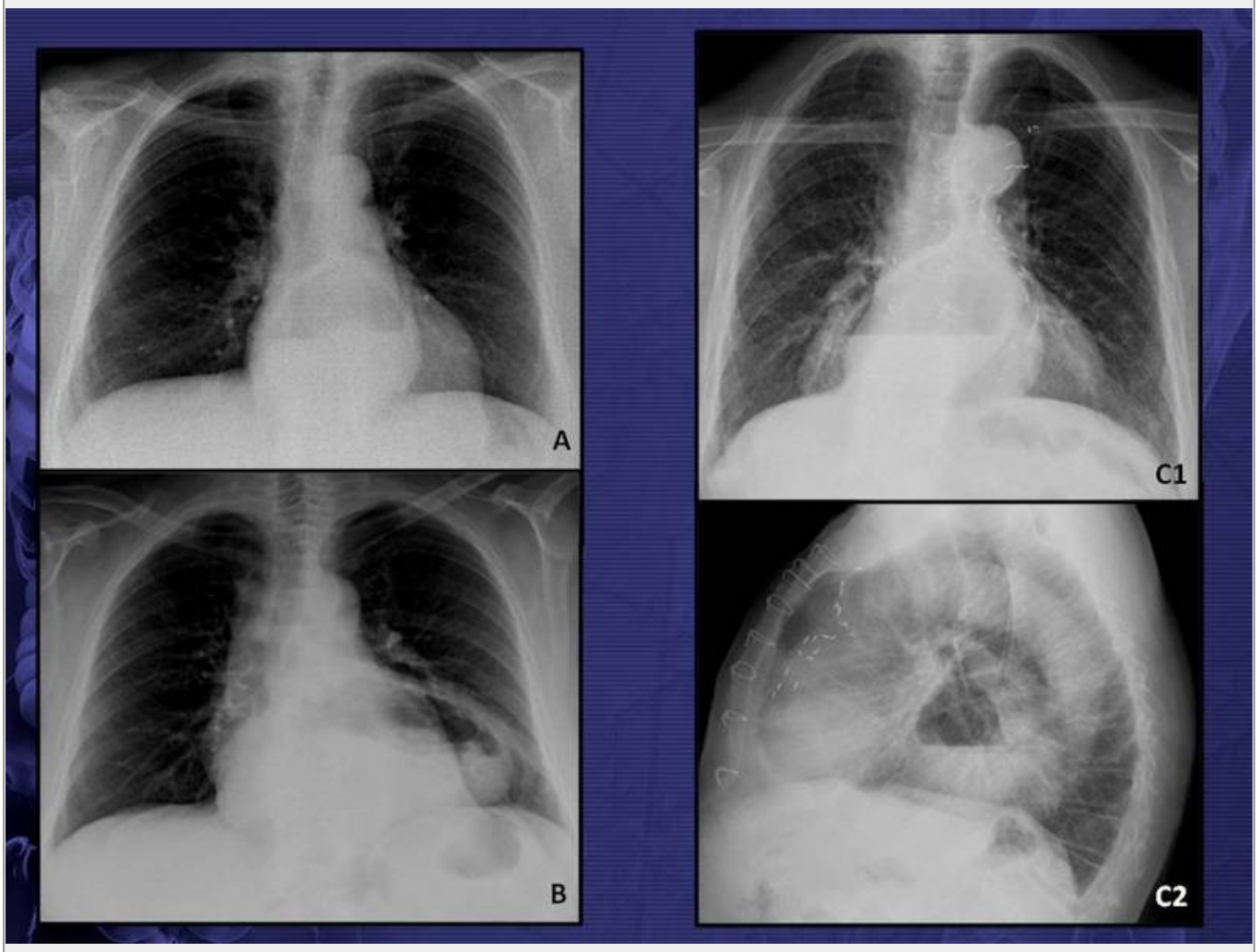

Figure 37. Other three cases of proven hiatal hernia on chest radiographs.

Barium swallow or a CT scan will confirm the diagnosis.

Traumatic Diaphragmatic Hernia

By far, the most common cause of acquired diaphragmatic disorders is either penetrating or blunt abdominal or lower thoracic trauma. The rupture usually involves the posterior central portion of the left hemidiaphragm and extends medially. Left-sided rupture is much more common than right-sided rupture, which is probably due to hepatic protection and increased strength of the right hemidiaphragm.

Plain chest radiographic findings are abnormal in approximately 95% of the cases and include an elevated (>4 cm higher on left vs right) and irregular diaphragm, pleural effusion, atelectasis, and rib fractures. Gas bubbles or air-fluid levels may appear in the chest, as the stomach often herniates into the thorax, and the mediastinum may appear shifted to the side (Fig.38).

diapositivo38.jpg

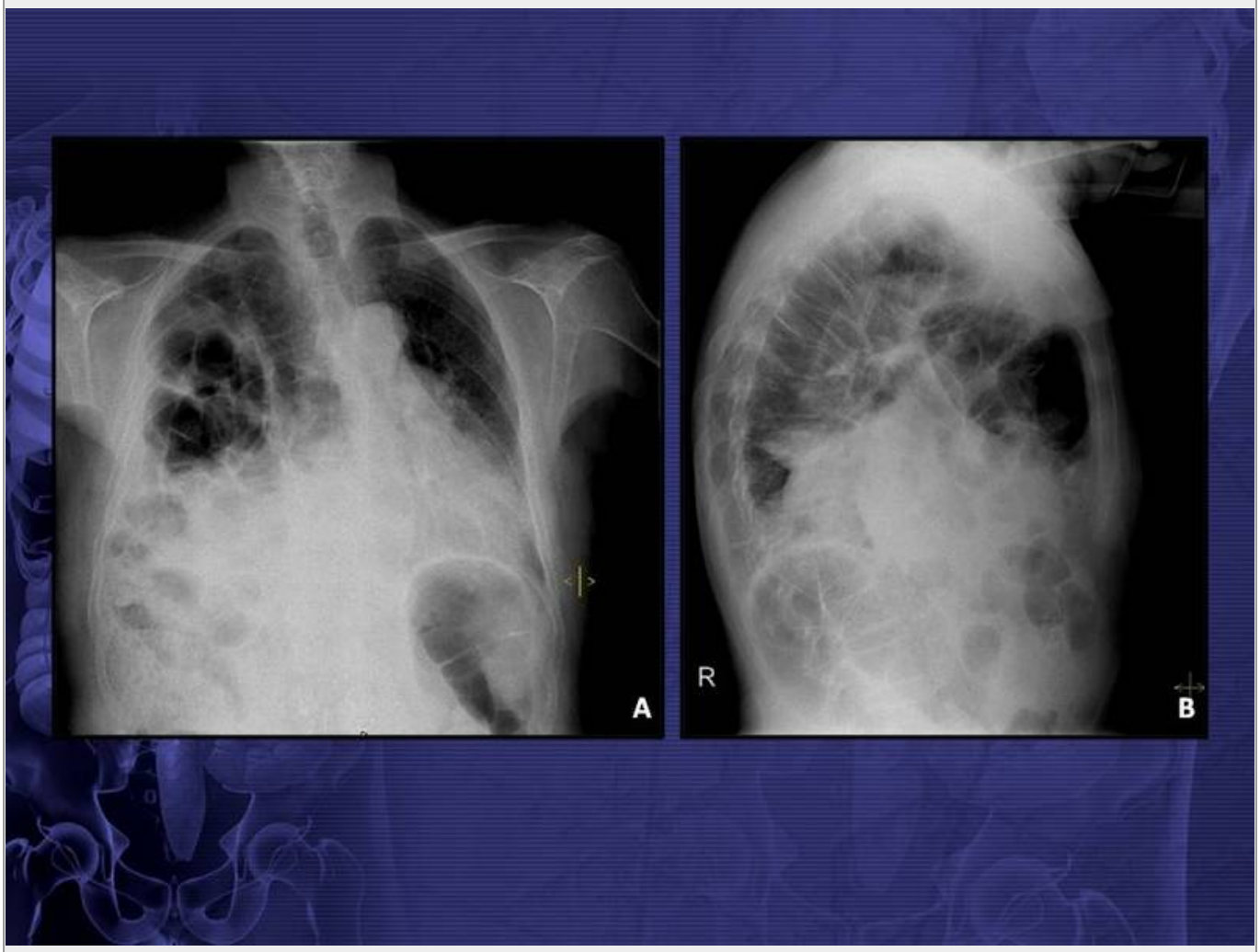

Figure 38. Frontal (A) and lateral (B) chest plain films show a traumatic diaphragmatic hernia, with uncommon rupture of the right side of the diaphragm, with herniation of abdominal contents (namely colon) into the thoracic cavity. Note also the mediastinum shifted to the left.

The gastroesophageal junction usually remains in its normal position. A nasogastric tube from the stomach may appear on the film in the chest cavity; this sign is pathognomonic for diaphragmatic rupture, but it is rare.

Iatrogenic Diaphragmatic Hernia

Injury to the diaphragm with subsequent development of a diaphragmatic hernia may occur after medical intervention, for example during surgery to the abdomen or chest.

4. Conclusion

A considerable number of gastrointestinal conditions present with thoracic complaints. Therefore, the plain chest radiography is usually the first exam performed for diagnostic evaluation.

Awareness of the subtle changes on the plain chest radiograph secondary to pathology of the gastrointestinal tract allows prompt diagnosis and can lead to the next appropriate therapeutic or diagnostic procedure.

5. References

1. Burgener FA, Kormano Martti. Differential Diagnosis in Conventional Radiology. 3nd ed. Stuttgart: Thieme; 1991: 592.

2. Lange S, Walsh G. Radiology of Chest Diseases. 3rd ed. Stuttgart: Thieme; 2007: 231.

3. Wright F. Radiology of the Chest and Related Conditions.

4. Lee JKT et al. Computed Body Tomography with MRI Correlation.Lippincott Williams & Wilkins; Fourth Edition.

5. Brant WE, Helms CA. The Brant and Helms Solution: Fundamentals of Diagnostic Radiology. Lippincott Williams & Wilkins; Third Edition edition.

6. Gibbs et al. Lines and Stripes: Where Did They Go – From Conventional Radiography to CT. RadioGraphics 2007; 27:33–48.

7. Stark P et al. Manifestations of Esophageal Disease on Plain Chest Radiographs. AJR 155:729-734, October 1990

8. Cole TJ. Manifestations of Gastrointestinal Disease on Chest Radiographs. RadioGrapbics 1993; 13:1013-1034

9. Kim TJ et al. Postoperative Imaging of Esophageal Cancer: What Chest Radiologists Need to Know. RadioGraphics 2007; 27:409–429.

10. Han SY et al. Perforation of the Esophagus: Correlation of Site and Cause with Plain Film Findings. AJR 145:537-540, September 1985.

11. Menuck L. Plain Film Fndings of Gastric Volvulus Herniating into the Chest. Am JRoentgenol 126:1169-1174, 1976.

12. Marshall, GB. The Cupola Sign. Radiology 2006; 241:623– 624.

13. Connell TR. Upper Abdominal Abscess: A Continuing and Deadly Problem. AJR 1 34:759-765, April 1980.

14. Curvo-Semedo L e al. Hérnia Diafragmática Congénita: Aspectos Imagiológicos na Radiografia do Tórax. Acta Radiológica Portuguesa, Vol.XIV, nº 56, pág. 35-40, Out.-Dez. 2002.

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7. Mediafiles

diapositivo1.jpg

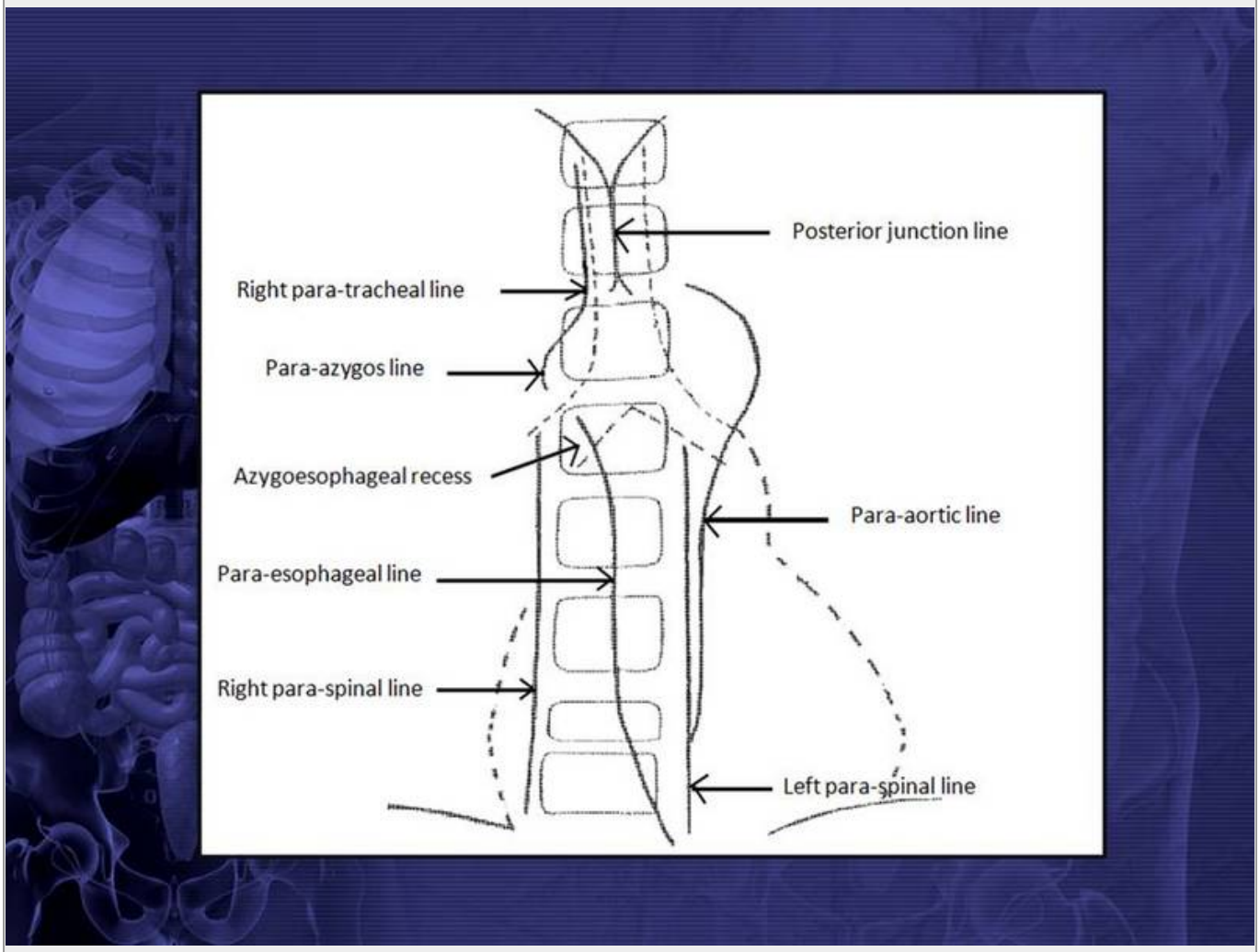

Figure 1. Lines in the posterior mediastinum. (adapted from Wright F. Radiology of the Chest and Related Conditions. p. 1.10)

