Diaphragm 2

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Contents

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Case 1: Pneumoperitoneum

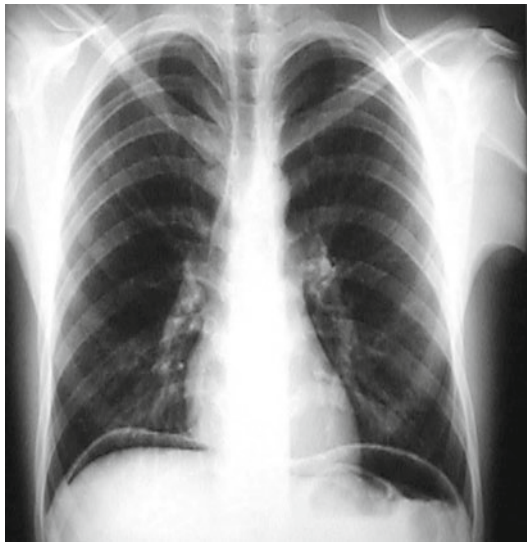

Fig. 2.1.1

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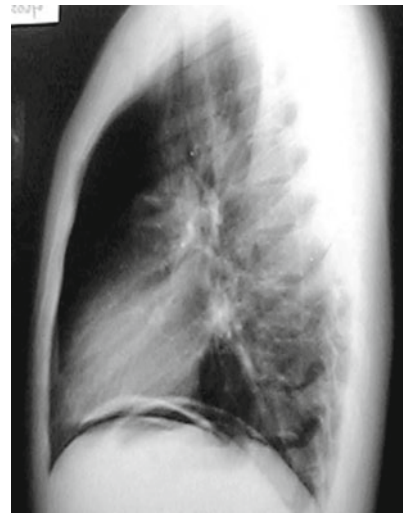

Fig. 2.1.4

A 60-year-old man with abdominal wound opened for exploratory laparotomy, with symptoms of dry cough and dyspnea grade 2 and history of pancreatic carcinoma.

Comments

Pneumoperitoneum refers to the presence of air within the peritoneal cavity. The most common cause is a perforation of the abdominal viscus—most commonly, a perforated ulcer, although a pneumoperitoneum may occur as a result of perforation of any part of the bowel; other causes include a benign ulcer, a tumor, or trauma. Likewise, not every bowel perforation results in a pneumoperitoneum; some perforations seal over, allowing little gas to escape. A pneumoperitoneum is common after abdominal surgery; it usually resolves 3–6 days after surgery, although it may persist for as long as 24 days after surgery.

Signs of a large pneumoperitoneum include the following:

The football sign, which usually represents a large collection of air within the greater sac. The air seems to outline the entire abdominal cavity.

The gas-relief sign, the Rigler's sign, and the double-wall sign are all terms applied to the visualization of the outer wall of bowel loops caused by gas outside the bowel loop and normal intraluminal gas. Free intraperitoneal gas and intraperitoneal fluid in excess of 1,000 mL are usually required to elicit this sign.

The urachus is a vestigial peritoneal reflection not normally seen on a plain abdominal radiograph.

The lateral umbilical ligaments, which contain the inferior epigastric vessels, may become visible as an inverted V sign in the pelvis as a result of a large pneumoperitoneum.

A telltale triangle sign represents a triangular pocket of air between 2 loops of bowel and the abdominal wall.

Free air under the diaphragm may depict the diaphragmatic muscle slips as arcuate soft tissue bands, arching parallel to the diaphragmatic dome.

Gas within the lesser sac may be present, particularly with a perforation of the posterior wall of the stomach.

Air may be present around the spleen.

Signs of partial large bowel obstruction with a sigmoid diverticulum perforation may occur in association with signs of a pneumoperitoneum.

On a left lateral decubitus radiograph, free air is apparent around the inferior edge of the liver, which forms the least-dependent part of the abdomen in that position.

CT can readily depict a pneumoperitoneum. It can be an incidental finding on MRI because MRI is not the primary imaging modality.

Imaging Findings

CRX film (frontal and lateral) shows the air bubble below the left and right hemidiaphragm (pneumoperitoneum) (Figs. 2.1.1, 2.1.2, 2.1.3, and 2.1.4).

