

Module 6 Case Scenario

1. You are called to the emergency room to see a 35-year-old G2P2 woman with a 3-day history of right upper quadrant (RUQ) abdominal pain associated with anorexia and postprandial vomiting. Which of the following questions is the most important to ask first?
 - a. When was your last normal menstrual period?
 - b. Is the abdominal pain related to meals?**
 - c. What surgeries have you had in the past?
 - d. Have you experienced diarrhea in the last 5 days?

Multiple pathologies can cause upper abdominal pain. Diagnoses with a recognized relationship to meals include gallbladder disease, pancreatitis, and peptic ulcer diseases.

Gallbladder disease can present as biliary colic or acute cholecystitis. Biliary colic is a common presentation of transient occlusion of the cystic duct or common bile duct of the biliary tree. Colic refers to the type of pain that "comes and goes," typically after eating a large, fatty meal which causes contraction of the gallbladder. Onset of pain usually occurs approximately 30 minutes after meals and lasts one to five hours. Biliary colic generally refers to the pain that occurs from a temporary obstruction of the biliary tree which resolves on its own. However, prolonged obstruction of the biliary tree or complete impaction of a stone within the biliary tree will eventually lead to cholecystitis (gallbladder inflammation) or cholangitis (bile duct inflammation), at which point the pain will be constant and increasing.

Acute calculous cholecystitis presents with constant pain lasting more than 24 hours. This pain results from inflammatory changes or infection in the gallbladder from an impacted stone at the cystic duct.

Unlike gallbladder symptoms described above, pain related to pancreatitis tends to be epigastric or right upper abdominal, constant, more severe, radiating to the back, and worsens with a supine position. However, some patients with pancreatitis can present with generalized abdominal pain.

Pain related to peptic ulcer disease tends to be epigastric and worsens after periods of prolonged fasting.

Reference:

- Kelly R. Haisley, John G. Hunter. Gallbladder and the Extrahepatic Biliary System. In: Brunicaardi F, Andersen DK, Billiar TR, Dunn DL, Kao LS, Hunter JG, Matthews JB, Pollock RE. eds. *Schwartz's Principles of Surgery*, 11e. McGraw Hill; 2019. Accessed February 16, 2022.
- Malik TF, Gnanapandithan K, Singh K. Peptic Ulcer Disease. [Updated 2023 Jun 5]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK534792/>

- Sigmon DF, Dayal N, Meseeha M. Biliary Colic. [Updated 2023 Jul 31]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK430772/>

2. The patient has her regular menstrual cycle and denies a history of cough, shortness of breath, change in bowel habits, or jaundice. She is married and has had 2 children. She denies any chronic medical conditions. There is no family history of sickle cell anemia or thalassemia. On examination, she is afebrile with HR of 103 beats/min and BP of 118/60. Her body mass index is 35 kg/m². Abdominal exam reveals RUQ tenderness and an inspiratory arrest on deep palpation of the right subcostal area. Her laboratory workup is significant for a WBC count of 13,000/mm³ and normal total bilirubin. A pregnancy test is negative. What is her most likely diagnosis?
- a. Peptic ulcer disease
 - b. Acute pancreatitis
 - c. Perihepatitis (Fitz-Hugh–Curtis syndrome)
 - d. Acute cholecystitis**

Acute cholecystitis is acute inflammation of the gallbladder. In 90% of cases, acute cholecystitis is secondary to gallstones.

In acute calculous cholecystitis, obstruction of the cystic duct by a stone results in an inflammatory process mediated by mucosal proinflammatory factors. Additional prostaglandin synthesis amplifies inflammation. The result of this inflammatory process is the thickening of the gallbladder wall and pericholecystic fluid. Secondary bacterial contamination leading to infection occurs in 15% to 30% of cases.

Diagnosis of acute cholecystitis is made based on history, physical exam, laboratory work, and imaging findings. Both the World Society of Emergency Surgery guidelines and the Tokyo guidelines utilize these criteria for the diagnosis of cholecystitis:

- A. Local signs of inflammation (1. Murphy's sign 2. RUQ mass/pain/tenderness)
- B. Systemic signs of inflammation(1. Fever 2. Elevated CRP 3. Elevated WBC)
- C. Imaging findings characteristic of acute cholecystitis

Definite diagnosis:

- 1) One item in A and one item in B
- 2) C confirms the diagnosis when acute cholecystitis is suspected clinically

Reference:

- Kelly R. Haisley, John G. Hunter. Gallbladder and the Extrahepatic Biliary System. In: Brunicaardi F, Andersen DK, Billiar TR, Dunn DL, Kao LS, Hunter JG, Matthews JB, Pollock RE. eds. Schwartz's Principles of Surgery, 11e. McGraw Hill; 2019. Accessed February 16, 2022.

- Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculous cholecystitis. *World J Emerg Surg.* 2020 Dec;15(1):61.
- Yokoe M, Hata J, Takada T, Strasberg SM, Asbun HJ, Wakabayashi G, et al. Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholecystitis (with videos). *J Hepato-Biliary-Pancreat Sci.* 2018 Jan;25(1):41–54.