diapositivo2.jpg

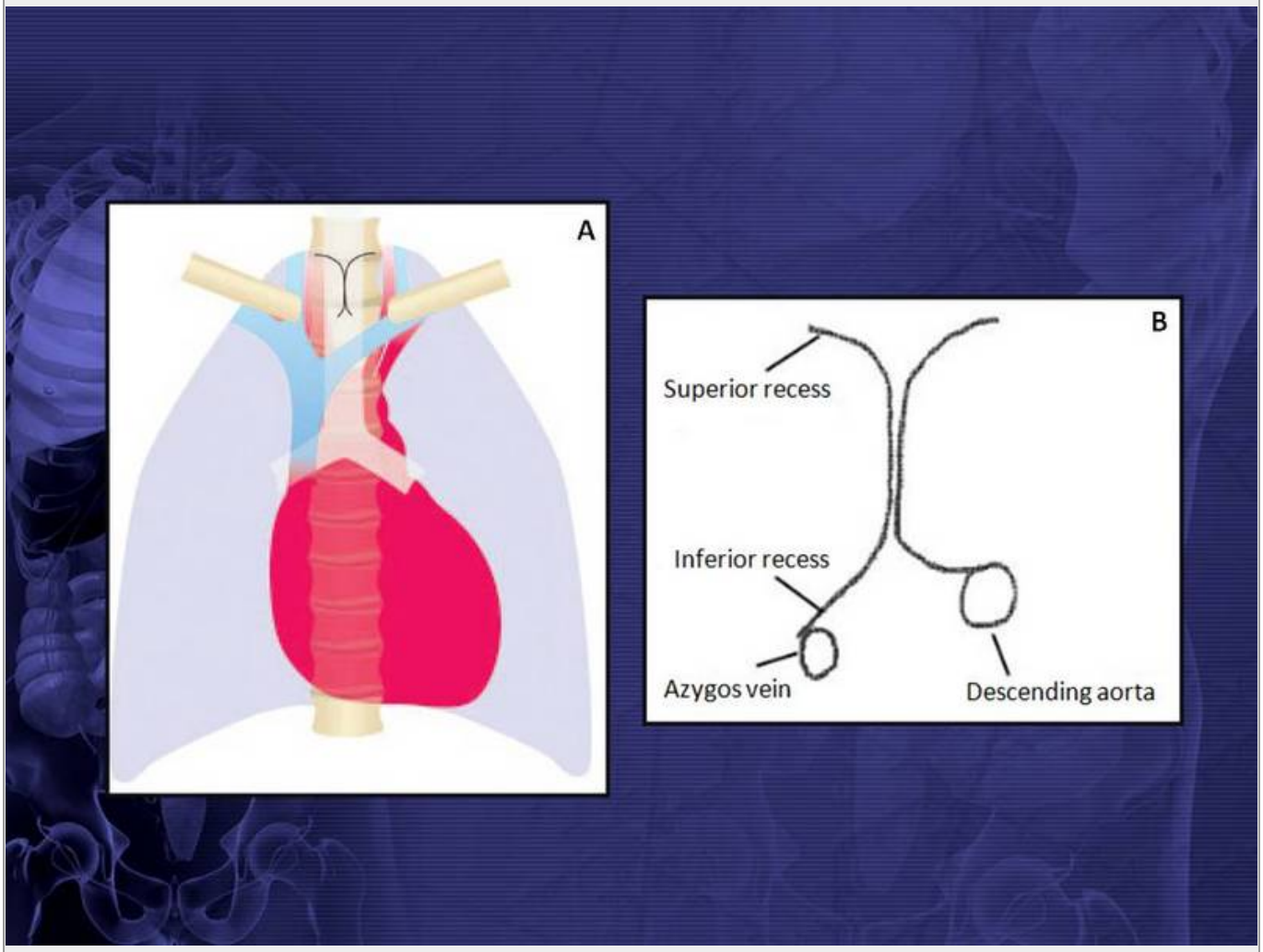

Figure 2. Illustration (A) and diagram (B) depicting the normal anatomy of the posterior junction line. (A. from Gibbs et al. Lines and Stripes: Where Did They Go – From Conventional Radiography to CT. RadioGraphics 2007; 27:33–48. B. adapted from Wright F. Radiology of the Chest and Related Conditions. p. 1.15)

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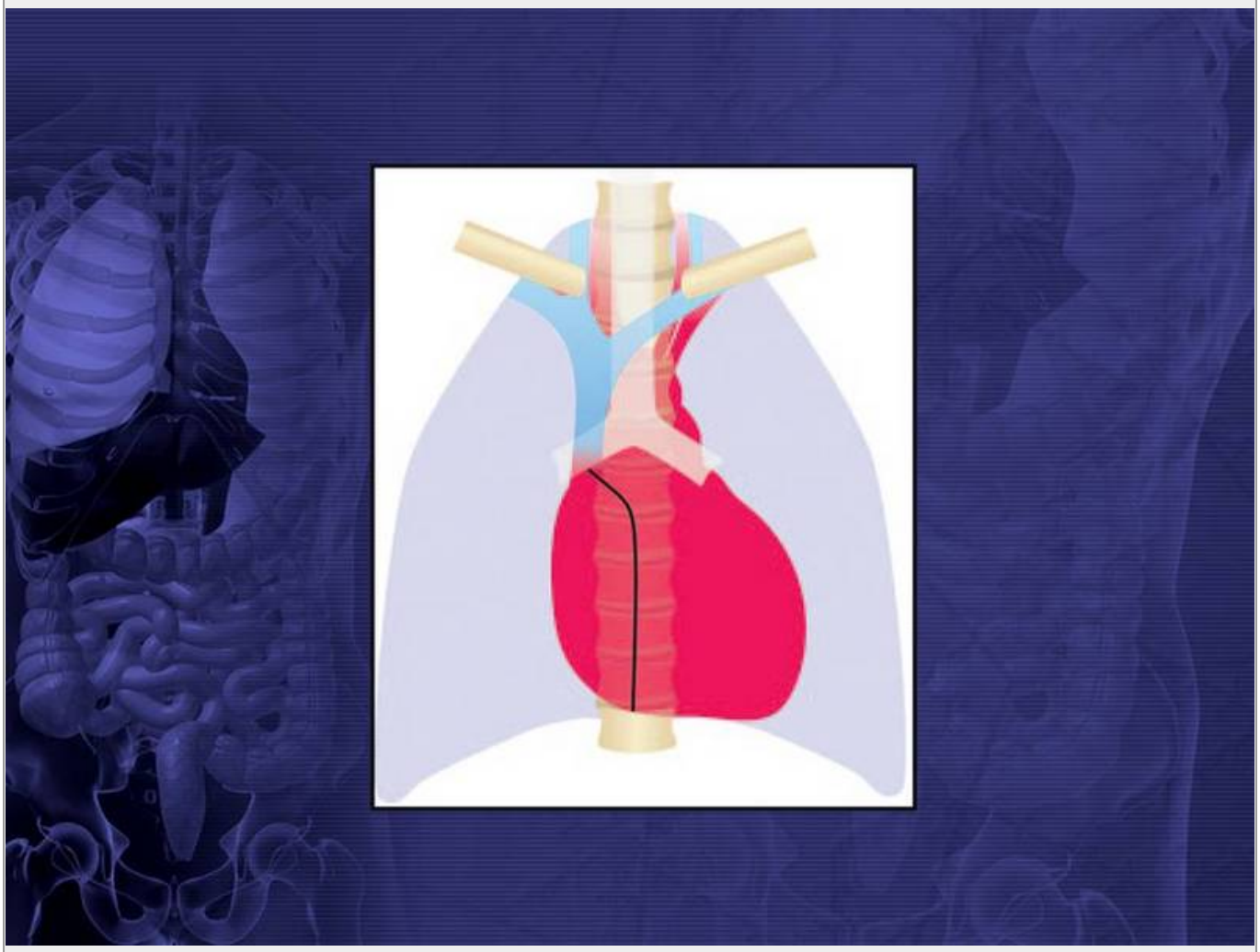

Figure 3. Illustration showing the normal azygoesophageal recess. (from Gibbs et al. Lines and Stripes: Where Did They Go – From Conventional Radiography to CT. RadioGraphics 2007; 27:33–48)

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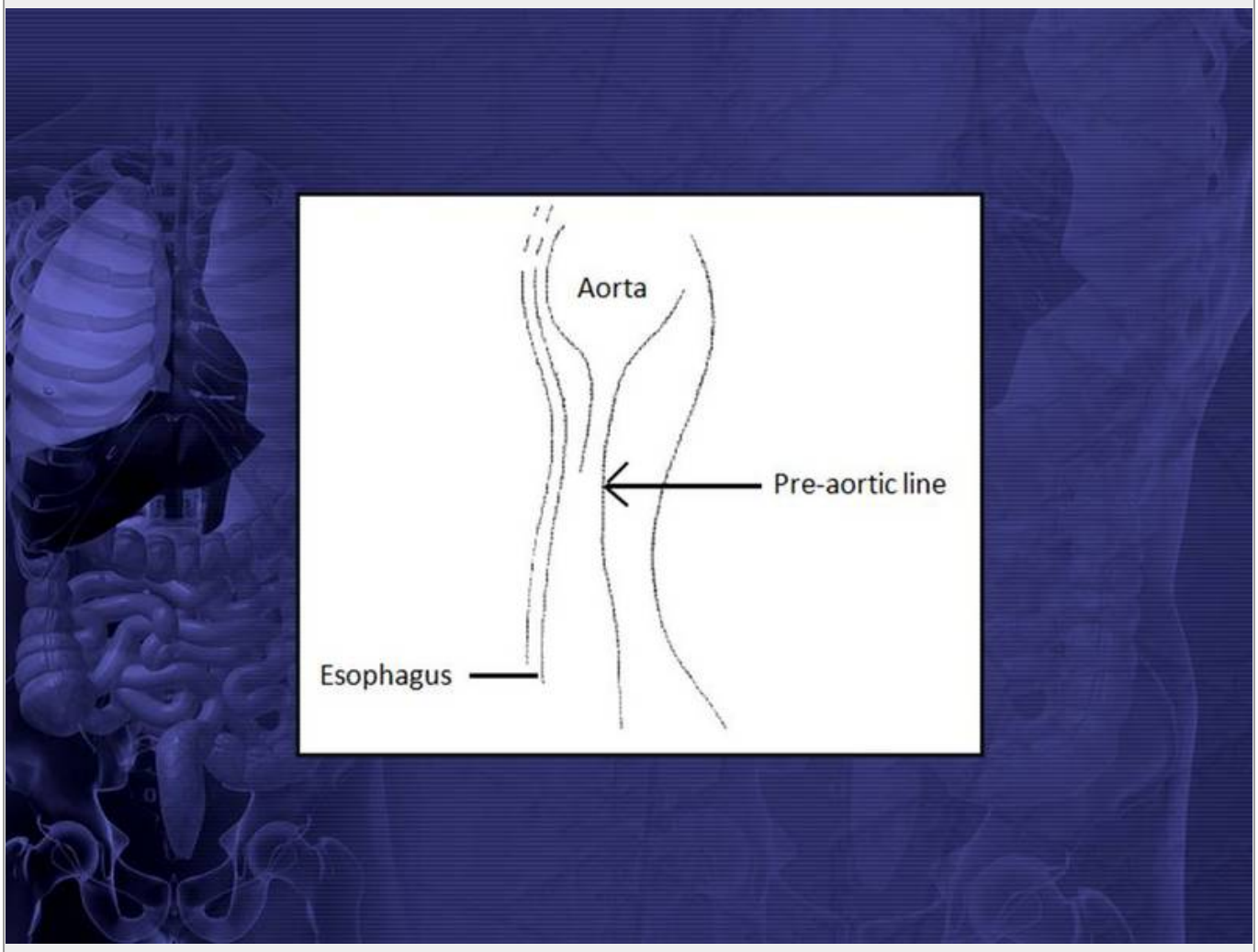

Figure 4. The pre-aortic line. (adapted from Wright F. Radiology of the Chest and Related Conditions: p. 1.19)

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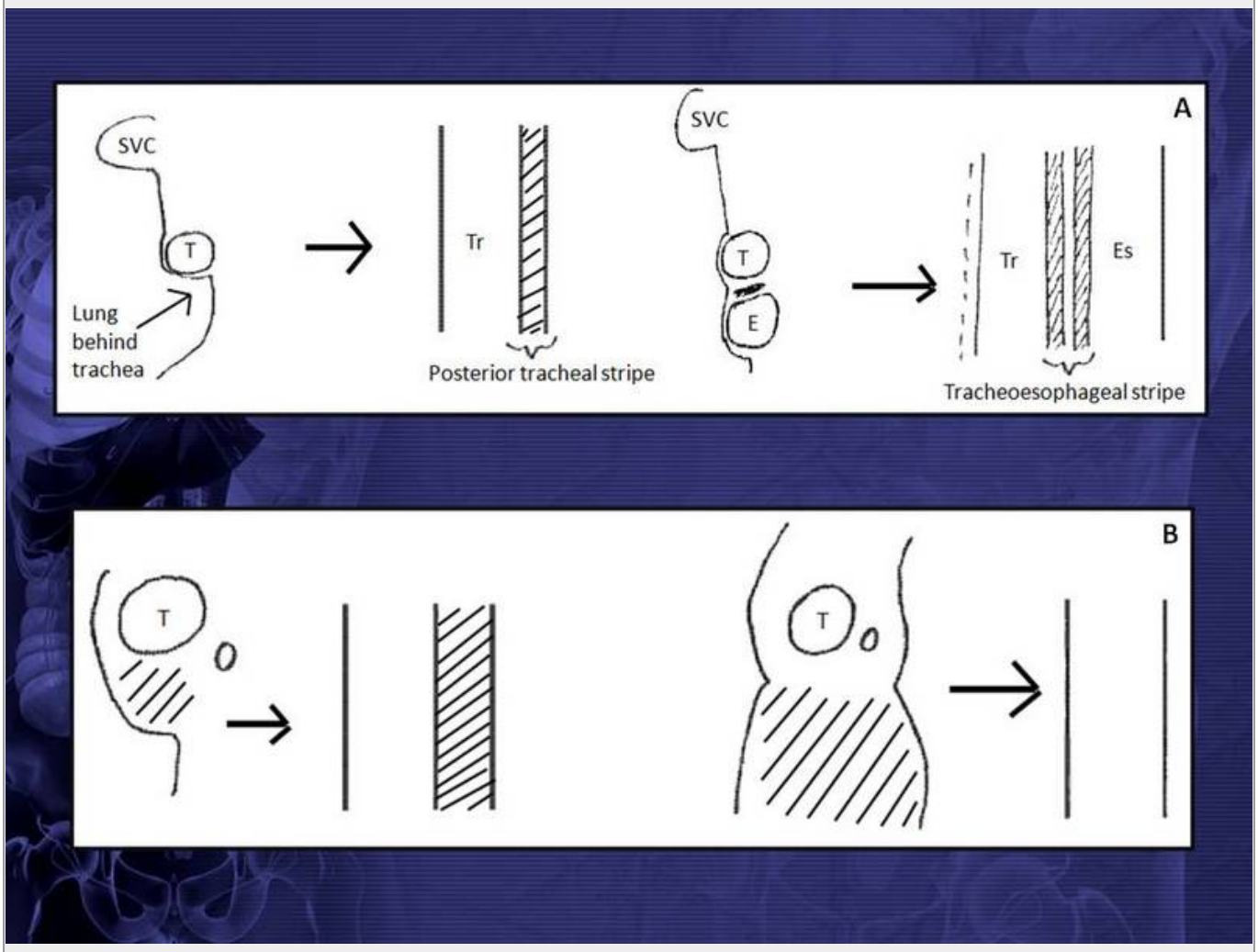

Figure 5. (A) Retrotracheal and retroesophageal stripes. (B) Tumor, nodes and esophageal mass thickening the retrotracheal stripe. When there are very large nodes or a tumor obliterating the retrotracheal space, the stripe will be completely lost, since no air-filled lung will project behind the trachea. (adapted from Wright F. Radiology of the Chest and Related Conditions. p. 1.23-1.24)

diapositivo6.jpg

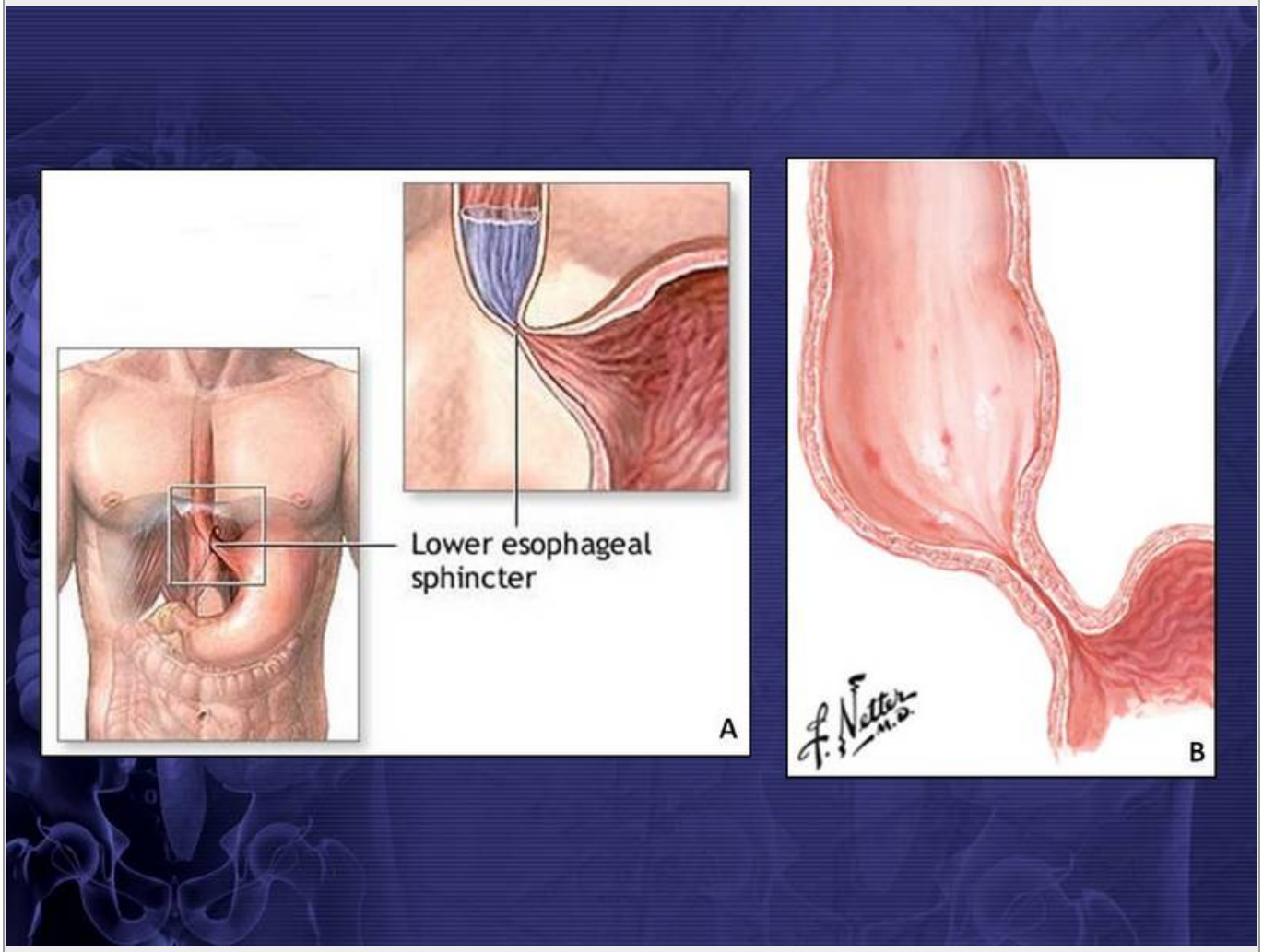

Figure 6. Achalasia. In advanced disease, the esophagus becomes dilated and filled with food residues. The esophageal wall is thickened and the lower esophageal sphincter fails to relax properly in response to swallowing. (A. adapted from http://adam.about.com/surgery/Achalasia-series.htm. B. adapted from Netter F. Netter's Illustrated Human Pathology.)

