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CHAPTER 7.7

Laparoscopic General Surgery

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[1]Laparoscopic general surgery

[2]Laparoscopic bariatric surgery

[3]Laparoscopy in pregnancy

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Laparoscopic Repair of Perforated Peptic Ulcer

Surgical Considerations

Description: Duodenal ulcer perforation occurs in 5–10% of duodenal ulcer patients and is responsible for more than 70% of deaths associated with PUD. These patients can present in shock and often are extremely volume depleted. Open repair is indicated if the patient has a "hostile" abdomen, if there is simultaneous bleeding and perforation, if the patient is hemodynamically unstable, if the patient has significant cardiovascular or respiratory risk factors that would make them not tolerate a pneumoperitoneum, or if the surgeon has inadequate experience with the laparoscopic approach. In addition, trained OR personnel and equipment must be available. Risk factors associated with unsuccessful laparoscopic repair include shock on admission, delayed presentation (>24 h), underlying comorbidities, age > 70 yr, and ASA III to iv. For laparoscopic repair, the patient is often placed in a modified lithotomy position with the surgeon standing between the legs. In this case, both arms can be left out. Alternatively, the patient may be in a supine position with the surgeon standing on the patient's left side. In this case, the patient's left arm should be tucked. The patient should be placed in a reverse Trendelenburg position. Access to the abdomen is obtained at the umbilicus with either a Veress needle or a Hasson technique (peritoneal entry through a 1 cm skin incision). Two to four additional ports are placed. Generally, the perforation site can be easily identified by laparoscopy. Occasionally, the surgeon may ask the anesthesiologist to insufflate air through an orogastric or nasogastric tube to help localize the perforation site. Several methods of repair have been reported. The most common involves suture closure of the perforation with omentopexy. Occasionally omentopexy or suture repair alone is used. Reports of closure with fibrin glue have also been published although this technique may be associated with a higher leak rate. Some surgeons will perform endoscopy after repair to ensure adequate closure. Extensive irrigation of the peritoneal cavity (6–10 L or more) is recommended. The position of the operating table is frequently changed during irrigation to allow better access to the entire abdominal cavity. Adequate irrigation can take 20–30 min. Conversion rates are quite high (10–15%) with inability to localize the perforation the most common reason for conversion to open surgery.

Summary of Procedures

Position	Supine, low lithotomy
Incision	3–5 ports
Antibiotics	Cefoxitin 1–2 g iv preop
Surgical time	1–1.5 h
Closing considerations	Port closure only
Special instrumentation	Gastroscope; oro or nasogastric tube
EBL	< 75 mL

Postop care	2–4 d hospital stay; liquids on pod 1
Mortality	typically < 0.1% (as high as 3% in some series)
Morbidity	6–10% overall, including: Abscess (2–8%) Suture leak (5%) Ileus (3–6%); pneumonia
Pain score	3

Patient Population Characteristics

Age range	40–60 yr
Male:Female	May be slightly more common in males
Incidence	10% lifetime risk for perforation
Etiology	May be related to H. pylori infection; NSAID use; stress; corticosteroid use
Associated conditions	gastrinoma; MEN type 1; COPD; CRF; up to 20% may be in shock at the time of admission

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Anesthetic Considerations

See [Anesthetic Considerations following Laparoscopic Cholecystectomy, p. 577.]

Suggested Readings

1. Lunevicius R, Morkevicius M: Management strategies, early results, benefits, and risk factors of laparoscopic repair of perforated peptic ulcer. *World J Surg* 2005; 29(10):1299–310.

2. Sanabria AE, Morales CH, Villegas MI: Laparoscopic repair for perforated peptic ulcer disease. *Cochrane Database Syst Rev 2005*; 4:CD004778.

Laparoscopic Esophageal Fundoplication

Surgical Considerations

Description: Approximately 40% of Americans suffer from heartburn, and most cases are treated medically. Indications for **esophageal fundoplication** (to ↑ lower esophageal sphincter pressure) include complications of GERD, such as stricture, respiratory problems, esophageal ulcerations, and Barrett's esophagus (a premalignant condition). Other indications include failure of medical management or an unwillingness to submit to a lifetime of medication. Most patients with GERD are treated laparoscopically; those undergoing laparoscopic fundoplication have the benefits of a minimally invasive approach—decreased pain, earlier return of GI function, earlier ambulation, earlier discharge, quicker return to normal activities, decreased incidence of wound infections and hernias. The most common fundoplication is the **Nissen (360°) wrap;** and its variations include the Rossetti modification, a **Toupet** (270° posterior) wrap, and the **Dor** (anterior) wrap. Before surgery, patients with GERD should have documented esophageal hyperacidity (by either pH probe or by esophagitis revealed on upper endoscopy), and also should have a hypotensive sphincter (demonstrated on manometry). Typically, they will have been treated with proton pump inhibitors (e.g., lansoprazole) and sometimes with prokinetic agents (e.g., metoclopramide). The patient is placed supine in a low lithotomy position, with the surgeon standing between the legs. The abdomen is entered 2 cm above the umbilicus with either a closed (**Veress needle:** blind placement) or open (**Hasson trocar:** direct visual placement through small skin incision) technique. A total of five trocars are inserted—two in the LUQ, two in the RUQ, and one at the umbilicus. The stomach should be decompressed either with a OG tube or with a gastroscope. The liver is elevated with a liver retractor, and the gastroesophageal (GE) junction and both diaphragmatic crura are dissected out. The hiatus should be closed with one or two sutures. The esophagus is encircled (Fig. 7.7-1

A), and the vagal nerves are identified and preserved. The short gastrics are then taken down to decrease tension on the wrap. The fundus is brought in through the retroesophageal window (Fig. 7.7-2). An esophageal dilator (56–60 Fr) generally is placed (often by the anesthesiologist) to calibrate the wrap. Passage of the dilator is possibly the most hazardous part of the procedure, because it may cause perforation of the esophagus at the GE junction. As the dilator approaches the stomach, it is important to watch the junction on the video monitors to ensure that the dilator is not being held at an angle that will risk perforation. The anesthesiologist should stop passing the dilator immediately if any resistance is felt. The dilator is withdrawn. An NG tube may be placed at this time.

Variant procedure or approaches: Open surgery (see Esophageal Surgery, p. 478) may be indicated if the patient has had previous gastric surgery or if there is a complication with an ongoing laparoscopic procedure. In the **Rossetti modification,** the short gastrics are not taken down, which decreases operative time. The **Dor fundoplication** is an anterior hemifundoplication *(Print pagebreak 572)* in which the fundus is wrapped and sutured to the left and right sides of the esophagus and to the left and right crura, but anteriorly. A Dor fundoplication is often used in combination with a Heller myotomy for treatment of achalasia. A **Toupet procedure** (Fig. 7.7-1 B) is a posterior hemifundoplication in which the two walls of the fundus do not actually meet. The stomach is sewn to the left and right walls of the esophagus and then are anchored to the right and left crura. In the past, these procedures were performed commonly in patients with a high risk of postop dysphagia (e.g., those who have impaired esophageal peristalsis or a preop stricture). Now, because of their higher failure rate, they are seldom performed except in patients with severe esophageal dysmotility, such as patients with scleroderma. These procedures are identical to the Nissen fundoplication except for the wrap itself.

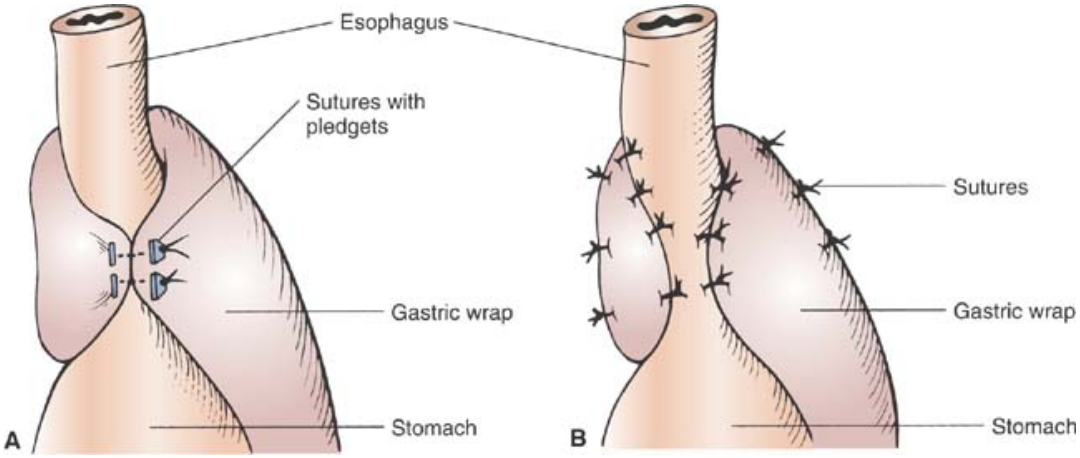

Figure 7.7-1. 1. (A) Nissen fundoplication. **(B)** Partial fundoplication (Toupet procedure).

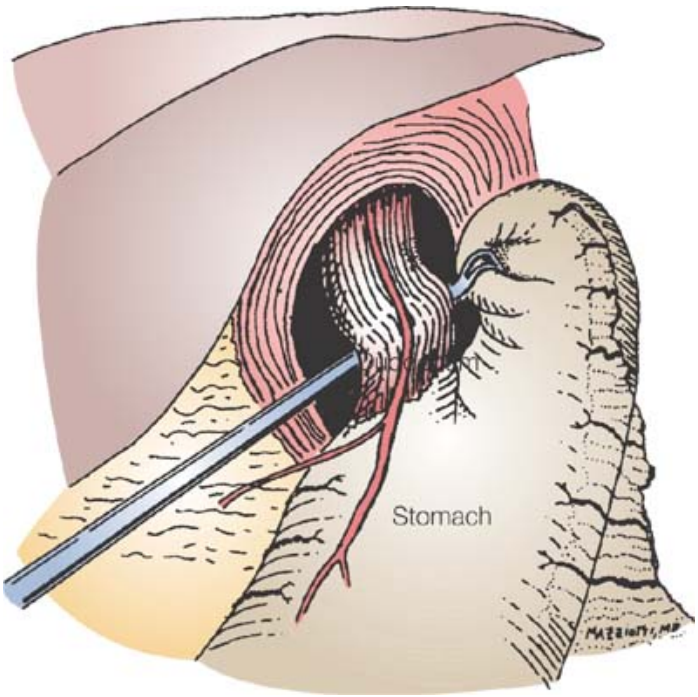

Figure 7.7-2. 2. Gastric fundus is pulled posteriorly and to the right of the esophagus, with the fundus itself used as a retractor, reaching from right to left behind the esophagus to grasp the fundus and retract it back to the right side behind

the esophagus. Placing caudad traction on the wrapped fundus, the GE junction and distal esophagus can be brought further into the abdominal cavity. (Reproduced with permission from Baker RJ, Fischer JE: *Mastery of Surgery,* Lippincott Williams & Wilkins, Philadelphia: 2001.)

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Usual preop diagnosis: GERD, with or without esophagitis, esophageal stricture, or Barrett's esophagus

Summary of Procedures

Position	Supine low lithotomy
Incision	Five ports, upper abdomen
Special instrumentation	Harmonic Scalpel; bipolar cautery or endoscope. Esophageal dilators should be available.
Antibiotics	Cefazolin 1 g iv
Surgical time	1.5–2.5 h
Closing considerations	Port closures only; muscle relaxation may be needed for fascial closure
EBL	< 75 mL
Postop care	1–2 d hospital stay; liquids on pod 1
Mortality	< 0.1%
Morbidity	Overall: 8% Atelectasis: common Esophageal or gastric perforation: rare (most commonly associated with passage of NG tube or esophageal dilator) Hemorrhage from short gastrics or splenic tear Pneumothorax (does not usually require treatment) Postop dysphagia
Pain score	4

Patient Population Characteristics

Age range	All ages (indcidence ↑ with age). May be performed in infants; next peak occurs in adulthood; rare in children and adolescents.
Male:Female	1:1
Incidence	1% (increasing significantly over past 5 yr)
Etiology	Unknown
Associated conditions	Aspiration risk; reactive airway disease; occasionally, respiratory problems associated with chronic aspiration

Anesthetic Considerations

See [Anesthetic Considerations following Laparoscopic Cholecystectomy, p. 577.]

Suggested Readings

1. Bammer T,m Hinder RA, Klaus A, et al: Fve-to eight-year outcome of the first laparoscopic Nissen fundoplications. *J Gastrointest Surg* 2001; 5(1):42–8.

2. Champion JK, McKernan JB: Laparoscopic Toupet fundoplication. In *Surgical Laparoscopy,* 2nd edition. Zucker KA, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 401–8.

3. Cowgill SM, Gillman R, Kraemer E, et al: Ten year follow up after laparoscopic Nissen fundoplication for gastroesophageal reflux disease. *Am Surg* 2007; 73(8):748–53.

4. Dallemagne B: Laparoscopic Nissen fundoplication. In *Atlas of Laparoscopic Surgery*. Ballantyne GH, ed. WB Saunders, Philadelphia: 2000, 92–101.

5. Hughes SG, Chekan EG, Ali A, et al: Unusual complications following laparoscopic Nissen fundoplication. *Surg Laparosc Endosc Percutan Tech* 1999; 9(2): 143–7.

6. Zucker KA: Laparoscopic Nissen fundoplication technique. In *Surgical Laparoscopy,* 2nd edition. Lippincott Williams & Wilkins, Philadelphia: 2001, 375–400.

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Laparoscopic Heller's Myotomy ± Antireflux Procedure

Surgical Considerations

Description: Laparoscopic and thoracoscopic esophageal myotomies have become much more common over the last 5 yr as confidence in laparoscopic esophageal surgery—particularly antireflux surgery—has increased. These procedures are performed for achalasia, an uncommon condition in which the lower esophageal sphincter fails to relax with swallowing, and in which the body of the esophagus is aperistaltic and dilates. Patients typically complain of dysphagia with chest pain and may experience regurgitation. The etiology of this condition remains unknown.

