The Postesophagectomy Chest

Jared D. Christensen, MD

Objectives

- Develop an understanding of esophagectomy surgical technique and anatomic considerations
- Recognize common postoperative complications and patterns of recurrence

Introduction

- Carcinoma of the esophagus:
  - 3rd most common GI malignancy
  - 6th leading cause of cancer deaths worldwide
- ~ 15,500 new cases in the U.S. in 2007, with nearly the same amount of deaths
- 5 year survival is < 15%, as most patients present with advanced disease

Introduction

- Imaging interpretation of the post-esophagectomy chest can be challenging due to:
  - Altered normal anatomic landmarks
  - Variable surgical techniques
  - Difficulty in distinguishing postsurgical changes from disease recurrence

Introduction

- Notwithstanding, interpretation may be facilitated by familiarity with:
  - Post-esophagectomy anatomy
  - Strengths and limitations of routine imaging modalities
  - Common postoperative complications
  - Patterns of disease recurrence

Esophagectomy Surgical Technique

Jared D. Christensen, M.D.
An understanding of post-esophagectomy anatomic changes is crucial for accurate diagnosis of complications and disease recurrence.

Postoperative anatomy is largely determined by surgical technique.
**Esophagectomy**

- Laparoscopic:
  - Tumor in any portion of the thoracic esophagus
  - Requires thoracic, abdominal, and neck incisions
  - Thoracic or cervical anastomosis
  - Limited 2-field node dissection

**Esophagectomy**

- Esophageal lymphatic drainage is complex with multiple interconnected channels
- Locoregional nodal involvement is common at the time of diagnosis
- Most common stage at presentation is T3N1

**Esophagectomy: Node Dissection**

- 2-Field Node Dissection:
  - Abdominal
  - Thoracic
- 3-Field Node Dissection:
  - Abdominal
  - Thoracic
  - Cervical

**Esophagectomy**

- Sites of nodal dissection are readily identified on postoperative imaging (arrows) and should be scrutinized for evidence of recurrent disease.

**Conduit Selection**

- An appropriate conduit connecting the residual esophagus to the bowel must be selected.

  Options include:
  - Gastric - most common & preferred
  - Colonic
  - Jejunal - rare

**Conduit Placement**

- Conduit location depends upon the type of conduit selected and surgeon preference.

  Placement may be:
  - Prevertebral
    - Preferred location as this facilitates anastomosis with the esophageal remnant
    - Used primarily with gastric conduit & transhiatal approach
    - Prone to dysphagia/obstruction if there is locoregional recurrence
Conduit Placement
- Prevertebral: different patients

Conduit Placement
- Conduit location depends upon the type of conduit selected and surgeon preference. Placement may be:
  - Prevertebral
  - Paravertebral

- Used with gastric or colonic conduits
- Primary site of placement with transthoracic approach
- Less prone to dysphagia/obstruction if there is locoregional recurrence

Conduit Placement
- Paravertebral: different patients

Imaging Considerations
- There is no national consensus on the modality or frequency of imaging post-esophagectomy, with NCCN Guidelines recommending imaging "...as clinically indicated."*

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Imaging Considerations
- Most patients follow institutional surgical protocols; an example of which may include:
  - Esophagram: within 1 week postop to evaluate for anastomotic leak
  - CT of the chest, abdomen, and pelvis: every 4 to 6 months for 2 years, and thereafter annually
  - PET-CT: at any point for suspect findings

Common Complications

Identifying post-esophagectomy complications is important in providing timely management and limiting patient morbidity.

Postoperative complications may be classified as:
- Pulmonary
- Anastomotic
- Conduit-related
- Technical
- Functional

Pulmonary Complications

Pulmonary complications are the most common and frequently include:
- Pleural effusion
- Pneumonia
- Pneumothorax

Pleural Effusion:
- Can be acute or chronic
- Most common with transthoracic approach
- Can be secondary, i.e. parapneumonic effusion
- Characteristic imaging features on CXR and CT
- Treat with percutaneous drainage
- Recurrent malignancy must be excluded with a new or chronic effusion

Pulmonary Complications

Abductor patient 6 months post-esophagectomy with dyspnea. AP chest radiograph (A) shows loss of the bilateral hemidiaphragms and flattening of the left heart border with bilateral “fluffy” alveolar opacities. Contrast-enhanced CT through the chest (B) shows a large left pleural effusion (arrow), small right effusion, and bilateral atelectasis.