diapositivo7.jpg

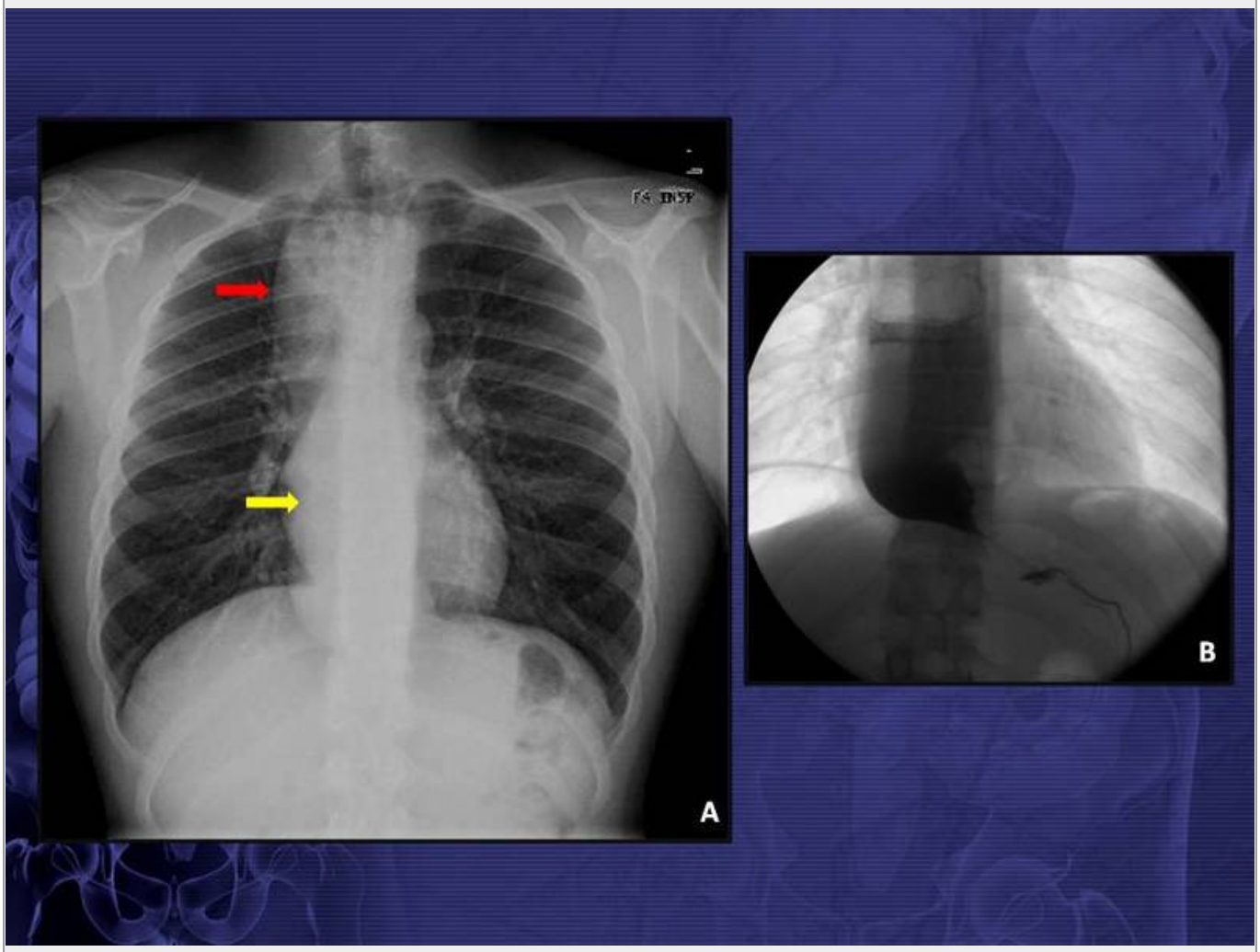

Figure 7. (A) Frontal chest radiograph of a 18-year-old patient showing widening of the superior mediastinum (red arrow), with some air lucencies patent on the right (debris-filled dilated esophagus). Note also the right convexity of the azygoesophageal recess (yellow arrow), secondary to the opacity of the dilated esophagus behind the right heart border. (B) Frontal esophagogram in the same patient confirmed the diagnosis of achalasia.

diapositivo8.jpg

Figure 8. (A) Frontal chest film reveals widening of the superior mediastinum secondary to massive dilatation of the esophagus, which protrudes into the right hemithorax, with an air-fluid level (arrow). (B) The esophagogram shows the typical findings of achalasia, confirming the diagnosis.

diapositivo9.jpg

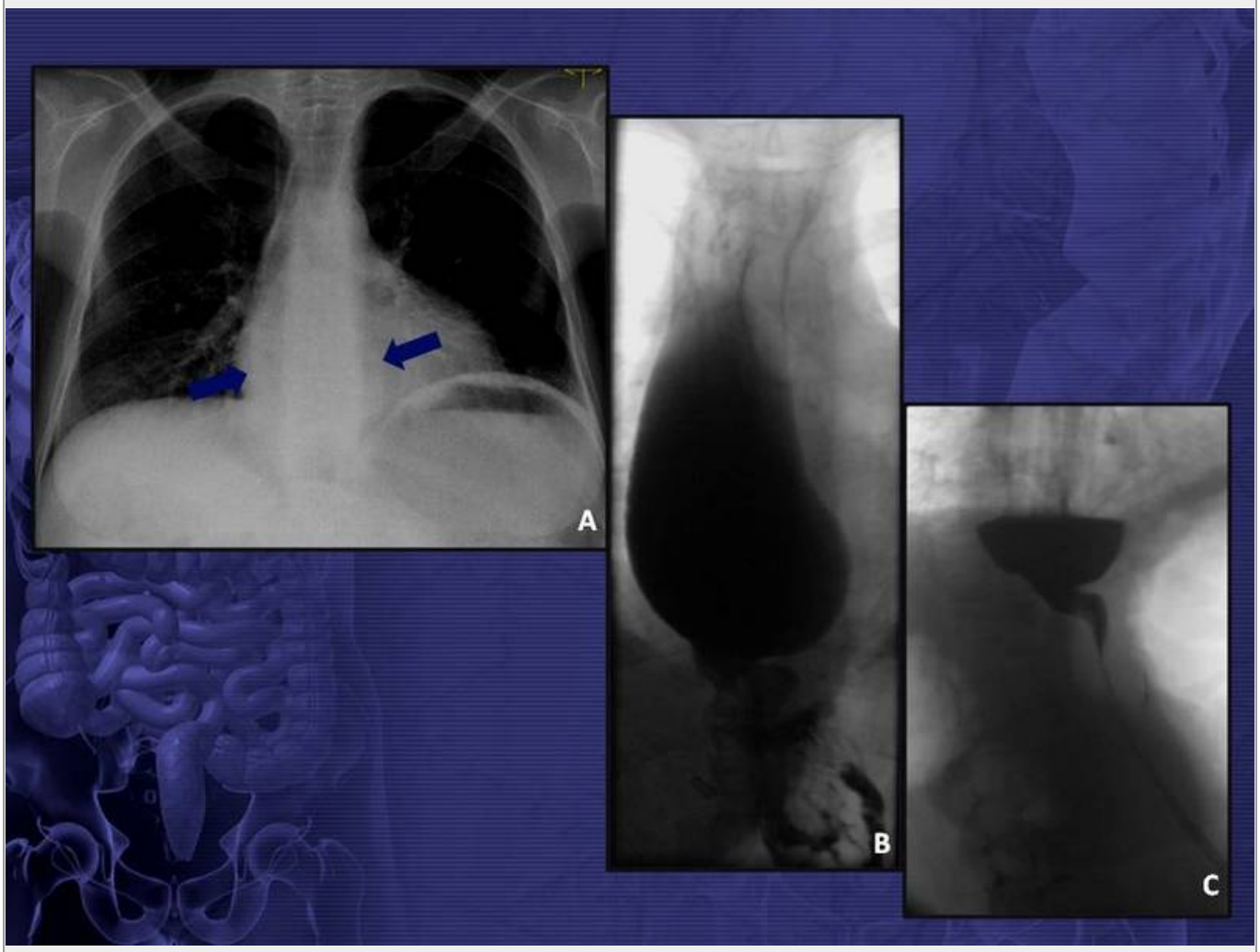

Figure 9. Scleroderma. (A) Frontal chest radiograph of this 45-year-old female demonstrates a well-defined opacity behind the heart shadow (arrows). (B) and (C) Barium swallow X-rays show dilated distal esophagus with aperistalsis and a stricture at the lower end of esophagus.

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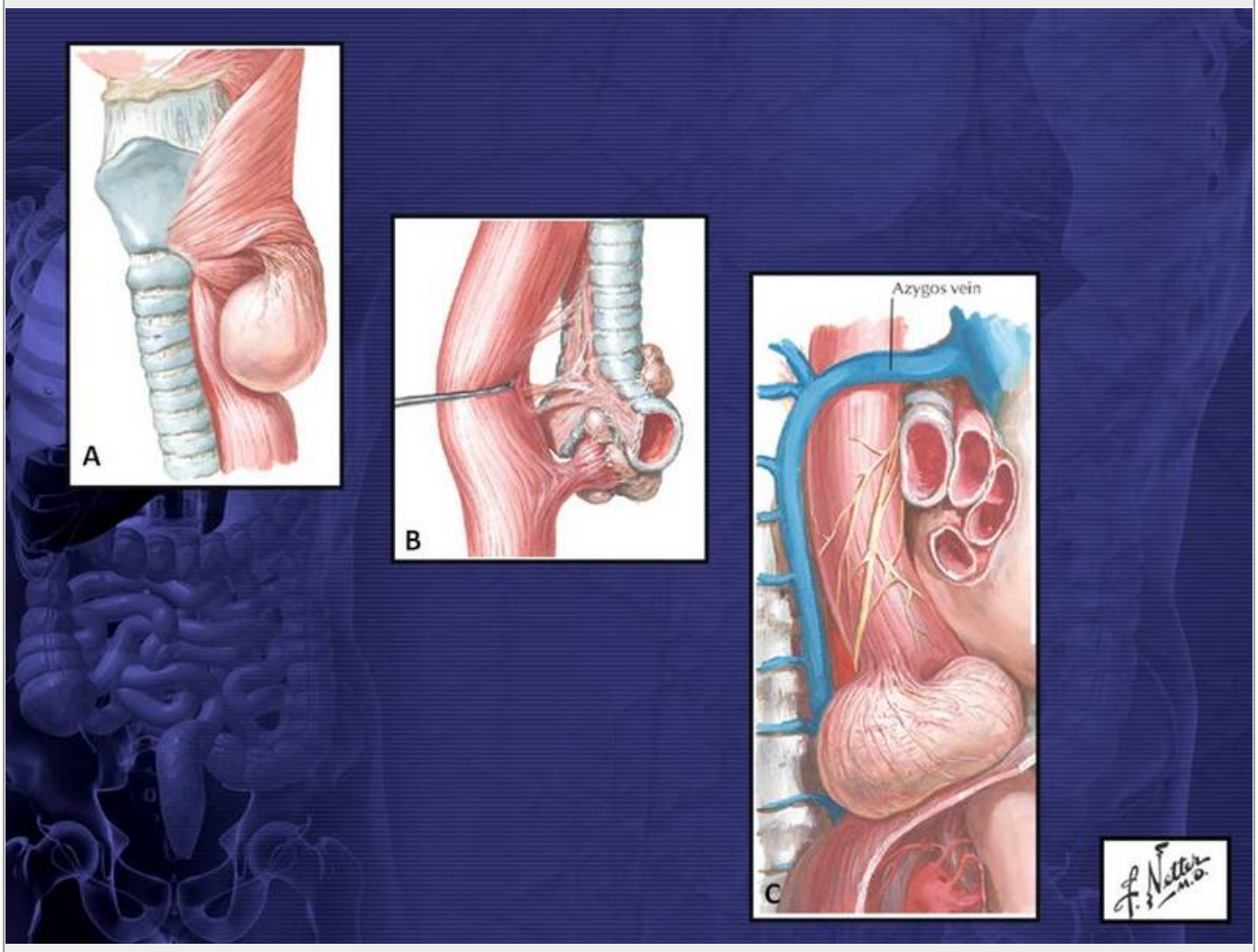

Figure 10. Esophageal diverticula. (A) Zenker diverticulum. (B) Midesophageal diverticulum. (C) Epiphrenic diverticulum. (adapted from Netter F. Netter's Illustrated Human Pathology.)

diapositivo11.jpg

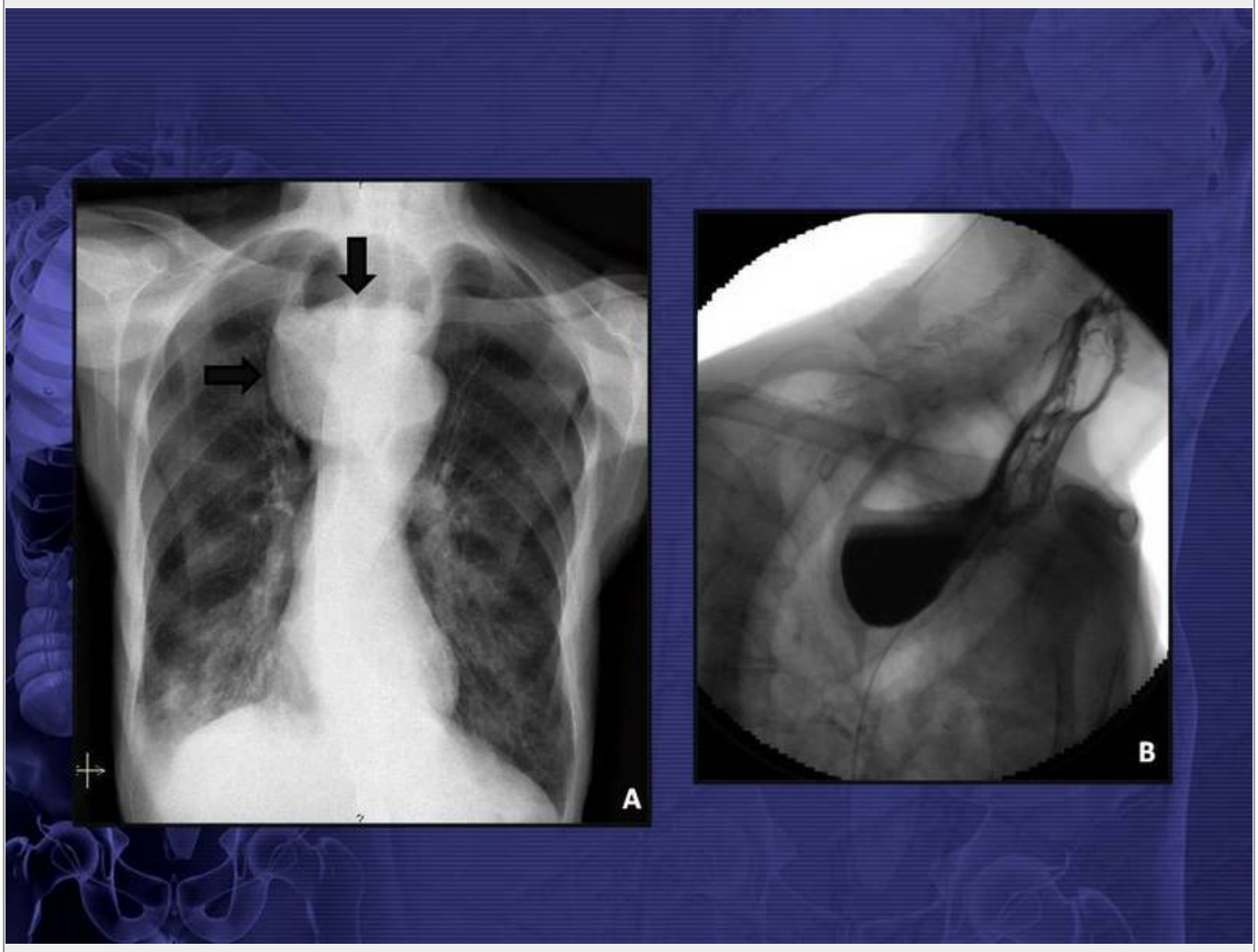

Figure 11. (A) Frontal chest film in the upright position shows an opacity in the superior mediastinum with an air-fluid level (arrows). (B) Esophagogram performed afterwards was consistent with a large Zenker diverticulum.