Treatment options consist of pneumatic dilation, botulinum toxin injection of the lower esophageal sphincter, or surgical myotomy. **Pneumatic dilation** remains the most common procedure performed for achalasia, and is effective in 60% of patients. Many gastroenterologists are reluctant to perform this procedure, however, because of the risk of esophageal perforation, which is generally considered to be 3–5%, but may be as high as 10%. **Botulinum toxin injection** is a newer technique that is effective to some degree in most patients, but the duration of its effectiveness is short. Most patients require retreatment within 1.5 yr, and the efficacy of retreatment may diminish over time. In many centers, **surgical myotomy (Heller's operation)** has become the procedure of choice for the treatment of achalasia.

The patient is positioned as for a laparoscopic antireflux procedure—supine in the lithotomy position with reverse Trendelenburg. The abdomen is usually entered with a Veress needle (blind) or Hasson trocar (direct vision) at the umbilicus, and five laparoscopic ports are placed across the upper abdomen—two beneath the left costal margin, two beneath the right costal margin, and one in the midline either at the umbilicus or midway between the umbilicus and the xiphoid. The liver is elevated, and the ligamentous attachments anterior to the esophagus are divided. The esophagus is not usually encircled; and, as hiatal hernias are uncommon with achalasia, crural repair is seldom necessary.

The myotomy is begun at the gastroesophageal junction using monopolar cautery, bipolar scissors, or a Harmonic Scalpel (ultrasonic cutting/coagulation). It is carried proximally until normal musculature is encountered. Some surgeons perform intraop esophagoscopy to ensure that the myotomy has been carried proximally enough and that there has not been a mucosal perforation. Generally, a myotomy of 5–8 cm is adequate, although sometimes a longer myotomy may be necessary. Some surgeons then perform a very loose, partial fundoplication to prevent reflux. This can be performed as an anterior or posterior fundoplication, bringing the fundus either anterior (Dor fundoplication–our preference) or posterior (Toupet fundoplication) to the esophagus. The stomach is secured to the esophageal wall and crural with sutures, and an NG tube may be passed. The ports are removed and port closure carried out.

Variant procedure or approaches: Although most of these procedures are being performed laparoscopically, they also can be performed by thoracoscopy or thoracotomy. If a thoracoscopy or thoracotomy is performed, a DLT is placed to allow collapse of the left lung.

Usual preop diagnosis: Achalasia required

Summary of Procedures

Position	Supine lithotomy, reverse Trendelenburg
Incision	Five ports, upper abdomen
Special instrumentation	Laparoscopic instrumentation ± gastroscope
Antibiotics	Cefazolin 1 g iv
Surgical time	1.5–2 h
Closing considerations	None
EBL	Minimal
Postop care	2-d hospital stay; liquids on pod 1
Mortality	Rare
Morbidity	Insignificant atelectasis: Common Esophageal or gastric perforation: Rare Pneumothorax (does not usually require treatment) Gastroesophageal reflux: > 15%
Pain score	4

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Patient Population Characteristics

Age range	20–40 yr
Male:Female	1:1
Incidence	Uncommon but not rare
Etiology	Unknown
Associated conditions	None. Chagas' disease may produce identical esophageal findings.

Anesthetic Considerations

See [Anesthetic Considerations following Laparoscopic Cholecystectomy, p. 577.]

Suggested Readings

1. Bonavina L. Minimally invasive surgery for esophageal achalasia. *World J Gastroenterol* 2006; 12(37):5291–5.

2. Bonatti H, Hinder RA, Dlocker J, et al: Long-term results of laparoscopic Heller myotomy with partial fundoplication for the treatment of achalaisa. *Am J Surg* 2005; 190(6):874–8.

3. Jeansonne LO, White BC, Pilger KE, et al: Ten-year follow-up of laparoscopic Heller myotomy for achalasia shows durability. *Surg Endosc* 2007; 21(9):1498–1502.

4. Sharp KW, Khaitan L, Scholz S, et al: 100 minimally invasive Heller myotomies: lessons learned. *Ann Surg* 2002; 235(5):631–9.

Laparoscopic Cholecystectomy, ± Common Duct Exploration

Surgical Considerations

Description: This operation typically is performed for symptomatic gallstones or acute cholecystitis. A laparoscopic approach is preferred over an open cholecystectomy because of its minimally invasive nature, which allows earlier recovery and return to normal activities. Laparoscopic cholecystectomy may be contraindicated for patients with uncorrectable coagulopathy, severe COPD, or severe cardiac disease (unable to tolerate ↑ intraabdominal pressure). In addition, patients with prior abdominal surgery or with acute cholecystitis are at a higher risk for conversion to open surgery. The operation begins with access to the abdominal cavity at the umbilicus, either with a Veress needle (closed technique: blind placement) or a **Hasson trocar** (open technique: ↓ risk of vascular, bowel, and bladder injury). If a **Veress needle** is to be used, the patient will need an OG tube and a Foley catheter to decompress the stomach and bladder before proceeding. CO_2 is insufflated to an intraabdominal pressure of 15 mmHg. If the patient develops ventilatory or hemodynamic problems, consider decreasing the intraabdominal pressure to 10–12 mmHg. A total of four trocars are used—one at the umbilicus and three in the RUQ. The patient is placed in a reverse Trendelenburg position and rotated to the left to move the stomach, duodenum, and transverse colon away from the operative field. *(Print pagebreak 576)* The cystic artery and cystic duct (with hepatic duct = triangle of Calot) are clipped and cut (Fig. 7.7-3). The gallbladder is then dissected off the liver with monopolar cautery, placed in a bag, and brought out, usually through the umbilical cord site. Hemostasis is then achieved, the area is irrigated with NS, and the 10 mm trocar sites are closed. The rate of conversion to an open operation is 5% for elective gallbladder surgery and 10% for acute cholecystitis. Should this occur, the operation is then converted to an open cholecystectomy (see p. 558).

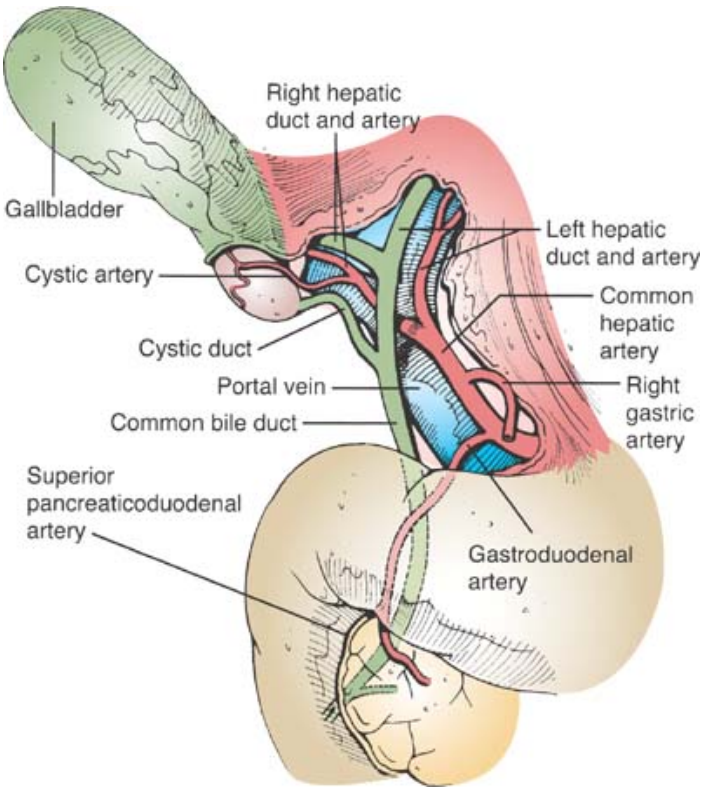

Figure 7.7-3. 3. Surgical anatomy for laparoscopic cholecystectomy and common duct exploration.

Cholangiography can be added easily to the laparoscopic cholecystectomy. A clip is placed high on the cystic duct; then a small incision is made in the duct just beneath the clip. A cholangiocatheter may be introduced and dye injected into the biliary tree. X-rays—either fluoroscopy or, more commonly, hard copy—are used to assess the biliary anatomy and to look for stones within the ductal system. Cholangiography carries few risks, generally adds about 10–15 min to the procedure, and can be used to identify the important anatomy 85% of the time. Some surgeons perform it routinely during all cholecystectomies; others perform it selectively and only if there is evidence that the patient has had common duct stones or if the anatomy is in question.

In rare circumstances, **laparoscopic common duct exploration** may be carried out to treat common duct stones. A number of techniques have been used, most employing a thin fiber optic choledochoscope passed through the cystic duct into the common duct. This procedure is performed in only a relatively few centers. More commonly, **endoscopic retrograde cholangiopancreatography (ERCP)** will be used, either preop or postop to demonstrate the presence or absence of stones and to remove any stones that are found.

Variant procedure or approaches: Open cholecystectomy (p. 558) remains the major alternative to laparoscopic cholecystectomy, either because the cholecystectomy is predicted to be technically difficult or because of the illness of the patient. Approximately 5% or less of laparoscopic cholecystectomies are converted to open cholecystectomy intraop because of difficulties

with the procedure. **ERCP** remains the most common means of treating choledocholithiasis in the industrialized world with laparoscopic techniques used in a relatively small number of centers and by a small number of surgeons. **Open common duct exploration** is occasionally necessary for stones not retrievable by ERCP (generally < 5%).

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Usual preop diagnosis: Acute or chronic cholecystitis, usually with cholelithiasis, with or without choledocholithiasis

Summary of Procedures

Position	Supine
Incision	For upper abdominal ports
Special instrumentation	Routine laparoscopic instruments. May require fluoroscopy and choledochoscopes for cholangiography, common duct exploration; OG tube
Antibiotics	Cefazolin 1 g iv
Surgical time	0.5–2 h; may be longer for common duct exploration.
Closing considerations	Muscular relaxation helpful for closure of umbilical port site
EBL	Minimal
Postop care	Usual discharge within 24 h
Mortality	< 1/1000
Morbidity	Bile leak: 1% Common duct injury: 0.5% Hemorrhage (requiring transfusion) Infection Injury to bowel Major vascular injury: Uncommon
Pain score	3

Patient Population Characteristics

Age range	Typically adult, increasing with age
Male:Female	Female > Male
Incidence	Common
Etiology	Stone disease. Risk factors = female gender, age, parity, obesity.
Associated conditions	Hemolytic anemia for pigmented stones

Anesthetic Considerations

(Procedures covered: repair of perforated peptic ulcer; laparoscopic esophageal fundoplication; laparoscopic Heller's myotomy and antireflux surgery; laparoscopic cholecystectomy)

Preoperative: Laparoscopic Fundoplication/Heller's Myotomy

In general, this patient population is healthy, with the exception of those with a perforated peptic ulcer or GERD. GERD patients often present with intractable heartburn, which is the reason for undergoing these surgical procedures.

Patients undergoing laparoscopic fundoplication may have a history of gastroesophageal reflux resulting in aspiration, particularly when recumbent. Recurrent aspiration may result in a

Respiratory	number of respiratory complications including bronchospasm, pneumonia, and chronic pneumonitis. A prolonged history of reflux may give rise to premalignant Barrett's esophagus which may result in stricture formation and weakness of the esophageal wall. Patients with achalasia may also present for laparoscopic fundoplication. Achalasia may result in severe regurgitation and aspiration. Pulmonary physiological changes include both restrictive and obstructive lung defects, and broncho-alveolar injury. A detailed history and physical examination may reveal cyanosis, wheezing, and rhonchi. Pulmonary function tests findings: ↓ FCV, ↓ FEV_1, ↑↓ FEV_1/FVC, ↓ FRC, ↓ TLC, and ↓ DLCO. **Tests:** Consider PA & lateral CXR. Consider baseline arterial blood gases, and pulmonary function tests if compromised pulmonary function is suspected.
Cardiovascular	Patients with both reflux and achalasia may present with chest pain. Typically the pain of reflux is sharp and substernal. Chest pain in achalasia may radiate to the neck, back and arms, and may be difficult to differentiate from pain of cardiac or vascular origin. Differentiation should be made before surgery both by careful history taking and appropriate tests. In patients with a long history of aspiration, who may have coexisting obstructive airways disease leading to parenchymal lung disease, cor pulmonale or right heart failure may result. Typical physical findings include elevated neck veins, hepatojugular reflux, right ventricular 3rd heart sound and dependent edema. **Tests:** ECG (r/o MI as cause of pain), exercise or chemical stress testing. If severe pulmonary dysfunction consider echocardiography. Other tests as indicated from H&P.
Laboratory	Patients with severe inflammation and erosion may suffer from an iron deficient anemia. In such patients consider CBC. Otherwise laboratory tests as indicated from H&P.
Premedication	These patients are at risk for aspiration and should be treated with full-stomach precautions. H_2antagonists and continue proton pump inhibitors. Metoclopramide may be administered to aid gastric emptying. Na citrate 30 mL po immediately before induction.

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Preoperative: Laparoscopic Cholecystectomy

The preop evaluation of patients undergoing open cholecystectomy is discussed under Anesthetic Considerations for Biliary Tract Surgery, p. 565. Laparoscopic cholecystectomy is being performed much more commonly than the open procedure and can be accomplished quickly and safely, even in very sick patients.

Respiratory	Patients presenting for laparoscopic cholecystectomy may present electively or acutely. Increasingly, cholecystectomy is performed in patients with acute cholecystitis. This presents more challenges to the anesthesiologist than in the elective setting. Patients presenting acutely may experience severe abdominal pain, leading to diaphragmatic splinting and basal lung atelectasis. On examination, the patient may exhibit shallow, rapid breathing, and be cyanosed as a result of poor respiratory effort and increased metabolic demands. Adequate pain relief and respiratory exercises in conjunction with supplemental oxygen preoperatively may help to optimize the patient prior to surgery. During the procedure, intraabdominal CO_2insufflation →

	atelectasis, ↓ FRC, ↑ PIP, ↑ $PaCO_2$ and ↓ PaO_2; therefore, laparoscopic procedures may be contraindicated in patients with severe respiratory or cardiovascular disease. Postop respiratory function, however, is less impaired (e.g., ↓ FRC 30% vs. 50%) and is recovered more quickly (24 h vs. 72 h) in patients undergoing laparoscopic cholecystectomy then in the open procedure.
Systemic	Patients presenting for laparoscopic cholecystectomy with acute cholecystitis may have evidence of mild to moderate sepsis. They may be febrile, tachycardic and hypotensive, and need appropriate resuscitation prior to surgery. Elderly patients may exhibit an acute confusional state.
Laboratory	CBC. Consider T & S in patients with recurrent and chronic gall bladder disease. They may have liver adhesions. During the acute inflammatory stage vascularity may occur → bleeding.
Premedication	See Anesthetic Considerations for Biliary Tract Surgery, p. 566.

