A 70-YEAR-OLD unrestrained female driver was involved in a head-on motor vehicle collision. On arrival at the trauma room, she was only experiencing pain in her right knee. There was no shortness of breath. Her medical history was remarkable for asthma and hypertension. On examination, her respiratory rate was 18 breaths per minute. Breath sounds were decreased over the left hemithorax. Bowel sounds were not heard. Her room-air arterial blood gas pH was 7.38, with PO₂ and PCO₂ levels of 145 mm Hg and 44 mm Hg, respectively, and a bicarbonate level of 28 mEq/L. Radiograph images (Figure 1 and Figure 2) showed marked elevation of the left hemidiaphragm.

What Is the Diagnosis?

A. Ruptured diaphragm
B. Bochdalek hernia
C. Phrenic nerve paralysis
D. Eventration

From the Critical Care Unit, Yale–New Haven Hospital, New Haven, Conn.
Eventration of the Diaphragm

**Eventration** is defined as an abnormal elevation of an intact hemidiaphragm. It was first described by Jean Louis Petit in 1774 during a postmortem examination. In true eventration, all or part of the elevated hemidiaphragm retains its attachments to the abdominal wall, and the peripheral musculature is normal. Eventration is uncommon, with a reported incidence of one in 1400 cases. Both conditions occur more frequently in males and on the left side; however, Bochdalek hernia represents a true postero-lateral defect.

Diaphragmatic elevation due to phrenic nerve paralysis is an acquired lesion. Disorders of the phrenic nerve are classified as post-traumatic, infectious, neoplastic, neuromuscular, or idiopathic. Trauma occurs most commonly after surgery for congenital cardiovascular disorders. Herpes zoster, influenza, and subphrenic abscess are infectious causes. Poliomyelitis is a neurogenic cause. Neoplastic involvement of the phrenic nerve is often secondary to mediastinal tumors and bronchogenic carcinoma with mediastinal involvement.

Newborns with eventration may have respiratory distress requiring mechanical ventilation. Rotation of the gastric fundus underneath the elevated diaphragm can cause frequent regurgitation, epigastric pain, or progression to gastric volvulus. In adults, the primary physiological abnormality is a restrictive respiratory defect characterized by moderate hypoxia and decreased vital capacity and expiratory reserve volume. Hoover's sign—the marked outward excursion of the costal margin from the midline on inspiration—is considered to be a sensitive sign of eventration that results from the unopposed action of intercostal muscles.

In adults, the diagnosis of eventration is usually made with posterior-anterior and lateral radiographs. Eventration is distinguished from acquired phrenic nerve disorders by the absence of paradoxical motion during fluoroscopic examination. Computed tomography scans and ultrasonography do not reliably differentiate eventration from a diaphragmatic hernia.

Surgery for diaphragmatic eventration is indicated in newborns and infants who have severe respiratory distress, require prolonged ventilatory support, or fail non-operative management. Adults with disabling respiratory symptoms and a marked restrictive ventilatory defect are also surgical candidates. Asymptomatic adults are managed without surgery.

When surgery is indicated, the diaphragm is usually approached through a posterolateral thoracotomy. When the eventration is bilateral or has an infracardiac component, an abdominal approach is recommended. In both cases, the surgical goal is to immobilize the diaphragm in a flattened position 1 to 2 intercostal spaces inferiorly. Simple plication of the diaphragm involves mobilizing the muscle in a radial direction while creating pleats in the anteromedial and posteromedial direction using full-thickness nonabsorbable horizontal mattress sutures. This approach is favored in children because of its speed and minimal blood loss. An alternative approach is resection of the redundant aponeurotic section of the diaphragm, followed by an overlapping reaproximation of normal muscle. This approach is associated with better functional recovery of the diaphragm. A third alternative uses video-assisted thoracic surgery to plicate the diaphragm through a mini thoracotomy made over the ninth intercostal space. Because this approach is minimally invasive, it can reduce pain and disability and result in shorter hospital stays.

**REFERENCES**


**Submissions**

The Editor welcomes contributions to the Image of the Month. Send manuscripts to Grace S. Rozycki, MD, Department of Surgery, Emory University School of Medicine, 69 Butler St SE, Atlanta, GA 30303; (404) 616-3556; fax (404) 616-7333 (e-mail: grozyck@emory.edu). Articles and photographs accepted will bear the contributor's name. Manuscript criteria and information are per the Instructions for Authors for Archives of Surgery. No abstract is needed, and the manuscript should be no more than 3 typewritten pages. There should be a brief introduction, 1 multiple-choice question with 4 possible answers, and the main text. No more than 2 photographs should be submitted. There is no charge for reproduction and printing of color illustrations.