diapositivo12.jpg

Figure 12. (A) Chest frontal radiograph shows an air-fluid level within a mass in retrocardiac location, on the right. (B) Barium esophagogram demonstrates a large epiphrenic diverticulum.

diapositivo13.jpg

Figure 13. Frontal (A) and lateral (B) chest radiographs of a patient with carcinoma of the esophagus. Note in (B) the thickened posterior tracheal stripe, with a soft-tissue mass with irregular borders producing a slight posterior tracheal indentation.

diapositivo14.jpg

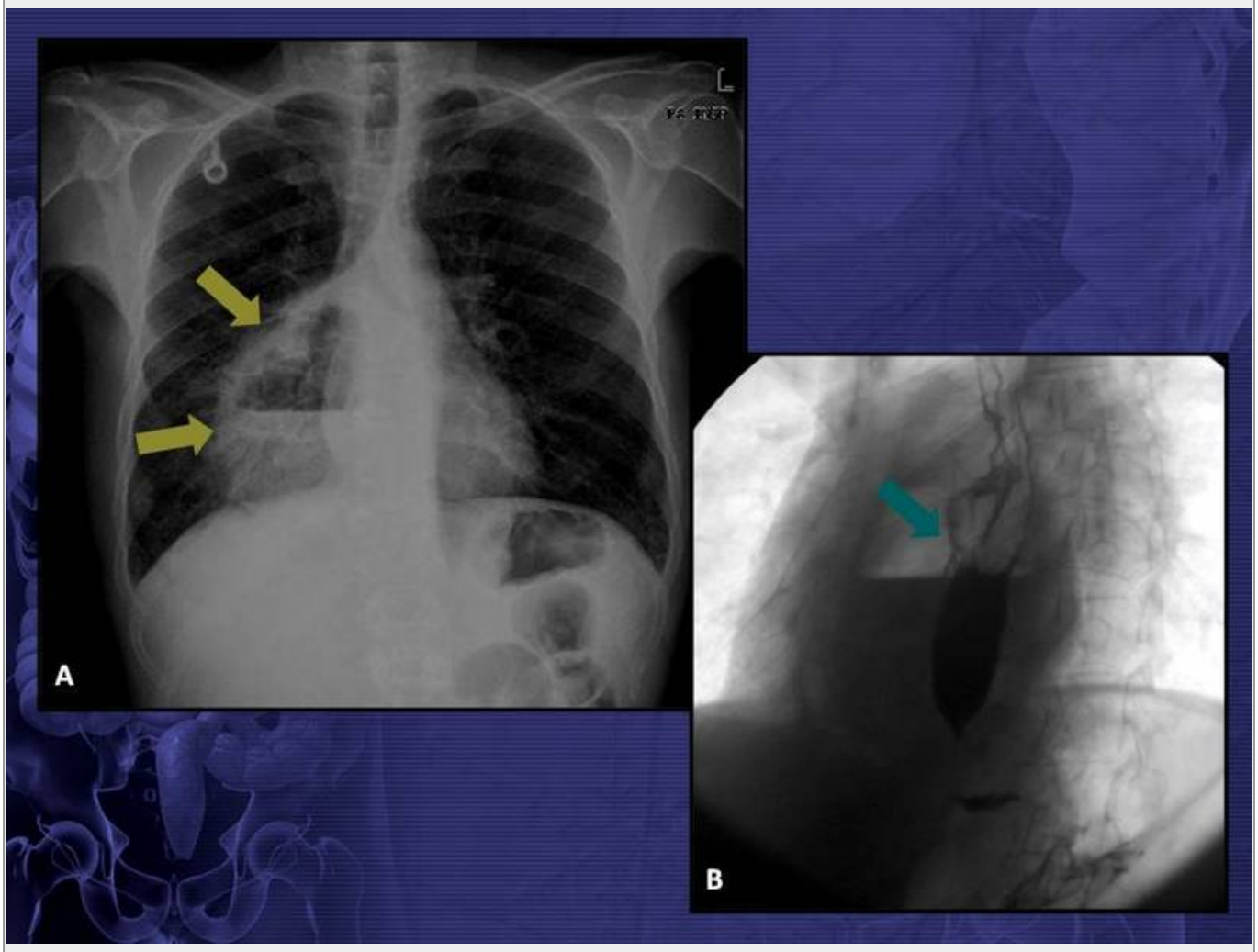

Figure 14. Frontal chest radiograph (A) and esophagogram (B) of a patient with known esophageal carcinoma, who developed a fistulous tract (arrow in B) between the ulcerated neoplasm and the right lung, leading to abscess formation (arrows in A).

diapositivo15.jpg

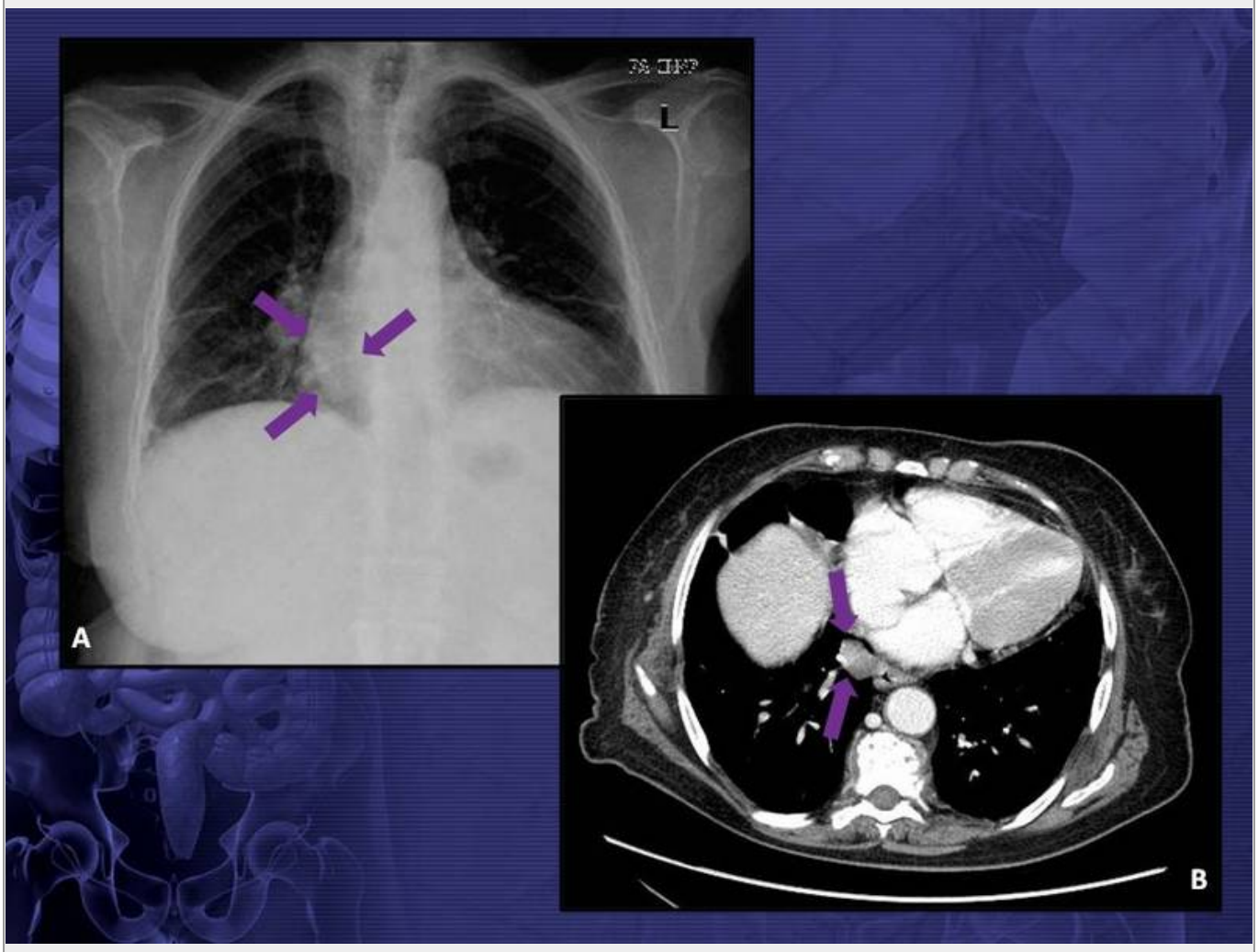

Figure 15. Esophageal duplication cyst. (A) Routine frontal chest radiograph in this 78-year-old female demonstrates a rounded well-defined mass adjacent to the distal esophagus, on the right (arrows). (B) Enhanced CT scan reveals a low attenuation, rounded, well-defined mass adjacent to the esophagus that doesn't seem to communicate with its lumen. The right-sided location is typical.

diapositivo16.jpg

Figure 16. Frontal (A) and lateral (B) chest radiographs of a patient with an aortic aneurysm and prominent ectasia of the thoracic aorta. Unfolding of the aortic arch and a tortuous dilated aorta are seen. This patient sought medical attention due to dysphagia and vague chest pain. The diagnosis of aortic dysphagia should always be considered in differential diagnosis when these atypical symptoms are present.

diapositivo17.jpg

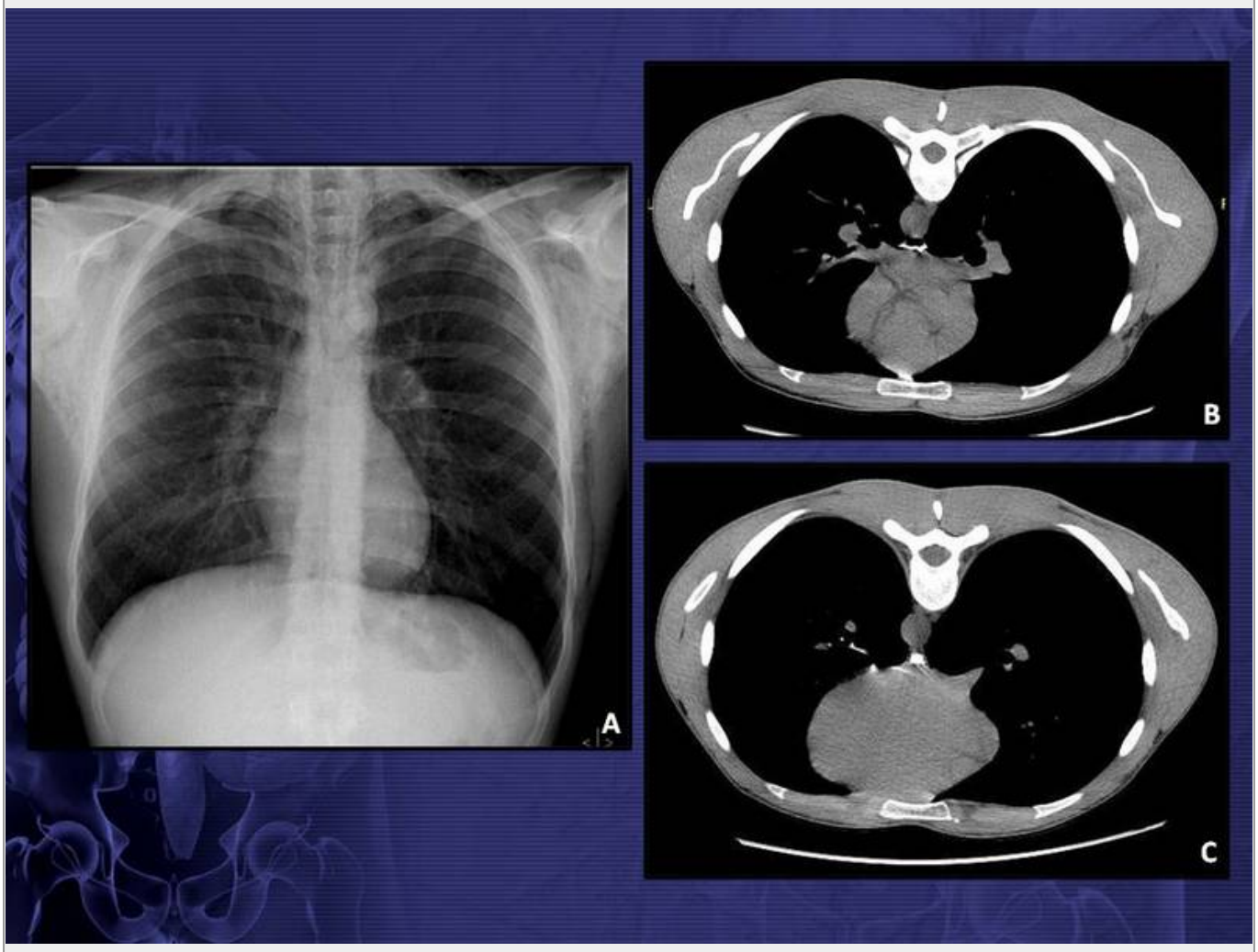

Figure 17. Boerhaave syndrome. (A) Chest frontal radiograph of a 18-year-old patient admitted in our emergency room for abdominal pain, nausea and persistent vomiting after heavy alcohol ingestion. It shows pneumomediastinum as well as deep cervical and subcutaneous emphysema. (B) and (C) show that the CT scan obtained in prone position after oral ingestion of water-soluble contrast medium demonstrate a small accumulation of contrast in the mediastinum, which suggest rupture of the esophagus.

diapositivo18.jpg

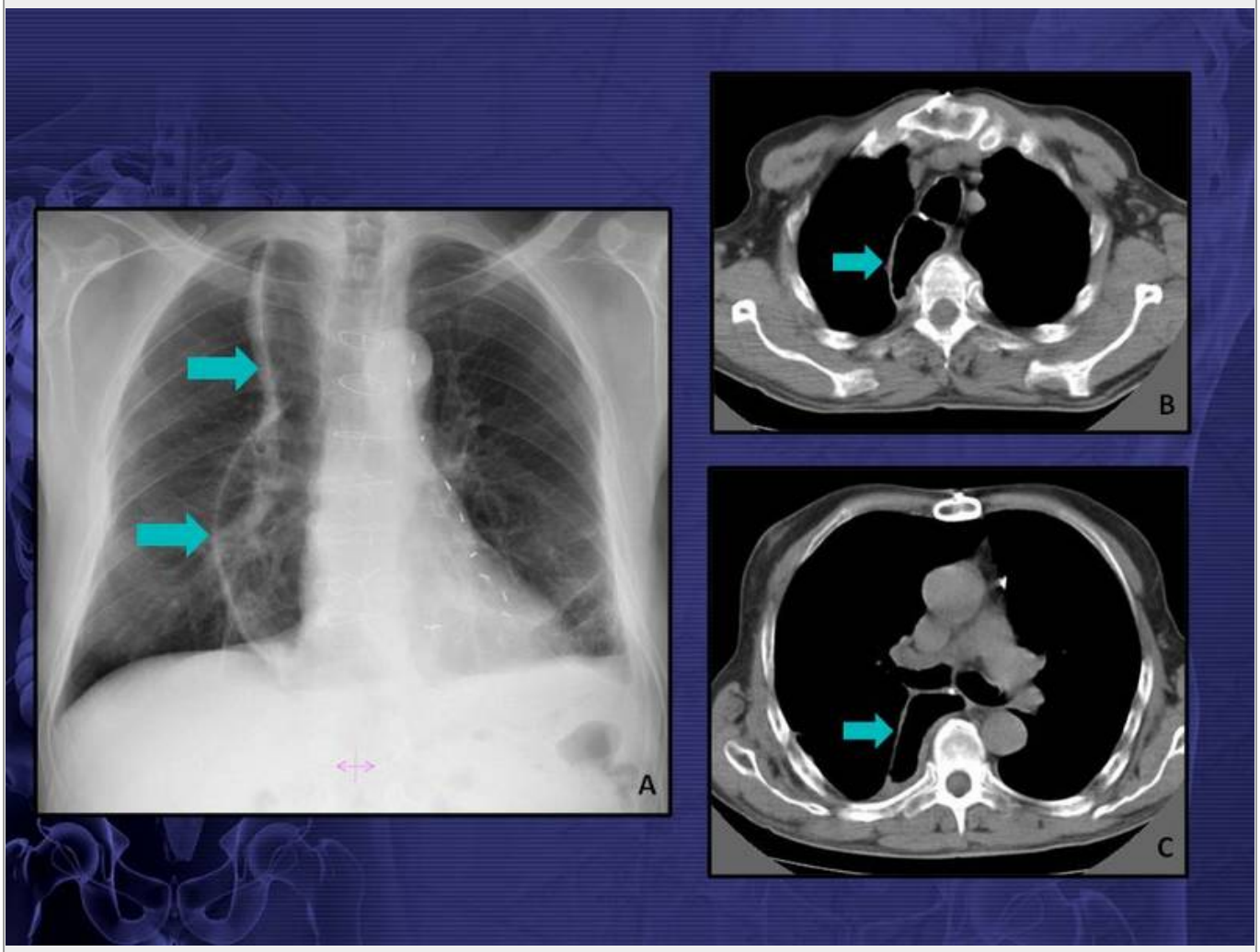

Figure 18. Postoperative esophagus. (A) Frontal chest radiograph of a patient who underwent resection and replacement of the esophagus with an intrathoracic stomach. The transplanted stomach produces mediastinal widening (arrows). (B) and (C) CT scan confirms that this widening is due to the intrathoracic stomach.