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Intraoperative

Anesthetic technique: GETA

Induction	**Laparoscopic fundoplication and Heller's myotomy:** Given the patient's risk for aspiration, the trachea should be intubated after rapid-sequence induction with cricoid pressure (p. B-4). Additional iv access may be required if the arms are inaccessible. **Laparoscopic cholecystectomy:** Standard induction (p. B-2). In acutely unwell patients, despite resuscitation, patients may be more susceptible to the effects of anesthesia, and positive pressure ventilation. Consider additional iv access, invasive arterial pressure monitoring, and central access in labile patients. Etomidate may be a useful induction agent in this setting. Ensuring optimal venous return and right heart filling, through adequate fluid resuscitation and ventilatory strategies to minimize the effect of positive pressure ventilation will be beneficial.
Maintenance	Standard maintenance (p. B-2). Continue muscle relaxation. Intra-abdominal CO_2 insufflation will →↑ intraabdominal pressure, which will predispose to passive regurgitation of gastric contents. In addition, intraabdominal pressure > 15 mmHg → ↓ venous return + ↑ SVR → ↓ CO. Controlled ventilation will minimize the possibility of hypercarbia from absorbed CO_2. N_2O can diffuse into CO_2-containing intraabdominal space and ↑ distension, as well as risk of explosion.
Emergence	Given the high incidence of PONV, prophylactic antiemetic rx (e.g., odansetron 4 mg iv) recommended and should be given 30–60 min before the end of the case (p. B-2).
Blood and fluid requirements	iv: 16–18 ga × 1 NS/LR @ 8–12 mL/kg/h Fluid warmer Blood loss should be minimal, although assessment may be difficult 2° concealed bleeding. Consider retroperitoneal bleeding.
Monitoring	Standard monitors (p. B-1) Urinary catheter NG tube Others as clinically indicated. Prevent hypothermia (forced-air warmer, warming blanket, warm OR, etc.)
Positioning	Initially in Trendelenburg position (↑ venous return, ↓ lung volumes, potential for mainstem intubation) for trocar placement; then reverse Trendelenburg (↓ venous return, ↑ lung volumes) during subsequent portions of the surgical procedure. Maintain adequate MAP to ensure cerebral perfusion in reverse Trendelenburg. and pad pressure points eyes Pneumoperitoneum with CO_2 allows the surgeon to operate laparoscopically. This

Complications	Respiratory: Pneumoperitoneum Hypercarbia/hypoxemia Pneumothorax Pneumomediastinum Endobronchial intubation	creates cephalad displacement of the diaphragm with ↓ FRC, ↓ pulmonary compliance, and atelectasis. This can manifest as ↑ PIP, ↓ $PO_2$and ↑ PCO_2 Ventilation should be controlled during the operation to minimize the effects of pneumoperitoneum and hypercarbia. An increase in MV is appropriate. Pneumothorax can occur 2° retroperitoneal dissection of insufflated CO_2 Pneumothorax will manifest as ↓ PO_2 ↑ PIP, hemodynamic instability (↑ HR, ↓ BP), and possibly subcutaneous emphysema. The position of the ETT may change with altered patient position → endobronchial intubation.
	Cardiovascular: ↓BP Hemorrhage Dysrhythmias	↓ BP can occur 2° patient positioning (reverse Trendelenburg) and from ↓ venous return 2° pneumoperitoneum (↑ intraabdominal pressure > 15 mmHg). Hemorrhage can result from inadvertent injury to blood vessels (during trocar placement). Vascular injection of CO_2(air embolism) can cause ↓ BP, dysrhythmias, and even cardiovascular collapse. If cardiopulmonary compromise occurs, the pneumoperitoneum can be released to allow for differential diagnosis and treatment.
	Visceral injury	Injury to the viscera may necessitate an open procedure or may go undiagnosed and → other postop complications, depending on the organ that is injured. At all times, be prepared to convert to an open procedure.
	Hypothermia	2° dry gas insufflation
	Subcutaneous emphysema	Dx: Sudden ↑ $ETCO_2$+ subcutaneous crepitation (abdomen/chest wall). Rx: Stop insufflation of CO_2 D/C N_2O, ↑ ventilation. Prevention: Keep CO_2insufflation pressure < 12 mmHg.

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Postoperative

Complications	PONV (common) Shoulder pain Respiratory	From pneumoperitoneum; usually self-limited (p. B-2). Respiratory complications can be seen in the postoperative period as well. Typical post operative complications are secondary to pneumoperitoneum but mainly to pain. Adequate pain relief is essential to ensure good respiratory efforts. In the pre-emergence period, lung recruitment measures may help to offset potential respiratory problems. Bronchodilators may also be used in patients with coexisting

		bronchospasm. Early in the postoperative period, starting in the PACU incentive spirometry may be beneficial particularly in obese patients.
Pain management	PCA (see p. C-3). Oxycodone/hydrocodone in combination with acetaminophen	Shoulder pain responds to ketorolac (15–30 mg iv), or other NSAIDs such as Diclofenac provided there are no contraindications.
Tests	As indicated from H&P.	

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2. Cunningham AJ, Nolan C: Anesthesia for minimally invasive surgery. In: *Clinical Anesthesia,* 5th edition, Barash PG, Cullen BF, Stoelting, RK, eds. Lippincott Williams & Wilkens, Philadelphia: 2006, 1061–71.

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(Print pagebreak 581)

Laparoscopic Splenectomy

Surgical Considerations

Description: Laparoscopic-assisted splenectomy is best suited for normal or slightly enlarged spleens (e.g., idiopathic thrombocytopenic purpura [ITP]). Laparoscopic splenectomy usually is contraindicated in patients who have cancer, large hilar lymph nodes, or portal hypertension. At present, the only absolute contraindication to the procedure is massive splenomegaly, with spleens > 30 cm in the longitudinal axis. There is a high conversion rate (to open surgery) if the size of the spleen is between 20–30 cm. Sometimes a hand-assisted approach may be helpful for spleens in this size range. Conversion rates are higher in patients with perisplenitis and morbid myeloproliferative disorders. For the procedure, patients should be placed on a beanbag in a 45° lateral decubitus position or a full lateral decubitus position. The advantage of the 45° right lateral decubitus position is that it is easy to rotate the table and place the patient in a supine position if there is an urgent need for conversion. With the 45° lateral decubitus or the full lateral decubitus position, the kidney rest should be elevated and the OR table should be flexed to increase the area between

the costal margin and the superior iliac crest. All pressure points should be padded, and the patient should be secured firmly to the table. The first trocar site is generally in the LUQ. Access can be with a closed (Veress needle or Optiview trocar) or open (Hasson trocar) approach. The initial approach may be to the hilum, short gastrics, or inferior pole. Most surgeons use the Harmonic Scalpel to take down the various ligaments and to dissect out the hilum, which generally is stapled with an endo GIA. The short gastrics are taken down either with the Harmonic Scalpel or are stapled. The lateral and superior attachments are taken down last. The spleen is then placed in a bag. Removal of the spleen can be done in several ways. Some surgeons remove it with a morselizer placed through one of the trocar sites. Others enlarge one trocar site slightly and remove the spleen in chunks. For very large spleens, some surgeons make a Pfannenstiel incision and extract it through the pelvis.

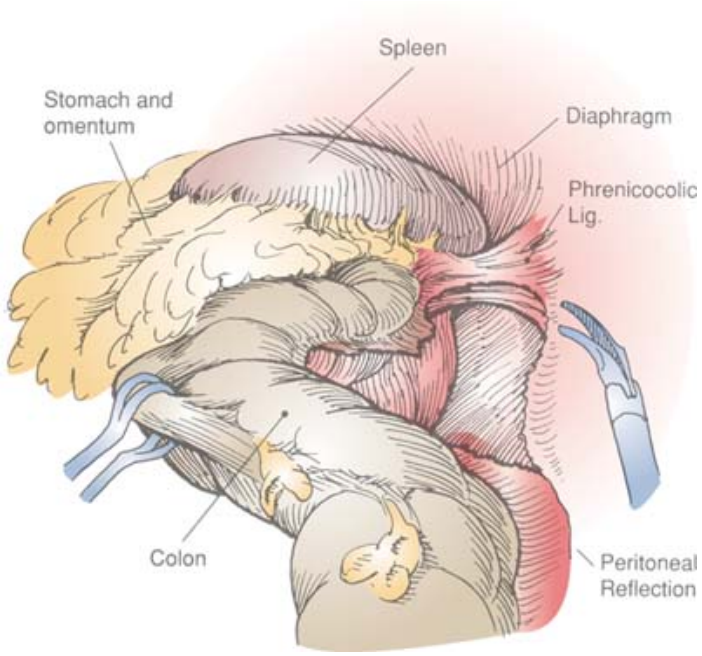

Figure 7.7-4. 4. Anatomy of the spleen. (Reproduced with permission from Wind GG: The spleen. In *Applied Laparoscopic Anatomy: Abdomen and Pelvis.* Williams & Wilkins, Baltimore: 1997.)

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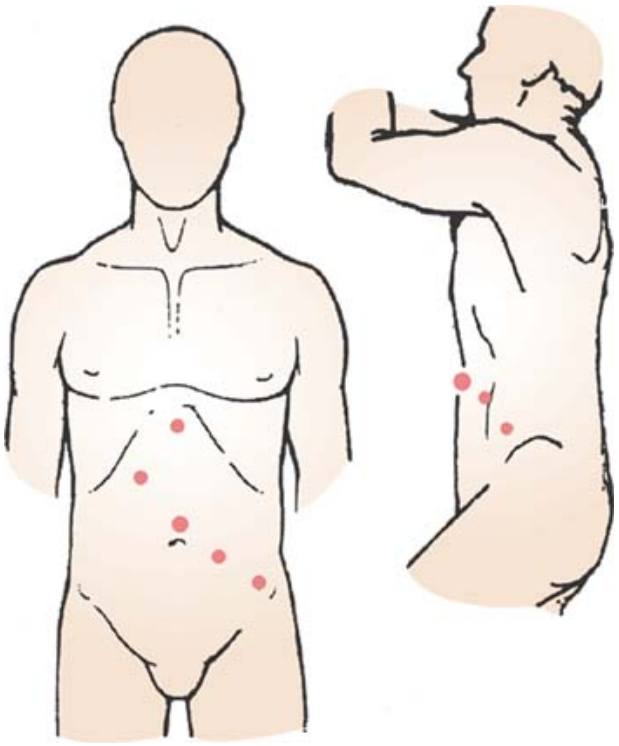

Figure 7.7-5. 5. Trocar location for splenectomy. (Reproduced with permission from Scott-Conner CEH, Dawson DL: *Operative Anatomy,* 2nd ed. Lippincott Williams & Wilkins, Philadelphia: 2003.)

Variant procedure or approaches: Open splenectomy (described on p. 631). **A hand-assist device can be used** for larger spleens. In such a case, a larger incision (5 cm) is made either in the midline or the pelvis and a hand is inserted to assist in retracting and dissecting the spleen, while improving visualization.

Usual preop diagnosis: Idiopathic thrombocytopenic purpura (ITP) (60%); hereditary spherocytosis (10%); hemolytic anemia (5%); thrombotic thrombocytopenic purpura (TTP) (5%); lymphoma (5%); hypersplenism (5%)

Summary of Procedures

Position	Usually decubitus, flexed or beanbag
Incision	3–5 trocar ports; 1 enlarged to extract spleen
Special instrumentation	Vascular staplers; Harmonic Scalpel; bipolar instruments
Unique considerations	Patients should have received vaccinations (pneumococcal, meningococcal, *Haemophilus influenzae*) preop. DVT prophylaxis; ± stress steroids; ± Plt transfusion.
Antibiotics	Cefazolin 1 g iv preop
Surgical time	1–3 h
Closing considerations	Rapid closure not requiring muscle relaxation (following search for accessory spleen)
EBL	< 100 mL; if significant enough to require transfusion, may require conversion to laparotomy.
Postop care	PACU → ward. Generally begin liquids pod 1 and discharge pod 2.
Mortality	0.1 % (predominately related to underlying disease)
Morbidity	5% Hemorrhage Pulmonary complications Injury to pancreas, stomach or splenic flexure of colon
Pain score	5–6

(Print pagebreak 583)

Patient Population Characteristics

Age range	All ages; more common in adults
Male:Female	1:1
Incidence	Uncommon
Etiology	Hematologic disorders (e.g., ITP, TTP); hemolytic anemia, tumor of the spleen (e.g., Hodgkin's disease); hypersplenism
Associated conditions	Steroid dependence; neutropenia; thrombocytopenia; hemolytic anemias

Anesthetic Considerations

Preoperative

Patients present for laparoscopic splenectomy with a variety of diseases, including ITP, lymphomatous disease (Hodgkin's and non-Hodgkin's), autoimmune hemolytic anemia, TTP, hereditary spherocytosis, Evans' syndrome, hairy-cell leukemia, hypersplenism 2° portal HTN, sarcoidosis, polycythemia vera, and myelofibrosis. Open splenectomy is usually reserved for traumatic laceration of the spleen. Previous upper abdominal surgery does not absolutely mitigate against the laparoscopic procedure. Laparoscopic cases tend to take longer than open splenectomies. Patients who have been treated with chemotherapeutic drugs will require careful preop

exam to evaluate for potentially toxic side effects. See Anesthetic Considerations for (open) Splenectomy, p. 627. Patients should receive pneumococcal, meningococcal, and H. influenza vaccinations at least 1 wk preop.

