Laparoscopic Cholecystectomy

78

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Indications

Confirmed diagnosis of symptomatic gallstones
Acute or chronic cholecystitis

Contraindications

Prior major surgery of the upper abdomen
Cirrhosis and bleeding disorders (relative contraindications)

Preoperative Preparation

Ultrasonography demonstrating the presence of gallbladder calculi
Perioperative antibiotics initiated prior to the induction of anesthesia
Insertion of an orogastric tube for gastric decompression during surgery
Insertion of a Foley catheter (optional)

The management of patients with suspected common bile duct (CBD) calculi will vary depending upon local expertise and the degree of suspicion. As discussed in Chap. 76, patients who present with acute cholangitis require urgent decompression of the bile duct, best obtained by ERCP and endoscopic papillotomy with stone removal followed, in most cases, by laparoscopic cholecystectomy several days later. Patients who have a dilated CBD on ultrasound, or those with suspicious liver chemistry abnormalities, may be candidates for intraoperative cholangiography. If the team is skilled at laparoscopic choledocholithotomy, stones may be removed if identified.

Operative Strategy

Avoiding Bleeding

Meticulous hemostasis is essential for laparoscopic cholecystectomy, not only to avoid blood loss but because bleeding impairs the visibility necessary to perform this operation safely and with precision. Careful use of electrocautery can accomplish this end.

Great care must be exercised with any source of energy, especially in the triangle of Calot, as there have been reports of lengthy strictures of the common and hepatic ducts presumably due to careless application of the laser or electrocautery in this area. When employing cautery near the bile ducts, use a hook cautery and elevate the tissues above any underlying structures in Calot's triangle before applying energy. This practice minimizes damage to the bile ducts.

Preventing Bile Duct Damage

As discussed under Complications at the conclusion of this chapter, the most serious bile duct injuries result from the surgeon's mistaking the CBD for the cystic duct, resulting in transection of the CBD and occasionally excision of the CBD and most of the common hepatic duct. During laparoscopic cholecystectomy, cephalad retraction of the gallbladder fundus results in abnormal displacement of the usual pathway of the common and hepatic ducts. Normally the CBD and common hepatic duct are aligned essentially in a straight line ascending from the duodenum to the liver. However, with forceful cephalad retraction of the gallbladder fundus, the CBD appears to run in a straight line with the cystic duct directly into the gallbladder, as illustrated in Fig. 78.1. In this situation, the common hepatic duct appears

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to join this straight line at a right angle. It is dangerous to initiate the dissection in the region of the bile ducts, as it may lead to the mistake of assuming that the CBD is indeed the cystic duct. A dissection proceeding in an ascending direction toward the gallbladder may very well transect the common hepatic duct.

Two precautions must be taken to avoid this error. First, always initiate the dissection on the gallbladder and remove all areolar tissue in a downward direction so the dissection continuously proceeds from the gallbladder ampulla downward toward the cystic duct. Second, after the gallbladder ampulla and infundibulum have been cleared of areolar tissue and fat, retract these structures laterally toward the patient's right, as seen in Fig. 78.2a. This helps restore the normal anatomy of the common and hepatic ducts and serves to open up the triangle of Calot and the space between the cystic and common hepatic ducts.

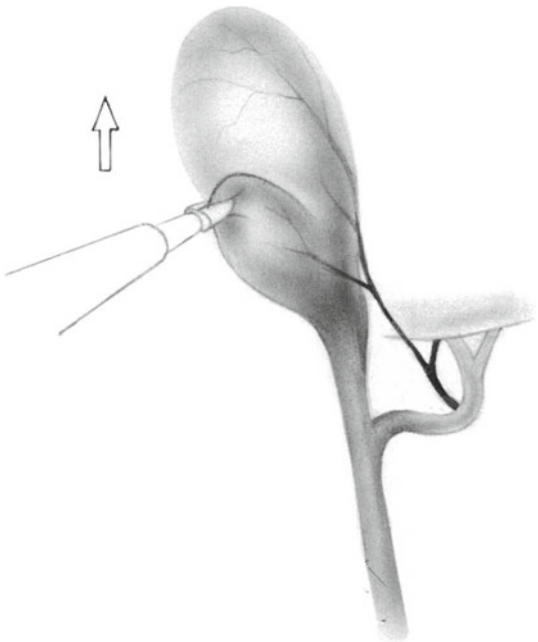

Fig. 78.1

The final essential component of a technique that avoids damaging the common bile duct is *creating a window behind the gallbladder near the termination on the cystic duct* by dissecting the gallbladder away from the liver. Then, having exposed the posterior surface of the gallbladder, continue to clear the posterior walls of the infundibulum and the cystic duct until there is a 3- to 4-cm window of empty space behind the cystic duct, infundibulum, and gallbladder ampulla (Fig. 78.2b). If the continuum between gallbladder, infundibulum, and cystic duct is clearly identified after elevating the structures, one can then be assured of the identity of the cystic duct. If by mistake one had initiated the dissection by freeing up the CBD caudal to its junction with the cystic duct, as the dissection proceeded cephalad toward the gallbladder, the common hepatic duct would be encountered joining the cystic duct on its medial aspect (Fig. 78.1). This approach puts the hepatic and common ducts at risk of major injury.

Ensuring Good Exposure

Because excellent visibility is essential to prevent unnecessary damage, do not hesitate to install an additional cannula and use a retractor to depress the transverse colon or to elevate the liver when necessary.

