Multimodality Imaging of Complex Esophageal Injuries

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Objectives

• Discuss multi-modality imaging (barium upper GI study, CT, MR and US) of esophageal injuries in the setting of trauma, foreign body aspiration, following various surgeries like hiatal hernia repair, resection of benign and malignant esophageal neoplasms, endoscopy, and other cervical and thoracic surgeries.

• Provide institutional imaging protocols and algorithm for management of patients with suspected early or delayed esophageal injuries.

• Case based scenarios will be used to highlight protocols in specific situations to best assess extent of injury and complications.

• Discuss role of radiology in assessment of complications like hematomas, pseudoaneuysms, mediastinitis, mediastinal abscess and fistulas.

What makes the esophagus prone to injuries?

• Proximity to other cervical & intra-thoracic organs (thyroid, trachea, aorta, spine)

• Diseases & surgery involving these organs can involve esophagus secondarily

• Lack of adventitia, relatively poor vascular supply makes esophagus more to injury and pressure necrosis

Esophageal injury classification: Mechanism

Extra-luminal injury

• Blunt or penetrating trauma (cervical or thoracic esophagus)
• Surgery involving adjacent organs (thyroidectomy, cervical diskectomy, aortic stent graft placement)

Intra-luminal injury

• Instrumentation
• Foreign body impaction
• Baro-trauma
• Erosive esophagitis

Esophageal injury classification: Depth of injury

Non Transmural esophageal injuries: more common

• Linear mucosal tear (Mallory Weiss tears)

Submucosal dissection / intramural hematoma

• Mucosal laceration with outpouching / diverticula

Transmural esophageal injuries (Boerhaave’s Syndrome)
Free extravasation into mediastinum, pleura & subphrenic space

No disclosures

• Rachna Madan
Suspected esophageal trauma: Imaging protocol

- Suspected perforation – esophagogram with water soluble contrast
- Negative esophagogram study – repeat esophagogram with barium
- CT used to complement esophagogram as needed
- Penetrating trauma with suspected vascular injury – first CT study with IV contrast to rule out vascular injury; then repeat CT with oral contrast
- Non-cooperative patient – CT preferred first investigation

Algorithm: management of esophageal perforation

- Main factors:
  - Type (Non Transmural or transmural): mucosal lacerations managed conservatively; acute free uncontained transmural intra-thoracic perforation is a surgical emergency with risk of mediastinitis & abscess
  - Location (Cervical, thoracic, GE junction)
  - Severity of esophageal disease (diseased – inflammation, infection or healthy)
  - Size of perforation (small contained or large free)

Acute esophageal trauma: Imaging findings

- Chest radiographs:
  - Pneumomediastinum, subcutaneous emphysema, pleural effusions
- Esophagogram:
  - Use water soluble contrast or thin barium
  - Delineates site of perforation
- CT (with oral and/or IV contrast):
  - Esophageal wall thickening, periesophageal gas and fluid collections, contrast material extravasation
  - Determine the site and degree of containment of perforation (to plan for surgical or non surgical intervention)
  - Assess complications such as aortoesophageal or esophagorespiratory fistulas

Submucosal Dissection / Intramural Hematoma

- Symptoms: abrupt onset retrosternal chest pain, dysphagia, hematemesis
- Cross sectional imaging preferred over endoscopic US to avoid risk of esophageal perforation
  - CT with oral contrast/ esophagogram: Double-barrelled appearance, mucosal flap with submucosal gas or contrast material. Dissection & hematoma mostly posterior to true lumen of esophagus
  - CT or MR with IV Contrast: non-enhancing, eccentric, well-defined, intramural esophageal mass with density of blood. Defines extent of dissection and hematoma
  - CT & MR exclude conditions mimicking esophageal hematoma, including masses with hemorrhage, aortic dissection, and pulmonary embolism
- Management – conservative, NPO, correct coagulation abnormalities, acid suppression

