Imaging of the Diaphragm

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Imaging of the Diaphragm

Learning Objectives

- Know the basis embryology – anatomy
- Manifestation in images the diaphragmatic pathology
  - Hernias
  - Paralysis
  - Eventration
  - Tumors

Embriology

- Develops during weeks 4-12
- Composed of 4 components:
  - Transverse septum
  - Pleuroperitoneal fold
  - Esophageal mesentery
  - Muscular body wall

RadioGraphics 2012; 32:E51–E70

Diaphragm

- The Greek derivation of the words
  - Dia: in between
  - Phragma: fence

Morgagni Hernia

- Constitute fewer than 10% of congenital diaphragmatic hernias

Disclosures

- There are no commercial supporters of this workshop
- There are no conflict of interest
Bochdaleck Hernia
• 90% of congenital hernia
• more common on the left side

Where the hernias usually goes?

Posterior attachments
• Cruras attach the diaphragm to the lumbar vertebral bodies and disks
• The crura are joined by a fibrous median arcuate ligament
• Lateral arcuate ligaments
Medial arcuate ligament syndrome.

Normal Anatomy

Anterior – lateral attachments

- Inferior sternum
- Xiphoid process
- Lower six ribs
- Costal cartilage

Normal Lateral arcuate ligament
Innervation

- Cervical nerves C3-C5 facilitate sensory and motor function.

Hiatuses

- IVC
- Esophageal
- Aortic

Function

- Primary muscle of ventilation
- Emesis
- Urination
- Defecation
- Prevent gastroesophageal reflux

Disfunction

- Paralysis
- Weakness
- Eventration

Paralysis

**Synonyms**
- Diaphragmatic palsy
- Diaphragmatic paresis
- Diaphragmatic weakness

**Definitions**
- Extreme form of diaphragmatic weakness
- Decreased strength of diaphragmatic musculature

Paralysis

**Etiology**
- Traumatic: post surgical
- Compression: malignancy compressing or invading phrenic nerve
- Inflammatory
- Neuropathic
- Idiopathic: minority of cases
Paralysis

Most common signs/symptoms
- Unilateral; more common than bilateral
  - Asymptomatic in 50%
  - Orthopnea, tachypnea, chest pain, cough
  - Inward motion of abdomen during inspiration
- Bilateral; more severe symptoms
  - Exertional dyspnea, orthopnea
  - Cor pulmonale
  - Increased incidence of pneumonia
  - Decreased oxygenation & vital capacity on supine position, worse with bilateral paralysis

Natural History and Prognosis
- Poor prognosis if bilateral when associated with
  - Myopathy
  - Chronic demyelinating condition
  - Coexistent COPD or pulmonary fibrosis

Treatment
- Unilateral:
  - Usually no treatment required
  - Surgical plication and phrenic pacing in selected cases
- Bilateral:
  - Mechanical ventilation &/or tracheostomy

Imaging Recommendations
- Chest fluoroscopy
  - Normal diaphragmatic dome excursion 3-5 cm
- Sniff test
  - Technique: Rapid forced inhalation through nose with closed mouth
  - Normal: Sharp brief downward motion of both hemidiaphragms
  - Paralysis: Absent or paradoxical upward motion
- False-positive sniff test:
  - COPD, weak, debilitated patients

Ultrasonographic Findings
- Absent caudal diaphragm movement on inspiration
- Paradoxical diaphragmatic movement on sniff test during M mode (motion mode)

• Video Diaphragm paralysis
**Paralysis**

**MR Findings**
- Real-time diaphragm imaging; only considered when other methods are inconclusive.
- May be useful for long-term follow-up and monitoring of therapeutic interventions.