Intraoperative Cholangiography

Many experienced laparoscopic surgeons believe that an intraoperative cholangiogram, obtained as soon as the cystic

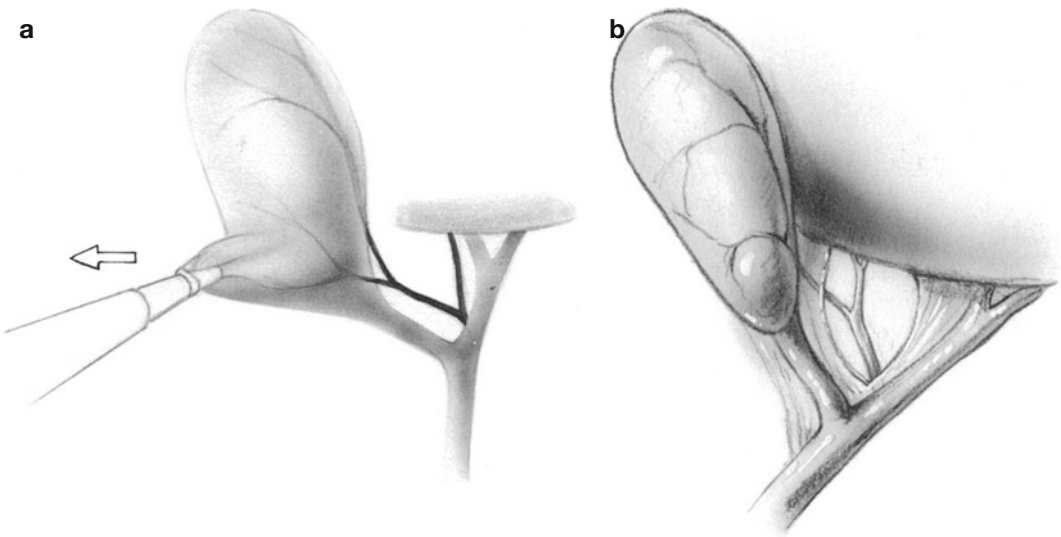

Fig. 78.2

duct is identified, is an excellent means for ascertaining the exact anatomy of the biliary tree. This confirms identification of the cystic duct and detects an anomalous hepatic duct in time to avoid operative trauma.

Conversion to Open Cholecystectomy

Whenever there is any doubt about the safety of a laparoscopic cholecystectomy, whether because of inflammation, scarring, poor visibility, equipment deficiencies, or any other reason, *do not hesitate to convert* the operation to an open cholecystectomy. Every patient's preoperative consent form should acknowledge the possibility that an open cholecystectomy may be necessary for the patient's safety. *Conversion to open cholecystectomy is not an admission of failure but an expression of sound judgment by a surgeon who gives first priority to the safe conduct of the operation. Because conversion is generally required only in difficult cases, it is essential that the laparoscopic surgeon be familiar with the material in* Chap. 77 *on the open cholecystectomy even though most cholecystectomies are performed laparoscopically.*

Pitfalls and Danger Points

Be aware that some patients have a *short cystic duct*, which increases the risk of bile duct damage by misidentification. Again, if the dissection is initiated to free the posterior wall of the gallbladder and its infundibulum, expose the common hepatic duct behind the gallbladder early during the dissection (Fig. 78.3). This should prevent misidentification of the anatomy. If one suspects the presence of a short cystic duct but is not certain, perform intraoperative cholecystocholangiography by injecting contrast material into the gallbladder with a long needle.

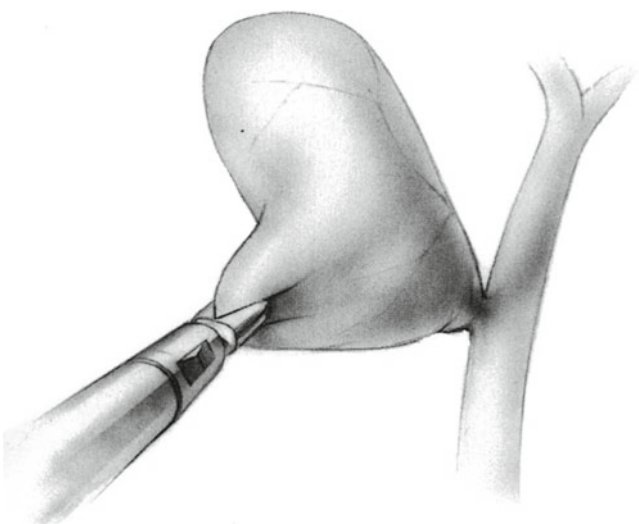

Fig. 78.3

There may be *damage to aorta, vena cava, iliac vessels, or bowel during trocar insertion* (see Chap. 9). There may also be *damage to the common or hepatic duct* due to misidentification.

Bleeding may be due to avulsion of the posterior branch of the cystic artery that has not been properly identified.

Documentation Basics

- Findings
- Cholangiogram or not?
- Document identification of key structures and steps to avoid injury

Operative Technique

This chapter describes the basic, four-trocar technique of laparoscopic cholecystectomy. Variations involving smaller numbers of trocars, including natural orifice and single-site approaches, are described in the references at the end. The room setup, entry into the peritoneal cavity, and first steps for any laparoscopic procedure are described in Chap. 9.

Initial Inspection of the Peritoneal Cavity

Plan the initial trocar site either just above or below the umbilicus in a natural skin crease. Gain access to the abdomen via a closed (Veress needle) or open (Hassan cannula) technique. Some surgeons prefer a 30° angled laparoscope for biliary surgery, but the operation can comfortably be performed with a straight (0°) laparoscope.

Insert the laparoscope into the cannula. Inspect the organs of the pelvis and posterior abdominal wall. Look for unexpected pathology and evidence of trauma that might have been inflicted during needle insertion to the vascular structures or the bowel. If no evidence of trauma is seen, aim the telescope at the right upper quadrant and make a preliminary observation of the upper abdominal organs and gallbladder.

Insertion of Secondary Trocar Cannulas

A second 10- to 11-mm cannula is inserted in the epigastrium at a point about one-third the distance between the xiphoid process and the umbilicus. It generally is placed just to the right of the midline to avoid the falciform ligament. With a finger, depress the abdominal wall in this general area and observe with the telescope to define the exact location at which to insert the trocar. Make a 1-cm transverse skin incision at this point and insert the trocar cannula under direct vision by aiming the telescope-camera at the entry point of the trocar. Apply even pressure with no sudden motions.