diapositivo19.jpg

Figure 19. (A) Frontal chest film of a patient with pancreatitis. Note the elevated right hemicupula of the diaphragm. (B) CT confirmed the diagnosis and showed the presence of loculated right pleural effusion (C). The right-sided location is atypical.

diapositivo20.jpg

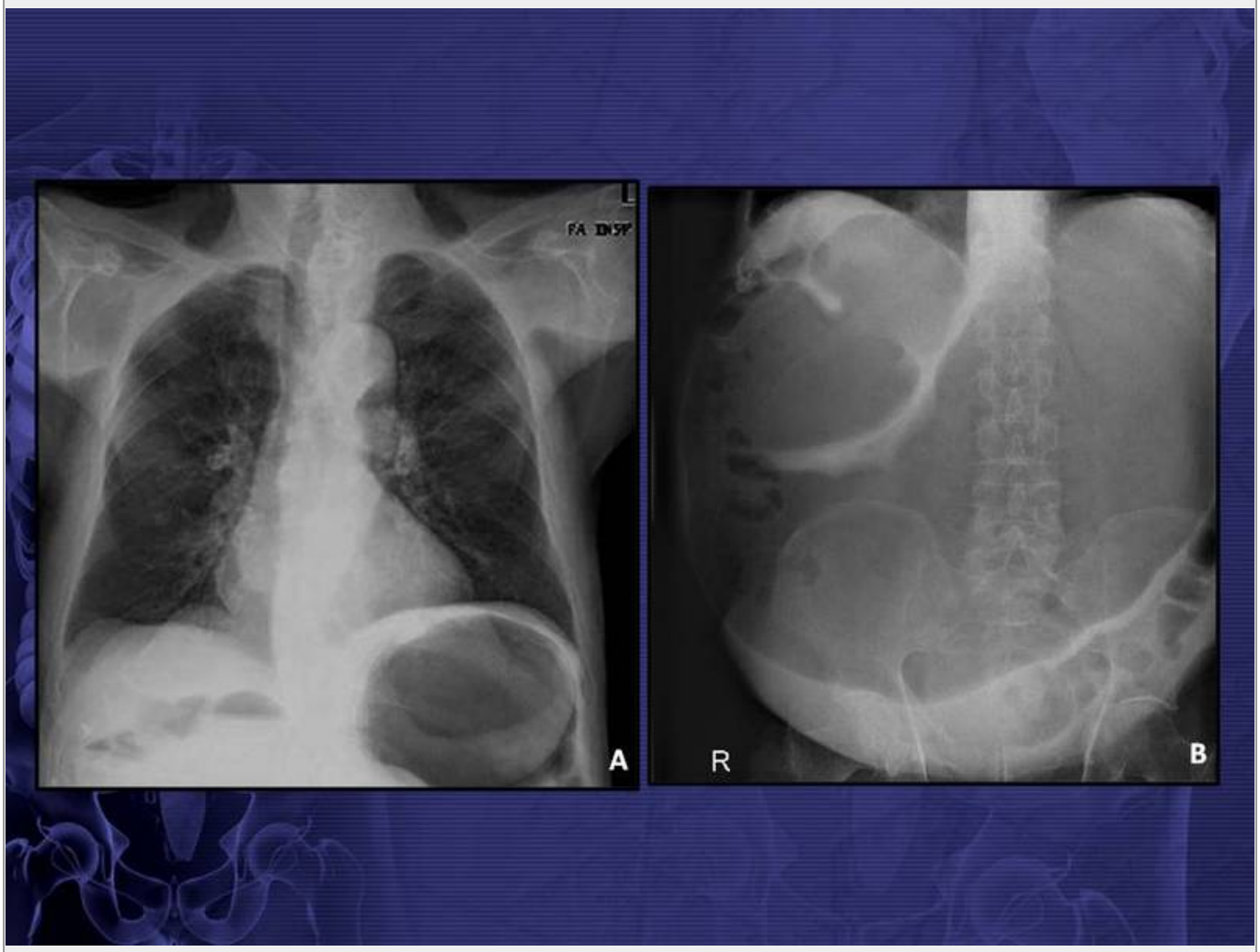

Figure 20. Pyloric obstruction. (A) Frontal upright chest radiograph of this 80-year-old patient shows a markedly distended gastric air bubble. (B) The supine abdominal film reveals an intensely dilated air-filled stomach due to gastric outlet obstruction.

diapositivo21.jpg

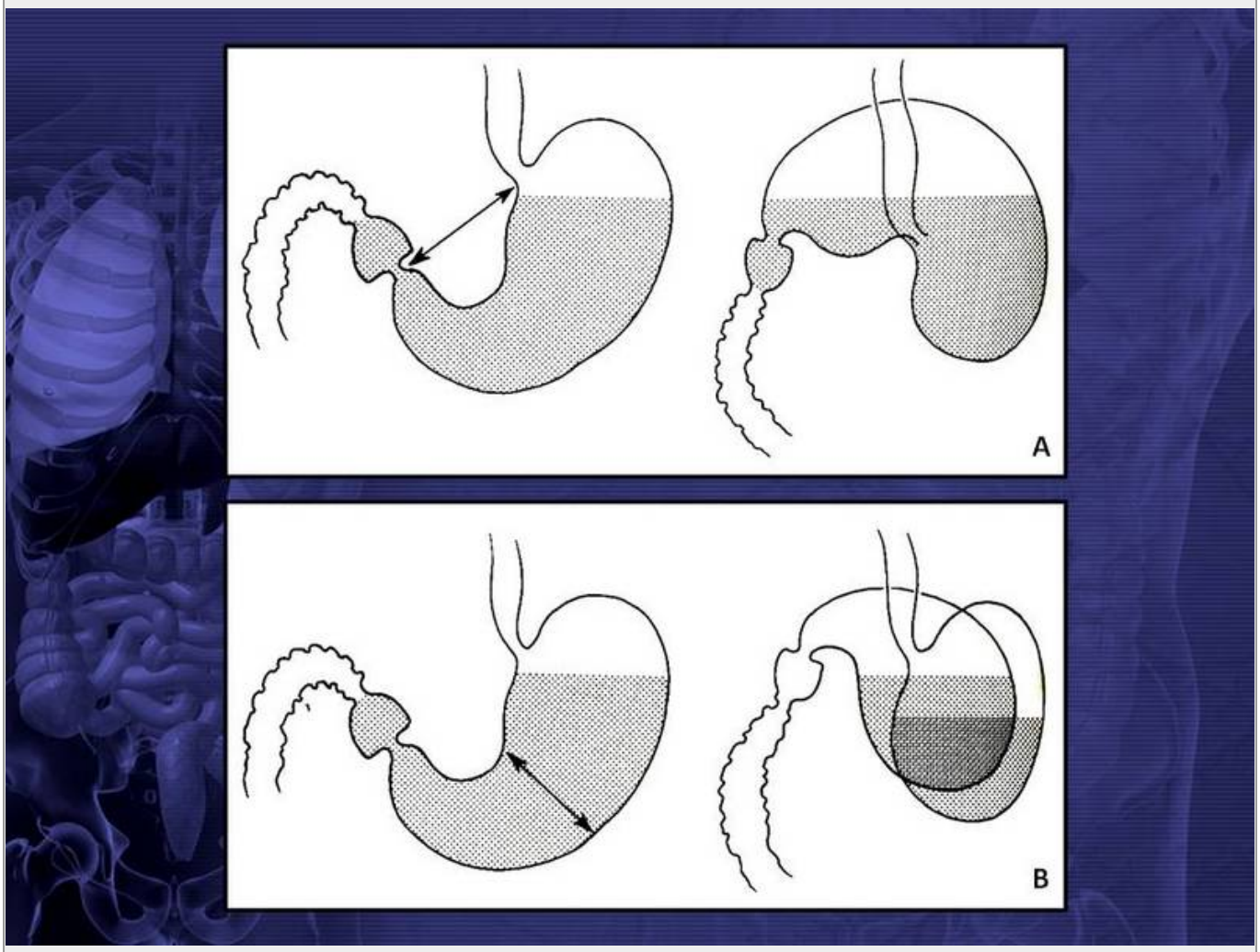

Figure 21. Gastric volvulus. (A) Organo-axial volvulus. (B) Mesentero-axial volvulus. (from Burgener FA, Kormano Martti. Differential Diagnosis in Conventional Radiology. 3nd ed. Stuttgart: Thieme; 1991: 592)

esgar2.jpg

Figure 22. Organo-axial gastric volvulus. (A) Chest frontal radiograph shows a large retrocardiac opacity, consistent with the stomach, with an air-fluid level. (B) and (C) Barium x-rays demonstrate an organo-axial gastric volvulus in a sliding hiatal hernia.

diapositivo 23.jpg

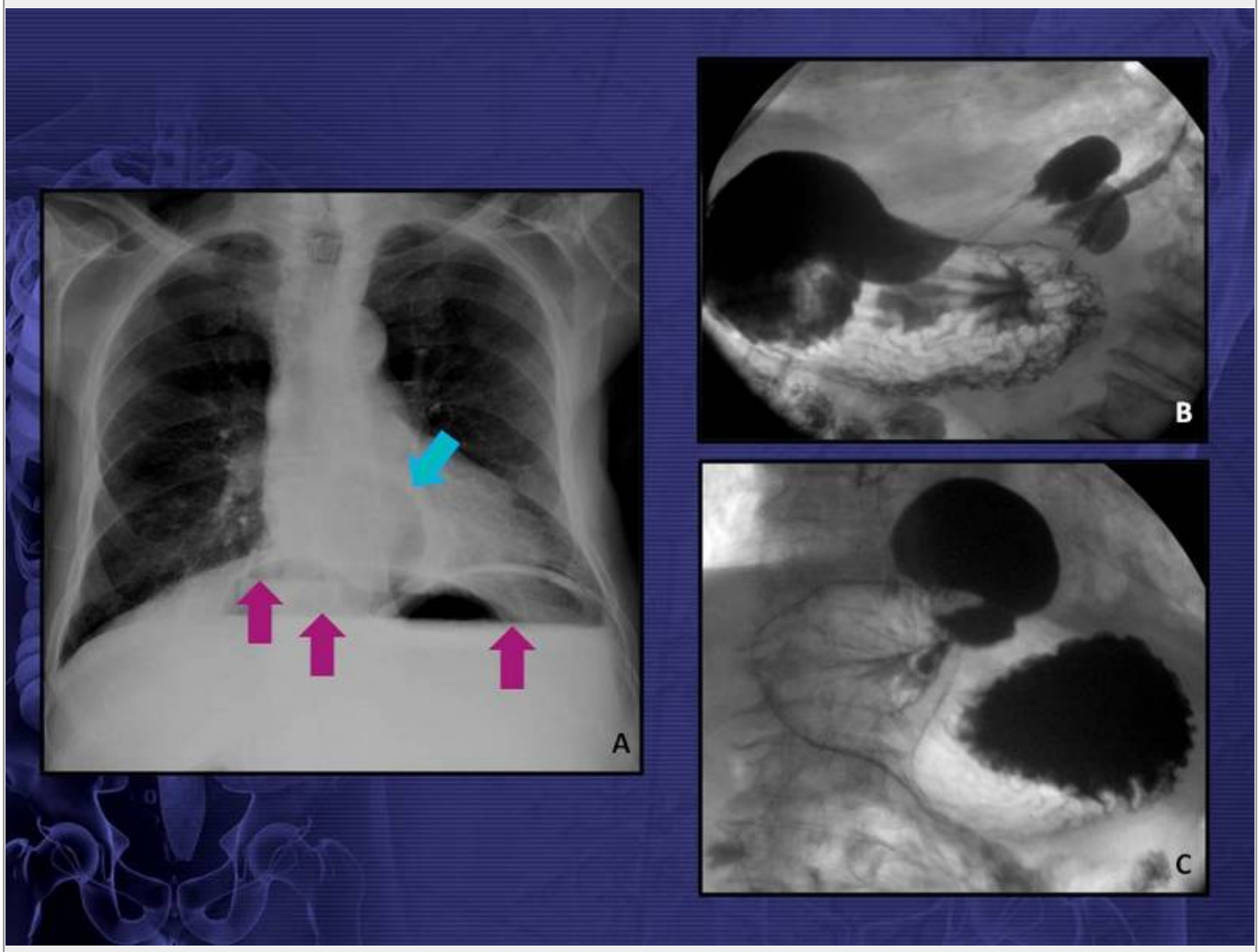

Figure 23. (A) Frontal chest radiograph of a patient with a previously known paraesophageal hiatal hernia demonstrates air-fluid levels in the upper abdomen (pink arrows) and a gas-filled structure in retrocardiac position (blue arrow). (B) and (C) The barium x-rays show torsion of the stomach at the level of the antrum, which herniates along with the duodenal bulb into the thorax, thus confirming the diagnosis of a mesentero-axial gastric volvulus. This type of gastric volvulus is less frequently associated to diaphragmatic defects than organo-axial volvulus.

diapositivo24.jpg

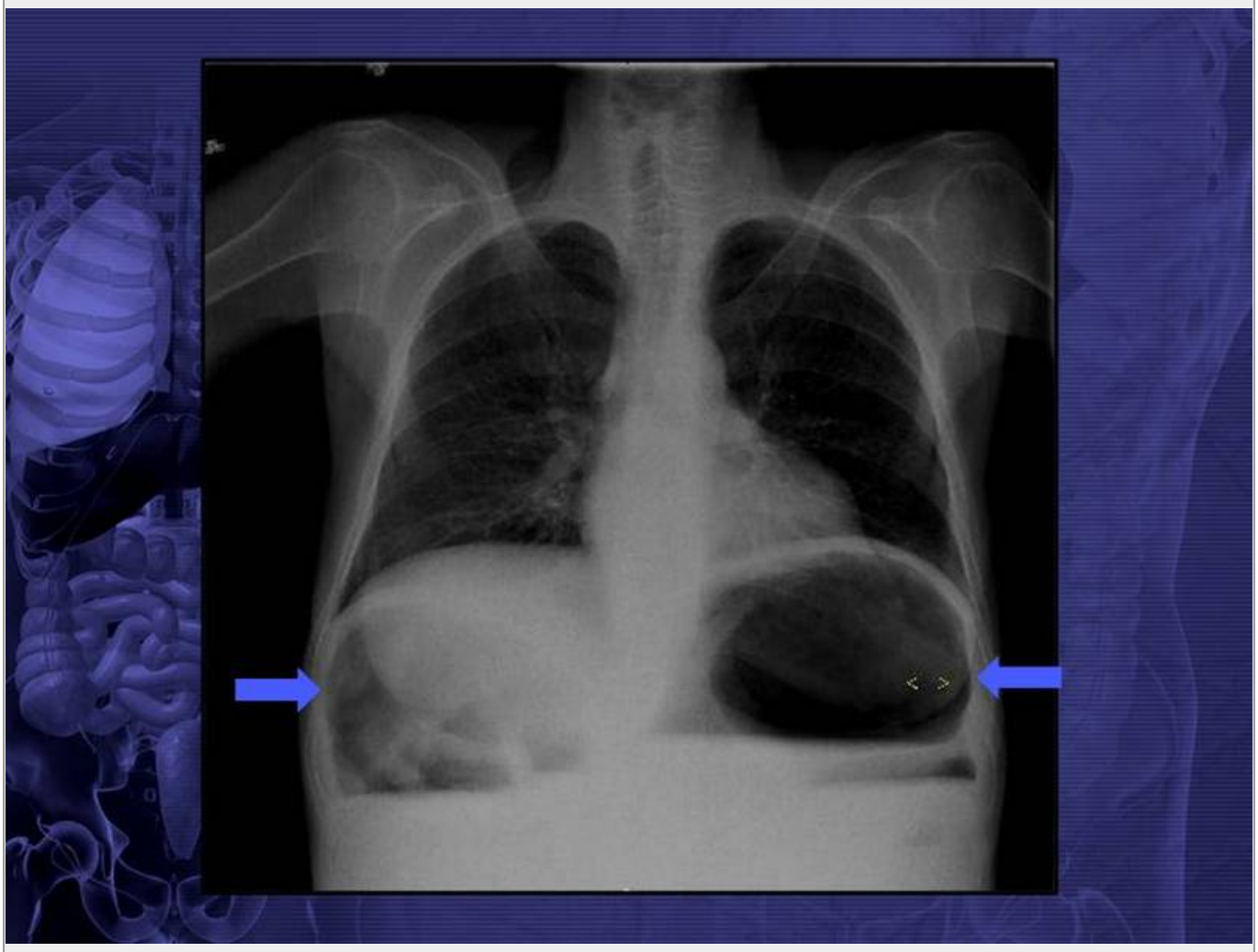

Figure 24. Chest frontal radiograph of a patient with scleroderma shows marked dilatation of the hepatic and splenic flexures of the colon.