Case 2: Diaphragmatic Eventration

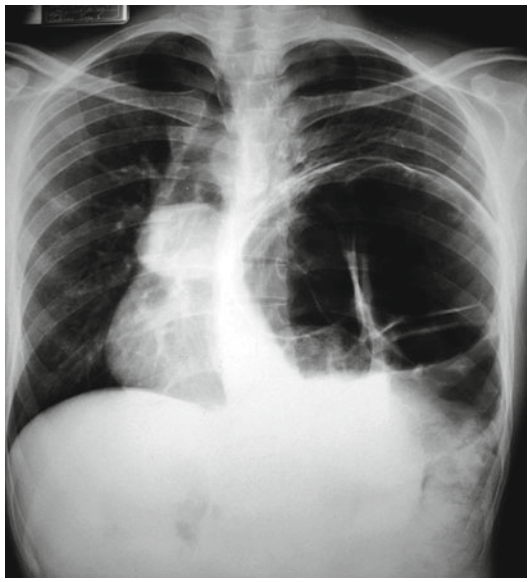

Fig. 2.2.1

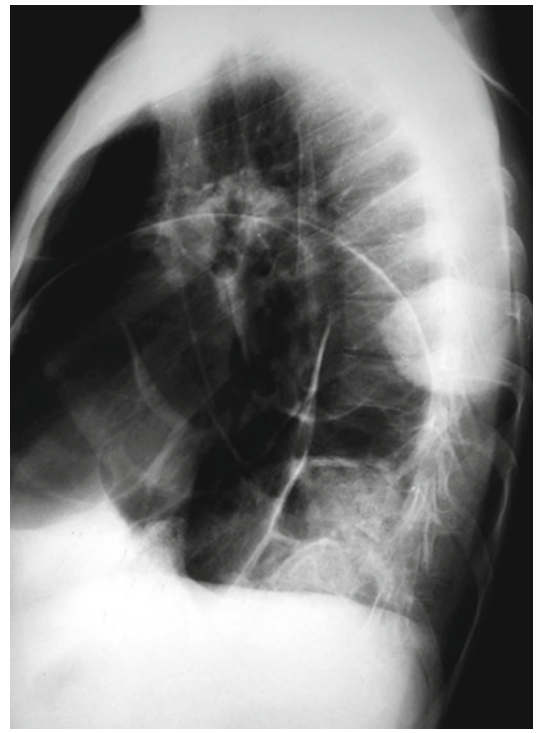

Fig. 2.2.2

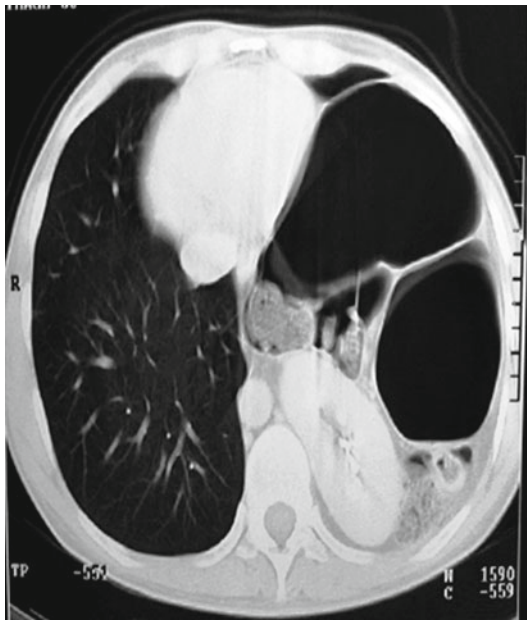

Fig. 2.2.3

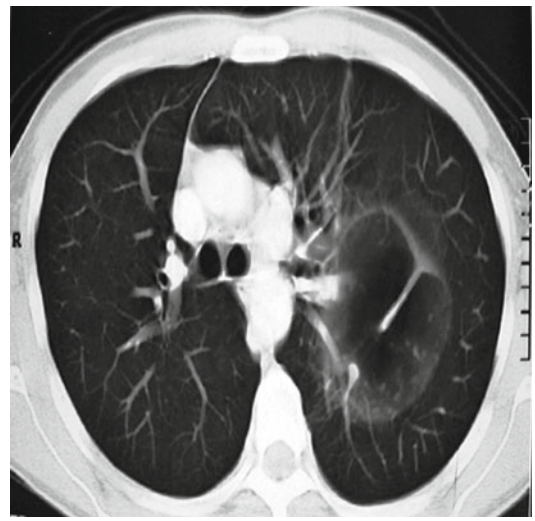

Fig. 2.2.4

A 36-year-old man referred with dyspnea and history of chest trauma.

Comments

From diaphragmatic pathology, 5 % is due to eventration. The diaphragmatic eventration is the elevation of part or all of the diaphragm or an upward displacement of the abdominal contents. It can be congenital, phrenic nerve paralysis, subphrenic abscess, for bulky right middle lobe, hepatomegaly, or trauma to the diaphragm. Usually asymptomatic and presents with loss of muscle tone of the diaphragm. It may be associated with other anomalies such as high renal ectopia and extralobar pulmonary sequestration. Also, it may be associated with alterations in the column as the kyphosis, chest deformity, or bone for pectus excavatum and pectus carinatum.

The differential diagnosis includes diaphragmatic eventration, congenital lobar emphysema and right diaphragmatic eventration cases, tumor, cyst, pleural, and/or hepatic hernia.

The chest X-ray diagnostic often many of the cases, the aid of fluoroscopy. In doubtful cases, the CT scan of upper abdomen shows hypoplastic diaphragm and liver evisceration; when the condition is right, rule out the possibility of mediastinal masses. The ability to confirm the presence of liver tomography is based on the observation of portal vessels after injection of contrast medium. The liver sections show the normal flow of the rear of the diaphragm and liver; it does not appear in its anterior portion due to its elevated position at the craniocaudal superior. It mentions the MRI as a very accurate method of third order.

Imaging Findings

CRX film (frontal and lateral) shows elevation of the left hemidiaphragm with substantial presence of bowel loops (Figs. 2.2.1 and 2.2.2). CT scan (lung window) shows left massively distended colon below the left diaphragm (Figs. 2.2.3 and 2.2.4). RNM shows left colon massively distended below the diaphragm and presence of left paravertebral mass (Figs. 2.2.5 and 2.2.6).