3. Which clinical sign described in the physical examination helps make the diagnosis?

- a. **Murphy's sign**
- b. Rosving's sign
- c. Blumberg's sign
- d. Obturator sign

Murphy's sign is frequently found in acute cholecystitis. For this maneuver, the patient inhales deeply as the examiner gently palpates the right subcostal region. If a patient has an acutely inflamed gallbladder, the patient will demonstrate an inspiratory arrest when the examiner is palpating the right upper quadrant. This sign can also be demonstrated during a transabdominal ultrasound of the right upper abdomen when the ultrasound probe is placed directly over the inflamed gallbladder.

The other signs mentioned are useful in the assessment of acute appendicitis.

Reference:

- O'Connell PR, McCaskie AW, Sayers RD. *Bailey & Love's Short Practice of Surgery* [Internet]. 28th ed. Boca Raton: CRC Press; 2022 [cited 2023 Nov 28]. Available from: <https://www.taylorfrancis.com/books/9781003106852>
- Yokoe M, Hata J, Takada T, Strasberg SM, Asbun HJ, Wakabayashi G, et al. Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholecystitis (with videos). *J Hepato-Biliary-Pancreat Sci.* 2018 Jan;25(1):41–54.

4. What is the most cost-effective imaging modality to confirm the diagnosis?

- a. Hepatobiliary iminodiacetic acid scan (HIDA Scan)
- b. **Right upper quadrant abdominal ultrasound**
- c. Abdominal CT scan with IV contrast
- d. Abdominal Magnetic resonance imaging (MRI)

An ultrasound of the right upper quadrant is recommended as the first-line imaging modality for the diagnosis of acute cholecystitis because it is non-invasive, affordable, widely available, and highly sensitive and specific for gallstone disease.

The sensitivity and specificity of ultrasound in diagnosing acute cholecystitis are reported to be around 80 percent and 89 percent respectively.

The diagnostic imaging findings of acute cholecystitis include thickening of the gallbladder wall (≥ 4 mm), enlargement of the gallbladder (long axis ≥ 8 cm, short axis ≥ 4 cm), gallstones or retained debris, pericholecystic fluid, and linear shadows in the fatty tissue around the gallbladder.

HIDA scan has a higher diagnostic yield compared to ultrasound; however, HIDA scan utilization in clinical practice is limited due to the required resources and time.

An abdominal CT scan may also demonstrate acute cholecystitis but would more commonly be utilized if other pathologies are being considered as it is more invasive and could be less readily available.

Reference:

- Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculus cholecystitis. *World J Emerg Surg.* 2020 Dec;15(1):61.
 - Yokoe M, Hata J, Takada T, Strasberg SM, Asbun HJ, Wakabayashi G, et al. Tokyo Guidelines 2018: diagnostic criteria and severity grading of acute cholecystitis (with videos). *J Hepato-Biliary-Pancreat Sci.* 2018 Jan;25(1):41–54.
5. The patient is taken to imaging for a right upper quadrant ultrasound which shows stones in the gallbladder with associated gallbladder wall thickening and pericholecystic fluid, confirming the diagnosis of acute calculous cholecystitis. What is considered the most definitive treatment for this patient?
- a. IV fluid, antibiotics, and analgesics
 - b. Open cholecystectomy
 - c. Laparoscopic cholecystectomy
 - d. Percutaneous drainage of the gallbladder

The definitive and first-line treatment of acute cholecystitis is laparoscopic cholecystectomy. Although the patient should receive IV fluids, antibiotics (with gram-negative and anaerobic coverage), and analgesics, cholecystectomy remains the definitive treatment. Patients with severe cholecystitis may present with organ dysfunction. These patients may require resuscitation in the intensive care unit with source control through either cholecystectomy, if feasible, or percutaneous cholecystostomy tube.

Non-operative management with fluids, analgesia, and antibiotics may be an option for patients who are not surgical candidates.. However, strong consideration should

be made to perform an interval cholecystectomy. Up to 60% of patients managed non-operatively underwent cholecystectomy subsequently with long-term follow-up.

Reference:

- Kelly R. Haisley, John G. Hunter. Gallbladder and the Extrahepatic Biliary System. In: Brunicaardi F, Andersen DK, Billiar TR, Dunn DL, Kao LS, Hunter JG, Matthews JB, Pollock RE. eds. Schwartz's Principles of Surgery, 11e. McGraw Hill; 2019. Accessed February 16, 2022.
- Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculus cholecystitis. World J Emerg Surg. 2020 Dec;15(1):61.

6. What is the optimal timing for cholecystectomy in patients with acute cholecystitis?

- a. Within 72 hours of the onset of symptoms
- b. Within 7 days of hospital admission
- c. Within 14 days of the onset of symptoms
- d. Within 6 weeks of the onset of symptoms

Laparoscopic cholecystectomy (LC) is the first-line treatment of acute cholecystitis. The “golden 72-hour rule” recommends performance of the LC during the acute phase of the disease within 72 hours of onset of symptoms.