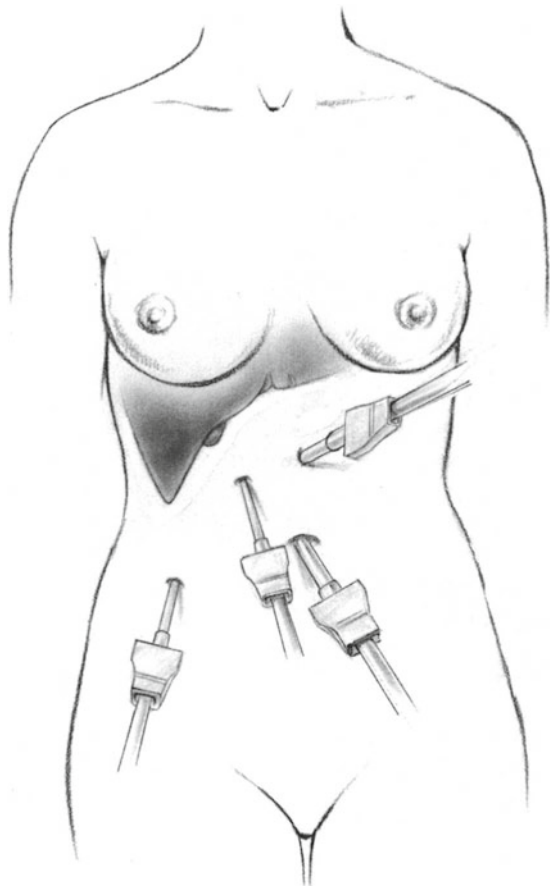

Fig. 78.4

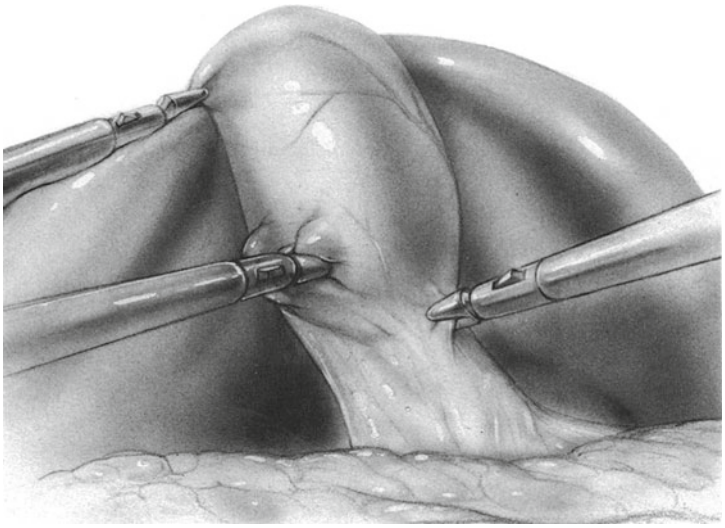

Fig. 78.5

Serious injuries of the liver and other organs have been reported following vigorous insertions of the trocar. As soon as the cannula has entered the abdominal cavity, remove the trocar; this site constitutes the main operating port.

Establish two secondary ports, one in the midclavicular line about 2–3 cm below the costal margin and the other in the anterior axillary line at a point about level with the umbilicus. These two 5-mm ports are mainly used for grasping and retraction.

Insert a trocar in each of these ports after making a 5-mm skin incision. Observe and control the entry of these trocars carefully by watching the television monitor. The objective is to position the ports so the surgeon can manipulate the dissecting instruments at a point in front of and roughly at right angles to the telescope. Figure 78.4 illustrates a typical arrangement of cannulas.

Dissecting the Gallbladder to Expose the Cystic Duct

To expose the gallbladder, elevate the head of the table to a 30° reverse Trendelenburg position. Apply suction to the nasogastric tube as necessary to deflate the stomach. Sometimes moderate upward rotation of the right side of the operating table is also helpful for improving exposure. Insert a grasping forceps through the right lateral port and grasp the upper edge of the gallbladder. Push the gallbladder in a cephalad direction anterior to the liver. Utilizing the midclavicular port, have the assistant insert a second grasping forceps to grasp the gallbladder fundus and apply countertraction while the surgeon uses an appropriate dissecting forceps inserted through the upper midline port.

The first objective is to expose the gallbladder fundus by dissecting away any adherent omentum and other structures. Then grasp the areolar tissue and fat overlying the fundus with a grasping forceps (Fig. 78.5), apply a burst of coagulating current, and pull the tissue in a caudad direction. While this is being done, the assistant's grasping forceps draws the ampulla of the gallbladder gently toward the patient's right, as illustrated in Fig. 78.2. Hook electrocautery or electrified scissors can also be used to divide the peritoneal layers that cover the infundibulum of the gallbladder and cystic duct. Use the hook dissector to liberate the lower portion of the gallbladder from its attachment to the liver, both laterally and medially. *Create a large window of space behind the gallbladder*, *the infundibulum*, *and the cystic duct* (Fig. 78.2). The dissection should continuously be directed from the gallbladder downward toward the cystic duct. Always consider that the CBD and hepatic ducts may be closer to the gallbladder than you think, especially in patients who have a short cystic duct (Fig. 78.3). Concentrating on the lower portion of the gallbladder and infundibulum is much safer than initiating the dissection behind what you *think* is the cystic duct but that may indeed be the CBD.