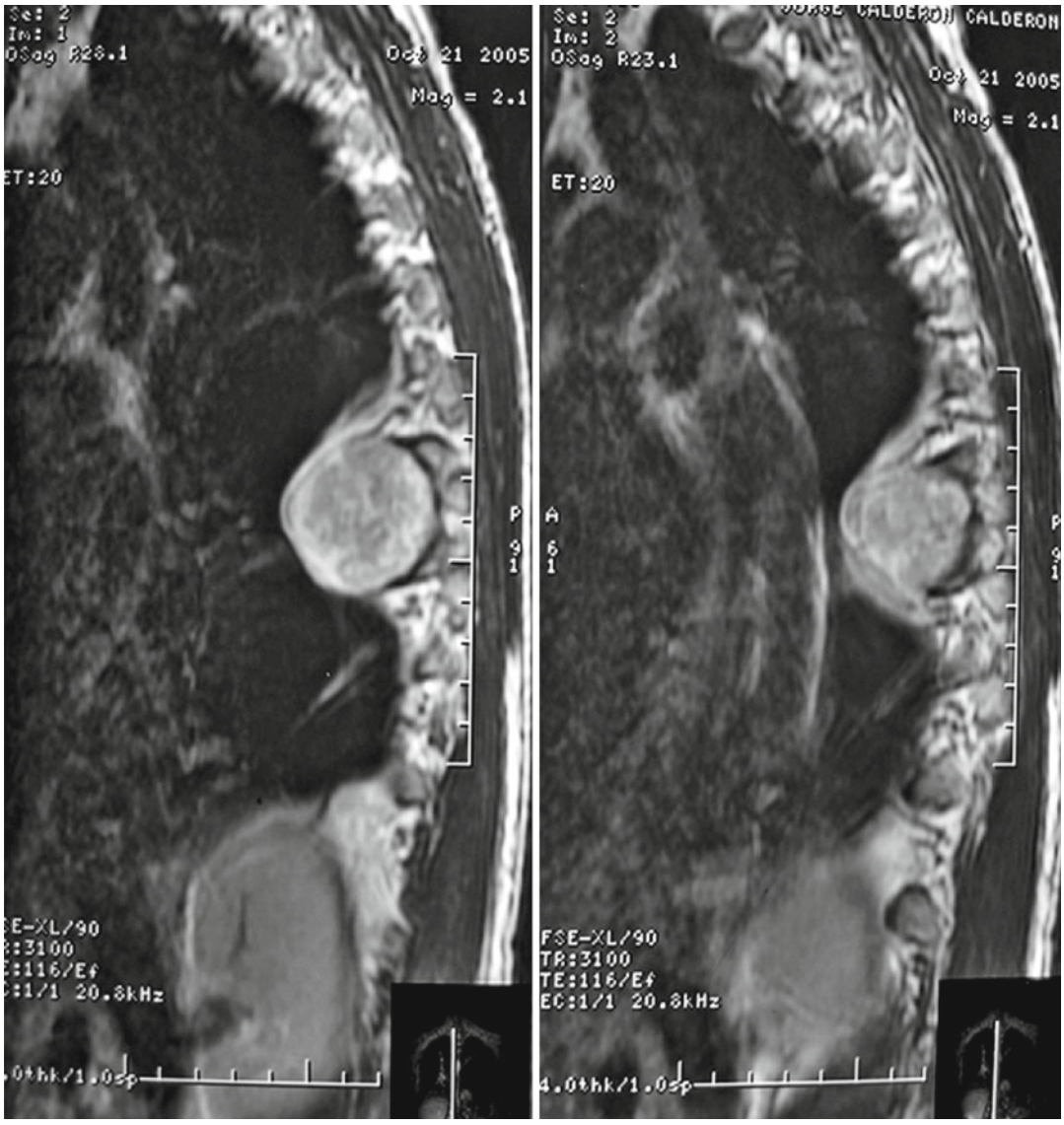
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Fig. 2.2.5

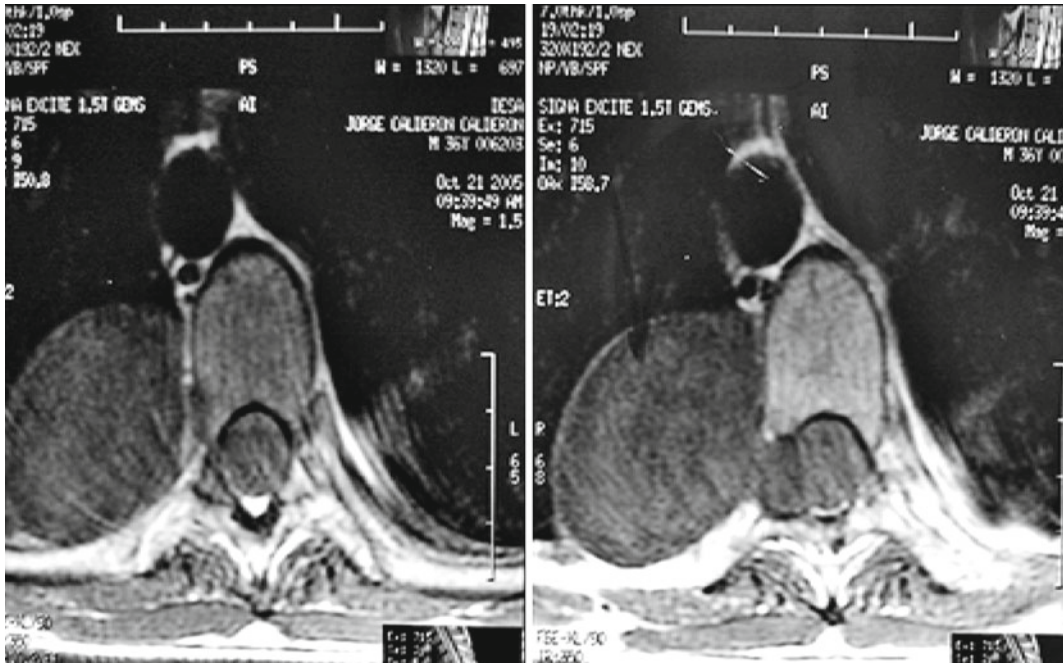
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Fig. 2.2.6