Abductor patient 6 months post-esophagectomy with dyspnea. AP chest radiograph (A) shows loss of the bilateral hemidiaphragms and heart borders. Contrast-enhanced CT through the chest (B) shows a localized complex right pleural effusion and large left effusion.
Pulmonary Complications

- **Pneumonia:**
  - 3rd most common cause of postoperative fever
  - Increased incidence with transthoracic approach
  - Critical finding as there is a 20x increase in mortality in the setting of postoperative pneumonia
  - Characteristic imaging findings on radiographs and CT

- **Pneumonia:**
  - Frontal chest radiograph (A) demonstrates a right mid and lower lung zone alveolar process, predominantly involving the right lower lobe, whereas the right heart border is preserved. Small opacities are seen on the left. CT with lung windows (B) demonstrates similar findings consistent with pneumonia.

- **Pulmonary Complications**
  - Pneumothorax:
    - Early complication
    - Most common with transthoracic approach, however can also be seen with transhiatal approach in the setting of a dissecting pneumomediastinum

- **Pulmonary Complications**
  - Pneumothorax:
    - CT of the chest (A) performed on POD 2 for suspected PE showed a small right pneumothorax (arrow). Given the small size, the patient was treated conservatively. However, the POD 7 esophagram demonstrated that the pneumothorax had considerably enlarged (arrowheads; lower lung margin denoted by *). A pigtail chest catheter was subsequently placed (not shown).

- **Anastomotic Complications**
  - Complications involving the surgical anastomosis of the residual esophagus and conduit are common and result in the highest operative-related morbidity.
  - Examples include:
    - Anastomotic leak
    - Anastomotic stricture
**Anastomotic Complications**

**Anastomotic Leak:**
- Reported to occur in 10-50% of patients
- Can occur early (2-3 days) due to technical failure or late (3-7 days) due to ischemic changes at the anastomosis
- Important to accurately diagnose, as an untreated leak can result in significant morbidity including mediastinitis, fistula formation, stricture, and conduit loss

Sequential images from an esophagram (A, B, and C) and an AP radiograph in a patient post-esophagectomy with gastric pull through demonstrating a large thoracic anastomotic leak (arrow).

**Anastomotic Stricture:**
- Late finding following maturation of the surgical anastomosis
- Increased risk in setting of anastomotic leak
- Increased risk with adjuvant radiation therapy
- Must exclude disease recurrence
  - Stricture is typically circumferential and focal with smooth margins
  - Recurrence is typically eccentric and irregular

**Patient undergoing esophagram on POD 7. AP image (A) demonstrate mild contour irregularity at the thoracic esophagogastric anastomosis (arrow) with wisps of extraluminal contrast (arrowhead).**

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**CT demonstrating marked narrowing at the esophagogastric anastomosis (A and B).** There is no associated nodularity or mass to suggest recurrence. The proximal esophageal is dilated, containing an air-fluid level (C). This is consistent with a contained leak. The area corresponded with a contained leak on (D).

**CT demonstrating marked narrowing at the esophagogastric anastomosis (A and B).** There is no associated nodularity or mass to suggest recurrence. The proximal esophageal is dilated, containing an air-fluid level (C). This is consistent with a contained leak. The area corresponded with a contained leak on (D).
Conduit Complications

- Conduit complications include:
  - Ischemia
    - Primary cause of anastomotic leak
    - Can be generalized leading to conduit failure
  - Herniation
    - Predisposes to dysmotility and pulmonary complications
    - More common with colonic conduits and paravertebral placement

Diffuse Conduit Ischemia:
Contrast-enhanced axial CT images demonstrate diffuse wall thickening of the paravertebral gastric conduit (arrows) with associated mediastinal and pleural fluid. The patient required reoperation with gastric conduit removal and colonic interposition.