Submucosal Dissection / Intramural Hematoma

- Sagittal non contrast CT cervical spine and sagittal MR (T2 and STIR) images shows the extension of intramural esophageal and posterior mediastinal hematoma into the retropharyngeal space of neck. A dark flap separates the true and false lumen containing blood
- Presence of flap suggests intramural hematoma rather than hemorrhage in an underlying mass
- History: Fall from bicycle, delayed difficulty in breathing, swallowing and aspiration.
- CT: Hyperdense posterior mediastinal mass inseparable from posterior wall of esophagus. Marked displacement of esophagus and airway anteriorly. Also note diffuse stranding of mediastinal fat.
- Findings suggest intramural esophageal hematoma but hemorrhage in an underlying mass like duplication cyst, leiomyoma or lymphoma is also in the differential.
High pressure penetrating injury from water gun

- History: Self-inflicted wound with high pressure water gun pointing into oropharynx.
- Contrast CT: Focal dissection in the right posterior oropharynx (red arrows) and air dissecting along pre-vertebral space down to mediastinum. No arterial or vascular injury seen and the airway is patent.
- Direct inspection: A 1cm gaping mucosal injury at the junction of right anterior tonsil pillar to soft palate.
- IV contrast use is essential in these high pressure injuries to rule out vascular injuries.
- Imaging follow up needed to assess for delayed vascular injuries and mediastinitis.

Iatrogenic Esophageal Injuries

- Etiology: Following therapeutic endoscopic procedures, esophageal surgeries and surgical procedures involving adjacent cervical and thoracic structures.
- Esophageal stricture dilation & stent placement – most common.
- Gastric fundoplication, esophageal myotomy.
- Thyroidectomy, anterior cervical dissection.
- Trans-esophageal ECHO.
- Pulmonary vein ablation for atrial fibrillation.
- Pneumonectomy followed by esophagopleural fistula.

Iatrogenic injury: Anterior cervical disectomy

History: Cervical disk fusion followed by development of air filled collection in neck.
A: Soft tissue thickening in prevertebral soft tissues inseparable from the esophagus.
B: Persistent air filled collection in the neck.
C: Cervical hardware bulges anteriorly into the esophagus.

Barium esophagogram confirms esophageal injury and esophagocutaneous fistula, also seen on subsequent endoscopy.
Subsequent attempted repair of the esophageal perforation with sternocleidomastoid muscle flap (green arrows) with residual post operative air.

Iatrogenic injury: Atrio-esophageal fistula post trans-catheter ablation for atrial fibrillation

- Rare, potentially fatal complication of catheter radiofrequency ablation.
- Difficult clinical diagnosis: variable onset (2 - 41 days) & presentation (fever, neurological deficits and polymicrobial bacteremia) leads to infectious disease consults & cases are misdiagnosed as endocarditis if procedure history unavailable.
- May need multiple CT scans if initial scan negative and patient continues to be symptomatic.
- Treatment: Antibiotics + surgical treatment of fistula.
- Strategies to decrease incidence of atrio-esophageal fistula: Define esophageal – left atrium relationship on an electroanatomic reconstruction and CT scan. Mobility of the esophagus, however, cannot be monitored by this approach.

Iatrogenic injury: Atrio-esophageal fistula post trans-catheter ablation for atrial fibrillation

- History: Percutaneous trans-catheter ablation for atrial fibrillation.
- CT: Abnormal air foci in left atrium, pulmonary veins and left atrial appendage. Pneumomediastinum may also be seen in some cases indicating esophageal injury.
- Proximity of the esophageal wall to the area ablated in the heart may result in transectional injury of esophagus and formation of atrio-esophageal fistula.

Case courtesy Dr.Amita Sharma, MGH.
Iatrogenic injury: Trans-esophageal ECHO

- History: Recent CABG and AVR; increased left chest tube output concerning for esophageal leak
- Esophagram: Free extravasation of oral contrast from distal esophagus into left pleural space.
- Trans-esophageal ECHO used to assess cardiac function during AVR and CABG likely cause of esophageal perforation (ultrasonic thermal injury, ischemia during bypass, probe pressure).