Case 3: Hiatal Hernia

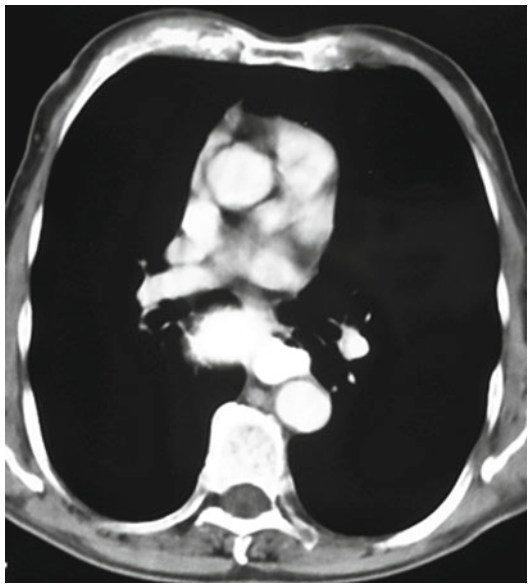
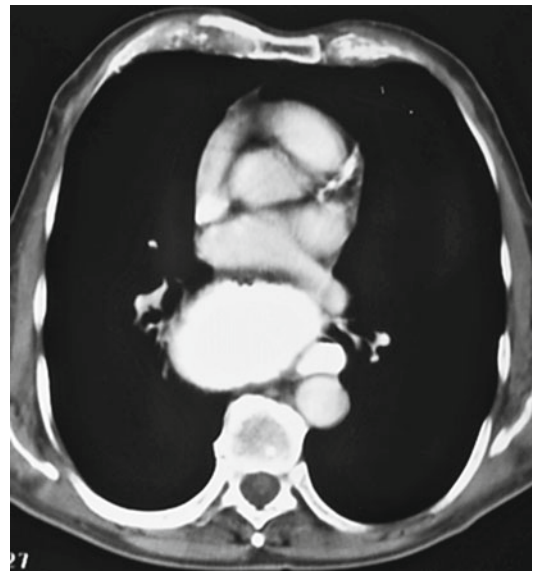


Fig. 2.3.1



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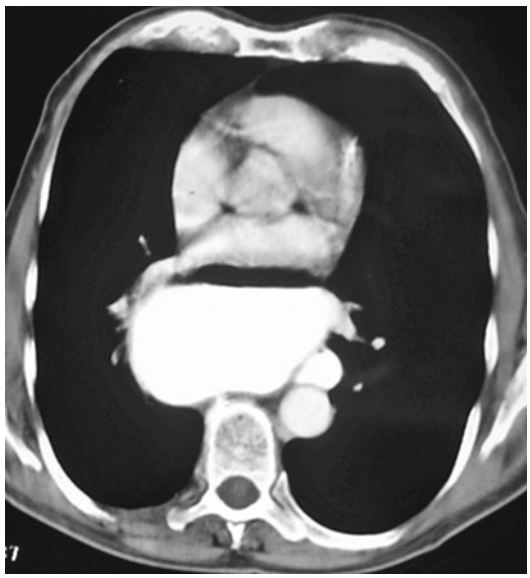

Fig. 2.3.3

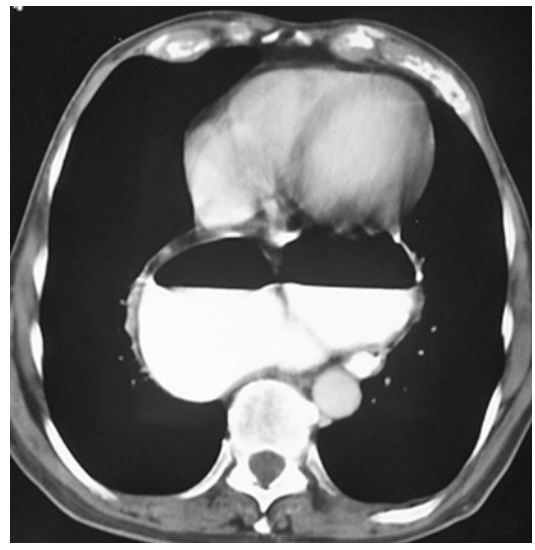

Fig. 2.3.4

A 45-year-old man is referred for symptoms of a 6-month history of dry cough and frequent heartburn.

Comments

The most common type of gastric hernia is a hiatal hernia, in which weakening of the phrenoesophageal membrane and gradual enlargement of the esophageal hiatus of the diaphragm allow the gastric cardia and fundus to herniate through the diaphragm into the thorax. The prevalence of hiatal hernias increases with age; 60 % of elderly persons in the United States are found to have a hiatal hernia on barium studies.

The hiatal hernias are divided into three or four types. The intrathoracic stomach may be found in paraesophageal hiatal hernias (types 2–4). The paraesophageal hiatal hernia (types 2–4) is an uncommon disorder, representing approximately 5 % of all hernias occurring through the esophageal hiatus. An intrathoracic stomach results from a paraesophageal hiatal hernia in which a substantial portion of the stomach has herniated into the chest.

