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Radiologic-pathologic correlation of esophageal diseases

ABSTRACT

This paper reviews the radiologic findings of esophageal pathology, the role of modern imaging techniques: computed tomography (CT) and magnetic resonance imaging (MRI), and evaluates indirect signs of this kind of pathology on chest radiographs.

First we describe the radiologic anatomy of the esophagus on CT and MRI, considering several anatomic levels.

Then, we evaluate different semiological criteria on chest radiographs, which may be the initial clue to the diagnosis of esophageal disease, considering two aspects: alteration of the mediastinal lines, and the presence of air-fluid levels in achalasia and esophageal diverticula.

Next, we consider "chest pain", as a manifestation of esophageal disease, evaluating motility disorders of the esophagus, gastroesophageal reflux disease, Barret esophagus, Schatzki ring and esophageal perforation.

Finally, we describe esophageal neoplasm, and discuss CT and MRI staging criteria, the strengths and limitations of each as well as their complementary use.

Cases illustrating the radiographic characteristics of esophageal diseases are presented with the corresponding pathologic findings.

KEY WORDS: Esophageal diseases – Esophageal diverticula – Achalasia – Esophageal neoplasm

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Radiologic anatomy of the esophagus on CT and MRI

In most clinical situations the modern radiological approach to esophageal pathology consists in performing a CT scan following the chest radiograph.

MR represents a powerful imaging tool, with its high inherent soft tissue contrast, direct multiplanar capabilities, as well as provision of biochemical and anatomic information. T1 - weighted images best define esophageal margins by enhancing the difference in intensity between the esophagus and the adjacent mediastinal fat. Esophageal wall signal intensity is approximately equal to that of skeletal muscle at all pulse sequences. Without air or other intraluminal contrast agent, wall thickness cannot be directly measured.[1,2,3]

The normal esophagus is routinely well visualized in the upper thoracic and gastroesophageal regions. However, the middle portion is flattened behind the left atrium, making its visualization difficult. (Figures No. 1,2,3,4).

Semiological criteria on chest radiographs

Air-fluid levels

Achalasia

Primary esophageal motility disorder, characterized by aperistalsis and LES (lower esophageal sphincter) dysfunction.

Radiographically the lower end of the esophagus has a smooth, tapered "beak-like" appearance at

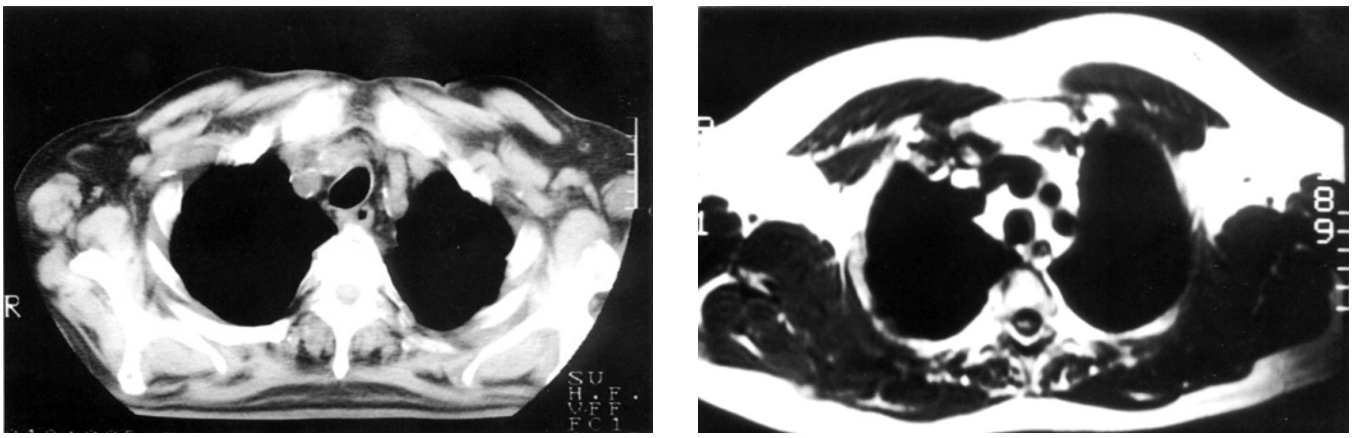

Figure 1. Radiologic anatomy. CT (a) MR correlation (T1 weighted image) (b) showing upper mediastinum. In the MR image esophagus is recognized due to its intermedium signal intensity that contrasts between the empty-signal of vascular structures and the high signal of the mediastinal fat.

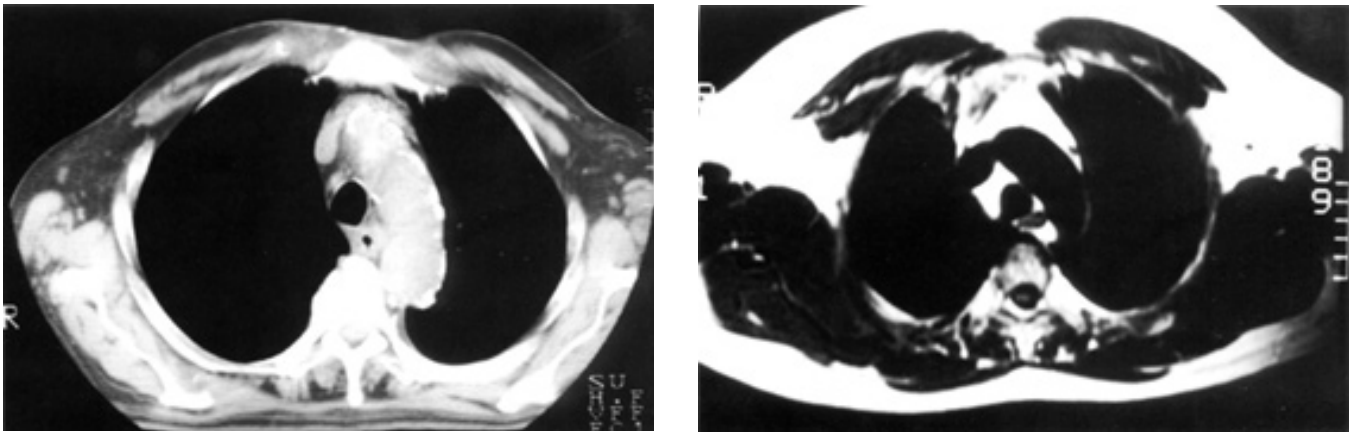

Figure 2. Radiologic anatomy. CT (a) MR correlation (T1 weighted image) (b) in the aortic arch level. Sometimes, when the esophagus is distended by air, it is possible to define it's wall thickness that is less than 3 mm in normal esophagus.