Respiratory	Patients who present with splenomegaly may have a degree of left lower-lobe atelectasis, which should be evaluated by physical examination. As intraabdominal CO_2 insufflation → further atelectasis, ↓ FRC, ↑ PIP, ↑ $PaCO_2$ and ↓ PaO_2; therefore, laparoscopic procedures may be contraindicated in patients with severe respiratory disease. **Tests:** Consider P/A & lateral CXR; ABG; PFTs, if clinically indicated.
Cardiovascular	Cardiovascular changes caused by the pneumoperitoneum include ↓ venous return → ↓ CO and ↑ SVR. Decreased blood flow to the splanchnic and renal circulations (→ ↓ UO) may result from high intraabdominal pressures.
Hematologic	Cytopenias are very common. **Tests:** CBC with differential & Plt count. In view of potential bleeding, a type and screen should be performed. Consider cross matching in patients with coexisting disease. It may be difficult to cross match patients as they may exhibit antibodies, extra time should be allotted for cross matching preoperatively
Hepatic	Consider presence of coexisting hepatic dysfunction due to primary disease and/or therapy for it. **Tests:** Hepatinc panel, PT/PTT
Laboratory	As indicated from H&P.
Premedication	Standard premedication (p. B-1).

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Intraoperative

Anesthetic technique: GETA

Induction	Standard induction (p. B-2). In patients with coexisting liver disease, modify medication choice and dosage accordingly.	
Maintenance	Standard maintenance (p. B-2)	
Emergence	No special considerations. Prophylactic antiemetics are appropriate.	
Blood and fluid requirements	iv: 18–16 ga × 1 NS/LR @ 8–12 mL/kg/h Fluid warmer	Blood loss should be < 1 U. If Plt transfusion is necessary, it should be given after ligation of splenic vessels (↓ sequestration). Be prepared to obtain more iv access if bleeding is excessive. Consider extra iv access if arms inaccessible at the start of the case.
Monitoring	Standard monitors (p. B-1). Urinary catheter NG tube	Others as indicated by patient status. Prevent hypothermia (forced-air warmer, heated and humidified inspired gases, warming blanket, warm OR, etc.).
Positioning	and pad pressure points eyes	Careful positioning and padding of patient is essential.
General Considerations		If the spleen is large (> 20 cm), there is a higher rate of conversion to an open procedure. In particular, intraoperative pain will be greater; hence, analgesic requirements will be higher.
	Respiratory: Cardiovascular:	

Complications	↓ BP Hemorrhage Dysrhythm Visceral injury Hypothermia Subcutaneous emphysema Bleeding	The complications of laparoscopy are discussed in Anesthetic Considerations for Laparoscopic Cholecystectomy, p. 577. Typically, when blood loss > 750–1000 mL, convert to open splenectomy. Plt transfusion may be necessary.

Postoperative

Complications	Shoulder pain PONV Atelectasis	2° pneumoperitoneum; usually self-limited. Ketorolac (30 mg iv) or other NSAIDs effective. See p. B-2. Usually left lower lobe
Pain management	PCA (p. C-3). A multimodal approach to analgesia is useful in these patients. Be cautious with NSAIDs in patients with coexisting bone marrow disease.	
Tests	As indicated by patient status.	

Suggested Readings

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6. Park AE: Lateral approach to laparoscopic splenectomy. In *Surgical Laparoscopy,* 2nd edition. Zucker KA, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 625–34.

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8. Sampath S, Meneghetti At, MacFarlane JK, et al: An 18-year review of open and laparoscopic splenectomy for idiopathic thrombocytopenic purpura. *Am J Surg* 2007; 193(5): 580–58.

Laparoscopic Adrenalectomy

Surgical Considerations

Description: Laparoscopic adrenalectomy typically is performed for a variety of adrenal problems, such as Conn's disease, functioning adenoma, pheochromocytoma, Cushing's disease, hyperplasia, virilizing or feminizing tumors, and an enlarging, nonfunctioning adenoma. Contraindications to laparoscopic surgery include invasive malignancy, malignant pheochromocytoma, and coagulopathy that cannot be corrected. Urologists generally use a retroperitoneal approach, while other surgeons use a

transabdominal approach. The patient should be on a beanbag in the full lateral decubitus position (Fig. 7.7-6). The kidney rest should be elevated and the table should be flexed to open up the area between the costal margin and iliac crest. A left adrenalectomy is typically easier than a right adrenalectomy. On the left side, three trocars are required along the costal margin. Surgery begins by immobilizing the spleen and the colon laterally, which allows the spleen to fall away completely from the adrenal gland. The adrenal is then seen behind the hilum of the spleen. Care should be taken to minimize manipulation of a pheochromocytoma, to prevent sudden, unexpected HTN during the operation. In general, most surgeons prefer to clip and cut the adrenal vein first. After the adrenal is completely mobilized, it is removed through one of the port sites. For a right-sided approach, four trocars generally are required along the costal margin. The 4th trocar is used to retract the liver. The first step on the right side is to mobilize the lateral attachments of the liver to expose the adrenal. An enlarged right adrenal may be difficult to mobilize enough to see the adrenal vein, because the right adrenal vein empties directly into the IVC. Most surgeons recommend using an endo GIA stapler to divide the right adrenal vein.

Variant procedure or approaches: Open procedure (p. 668) or retroperitoneal approach

Usual preop diagnosis: Indeterminate adrenal mass (nonfunctional adenoma); also can be performed for functional adenomas, rarely for pheochromocytoma. Contraindicated for known carcinoma.

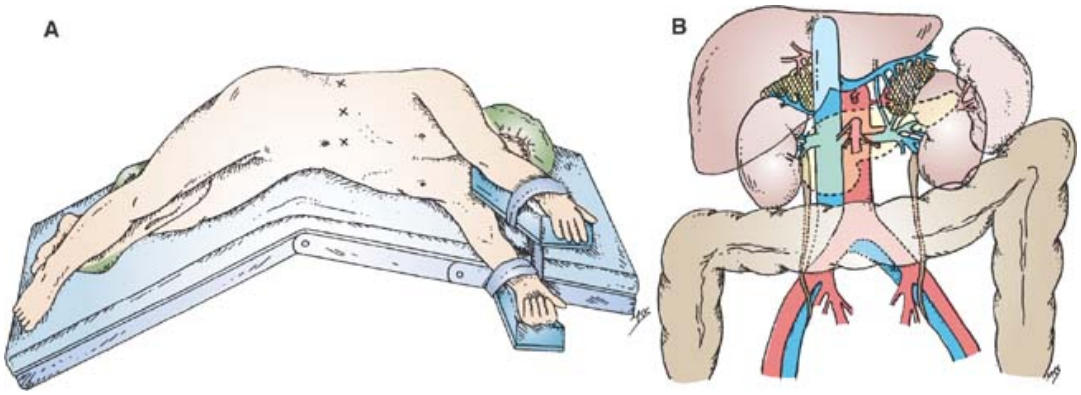

Figure 7.7-6. 6. Laparoscopic adrenalectomy. **(A)** Patient positioning and port locations. **(B)** Anatomic relationships of adrenals (sutured) to adjunct and overlying structures. (Reproduced with permission from Scott-Conner CEH, Dawson DL: *Operative Anatomy,* 2nd ed. Lippincott Williams & Wilkins, Philadelphia: 2003.)

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Summary of Procedures

Position	Lateral decubitus. A patient with bilateral disease may need repositioning between sides; or surgeon may use a supine approach.
Incision	3 ports on left side; 4 ports on right side
Antibiotics	Cefazolin 1 g iv
Surgical time	1–2 h
Closing considerations	Brief closure; muscle relaxation helpful for fascial repair
EBL	< 75 mL, although occasionally significant blood loss may occur.
Postop care	Patient usually discharged on pod 1 or 2, depending on BP control.
Mortality	< 0.1%
Morbidity	Hemorrhage/hematoma Injury to pancreas or kidney UTI DVT
Pain score	4

Patient Population Characteristics

Age range	All ages
Male:Female	1:1
Incidence	Varies with underlying disorder
Etiology	Pheochromocytoma (25%); nonfunctioning adenomas, aldosteronoma (21%); cortisol-producing adenoma (15%); Cushing's disease (8%)
Associated conditions	Depending on function of tumor (e.g., HTN for aldosteronoma, Cushing's disease)

Anesthetic Considerations

Preoperative

The preop evaluation of patients undergoing laparoscopic adrenalectomy is discussed under Anesthetic Considerations for (open) Adrenalectomy, p. 672.

Cardiovascular	Cardiovascular changes caused by the pneumoperitoneum include ↓ venous return →↓ CO and ↑ SVR. Decreased blood flow to the splanchnic and renal circulations (→ ↓ UO) may result from high intra-abdominal pressures.

Intraoperative

Anesthetic technique: GETA. An epidural should not be necessary for postop analgesia if the procedure is performed laparoscopically. If the surgical team feels that there is a high likelihood of conversion to an open procedure, consider placement of an epidural catheter for postop analgesia.

Induction	See induction under (open) Adrenalectomy, p. 673.	
Maintenance	See maintenance under (open) Adrenalectomy, p. 673.	
Emergence	See emergence under (open) Adrenalectomy, p. 674. Case is likely to take longer if performed laparoscopically, but usually has a less painful postop course. Prophylactic antiemetics are appropriate.	
Blood and fluid requirements	iv: 16–14 ga × 1 NS/LR @10–15 mL/kg/h	Warming techniques important (forced-air warmers, fluid warmers, humidified inspired gases, etc.).
Monitoring	Standard monitors (p. B-1). UO Arterial line ± PA catheter TEE	A PA catheter is useful in the management of patients with pheochromocytoma. TEE may be needed to evaluate cardiac function and filling.
Positioning	and pad pressure points eyes	Careful support and padding of extremities and torso is very important.
Complications: laparoscopic	Respiratory: Pneumoperitoneum Hypercarbia/hypoxemia Pneumothorax Pneumomediastinum Endobronchial intubation Cardiovascular: ↓ BP Hemorrhage	The complications of laparoscopy are discussed in Anesthetic Considerations for Laparoscopic Cholecystectomy, p. 579.

	Dysrhythmias Visceral injury Subcutaneous emphysema Hypothermia	
	Pheochromocytoma: BP lability Myocardial dysfunction Conn's syndrome: CHF 2° hypervolemia ↓ BP Electrolyte disturbances Hyperglycemia Cushing's syndrome: ↓ BP Acute adrenal insufficiency	Rx: intraop HTN with SNP or phentolamine (2.5–5 mg q 5 min); ↑ HR with esmolol; ↓ BP with phenylephrine or dopamine. (See Anesthetic Considerations for Adrenalectomy, p. 673.) See Anesthetic Considerations for Adrenalectomy, p. 673. Continue replacement steroids. (See Anesthetic Considerations for Adrenalectomy, p. 673.)
Complications: endocrine		

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Postoperative

Complications	PONV Shoulder pain	See p. B-2. Consider ketorolac 30 mg iv.
Pain management	PCA (p. B-4).	See Anesthetic Considerations for Adrenalectomy, p. 674.
Tests	As indicated	

Suggested Readings

1. Area MJ, Gagner M: Laparoscopic management of adrenal lesions. In *Surgical Laparoscopy,* 2nd edition. Zucker KA, ed. Lippincott Williams & Wilkins, Philadelphia: 2001, 635–42.

(Print pagebreak 588)
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Laparoscopic Bowel Resection

Surgical Considerations

Description: The surgical community has not uniformly embraced **laparoscopic bowel surgery.** It is technically very difficult because the surgeon has to maneuver in several quadrants during the operation. In benign diseases (e.g., ulcerative colitis, Crohn's disease, diverticular disease, and polyps) there are clear advantages to a laparoscopic approach to bowel resection, including decreased pain, earlier return of GI function, earlier ambulation, and earlier discharge from the hospital. Although these advantages also apply to the patient with cancer, there are still reservations about whether cure and survival rates are the same. Preliminary data from several ongoing multicenter trials indicate *(Print pagebreak 589)* that the length of the specimen and the number of lymph nodes removed are the same with both approaches. Data regarding staging and survival indicate similar outcomes are similar with laparoscopic or open approaches.

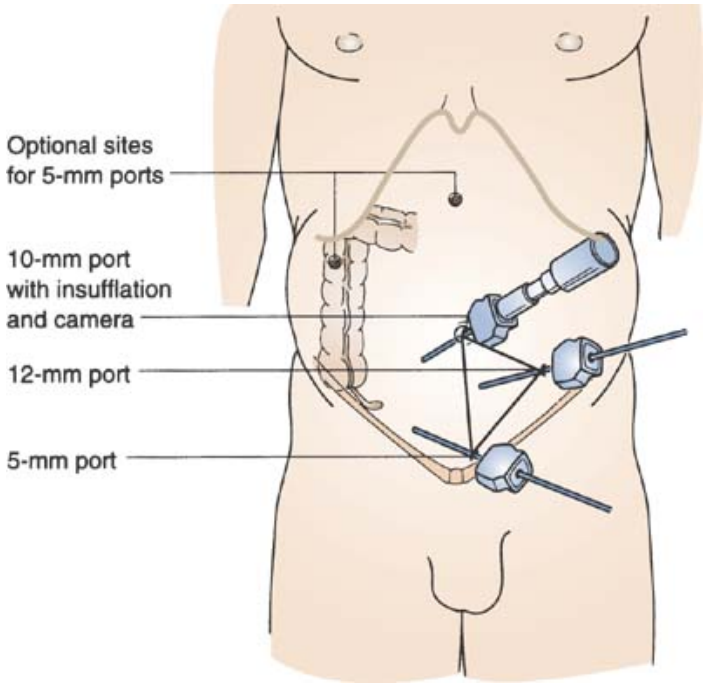

Figure 7.7-7. 7. Trocar placement for a right colectomy. The general principle is to place the camera port so that the surgeon's visual axis is parallel to the telescope, and to place the working ports so that the operative site is at the apex of an isosceles triangle. (Reproduced with permission from Greenfield LJ, Mulholland MW, Oldham KT, et al, eds: *Surgery: Scientific Principles and Practice,* 2nd ed Lippincott-Raven Publishers, Philadelphia: 1997.)