Iatrogenic injury: Trans-esophageal ECHO

- Sites of injury: Hypopharyngeal perforation, distal esophageal injury
- Types of injury: Mallory-Weiss tear at GE junction, erosions in the cardia, transmural perforation
- Etiopathogenesis: Contact pressure by the ECHO probe, ultrasonic thermal injury, ischemia due to cardiopulmonary bypass.
- When not actively imaging, the ECHO probe should be withdrawn and not left in the esophagus; acoustic power should be shut off.

Iatrogenic injury: Esophagopericardial fistula following esophageal stent placement

- History: Partial esophagectomy & esophagogastric anastomosis for esophageal carcinoma.
- Pre stent CT: CT for evaluation of increasing dysphagia shows dilated esophagus with air and fluid level proximal to anastomosis (yellow arrows).
- Post stent CT: Esophageal stent (green arrow) placed across malignant stricture. New moderate hypopneumopericardium, enhancing pericardium suggestive of pericarditis & tamponade due to esophagopericardial fistula following stent placement. E. coli aspirated from pericardial fluid.

Iatrogenic injury: Aorto-esophageal fistula following aortic stent graft surgery for Type B dissection

- History: Type B aortic dissection requiring open repair with dacron graft, subsequent severe hematemesis & hematochezia and loss of consciousness. EGD showed proximal aortoesophageal fistula "bleeding blood" at 28 cm from incisors.
- Post op CT: Emergent repair of aortoesophageal fistula with metal stent (yellow arrows) and patch repair with omentum (biologic mesh, red arrows). Air collection due to combination of esophageal fistula and surgery (green arrows).

Post operative injury: Diverticulum formation

- History: A 22 year old male status post recent enucleation of esophageal leiomyoma.
- Pre-op CT: Homogeneously enhancing blbcded mass in the upper thoracic esophagus consistent with leiomyoma (red arrows).
- Post-op CT: The esophagus is patent and dilated following enucleation of mass; medial contained contrast filled out pouching (green arrow) has the shape of a diverticulum and is an acceptable post surgical appearance. Differential diagnosis also includes focal esophageal leak and mediastinal collection following surgery and hence is closely followed with imaging.

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Esophageal foreign body impaction

- Pain, dysphagia, regurgitation
- Most common foreign bodies (coins, bones, meat bolus – steakhouse syndrome)
- Sharp or pointed foreign bodies, button batteries, and objects that cause obstruction require emergent removal
- Vinyl gloves, tend to harden, and should be removed surgically rather than endoscopically
- Imaging protocol: conventional radiography of the neck, chest, and abdomen. Barium studies discouraged as they hinder subsequent attempts at endoscopic examination and retrieval
- CT scan is important in diagnosing complications related to esophageal foreign bodies, such as
  - Esophageal perforation
  - Mediastinal or retroperitoneal abscess
  - Tracheoesophageal or aortoesophageal fistula

Esophageal food bolus impaction (Steakhouse syndrome)

- History: 57-yr-old male with cerebral palsy choked while eating steak, presents with mid-back pain, hypotension and tachycardia.
- CXR: Pneumomediastinum and pneumoperitoneum

Esophageal food bolus impaction (Steakhouse syndrome)

- Large amount of pneumomediastinum indicates transmural perforation
- Transmural perforation usually requires open esophageal surgery and repair
- Thickening of esophageal wall due to hematoma or esophagitis indicates site of injury (likely distal thoracic esophagus / GE junction in this case – green arrows)
- Aspirated oral contrast (red arrows) in lung bases due to associated dysphagia and odynophagia

Management and post operative complication following open repair of esophageal perforation

- Surgery: Resection of distal esophagus, esophageal exclusion, gastrostomy, & feeding jejunostomy tube placement. A 3 cm tear seen 3 cm above GE junction at 3 o’clock position.
- Imaging: Large posterior mediastinal collection with gas adjacent to site of esophageal repair and thick walled perigastric collection with complex fluid and air indicate formation of intrathoracic and abdominal abscesses following repair of esophageal perforation.
- Large sentinel air collection or persistent focal fluid collection several days after surgery indicates abscess with / without underlying leak. A water soluble esophagogram should be considered.

