ELSEVIER

Seminars in
ULTRASOUND
CT and MRI

Multidetector Computed Tomography of Pharyngo-Esophageal Perforations

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Perforation of the esophagus remains a diagnostic and therapeutic challenge. Currently, the most common cause of perforation is instrumentation of the esophagus, but other conditions such as foreign body, trauma, or spontaneous rupture are possible entities in the clinical practice. Multidetector computed tomography has become the imaging technique of choice in the evaluation of this setting of patients because of its capability to depict all the different signs associated with the degrees of wall impairment. By being aware of the appearance of the various entities that affect the esophagus, the radiologist can play an important role in detecting and staging esophageal injuries.
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Introduction

Pharyngo-esophageal injuries are not infrequent entity often associated to wall perforation with a consequent high-mortality rate.[1] Perforation can be a result of a large variety of wall stress, which can lead to significant increase of the lumen pressure or direct impairment of the pharynx or esophagus wall.

Early and accurate diagnosis of trauma is critical to avoid devastating consequences of wall perforation such as mediastinitis or septic shock; delay in treatment beyond 24 hours adversely affects the prognosis, transforming a possible self-limiting condition to a life-threatening condition.[2]

The first diagnostic tool in this setting of patients is still often direct radiography, with oral contrast use sometimes, but the large availability nowadays, in emergency conditions, of multidetector computed tomography (MDCT) has made this robust tool the first-choice imaging method in most parts of patients presenting with a suspected injury of the upper digestive tract.[3]

Correct and ready diagnosis of the clinical scenario by imaging is fundamental in the choice of the most appropriate management approach varying from conservative treatment to the surgical approach but most frequently using endoscopic strategies.[4]

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Anatomical Considerations

The pharynx is anatomically divided into the oropharynx and hypopharynx by the pharyngo-epiglottic fold. Therefore, either the base of the free margin of the epiglottis or the hyoid bone is used as a proxy landmark to delineate this boundary.[5] The hypopharynx lies posterior and lateral to the laryngeal cartilages.

The hypopharynx consists of the piriform sinuses, the posterior pharyngeal wall, and the postcricoid region anteriorly. The lateral walls of the piriform sinuses are the lateral margins of the hypopharynx. The cricoid cartilage compresses the anterior hypopharyngeal wall and divides the piriform sinuses inferiorly.

The esophagus is 23-37 cm long with a diameter of 1-2 cm and is divided into 3 parts:

- *cervical*—continuous with the oropharynx and commences at the lower border of cricoid cartilage (at level of C5/6) or cricopharyngeus muscle,
- *thoracic*—from thoracic aperture (T1) to the esophageal hiatus (T11), and
- *abdominal*—from esophageal hiatus and is continuous with the cardia of the stomach at the gastroesophageal junction.

It courses inferiorly to the left of the midline in the neck and superior mediastinum, returning to the midline at T5 before coursing to the left again of the midline in the posterior

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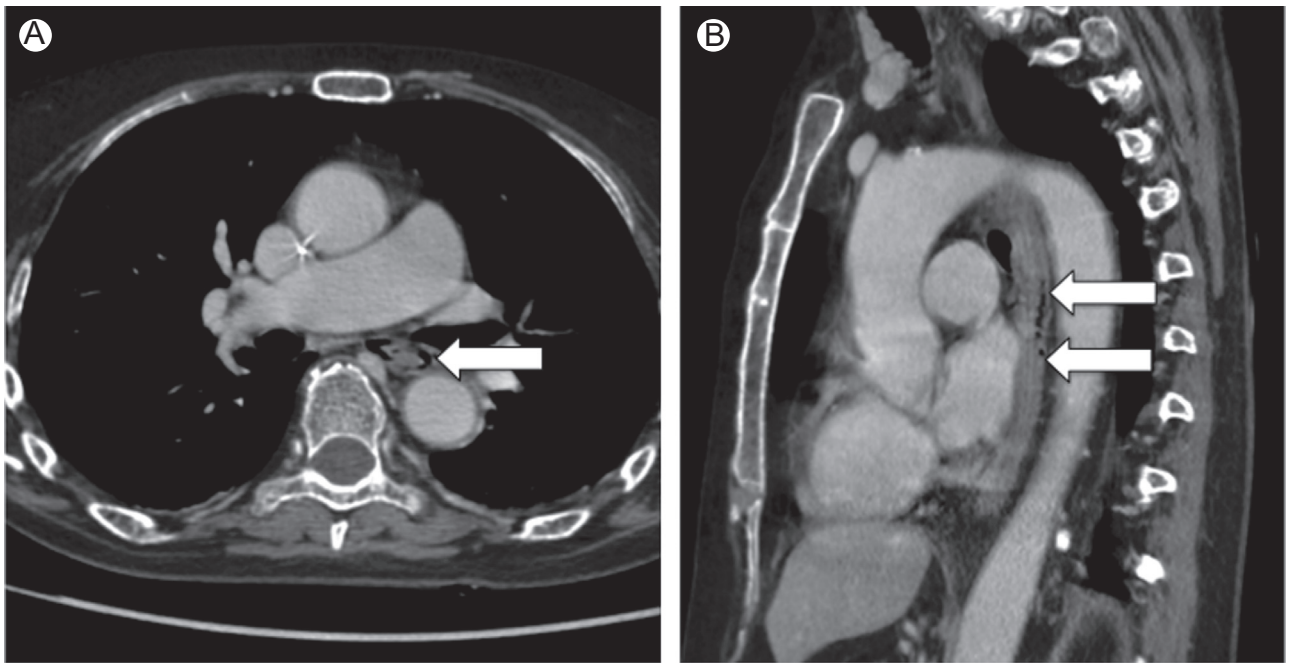