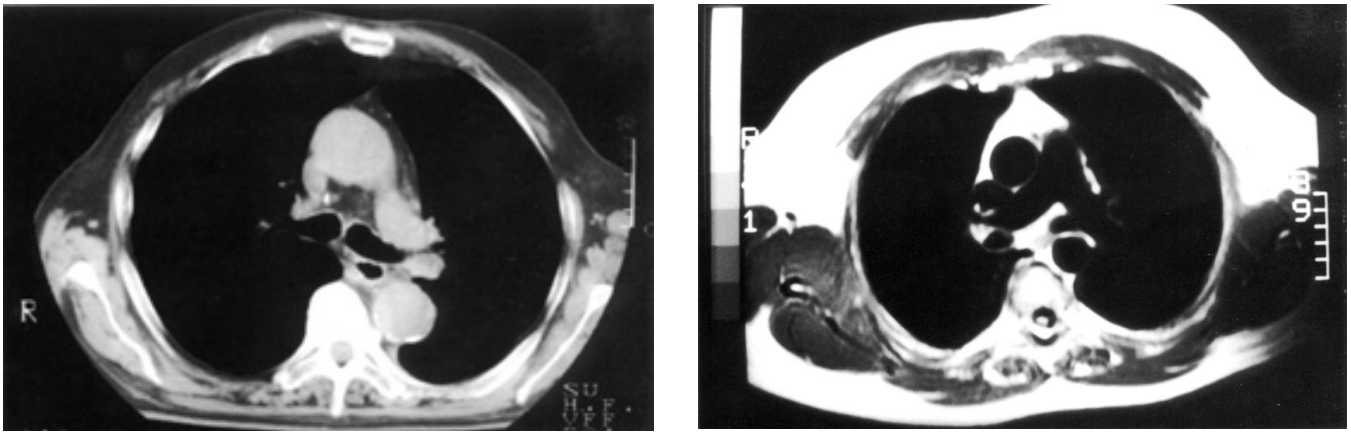

Figure 3. Radiologic anatomy: CT (a) MR correlation (T1 weighted image) (b) in the carinal bifurcation level. Here the esophagus is adjacent to the left main bronchus and so its involvement is possible in the evolution of an esophageal neoplasm.

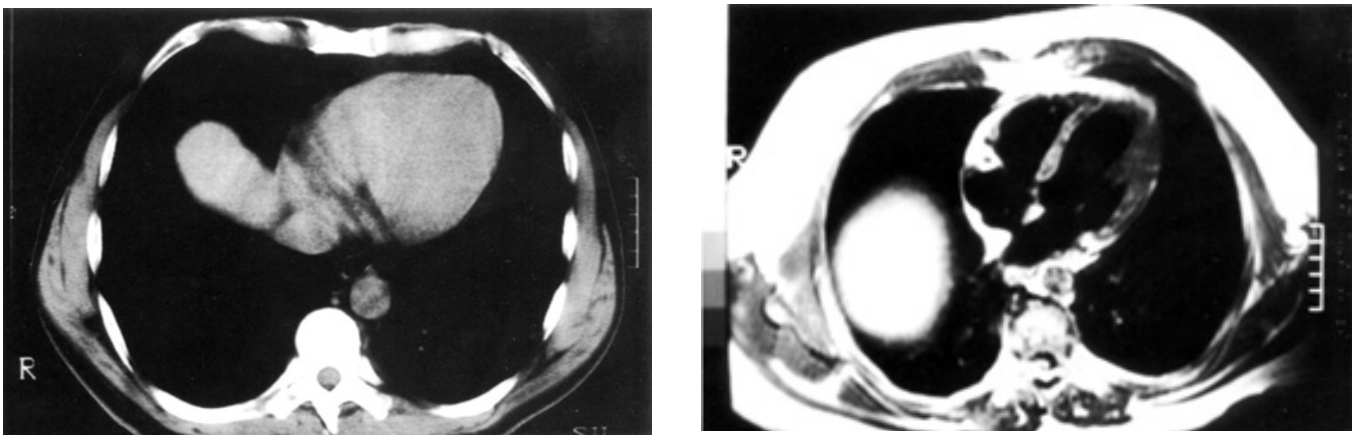

Figure 4. Radiologic anatomy: CT (a) MR correlation (T1 weighted image) (b). Cardiac chambers level. The left atrium and the descending thoracic aorta are close to the esophagus and so it is frequent the direct invasion in case of an esophageal neoplasm.

the level of esophageal hiatus. This tapered appearance reflects LES dysfunction and failure of the barium bolus to distend the tonically contracted sphincter.

Depending on the severity and duration of achalasia, the esophagus may become markedly dilated and tortuous, producing a sigmoid appearance, which may be seen on plain chest films. (Figure No. 5).