Esophageal foreign body: Bristle scrub brush

- History: Ingestion of large piece of steak and sharp knife-like sensation in the left side of neck. Presented one week later with neck swelling for US evaluation.
- US shows a linear foreign body (similar to pin or toothpick) extending from the lumen of the cervical esophagus into the peri-esophageal tissues posterolateral to the left lobe of the thyroid with associated soft tissue reaction.
- Transversely oriented linear dense foreign body embedded in the soft tissues extending from left posterolateral margin of cervical esophagus to posterior aspect of left lobe of thyroid at the C6/C7 level.

Esophageal foreign body: Bristle scrub brush

- Linear radiopaque foreign body projects over C6-C7. No contrast leak seen with gastrograffin.
- Treatment: Left neck exploration with removal of foreign body which was seen extending from the wall of the cervical esophagus into adjacent peri-esophageal soft tissues.
- Foreign body: Bristle from a grill scrub brush
Chronic injury: Esophagomediastinal fistula

- History: A 52-year-old man with one month of malaise, fevers, weight loss and recent back pain.
- CT: Amorphous air collection in subcarinal region close to esophagus and large caudal thick walled lesion in right lower lobe. Sequelae of prior granulomatous disease with calcified mediastinal nodes. Findings suggest esophageal mediastinum-bronchial fistula and lung abscess.
- Esophagogram: Focal contained extraluminal contrast extravasation at level of carina. Perforation diverticula or fistula
- Differential diagnosis: infection (TB, Histoplasmosis) and malignancy. Patient placed in negative pressure room.

Chronic injury: Esophagomediastinal “fistula”: Histoplasmosis

- Endoscopy: Chronic epithelialized “fistula” / diverticula 3 cm from incisors; no connection with bronchial tree. No mass seen. Biopsy consistent with Histoplasmosis.
- Fully covered nitinol 120 x 22 mm Allimax Merit soft esophageal stent placed under direct vision on endoscopy to maintain esophageal patency and occlude the “fistula”. Antifungal treatment started.
- Follow up CT: Resolution of right lower lobe consolidation and contained esophageal perforation / diverticular outpouching is no longer evident (green arrows).

Chronic injury: Long standing dysphagia and history of marijuana use

- History: A 41-year-old man, 15 year history of progressive dysphagia & prior marijuana use
- Esophagogram: Long segment narrowing mid and distal esophagus with proximal dilation
- 18 FDG PET/CT: Moderate - Intense FDG uptake involving mid & lower thoracic esophagus
- MRI (T2Weighted image): Fluid filled dilated esophagus with surrounding abnormal thickening

Chronic injury: Para-esophageal abscess and micro-perforations due to marijuana use

- History: 41-year-old male, 15 year history of progressive dysphagia & prior history of marijuana use
- Coronal section through distal esophagus and stomach; a para-esophageal abscess (yellow arrows) causes distal narrowing and stricture of distal esophagus (white arrows)
- Para-esophageal abscess (9.5cm) containing foreign plant material (red arrows) most likely marijuana suggests underlying esophageal micro-perforation

Summary

- Radiologic manifestations of complications associated with complex spontaneous, traumatic and post surgical esophageal injuries have been reviewed
- Knowledge of the imaging appearances helps in early detection and interdisciplinary management of these patients
- Clinico-radiologic manifestations of esophageal injuries runs a wide spectrum depending on acuity of onset, depth and location of injury and associated surgical procedure / presence of esophageal disease
- Various imaging protocols are discussed to provide prompt diagnosis in different clinical scenarios
- Appropriate and early diagnosis avoids morbidity from unnecessary invasive investigations or treatments

References