Esophageal Perforation

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Objectives: At the completion of this module, fellows will be able to:

1. **Describe the diagnostic tests to confirm an esophageal perforation**
2. **Know the key principles of management for an esophageal perforation**
3. **Describe the non-operative and operative management for treatment of an esophageal perforation**
4. **Discern the optimal treatment option based on timing of patient presentation, co-morbidities and peri-operative considerations.**

Background

- In trauma, esophageal perforation is a rare injury, and more commonly occurs following penetrating mechanisms.
  - The majority will have an associated injury.
  - Cervical esophageal injuries are more common than thoracic injuries.
- Other scenarios causing esophageal perforation include barotrauma (which classically involves the GE junction), foreign body ingestion, and caustic injury.
  - Boerhaave's syndrome or spontaneous esophageal rupture is esophageal perforation as the result of barotrauma.
  - Commonly described in setting of binge drinking and vomiting, Mackler's triad is substernal chest pain associated with vomiting and subcutaneous emphysema as the result of esophageal perforation.
- Other important causes of esophageal perforation include iatrogenic injury caused by esophagoscopy or esophageal dilation associated with malignancy, inflammation, and infection.
  - Instrumentation is now the most common cause of esophageal perforation.
- Mortality is high if not treated early.
  - With early identification and repair, mortality is 10%.
  - Delayed repairs (> 24 hours) have mortality rates above 20%.
- Early primary repair with wide mediastinal drainage appears to have best outcomes but preliminary reports of stent-grafting do show promise.

Evaluation/Diagnostics

- Patient signs and symptoms may reveal dysphagia, chest pain (acute or subacute), epigastric pain, back pain or fever.
  - Specifically ask the patient if they have any history of esophageal instrumentation or recent forceful vomiting.
- Physical exam may reveal signs and symptoms of a pneumothorax and/or pneumomediastinum with subcutaneous emphysema.
  - Chest tube output consistent with saliva or food particles is diagnostic
  - "Hammon's sign" is a systolic crunching sound heard best over the left sternal border.
  - Most often signs and symptoms are vague, which can delay diagnosis.
  - High index of suspicion is imperative.
- Lateral neck radiograph may reveal air in the prevertebral fascial planes if injury is cervical.

- Chest radiograph can demonstrate:
  - Hydrothorax or pleural effusions.
  - Pneumomediastinum or pneumothorax.
  - Right sided effusions suggest mid-thoracic esophageal involvement, whereas left-sided effusions indicate distal esophagus.
  - Findings on plain films can take several hours to be evident.
- Contrast esophagography and/or chest computed tomography (CT) with water-soluble contrast are the studies of choice.
  - Thin-barium can demonstrate extravasation that Gastrograffin cannot; if there is a high index of suspicion with a negative water-soluble contrast esophagography exam, one should consider imaging with thin-barium or proceed with CT scanning.
- Esophagoscopy can provide direct visualization and is highly sensitive
  - Intraoperative esophagoscopy can identify the exact location of injury and assess for leak after repair.

Management

- Following identification of an injury, key management principles include source control, adequate drainage, broad-spectrum antibiotic therapy and nutrition support.
  - Gastric acid suppression should be considered.
  - Broad-spectrum antibiotics should cover aerobes and anaerobes with a defined course once source control is achieved.
  - Fungal coverage may be indicated in patients with immunosuppression, prolonged hospitalization, or those with poor response to the current antibiotic regimen.
- Non-Operative Management:
  - May be considered in patients with a contained perforation and no signs of sepsis.
  - Associated malignancy or obstructive pathology often negate this as a reasonable option.
  - Is typically considered in the setting of iatrogenic or spontaneous perforations; experience with this approach is lacking in traumatic perforations.
- Endoscopic stenting and/or clipping has emerged as an option.
  - The majority of experience is in iatrogenic or spontaneous perforations.
  - Dependent upon local expertise.
  - Adequate drainage and enteral nutrition is still recommended.
- Operative Indications:
  - Free perforation - principles of surgery are based on location and timing.