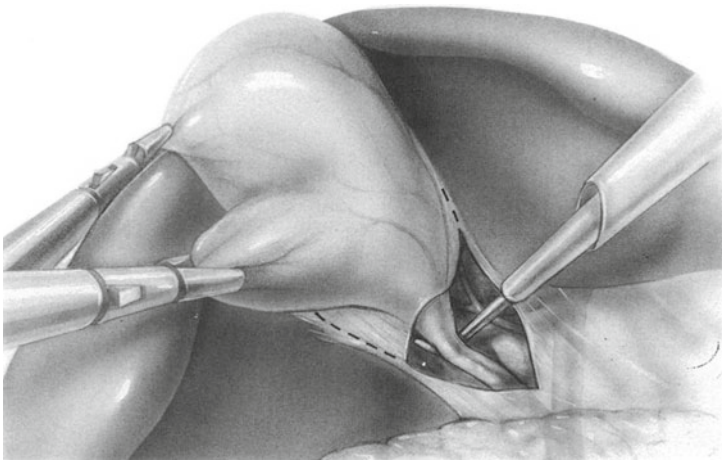

Fig. 78.6

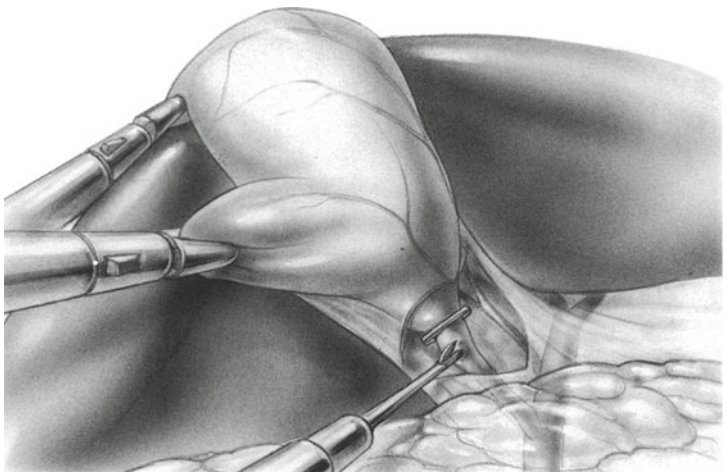

Fig. 78.7

After dissecting on both sides of the cystic duct by manipulating the ampulla from right to left, pass a right-angled Maryland dissector or a hook behind the cystic duct and free up several centimeters so there is *complete exposure of the continuum of the posterior cystic duct going up to the infundibulum and the lower portion of the gallbladder* (Fig. 78.6).

Cystic Duct Cholangiogram

When certain that the cystic duct has been identified, apply an endoscopic clip to the area of the infundibulum of the gallbladder and use scissors to make an incision in the cystic duct just below the clip (Fig. 78.7). For cholangiography, we prefer a balloon-tipped catheter of the type made by the Arrow Company. Test the balloon and insert the catheter into the upper midline or midclavicular port. Adjust the curvature

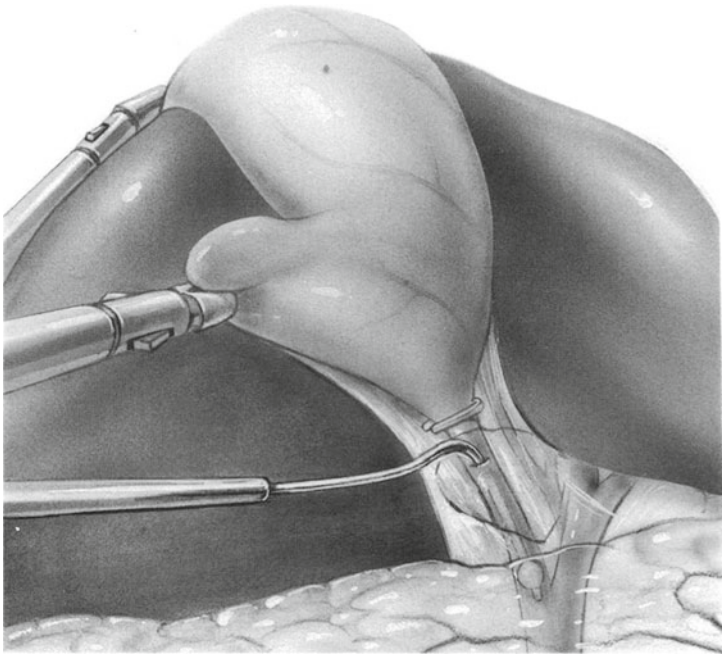

Fig. 78.8

of the catheter tip by pushing or withdrawing the catheter through its curved plastic catheter holder. Thread the catheter into the cystic duct incision for no more than 1 cm (Fig. 78.8), a point marked by two black lines on the catheter body. Inflate the balloon and tentatively inject some contrast material to determine that leakage does not take place. Do not insert the catheter too far into the cystic duct; otherwise, it enters the CBD, and the balloon occludes the CBD at the point of injection, resulting in an image of the distal CBD only from the catheter tip to the ampulla of Vater. This image cannot prove that the common hepatic duct is intact. In this case, back out the catheter for a short distance and repeat the cholangiogram. Use C-arm fluoroscopy to monitor the injection. If fluoroscopy is not available, obtain two plain radiographs. Inject 4 ml of contrast material for the first film and an additional 8 ml for the second. *If the proximal ducts do not fill, assume a CBD injury and convert to open laparostomy*.

If the cholangiogram demonstrates satisfactory filling of the hepatic duct and CBD as well as the duodenum, remove the catheter and continue to the next step, which is dividing the cystic duct as described below. If the cholangiogram demonstrates a calculus in the CBD, perform a laparoscopic CBD exploration if the technology and skill are available (see References). Otherwise, one has the choice of performing an open cholecystectomy and choledocholithotomy or scheduling the patient for a postoperative endoscopic papillotomy for stone extraction. If the stone is exceedingly large (approaching 2 cm), an open choledocholithotomy is preferable. This is also the case if the patient has a large number of