For a left-sided colon resection, the patient is placed in a low lithotomy position, while in other bowel resections, a supine position is used. The patient's arms should be tucked to improve access to all four quadrants. Generally, four to five ports are required, one in each quadrant. For a **laparoscopic-assisted approach,** one of these ports will be enlarged slightly for removal of the specimen. Very often the operating table will need to be tilted or rotated throughout the course of the procedure to help move the small intestines away from the surgical dissection site. The procedure typically begins with localization of the pathology. This may require an intraop sigmoidoscopy if the lesion has not already been marked on colonoscopy or if it is not grossly apparent. The involved section of the intestine is then mobilized. Often, division of the mesentery is done intracorporeally. Occasionally, surgeons will exteriorize the bowel and do extracorporeal division of the mesentery and extracorporeal division of the bowel. For right-sided lesions, the anastomosis typically is done extracorporeally; however, for left-sided lesions, once the bowel is removed, the extraction site will be closed. The pneumoperitoneum will be reinsufflated and the anastomosis will be performed intracorporeally with an end-to-end stapler placed through the anus.

Unipolar and bipolar cautery, the Harmonic Scalpel, and many different surgical staplers may be used during these procedures. These generally require longer operative times than the corresponding open procedures but, typically, they are associated with shorter hospitalization stays and earlier return to work than traditional laparotomy.

Variant procedure or approaches: Open surgery (see p. 518), laparoscopic-assisted, or totally laparoscopic procedures. Some surgeons also have recommended a hand-assisted procedure where a pneumoperitoneum is still used, but the port site of extraction is enlarged at the beginning of the operation. The surgeon's hand can be placed through a special sleeve that maintains

pneumoperitoneum, but also allows the surgeon to retract and dissect manually. Occasionally, the specimen is removed via the anus or through a vaginotomy.

Usual preop diagnosis: Intestinal obstruction; inflammatory conditions (e.g., diverticulitis, bleeding, neoplasms); cancer (controversial)

Summary of Procedures

Position	Usually supine; sometimes lithotomy for left-sided procedures
Incision	4–5 trocar sites, one in each quadrant. One site will be enlarged for specimen removal and/or anastomosis in laparoscopic-assisted procedures.
Special instrumentation	Harmonic Scalpel, various laparoscopic stapling instruments
Unique considerations	The operating table will be moved quite frequently to help with visualization.
Antibiotics	Cefotetan 1 g iv preop
Surgical time	1.5–2 h (small bowel resection); 3–4 h (colonic resection). Surgical times will ↑ in the presence of acute inflammation and as the bowel resection becomes more extensive.
Closing considerations	Usually requires closure of several port sites; muscle relaxation helpful.
EBL	< 200 mL
Postop care	NG tube seldom used. Most patients begin regular diet within 48 h; discharge, generally 3–4 d.
Mortality	< 0.1%
Morbidity	< 5% (similar in magnitude to those seen with open operations) Complications include: Hemorrhage Infection Anastomotic leak Intestinal obstruction
Pain score	6–7

(Print pagebreak 590)

Patient Population Characteristics

Age range	All ages (increases with age)
Male:Female	1:1
Incidence	Varies with disease process.
Etiology	Diverticulitis; polyps; inflammatory bowel disease (IBD)
Associated conditions	None

Anesthetic Considerations

Preoperative

For respiratory, cardiovascular, musculoskeletal, gastrointestinal, and renal considerations, see Anesthetic Considerations for Intestinal and Peritoneal Procedures, p. 627.

Additional considerations	Laparoscopic bowel resection is performed for both malignant and benign disease. Patients presenting may have a long history of inflammatory bowel disease such as ulcerative colitis or Crohn's disease. Typically they have received medical therapy, surgical treatments or both. Medical therapies include 5-aminosalicylic acid compounds and immunosuppressants, such as corticosteroids and methotrexate. Side effects of medical therapies include interstitial nephritis, pancreatitis, pleuropericarditis (5-aminosalicylic acids) immunosuppression, truncal obesity, diabetes, and hypertension (corticosteroids). Patients who have had previous surgery or severe disease may have adhesions making the impending laparoscopic surgery more technically challenging. Inflammatory bowel disease is associated with a number of coexisting conditions including arthritis, uveitis, biliary stasis which may impact upon anesthetic management.
Tests	CBC, Renal panel, T&S. Others as per history and physical exam
Premedication	Standard premedication (p. B-2). If patient is at risk for a full stomach, administration of metoclopramide (10 mg iv) and H_2 blocker (ranitidine 50 mg iv), as well as Na citrate 0.3 M 30 mL po. Metoclopramide should not be used in patients with bowel obstructions or perforations.

Intraoperative

Anesthetic technique: GETA

Induction	Standard induction (p. B-2). Standard rapid-sequence induction if at risk for aspiration (p. B-4).	
Maintenance	Standard maintenance (p. B-2).	
Emergence	No special considerations unless the patient is at risk for aspiration; extubation should then occur after the patient is fully awake and has protective airway reflexes.	
Blood and fluid requirements	IV: 16–18 ga × 1 NS/LR @ 8–12 mL/kg/h Fluid warmer	Blood loss should be < 1 U.
Monitoring	Standard monitors (p. B-1). Urinary catheter	Others as indicated by patient status. Prevent hypothermia (forced-air warmer, warming blanket, warm room, etc).
Positioning	NG tube to decompress the stomach and pad pressure points eyes	
Complications	Respiratory: Pneumoperitoneum Hypercarbia/hypoxemia Pneumothorax Pneumomediastinum Endobronchial intubation Cardiovascular: ↓ BP Dysrhythmias Hemorrhage Visceral injury Hypothermia Subcutaneous emphysema	These complications (associated with the preperitoneal approach), as well as the general complications of laparoscopy, are discussed in Anesthetic Considerations for Laparoscopic Cholecystectomy, p. 577.

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Postoperative

Complications	PONV Shoulder pain	See p. B-2. Ketorolac (30 mg iv) or other NSAIDS.
Pain management	PCA (p. C-3).	
Tests	As indicated by patient status.	

Suggested Readings

1. Ballantyne GH, ed: *Atlas of Laparoscopic Surgery.* WB Saunders, Philadelphia: 2000, 300–404.

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Laparoscopic Appendectomy

Surgical Considerations

Description: Appendectomy generally is performed for suspected appendicitis. The patient is placed in the supine position with the left arm tucked. An OG tube should be inserted to decompress the stomach. Access is obtained at the umbilicus, either through a closed (**Veress needle**) technique or open (**Hasson trocar**) technique. If a Veress needle is used, a Foley catheter should be inserted. Two additional trocars are inserted—one suprapubic and the other in the LLQ. The port in the LLQ is a 10/12 mm trocar to allow passage of an endo GIA stapler. Occasionally, a 4th trocar may be placed in the RUQ to help with mobilization and retraction. The table will then be rotated to the left side and the surgeon may ask for it to be placed in Trendelenburg or reverse Trendelenburg position, depending on the location of the cecum. The base of the cecum is identified and the appendix is mobilized (Fig. 7.7-8B). This may require dissection of the peritoneal edge along the right gutter. After the appendix is mobilized, a window is created in the mesoappendix, and the base of the appendix is stapled with an endo GIA. The mesoappendix is then stapled with a vascular-cartridge endo GIA. The appendix generally is placed in a bag prior to delivering it or it may *(Print pagebreak 592)* be brought directly through the 10/12-mm trocar. The umbilical fascia is closed and the skin is loosely approximated. When unexpected pathology is identified, it can be dealt with by laparoscopy or by laparotomy, with incision placement dependent on findings.

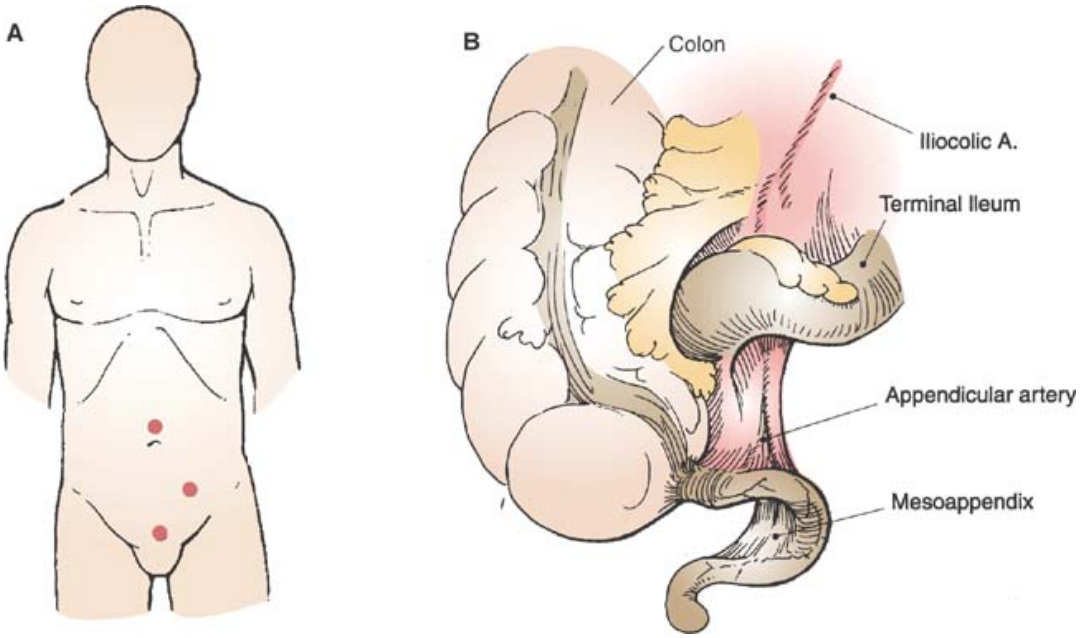

Figure 7.7-8. 8. Setup and initial view for laparoscopic appendectomy. **(A)** Reproduced with permission from Scott-Conner CEH, Dawson DL: *Operative Anatomy,* 2nd edition. Lippincott Williams & Wilkins, Philadelphia: 2003. **(B)** Reproduced with permission from Wind GG: The spleen. In *Applied Laparoscopic Anatomy: Abdomen and Pelvis.* Williams & Wilkins, Baltimore: 1997.

Variant procedure or approaches: Open appendectomy (see p. 509) via RLQ or midline incision

Usual preop diagnosis: Acute abdomen; possible acute appendicitis

Summary of Procedures

Position	Supine
Incision	3–4 ports (see Fig. 7.7-8A)
Antibiotics	Cefazolin 1 g iv preop
Surgical time	60–90 min
Closing considerations	Muscular relaxation helpful for umbilical closure; NG tube if prolonged ileus suspected.
EBL	< 75 mL
Postop care	Patients are hospitalized for varying lengths of time, depending on their need for antibiotics. Many with simple acute appendicitis can go home within 24 h.
Mortality	Perforated: 2–5% (nonperforated: < 0.1%); increased in elderly patients and infants.
Morbidity	Overall: 3% if nonperforated; 20–50% with perforation Intraabdominal abscess Hematoma Ileus Risk of intraabdominal abscess, mostly dependent on pathology (e.g., early acute inflammation vs perforation) Hemorrhage Infection Stump leak: exceedingly rare Conversion to open procedure: dependent on pathology and experience of surgeon
Pain score	4

(Print pagebreak 593)

Patient Population Characteristics

Age range	All ages; commonly, 19–25 yr
Male:Female	1:1
Incidence	Common (7%)
Etiology	Acute appendicitis; etiology unknown
Associated conditions	Consider other pelvic pathology in women of childbearing age.

Anesthetic Considerations

Preoperative

This patient population is generally fit and healthy, apart from their acutely presenting illness. Full-stomach precautions (see p. B-4) are appropriate in these patients.

Respiratory	Respiratory impairment can occur 2° acute abdominal pain and splinting. Tachypnea and hyperpnea can be heralding Sx of appendiceal perforation and sepsis. Patients with acute abdomen should be treated as if they have full stomachs. **Tests:** As indicated from H&P.
Cardiovascular	Cardiovascular changes caused by the pneumoperitoneum include ↓ venous return → ↓ CO and ↑ SVR. Decreased blood flow to the splanchnic and renal circulations (→ ↓ UO) may result from high intraabdominal pressures. May be dehydrated from fever, emesis, and decreased oral intake. Assess volume status with VS and hydrate adequately before anesthetic induction. **Tests:** ECG, if indicated from H&P.
Gastrointestinal	Patient typically has abdominal pain with N/V. Muscular resistance to palpation of abdominal wall frequently parallels the severity of the inflammatory process. With spreading peritoneal irritation (as with perforation), patient will develop abdominal distension and paralytic ileus. **Tests:** Renal panel, consider pregnancy test
Hematologic	Moderate leukocytosis (10,000–18,000) with left shift. Hemoconcentration likely if patient dehydrated. **Tests:** CBC
Laboratory	Others as indicated from H&P.
Premedication	Patients with acute appendicitis should be treated as if they have full stomachs. Consider administration of metoclopramide (10 mg iv) and H_2blocker (ranitidine 50 mg iv), as well as Na citrate 0.3 M 30 mL po. Opiate premedication (morphine 0.08–0.15 mg/kg im) is indicated after patient is scheduled for surgery if patient in pain. Acertain if patient received opiates during ED eval and management.

(Print pagebreak 594)

Intraoperative

Anesthetic technique: GETA, with rapid-sequence iv induction.

Induction	Preoxygenate patient and have an assistant apply cricoid pressure. Etomidate 0.1–0.4 mg/kg or propofol 1.5–3 mg/kg + succinylcholine 1.5 mg/kg, for intubation.	
Maintenance	Standard maintenance (p. B-2), without N_2O.	
Emergence	Extubate when the patient is awake and with active laryngeal protective reflexes.	
Blood and fluid requirements	IV: 16–18 ga × 1 NS/LR @ 5–8 mL/kg/h	
Monitoring	Standard monitors (p. B-1). Urinary catheter NG tube	Others as indicated by patient status. Prevent hypothermia (forced-air warmer, warming blanket, warm room, etc.)
Positioning	and pad pressure points eyes Secure or tuck arms	Trendelenburg position with elevation of the right side of the abdomen improves surgical exposure.
Complications	Respiratory: Pneumoperitoneum Hypercarbia/hypoxemia Pneumothorax Pneumomediastinum Endobronchial intubation Cardiovascular: Hypotension Dysrhythmias Visceral injury Hypothermia Subcutaneous emphysema	These complications (associated with the preperitoneal approach), as well as the general complications of laparoscopy, are discussed in Anesthetic Considerations for Lap Cholecystectomy, p. 577.

