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CHAPTER 7.1

Esophageal Surgery

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Esophagostomy

Surgical Considerations

Description: Esophagostomy is performed to divert oral secretions away from the esophagus to a stoma in certain types of esophageal perforation. To perform an esophagostomy, the esophagus is approached through a left cervical incision. The sternocleidomastoid muscle and carotid sheath are retracted laterally and the thyroid medially, exposing the cervical esophagus (Fig. 7.1-1). The esophagus is mobilized with care being taken not to injure the left recurrent laryngeal nerve which typically lies in the tracheoesophageal groove. The esophagus is brought to the skin surface as a loop or end stoma and sutured to the skin with absorbable sutures.

Variant procedure or approaches: The procedure is usually performed via a left cervical approach; the right side is an alternative.

Usual preop diagnosis: Esophageal perforation; distal esophageal obstruction

Summary of Procedures

Position	Supine, with head rotated to right
Incision	Cervical
Antibiotics	Cefazolin 1 g iv preop
Surgical time	45 min
EBL	2550 mL
Postop care	Stoma pouch to collect saliva PACU → ward
Mortality	< 0.1%
Morbidity	Skin irritation: 1520% Saliva leakage: 510% Wound infection: < 5% Recurrent laryngeal nerve injury: 12%
Pain score	57

Patient Population Characteristics

Age range	20–60 yr
Male:Female	1:1
Incidence	Not uncommon
Etiology	Surgically created
Associated conditions	Esophageal perforation; pharyngeal cancer

Anesthetic Considerations

See Anesthetic Considerations for Esophageal Surgery following Esophagectomy, p. 482.

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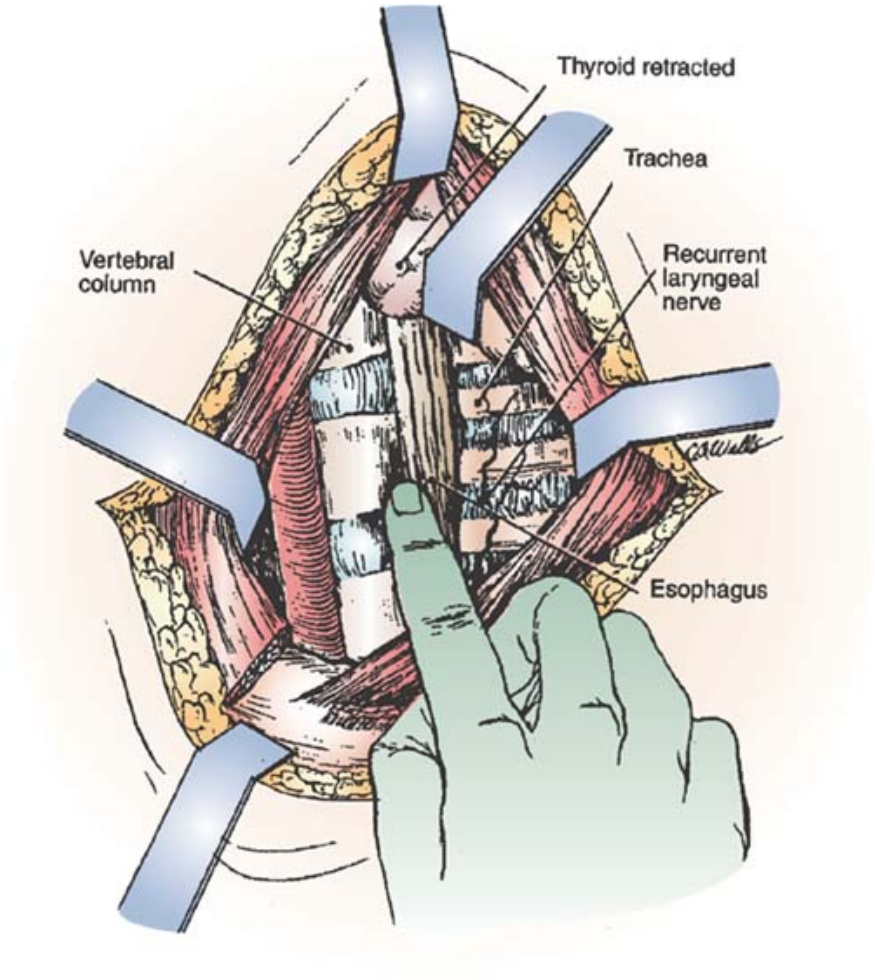

Figure 7.1-1. 1. Surgical anatomy for cervical esophagostomy. (Reproduced with permission from Nora PF, ed: *Operative Surgery Principles and Techniques.* WB Saunders, Philadelphia: 1990.)

Suggested Reading

1. Jones WG, Ginsberg RJ: Esophageal perforations: a continuing challenge. *Ann Thorac Surg* 1992; 53:534.

Esophageal Diverticulectomy

Surgical Considerations

Description: Esophageal diverticula are divided into three anatomic types: **pharyngoesophageal (Zenker's), midesophageal,** and **epiphrenic.** Structurally, they are either "true" diverticula—meaning they consist of all three layers of the esophageal wall (mucosa, submucosa, and muscularis)—or "false" diverticula consisting of *(Print pagebreak 472)* only mucosa (or mucosa and submucosa). Pharyngoesophageal diverticula account for 60–65% of all cases. These are false diverticula that originate in Killian's triangle, a weak point in the posterior esophagus, just proximal to the transverse fibers of the cricopharyngeal muscle (Fig. 7.1-2). They are associated with incomplete, or discoordinate, upper esophageal sphincter relaxation and the resultant increased hypopharyngeal pressure produces a narrow-mouthed posterior diverticulum. These diverticula frequently present in the seventh decade and are 2–3 times more common in men. Symptoms depend on the stage of the disease. Early on, patients may complain of vague pharyngeal

sensations, dysphagia, cough, and excess salivation. Later, more severe symptoms—such as severe (or frequent) dysphagia, regurgitation of food, halitosis, voice changes, aspiration, and odynophagia (painful swallowing)—may occur.