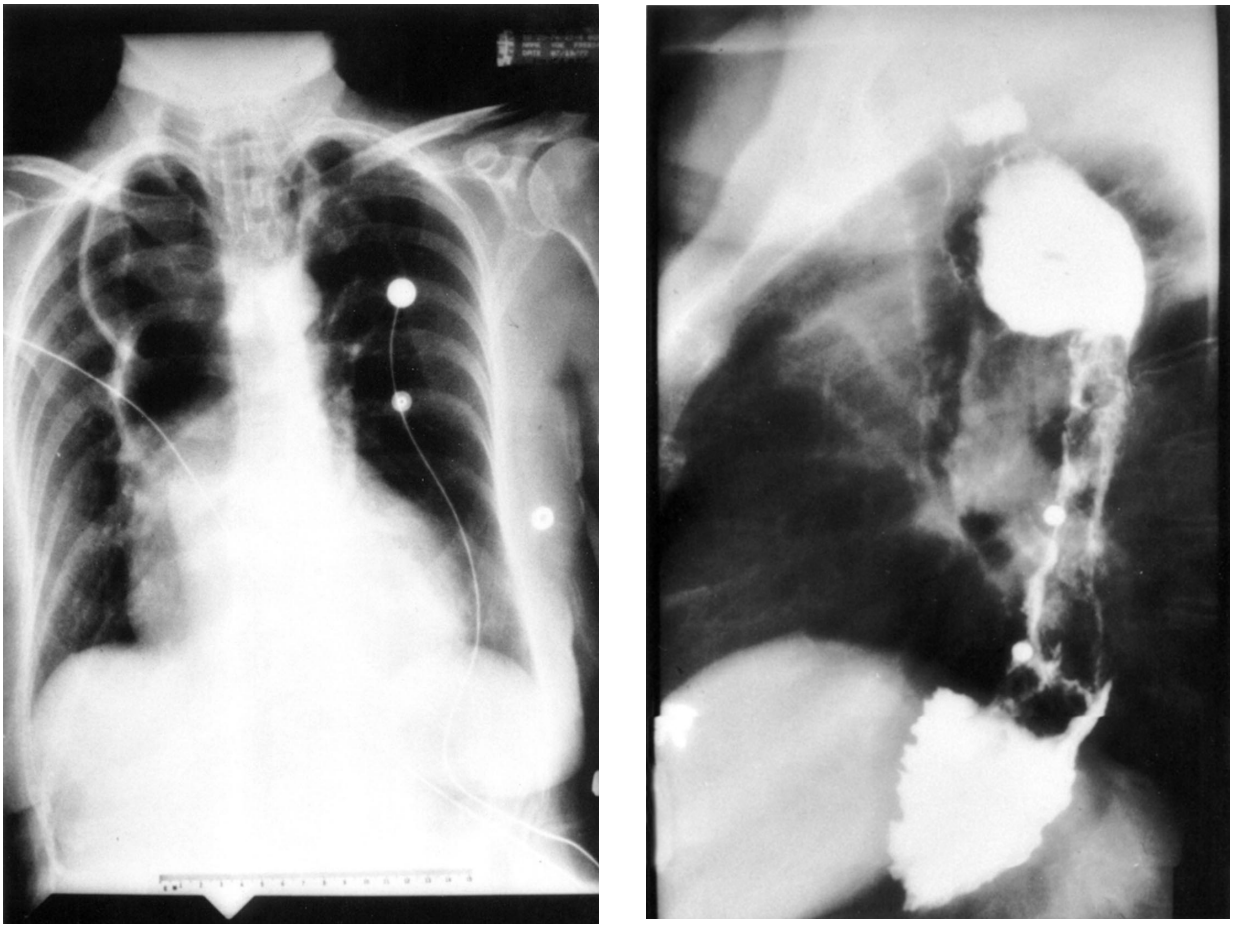

Figure 5. Achalasia. Posteroanterior (a) lateral (b) chest projection. The double-contour of the right mediastinal border corresponds to a dilated esophagus wall. There is a nick that represents an imprint on the azygos vein. The lateral chest film shows a level in the inferior segment of the dilated esophagus.