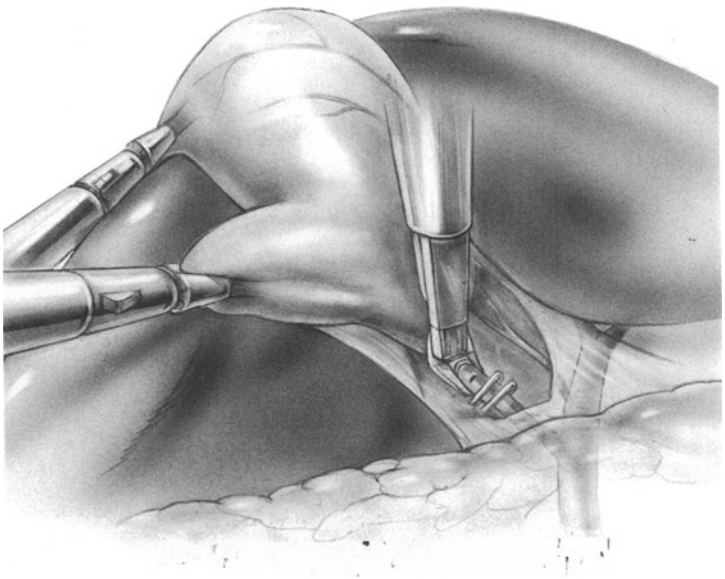

Fig. 78.9

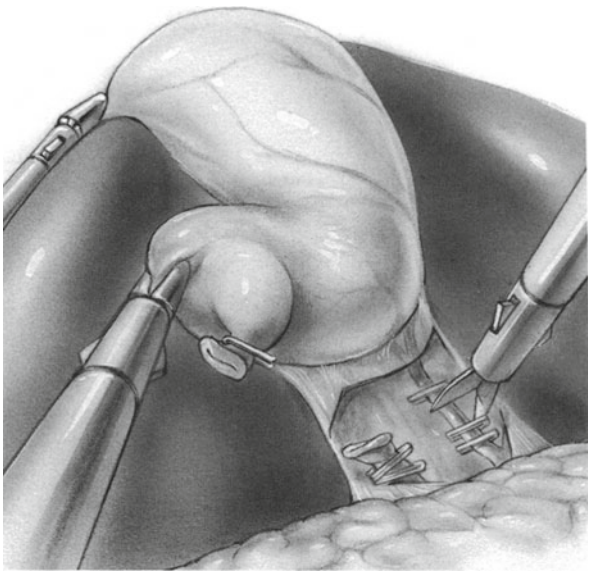

Fig. 78.10

stones or has had a previous Billroth II gastrectomy, making endoscopic papillotomy an unlikely choice.

There need be no hesitation on the part of the surgeon to proceed to open cholecystectomy and choledocholithotomy. This is a safe operation that generally accomplishes complete clearing of the CBD in one procedure. Such clearance may take the endoscopist several attempts to accomplish by endoscopic papillotomy. Remember also that endoscopic papillotomy for CBD extraction is associated with 1 % mortality. One advantage of the open choledocholithotomy in patients who have 10–20 calculi is the ability to incorporate into the operation a biliary-enteric bypass, such as choledochoduodenostomy. Because endoscopic papillotomy is feasible in only about 90 % of patients owing to anatomic variability or periampullary diverticula, it may be helpful to insert a guidewire through the opening in the cystic duct and pass it down the CBD into the duodenum. Duodenal placement can be confirmed by an abdominal radiograph. In the presence of this guidewire, endoscopic papillotomy can be performed in almost 100 % of patients.

In cases where passage of the cholangiogram catheter is obstructed by the valves of Heister, the obstruction may be corrected by inserting the tip of the scissors into the cystic duct. Keep the scissors closed upon entering the duct and then open them with mild force to dilate the valves.

Removing the Gallbladder

Remove the cholangiogram catheter and apply another endoscopic clip on the gallbladder side of the incision (Fig. 78.9). Then apply two clips on the distal portion of the cystic duct. Divide the cystic duct with scissors.

During dissection of the cystic duct, the cystic artery is generally identified slightly cephalad to the cystic duct. Whenever this structure has been clearly identified, elevate it with either a Maryland dissector or a hook so at least 1 cm is dissected completely from surrounding structures. Then apply one endoscopic clip above and two clips below, and divide the artery with scissors (Fig. 78.10). Note that the point at which the cystic artery divides into its anterior and posterior branches can be somewhat variable. When you think you have divided the main cystic artery, you may have divided only the anterior branch. Be alert during the latter part of the dissection for a posterior branch that must often be clipped and divided when the infundibulum of the gallbladder is freed. If this branch is small enough, it may be handled by electrocautery instead of clipping.

Now continue to dissect the gallbladder away from the liver. This can be done with electrocautery using either a hook or a spatula dissection. Divide the peritoneum between the gallbladder and the liver on each side of the gallbladder. Then continue the dissection on the posterior wall of the gallbladder. The first assistant maneuvers the two grasping forceps to expose various aspects of the gallbladder and applies countertraction for the surgeon. Some surgeons utilize a two-handed technique: dissection with the right hand and manipulating the medial grasping forceps with the left hand.

Before the gallbladder is totally free of its attachment to the liver, carefully inspect the liver bed for bleeding points. Irrigate the area. If there are any bleeding points in the liver bed, they can be occluded by applying a suction electrocoagulator.

Finally, elevate and divide the gallbladder from its final attachment to the liver (Fig. 78.11). Leave the gallbladder in position over the dome of the liver being held in the lateral port grasper.