Postoperative

Complications	PONV Urinary retention	See p. B-2. Straight catheterization of the bladder
Pain management	PCA (p. C-3). Oral analgesics Ketorolac	Acetaminophen po q 6 h or Percocet – 2 po q 6 h 30 mg iv
Tests	As indicated by patient status.	

Suggested Readings

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(Print pagebreak 595)

Laparoscopic Inguinal Hernia Repair

Surgical Considerations

Description: Laparoscopic hernia repair is clearly preferred in patients with recurrent or bilateral hernias. In patients with first-time unilateral hernias, there are no clear advantages in terms of operative time, postop pain, time to discharge, or time to return to normal activities, compared with tension-free open repair (see p. 636). There are three types of laparoscopic hernia repairs. The first, **ONLAY,** generally has been discarded because of high recurrence rates. The other two are the **totally extraperitoneal** (**TEP**) and the **transabdominal preperitoneal** (**TAPP**) techniques. Of these, the TEP is somewhat more difficult to learn, but is associated with lower recurrence rates and complications than is the TAPP. For both the TEP and the TAPP, the patient is placed in the supine position with both arms tucked. Some surgeons insert a Foley, but many do not. A small incision is made at the umbilicus. For a **TEP,** this incision only goes to the preperitoneal space, and a balloon is then used for dissection. Two additional ports are placed in the midline—one suprapubic and one halfway between the umbilicus and the suprapubic port. Further dissection is required to identify the hernia defects, which are then reduced. The cord structures are completely freed and any cord lipomas are dissected. Mesh is placed to cover the entire area and is tacked to Cooper's ligament. For a **TAPP** repair, the umbilical incision extends into the abdomen. Two additional ports are placed at the level of the iliac crest—one in the RLQ and one in the LLQ. A peritoneal flap over the hernia defect is created and the preperitoneal space is entered. The rest of the dissection and the placement of the mesh are the same as with the TEP repair. At the end of the TAPP procedure, the peritoneal flap is placed over the mesh and tacked into place to prevent exposure of the bowel to the mesh.

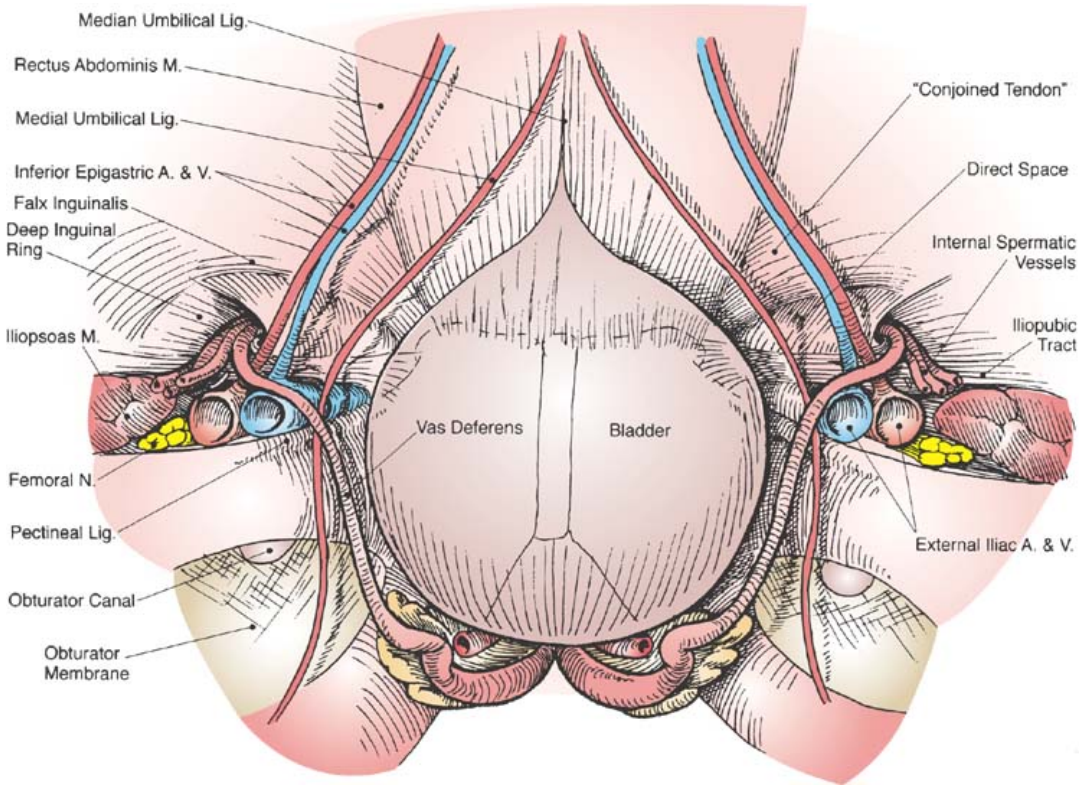

Figure 7.7-9. 9. The inguinal region. (Reproduced with permission from Wind GG: The inguinal region. In *Applied Laparoscopic Anatomy: Abdomen and Pelvis.* Williams & Wilkins, Baltimore: 1997.)

(Print pagebreak 596)

Variant Procedure or approaches: Open hernia repair (see Inguinal Herniorrhaphy, p. 636).

Usual preop diagnosis: Inguinal hernia

Summary of Procedures

Position	Supine, arms tucked
Incision	3 ports—1 at the umbilicus; 2 either in the midline or RLQ or LLQ, depending on the laparoscopic approach.
Special instrumentation	Balloon dissector for TEP repair
Antibiotics	Cefazolin 1 g iv preop
Surgical time	1–2 h
Closing considerations	Minimal time; muscle relaxation may be helpful.
EBL	< 50 mL
Postop care	1–2 h in PACU/holding area → home
Mortality	< 0.1%
Morbidity	2% Orchialgia, neuralgia Recurrence of hernia: significant learning curve Bowel obstruction Bladder injury: rarely reported
Pain score	3–4

Patient Population Characteristics

Age range	Mostly adults
Male:Female	Male > Female
Incidence	Common
Etiology	Most hernias congenital; chronically increased intraabdominal pressure (e.g., chronic cough, obesity)
Associated conditions	None important

Anesthetic Considerations

Preoperative

The preop evaluation of patients undergoing laparoscopic hernia repair is discussed in Anesthetic Considerations for Inguinal Hernia, p. 641. Patients presenting for this procedure are generally healthy. Laparoscopic repair of inguinal hernia is usually associated with less pain and earlier return to preop function when compared to the open procedure. Patients with strangulated or incarcerated hernias usually require open procedures.

Cardiovascular	Cardiovascular changes caused by the pneumoperitoneum include ↓ venous return → ↓ CO and ↑ SVR. Decreased blood flow to the splanchnic and renal circulations (→ ↓ UO) may result from high intraabdominal pressures.
Laboratory	Hb/Hct (healthy patients); otherwise, as indicated from H&P.
Premedication	Standard premedication (p. B-2).

(Print pagebreak 597)

Intraoperative

Anesthetic technique: GETA

Induction	Standard induction (p. B-2)
Maintenance	Standard maintenance (p. B-2)

Emergence	No special considerations except to minimize coughing on emergence. Consider 1 mg/kg iv lidocaine.	
Blood and fluid requirements	iv: 18 ga × 1 NS/LR @ 5–8 mL/kg/h	Blood loss should be minimal.
Monitoring	Standard monitors (p. B-1). Urinary catheter NG tube	Others as indicated by patient status. Prevent hypothermia (forced-air warmer, heated and humidified gases, warming blanket, warm OR, etc.).
Positioning	and pad pressure points eyes	Careful positioning and padding of the patient is essential.
Complications	Hemorrhage from trocar insertion. Subcutaneous emphysema	These complications (associated with the preperitoneal approach), as well as the general complications of laparoscopy, are discussed in Anesthetic Considerations for Laparoscopic Cholecystectomy, p. 577.

Postoperative

Complications	PONV (see B-6) Urinary retention	Ondansetron (4 mg iv) Straight catheterization of the bladder
Pain management	Oral opiates Ketorolac	Tylenol #3 – 2 po q 6 h or Percocet – 2 po q 6 h. 15–30 mg iv
Tests	As indicated by patient status.	

Suggested Readings

1. Cooper SS: Laparoscopic inguinal hernia repair: is the enthusiasm justified? *Am Surg* 1997; 63(l):103–6.

2. Corbitt J: Laparoscopic transabdominal preperitoneal patch hernia repair. In *Atlas of Laparoscopic Surgery.* Ballantyne GH, ed. WB Saunders, Philadelphia: 2000, 502–15.

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6. Liem MS: Comparison of conventional anterior surgery and laparoscopic surgery for inguinal-hernia repair. *N Engl J Med* 1997; 336(22):1541–7.

7. Matthews RD, Anthony T, Kim LT, et al: Factors associated with postoperative compilations and hernia recurrence for patients undergoing inguinal hernia repair: a report from the VA Cooperative Hernia Study Group. *Am J Surg* 2007; 194(5):611–7.

8. Neumayer L, Giobbie-Hurder A, Jonasson O, et al. Open mesh versus laparoscopic mesh repair of inguinal hernia. *N Engl J Med* 2004; 350(18):1819–27.

Laparoscopic Bariatric Surgery

Surgical Considerations

Description: Morbid obesity is increasing worldwide. Many patients have associated comorbidities including HTN, diabetes, and sleep apnea, which they have been unable to correct by dieting and exercise. Surgical treatment results *(Print pagebreak 598)* in weight loss of approximately 2/3–3/4 of excess body weight, usually with consequent correction of comorbidities. Operations for morbid obesity are classified as restrictive, such as the **adjustable gastric banding and vertical banded gastroplasty;** malabsorptive, such as a **jejunoileal bypass;** or a combination, such as the **Roux-en-Y gastric bypass.** The 1991 NIH consensus statement identified the Roux-en-Y bypass as the best surgical treatment for morbid obesity. In general, this operation is approached laparoscopically in most patients because of the decreased pain, earlier ambulation, earlier discharge from the hospital, quicker return to regular activity, and decreased wound complication rates, when compared with an open approach. Open approaches are undertaken in patients with previous upper abdominal surgery; patients who may not tolerate an increased intra-abdominal pressure (e.g., CHF, severe CAD, severe pulmonary disease); patients undergoing revision bariatric surgery, and, occasionally, in patients who fall into a super morbidly obese group (BMI > 60 kg/m^2). Surgery is indicated in patients with a BMI of 35–40 kg/m^2, if they have associated comorbidities, or > 40 kg/m^2, if they have no associated comorbidities.

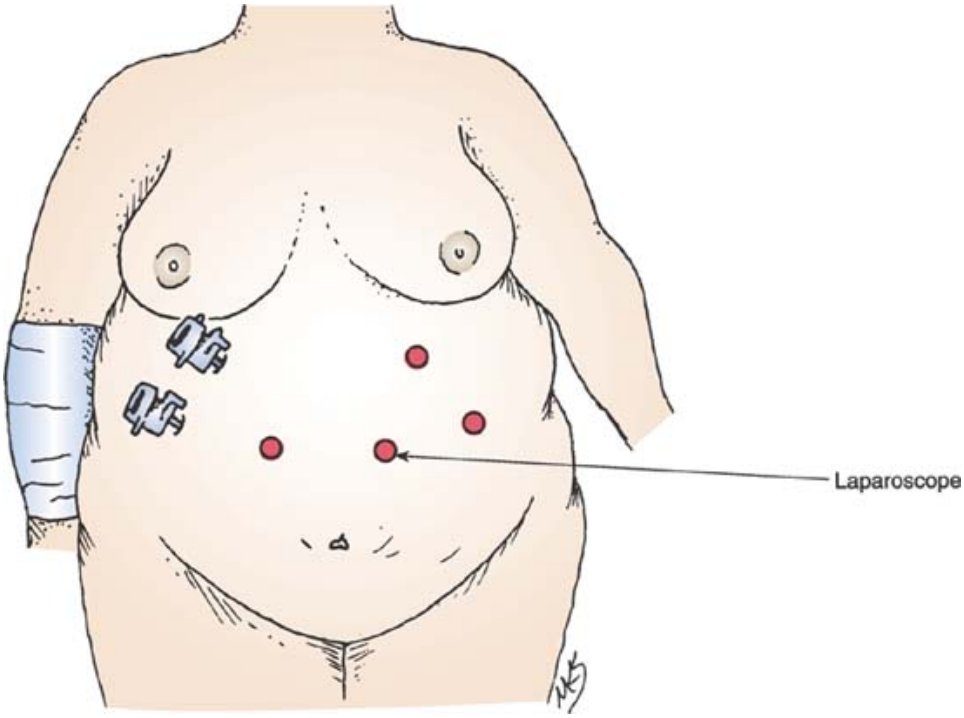

Figure 7.7-10. 10. Patient position and trocar position for bariatric laparoscopic surgery. (Reproduced with permission from Scott-Connors CEH, Dawson, DL: *Operative Anatomy,* Lippincott Williams & Wilkins, Philadelphia: 2003.)

In these procedures, the patient generally is placed in RT-HELP position. Some surgeons prefer a split-leg table, with the surgeon standing between the legs. For a laparoscopic Roux-en-Y bypass, the first incision is made in the midline, approximately halfway between the umbilicus and the xyphoid; 4–5 additional ports are then placed in the LUQ and the midline. Most surgeons begin by performing a jejunojejunostomy. During this time, the patient is placed in a reverse Trendelenburg position to drop the small intestines into the pelvis. The omentum is placed in the upper abdomen and the ligament of Treitz is identified. The jejunum is divided with an endo GIA stapler 20 cm from the ligament of Treitz. A Roux limb of 100 cm is then measured. (Occasionally, this Roux limb may be 150 cm, if the patient's BMI is > 50 kg/m^2.) The jejunojejunostomy is created with a stapler and the enterotomy is closed. Some surgeons prefer a **retrocolic approach,** wherein a passage is made through the transverse mesocolon. Other surgeons prefer an **antecolic approach,** in which the omentum is divided to allow for a place where the Roux limb can pass without tension. At this point, the liver retractor is placed and the gastric pouch is created. Before stomach stapling, everything in the stomach, including temperature probes, OG tubes, and calibrating tubes, should be removed. The gastric pouch is then stapled and cut. Often a calibrating tube is placed after the first two staple firings to help maintain the size of the pouch and the anastomosis. Some surgeons hand sew the gastrojejunostomy and some staple it with a linear stapler. Some surgeons staple the anastomosis and place the anvil of the end-to-end anastomotic stapler through the mouth (rarely done). Other surgeons place the anvil through a separate gastrotomy prior to complete *(Print pagebreak 599)* division of the pouch. At the end, the gastrojejunostomy typically is tested by inflating air into the gastric pouch, either through an OG tube, the sizing tube, or a gastroscope. Generally, the NG or OG tube is removed at the end of the procedure. Often, at this point, surgeons will close the defect of the transverse mesocolon.