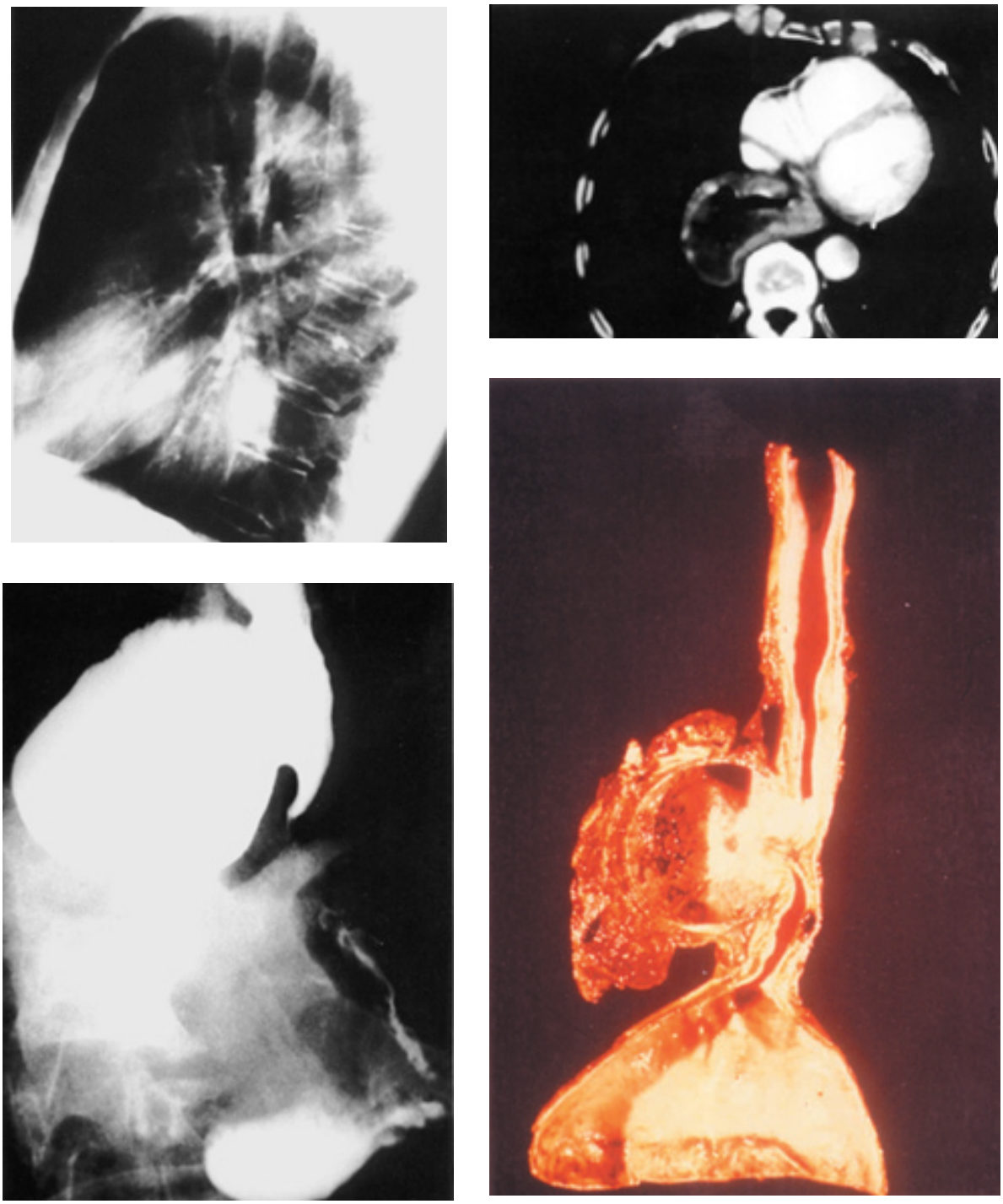

Figure 6. Epiphrenic diverticulum. Lateral chest projection (a). Chest CT (b), Barium study (c), Macroscopic correlation (d), The lateral chest radiograph shows a retrocardiac soft tissue density mass. The CT study confirms the radiographic findings, showing the retrocardiac mass, defining clearly the walls and the lumen with a hydroair level inside. The esophagogram reveals a large diverticulum localized at the right border of distal esophagus, the typical epiphrenic diverticulum localization. In some cases a familiar incidence and/or a hiatal hernia association, is postulated.

Esophageal diverticula

Diverticula may be classified by their location or by their mechanism of formation.

The most common locations include the pharyngoesophageal junction (Zenker's diverticulum), the midesophagus, and the distal esophagus just above the esophageal hiatus (epiphrenic diverticulum). (Figure No. 6).

Diverticula may be formed either by pulsion due to increased intraluminal esophageal pressure or by traction due to fibrosis in adjacent periesophageal tissues.

Pulsion diverticula are usually incidental findings without clinical significance. When symptoms are present, they are almost always related to the patient's underlying esophageal motor disorder. However, some diverticula that are extremely large may cause symptoms (dysphagia, aspiration).[4]

Alteration of the mediastinal lines

Leiomyoma

More than 50% of all benign esophageal tumors are leiomyomas (Figure No. 7).

They may be recognized on chest radiographs by the presence of a soft tissue mass in the posterior mediastinum or by amorphous or punctate areas of calcification.

Computed tomography may be helpful in demonstrating the intramural location.

Other unusual submucosal tumors such as fibromas, neurofibromas, lipomas (Figure No. 8), hemangiomas, and granular cell tumors may produce identical radiographic findings. Cystic lesions such as congenital duplication cyst and acquired retention cysts may also appear as submucosal masses, that distort the mediastinal contours.

" Chest pain " as a manifestation of esophageal disease

Motility disorders

In diffuse esophageal spasm nonperistaltic contractions, repetitive and simultaneous, affect the smooth muscle portion of the esophagus and may compartimentalize the esophageal lumen, producing the typical "corkscrew" or "rosary bead" appearance. Thickening of the esophagus wall is best estimated along the right border of the esophagus, where the wall is close to the pleural reflection line. Other primary motility disorders are achalasia, nutcracker esophagus and nonspecific esophageal motility disorders.[5]

Secondary motility disorders include collagen-vascular diseases, most often Sclerodermia, Chagas disease, a variety of metabolic and endocrine disorders, and neuromuscular disorders.

Reflux esophagitis

The more common structural abnormalities seen radiographically include mucosal nodularity, thickening of the esophageal folds, erosions and ulcerations, thickening of the wall of the esophagus, and segmental narrowing due to spasm, inflammation or stricture (Figure No. 9).

Less frequent findings may include transverse striations, pseudodiverticula, inflammatory polyps and pseudomasses, and esophagogastric fistula.[6]

Barret esophagus

It is an acquired condition in which there is a progressive columnar metaplasia of the distal esophagus due to long-standing gastroesophageal reflux and reflux esophagitis.

The classic radiologic features consist of a high esophageal stricture or ulcer, often associated with a sliding hiatal hernia. A reticular mucosal pattern has also been described, characterized radiographically by multiple tiny, barium-filled grooves on the esophageal mucosa (Figure No. 10).