diapositivo25.jpg

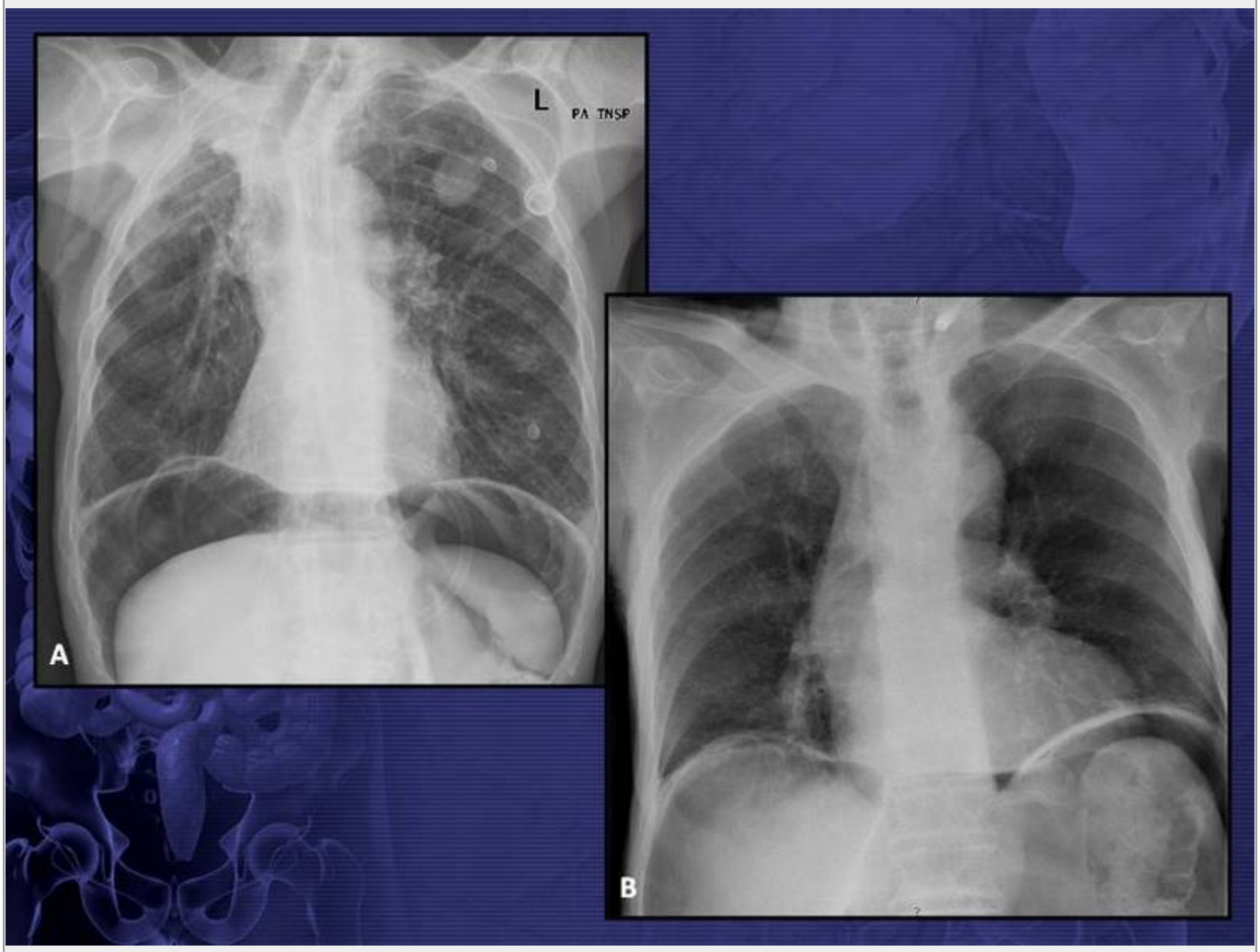

Figure 25. (A) Pneumoperitoneum after surgery in a patient with esophageal neoplasm. (B) This patient developed pneumoperitoneum after perforation of a duodenal ulcera.

diapositivo26.jpg

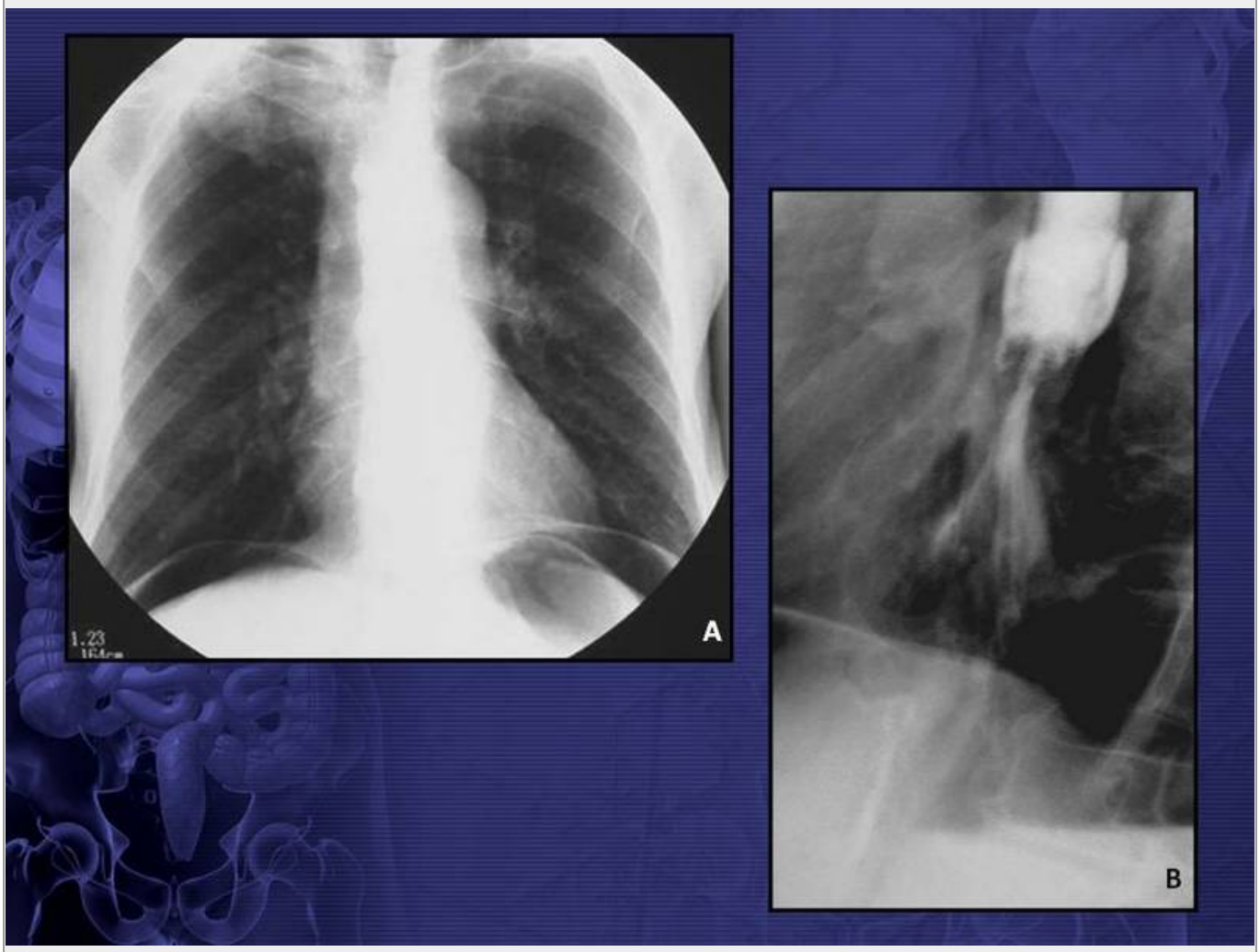

Figure 26. Pneumoperitoneum due to distal esophageal perforation after protesis placement in a patient with esophageal carcinoma.

diapositivo27.jpg

Figure 27. 85-year-old female submitted to ERCP with sphyncterothomy for biliary lythiasis. Chest (A) and abdominal (B) radiographs reveal the extent of gas collections, with pneumoretroperitoneum and mediastinal, deep cervical, and subcutaneous emphysema. (C) and (D) Contrast-enhanced CT performed with water-soluble positive oral contrast agent shows retroperitoneal extravasation to the right anterior pararenal space and abundant retroperitoneal gas.

diapositivo28.jpg

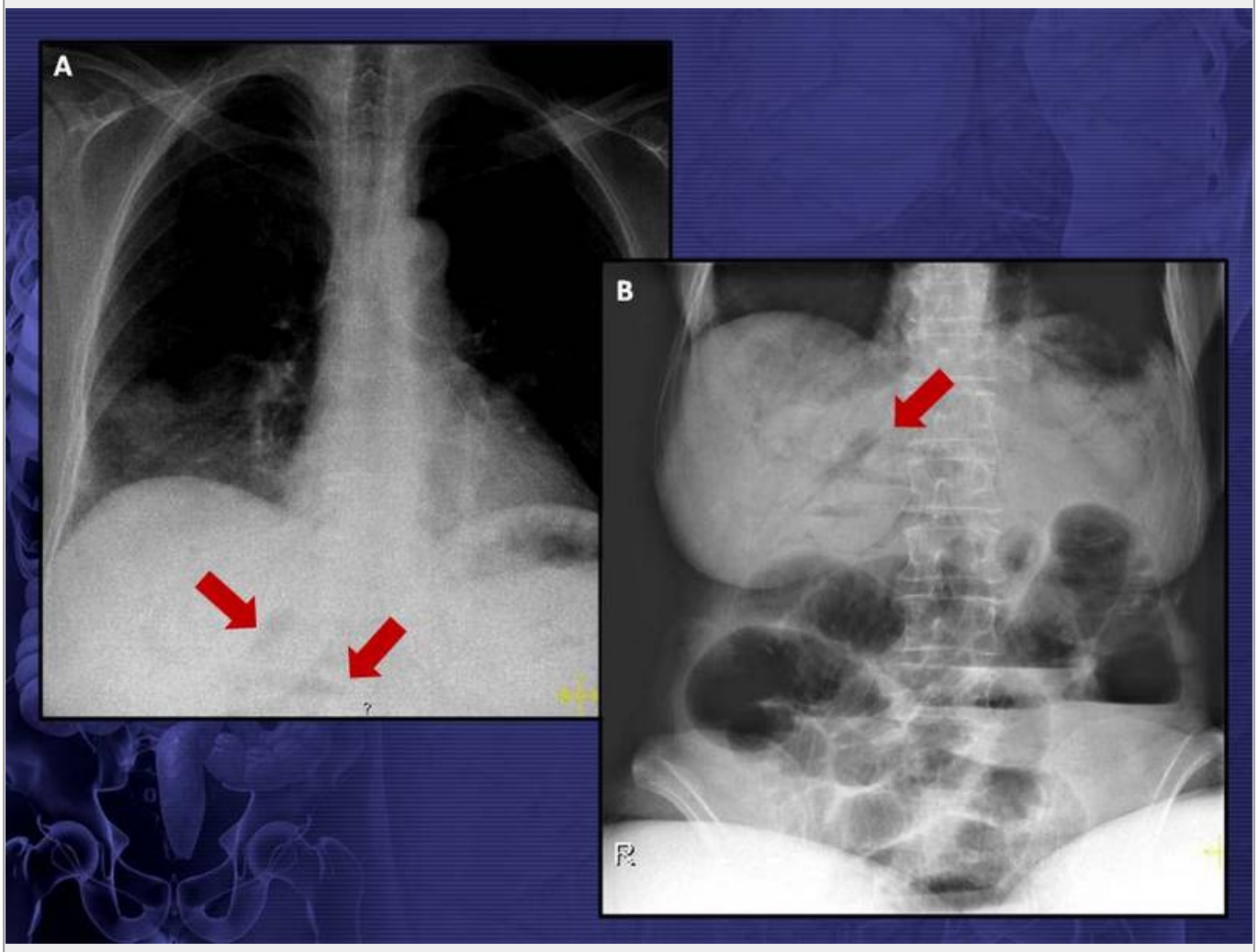

Figure 28. (A) Frontal chest radiograph of this 73-year-old lady raised the suspicion of portal venous gas. (B) Abdominal x-ray findings were even more suggestive. The patient was submitted to surgery, which confirmed acute mesenteric ischemia.

diapositivo29.jpg

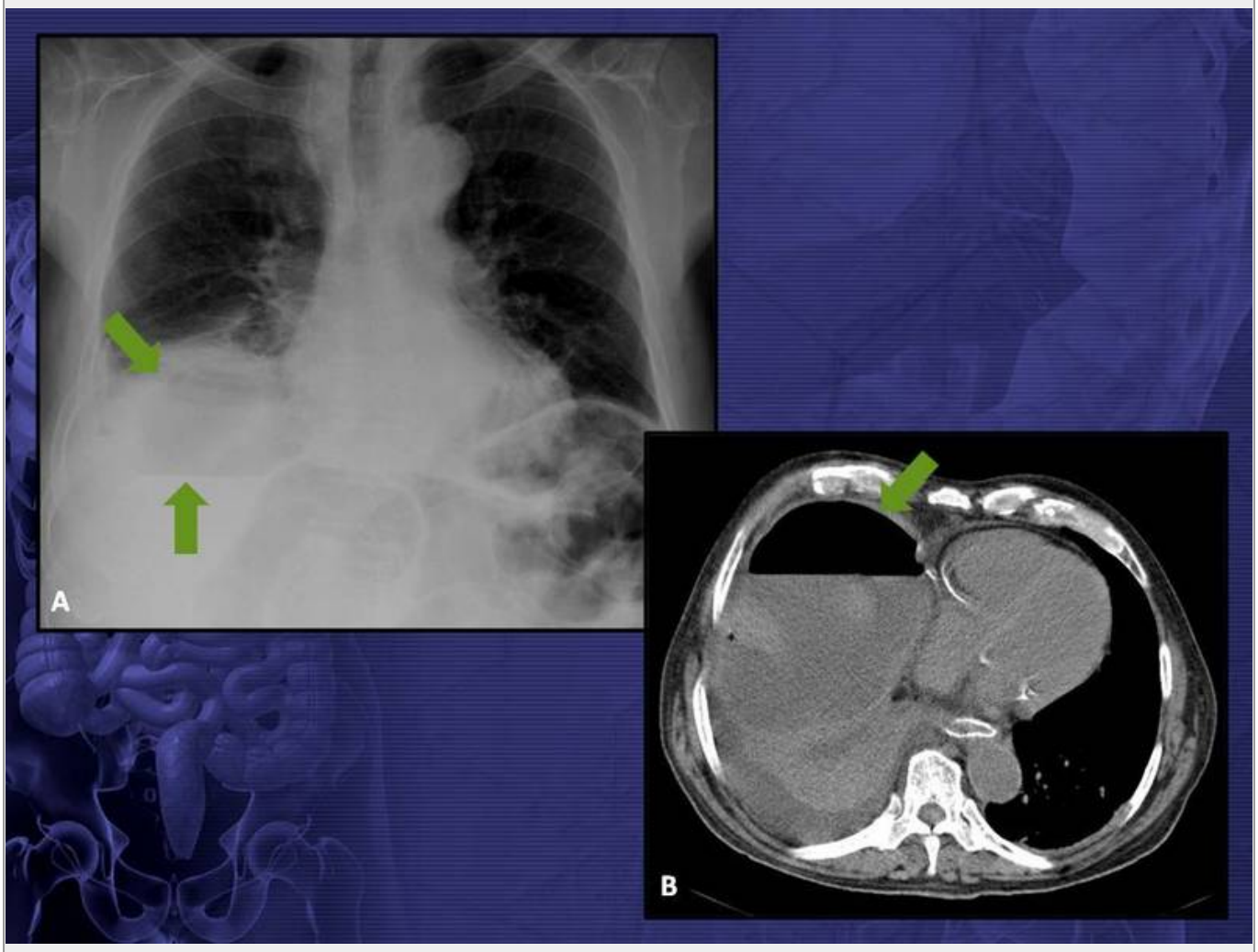

Figure 29. (A) Frontal chest radiograph reveals an elevated right hemidiaphragm, below which there is an air fluid level, projecting at the site of the liver (arrows). (B) CT scan confirmed the diagnosis of a liver abscess.