Intermediate LC (performed between 7 days of hospital admission and 6 weeks) and Delayed LC (performed between 6 weeks and 3 months) are less preferable to Early LC.

Reference:

- Cao AM, Eslick GD, Cox MR. Early laparoscopic cholecystectomy is superior to delayed acute cholecystitis: a meta-analysis of case-control studies. Surg Endosc. 2016 Mar;30(3):1172–82.

7. What are the contraindications to performing laparoscopic cholecystectomy?

- a. Patient is pregnant
- b. Patient's age is greater than 80 years
- c. Patient is in septic shock
- d. Patient presenting 10 days after onset of symptoms

Refractory hemodynamic instability of any origin is an absolute contraindication to laparoscopic surgery. Absolute contraindications include: overt peritonitis with gross

intra abdominal contamination, intra abdominal visceral/vascular injuries following trauma, abdominal compartment syndrome, evisceration, abdominal wall dehiscence, and uncorrected coagulopathy.

Pregnant patients with acute cholecystitis may be treated with laparoscopic cholecystectomy. Operative management is associated with fewer complications compared to non-operative management, which exposes pregnant patients to medication toxicity, higher risk of pregnancy loss, and recurrence of gallstone disease with its complications. Laparoscopic cholecystectomy in pregnancy is recommended in the second trimester and early third trimester of the pregnancy.

Patients with advanced age, including those with age greater than 80 years, need appropriate assessment of their perioperative risk. Chronological age is not a contraindication to surgical management. Elderly patients' intrinsic surgical risk, life expectancy, rate of relapse in cases treated through conservative management, and frailty scores need to be considered in consideration of the treatment.

Patients with symptoms greater than 10 days may still have laparoscopic cholecystectomy if clinically appropriate.

Reference:

- Exploratory (Diagnostic) Laparoscopy: Background, Indications, Contraindications. 2022 Jun 29 [cited 2023 Feb 24]; Available from <https://emedicine.medscape.com/article/1829816-overview>.
- Pisano M, Allievi N, Gurusamy K, Borzellino G, Cimbanassi S, Boerna D, et al. 2020 World Society of Emergency Surgery updated guidelines for the diagnosis and treatment of acute calculus cholecystitis. *World J Emerg Surg.* 2020 Dec;15(1):61.

8. You have made the diagnosis of acute cholecystitis and would like to proceed with a laparoscopic cholecystectomy. Which of the following is an absolute contraindication to performing the procedure laparoscopically?

- a) Current pregnancy
- b) Patient with BMI > 30
- c) Prior laparoscopic abdominal surgery
- d) Uncorrectable coagulopathy**

Explanation: Absolute contraindications to laparoscopy include: Uncorrectable coagulopathy, refractory hemodynamic instability of any origin, overt peritonitis with gross intra abdominal contamination, intra abdominal visceral/vascular injuries

following trauma, abdominal compartment syndrome, shock, evisceration, and abdominal wall dehiscence.

Though there is a risk of fetal loss and uterine injury with laparoscopy, pregnancy is not an absolute contraindication to laparoscopy. Recent laparotomy within 4-6 weeks or extensive abdominal adhesions from a prior surgery are relative contraindications to laparoscopy. Obesity may pose a challenge with trocar placement and maintenance of insufflation but is not a contraindication to laparoscopy.

Additional relative contraindications include critical ICU patients with hemodynamic lability, infections involving the anterior abdominal wall, cardiopulmonary compromise, and acute intestinal obstruction with dilated bowel > 4 cm

Reference:

- Curet MJ. SPECIAL PROBLEMS IN LAPAROSCOPIC SURGERY: Previous Abdominal Surgery, Obesity, and Pregnancy. *Surg Clin North Am.* 2000 Aug 1;80(4):1093–110.
- Exploratory (Diagnostic) Laparoscopy: Background, Indications, Contraindications. 2022 Jun 29 [cited 2023 Feb 24]; Available from <https://emedicine.medscape.com/article/1829816-overview>
- Nasioudis D, Tsilimigras D, Economopoulos KP. Laparoscopic cholecystectomy during pregnancy: A systematic review of 590 patients. *Int J Surg Lond Engl.* 2016 Mar;27:165–75.
- Soriano D, Yefet Y, Seidman DS, Goldenberg M, Mashiach S, Oelsner G. Laparoscopy versus laparotomy in the management of adnexal masses during pregnancy. *Fertil Steril.* 1999 May;71(5):955–60.

9. Before induction of anesthesia, you discuss anesthesia and preferred positioning with the operating room team. Which of the following anesthesia types and positioning is appropriate for this patient undergoing laparoscopic cholecystectomy?