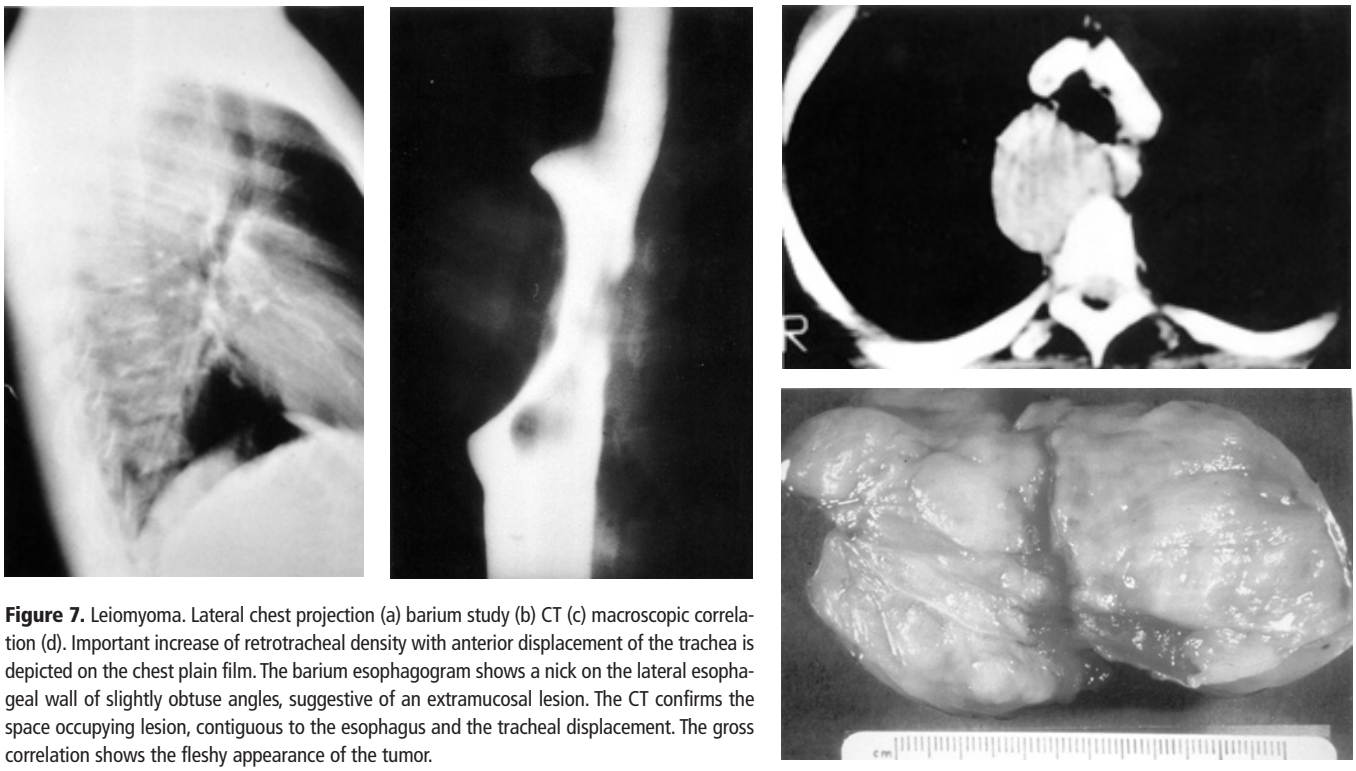

Figure 7. Leiomyoma. Lateral chest projection (a) barium study (b) CT (c) macroscopic correlation (d). Important increase of retrotracheal density with anterior displacement of the trachea is depicted on the chest plain film. The barium esophagogram shows a nick on the lateral esophageal wall of slightly obtuse angles, suggestive of an extramucosal lesion. The CT confirms the space occupying lesion, contiguous to the esophagus and the tracheal displacement. The gross correlation shows the fleshy appearance of the tumor.

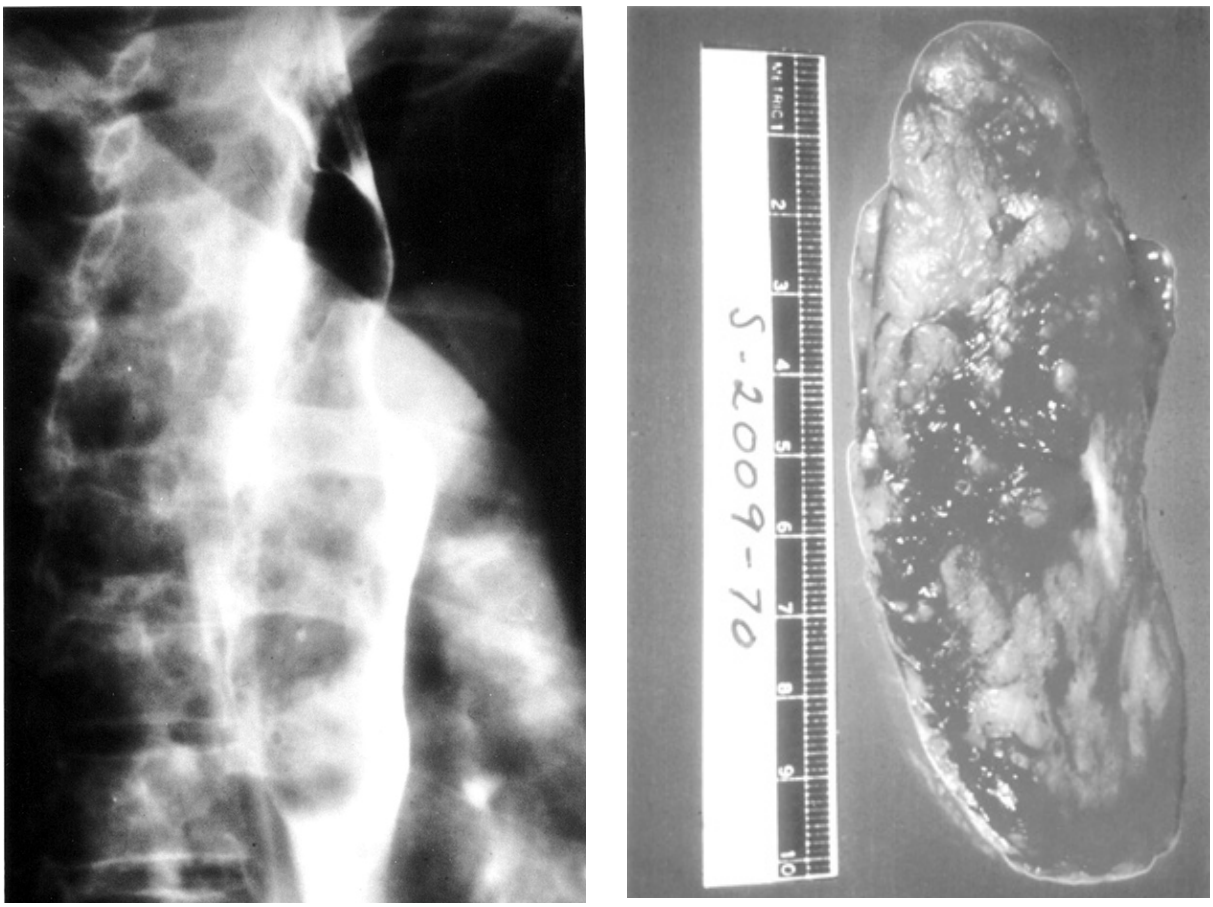

Figure 8. Esophageal lipoma. Barium study (a) Macroscopic correlation (b) The esophagogram demonstrates a smoothly marginated filling defect, endoluminal, with sharp borders, characteristic of submucosal lesions. Peristaltism was preserved. Macroscopic correlation confirms the benign morphologic appearance that explains the barium study findings.

