Learning objectives

- To describe the causes and radiological findings of the traumatic diaphragmatic hernias.

- To highlight the importance of the diagnosis due to the fact that its complication entail the risk of high morbidity and mortality.
Background

The root causes of the diaphragmatic injuries are the traumatism, and result from penetrating wounds or blunt trauma; though they present with low frequency (0.8-6 %) the higher incident is due to the penetrating traumas.

1. ETIOPATHOGENY AND LESIONAL MECHANISM

1.1 Blunt traumatism: traffic accidents, run over or falls of height. The mechanisms that produce the injury are the abdominal sudden hypertension and the collapse of the costal gridiron for direct impact. The injury usually affect a hemidiaphragm, the majority have occurred on the left side to being congenitally weaker and for lacking the effect absorber of the liver; also it is believed that it owes to an infradiagnosis of the injuries of the right, since these have higher mortality. The types of injury can be for tear (radial or transverse), disinsertion (costal or pillars) or mixed.

1.2 Penetrating traumatism: wounds caused by bull horn, knife or firearm. They produce the injuries for direct penetration to the tissues. In this case do not exist a specific area to be damaged, they can affect both diaphragms.

2. ASSOCIATED INJURIES

2.1 Blunt traumatism

Abdominal:
- Spleen 40-60 %
- Liver 93 % on right sided ruptures and 23% on left side.

Thoracic:
- Rib fractures 50-70 %
- Pneumothorax and/or hemothorax 35-75%
- Lung contusion 15-25%
- Aortic tear 3-10%
- Cardiac injuries 4%

Fractures:
- Pelvic 30-40%
- Long bones 40-75%

2.2 Penetrating traumatism
- Liver 50%
- Stomach 25%
- Transverse colon, kidney and spleen 12-18%
- Lung 65%

3. CLINICAL MANIFESTATIONS

The evolution of the diaphragmatic injury can divide in three stages:

1. **Acute**: begins with the injury. It usually occurs with thoracic pain and as acute respiratory distress, produced for mediastinal compression because of gastric progressive and gradual dilatation.

2. **Chronic phase or latent**: If not diagnosed early, can pass months or years. Is related to the pressure gradient between the pleural and peritoneal cavities may evolve into gradual herniation of abdominal contents. This phase can present unspecific abdominal and respiratory symptoms that they could guide to other pathologies.

3. **Obstructive phase or strangulation**, is characterized by bowel or visceral herniation, obstruction, incarceration, strangulation, and possible rupture of of the stomach and colon. If herniation causes significant lung compression, it can lead to tension pneumothorax. Diaphragmatic paralysis also may occur. The morbidity and mortality rates are substantially increased up to 60-80%.

The treatment of the diaphragmatic hernias is the surgery in the moment of its diagnosis, still in asymptomatic patients, even for small tears, because the defect will not heal spontaneously. The hernia is reduced, intestinal resection is realized when it is necessary and the muscular fault is repaired with simple suture or plicatura or prothesis.
Imaging findings OR Procedure details

1. CHEST RADIOGRAPHY

Is the initial study, that It could be normal or can show specific signs.

- The visualization of herniation of hollow viscera Fig. 1 on page 7 Fig. 2 on page 7.

- Elevation of the hemidiaphragm: In 90% of the patients the left hemidiaphragm is between 1 and 3 cm lower than the right; an important elevation of the left hemidiaphragm (> 4 cm that the right) is suggestive of injury. Fig. 3 on page 8

- Distortion or obliteration of the outline of the hemidiaphragm.

- The mediastinal displacement towards the contralateral side.

- A nasogastric tube passing into the abdomen and then curling up into the chest.

In acute phase can make it difficult to identify the presence of basal atelectases, pneumothorax, hemothorax or lung contusion. Fig. 3 on page 8 Fig. 4 on page 9

2. COMPUTED TOMOGRAPHY

It allows the evaluation of associate injuries, for what must administer intravenous contrast. Furthermore, multiplanar and volumetric reformatted CT images provide improved visualization of injuries.

- Direct visualization of the diaphragm injury, easier in the multiplanar reconstructions. Fig. 5 on page 10 Fig. 6 on page 11

- The collar sign, a waistlike constriction of the herniating hollow viscus at the site of the diaphragmatic tear. Fig. 7 on page 12

- Intrathoracic herniation of abdominal contents has, the stomach and colon are the most common viscera to herniate on the left side and the liver is the most common viscus to herniate on the right side. Fig. 8 on page 13 Fig. 9 on page 13

- The dependent viscera sign: when a patient
• With a ruptured diaphragm lies supine at CT examination, the herniated viscera are no longer supported posteriorly by the injured diaphragm and fall to a dependent position against the posterior ribs. Fig. 10 on page 14

• Sign of the wrinkled diaphragm: diaphragmatic thickening.