Operative Technique

- Approach is based upon the location of injury:
  - Cervical injury
    - Left neck incision anterior to sternocleidomastoid
    - Blunt dissection in prevertebral space
    - Be careful to avoid the recurrent laryngeal nerve
    - Primary repair and/or placement of drains

        - A muscle flap should be placed between the esophagus and trachea when combined injuries are identified.
    - Thoracic injury
        - Right posterolateral thoracotomy (5^{th} or 6^{th} intercostal space) for upper esophageal injuries.
        - Left posterolateral thoracotomy (6^{th} or 7^{th} intercostal space) for lower esophageal injuries.
        - Anterolateral thoracotomy is appropriate in the unstable patient
        - Open parietal pleura and mediastinum widely
        - Ample irrigation
        - Longitudinal myotomy and exploration of mucosal defect
        - Debridement of necrotic esophageal tissue
        - 2-layered repair: mucosa and submucosa approximation and muscular layer approximation
        - Reinforcement of repair with vascularized autogenous tissue
            - Pleural flap, diaphragmatic pedicle, omentum onlay, intercostal flap
    - Esophagogastric junction
        - Left thoracotomy or upper midline laparotomy
        - The lower esophagus is approached from a left thoracotomy

Intraoperative Considerations

- Assess for distal obstruction by endoscopy or palpation.
- Options for patients with a delayed presentation or in those you are unable to reconstruct
    - T-tube placement: should be placed distal to the perforation with the long arm directed to stomach and short arm above the injury
    - Esophageal exclusion and diversion: this is a morbid procedure and should only be considered as a last option.
    - Esophageal resection with immediate or delayed reconstruction.
- Placement of enteral access is imperative.
- NG placement under direct vision in the operating room.
- Locating the defect can be sometimes difficult if the patient presents greater than 24 hours after the injury. If the defect cannot be located place multiple large drains and or chest tubes to make sure that the area is drained.

Postoperative Management and Potential Complications

- Contrast esophagoscopy to evaluate the esophageal repair is typically performed 3-7 days post-operatively.
    - Withhold oral intake until the contrast study demonstrates an intact repair
- Anastomotic leak/fistulas and ongoing sepsis is the feared complication.
    - Missed or delayed diagnosis of these operative sequelae is associated with an increase in mortality.
- Continuous suction from thoracostomy tubes can sometimes compromise repair; place on water seal expeditiously

- Post-discharge complications include esophageal strictures at the repair site and tracheoesophageal fistulas.

Long-Term Outcomes

- No real long term studies on outcome; may depends largely on etiology of the esophageal perforation (i.e. iatrogenic vs malignancy-associated)
- Patients with rupture after Boerhaave's
    - May have esophageal dysmotility and gastroesophageal reflux long-term
    - Follow up with endoscopy may be necessary

Special Circumstances

1. Esophageal cancer: primary or delayed esophagectomy may be more appropriate in the setting of perforation; stenting has also been employed
2. Achalasia: myotomy with fundoplication to buttress repair; the use of stents has been reported
3. Caustic injury: these patients have an increased risk of esophageal cancer in their lifetime, and many will develop strictures long term. Elective esophagectomy may be required.
4. Gastroesophageal reflux: Similar to achalasia, fundoplication should be considered at the time of repair.

Pearls from the Experts: Drs. Kenneth L. Mattox and David Feliciano

- No one evaluative test or workup is consistently diagnostic.
- If an esophageal injury is present, the surgeon would much rather deal with the injury than the complications of a missed esophageal injury.
- A barium esophagogram is more diagnostic than one done with a water soluble material.
- Aspirated barium contrast material is better tolerated than aspirated water soluble material, which can cause chemical pneumonitis (avoid Gastrograffin esophagograms).
- For a severely injured esophagus, consider esophagectomy.
- ALWAYS avoid exclusion of an esophageal injury .
- Prepare an intercostal muscle flap during the initial lateral thoracotomy to be available to wrap the repaired esophageal injury.
- If posterior thoracic esophageal injury is discovered while working through an anterior thoracic incision, close the anterior incision, and approach the posterior injury through a posterior thoracotomy incision.
- A presumptive diagnosis of a traumatic esophageal perforation without further imaging can be made based on a combination of air in the lateral neck and prevertebral spaces and a positive "sip test" – i.e., odynophagia while swallowing a cup of water.
- Suspicion of an esophageal injury on a cervical or thoracic CT (track of stab or gunshot wound immediately adjacent, irregular wall without extravasation, significant amount of local air) should be followed by a CT esophagogram with Gastrograffin.