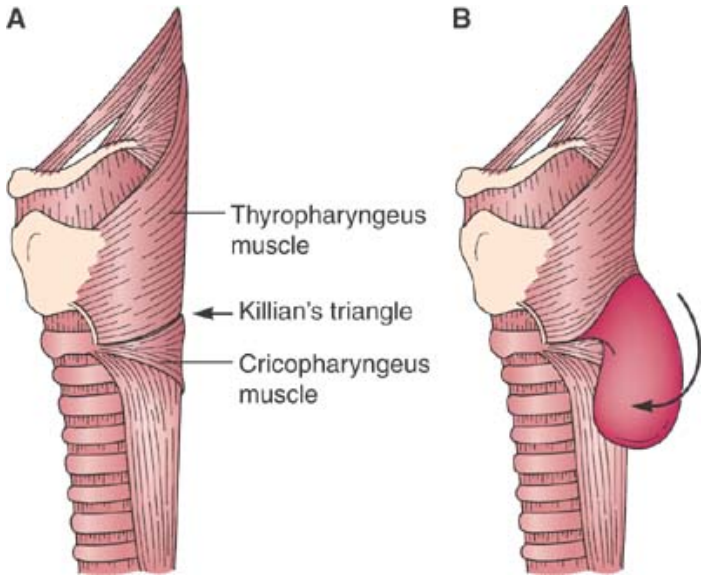

Figure 7.1-2. 2. Formation of Zenker's diverticulum. **A.** Herniation of the pharyngeal mucosa and submucosa occurs at the point of potential weakness (Killian's triangle [arrow]) between the oblique fibers of the thyropharyngeus muscle and the more horizontal fibers of the cricopharyngeus muscle. **B.** As the diverticulum enlarges, it drapes over the cricopharyngeus sphincter and descends into the superior mediastinum in the prevertebral space. (Reproduced with permission from Greenfield LJ, Mulholland, MW, Oldham KT, et al, eds: *Surgery: Scientific Principles and Practice,* 3rd edition. Lippincott Williams & Wilkins, Philadelphia: 2001. After Orringer MB: Diverticula and miscellaneous conditions of the esophagus. In *Textbook of Surgery,* 13th edition. Sabiston DC Jr, ed. WB Saunders, Philadelphia: 1986.)

Surgery is the only effective therapy for Zenker's diverticulum. Respiratory complications (aspiration) or nutritional deficiencies (weight loss) may be directly attributable to the diverticulum and should not be contraindications to surgery. Multiple different operative approaches are advocated: diverticulectomy alone, cricopharyngeal myotomy, diverticulectomy with myotomy, and myotomy with suspension of the diverticulum. **Myotomy** alone, which corrects the underlying physiologic abnormality, is up to 78% effective and may be considered for patients with small (< 2 cm) diverticula. **Diverticulectomy** or **suspension** should be added if the diverticulum itself is large or dependant. Both procedures are performed via a left cervical incision (Fig. 7.1-3: inset) and are associated with a low rate of recurrence and complications. The upper esophagus is exposed by retracting the sternocleidomastoid muscle and carotid sheath laterally and the thyroid gland medially. The diverticulum is located in the prevertebral space. Care is taken not to injure the recurrent laryngeal nerve. Following excision of the diverticulum, a cricopharyngeal **myotomy** may be performed, starting on the upper esophagus and extending across the cricopharyngeal muscle near the neck of the diverticulum, and on to the inferior pharyngeal constrictor muscle.

Recent emphasis has been placed on endoscopic treatment of Zenker's diverticulum (**Dohlman procedure**). In this procedure, a modified laryngoscope and endoscopic stapler are used to divide the common wall between diverticulum and true esophageal lumen.

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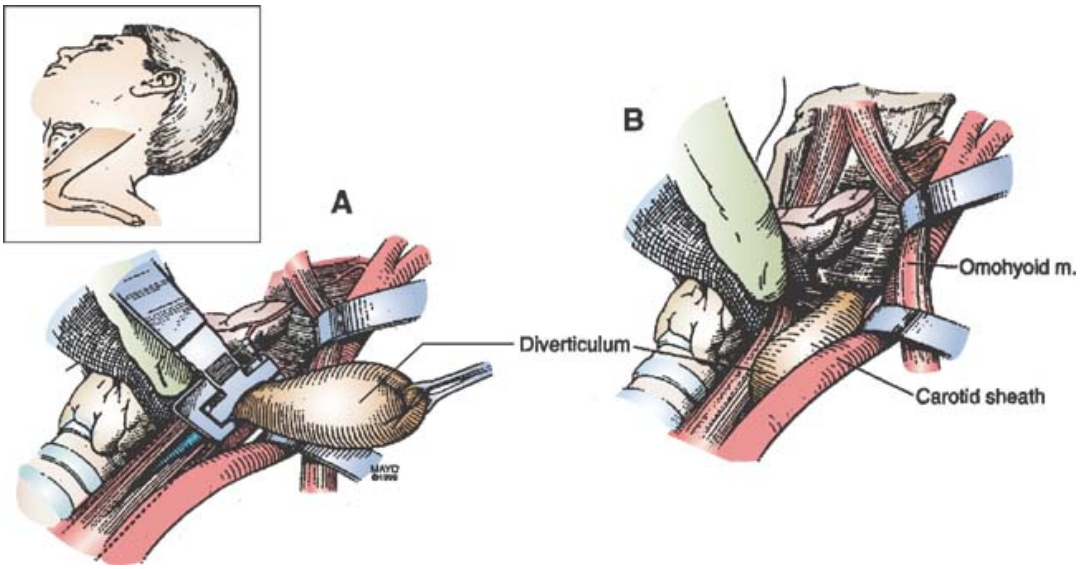

Figure 7.1-3. 3. Zenker's diverticulum approached through a left cervical incision (inset). **A.** The diverticulum is grasped and a cricopharyngeal myotomy is extended onto the upper esophagus. **B**. The base of the diverticulum is stapled and the diverticulum is resected. (Reproduced with permission from Shields TW, LoCicero J III, Ponn RB: *General Thoracic Surgery,* 5th edition. Lippincott Williams & Wilkins, Philadelphia: 2000.)

Midesophageal diverticula, by definition, occur in the middle 3rd of the esophagus. These "true" diverticula typically arise in the setting of mediastinal granulomatous disease whereby a fibrotic reaction around inflamed mediastinal lymph nodes results in traction on the muscular wall of the esophagus. Diverticula usually arise within 4–5 cm of the carina and comprise an estimated 10–17% of all esophageal diverticula. Most midesophageal diverticula are asymptomatic and do not require surgical intervention. In cases that require intervention, because of either regurgitation or development of an esophagobronchial fistula, the approach is through a **right thoracotomy** with excision of the inflammatory mass. Primary closure of the fistula and the interposition of viable tissue should be performed.