Conduit Herniation:
Axial CT (A) with coronal (B) and multiplanar reconstructions (C) demonstrate a gastric conduit in a prevertebral location (arrow) with a portion of the gastric body herniating into the left side and posterior mediastinum (arrowheads). Mild conduit herniation is common; however, problems may arise if colon herniates through the weakened diaphragmatic hiatus.

Technical Complications

- Technical complications are those directly attributable to surgical technique or error.
- Factors which increase the risk of a technical complication:
  - Stage III or IV disease
  - Proximal tumors (cervical or upper 1/3)
  - Cervical anastomosis
  - Patients with multiple co-morbidities

Hematoma:
AP chest radiograph (A) demonstrates widening of the mediastinum (double arrows). Noncontrast axial CT shows a large attenuating posterior mediastinal hematoma (arrow) displacing the paravertebral gastric conduit posteriorly (C).
Technical Complications

Thoracic Duct Injury:
- The thoracic duct is a posterior mediastinal structure originating at the cisterna chyli, which lies anterior to the L2 vertebral body.
- Although the course is variable, the thoracic duct typically ascends on the right, and crosses to the left at T4.
- The duct empties into the left subclavian vein.

Thoracic Duct Injury:
- The duct is ligated and resected with the esophagus in some transthoracic procedures.
- The duct is left intact with transhiatal esophagectomy.
- Clinical suspicion for duct injury is raised by large volume chest tube drainage beyond POD 2 (>1500 cc/day).
- Elevated triglycerides in pleural fluid is indicative = chylothorax.

AP chest radiograph of patient post transthoracic esophagectomy on POD 5 reveals bilateral pleural collections, R > L.

Clinical notes indicated persistent right chest tube output of 1200-1800 cc/day.

Same patient as prior images. Lymphangiogram was performed followed by MDCT imaging with coronal (A) and sagittal reconstructions (B) followed by AP radiograph (C). The images demonstrate two areas of lymph leak—one on the right at T12 (arrow, A, B1, C); the other on the left at T10 (arrowhead A, B2, C).

Pyloromyotomy Leak:
- Pyloromyotomy is performed to reduce gastric conduit outlet obstruction.
- Uncommon site of leak as there is no anastomosis.
- When present, typically due to a deep incision or inadvertent extension of the myotomy into the duodenum or gastric antrum.

Post-esophagectomy with gastric pull through upper GI series (A1, A2) shows extraluminal contrast leak at the pyloromyotomy (arrow). The leak is also shown on axial CT through the upper abdomen (B). Oblique views of the chest (C) obtained following the UGI series (arrow).
### Functional Complications

- Functional complications typically occur late in the postoperative course and may include:
  - Dysmotility
  - Delayed Emptying (outlet obstruction)
    - More common in patients without pyloromyotomy

### Patterns of Recurrent Malignancy

- Reported rates of recurrent malignancy post-esophagectomy range from 34-79%.
- Routine postoperative surveillance imaging is therefore clinically important.
- Recognizing patterns of recurrence facilitates early detection which may permit additional treatment in lieu of palliation.

### Classification of tumor recurrence is based on site of involvement:

- **Locoregional**
  - Sites of lymph node dissection
  - Cervical, mediastinal, or upper abdominal nodes not previously resected

- **Distant**

### Anatomic Considerations

1. *The definition of “distant” nodes varies depending upon the site of the primary tumor. For example, a cervical node is considered a distant metastasis for tumors of the lower third esophagus.*
Locoregional Recurrence: Nodal
56 year old male with esophagectomy 19 months prior for esophageal adenocarcinoma. Non contrast thoracic axial CT demonstrates a markedly enlarged subcarinal node (A3) and right paratracheal node (A4). Coronal PET demonstrates these nodes and others to be hypermetabolic, consistent with nodal recurrence. (*Denotes pull through.)