Type 1 hiatal hernia is also called the sliding or axial hernia. This type of hernia represents 95 % of all hiatal hernias. The esophagogastric junction is displaced into the chest because of diffuse weakening and stretching of the phrenicoesophageal membrane.

Type 2 hiatal hernia is called the paraesophageal or rolling hernia. This type of hernia has a focal defect in the anterior and lateral aspect of the phrenicoesophageal membrane. The gastric cardia and the esophagogastric junction remain below the diaphragm.

Type 3 hiatal hernia is called the "mixed" or "compound" hiatal hernia. This type of hernia is the most common form of paraesophageal hernias, combining the features of the type 2 and the type 1 hernias.

In type 4 hiatal hernia, with marked widening of the diaphragmatic hiatus, other organs such as the colon, omentum, small bowel, and liver can also herniate into the chest.

Radiography Findings: Hiatal hernia typically manifests radiographically as a retrocardiac mass, usually containing air or air-fluid level. A large mass may contain a double air-fluid level. In cases in which most of stomach has herniated through hiatus, the stomach may undergo volvulus.

CT Findings: Widening of esophageal hiatus allows stomach and omentum to protrude into chest. Normally, esophageal hiatus is elliptical and measures ≤15 mm in width. Multidetector CT with coronal and sagittal reformatted images is most effective and useful imaging technique in assessing diaphragmatic hernias.

Imaging Findings

CT scan (arterial phase) shows typical appearance of large hiatal hernia. There are superior displacement of the stomach, which contains oral contrast prior to the examination (Figs. 2.3.1, 2.3.2, 2.3.3, and 2.3.4).

Case 4: Morgagni Hernia

Fig. 2.4.1

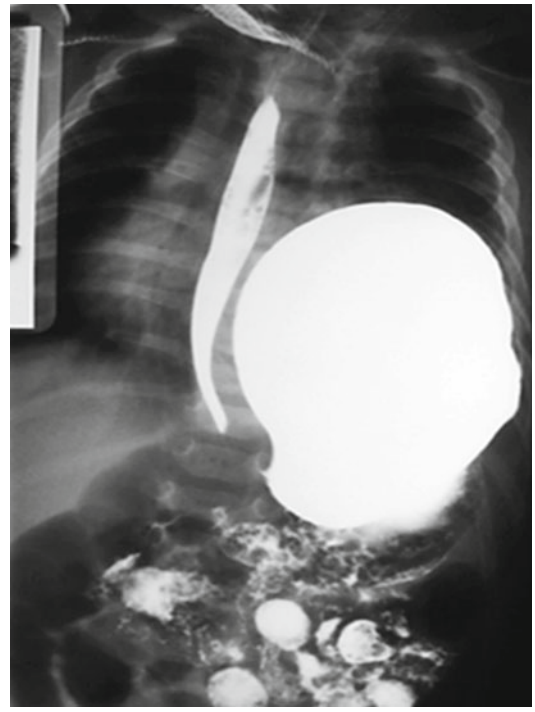

Fig. 2.4.2

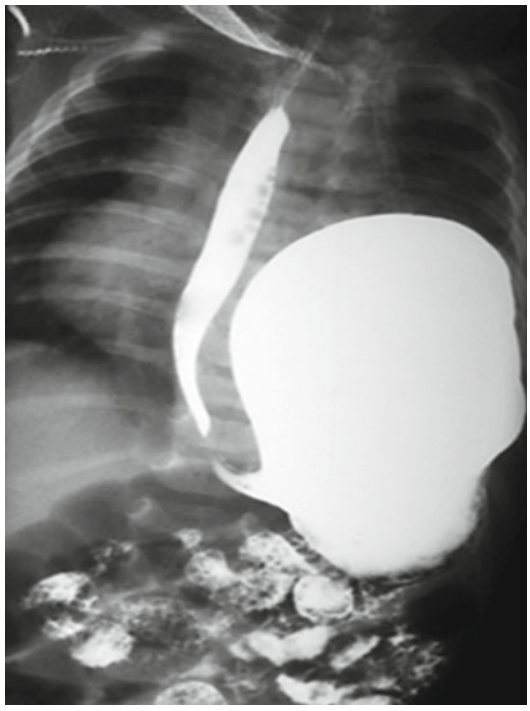

Fig. 2.4.3

An 8-month-old female child without symptoms underwent routine chest radiography.

Comments

The foramen of Morgagni is an anterior opening in the diaphragm that extends between the sternum medially and the eighth rib laterally. It is caused by failure of fusion between the transverse septum and the lateral body wall where the internal mammary artery crosses the diaphragm.

Morgagni hernia was first reported by Giovanni Battista Morgagni in 1761 that occurs in 5–10 % of CDH. It accounts for less than 2 % of all diaphragmatic hernias. Morgagni hernias are more frequently detected in women (61 %) with an average age of 58 years. They usually present in childhood with respiratory symptomatology. Incidental findings of this condition in adults are less common. These hernias are characterized by a defect between the septum transversum and the costal margin of the diaphragm, most frequently occurring on the right.