Epiphrenic diverticula arise in the distal 10 cm of the esophagus and are thought to be related to an underlying esophageal motility disorder. These false diverticula are most commonly present in the 6th decade. The clinical presentation is variable, with most patients presenting with symptoms related to their underlying dysmotility syndrome: dysphagia, chest pain, or regurgitation. Most patients with epiphrenic diverticula are asymptomatic, and there appears to be no relation between size of the diverticulum and symptoms. Surgery for epiphrenic diverticula typically consists of **diverticulectomy with myotomy** either through a **left thoracotomy** (Fig. 7.1-4) or via laparoscopy. With the transthoracic approach, a low, **left thoracotomy** is used, the esophagus is mobilized and encircled, and the diverticulum is mobilized and excised. A **myotomy** should be performed opposite the diverticulectomy and should extend proximally above the diverticulum and distally onto the stomach. Because there is, by definition, an underlying motility disorder, the myotomy should be carried onto the stomach and a nonobstructing fundoplication may be added to prevent significant postoperative reflux.

Variant procedure or approaches: Laparoscopic diverticulectomy and myotomy has gained increasing acceptance, and reported outcomes are similar to those obtained with the open procedure. The surgical approach is similar to that used during laparoscopic fundoplication (see p. 571). Dissection of the diverticula may be facilitated by the passage of a bougie or video endoscope. After the diverticulum is amputated using an endoscopic stapler, a myotomy is performed opposite the diverticula and a partial fundoplication is fashioned.

Usual preop diagnosis: Esophageal diverticulum

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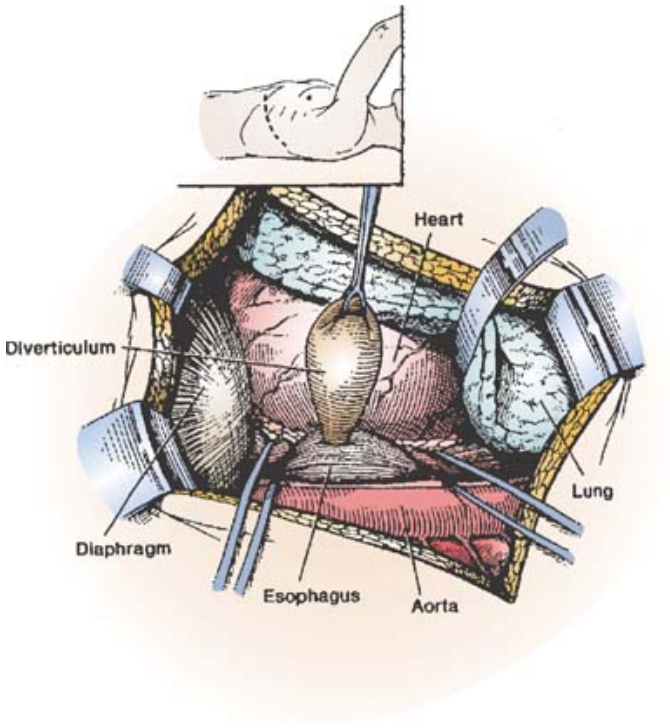

Figure 7.1-4. 4. Epiphrenic diverticulum. Through a left thoracotomy, the diverticulum is mobilized and resected. A contralateral myotomy is then created and extended distally to the stomach to eliminate any functional obstruction secondary to the pre-existent dysmotility. (Reproduced with permission from Shields TW, LoCicero J III, Ponn RB: *General Thoracic Surgery,* 5th edition. Lippincott Williams & Wilkins, Philadelphia: 2000.)

Summary of Procedures

	Hypopharyngeal	Epiphrenic
Position	Supine	Right lateral decubitus
Incision	Left or right cervical	Left thoracotomy
Special instrumentation	None	Chest retractor
Unique considerations	Care not to injure recurrent laryngeal nerve	10 cm myotomy
Antibiotics	Cefazolin 1 g iv preop	
Surgical time	1–2 h	
Closing considerations	Inspect for perforation	
EBL	50–100 mL	100–200 mL
Postop care	PACU → ward	ICU × 1–2 d
	Hypopharyngeal	**Epiphrenic**
Mortality	< 1%	
Morbidity	Recurrent nerve paralysis: < 5% Temporary phonetic problems: < 5% Esophageal stricture: < 3% Esophageal fistula: < 2%	Atelectasis: 5–10% Esophageal perforation: < 2% < 2%
Pain score	6–7	7–9

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Patient Population Characteristics

Age range	35–90 yr (50% of patients > 70 yr)

Male:Female	2:1
Incidence	Uncommon
Etiology	Uncoordinated cricoesophageal muscle and lower esophageal sphincter; weakness of esophageal wall.
Associated conditions	Cachexia (25–30%); hiatus hernia with or without reflux (25%); chronic pulmonary infection (15–20%); aspiration (30–40%)

Anesthetic Considerations

See Anesthetic Considerations for Esophageal Surgery following Esophagectomy, p. 482.

Suggested Readings

1. Deschamps C, Trastek V: Esophageal diverticula. In: *General Thoracic Surgery,* 5th edition. Shields TW, LoCicero J III, Ponn RB, eds. Lippincott Williams & Wilkins, Philadelphia: 2000.

2. Ferreira LE, Simmons DT, Bain TH: Zenker's diverticula: pathophysiology, clinical presentation, and flexible endoscopic management. *Dis Esophagus* 2008;21:1–8.

Management of Esophageal Perforation

Surgical Considerations

Description: Esophageal perforation may be spontaneous, instrumental (iatrogenic), traumatic, or 2° intrinsic esophageal disease. **Spontaneous (or emetogenic) perforation** most commonly occurs in the lower 3rd of the esophagus. **Instrumental perforations** may occur at any level, but are most common just above the cardia and in the cervical esophagus. The level of **traumatic perforation** depends on the location of the penetrating wound. Sx of esophageal perforation at the cricopharyngeal sphincter include neck pain, fever, and crepitations in the substernal and neck areas. Perforation in the mediastinum may result in hydropneumothorax, mediastinitis, fever, and substernal pain. Cervical perforations are managed with antibiotics and drainage in the cervical area. Therapy for intrathoracic perforation generally requires emergent operation. Surgical options include **primary repair, drainage and diversion,** and **esophageal resection.** The optimal choice depends on the nature and duration of the perforation as well as the clinical condition of the patient. Spontaneous perforations are often amenable to primary repair—either through the abdomen or the left chest. Patients suffering from iatrogenic perforation incurred during dilation of a malignant, or nondilatable, stricture may require urgent esophagectomy. Patients with delayed recognition of a perforation may be hemodynamically unstable and may only tolerate drainage and diversion (generally through a cervical esophagostomy).