- a) Spinal anesthesia, left lateral decubitus
- b) General anesthesia, left lateral decubitus
- c) Spinal anesthesia, supine in reverse Trendelenburg
- d) General anesthesia, supine in reverse Trendelenburg**

Laparoscopy is generally performed under general anesthesia through endotracheal tube with paralysis for careful control of ventilation when the patient acquires the state of pneumoperitoneum. Recent studies have challenged the necessity of general anesthesia, suggesting that regional anesthesia may be useful and, in some cases, better than general anesthesia in laparoscopy. This argument is based on the better immediate post-operative pain control, absence of airway manipulation, and ability to maintain spontaneous breathing with minimal side effects that can be easily controlled with medication. For the purposes of beginning laparoscopy, general anesthesia with endotracheal intubation is the classical and preferred method. However, spinal anesthesia might be safely utilized in low-resource settings if general anesthesia is not available.

The preferred patient positioning during laparoscopic cholecystectomy is reverse Trendelenburg which allows gravity to retract the small and large bowel inferiorly, providing optimal visualization of the gallbladder and the porta hepatis.

As part of proper positioning, the patient should be firmly secured to the table, with a board and padding underneath the patient's feet to prevent the patient from moving when placed in reverse Trendelenburg. It is typical to place an orogastric tube to decompress the stomach. A Foley catheter can be placed for bladder decompression depending on the anticipated difficulty and length of the case. Monitors are typically placed near the patient's head, on both sides, so both the operating surgeon and assistant have clear visualization. If need for an intraoperative cholangiogram is anticipated, tucking one of the patient's arms should be performed.

Reference:

- Deveney K. Laparoscopic Cholecystectomy. In: Scott-Conner CEH, ed. The SAGES Manual: Fundamentals of Laparoscopy, Thoracoscopy, and GI Endoscopy. Springer New York; 2006:130-139.

10. You establish pneumoperitoneum via the cut-down (Hassan) approach at the umbilicus. Which of the following describes the best port placement to perform a laparoscopic cholecystectomy?

- a) Two right-sided subcostal ports, one epigastric port, one umbilical port
- b) A right-sided subcostal port, a left-sided subcostal port, one epigastric port, one umbilical port
- c) Two left-sided subcostal ports, two epigastric ports
- d) One umbilical port, one suprapubic port, two right-sided subcostal ports

With any laparoscopic procedure, the principle of triangulation is utilized. Typically, the umbilicus is the site of the camera port while two additional ports are placed in the epigastrium and along the costal margin roughly 8-10 centimeters apart to serve as the working ports for the operating surgeon. A fourth port is often placed in the patient's right lateral subcostal position to allow the assistant to retract the fundus of the gallbladder, allowing for better visualization of the operative field.

There are often a total of four ports used. The sizes of the port can vary depending on the size of instruments and scope available. The classic teaching utilizes two 5-mm ports and two 10-mm ports. The need for a second 10-mm port can be re-evaluated given the size of the instruments available. With a Hassan approach, the initial entry site will be at least 10-mm in size.

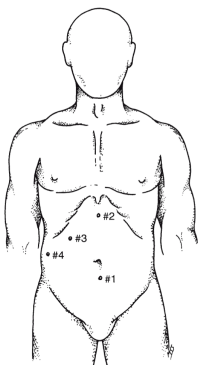


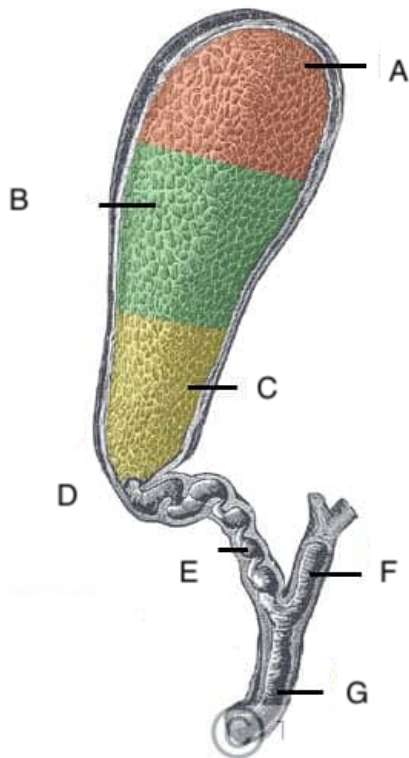
Figure 14.2. Trocar positions.

Reference:

- Deveney K. Laparoscopic Cholecystectomy. In: Scott-Conner CEH, ed. The SAGES Manual: Fundamentals of Laparoscopy, Thoracoscopy, and GI Endoscopy. Springer New York; 2006:130-139.
- Wakabayashi G, Iwashita Y, Hibi T, et al. Tokyo Guidelines 2018: surgical management of acute cholecystitis: safe steps in laparoscopic cholecystectomy for acute cholecystitis (with videos). Journal of Hepato-Biliary-Pancreatic Sciences. 2018;25(1):73-86. doi:10.1002/jhbp.517

11. Before operating on the gallbladder, you and your assistant review gallbladder anatomy. Given the following image, select the answer choice that correctly matches the letter to the anatomical name of the region.