Locoregional Recurrence: Anastomotic
62 year old male. Axial CT (A) demonstrates an eccentric mass (*) almost filling the gastric pull through at the anastomosis. Coronal (B1) and sagittal (B2) reconstructions further define the lesion. Eosophagram (C) shows a smooth, eccentric nodular contour abnormality (arrowheads). Biopsy was positive for recurrent adenocarcinoma.

Locoregional Recurrence: Anastomotic
56 year old male. Axial CT (A) demonstrates an eccentric, nodular mass (arrows) involving the wall at the intrathoracic esophago-gastric anastomosis. Companion esophagram (B) shows medial wall nodular contour abnormalities (arrows) extending from the thoracic anastomosis inferolaterally. Biopsy was positive for recurrent adenocarcinoma.

Locoregional Recurrence: Anastomotic
70 year old male one year post-esophagectomy with dysphagia. A: CT demonstrates eccentric nodular thickening at the esophago-gastric anastomosis (arrow). Axial (B) and coronal (C) fused PET-CT shows low-grade FDG activity (arrows). Biopsy was positive for recurrent adenocarcinoma.

Patterns of Recurrent Malignancy
- Distant Recurrence:
  - Recurrence rate of ~65%
  - Nodal and/ or solid organ
  - Distant nodes are those not classified as locoregional as determined by site of primary tumor
  - Most common sites of extranodal recurrence:
    - Liver, Lung, Bone, and Brain

Distant Recurrence: Liver and Nodal
58 year old male with biopsy proven recurrent esophageal adenocarcinoma. A. Axial image from initial abdominal CT post-esophagectomy shows a liver without focal lesion. B. Scan 4 months later now demonstrates diffuse liver metastases with an enlarged paraaortic node (arrow).
A. Locoregional & Distant Recurrence

Locoregional & Distant Nodal Recurrence

82 year old male post Ivor Lewis esophagectomy. A. PET-CT at presentation showed tumor confined to the distal esophagus; and gastric cardia (arrows). CT 3 months later demonstrates new right parasternal lymphadenopathy (B1, locoregional) and masses involving the mediastinal and paracardiac nodes (B2, distant). Biopsy of upper abdominal mass confirmed metastatic disease.

Distant Recurrence: Lung

Same patient as prior case. Chest CT demonstrates multiple, sub-centimeter pulmonary nodules, new from his study 4 months ago (left upper lobe, A; right lower lobe, B). In the setting of extensive liver disease, these nodules are consistent with metastases.

Distant Recurrence: Extranodal

64 year old male 10 months post-esophagectomy presenting with lower back pain. A1. CT examination demonstrates a 3.8 cm right L2 intramuscular paraspinous mass (arrow) which was not present at time of esophagectomy (A2). T2-B1 and T2-weighted (B2) MRI further define the lesion (arrow). PET was negative for any other disease. Biopsy confirmed metastatic adenocarcinoma.

Distant Recurrence: Nodal

65 year old male post-esophagectomy for distal 1/3 squamous cell carcinoma. Surveillance CT at 21 months following surgery demonstrates distal necrotic right cervical and supravacular lymphadenopathy (A, arrows). Additionally, a new locoregional AP window node is identified (B, arrow). Cervical node biopsy was positive for recurrent disease.

Distant Recurrence: Pleural Effusion

59 year old male post-esophagectomy. A. Axial CT 6 months postop demonstrates a new large left pleural effusion which was positive for recurrent tumor on cytology; no other disease was present. B. Two month followup CT shows recurrent effusion with new retrocrural lymphadenopathy [arrow] consistent with distant nodal metastasis.
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Conclusions

Familiarity with surgical technique facilitates interpretation of the post-esophagectomy chest.

Pulmonary complications are most common.

Postoperative pneumonia is a critical finding - 20x increased mortality.

Anastomotic leak is not uncommon (>10%) and predisposes to stricture formation.

Conclusions

- Most patients develop recurrent disease - up to 80%.
- Distant metastases are much more common than locoregional recurrent disease (~85% vs. 15%).
- Anastomotic recurrence is rare (~5%).

References


Author Correspondence

Jared D. Christensen, M.D.

jared.christensen@duke.edu