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Variant procedure or approaches: Cervical or right thoracic drainage is indicated when the perforation occurs in the neck or high in the mediastinum.

Usual preop diagnosis: Esophageal perforation

Summary of Procedures

	Left Thoracotomy	Cervical or Thoracic Drainage
Position	Right lateral decubitus	Supine or right lateral decubitus
Incision	Left thoracotomy	Cervical or right chest
Antibiotics	Zosyn (piperacillin & tazobactom) 3.375 g iv q6h	

VTE prophylaxis	Heparin 5,000 units sq	
Surgical time	2–4 h	1 h
Closing considerations	Chest drain	Cervical or thoracic drain
EBL	100–200 mL	50–100 mL
Postop care	Chest tube to suction; PACU → ward	
Mortality	5–10%	2–5%
Morbidity	Pneumonia: 5–10% Esophageal leak: 2–5% Pericarditis: 1–3%	— 10% —
Pain score	8–10	8–10

Patient Population Characteristics

Age range	Variable: 20–80 yr
Male:Female	1:1
Incidence	1 in 8,000 admissions
Etiology	Instrumental (endoscopy, dilatation, intubation); traumatic (penetrating, foreign body, caustic agents); intrinsic disease (carcinoma, peptic ulceration); spontaneous
Associated conditions	Esophageal stricture (75%); cancer (25%)

Anesthetic Considerations

See Anesthetic Considerations for Esophageal Surgery following Esophagectomy, p. 482.

Suggested Readings

1. Fell SC: Esophageal perforation. In: *Esophageal Surgery.* Pearson FG, Cooper JD, Deslauriers J, et al, eds. Churchill Livingstone, New York: 2002, 615–36.

2. Orringer MB: The mediastinum. In: *Operative Surgery,* 3rd edition. Nora PF, ed. WB Saunders, Philadelphia: 1990, 370–3.

3. Wong AS, Myers JC, Jamieson GG: Esophageal pH profile after laparoscopic total fundoplication compared to anterior fundoplication. *J Gastrointest Surg* 2008; in press.

4. Wu JT, Mattox KL, Wall MJ: Esophageal perforations: new perspectives and treatment paradigms. *J Trauma* 2007;63:1173–84.

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Esophagomyotomy

Surgical Considerations

Description: Esophagomyotomy is performed for achalasia and other motility disorders to facilitate esophageal emptying into the stomach. Most authors recommend incising the muscular layer of the distal esophagus and continuing down across the gastroesophageal junction for at least 1 cm (**Heller's myotomy**). The muscle is dissected back from the mucosa so that roughly 180° is exposed (Fig. 7.1-5). The distal esophagus is mobilized either from below the diaphragm or via a left thoracic approach. Care is taken not to injure the vagus nerves.

When approached from the abdomen, the esophagus is exposed by incising the gastroesophageal ligament. The distal esophagus is

mobilized and pulled downward to perform the myotomy.

Variant procedure or approaches: The procedure usually is performed through a **left thoracotomy**, but some surgeons prefer a **transabdominal approach.** More recently, laparoscopic or thoracoscopic approaches are being employed to perform esophagomyotomy (see p. 574).

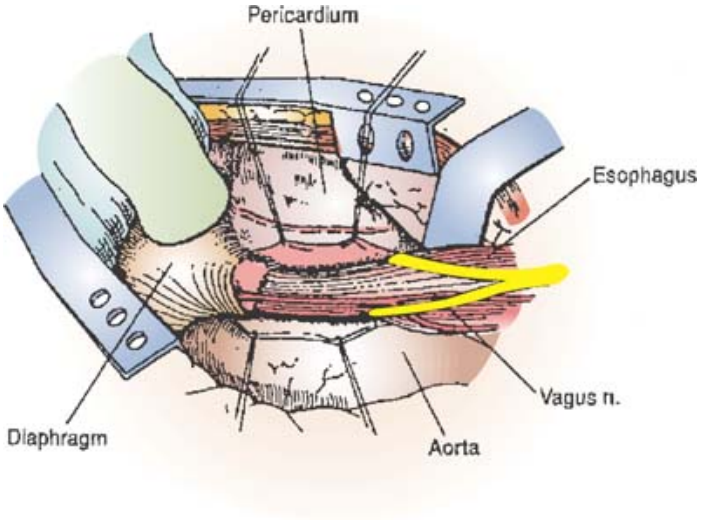

Figure 7.1-5. 5. Surgical anatomy for esophagomyotomy. (Reproduced with permission from Hardy JD: *Hardy's Textbook of Surgery,* 2nd edition. JB Lippincott, Philadelphia: 1988.)

Usual preop diagnosis: Achalasia; diffuse esophageal spasm; nutcracker esophagus

Summary of Procedures

	Thoracic Approach	Abdominal Approach	Endoscopic Approaches
Position	Right lateral decubitus	Supine	Supine
Incision	Left thoracotomy in 6th interspace	Midline upper abdomen	Multiple small abdominal incisions
Special instrumentation	Chest retractor	Denier retractor	Laparoscopic instrumentation
Unique considerations	Care should be taken to avoid extending gastric myotomy too far to prevent esophageal reflux.		Legs spread apart (laparoscopic approach)
Antibiotics	Cefazolin 1–2 g iv preop		
VTE prophylaxis	Heparin 5,000 units sq		
Surgical time	1–2 h		
Closing considerations	for perforation. Consider fundoplication to prevent esophageal reflux.		
EBL	150–200 mL	100–150 mL	50 mL
Postop care	ICU × 1–2 d	PACU → room	
Mortality	< 0.5%		
Morbidity	Esophagitis: ≥ 20% Transient dysphagia/reflux: 5% Esophageal leak: 1–2%		
Pain score	7–9	6–8	3–4

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Patient Population Characteristics

Age range	30–50 yr
Male:Female	1:1
Incidence	0.6/100,000
Etiology	Neuromuscular disorder of unknown etiology often characterized by absence of ganglion cells of Auerbach's plexus.
Associated conditions	Predisposition to development of carcinoma (1–20%); pulmonary complications 2° aspiration (5–10%)

Anesthetic Considerations

See Anesthetic Considerations for Esophageal Surgery following Esophagectomy, p. 482.

Suggested Readings

1. Ellis FH Jr, Crozier RE, Watkins E Jr: Operation for esophageal achalasia. Results of esophagomyotomy without an antireflex. *J Thorac Cardiovasc Surg* 1984; 88(3):344–51.