- a) A: neck, B: fundus, C: body, D: cystic duct, E: common hepatic duct, F: common bile duct, G: infundibulum
- b) A: infundibulum, B: fundus, C: body, D: neck, E: cystic duct, F: common bile duct, G: common hepatic duct
- c) A: fundus, B: body, C: neck, D: infundibulum, E: cystic duct, F: common hepatic duct, G: common bile duct**
- d) A: fundus, B: body, C: infundibulum, D: neck, E: cystic duct, F: common hepatic duct, G: common bile duct



Explanation: The gallbladder is a pear-shaped sac that sits on the posterior surface of the right lobe of the liver. It is roughly 10 cm long and 3-4 cm wide in most adults. The fundus and the body form the largest sections of the gallbladder, tapering to the neck that eventually becomes the cystic duct, through which bile can flow from the gallbladder into the common bile duct and eventually the duodenum. In most patients, there is an outpouching of the gallbladder as the neck tapers down to the cystic duct. This outpouching is called the infundibulum and is also known as Hartmann's pouch. This is a key anatomical landmark because retracting this area of the gallbladder often creates the tension needed to dissect the gallbladder free from the liver in order to achieve the critical view of safety.

Reference:

- Frierson HF, Jr. The gross anatomy and histology of the gallbladder, extrahepatic bile ducts, Vaterian system, and minor papilla. *Am J Surg Pathol.* Feb 1989;13(2):146-62. doi:10.1097/00000478-198902000-00008

12. You have placed two 10-mm and two 5-mm ports in the appropriate position and placed the patient in reverse Trendelenburg. What of the following demonstrates the basics steps of a laparoscopic cholecystectomy in correct order?

1= Dissect adjacent to the gallbladder

2= Identify the critical view of safety

3=Perform adhesiolysis

4= Retract the gallbladder over the liver

5= Use clips or sutures to ligate the cystic artery and duct

6= Divide the cystic artery and duct

7= Dissect the gallbladder from gallbladder fossa

8=Remove the specimen

a) 1,2,3,4,5,6,7,8

b) 3,4,1,2,5,6,7,8

c) 2,3,4,6,5,1,7,8

d) 3,4,1,6,5,2,7,8

Explanation:

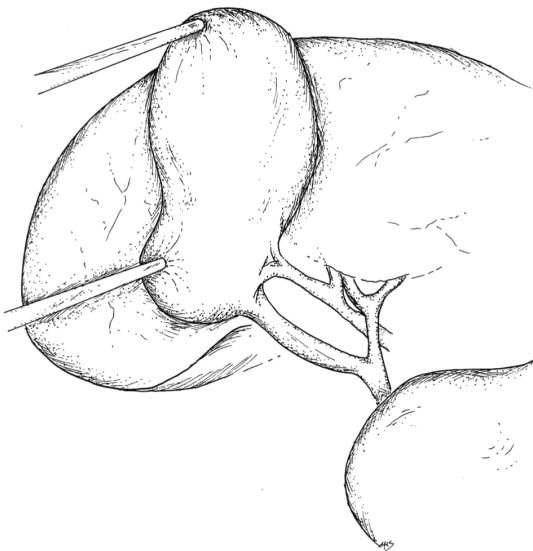
Following insufflation, placement of the appropriate ports, and optimal patient positioning, the surgeon should proceed with the steps of the operation.

First, the surgeon visualizes the gallbladder. Often there is a layer of omentum attached to an inflamed gallbladder or some adhesions between the gallbladder and bowel. These adhesions can often be detached bluntly. When available, cautery can be used if the adhesions appear to be thick, densely adherent to the gallbladder, or highly vascularized. During adhesiolysis, the surgeon must dissect as close to the gallbladder as possible to minimize the risk of injury to surrounding structures.

Then, the assistant grasps the fundus of the gallbladder, often with a locking device to retract the gallbladder to help the operating surgeon better visualize the subhepatic space and the infundibulum. Though there are several strategies to initiate dissection, one common strategy is for the operating surgeon to grasp the infundibulum and retract it laterally to expose Calot's triangle which is defined as the space bordered by the cystic duct inferiorly, the common hepatic duct medially, and the inferior edge of the liver superiorly. A combination of electrocautery and blunt dissection can be used to incise the peritoneum along the edge of the gallbladder,

elevate the lower one-third of gallbladder off of the cystic plate, and carefully identify the only two structures (cystic artery and cystic duct) entering into the gallbladder.

Once the critical view of safety is obtained, clips or sutures are placed around both structures (cystic artery and cystic duct). The number of clips or sutures used may depend on the availability of materials. When clips are used, two clips are placed proximally (side where structure that will remain), and one clip is placed distally (side of specimen). The cystic duct and the cystic artery are then divided. The gallbladder is then elevated off of the cystic plate using a combination of traction and electrocautery. To prevent spillage of bile and stones into the abdomen, the specimen is typically removed from the body through the largest port using a specimen bag, a glove, or other available sterile container.



Reference:

- Deveney K. Laparoscopic Cholecystectomy. In: Scott-Conner CEH, ed. The SAGES Manual: Fundamentals of Laparoscopy, Thoracoscopy, and GI Endoscopy. Springer New York; 2006:130-139.