**Eventration**

- Congenital nonparalytic weakening and thinning of anterior portion and dome of hemidiaphragm

**Pathology**
- Congenital failure of fetal diaphragm to muscularize
- Thin diaphragmatic tendon and membranous muscle decreased muscle fibers
- Permanent diaphragmatic elevation
- Usually unilateral

**Radiography Imaging**
- Lobular elevation or smooth hump-like morphology of anteromedial hemidiaphragm
- Preservation of posterior costophrenic angle

**Location**
- Right hemidiaphragm usually affected
- Anteromedial portion of hemidiaphragm
- CT
- Useful when x-ray is inconclusive or when mimics a mass

**Eventration**

- Clinical Issues
  - Adults over 60 years of age
  - Women typically affected
  - Characteristic benign course with good prognosis

**Treatment**
- Asymptomatic adults do not require treatment
- Surgical repair in extreme cases symptomatic children
**Disfunction**

- Usually unilateral
- Often asymptomatic
- Discovered incidentally
- Symptoms are more severe in patients with underlying pulmonary diseases

**Disfunction**

- Bilateral
- Syntomatic
- Ventilation failure
- Use of the accessory muscle

**Mimics elevation**

- Normal exhalation
- Increases intra abdominal preassure
  - Obesity
  - Ascitis
  - Hepatosplenomegaly
- Conditions cause lung volume loss
  - Atelectasis
  - Lung resection
  - Pulmonary fibrosis
  - Pleural thickening
  - Subpulmonic pleural effusion

**Traumatic Hernia**

- Traumatic hemidiaphragm laceration; may result in intrathoracic herniation of abdominal viscera
- Incidence 0.16% to 5%
- More common with blunt than penetrating trauma
- Up to 7.2% of injuries that are missed acutely may manifest delayed complications in a period that ranges from days to 50 years


**Traumatic Hernia**

- General Features
- Best diagnostic clue
- Air-filled bowel above hemidiaphragm
  - Increased accuracy with supradiaphragmatic enteric tube
- Location
- Equal in blunt trauma
- Penetrating trauma
  - Right side affected in 12%-40%
  - Left side is affected in 50%-88%
  - Visceral herniation much more common on left (70-90%)
  - Liver less likely to herniate through right-sided lacerations

*Eur J Cardio-Thorac Surg 1999;5:469–74*
Traumatic Hernia

- Size
  - Variable size of diaphragmatic tear:
    - Small in penetrating trauma, large in blunt trauma
    - Prevalence of visceral herniation increases with larger tears

- Morphology
  - Blunt: Linear or radial tears typically at hemidiaphragm dome where tendon is thinnest
    - Most commonly extend posterolaterally along embryonic closure of pleuroperitoneal membrane

The higher frequency of left-sided BDR has been attributed to an area of congenital posterolateral weakness

Traumatic Hernia

Radiographic Findings
- Abnormal in 90% of cases
- Sensitivity 50% for left-sided tears
  20% for right-sided tears
  - Often nonspecific because of associated lower lobe atelectasis or contusion
- Abnormal diaphragmatic contour
  - Hemidiaphragm elevation > 7 cm
  - Positional change of hemidiaphragm contour/shape

CT Findings
- CT detection of BDR: sensitivity of 71% to 100%
  Specificity of 75% to 100%
- Sensitivity for left-sided injuries is greater (78–100%) than for right-sided injuries (50–79%)

CT signs
- Direct visualization of injury
- Segmental diaphragm non-visualization
- Intrathoracic herniation of viscera
- “Collar sign”
- Dependent vescera sign
- Diaphragm thickening, and peri-diaphragmatic active contrast extravasation.
- Others
Hiatal Hernias

- Sliding hiatus hernia
- Paraesophageal hiatus hernia

Traumatic Hernia

First day

Ten days later
Diaphragm Tumors

- Primary: rare
- Metastases

Metastases

Summary

- Development anomalies of the diaphragm comes:
  - Morgagni hernia
  - Bochdaleck hernia
  - Eventration
- Hernias can also due to trauma
- Imaging modalities of study:
  - Xray
  - Fluoroscopy
  - US with M mode specially in children
  - CT specially in trauma
  - MR with cine images

THANK YOU