2. Pellegrini C, Wetters LA, Palti M, et al: Thorascopic esophagomyotomy. *Ann Surg* 1992; 216:29.

3. Stuart RC, Hennessy TP: Primary motility disorders of the esophagus. *Br J Surg* 1989; 76:111.

4. Zhu ZJ, Chen LQ, Duranceau A: Long-term results of total vs. partial fundoplication after esophagomyotomy for primary esophageal motor disorders. *World J Surg* 2008; 32:401–7.

Esophagogastric Fundoplasty

Surgical Considerations

Description: Esophagogastric fundoplasty represents a variety of operations designed to prevent esophageal reflux by wrapping the fundus of the stomach around a 3–4 cm segment of the lower esophagus. This fundal wrapping acts to reinforce the lower esophageal sphincter. Surgery may be performed transabdominally, transthoracically, or laparoscopically, depending on surgeon's preference. The most common approach is the open or laparoscopic **Nissen fundoplication,** wherein the anterior and posterior walls of the stomach are sutured together around the lower esophagus with nonabsorbable sutures (Fig. 7.1-6A). This is accomplished by incising the gastrosplenic ligament and ligating three or four short gastric vessels. Care must be taken not to injure the spleen or vagus nerves during the repair.

Variant procedure or approaches: Modifications of the Nissen fundoplication include the **Toupet procedure,** a posterior partial fundoplication, and the **Hill procedure,** in which the gastroesophageal junction is sutured to the median arcuate ligament of the diaphragm or to the preaortic fascia (Fig. 7.1-6B). Another modification is the **Belsey Mark IV** repair, in which there is a 240° semifundoplication between the stomach and esophagus, making it easier for the patient to overcome the resistance of the wrap. There are proponents of each repair, although the Nissen fundoplication remains the standard to which others are compared. The **laparoscopic approach** is widely used, although the left transthoracic approach provides excellent exposure for either Nissen or Belsey repairs (see p. 574).

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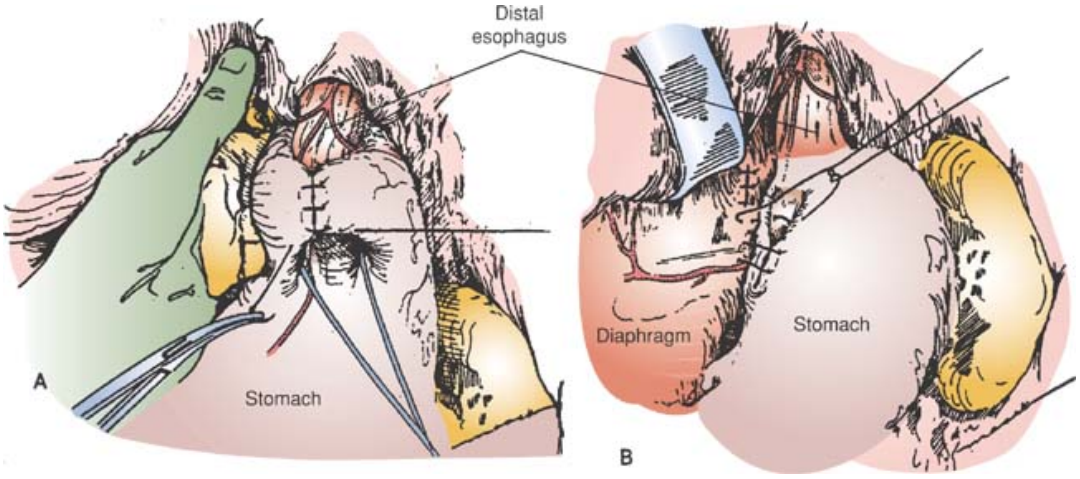

Figure 7.1-6. 6. A. Nissen fundoplication may be performed via either the transabdominal or transthoracic approach; **B.** Hill repair is performed through the abdomen. (Reproduced with permission from Hardy JD: *Hardy's Textbook of Surgery,* 2nd edition. JB Lippincott, Philadelphia: 1988.)

Usual preop diagnosis: Sliding hiatus (hiatal) hernia, paraesophageal hiatus hernia, or free reflux

Summary of Procedures

	Nissen (Toupet) Fundoplication	Laparoscopic Nissen	Hill Procedure	Belsey Mark IV
Position	Supine	Supine, legs apart		Right lateral decubitus
Incision	Midline abdominal or laparoscopic ports	Laparoscopic ports	Midline abdominal	Left posterolateral thoracotomy
Special instrumentation	#40–50 Hurst dilators; NG tube	Laparoscopic instrumentation	NG tube	Chest retractor; NG tube
Unique considerations	Fundoplication should be loose; parietal cell vagotomy performed if peptic ulcer disease present. Fundoplication may be limited to 180–280° posterior wrap (Toupet)	CO_2 insufflation		240° semi-fundoplication
Antibiotics	Cefazolin 1–2 g iv			
VTE prophylaxis	Heparin 5,000 units sq			
Surgical time	1–2 h			
Closing considerations	Inspect spleen for bleeding			
EBL	100–150 mL	50 mL	100–150 mL	100–200 mL
Postop care	PACU → ward			ICU × 1–2 d
Mortality	< 0.5%			
Morbidity	Recurrent hernia: 20% Gas-bloat syndrome: 10–20% Temporary dysphagia: 5–10% Gastric fistula: < 2%		< 5% 5%	2%
Pain score	6–8	2–4	7–8	7–9

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Patient Population Characteristics

Age range	46–60 yr
Male:Female	1:2
Incidence	Not uncommon
Etiology	Esophagogastric reflux (100%); esophageal hiatus hernia (80–90%)
Associated conditions	Diverticulosis of colon (30–35%); cholelithiasis (25–30%)

Anesthetic Considerations

See Anesthetic Considerations for Esophageal Surgery following Esophagectomy, p. 482.

Suggested Readings

1. Belsey R: Mark IV repair of hiatal hernia by the transthoracic approach. *World J Surg* 1977; 1(4):475–81.

2. Cuschieri, A: Laparoscopic antireflux surgery and repair of hiatal hernia. *World J Surg* 1993; 17(1):40–5.

3. Wong AS, Myers JC, Jamieson GG: Esophageal pH profile after laparoscopic total fundoplication compared to anterior fundoplication. *J Gastrointest Surg* 2008; in press.