Herniated organs in Morgagni hernia may include omentum, stomach, small bowel, large bowel, and liver. In adults, protrusion of omentum is common and only rarely with bowel, stomach, or liver. Newborn patients may present with right-sided heart, decreased breath sounds on affected side, scaphoid abdomen, bowel sounds in the thorax, respiratory distress, and/or cyanosis on auscultation. Adult patients may exhibit chest mass on chest radiograph, gastric volvulus, splenic volvulus, and/or large bowel obstruction.

Radiographically, Morgagni hernia appears as a fatty mass in the right cardiophrenic angle and can be difficult to differentiate from prominent epicardial fat pad. Other fat-containing masses include lipoma, teratoma, thymoma, thymolipoma, or liposarcoma.

Ultrasonography has been shown to be useful in assessing diaphragmatic hernias, but CT is the most sensitive method by demonstration of anatomical detail on the contents of the hernia and its complications such as strangulation.

CT or MRI demonstrates displaced curvilinear omental vessels within the "mass" or coursing across the diaphragmatic defect which is characteristic for Morgagni hernia.

Imaging Findings

CRX film shows the foramen of Morgagni hernia. The contrast will intestines that are in front of the chest (Figs. 2.4.1, 2.4.2, and 2.4.3).

Case 5: Diaphragmatic Sarcoma

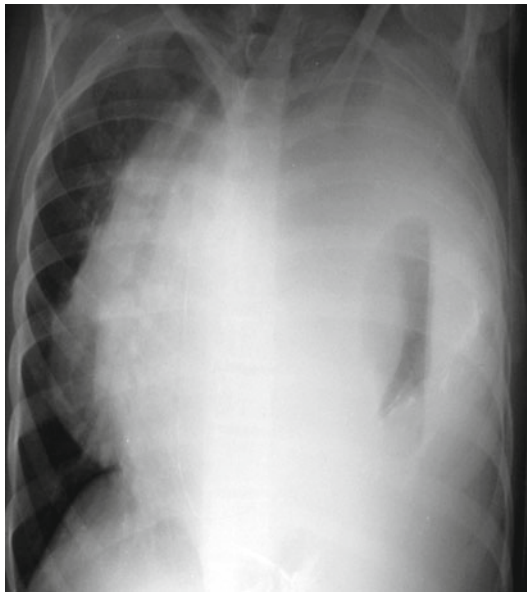

Fig. 2.5.1

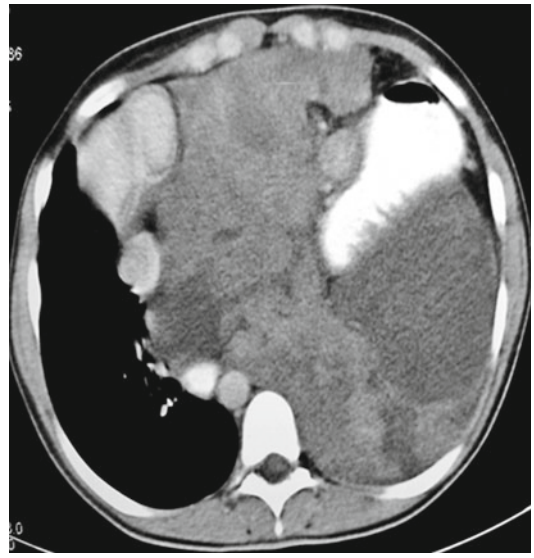

Fig. 2.5.2

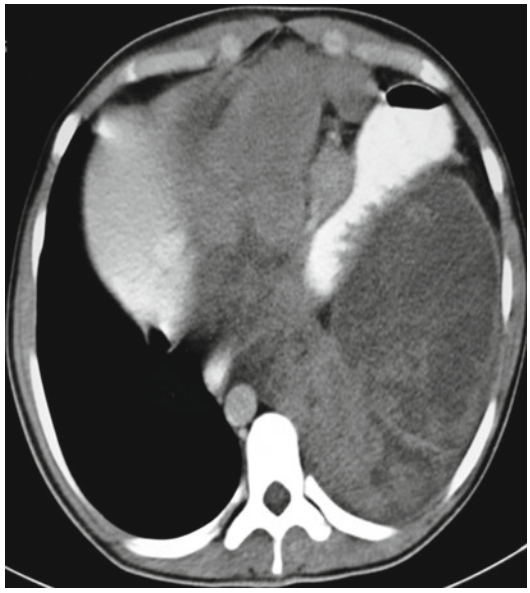

Fig. 2.5.3

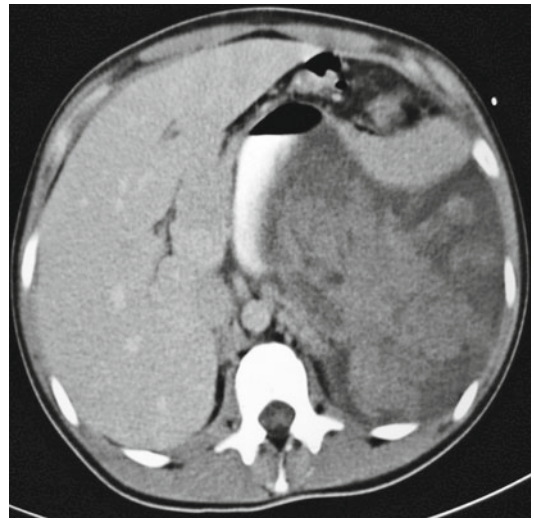

Fig. 2.5.4

A 36-year-old man was referred for dyspnea, chest pain, and weight loss of 3-month duration.