Figure 1 Patient presenting with lower chest pain and vomiting 1 day after gastroscopy procedure. Axial (A) and sagittal (B) images show the presence of air bubbles collection (arrows) within the esophageal wall, as a consequence of mucosal dissection without transmural damage.

mediastinum, and in its inferior aspect curving anteriorly to pass through the diaphragm into the abdominal cavity, and its relations with other mediastinal structures contribute directly to generate radiological lines and stripes, often fundamental for thoracic pathology recognition.[6]

There are 3 normal esophageal constrictions that should not be confused for pathologic constrictions and which, because of the narrowed lumen, can be more prone to an injury mechanism:

- *cervical constriction*—because of cricoid cartilage at the level of C5/6,
- *thoracic constriction*—because of aortic arch at the level of T4/5, and
- *abdominal constriction*—because of esophageal hiatus at T10/11.

MDCT Acquisition Protocol

Computed tomography (CT) of the chest, especially in the era of MDCT technology, has become a common imaging modality because of its availability in almost all emergency centers, because the scan times have markedly decreased, and because it is easy to use.[7] The superiority of CT over direct radiography in the assessment of injuries in the prime digestive tract relies on its ability to depict occult injuries otherwise not clearly detectable in neck and chest radiographs, such as parietal hematoma, periesophageal air bubbles, pneumothorax, or hemopericardium.

At the authors' institution, 64 MDCT imaging is available. CT protocol parameters currently in use are described in brief: a collimation of 64 Å ~0.6 mm at 120 kV is operated and a reference mAs of 220 on the 64-slice scanner; 100-mL intravenous contrast is injected for CT angiographic assessment of the neck and a 50-mL normal saline "chaser" following the intravenous contrast injection. A contrast injection rate of 3-5 mL per second through (at smallest) a 19-G venous cannula is used. Bolus tracking from the arch of the aorta is routinely operated with a delay of 7 seconds after triggering of contrast injection (initiated at 100 Hounsfield units).

Liberal use of multiplanar reformats, always in correlation with the axial source data set images, is advised. Appropriate window-level and window-width settings for the different anatomical regions (eg, the osseous cervical spine and skull base) should also be used.

Perforation Mechanism and Dynamics

Esophageal perforation is a life-threatening condition; even with early diagnosis, mortality remains high.[8]

The Mackler classic triad of signs and symptoms (vomiting, lower thoracic pain, and emphysema) is useful to rapidly hypothesize the presence of perforation. Many patients, however, present with less specific symptoms such as severe respiratory distress, thoracic pain, hypotension, or shock. Perforation when it is not readily assessed becomes a life-threatening condition that may rapidly progress to acute mediastinitis and septic shock.[9]

In a retrospective evaluation of a large series of patients,[10] esophageal perforation was related to iatrogenic injuries in 55% of cases, spontaneous in 15%, to foreign bodies or caustic materials ingestion in 14%, and traumatic in 10%.

In most cases the site of perforation is the thoracic esophagus (50%-55%), and distal esophagus is perforated with a lower