Esophagectomy

Surgical Considerations

Description: Esophagectomy is most commonly performed for malignant disease of the middle and lower 3rd of the esophagus and gastric cardia. This procedure also may be indicated for intractable benign stricture, **Barrett's esophagus** with high-grade dysplasia, and end-stage achalasia. There are several surgical options for esophageal resection, including the **Ivor Lewis approach,** which involves a laparotomy and right thoracotomy; the transhiatal approach, whereby the esophagus is mobilized through abdominal and neck incisions, and the **left thoracoabdominal approach** (Fig. 7.1-7). Although there are advantages and disadvantages to each, the final result is to use a portion of the stomach to replace the esophagus. In all approaches, the stomach is mobilized while preserving its blood supply from the right gastroepiploic and gastric arteries. The stomach is then transposed into the chest and a gastroesophageal anastomosis is fashioned either in the chest (Ivor Lewis and left chest approaches) or in the neck (transhiatal approach). To avoid delayed gastric emptying, a **pyloroplasty** or **pyloromyotomy** is often added, as is placement of a temporary jejunal feeding tube. Regardless of the surgical technique, patients with larger or locally advanced tumors may have received preoperative chemotherapy or radiation. In these patients, the combination of less distinct tissue planes and radiation-induced inflammation tends to lead to increased bleeding and/or increased insensible fluid losses.

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The previously mentioned variants of esophagectomy all involve use of the **stomach** as an esophageal replacement. When the stomach is not available (as with prior resection or caustic injury), the **colon** can be used as an esophageal substitute. Both the left and right colon can be used, with the vascular supply to the grafts based on either the ascending branch of the left colic artery or the right colic artery. Colon interpositions typically have higher complication rates than esophagectomies using gastric conduits.

Usual preop diagnosis: Carcinoma of esophagus or gastroesophageal junction; Barrett's esophagus; benign strictures

Summary of Procedures

	Ivor Lewis	Transhiatal Esophagectomy	Thoracoabdominal	Total Esophagectomy + Colonic Interposition
Position	Supine and left lateral decubitus	Supine	Right lateral decubitus	Supine and right lateral decubitus
Incision	Midline abdominal + right chest and/or cervical incisions	Cervical and midline abdominal	Thoracoabdominal across costal margin (see Fig. 7.1-8)	Midline + right thoracic and cervical
Unique considerations	DLT	None	DLT	
Antibiotics	Cefoxitin 2 g iv preop			
VTE prophylaxis	Heparin 5,000 units sq			
Surgical time	3–4 h	4–5 h	3–4 h	5–6 h
Closing considerations	Lung reexpansion	Pneumothorax	Lung reexpansion	Vascular integrity of colonic interposition
EBL	300–800 mL			
Postop care	ICU × 1–2 d			ICU × 2–3 d
Mortality	5–10%			10%
Morbidity	Respiratory complications: 15–20% Anastomotic leakage: < 5% Anastomotic stricture: < 5% Wound infection: < 5%	5–10%	< 5%	10% 10%
Pain score	7–9	6–8	7–9	7–9

Patient Population Characteristics

Age range	4–80 yr
Male:Female	2:1 for carcinoma
Incidence	1–2% of malignant disease
Etiology	Alcohol and tobacco; dietary factors – hot spicy foods; lye burns
Associated conditions	Barrett's esophagus; hiatus hernia; reflux esophagitis; radiation esophagitis; caustic burns

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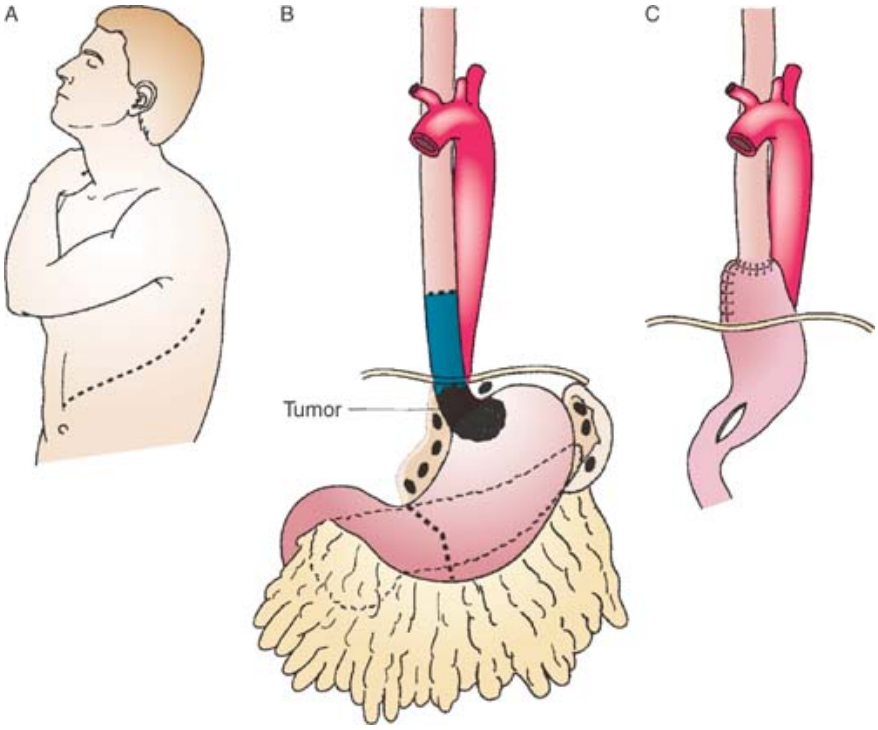

Figure 7.1-7. 7. Standard thoracoabdominal esophagosgastrectomy for carcinomas of the distal esophagus and cardia. **A.** Thoracoabdominal incision. **B.** Tissue to be resected (darker area). **C**. Completed reconstruction after intrathoracic esophagogastric anastomosis and either pyloromyotomy or pyloroplasty to prevent postvagotomy pylorospasm. (Reproduced with permission from Greenfield LJ, Mulholland, MW, Oldham KT, et al, eds: *Surgery: Scientific Principles and Practice,* 3rd edition. Lippincott Williams & Wilkins, Philadelphia: 2001).

Suggested Reading

1. Orringer MB: Resection of the esophagus. In: *General Thoracic Surgery,* 5th edition. Shields TW, LoCicero J III, Ponn RB, eds. Lippincott Williams & Wilkins, Philadelphia: 2000, 1697–722.