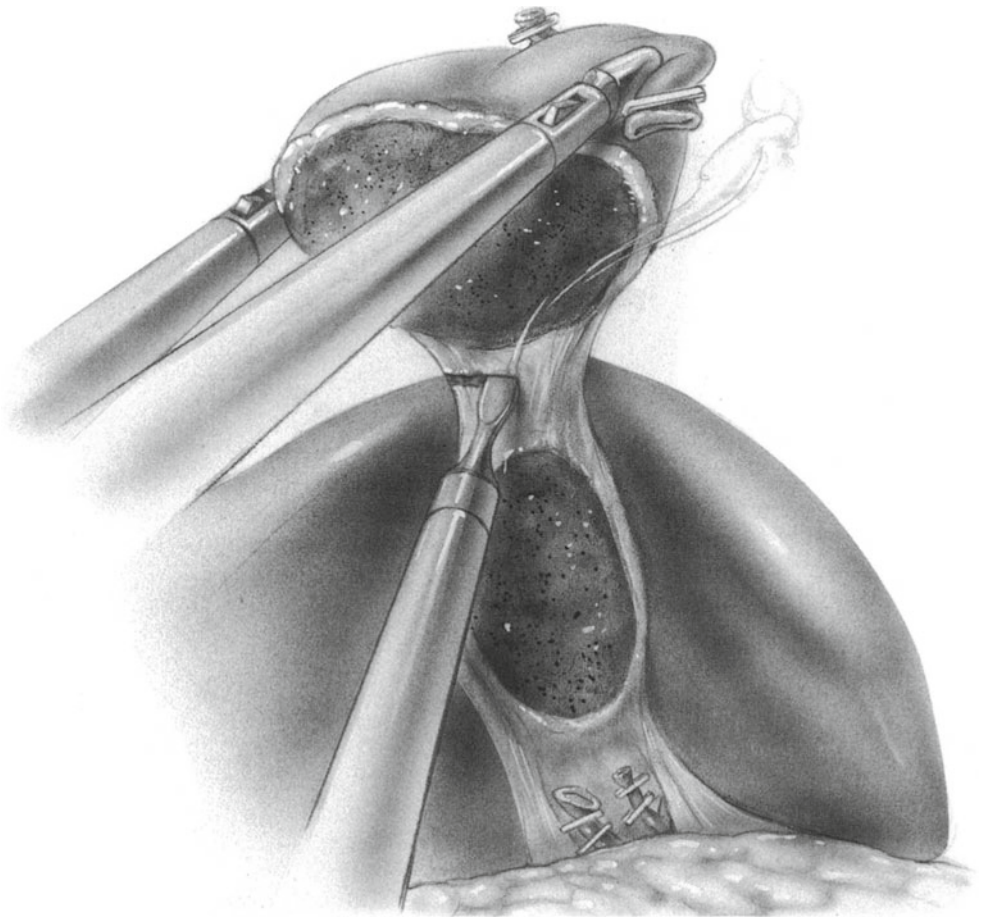

Fig. 78.11

Remove the laparoscope from the umbilical cannula and place it through the upper midline sheath. Insert a large claw grasper through the umbilical cannula. Pass the claw along the anterior abdominal wall to reach the gallbladder over the dome of the liver. Follow the action with the camera. The claw grasps the gallbladder at its neck. Then pull the gallbladder into the umbilical cannula as far as it will go. Now remove the cannula together with the gallbladder. As soon as the neck of the gallbladder is seen outside the umbilicus (Fig. 78.12), make an incision in the gallbladder (Fig. 78.13) and insert a suction device to aspirate bile (Fig. 78.14). Apply a Kelly hemostat to the neck of the gallbladder and gradually extract it from the abdomen while observing the action on the video monitor (Fig. 78.15). If the gallbladder is too large to pass through the umbilical incision, the incision can be enlarged somewhat by inserting a large hemostat and stretching the width of the incision. Alternatively, the incision may be lengthened by several millimeters in both directions using the scalpel until the gallbladder can be removed. Sometimes an endoscopic retrieval bag is useful, particularly if the gallbladder is inflamed.

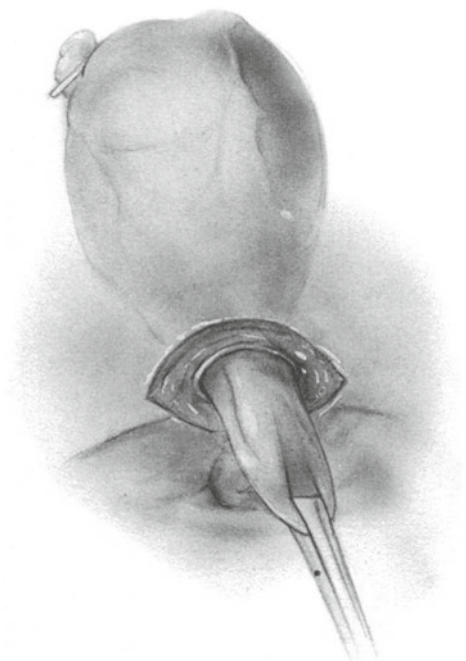

Fig. 78.12

In the patient with a small gallbladder, do not move the telescope from the umbilical port. Rather, pass the claw

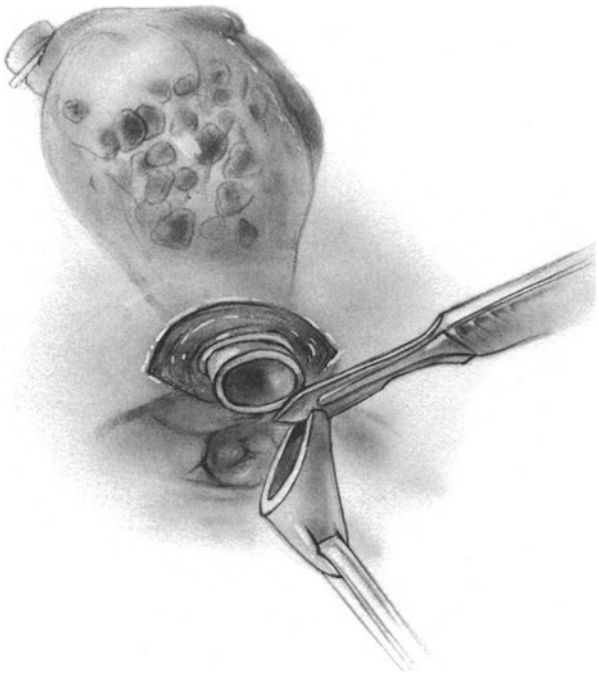

Fig. 78.13

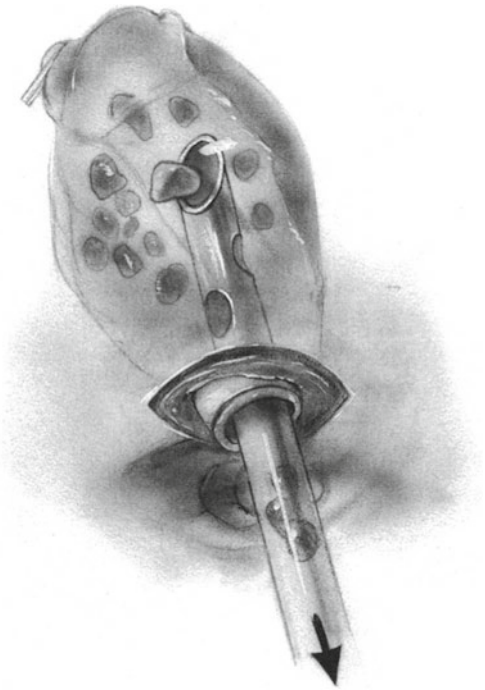

Fig. 78.14

grasper through the epigastric port and draw the gallbladder through the epigastric incision.