diapositivo30.jpg

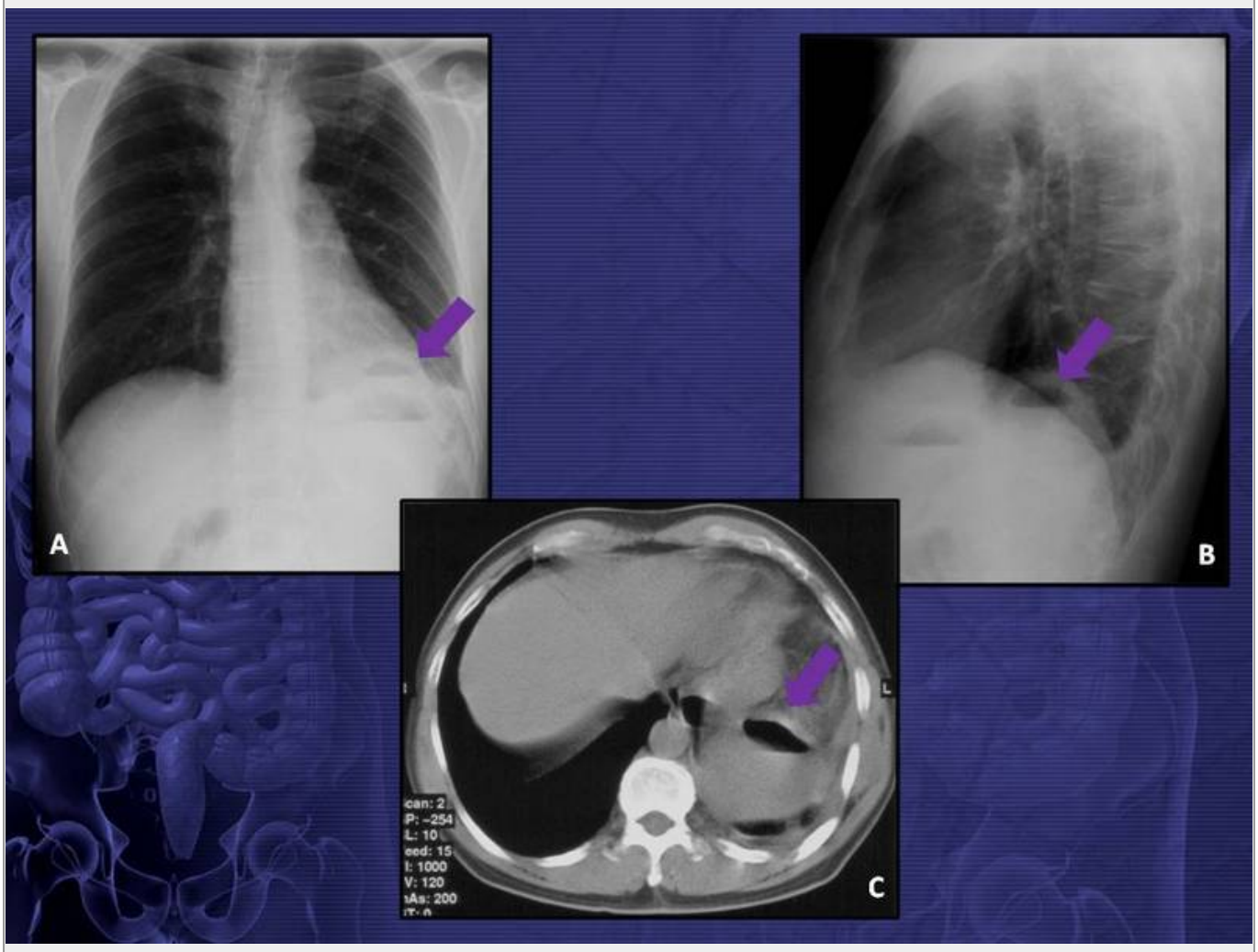

Figure 30. Frontal (A) and lateral (B) chest radiographs show an air-fluid level just below the elevated left hemidiaphragm. Note the normal gastric air bubble in its regular position. (C) CT scan was diagnostic for a left subphrenic abscess.

diapositivo31.jpg

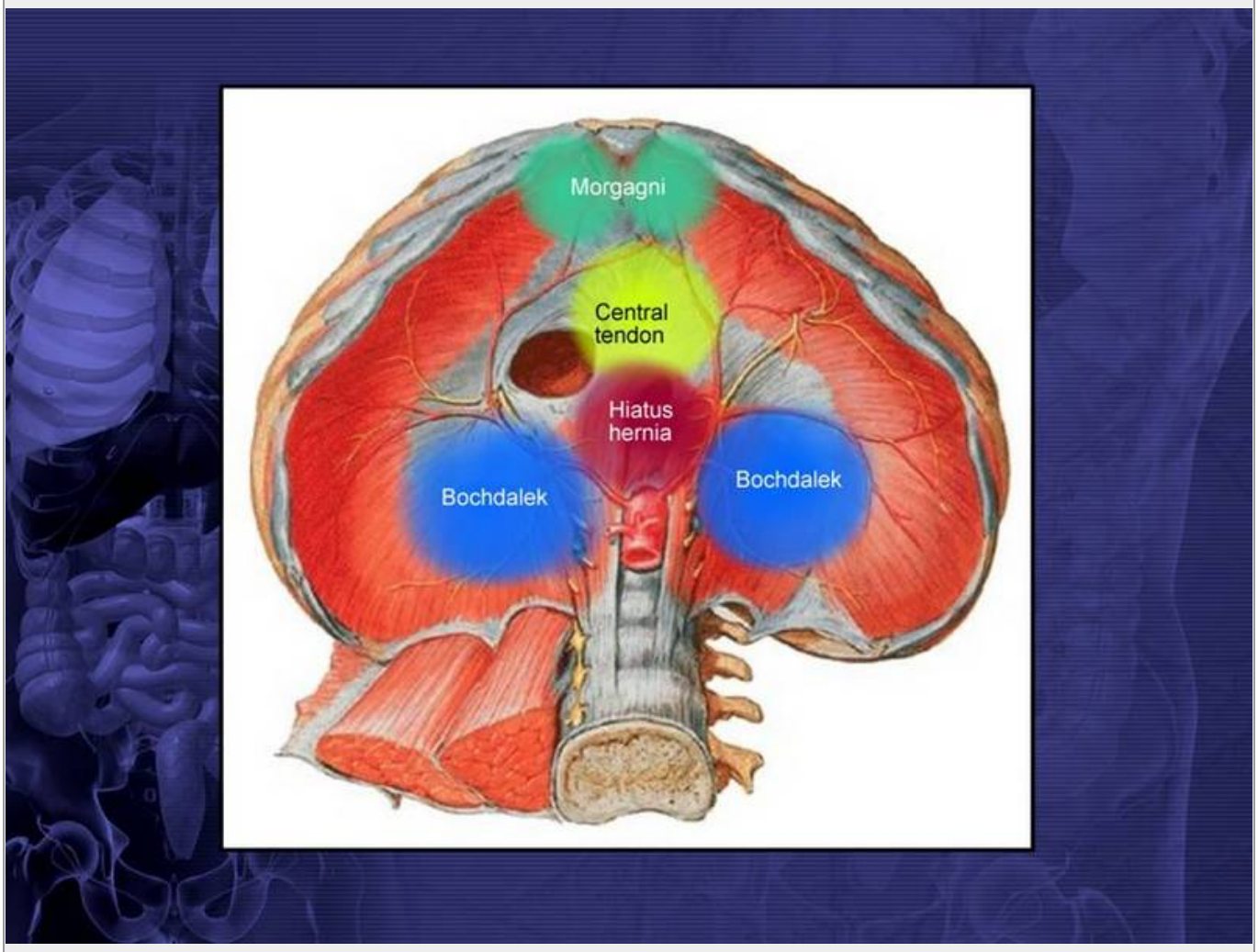

Figure 31. Types and sites of diaphragmatic hernias. (from www.med-info.nl)

diapositivo32.jpg

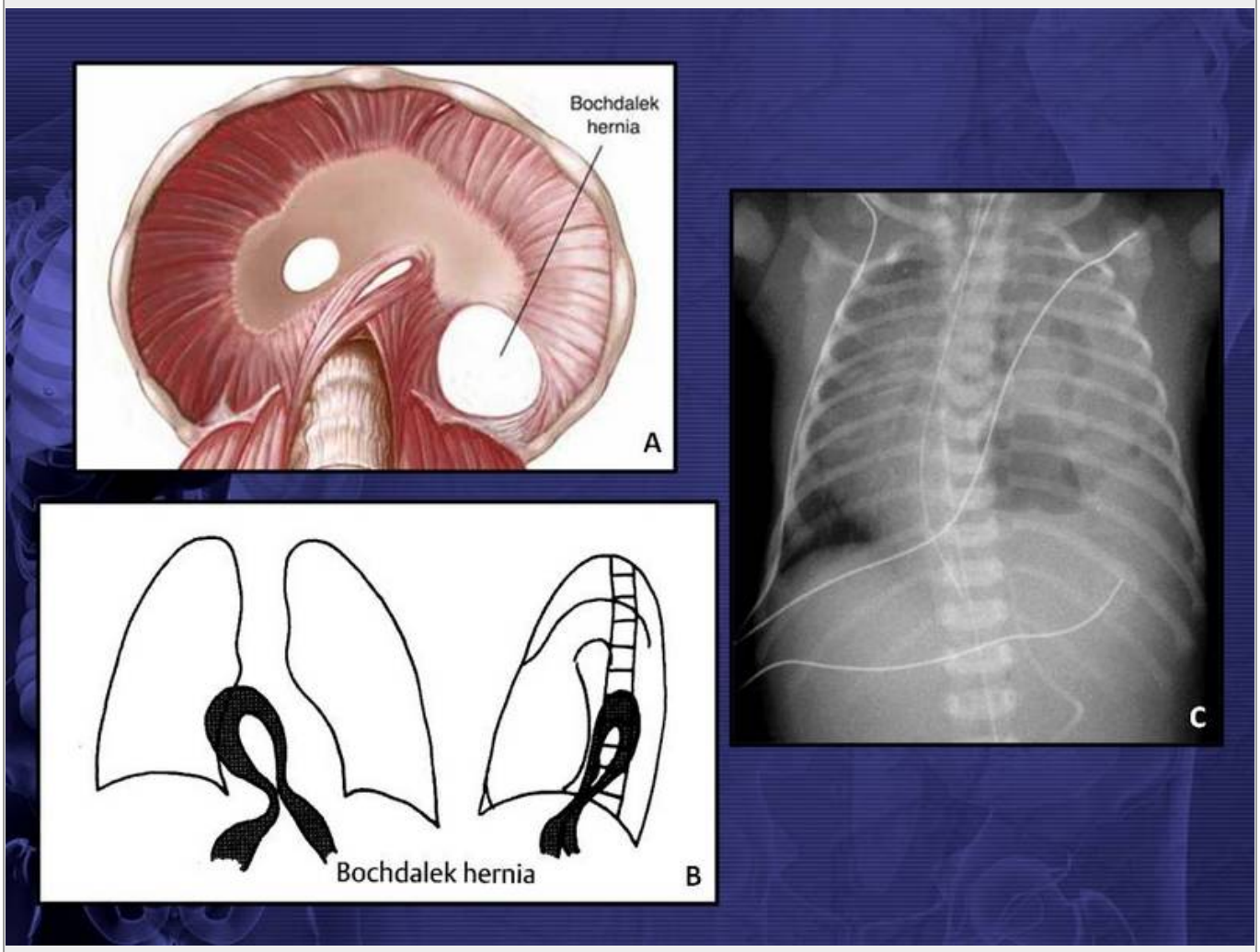

Figure 32. Bochdalek hernia. (A) and (B) Illustrations depicting the site of diaphragmatic defect (A) and the projection of the hernia on frontal and lateral radiographs (B). (C) Bochdalek hernia in a newborn with respiratory distress. (A. from www.vesalius.com. B. from Lange S, Walsh G. Radiology of Chest Diseases. 3rd ed. Stuttgart: Thieme; 2007: 231).

diapositivo33.jpg

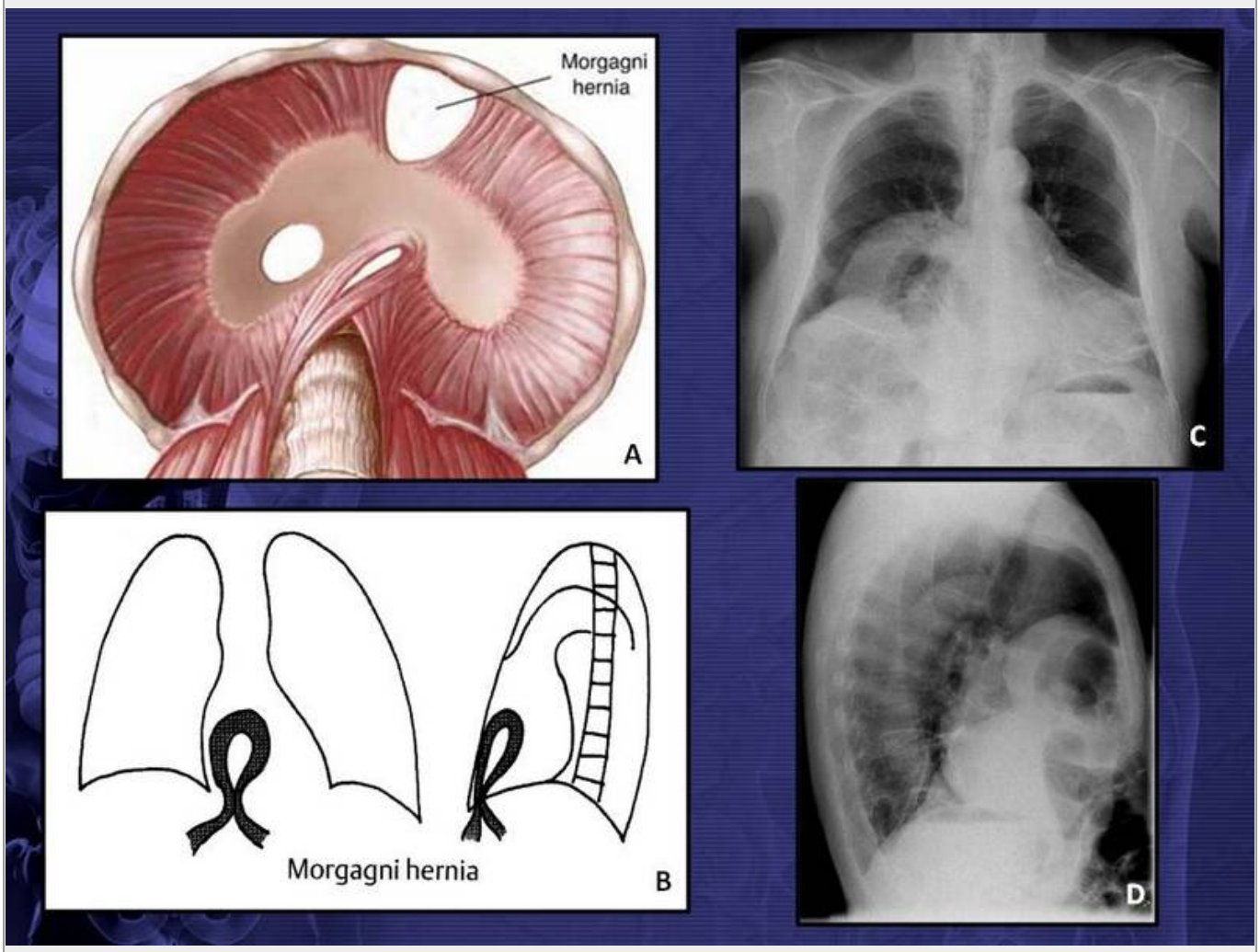

Figure 33. Morgagni hernia. (A) and (B) Illustrations depicting the site of diaphragmatic defect (A) and the projection of Morgagni hernia on frontal and lateral radiographs (B). Frontal (C) and lateral (D) chest radiographs show a Morgagni hernia in a 80-year-old man. Note that the hernia is seen on frontal radiographs in the right hemithorax, projecting anteriorly on lateral films. (A. from www.vesalius.com. B. from Lange S, Walsh G. Radiology of Chest Diseases. 3rd ed. Stuttgart: Thieme; 2007: 231).