Anesthetic Considerations For Esophageal Surgery

(Procedures covered: esophagostomy; esophageal diverticulectomy; closure of esophageal perforation; esophagomyotomy; esophagogastric fundoplasty; esophagectomy; colonic interposition)

Patients presenting for esophageal surgery typically are those with carcinoma, motility disorders, strictures, hiatal hernia, reflux esophagitis, diverticula, and perforation. Patients tend to be elderly, with a history of tobacco abuse *(Print pagebreak 483)* and alcohol consumption, and may have associated cardiopulmonary disease. Obesity and ischemic heart disease are increasingly frequent comorbid conditions. Esophageal disorders such as hiatal hernia, Barrett's esophagus, and carcinoma with incomplete obstruction predispose the patient to recurrent aspiration pneumonitis from intermittent reflux of gastric contents. Patients with esophageal diverticula, stricture, achalasia, and carcinoma with obstruction may present with retained food and oral secretions. Therefore, patients may need to be considered nonfasted.

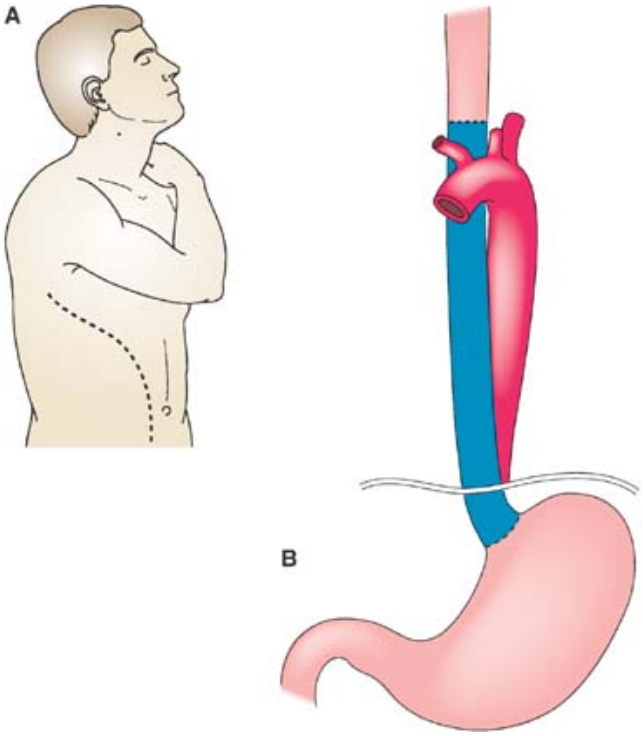

Figure 7.1-8. 8. Standard thoracoabdominal esophagogastrectomy for tumors of the upper and middle 3rd of the thoracic esophagus. **A.** Either a continuous thoracoabdominal incision or separate thoracic and abdominal incisions are used. **B.** Portion of esophagus to be resected (darker area). **C.** Completed reconstruction with high intrathoracic esophagogastric anastomosis and gastric drainage procedure. (Reproduced with permission from Greenfield LJ, Mulholland, MW, Oldham KT, et al, eds: *Surgery: Scientific Principles and Practice,* 3rd edition. Lippincott Williams & Wilkins, Philadelphia: 2001.)

Preoperative

Respiratory

Many patients with esophageal cancer have a long history of smoking resulting in COPD. Mediastinal lymphadenopathy and tumors of the upper esophagus may lead to tracheal/bronchial compression or erosion that may be revealed by CT and bronchoscopy. A history of gastric reflux and recurrent aspiration pneumonia → ↓ pulmonary reserve and ↑ risk of regurgitation/aspiration during anesthetic induction. (See Premedication, below.) If thoracotomy is a part of the procedure, the patient should be evaluated to ensure that OLV will be tolerated (see below). Determine if patient has been exposed to radiation and chemotherapeutic agents that may cause pulmonary fibrosis. Some agents, such as Bleomycin, may cause pulmonary toxicity (above a total dose of 300 U/m^2) that is worsened by high concentrations of O_2 which should be avoided during the perioperative period.

Tests: Consider PFTs (FEV1, FVC, DLCO), ABG, and flow-volume loops, if indicated by H&P. They can be helpful in predicting the likelihood of perioperative pulmonary complications and the possible need for postoperative ventilatory support. Patients with baseline hypoxemia/hypercarbia on room air have a greater likelihood of postop complications and ventilatory insufficiency. Severe restrictive or obstructive lung disease also will increase the chance of pulmonary morbidity in the periop period. A-P, lateral CXR (if suggestive of tracheal compression obtain MRI/CT).

Elderly patients may have coexisting CAD. In the setting of a recent angioplasty/stent, continued management with antiplatelet

Cardiovascular	agents (clopidogrel) may preclude the use of epidural techniques. Patients may be hypovolemic and malnourished from dysphagia or anorexia. Preop chemotherapy treatment with agents such as doxorubicin may cause acute dysrhythmias and chronic cardiomyopathy (seen in 10% of patients if total dose is > 550 mg/m^2). Some esophageal tumors are related to alcohol consumption and chronic abuse may produce a toxic cardiomyopathy. Preop optimization of cardiac status is important. **Tests:** ECG to r/o dysrhythmias, myocardial ischemia, or prior MI. ECHO or dobutamine stress ECHO will provide important functional information about the heart at rest or under stress, respectively. Reversible ischemia and significant cardiomyopathy should prompt further cardiac consultation.
Hematologic	**Tests:** CBC with differential.
Laboratory	PT & PTT, basic metabolic profile and tests as indicated from H&P.
Premedication	Consider midazolam 1–2 mg iv. Consider H_2antagonists (e.g., ranitidine 50 mg iv), metoclopramide (10 mg iv 1 h preop), and Na citrate (30 mL po 10 min preop) in patients with reflux and partial obstruction. Patients with esophageal motility disorders, strictures/tumors with complete obstruction may not tolerate oral antacids.

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Intraoperative

Anesthetic technique: GETA (with or without epidural for intraop/postop analgesia). If the patient is clinically hypovolemic, restore intravascular volume before epidural placement and induction of GA. Surgeries involving only a cervical or endoscopic approach typically do not require epidural analgesia. If epidural analgesia is planned, placement and testing of the catheter before anesthetic induction is recommended. This is accomplished by injecting 5–7 mL of 1–2% lidocaine with 1:200,000 epinephrine via the epidural catheter and eliciting a segmental block. If a thoracic or thoracoabdominal approach is performed, placement of a DLT is indicated to provide OLV for optimal surgical conditions. (For additional discussion of DLT placement and OLV, see Anesthetic Considerations in Lobectomy, Pneumonectomy in Thoracic Surgery, p. 275.)