Comments

Extraskeletal Ewing's sarcoma (EES) is simply Ewing's sarcoma arising in soft tissues, which is now regarded as a member of the family of small, round cell neoplasms of bone and soft tissue, including primitive neuroectodermal tumor and neuroblastoma. The most frequent sites of occurrence are the chest wall, lower extremities, and paravertebral region. Less frequently, the tumor occurs in the pelvis and hip region, the retroperitoneum, and the upper extremities. It occurs predominantly in adolescents and young adults between the ages of 10 and 30 years. Extraskeletal Ewing's sarcoma of the diaphragm presenting with hemothorax has been reported.

Primary tumors of the diaphragm are rare. They can occur at any age, but most cases occur in the fourth and fifth decades of life. Primary tumors may be benign or malignant. Sarcomas with diaphragmatic origin are extraordinarily rare, with fibrosarcoma, rhabdomyosarcoma, and leiomyosarcoma representing the majority of cases.

Imaging Findings

CRX film shows opacity in left hemithorax displacing the mediastinum contralaterally (Fig. 2.5.1). CT scan (arterial phase) shows expansive inhomogeneous tumor mass in the left upper abdomen (Figs. 2.5.2, 2.5.3, and 2.5.4).

Case 6: Diaphragmatic Hernia

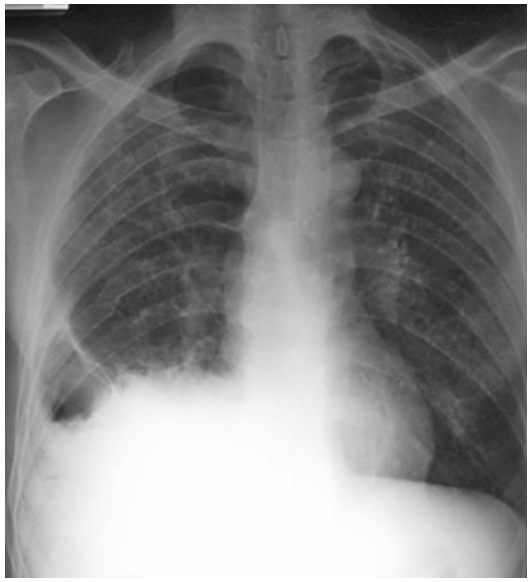

Fig. 2.6.1

Fig. 2.6.2

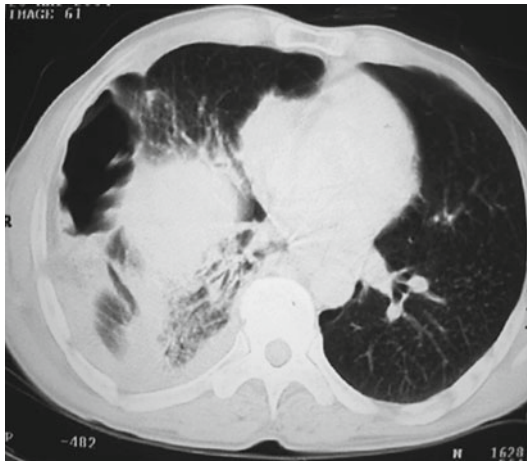

Fig. 2.6.3

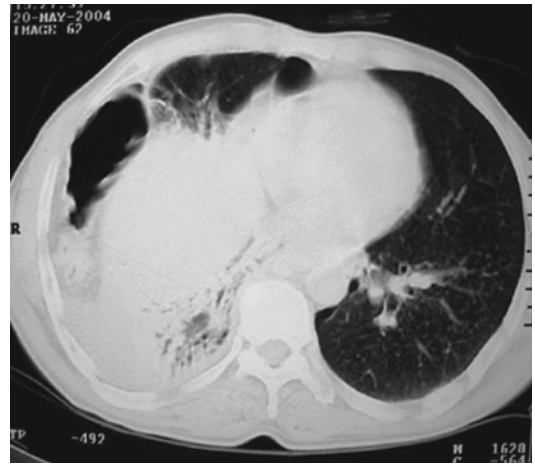

Fig. 2.6.4

A 59-year-old man presents with symptoms of right rib pain and occasional dry cough and a history of trauma.

Comments

Diaphragm injury may result from blunt and penetrating trauma. Blunt diaphragm rupture (BDR) is an uncommon injury with an overall reported incidence of 0.16–5 %. Acute diaphragm injury is associated with widely ranging mortality of 5.5–51 %, with death typically resulting from associated injuries or in-hospital complications, such as adult respiratory distress syndrome.

Chest radiography allows diagnosis of 27–60 % of left-sided injuries but only 17 % of right-sided injuries. Differentiation of a herniated liver through a diaphragmatic tear from other causes of elevated diaphragm such as atelectasis, pleural effusion, or pulmonary contusion or laceration remains difficult.

Specific diagnostic findings of diaphragmatic tears on chest radiographs include the following: (*a*) intrathoracic herniation of a hollow viscus (stomach, colon, small bowel) with or without focal constriction of the viscus at the site of the tear (collar sign) and (*b*) visualization of a nasogastric tube above the hemidiaphragm on the left side.

Computed tomography has a variable sensitivity of 14–61 % and specificity of 76–99 % in the diagnosis of diaphragmatic rupture. Helical CT has proved to be more valuable in the detection of diaphragmatic injuries with a sensitivity of 71 % (78 % for left-sided injuries and 50 % for right-sided injuries), a specificity of 100 %, and an accuracy of 88 % for left-sided injuries and 70 % for right-sided injuries.

