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Preface **ix**

Gail Darling

Surgical Conditions of the Diaphragm: Anatomy and Physiology **419**

Masaki Anraku and Yaron Shargall

The diaphragm (Greek: dia = in-between, phragma = fence) is a musculoaponeurotic structure that serves as the most important respiratory muscle and the separating structure between the abdominal and thoracic cavities. This article reviews the anatomic components of the diaphragm, its pivotal role in respiration and in the gastroesophageal mechanism, and the surgical implications of the anatomic structuring.

Imaging the Diaphragm **431**

Heidi C. Roberts

This article describes the normal and abnormal position, motion and morphology of the diaphragm, on chest radiography and fluoroscopy, as well as on computed tomography and magnetic resonance imaging.

Surgical Conditions of the Diaphragm: Posterior Diaphragmatic Hernias in Infants **451**

Priscilla P.L. Chiu and Jacob C. Langer

Recent advances in the management of congenital diaphragmatic hernia patients have resulted in a dramatic improvement in overall survival. The widespread use of lung-preserving strategies, such as high-frequency oscillatory ventilation and extracorporeal membrane oxygenation, have provided ventilatory or circulatory support for underlying pulmonary hypoplasia while surgical management has been deferred until medical stabilization has occurred. The increased survival, however, has been accompanied by increased neurological, nutritional, and musculoskeletal morbidities among long-term survivors. This article reviews the diagnosis and management strategies of congenital diaphragmatic hernia and the outcomes of congenital diaphragmatic hernia patients.

Foramen of Morgagni Hernia: Presentation and Treatment **463**

Ahmed Nasr and Annie Fecteau

The article discusses the presentation and treatment of foramen of Morgagni hernia. First, it describes the embryology of the diaphragm along with the incidence of associated anomalies. This is followed by the symptoms, diagnosis, and management. Morgagni hernias are rare and most often asymptomatic; however, there is always a concern about strangulated bowel. Diagnosis is usually by chest radiograph or CT scan. The surgical approach may be either transabdominal or thoracic. Experience is increasing with minimally invasive approaches, which has a low recurrence rate and an excellent prognosis.

Congenital Diaphragmatic Hernia in the Adult 469

Lana Schumacher and Sebastien Gilbert

Congenital diaphragmatic herniae (CDH) are uncommon in neonates and extremely rare in adults. The clinical presentation of CDH in adults tends to be very different from neonates. Many adults remain asymptomatic and CDH are diagnosed incidentally. All CDH should be repaired. Minimally invasive surgical approaches are now gaining popularity for the repair of CDH with excellent outcomes.

Paraesophageal Hernia: Clinical Presentation, Evaluation, and Management Controversies 473

Colin Schieman and Sean C. Grondin

Few topics within thoracic surgery are as controversial as the management of paraesophageal hernias (PEH). In this article, the types of hiatal hernia are classified and the clinical presentation and evaluation of patients with PEH are discussed. Controversies in the management of PEH including the indications for surgery, the different operative approaches, and the role of esophageal shortening are reviewed. Finally, the evidence regarding the need for fundoplication or fixation of the stomach with gastropexy or gastrostomy and the use of prosthetic material in performing the hiatal closure are examined.

Acute Traumatic Diaphragmatic Injury 485

Waël C. Hanna and Lorenzo E. Ferri

Acute diaphragmatic hernia is a result of diaphragmatic injury that accompanies severe blunt or penetrating thoracoabdominal trauma. The incidence, characteristics, and diagnosis of acute diaphragmatic hernia are discussed. Acute traumatic diaphragmatic injuries are treated by surgical reduction of the herniated organs, if present, and closure of the diaphragmatic defect. The various treatment options are discussed. Outcomes of acute diaphragmatic hernia repair are largely dictated by the severity of concomitant injuries, with the Injury Severity Score being the most widely recognized predictor of mortality.

Chronic Traumatic Diaphragmatic Hernia 491

Maurice Blitz and Brian E. Louie

Traumatic diaphragmatic hernia encompasses a spectrum of disease ranging from acute to chronic. Chronic traumatic diaphragmatic hernia is uncommon and associated with significant morbidity and mortality. Multiplanar CT with coronal, sagittal, and axial reconstructions is most effective in making this diagnosis. Once diagnosed, repair should be undertaken. Open transthoracic repair is preferred. Basic hernia repair principles apply including the construction of a tension-free repair, which may necessitate the use of prosthetics.

Acquired Paralysis of the Diaphragm 501

Michael Augustine Ko and Gail Elizabeth Darling

Acquired diaphragmatic paralysis is an uncommon cause of respiratory insufficiency in adults. Symptoms of diaphragmatic paralysis range in severity from mild alterations in exercise capacity to severe, life-threatening illness. For well-selected patients, diaphragmatic plication is indicated for symptomatic relief. Plication may be performed via standard thoracotomy or by video-assisted techniques.

- Diaphragmatic Eventration** 511
Shawn S. Groth and Rafael S. Andrade
- Diaphragmatic eventration is defined as thinning of the diaphragm secondary to a congenital deficiency in diaphragmatic muscle structure. Clinically, diaphragmatic eventration can be impossible to differentiate from acquired paralysis. Diaphragmatic plication is indicated for symptomatic patients and leads to significant improvement in symptoms, quality of life, and pulmonary function tests.
- Tumors of the Diaphragm** 521
Min Peter Kim and Wayne L. Hofstetter
- Primary tumors of the diaphragm are very rare. Benign tumors of the diaphragm are resected if symptomatic or if there is concern for malignancy. Malignant tumors are either primary, metastatic, or the result of direct extension to the diaphragm from adjacent malignancy. Malignant tumors are treated based on histology and response to chemotherapy, with surgical resection performed when feasible.
- Reconstructive Techniques After Diaphragm Resection** 531
David J. Finley, Nadeem R. Abu-Rustum, Dennis S. Chi, and Raja Flores
- Diaphragm resection requires complete reconstruction to avoid respiratory compromise or herniation of abdominal contents into the chest. Primary reconstruction of the diaphragm is often possible, even with a large defect, as long as the tissue can come together without excessive tension. Larger defects or complete diaphragm resections necessitate reconstruction with synthetic material or autologous tissue. These reconstructions can be accomplished safely and effectively by following specific surgical tenets, and require an in-depth knowledge of the diaphragm's anatomy, innervation, blood supply, and adjacent organs.
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