Induction	Patients with esophageal disease are often at risk for pulmonary aspiration; therefore, the trachea should be intubated after rapid-sequence induction with cricoid pressure. In cases with a difficult airway needing a DLT, placement of a single lumen tube should be accomplished (a) with the aid of a bougie, (b) via an LMA, or (c) with FOB. The single lumen tube is then changed to a DLT using a tube exchange catheter.
Maintenance	Standard maintenance (p. B-2), with or without N_2O (for OLV). Alternatively, a combined technique may be used. A local anesthetic (e.g., 2% lidocaine with 1:200,000 epinephrine or 0.25% bupivacaine) can be infused or injected into a thoracic (3–5 mL) or lumbar (5–10 mL) epidural catheter to provide both anesthesia and optimal surgical conditions (contracted bowel and profound muscle relaxation). Continuous infusion of local anesthetic generally provides better hemodynamic stability than hourly bolus injections. To enhance the effect of epidural analgesia, a loading dose of opiates (e.g., hydromorphone 0.4–1 mg [thoracic] or 1–1.5 mg [lumbar]) can be administered early during the surgery and at least 1 h before conclusion of the case. Esophagectomy procedures can cause significant third-space losses; thus, maintenance of euvolemia with close monitoring of BP and UO. Esophageal procedures involving transient compression of the myocardium (i.e., thoracic approach for esophagomyotomy or esophagectomy) can induce dysrhythmias and/or ↓ BP. Monitoring of BP with an arterial catheter is recommended. Generally, tracheal extubation should be anticipated at the end of the case. The decision to keep the patient intubated postop depends on cardiopulmonary status and the site and extent of the surgical procedure. Patients with significant intraop fluid shift may

Emergence	develop airway edema that can → airway obstruction if extubated prematurely. This may also occur in operations involving high anastomoses in the neck. For those who may require prolonged postop ventilation, the DLT should be exchanged to a single-lumen ETT before transport to ICU. The use of an airway exchange catheter is safe, and direct laryngoscopy during the exchange prevents inadvertent seepage of blood or silent aspiration. Weaning from mechanical ventilation should begin when the patient is awake and cooperative, able to protect the airway, hemodynamically stable, and has adequate return of pulmonary function (as measured by VC > = 10 mL/kg; MIF of > 30 cmH$_2$O; rapid, shallow breathing index of ≥ 100 [RR÷TV(L)]; respiratory rate < 25; and ABG that demonstrates adequate gas exchange).	
Blood and fluid requirements	IV: 14–16 ga × l–2 NS/LR @ 8–12 mL/kg/h Warm fluids Consider T&C for 2–4 U PRBC	Plt, FFP, and cryoprecipitate (if required) should be administered according to lab tests (Plt count, PT, PTT, DIC screen, thromboelastography [TEG]). Maintain euvolemia based on estimates of blood loss, fluid shifts, fluids administered, and HR, BP, UO, base deficit, and invasive monitoring when em ployed.
Monitoring	Standard monitors (p. B-1) Urinary catheter ± Arterial line ± CVP	CVP cannulation site determined by surgical approach. Attempt to prevent hypothermia during long operations. Consider forced-air warmer, heated humidifier, warming blanket, warming the OR, keeping patient covered until ready for prep, etc.
Positioning	If lateral decubitus position, use axillary roll, airplane arm holder pressure points, including ears, eyes, and genitals radial pulses to ensure correct placement of axillary roll (if misplaced, will compromise distal pulses).	Problems that can arise include brachial plexus injuries, damage to soft tissues, ears, eyes, genitals from malpositioning. Check down eye at frequent intervals. Placing the oximeter probe on the down arm may assist in monitoring adequacy of perfusion.
Complications	Hypoxemia	Hypoxemia during OLV most commonly results from luminal obstruction (by blood or pulmonary secretions) of the DLT; shunting, or malposition of DLT, which can move during surgical manipulation. Rx: suction DLT and position; PEEP to ventilated lung (but may ↑ shunting); CPAP to nonventilated lung; return to double-lung ventilation. Temporary clamping of the PA (or inflate the balloon of the PA catheter, if available) may be necessary to improve shunting and oxygenation.
	Hypercarbia Dysrhythmia	Ensure adequate TV and RR. for mechanical compression of heart or great vessels. Check K^+ volume status and cardiac function.
	Hypotension	Consider neosynephrine for BP support if ↓ BP 2° epidural anesthetic. Maintaining an adequate BP is important for adequate perfusion and hence integrity of a newly formed anastomosis.
	VTE Prophylaxis	See Appendix B

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Postoperative

Complications	Aspiration Atelectasis	For patients at risk for atelectasis or aspiration, recover in the 45° head up or Fowler position (semi sitting)
	Hemorrhage	For hemorrhage, coags; replace factors as necessary
	Pneumothorax Hemothorax	Dx for pneumothorax and hemothorax: wheezing, coughing, dyspnea, ↓ PO_2 ↓ PCO_2 Confirm by CXR. Rx: chest tube drainage as necessary. In emergency (e.g., tension pneumothorax), use needle aspiration. Supportive Rx: O_2 vasopressors, volume, ± ETT and IPPV
	Hypoxemia Hypoventilation	For hypoxemia and hypoventilation; Rx: adequate analgesia, minimize sedation, supplemental O_2 may require IPPV
	Recurrent laryngeal nerve injury	For laryngeal nerve injury, Dx: indirect visualization of vocal cords; patient usually will be hoarse
	Esophageal anastomotic leak VTE prophylaxis	Surgical repair Rx for esophageal anastomotic leak
	SVT/AFib	Treat underlying cause and correct electrolyte abnormalities. Adenosine (6 mg iv, push and repeat to 12 mg iv) may be used for SVT. Most postop SVTs are 2° catecholamine surge. AFib may resolve spontaneously. Hemodynamically unstable patients will require cardioversion. β-blockers, amiodarone, Ca^{+}channel blockers, and overdrive cardiac pacing are effective in patients with stable AFib.
Pain management	Lumbar-thoracic epidural analgesia: hydromorphone (0.5–1.5 mg load, 0.1–0.3 mg/h infusion) + local anesthetic PCEA (p. C-3).	Patient should recover in ICU or hospital ward that is accustomed to treating side effects of epidural opiates (e.g., respiratory depression, hypotension, breakthrough pain, nausea, pruritus)
	PCA	When an epidural cannot be used, a PCA with an opiate such as fentanyl or morphine/hydromorphone may be used for pain control.
	NSAID	Ketorolac is helpful as adjuvant therapy for postop pain management.
Tests	CBC, basic metabolic profile, ABG	

CXR (r/o pneumothorax, atelectasis).

Suggested Readings

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