If the laparoscope has been transferred to the epigastric port, return it to the umbilical cannula and make a last inspection of the abdominal viscera, pelvis, and gallbladder bed. If there are any signs of retroperitoneal

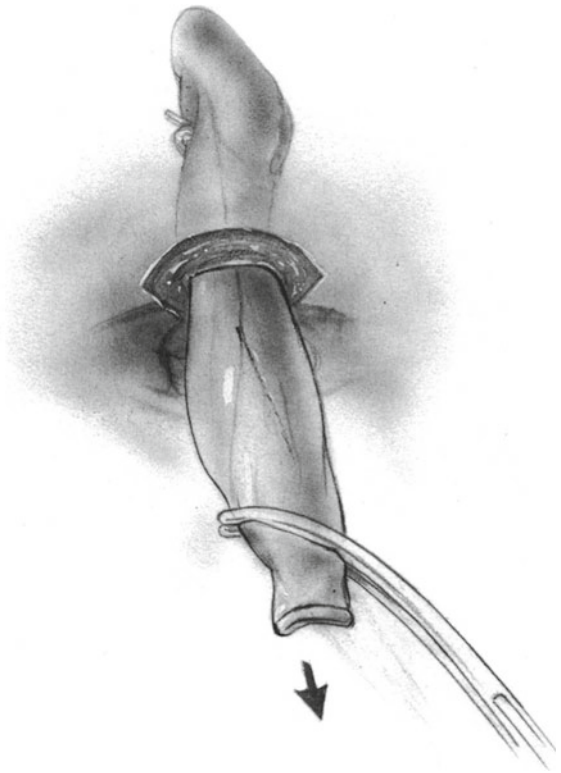

Fig. 78.15

hematomas in the region of the aorta, vena cava, or iliac vessels, assume that there has been major injury to these vessels and perform a laparotomy if necessary to rule out this possibility. Remember, even with disposable trocars that have plastic shields, forceful collision of the shielded trocar with the vena cava may result in perforation of this vessel. Bleeding from the great vessels constitutes the main cause of the rare fatality that follows laparoscopic cholecystectomy. Carefully observe the withdrawal of each cannula to ascertain the absence of bleeding in each case. Finally, permit the escape of carbon dioxide from the abdominal cavity and remove the final cannula. Insert sutures of heavy Vicryl in the two 10-mm incisions in the midline of the abdomen. The 5-mm incisions do not require closure. Close the skin with sterile adhesive tape or subcuticular sutures.

Postoperative Care

Remove the nasogastric or orogastric tube and urinary catheter (if placed) before the patient leaves the recovery room. Mild pain medication may be necessary. Ambulate the patient as soon as he or she awakens. A regular diet may be ordered unless the patient is nauseated.

Discharge patients a day or two following surgery. They may resume full activity by the end of 1 week.

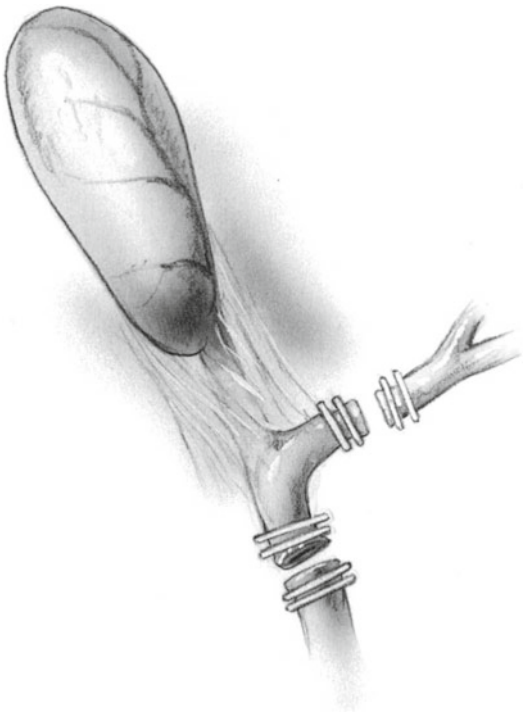

Fig. 78.16

Fig. 78.17

Complications

Needle or Trocar Damage

Retroperitoneal bleeding from damage to one of the great vessels during insertion of the initial trocar can be fatal. A retroperitoneal hematoma noted during laparoscopy requires open exploration for great vessel injury.

Bowel injury can result from introducing the Veress needle or a trocar, especially if the trocar is passed through adherent bowel. Careful inspection of the abdomen by laparoscopy after inserting the initial trocar and again before terminating the operation is essential if these injuries are to be detected early and then repaired.

Insufflation-Related Complications

See Chap. 9.

Bile Duct Damage: Excision of Common and Hepatic Ducts

The classic laparoscopic biliary injury includes resection of large sections of the CBD and the common hepatic duct together with the cystic duct and the gallbladder (Fig. 78.16). Injury results from mistaking the CBD for the cystic duct and applying clips to the CBD. The CBD is then dissected in a cephalad direction as though it were the cystic duct with transection of the proximal hepatic ductal system with or without clip ligation.

Significant leakage of bile into the operative field is a danger sign that should not be ignored. Inadequate visualization of the surgical field often contributes to these errors and to significant bleeding.

If, in fact, a surgeon divides the common bile duct by mistake, there is certainly no excuse for failing to detect this error when the dissection encounters the common hepatic duct. As seen in Fig. 78.16 (modified from Davidoff et al. (1992)), if one dissects the proximal divided end of the CBD in a cephalad direction, it is not possible to remove the gallbladder without transecting the common hepatic duct. With proper surgical dissection, it should be obvious that the presence of this duct indicates that the operative strategy is wrong and requires an immediate course correction.