Imaging Findings

CRX film shows right basal opacity and presence of intestinal loop (Figs. 2.6.1 and 2.6.2). CT scan (lung window) shows defect through right diaphragm, which produces upward movement of intestinal contents (Figs. 2.6.3 and 2.6.4).

Case 7: Unilateral Diaphragmatic Paralysis

Fig. 2.7.1

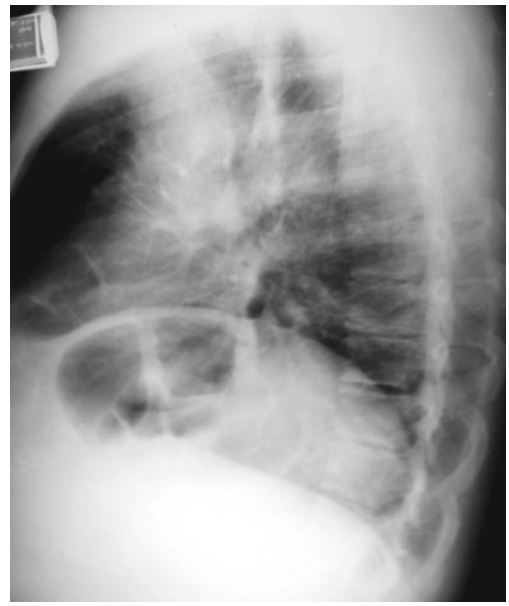

Fig. 2.7.2

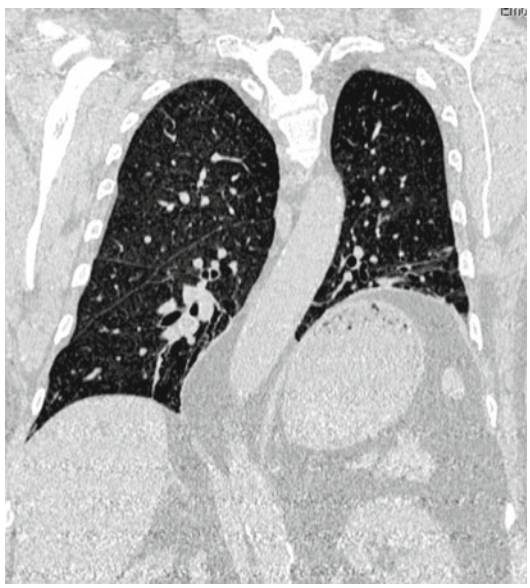

Fig. 2.7.3

Fig. 2.7.4

A 68-year-old man is referred with dry cough, history of chronic bronchitis, and is a heavy smoker.

Comments

Diaphragmatic paralysis can occur after disruption of the phrenic nerve integrity. Idiopathic unilateral paralysis accounts for the majority of cases, followed by malignancy and surgical trauma. Outcome and prognosis differ among affected subjects, from persistent disease to complete resolution, and appear to be directly related to the underlying etiology and whether muscle dysfunction is unilateral or bilateral.

Diaphragmatic paralysis can involve either the whole diaphragm (bilateral) or only one leaflet (unilateral). The etiology remains unidentified in more than two-thirds of cases. Bilateral diaphragmatic paralysis is characterized by profound symptoms and abnormalities of pulmonary and respiratory muscle function, whereas unilateral dysfunction may present with very subtle symptoms and is often discovered incidentally in patients undergoing chest radiography. Hemidiaphragmatic paralysis results in a vital capacity decrement of 10–30 %, with the more substantial decrements seen in the supine position. Measurement of the transdiaphragmatic pressure remains the accepted standard diagnostic test for bilateral paralysis, whereas fluoroscopy with sniff test reliably confirms the diagnosis of unilateral diaphragmatic paralysis. The M mode ultrasonography has been also introduced as an accurate method to evaluate the paralyzed diaphragm.

Diaphragmatic paralysis is likely most often idiopathic and unilateral. When a cause for diaphragmatic paralysis can be identified, it may be due to: trauma or surgery causing cervical cord or phrenic nerve damage (high C-spine injuries involving C3–C5, phrenic nerve injury during cardiac surgery), mechanical ventilation, COPD and other diseases that cause lung hyperinflation, myopathies and neuropathies (myasthenia gravis, critical illness neuro-/myopathy, amyotrophic lateral sclerosis, poliomyelitis, with a 35-year delay until diaphragmatic weakness), inflammatory disorders (e.g., sepsis), and mediastinal masses.

Findings on transthoracic ultrasound of the chest include paradoxical cephalad displacement of the hemidiaphragm, muscle atrophy, and evidence of decreased contraction and shortening during inspiration, compared to the normal diaphragm.

The following criteria are part of unilateral diaphragmatic paralysis: (1) elevation of the diaphragm (about 4 cm or more above the normal position: the extent of the elevation was determined by comparison with the sound side) and (2) paradoxical movement (especially noticeable on sniffing, the sound side descends on inspiration, while the paralyzed side rises by a smaller amount). Chest X-ray is 90 % sensitive for unilateral paralysis but only 44 % specific (high false-positive rate).

Imaging Findings

CRX film shows elevation of the left hemidiaphragm (Figs. 2.7.1 and 2.7.2). CT scan (mediastinal and lung window) shows elevation of the left hemidiaphragm and basal subsegmental atelectasis (Figs. 2.7.3 and 2.7.4).

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