Sometimes motion artifacts due to respiratory movement decrease the quality of multiplanar reformation images and can mimic a herniation or diaphragmatic rupture.

3. DIFFERENTIAL DIAGNOSIS

There must be known other reasons that can produce elevation of the diaphragm:

A) Thoracic:

• Atelectasis
• Pulmonary fibrosis
• Pleural adhesions
• Scoliosis

B) Caused by a decrease in muscle tone.

• Diaphragmatic paralysis caused by an injury to phrenic nerve Fig. 11 on page 15 Fig. 12 on page 16 Fig. 13 on page 17
• Congenital diaphragmatic eventration

C) Abdominal:

• Subphrenic abscesses
• Hydatidic cyst
• Splenomegaly
• Gastric distension or the splenic flexure
• Ascites
• Obesity
Fig. 1: Case 1. Chest X-ray PA. Young woman with personal history of aggression 4-5 years ago with incised wounds on the left hypochondrium and left hemithorax. X-ray shows slightly elevated left hemidiaphragm. The bubble under the left hemidiaphragm that proved to correspond to colon.

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Fig. 2: Case 1. Lateral chest X-ray of the previous patient. Elevation of the left hemidiphragm with an air bubble beneath (colon).

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Fig. 3: Case 2. Portable chest X-ray. A multiple trauma patient after a motor vehicle accident, frontal shock with airbag and safety belt, without loss of consciousness. Can be seen the elevation of the left hemidiaphragm (blue arrow), pneumomediastinum (green arrow). Focal homogeneous opacity in the left hemithorax compatible with pulmonary contusion (pink arrow) and absence of lung vessels in the periphery suspect of pneumothorax (yellow arrow). Rib fractures (brown arrows), old on the right side and acute with subcutaneous emphysema on the left side.

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Fig. 4: Contrast-enhanced axial CT image with lung window of the case 2. It confirms the pneumothorax and left pulmonary contusion (pink arrows), pneumomediastinum (green arrow) and rib fractures with subcutaneous emphysema (brown arrow).

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Fig. 5: Sagittal reformatted image of contrast-enhanced CT image in the case 1. Shows the interruption of the left diaphragm (green arrow) with colon herniation by the diaphragmatic tear (orange arrow).

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Fig. 6: Sagittal and coronal reformatted images of CT scan of case 2. Shows a defect in the continuity of the left hemidiaphragm (blue arrow) with intrathoracic herniation of the stomach and bowel (pink arrow).

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**Fig. 7:** Helical CT scan (direct axial section) of the case 1. Shows the collar sign (orange arrow), the constricting rim of the diaphragm is seen around the colon (splenic flexure).

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**Fig. 8:** Contrast-enhanced CT axial image of case 1. Shows an increase of the attenuation of the mesenteric fat and mesenteric vessels engorgement (blue arrows) in relation with intestinal obstruction for diaphragmatic hernia strangulated.

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Fig. 9: Coronal reformatted image of contrast-enhanced CT image case 1. Shows left diaphragm tear (green arrow) and the intrathoracic herniation of the colon more clearly (orange arrow). Also shows dilated loops of small bowel (blue arrow), without vascular compromise and free intraperitoneal fluid (violet arrow).

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**Fig. 10:** Unenhanced CT scan of case 2. Shows the depent viscera sign (blue arrow) the stomach abuts the posterior ribs on the left side.

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Fig. 11: Chest x-ray PA. A man who came to emergency for progressive dyspnoea and precordial pain developed after costal left traumatism 48h before. The x ray chest shows elevation of the left hemidiaphragm with intrathoracic stomach and colon and mediastinic displacement to the right. Incidentally a lung nodule in the right upper lobe was detected.

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Fig. 12: Lateral chest x ray of the previous patient shows intrathoracic herniation of the stomach and colon without diaphragmatic distortion. After urgent surgery it is confirmed diaphragmatic paralysis caused by an injury to phrenic nerve.

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Fig. 13: Axial contrast-enhanced CT of the patient of figure 11. CT image shows intrathoracic colon, stomach and spleen without diaphragmatic defect.

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Conclusion

- The diaphragmatic injury is a difficult diagnosis, needs high clinical suspicion based on the mechanism lesional, can develop months or years after the traumatism.

- The chest radiography presents good diagnostic profitability. The study complements with the CT to evaluate associate injuries.
References