Variant procedure or approaches: Open bypass (see p. 499).

Usual preop diagnosis: Morbid obesity (100 lb above ideal body weight or 100% over ideal body weight), generally in combination with a medical condition(s) felt to be worsened by the obesity (e.g., osteoarthritis, diabetes, respiratory insufficiency, CHF, hypertension, sleep apnea), BMI > 40 kg/m^2, or BMI > 35 kg/m^2 if associated comorbidities present.

Summary of Procedures

Position	Supine or split leg (see Fig. 7.2-6 in Open Operations for Morbid Obesity, p. 501 for suggested positioning.)
Incision	Five to six port sites
Unique considerations	Patients are at high risk for aspiration, and airway management may be difficult. Patients are at high risk for thromboembolic events and VTE prophylaxis is critical (p. B-2).
Antibiotics	Cefoxitin 1 g iv
Surgical time	2–4 h
Closing considerations	Typically, fascial defects are not closed.
EBL	< 50 mL
Postop care	Most patients receive an upper GI study the next day. Clear liquids are begun if the study is normal, and most patients are discharged within 48 h.
Mortality	< 1%
Morbidity	Overall: 10% Stricture: 10% Leak: 1–2% VTE Pneumonia Hemorrhage Hernia Obstruction Infection
Pain score	5–6

Patient Population Characteristics

Age Range	Generally, between 18–60 yr
Male:Female	Female > Male
Incidence	5%
Etiology	Genetic; environmental
Associated conditions	Sleep apnea; HTN; diabetes; GERD, osteoarthritis

Anesthetic Considerations

Preoperative

Obesity is associated with many chronic medical problems. A moderately overweight patient probably carries no excess health risks, especially while still young. However, morbidity and mortality rise sharply with increasing age and BMI. Medical comorbidities must be optimized before elective bariatric surgery. Evaluate any patient *(Print pagebreak 600)* who has had previous bariatric surgery for metabolic changes that can include protein, vitamin, iron and calcium deficiencies.

Review a list of all current medications the patient is taking, including nonprescription appetite suppressors and diet drugs. Many of

these drugs can have important side effects. For example, the combination of phentermine and fenfluramine ("phen-fen"), which is no longer prescribed in the United States, is associated with persistent, serious, heart and lung problems. Another weight loss medication, sibutramine, works in the brain by inhibiting the reuptake of norepinephrine, serotonin, and dopamine, producing a feeling of "anorexia," which limits food intake. Sibutramine has been implicated as a cause of dysrhythmias and hypertension. Orlistat blocks digestion and absorption of dietary fat by binding lipases in the gastrointestinal tract and can cause deficiencies in fat-soluble vitamins (A, D, E, K). A reduction in vitamin K levels can increase the anticoagulation effects of Coumadin.

Respiratory

Adipose tissue is metabolically active. Oxygen consumption and CO_2production rise with increasing weight 2° ↑ metabolic demands. The work of breathing is increased, while respiratory muscle performance is impaired. Mass loading of the thoracic and abdominal walls causes abnormalities in both lung volume and gas exchange, especially when the patient is supine. The increased total respiratory resistance and decreased compliance associated with extreme obesity result in shallow, rapid breathing. Decreased FRC 2°↓ ERV →↓ TLC. Airways close during normal ventilation→ ↑pulmonary shunt → hypoxemia. These changes increase in direct proportion with increasing BMI. General anesthesia further reduces FRC.

Preop PFTs show a restrictive breathing pattern. For symptomatic patients, an ABG obtained while the patient breathes room air is useful to establish a baseline. Younger obese patients have an increased ventilatory response to hypoxia and a relatively decreased response to hypercapnia. Their arterial blood sample often demonstrates alveolar hyperventilation ($PaCO_2$30–35 mm Hg) and relative hypoxemia ($PaO_2$70–90 mm Hg) while breathing air. With increasing age, sensitivity to CO_2decreases, so that $PaCO_2$rises and PaO_2falls further.

Preop assessment of a patient's face, neck, and upper airway is required because mask ventilation and tracheal intubation can be a challenge in some obese patients. A review of the patient's previous anesthetic records will reveal whether airway problems had been encountered during previous surgical procedures.

Tests: As indicated from H&P

Cardiovascular

Cardiac output rises proportionally with increased weight. ↑ CO and normal PVR → ↑ BP. Mild to moderate hypertension is seen in most morbidly obese patients. The increased left ventricular wall stress caused by increased stroke volume and the resultant ventricular dilation leads to cardiac hypertrophy. Left ventricular dysfunction is often present in young, asymptomatic patients. Even normotensive patients have increased pre-load and after-load, ↑ PAP, and elevated right and left ventricular stroke work. Because these patients are often not physically active, they may appear to be asymptomatic even in the presence of significant cardiovascular disease. Signs of pulmonary HTN (exertional dyspnea, fatigue, syncope) should be sought and TEE obtained in symptomatic patients. RV failure is common in older patients. A medical consultation with a cardiologist may be indicated before bariatric surgery. The ECG may show increased rate, changes in QRS voltage, left QRS axis shift, slowed conduction, and evidence of ischemia or previous myocardial infarction. Polycythemia suggests chronic hypoxemia.

Tests: ECG and others as indicated from H&P.

Many obese patients maintain a normal $PaCO_2$during the day, but have CO_2retention, sleep disturbances, intermittent airway obstruction with hypoxemia, pulmonary hypertension, and cardiac dysrhythmias at night. OSA syndrome is characterized by frequent episodes of apnea (> 10 sec cessation of airflow, despite continuous respiratory effort against a closed airway) and

Obstructive Sleep Apnea (OSA) Syndrome

hypopnea (50% reduction in airflow or reduction associated with a decrease of SpO_2 > 4%). OSA is frequently undiagnosed in patients scheduled for bariatric surgery. OSA occurs more often in patients with large fat necks and high Mallampati (III and IV) scores. The patient may not be aware of symptoms, so it is important to interview the patient's sleeping partner. If OSA is present, the partner will describe loud snoring followed by silence as airflow ceases with obstruction, then gasping or choking as the patient awakes and airflow restarts. A definitive diagnosis of OSA can only be confirmed by polysomnography in a sleep laboratory. Because of fragmented sleep patterns, OSA patients may complain of daytime sleepiness and headaches. Chronic sleep apnea leads to secondary polycythemia, hypoxemia, and hypercapnia, all of which increase the risk of cardiac and cerebral vascular disease. Patients with a history of snoring or OSA are often difficult to ventilate by mask, and their tracheas may be more difficult to intubate than those of similar weight patients without OSA. OSA patients who use CPAP devices at home should be instructed to bring them to the hospital to use following surgery. A patient known or even suspected of having OSA should be continuously monitored by pulse oximetry in the postop period, even following a completely uneventful operation.

Obesity Hypoventilation Syndrome

A small number of patients have obesity hypoventilation syndrome (OHS), characterized by somnolence, cardiac enlargement, polycythemia, hypoxemia, and hypercapnia. OHS patients tend to be older, super obese (BMI > 50 kg/m^2), and have more restricted pulmonary function than other patients with OSA. Hypoventilation that is central and independent of intrinsic lung disease is probably caused by the respiratory center's progressive desensitization to hypercapnia from nocturnal sleep disturbances. In the most severe form of OHS, the “Pickwickian Syndrome,” hypersomnolence, hypoxia, hypercapnia, pulmonary hypertension, right ventricular enlargement, and hypervolemia occur. These patients rely on a hypoxic ventilatory drive and may hypoventilate or even become apneic following emergence from general anesthesia after being given 100% O_2 to breathe.

Gastrointestinal

It is widely believed that morbidly obese patients are at greater risk for acid aspiration during induction of general anesthesia. Recently this belief has been challenged. One study reported that fasting obese patients actually had a lower incidence of high-volume, low-pH gastric fluid than lean patients while another found no differences in gastric volume or pH between lean and moderately obese surgical patients. Obese patients without GERD symptoms have relatively normal gastroesophageal sphincter tone. Obese patients at special risk for gastric acid aspiration may be those with diabetes and gastroparesis. Nonalcoholic steatohepatitis (NASH, “fatty hepatitis”), with or without liver dysfunction, is extremely common. Histologic abnormalities are present in the livers of as many as 90% of morbidly obese patients. Preop liver function tests should be obtained, but they often do not reflect the actual severity of liver dysfunction. Alanine aminotransferase (ALT) is the most frequently elevated liver enzyme. Liver clearance of many anesthetic agents is usually not altered with NASH.

Renal

There is ↑ RBF and ↑ GFR associated with obesity. Renal clearance of drugs may be greater than in the normal weight patient. The most common renal abnormality seen is proteinuria.

Tests: As indicated from H&P

Sedative drugs should be avoided. For the very anxious patient

Premedication

small amounts of midazolam (1–2 mg, iv) can be given. If a fiberoptic airway intubation is planned, atropine or glycopyrrolate will decrease oral secretions. Most medications for chronic HTN are continued before surgery. An exception is the ACE inhibitors, which should be stopped preop, because they can cause ↓↓BP following induction of anesthesia. Diabetic medications (insulin, oral hypoglycemics) are usually withheld on the morning of surgery, but blood sugar levels must be closely monitored in the perioperative period. Antibiotics and heparin (VTE prophylaxis) are usually administered before surgery at the surgeon's request. For protection against acid aspiration an H_2receptor antagonist can be given the night before and again on the morning of surgery along with 30 mL of nonparticulate antacid to increase gastric fluid pH and decrease gastric fluid volume.

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Intraoperative

Anesthetic Technique: Despite conflicting evidence that morbidly obese patients are at greater risk for acid aspiration, it remains prudent to establish a secure airway as quickly and safely as possible. Patients cannot tolerate the supine position and should be preoxygenated in the reverse Trendelenburg position (RTP) until SPO_2 is 100% for several min. With apneic patients expect rapid desaturation, because FRC is reduced and O_2 reserves are limited. Preoxygenation in RTP can increase O_2 reserves, but may cause pooling of blood and →↓ BP. Drug dosing by monitoring clinical end-points (HR, BP, degree of sedation) may be more important than empirical dosing based on patient weight formulae. In obese patients, highly lipophilic drugs have a significantly larger volume of distribution compared to that in nonobese patients, as a result loading doses are usually increased. Because lipophilic drug elimination half-lives are longer, maintenance dosing should be decreased to reflect IBW. Non- or weakly lipophilic drugs are given based on IBW.

Tracheal intubation is necessary for controlled ventilation and airway protection. High Mallampati score and large neck circumference are the most reliable predictors of potential intubation difficulties. If a problem is anticipated preop, an “awake intubation” with a fiberoptic bronchoscope is recommended. Appropriate nerve blocks and topical anesthesia to the airway are applied, and sedative drugs are kept to a minimum. It is important that the patient breathes supplemental O_2 during the intubation procedure. Successful direct laryngoscopy requires proper patient position. The patient must be placed with the head, upper body and shoulders significantly elevated (“stacked” or “ramped”) so that the ear is level with the sternum (head elevated laryngoscopy position, H.E.LP.) (see Fig. 7.2-6). When a morbidly obese patient is in this position, the endoscopist's view during direct laryngoscopy is significantly improved.

Induction

For most patients a rapid sequence induction with propofol (1.5–2.5 mg/kg TBW) and succinylcholine (1 mg/kg TBW), combined with cricoid pressure (10 lb), is the best means for securing the airway. Bag and mask ventilation is often difficult 2° upper airway obstruction and ↓ pulmonary compliance. Gastric insufflation during ineffective mask ventilation will further increase the risk of regurgitation and acid aspiration. A 2nd person experienced with airway management, preferably another anesthesiologist, must always be present to assist when difficulty is anticipated.

Aids for difficult intubation, including a short laryngoscope handle, a variety of laryngoscope blades, special laryngoscopy equipment (Bullard laryngoscope, Wu laryngoscope) a gum elastic bougie, a light-wand, and equipment for cricothyroidotomy and transtracheal jet ventilation should be available. A Pro-Seal LMA or intubating LMA can serve as a ‘bridge’ until an endotracheal tube is placed when difficulty is encountered.

Patients should be ventilated with an $FiO_2$of 0.5–1.0 and a tidal volume 12–15 mL/kg IBW, preferably in the RTP. Larger tidal volumes will only marginally improve oxygenation, while producing hypocapnia and potentially causing lung trauma. PEEP superimposed upon a large tidal volume can actually worsen hypoxemia by ↓CO cardiac output, which in turn will ↓ O_2delivery. Placement of subdiaphragmatic packs or retractors or changing to lithotomy or Trendelenburg positions will also impair ventilation.

Our maintenance technique consists of an iv infusion of remifentanil, supplemented

with small amounts of fentanyl and/or dexmedetomidine infusion. The patient is ventilated with an inhalational anesthetic (isoflurane, sevoflurane or desflurane) with a FiO_2 of 50–100% O_2 All inhalational anesthetics, including isoflurane, are rapidly eliminated. With appropriate timing there are no clinical differences in the recovery time after general anesthesia with any inhalational anesthetic agent. N_2O can be used because it does not dilate the bowel during laparoscopic bariatric surgery, but its role is limited due to the high oxygen demand of many patients.

Maintenance

The anesthesiologist is usually responsible for proper placement of the gastric tube to decompress the stomach and to help size the gastric pouch. The anesthesiologist may be asked to help perform leak tests for anastomotic integrity, either by insufflation of the gastric tube or placement of saline or dye down the tube. It is extremely important that the gastric tube and anything else in the esophagus (such as a temperature probe or TEE probe) be completely withdrawn before the gastric pouch is stapled. Heat loss may be exaggerated by the CO_2 pneumoperitoneum and by cold irrigating fluids. Warming blankets and other devices should be employed intraop, and warmed iv and irrigating fluids are occasionally needed if there is a significant drop in temperature.