- A positive contrast study eliminates the need for flexible endoscopy, unless there is a suspicion of a tracheobronchial injury.
- Nonoperative management of hypopharyngeal injuries with antibiotics remains the standard of care. Signs of local infection mandate drainage.
- Ideal positioning for a cervical operation involves a transverse sheet roll under the shoulders (hyperextension opens Zone II) and elevation of the head of the bed to 30-45° (brings operative field closer to surgeon).
- An emergent operation after a gunshot wound to the left chest inferior to the nipple level and in proximity to the posterior mediastinum should be performed with the patient on a beanbag with the left side elevated 30-45°.
- An open operation to repair a diagnosed perforation of the thoracic esophagus above the nipple level without an associated vascular injury in the mediastinum should be performed with the patient on a beanbag with the right side elevated 45-90°.
- VATS to repair a diagnosed perforation of the thoracic esophagus in a patient without an associated vascular injury in the mediastinum depends on local expertise.
- Insertion of an esophageal stent for a traumatic perforation would be appropriate in a patient with multiple extrathoracic injuries and physiologic exhaustion or early onset organ failure, but short-and long-term data in injured patients are lacking.
- To localize an occult perforation of the cervical esophagus at operation, compress the distal esophagus at the thoracic inlet, place a nasogastric tube in the proximal pouch, and instill 30-50mL of methylene blue dye in saline (one ampule in 200 mL).
- To visualize the complete extent of a perforation or rupture in the mucosa, split the muscularis layer if a 2-layer repair is to be performed.
- Repair of a longitudinal defect may cause significant narrowing, and it is worthwhile to place a Maloney dilator in the esophagus as the repair is performed.
- If a feeding tube is to be passed, this should be done before the esophageal repair is performed so that passage doesn't disrupt the repair.
- Muscle buttresses over cervical repairs are not routinely added, but are *always* indicated with combined injuries (trachea-esophagus, trachea-carotid artery, esophagus-carotid artery) to separate suture lines and decrease leaks.
- The blood supply to the cervical strap muscles is not robust, particularly with division and rotation. The best cervical buttress is the sternal head of the sternocleidomastoid muscle or the entire inferiorly detached sternocleidomastoid muscle. Each can be used to cover and/or separate most repairs in Zone II.
- Retraction of the sternal head after division from the sternum or the detached sternocleidomastoid muscle will preclude its use as a buttress at the junction of Zones I and II.
- A variety of thoracic buttresses have been described (rhomboid muscle, intercostal muscle, latissimus dorsi muscle, omental onlay, pericardial fat pad). The 3-sided pleural advancement flap is the easiest to create, but is simply a "serosal" cover.
- Buttresses available for the rare injury to the intra-abdominal esophagus include a partial fundoplication or a 3-sided diaphragm advancement flap.
- A large perforation of the cervical esophagus should *not* be managed by division and creation of an end cervical esophagostomy. Rather, a #1 absorbable suture should be tied around the esophagus distal to the tie. Then, the edges of the perforation are sewn to the

skin edges of the inferior part of the oblique cervical incision creating a temporary "end" blowhole esophagostomy.

- Another option would be to mobilize the entire cervical esophagus, visualize and protect the recurrent laryngeal nerves, and elevate the perforation over a red rubber rod creating a temporary "loop esophagostomy".
- A large perforation of the thoracic esophagus, particularly with surrounding mediastinitis, is managed with primary repair/muscle buttress versus the insertion of a man-made large "T-tube" (Abbott-Mansour) creating a controlled esophagocutaneous fistula.
- Cervical drains should be directed anteriorly and never contact or cross over the carotid sheath.
- Thoracostomy tubes serve as drains once the posterior mediastinum is open.
- Feeding the patient grape juice 3 days after a routine repair of the cervical esophagus is a "poor man's" esophagogram. The absence of the grape juice in the cervical drain prompts removal and discharge of the patient.
- A leak from a repair of the cervical esophagus (foul drainage or failed "grape juice test") is treated with continued drainage, NPO status, initiation of antibiotics and continuation of tube feedings or initiation of total parenteral nutrition. Evidence of a local infected fluid collection or cervical abscess (physical examination/ultrasound) prompts open drainage.
- A normal esophagogram 7 days after repair of the thoracic esophagus prompts removal of thoracostomy tubes and discharge of the patient.
- A leak from a repair of the thoracic esophagus on a contrast study is treated with continued drainage with thoracostomy tubes, NPO status, initiation of antibiotics, and continuation of tube feedings or initiation of total parenteral nutrition. A repeat contrast esophagogram is performed 7 days later. A persistent leak prompts consideration of inserting an esophageal stent.

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