13. You readily identify the gallbladder and see that it is inflamed, confirming the diagnosis of acute cholecystitis. At this point, what combination of operator and assistant retraction would be most helpful to start your dissection?

a) **Operator:** Retraction of the gallbladder infundibulum laterally/

Assistant: Retraction of the fundus towards the right shoulder

b) **Operator:** Retraction of the gallbladder infundibulum medially/

Assistant: Retraction of the fundus towards the patient's right

c) **Operator:** Retraction of the gallbladder body to the patient's left/

Assistant: Retraction of the fundus towards the feet

d) **Operator:** Retraction of the gallbladder fundus laterally/ **Assistant:**

Retraction of the infundibulum towards the right shoulder

Adequate retraction is essential to perform a laparoscopic cholecystectomy successfully. The most useful retraction during this operation is for the assistant, standing on the patient's right side, to grasp the fundus of the gallbladder and retract it over the liver towards the patient's right shoulder. This allows for visualization of the subhepatic space so the operating surgeon can visualize the infundibulum. The operator retracting the infundibulum laterally exposes Calot's triangle and allows the surgeon to begin the dissection needed to identify the cystic duct and cystic artery. Without proper retraction, structures will collapse upon each other, dissection planes become unclear, and key structures can be inadvertently injured.

14. During this procedure, your assistant asks about aberrant anatomy. What is the most common aberrant anatomy encountered during a laparoscopic cholecystectomy?

a) Absent cystic artery

b) Two cystic ducts

c) Replaced right hepatic artery

d) Replaced left hepatic artery

The cystic artery is typically a branch of the right hepatic artery. However, in ~15% of individuals, an accessory or a replaced right hepatic artery branches off of the superior mesenteric artery and courses through Calot's triangle near the gallbladder. Injury to a replaced right hepatic artery would be possible if dissection is not performed carefully.

In 2-5% of cases, the cystic artery is a branch from other vessels, such as the common hepatic artery or left hepatic artery, which results in its crossing in front of the common bile duct, the potential for ductal injury. There is a 2-15 % incidence of a double cystic artery in which case two arterial structures to the gallbladder require ligation.

Reference:

- Nagral S. Anatomy relevant to cholecystectomy. J Minim Access Surg. Jun 2005;1(2):53-8. doi:10.4103/0972-9941.16527

15. You discuss the Critical View of Safety (CVS) with your assistant.. Which of the following reflects the Critical View of Safety requirements in laparoscopic cholecystectomy?

- a) The hepatocystic triangle is cleared of fat and fibrous tissue, the lower one-third is separated from the liver to expose the cystic plate, and only two structures are seen entering the gallbladder
- b) All adhesions near the gallbladder have been lysed, two structures can be seen entering the gallbladder, and the duodenum is visualized far from the area of dissection
- c) The cystic duct, common hepatic duct, and common bile duct are skeletonized and clearly visualized
- d) The entire gallbladder (fundus to infundibulum) has been separated from the liver, the cystic duct is identified, and the common bile duct is identified

The Critical View of Safety (CVS) is a preventive measure against anatomical misidentification injuries. CVS allows for safe ligation and division of the cystic duct, avoiding accidental injury to other structures such as the common bile duct.

CVS requires three criteria to be met: (I) the hepatocystic triangle (defined as the triangle formed by the cystic duct, the common hepatic duct, and inferior edge of the liver) is cleared of all fat and fibrous tissue. (II) the lower one third of the gallbladder is separated from the liver to expose the cystic plate (defined as the liver bed of the gallbladder and represents the gallbladder fossa); and (III) two and only two structures should be seen entering the gallbladder, representing the cystic duct and the cystic artery. Once this view is established, there is a recommended pause and confirmation amongst the operating surgeon and assistant prior to clipping or cutting

of any structures. At this juncture, identification of aberrant anatomy is critical. Variations in cystic duct position and entry into the common bile duct are common, as are variants in arterial anatomy. One common consideration is ensuring the right hepatic artery is not mistaken for the cystic artery or accessory branch posteriorly in the area of the cystic plate.

Once CVS is obtained, the cystic artery, and then duct, can be divided after placing two ties proximally and one tie distally on the respective structures.

Reference

- Majumder, A. Altieri, M. S., Brunt, M. L. How do I do it: laparoscopic cholecystectomy. *Annals of Laparoscopic and Endoscopic Surgery*; Vol 5 (April 2020): *Annals of Laparoscopic and Endoscopic Surgery*. 2020; Volume 5 (April 2020). <https://ales.amegroups.org/article/view/5766>.

16. Which of these complications in laparoscopic cholecystectomy is the most difficult to treat?

- a) Hematoma
- b) Common bile duct injury**
- c) Postoperative abscess
- d) Biloma

An injury to the common bile duct is associated with considerable morbidity for patients. Bile duct injury occurs in roughly 3 of 1000 cases. The Society for American Gastrointestinal and Endoscopic Surgeons (SAGES) has created a safe cholecystectomy program to minimize the risk of ductal injuries. These strategies are helpful to consider when performing this operation:

- 1) Use the Critical View of Safety to identify the cystic duct and cystic artery
- 2) Understand the potential for aberrant anatomy in all cases
- 3) Make liberal use of cholangiography or other methods to image the biliary tree intraoperatively
- 4) Consider an intra-operative momentary pause prior to clipping, cutting, or transecting any ductal structures
- 5) Recognize when the dissection is approaching a zone of significant risk and halt the dissection before entering the zone. Finish the operation by a safe method other than cholecystectomy if conditions around the gallbladder are too dangerous

6) Get help from another surgeon when the dissection or conditions are difficult.