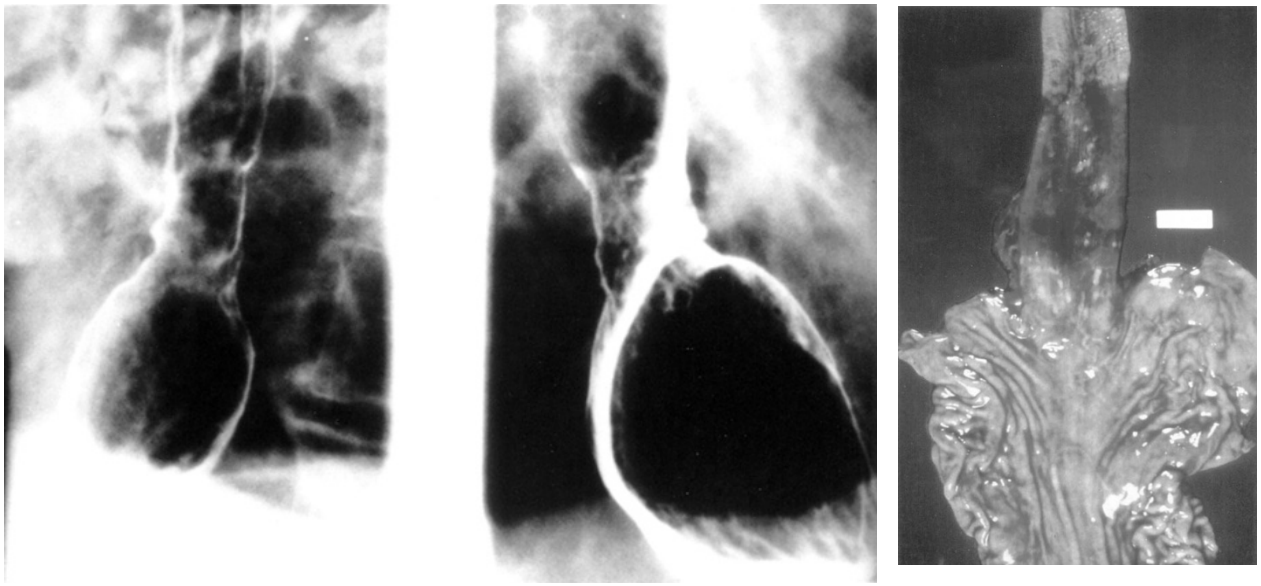

Figure 9. Reflux esophagitis. Double contrast esophagogram and Macroscopic correlation. The radiologic study shows the typical features of reflux esophagitis; like the thickening of the esophageal folds and segmental narrowing. The pathologic specimen depicts the esophageal mucosal inflammatory changes.