One factor contributing to injury is fibrosis or scarring in Calot's triangle, as shown in Fig. 78.17. The cystic duct is densely adherent to the common hepatic duct for several centimeters above the junction of the cystic and common ducts. This injury does not occur if the dissection is initiated at the distal gallbladder and if the posterior portion of the

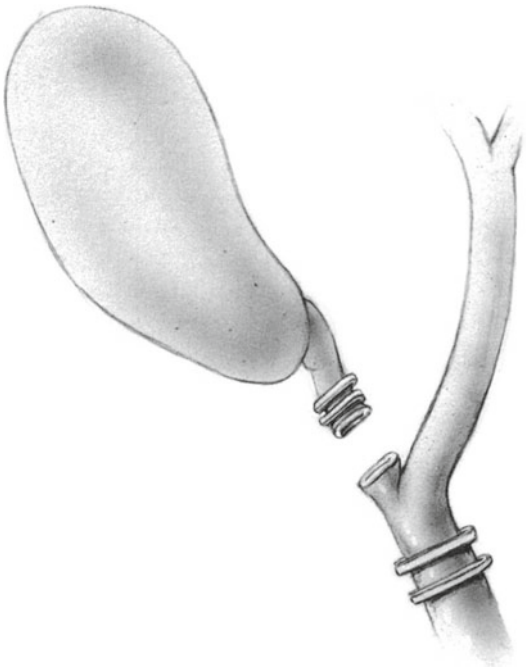

Fig. 78.18

gallbladder infundibulum is dissected away from the liver before dissecting the cystic duct. Dissection should always progress from the gallbladder toward the cystic duct, completely freeing the entire circumference of the fundus, the infundibulum of the gallbladder, and the cystic duct.

Another common pattern of CBD injury is illustrated in Fig. 78.18. Here, clips were applied to the CBD just below its junction with the cystic duct, but the transection took place across the distal portion of the cystic duct. In this case the patient will have a total biliary fistula into the peritoneal cavity.

The CBD may also be injured when the clip applied to the proximal portion of the cystic duct also encompasses the right hepatic duct. Fibrosis in Calot's triangle may contribute to this injury by placing the right hepatic duct in close proximity to the cystic duct. This injury may be avoided if the surgeon properly dissects the gallbladder infundibulum and cystic duct from above down prior to applying the clips.

Finally, late strictures (presumably due to thermal damage) have been reported.

In summary, prevention of damage to the bile ducts requires good visibility (sometimes facilitated by use of a 30° angled laparoscope), lateral traction on the fundus and infundibulum of the gallbladder to separate the cystic duct from the common hepatic duct, directing the dissection from the distal gallbladder downward toward the cystic duct rather than the reverse, using electrocautery with caution, applying routine cholangiography early in the operation, and converting to open cholecystectomy whenever there is any doubt concerning the safety of the laparoscopic cholecystectomy. A satisfactory intraoperative cholangiogram must show intact bile ducts from the right and left hepatic ducts down to the duodenum. When there is doubt concerning which duct to use for the cholangiogram, a cholecystocholangiogram may be obtained by injecting 30–40 ml of contrast material directly into the gallbladder.

Bile Leak

Leakage of bile into the right upper quadrant following laparoscopic cholecystectomy does not necessarily indicate an injury to the bile duct. It may simply mean that the occluding clips have slipped off the cystic duct or that a minor accessory bile duct is leaking. Symptoms generally develop a few days after laparoscopic cholecystectomy and consist of generalized abdominal discomfort, anorexia, fatigue, and sometimes jaundice. Sonography can reveal the presence of fluid in the subhepatic space. A HIDA scan demonstrates the presence of bile outside the biliary tree, and ERCP demonstrates the point of leakage. In the absence of obstruction in the CBD, these leaks generally heal spontaneously. Healing may be expedited by percutaneous insertion of a drainage catheter into the right upper quadrant and insertion of a stent into the CBD following endoscopic papillotomy. Of course, major ductal injury requires surgical reconstruction, generally by the hepaticojejunostomy Roux-en-Y procedure.

Intraoperative Hemorrhage from Cystic Artery

Occasionally brisk bleeding results when the cystic artery is cut or torn. It is generally a minor complication during open cholecystectomy because grasping the hepatic artery between two fingers in the foramen of Winslow (Pringle maneuver) ensures prompt if temporary control of bleeding. With laparoscopic cholecystectomy, however, losing 30–40 ml of blood may be serious because the blood obscures visibility through the laparoscope.

Frequently it is possible to control cystic artery bleeding by grasping the gallbladder ampulla near the bleeding vessel and pushing the ampulla firmly against the liver (Fig. 78.19). If this maneuver successfully controls the bleeding, insert one or more additional cannulas for suction and retraction and attempt to localize and clip the bleeding vessel. It is not worth spending much time on occluding this bleeder laparoscopically because making a subcostal incision affords an opportunity to localize and control the bleeder quickly with no risk.

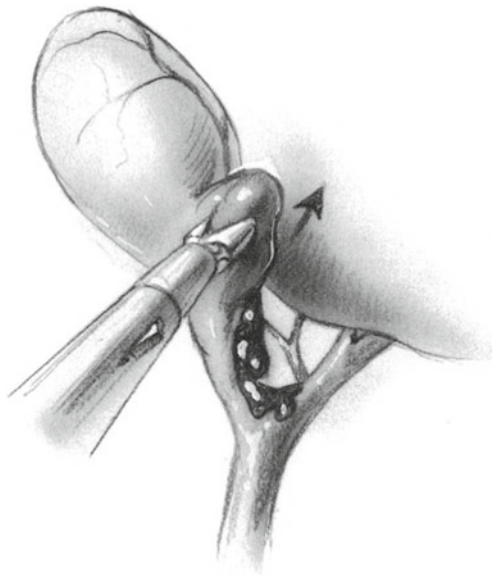

Fig. 78.19

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