Loss of pneumoperitoneum may indicate incomplete paralysis. Because nondepolarizing muscle relaxants are hydrophilic, there is limited distribution to adipose tissue and no clinical advantage between any of the commonly used agents. Neuromuscular recovery time is similar in obese and nonobese patients with atracurium, vecuronium or rocuronium. Relaxants should be administered in incremental doses based on IBW, and neuromuscular blockade must be completely reversed before extubation of the trachea.

Emergence

The inhalation agent is discontinued several min before surgery is completed, but the remifentanil infusion is continued until the very end of the procedure. After the remifentanil is stopped, the patient is awake and the trachea can be extubated within 3 min. If hemodynamically stable, the patient's airway should be extubated with the upper body elevated 30–45°. Then, the patient should be transferred from the OR in that position. Postop admission to an ICU and/or mechanical ventilation is rarely needed. Factors that may necessitate ventilatory support include extremes of age, super obesity, coexisting cardiac disease or pulmonary disease and CO_2 retention, fever or infection, and an uncooperative or extremely anxious patient. The need for postop admission to an ICU is relatively common after open bariatric procedures, but rare after laparoscopic surgery.

Blood and Fluid Requirements

iv: 16–18 × 1
NS/LR @ 8–12 mL/kg/h
Fluid warmer

Intraop fluid requirements are usually greater than would be anticipated in a normal weight patient. Several liters of crystalloid should be given during a laparoscopic bariatric operation. It is essential that adequate amounts of iv fluid be given to reduce postop renal failure, and to avoid other rare but serious complications such as rhabdomyolysis.

Monitoring

± CVP Standard monitors (p. B-1)

Noninvasive cuff pressure may be inaccurate if the anatomy of the upper arm doesn't allow a proper fit. Cuff pressures can be obtained from the wrist or ankle. Because venous access is often limited, a central line can be helpful for postop needs. Note that the length of a standard iv catheter placed percutaneously in the neck of a very large patient may not be long enough to reach an intrathoracic location.

In the supine position FRC is ↓↓ → V/Q mismatch + ↑ O_2 consumption, ↑ CO, and ↑ PAP. A left lateral tilt will prevent inferior vena cava compression in the supine patient. The Trendelenburg and

RTP
and pad pressure points

Positioning	eyes SCD's	lithotomy positions further decrease lung volumes. If possible, the patient should always be in the reverse Trendelenburg position (RTP) during surgery because in this position the diaphragm is “unloaded” and FRC is maximized.
CO_2Pneumoperitoneum	↑ PIP + ↓ TV ↑ $ETCO_2$+ $PaCO_2$ ↑ HR + ↑ MAP	The physiologic effects of the CO_2 pneumoperitoneum are usually well tolerated by the patient and require no intervention. Maintaining the patient in the RTP minimizes the restriction of respiratory mechanics from the CO_2 insufflation. All changes return to normal once the pneumoperitoneum is relieved. However, complications can occur.
Complications	Hypoxemia Massive gas embolism Pneumothorax Pneumomediastinum	The pneumoperitoneum can displace the diaphragm cephalad, causing the position of the endotracheal tube to change. Occasionally the endotracheal tube's tip can enter a bronchus, so always consider tube displacement in the differential diagnosis of hypoxemia during laparoscopy.

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Postoperative

Position and Oxygenation	Semirecumbent and RTP CPAP/BiPAP	Maximize oxygenation by allowing the diaphragm to fall and FRC to increase. Patients can become hypoxemic if supplemental $O_2$is withheld in the immediate recovery period. Restoration of normal pulmonary function after open abdominal surgery may take several days. In theory, CPAP could distend the gastric pouch, but its use following bariatric surgery has not been associated with anastomotic leaks.
Complications	Venous thromboembolism	VTE prophylaxis should always be considered in the postop, even for patients with epidural catheters. A vena cava umbrella is occasionally placed preop in older and high-risk patients. Early ambulation must be encouraged.
	PONV	Multimodal intraop prophylaxis with several antiemetic agents will reduce but not eliminate PONV. Dexamethasone (4–8 mg) should be part of the therapeutic regimen (see p. B-2).
Pain Management	PCA	PCA with opioid dose based on IBW is usually satisfactory. Avoid large amounts of opioids, which can depress ventilation. The use of nonopioid analgesic adjuncts should be instituted early. Dexmedetomidine, which has no respiratory depressant effects, is a useful alternative or supplement to opioids. Nonsteroidal anti-inflammatory drugs are

	helpful initially, but should be discontinued within a day or two to avoid the potential complication of gastric ulceration.
Tests	As indicated by patient status

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Anesthesia for Laparoscopy in Pregnancy

Anesthetic Considerations

Preoperative

Approximately 0.75–2% of pregnant woman require nonobstetric surgery, and 10–20% of those will require intraabdominal surgery (diagnostic or therapeutic), most commonly for cholecystectomy, appendectomy, trauma or gynecological indications. If surgery cannot be avoided, it is best carried out in the 2nd trimester. Warn patients about possible fetal loss (3–12% in 1st trimester) and premature labor (5–8% in 2nd and 25–40% in 3rd trimesters). Anesthesia and surgery are associated with increased spontaneous abortion, growth retardation, and perinatal mortality; however, no increase in congenital abnormalities has been found. Rates of fetal loss, premature labor, and maternal mortality are higher among sicker patients. It is unclear whether adverse outcomes after surgery relate to the disease process itself, disturbances in nutrition, the surgical procedure, exposure to radiation, or drugs. No correlation has been found between outcome and any specific anesthetic technique or agent (including N_2O).

Laparoscopy is the procedure of choice for many surgeries in nonpregnant patients; however, its use in pregnancy remains controversial, although significant experience now supports its safety and efficacy. Advantages of laparoscopy include more rapid recovery, shorter hospital stays, less postop narcotic use (→↓ fetal depression) and lower risk of wound infection. No differences in fetal outcome or incidence of preterm labor have been found. Risks of laparoscopy include difficult surgical access and potential uterine injury with Veress needles or trocars. Current recommendations suggest an open technique (e.g., Hasson cannula) for obtaining laparoscope access.

Note that acute appendicitis and cholecystitis often present with advanced or complicated disease because of difficulty diagnosing the “acute abdomen” and a reluctance to use radiation-based diagnostic tests in pregnancy.

Respiratory	Pregnant patients have ↑ MV with respiratory alkalosis ($PaCO_2$= 32–34 mmHg) and are subject to the rapid onset of hypoxemia if ventilation is compromised due to alterations lung and metabolic functions including a 20% ↓ in FRC and a 20% ↑ in O_2 consumption. Uptake of and sensitivity to inhalational anesthetics is enhanced (↓ FRC, ↓ MAC, and hyperventilation). During laparoscopy, peritoneal insufflation and head-down positioning may further compromise lung function (↓ FRC and ↓ lung compliance). Mucosal capillary engorgement in upper airways may necessitate a smaller ETT and mandates careful airway suctioning to avoid bleeding. Airway management is more difficult in this patient population. **Tests:** As indicated from H&P.
Cardiovascular	Pregnancy →↑ CO, ↓ MAP, → HR, → blood volume, and ↓ oncotic pressure →↑ risk of pulmonary edema. Supine hypotensive syndrome: To minimize aortocaval compression and → ↓↓ BP (> 20 wk gestation), the supine position should be modified by the use of a left lateral pelvic tilt to displace the uterus. Moderate abdominal insufflation pressures (8–12 mmHg) should be used to minimize further caval compression and ↓ uterine blood flow. **Tests:** As indicated from H&P.
Hematologic	WBC count is elevated during pregnancy (8000–12,000/mm) and may delay diagnosis of concurrent infections (e.g., appendicitis). Iron deficiency anemia often is superimposed on the dilutional anemia of pregnancy (Hct 33%). Pregnant patients are hypercoagulable, and antiembolic compression devices should be used. **Tests:** Hb/Hct. T&S if significant blood loss is anticipated. Coag studies and Plt count if + PIH.
Gastrointestinal	Emergency surgery, ↓ gastric motility, ↑ GERD, ↑ intragastric pressure and gastric hyperacidity →↑ risk of aspiration pneumonitis. All pregnant patients (> 16–20 weeks) should be considered to have full stomachs and should receive a nonparticulate antacid (e.g., 0.3 M Na citrate 30 mL) immediately before GA, as well as iv metoclopramide 10 mg and ranitidine 50 mg 30–60 min before surgery.
	Pregnancy →↑ renal blood flow and creatinine clearance and ↓

Renal	serum creatinine and ↓ BUN. Dependent edema results from increased water and sodium retention and ↓ oncotic pressure. **Tests:** As indicated from H&P.
Laboratory	Others tests as indicated from H&P.
Premedication	Full-stomach precautions (see Gastrointestinal, above); midazolam (1–2 mg) given as appropriate to decrease anxiety.

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Intraoperative

Anesthetic technique: After 16 wk gestation, anticipate ↑ risks of aspiration and difficult intubation. Plan ahead for management of a difficult airway (see pp. 581–582). GA is the preferred technique, because laparoscopy and abdominal surgery are poorly tolerated under regional anesthesia. A lead shield should be used to protect the fetus during fluoroscopy. Obtain preop obstetric consultation with baseline fetal heart rate (FHR) and uterine contraction readings. After 24 wk gestation, consider continuous monitoring of FHR during surgery (transvaginal Doppler) and develop a management plan for evaluation and action if a nonreassuring trace develops.

General anesthesia: If difficult intubation is anticipated, an awake fiber-optic intubation (p. B-4) is recommended. In any event, emergency airway management equipment (e.g., LMA, transtracheal jet ventilator), must be immediately accessible in the OR. Communication with the surgeon and obstetrician regarding maternal and fetal condition is essential.

Induction	Tilt table or elevate left hip to displace uterus. Standard rapid-sequence induction with cricoid pressure (p. B-5) as appropriate. To optimize intubation, place patient in maximal "sniff" position with elevation of shoulders if necessary (obese patients) (Fig. 7.2-6, p. 501). If tracheal intubation is unsuccessful, follow the difficult intubation/ventilation drill (p. B-5). After ETT is secured, pass OG tube and decompress stomach to minimize injury from the Veress needle or trocar.
Maintenance	0.8–1% isoflurane or 1.5–2.0% sevoflurane in air/O_2(50%) mixture. Avoid N_2O → distention of bowel, PONV. Administer an opioid (e.g. fentanyl 50–200 g iv) and/or midazolam (1–2 mg) to ↓ volatile requirements and ↓ maternal awareness. Administer muscle relaxants (e.g., vecuronium 0.1 mg/kg). Control ventilation, avoiding hypocapnia (PCO_2< 30 mmHg) → ↓ umbilical blood flow, and hypercapnia (PCO_2> 36 mmHg) → fetal acidosis. Maintain $ETCO_2$or $PaCO_2$at 32–36 mmHg by ↑ MV. Use low insufflation cut-off pressure (8–12 mmHg, not 15 mmHg as for nonpregnant patient).
Emergence	Reverse muscle relaxation with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg or atropine 0.02 mg/kg. Anticholinergics (glycopyrrolate/atropine) given before neostigmine may minimize possible ↑ uterine tone 2° neostigmine. Delay extubation until patient is fully awake and muscle strength has returned to normal. $O_2$by mask and transport in the lateral position. Metoclopramide (10 mg iv) and/or ondansetron (4 mg iv) may be needed for PONV.

Blood and fluid requirements	iv: 16–18 ga × 1 NS/LR 4–6 ml/kg/h	Laparoscopy is associated with minimal blood loss; however, inadvertent vascular injury may occur.
Monitoring	Standard monitors (see B-1) ± Arterial line (major surgery)	Maternal and neonatal outcome good, and severe acidosis absent when maternal ventilation controlled by $PaCO_2$or $ETCO_2$ measurement.
	FHR monitor	Continuous FHR monitoring may be appropriate after 24 wk gestation.
	Uterine contraction monitor	Uterine contraction monitoring is usually not possible intraop; however, preop and postop. Maternal and neonatal outcome good, and severe acidosis absent when maternal ventilation controlled by $PaCO_2$or $ETCO_2$measurement. Clinical experience indicates no long-term adverse neonatal effects.

Positioning	and pad pressure points eyes	Changes in position have marked effects on respiration (↓ compliance/↑ pressure, hypoxemia) and hemodynamics. Head-up position + GA + peritoneal insufflation → 50% ↓ CO in the nonpregnant patient and even greater decrease in late pregnancy. **Position changes should be gradual** to minimize adverse effects.
	± left uterine displacement	If > 20 wk gestation, left uterine displacement to avoid aortocaval compression.
CO_2peritoneum: Maternal effects	↓ ventilation	Impairs ventilation → hypoxemia and respiratory acidosis.
	↓ BP	↓ venous return → ↓ BP.
	Reflux	↑ GI reflux (↑ abdominal pressure)
	CO_2absorption	Absorption of CO_2→↑ MAP & ↑ SVR.
CO_2peritoneum Fetal effects	↓ uterine blood flow ↑ preterm labor Fetal acidosis Fetal ↑ HR/↑ BP	Up to 60% in animal studies → fetal hypoxia. 2° ↑ abdominal pressure 2° absorbed CO_2
Complications	Uterine injury Bowel/organ injury Venous air embolism	Dx: ↓ $ETCO_2$hypoxemia, hypotension. Rx: 100% O_2 stop insufflation immediately, volume and pressors, attempt CVP air aspiration.
	Thromboembolism/PE	Prevention: Pneumatic compression devices. Rx: Supportive
	Pneumothorax	Dx: ↑ Airway pressure, ↓ breath sounds, and hyperresonance. Rx: 100% O_2 stop insufflation, tube thoracostomy.

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Postoperative

Pain management	Standard pain management (p. C-2)	Minimize NSAIDS (e.g., ibuprofen) → pulmonary and CV fetal effects (closure of ductus venosus).
Tests	HCT/CBC Others as indicated by operative course.	

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