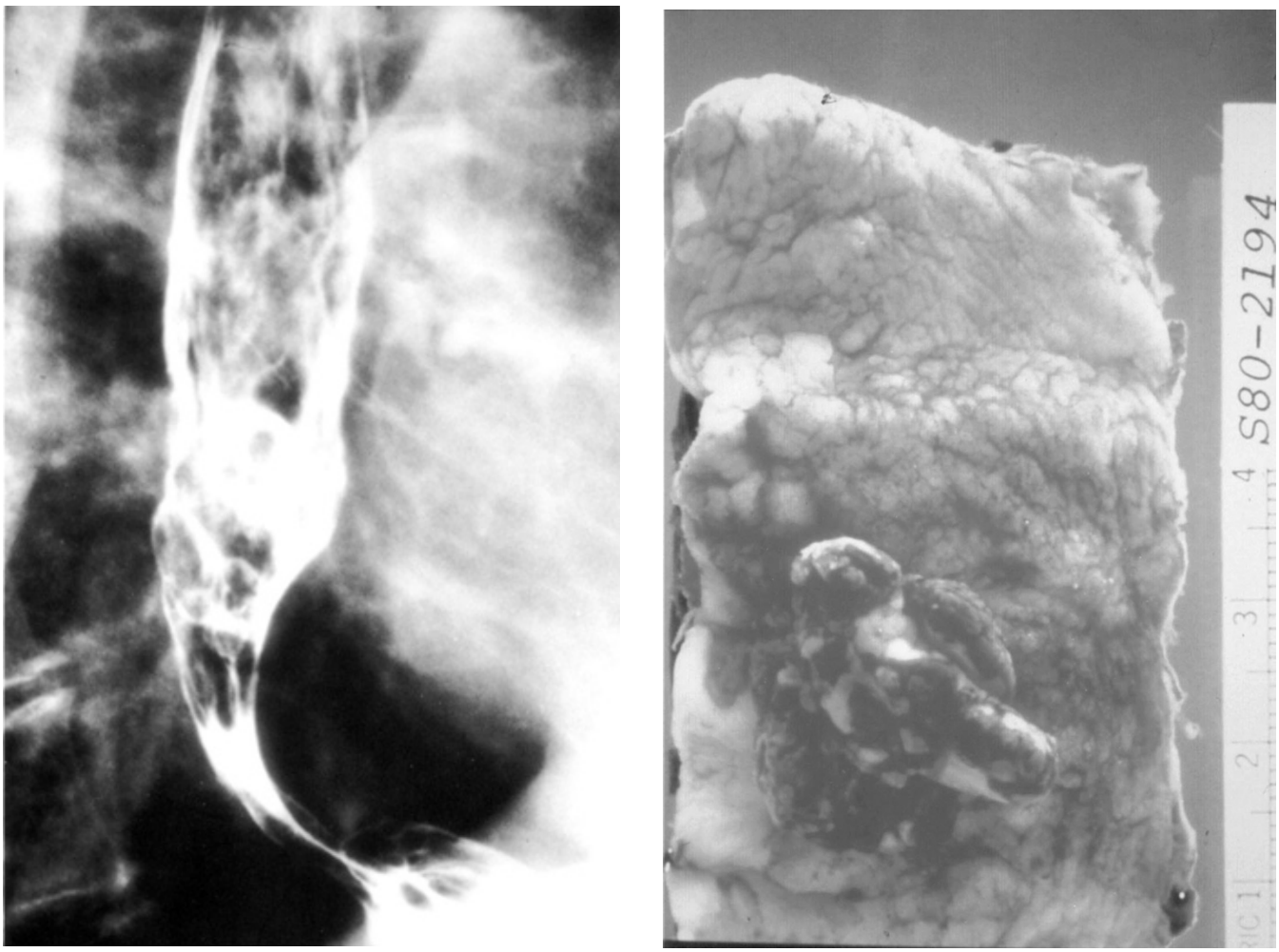

Figure 10. Barret esophagus. Double contrast esophagogram. Macroscopic correlation. The radiologic study shows the typical appearance of the columnar metaplasia of the distal esophagus and the presence of an adenomatous polyp. The pathologic specimen clearly shows the polyp and the metaplasic mucosa.

Schatzki ring

Represents an annular, ring-like structure due to scarring from reflux esophagitis (Figure No. 11). The impacted bolus in the distal esophagus may cause severe chest pain.

A hiatal hernia is almost always observed below the level of the ring.

Boerhaave´s Syndrome

Usually occur as vertically oriented linear tears on the left posterolateral wall of the distal esophagus just above the gastroesophageal junction. Thoracic esophageal perforations are manifested by the sudden onset of thoracic chest pain (Figure No. 12).

The earliest plain film findings are mediastinal widening and pneumomediastinum. Gas may dissect along fascial planes superiorly producing subcutaneous emphysema. Distal esophageal perforations often result in left pleural effusion. If the mediastinal pleural ruptures a hydropneumothorax is present.

Esophageal carcinoma

Most of these tumors are squamous cell carcinomas, but adenocarcinoma arising in Barret's esophagus also account for a significant percentage of cases.

Some form of axial imaging is often undertaken to stage the disease, which is important for judging the resectability and providing the patient with a prognosis. The system of staging classifies the extent of the tumor according to the degree of invasion into the esophageal wall, presence of malignant lymph nodes and distal metastasis.

The cephalad extent of the tumor often can be identified by its interface with a dilated proximal esophageal lumen. However, clear delineation of the caudal tumor margin can be difficult (Figure No. 13).

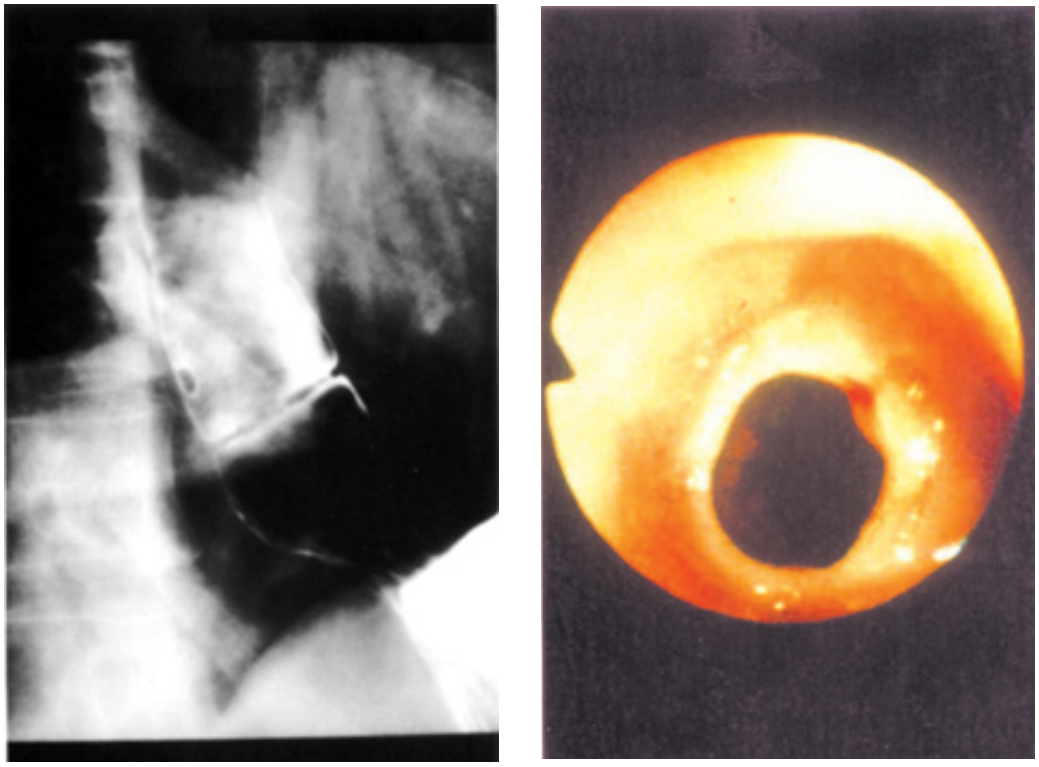

Figure 11. Schatzki ring. Double contrast esophagogram. Endoscopic correlation. Barium study shows the Schatzki ring typical appearance, which is clinically manifest when the esophagus lumen is less than 13 mm. The endoscopic appearance depicts the characteristic annular narrowing.