Reference:

- Brunt LM, Deziel DJ, Telem DA, et al. Safe Cholecystectomy Multi-society Practice Guideline and State of the Art Consensus Conference on Prevention of Bile Duct Injury During Cholecystectomy. *Ann Surg.* Jul 2020;272(1):3-23. doi:10.1097/sla.0000000000003791

17. You experience difficulty performing your dissection and are concerned that you may not achieve the CVS. You start to brainstorm adjuncts and alternative strategies to complete this operation safely. Which of the following strategies is UNLIKELY to help you proceed with the operation safely?

- a) Perform a Kocher maneuver and trace the common bile duct to the cystic duct
- b) Perform an intraoperative cholangiogram to identify ductal anatomy
- c) Perform a subtotal cholecystectomy
- d) Convert to open cholecystectomy

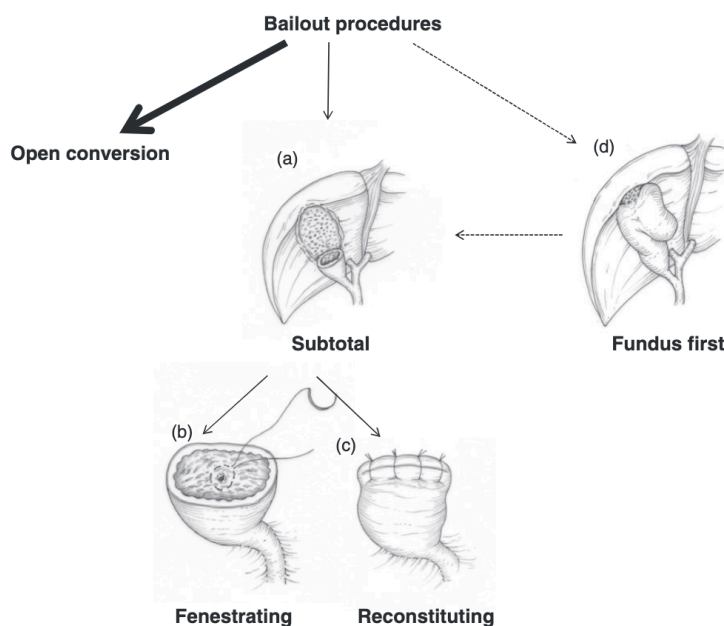
The gallbladder may be significantly distended or edematous from cystic duct obstruction, purulent fluid from a superimposed infection, or fluid from hydrops gallbladder (i.e. when the gallbladder is distended with mucus, water, or clear liquid content instead of bile due to chronic obstruction). Grasping the gallbladder is often easier when it is fully decompressed. This can be accomplished by puncturing the gallbladder with a Veress needle or other type of needle and attaching the needle to suction.

An intraoperative cholangiogram should be performed whenever there is any concern for ductal injury or assistance needed to define ductal anatomy. This is often performed by placing a catheter through the cystic duct and filling the biliary tree with contrast. Both the right and left hepatic ducts should opacify and the contrast should be seen passing through the common bile duct and entering the duodenum without

evidence of a leak. Glucagon can be used to relax the sphincter of Oddi if the duodenum does not opacify.

Surgeons performing a laparoscopic cholecystectomy should remember that their primary goal is to do no harm. While it is ideal to remove the entire gallbladder, there are times in which the inflammation or scarring of tissue planes is too severe, and visualization of the critical view of safety is impossible. In these situations, the surgeon can choose one of several bailout maneuvers.

Conversion to an open cholecystectomy is acceptable if the surgeon feels that it would improve visualization and allow for a fundus-down approach to the critical view. The surgeon can also choose to stay laparoscopic in approach and perform a fenestrated or a reconstituted subtotal cholecystectomy. In the fenestrated approach, the gallbladder is left open and the cystic duct is ligated internally. In the reconstituted approach, the remnant gallbladder wall is sutured closed. The rate of recurrent gallstones for a subtotal cholecystectomy is 5%, predominantly among those in which the gallbladder was reconstituted.



Reference:

- Sharma R, Stead TS, Aleksandrovskiy I, Amatea J, Ganti L. Gallbladder Hydrops. *Cureus*. Sep 2021;13(9):e18159. doi:10.7759/cureus.18159

- Wakabayashi G, Iwashita Y, Hibi T, et al. Tokyo Guidelines 2018: surgical management of acute cholecystitis: safe steps in laparoscopic cholecystectomy for acute cholecystitis (with videos). *Journal of Hepato-Biliary-Pancreatic Sciences*. 2018;25(1):73-86. doi:10.1002/jhbp.517

18. You are dissecting along the medial aspect of the gallbladder when you encounter a sudden rush of bile. You are concerned you have caused a ductal injury. How would you proceed?