diapositivo34.jpg

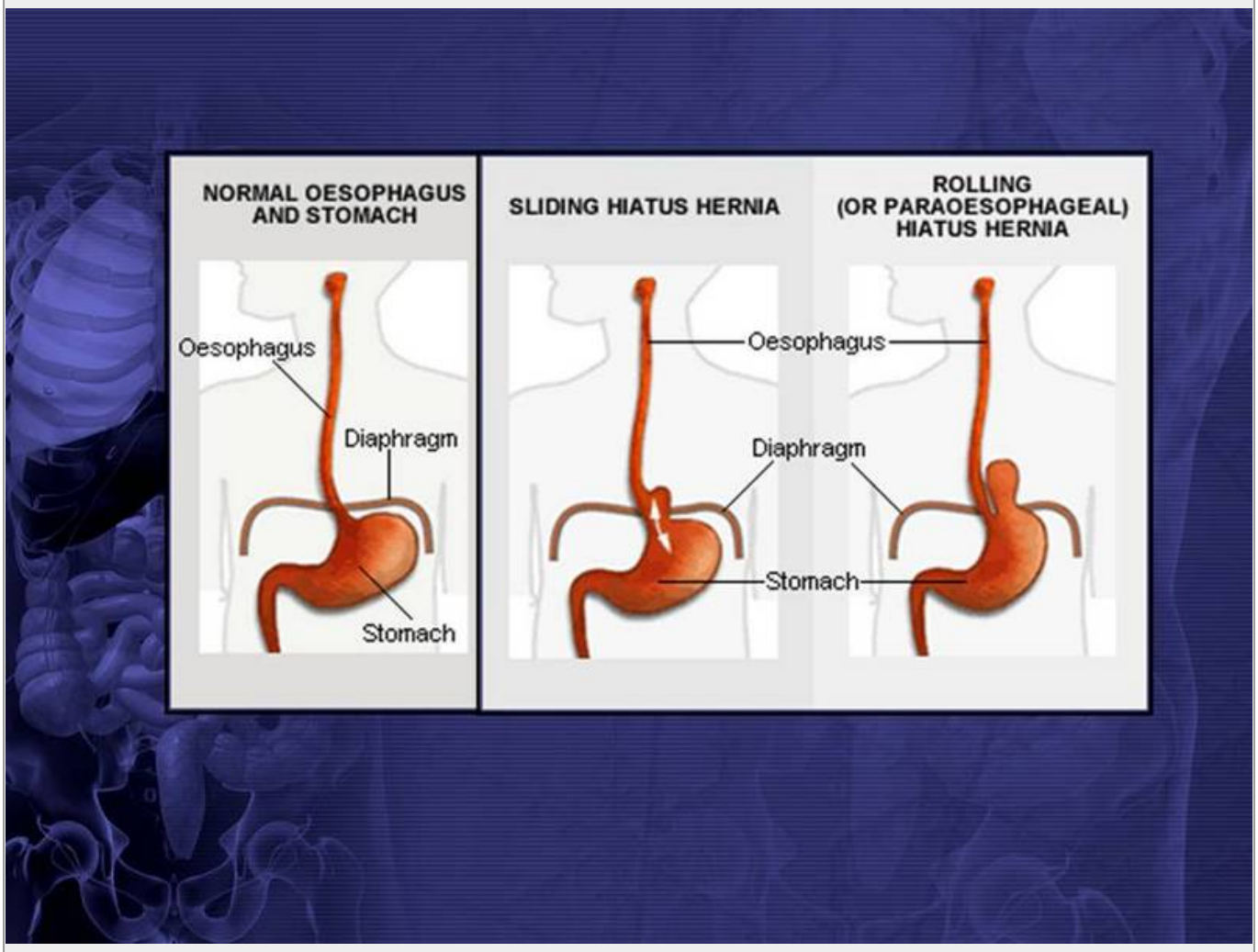

Figure 34. Types of hiatal hernias. (from hiatusherniasymptoms.com)

diapositivo35.jpg

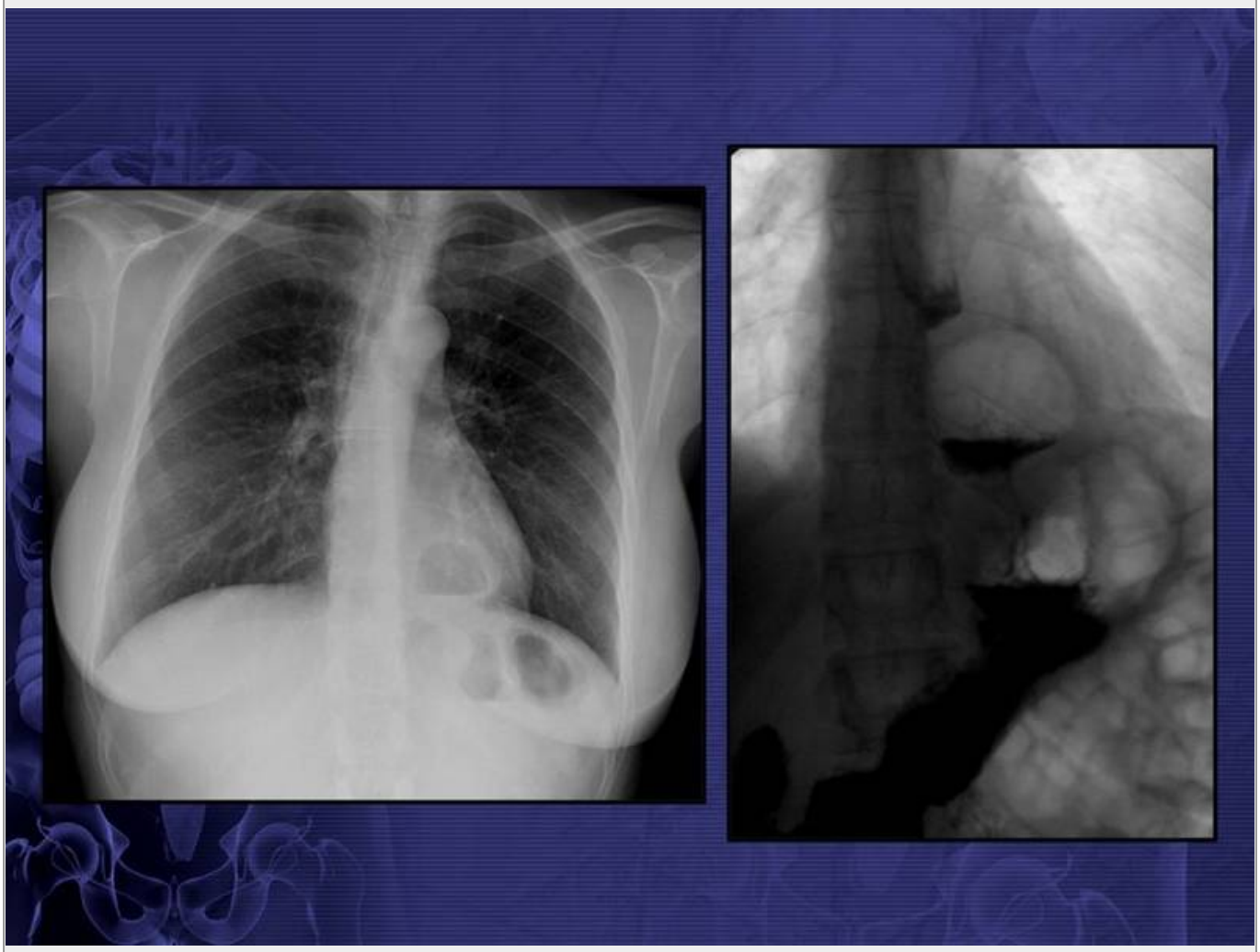

Figure 35. Chest radiograph (A) and barium swallow x-ray (B) showing a sliding hiatus hernia.

diapositivo37.jpg

Figure 36. (A) Frontal chest x-ray shows an opacity with an air-fluid level in retrocardiac location. (B) and (C) Barium swallow x-rays demonstrated that those radiographic findings corresponded to a paraesophageal hiatal hernia.

diapositivo36.jpg

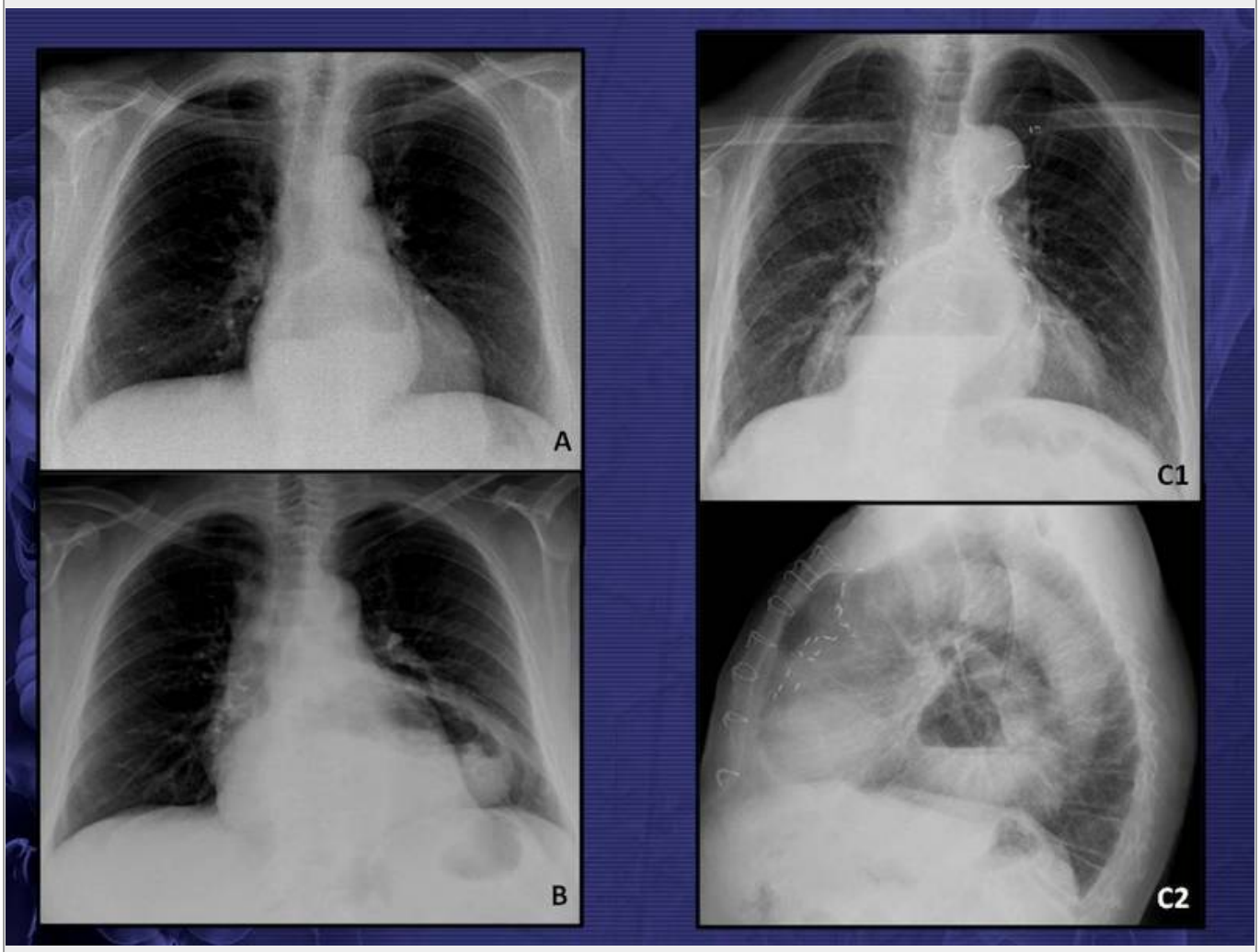

Figure 37. Other three cases of proven hiatal hernia on chest radiographs.

diapositivo38.jpg

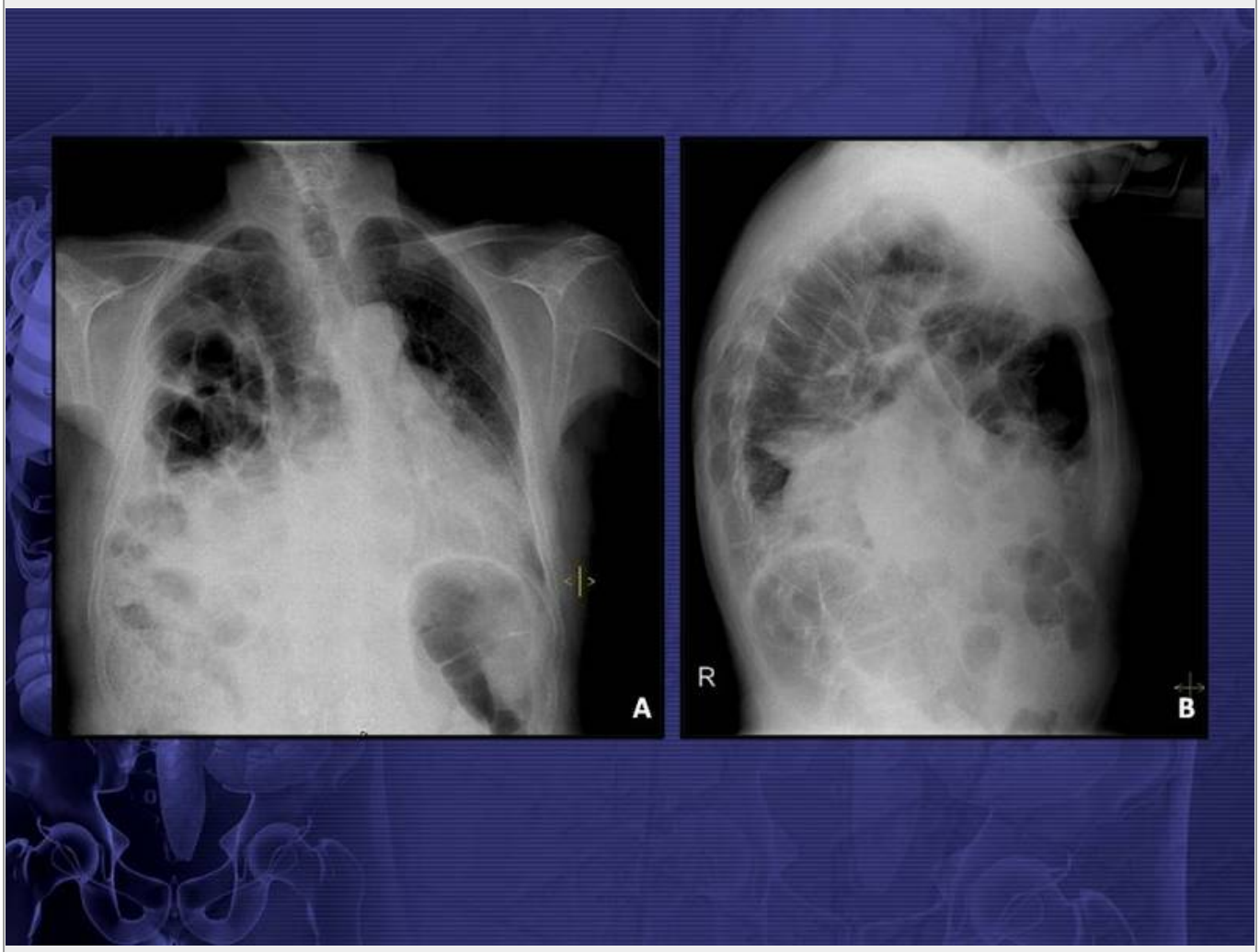

Figure 38. Frontal (A) and lateral (B) chest plain films show a traumatic diaphragmatic hernia, with uncommon rupture of the right side of the diaphragm, with herniation of abdominal contents (namely colon) into the thoracic cavity. Note also the mediastinum shifted to the left.

oa gastric volvulus.avi

Video 1. CT scan performed afterwards confirmed the diagnosis of organo-axial gastric volvulus associated with a previouly existing hiatal hernia.