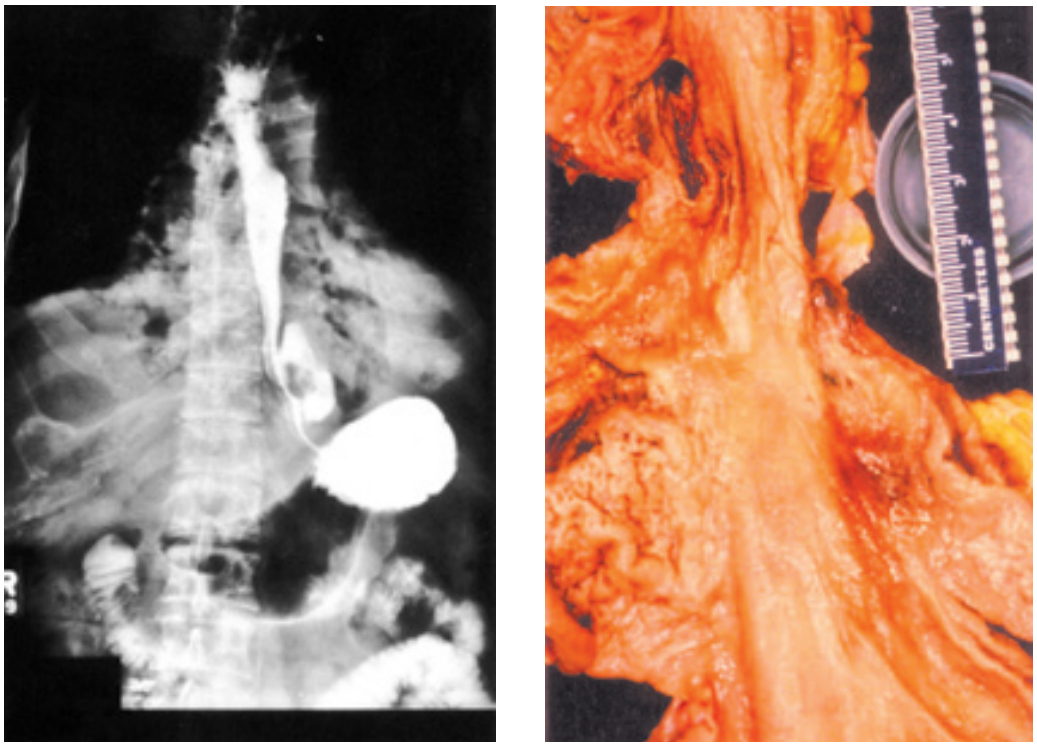

Figure 12. Boerhaave's syndrome. Barium study (a). Macroscopic correlation (b). The esophagogram demonstrates contrast medium extravasating from the left lateral wall of distal esophagus. Pneumomediastinum is evident. The pathologic specimen (posterior view) shows the typical localization of the spontaneous esophageal perforation that is secondary to a sudden increase in intraluminal esophageal pressure.

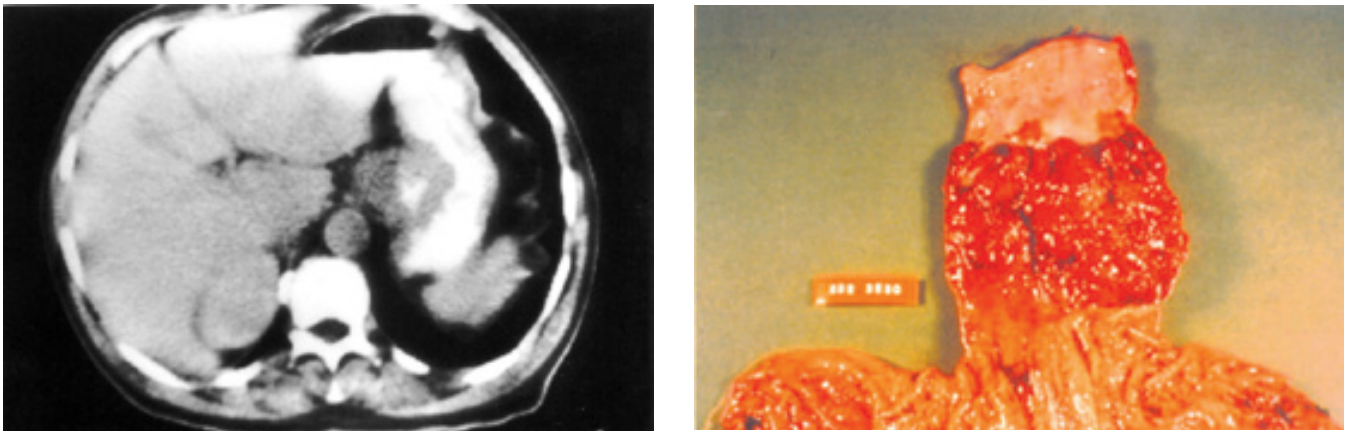

Figure 13. Gastroesophageal junction carcinoma. CT study. Macroscopic correlation. CT demonstrates a focal area of wall thickening in the gastroesophageal junction. There are not any local lymphadenopathies or gastrohepatic epiplon invasion. The pathologic specimen confirms the mural excrescence that surrounded the distal esophagus lumen.

For assessing resectability, CT and MRI have comparable accuracy when using criteria such as tracheobronchial and aortic invasion. Whereas CT appears more sensitive for detecting lymphadenopathy, MR is useful for demonstrating the extent of local disease. Both CT and MR present the same sensitivity using the finding of obliteration of the triangular fat plane between esophagus, spine, and aorta by tumor as a criterion of unresectability.[7,8]

Resumen:

En este artículo, revisamos los hallazgos radiológicos en la patología esofágica, el papel de las técnicas de imagen más modernas; tomografía computada (TC) y resonancia magnética (RM); y evaluamos los signos indirectos, de este tipo de patología en placa simple de tórax.

Primero describimos la anatomía radiológica del esófago, en TC y RM; considerando diversos niveles anatómicos.

Después evaluamos los diferentes criterios semiológicos en placa simple de tórax, la cual debe ser la clave inicial en el diagnóstico de la enfermedad esofágica, tomando en cuenta dos aspectos: Alteraciones en las líneas mediastinales y la presencia de niveles hidroaéreos en acalasia y divertículos esofágicos.

Después, considerando al "dolor precordial" como una manifestación de patología esofágica; evaluamos las alteraciones en la motilidad esofágica: reflujo gastroesofágico, esófago de Barret; anillo de Schatzki y perforación esofágica.

Por último describimos la patología neoplásica maligna; discutimos los criterios de TC y RM para la estadificación; y las capacidades y limitaciones de cada una de ellas así como su utilización complementaria. Ilustramos todo lo anterior con imágenes de cada caso.

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