- a) Convert to an open cholecystectomy
- b) Abort the surgery and refer the patient to a hepatobiliary surgeon
- c) Perform an intraoperative cholangiogram
- d) Perform more dissection to try and identify the duct that was injured

If you are concerned that you may have caused a ductal injury, it is important to further characterize the nature of the injury with an intraoperative cholangiogram. This test will identify the location of the injury so that the surgeon can begin to plan out the appropriate next steps. If there is a ductal injury, a consult to a hepatopancreaticobiliary surgery is recommended for guidance on the repair or temporizing techniques. Depending on the type of injury, a primary repair may be possible but a formal hepaticojejunostomy is often required. It is also possible that your rush of bile came from an injury to a duct of Luschka, which are small bile ducts that originate from the right hepatic lobe and can be found along the gallbladder fossa. An injury to these small ducts is the second most common cause of bile leaks following a cholecystectomy.

Reference:

- Spanos CP, Syrakos T. Bile leaks from the duct of Luschka (subvesical duct): a review. *Langenbecks Arch Surg*. Sep 2006;391(5):441-7. doi:10.1007/s00423-006-0078-9

19. You are able to successfully complete the dissection, have ligated the cystic duct and cystic artery, and have removed the gallbladder in a specimen bag through a 10-mm port. The patient recovers well and is discharged home. However, roughly 24 hours later she returns to the emergency room with severe abdominal pain. She has a temperature of 101.3 F, HR 125, and BP 88/60. On exam, her abdomen is rigid with diffuse peritonitis. An upright X-ray reveals free air under the diaphragm. What is the likely cause of this patient's presentation?

- a) Inadequate occlusion of the cystic duct
- b) Bile leak from the gallbladder fossa
- c) Injury to a replaced right hepatic artery
- d) Missed enterotomy**

As with any laparoscopic operation, the surgeon must pay close attention to surrounding structures. In a laparoscopic cholecystectomy, the duodenum can be only millimeters away from the dissection. It is also possible that, due to inflammation, the hepatic flexure or other loops of the small intestine are close to the working space of the gallbladder. Thermal energy from the electrocautery used during dissection can easily spread to adjacent tissue. Most often, these small injuries are not appreciated at the time and may even occur off screen as instruments are exiting, or being introduced to, the abdomen. Machado et al observed an average of 1.6 days for duodenal injuries to present, which most often present with intra-abdominal sepsis and peritonitis. Additionally, a small bowel laparotomy may be possible from placement of trocar or inadvertent bowel injury during cholecystectomy. Thus, clinicians should have a high index of suspicion with a postoperative cholecystectomy patient in extremis. While it is expected that patients will still have pneumoperitoneum one day after laparoscopic surgery, the patient's overall presentation consistent with sepsis makes a missed enterotomy a chief concern.

Reference:

- Machado NO. Duodenal injury post laparoscopic cholecystectomy: Incidence, mechanism, management, and outcome. *World J Gastrointest Surg.* Apr 27 2016;8(4):335-44. doi:10.4240/wjgs.v8.i4.335

20. You perform another laparoscopic cholecystectomy for a patient who has gallstone pancreatitis. The patient initially recovers well, but she returns to the emergency room postoperative day 1 with vague abdominal pain, distention, and food intolerance. Her temperature is 100.9 F, HR 108, and BP 110/90. On exam, she is globally tender to palpation without signs of frank peritonitis. An ultrasound shows a large fluid collection and a follow-up CT scan reveals a large amount of simple fluid in the gallbladder fossa, perihepatic space, and in the pelvis. What is the most likely cause of her presentation?

- a) Bile leak
- b) Hemorrhage
- c) Perforated viscus
- d) Abscess

A postoperative bile leak often presents with slowly progressive abdominal pain, distention, malaise, and anorexia. It can happen up to 30 days after surgery. Often, patients are not in extremis upon presentation, but may have abnormalities in their liver function tests and chemical evidence of biliary obstruction. The incidence of bile leak following a laparoscopic cholecystectomy is 0.3-2.7%, though the rate increases in cases of gallstone pancreatitis or choledocholithiasis due to the pressurized ductal system. Ties and clips placed on the cystic duct can be dislodged, particularly if these areas of tissue become ischemic. The diagnosis of a suspected bile leak is made through ultrasound or cross-sectional imaging such as CT scan. A drain can be both diagnostic and therapeutic. It will both confirm the diagnosis when bilious output is obtained and therapeutically drain the fluid. If the drain continues to have large volume of bilious output over time, an ERCP with stent placement may be needed to manage the leak definitively.

Reference:

- Mungai F, Berti V, Colagrande S. Bile leak after elective laparoscopic cholecystectomy: role of MR imaging. *J Radiol Case Rep.* Jan 2013;7(1):25-32. doi:10.3941/jrcr.v7i1.1261