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# Bedside Percutaneous Cholecystostomy

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Additional information is available at the end of the chapter

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## Abstract

Although percutaneous cholecystostomy historically is an alternative to cholecystectomy, it is typically performed as a bridge to gallbladder removal. As a low mortality procedure, it proves itself a valuable tool in morbid patients such as the elderly and the critically ill who present with acute cholecystitis and as an alternate route for biliary access. In high-risk patients, PC can be performed at the patient's bedside in patients who are too unstable to be transported outside the ICU. PC is performed using ultrasound, CT, or fluoroscopic guidance; however, bedside PC can only be performed using ultrasound. Ultrasound is readily available and portable and allows for real-time imaging. A 2010 study performed by Donkol et al. demonstrated success rates for CT (93%), US (46%), and fluoroscopy (62%). Though US had the lowest success rate, it remains the only option for those critically ill who cannot tolerate transportation or an immediate cholecystectomy. Contraindications of PC include hemorrhage, pericholecystic abscess, gallbladder tumor, etc. Complications include bile leak, hemorrhage, sepsis, bowel perforation, etc. The gallbladder is a small organ with much pathology. Having the knowledge and skill to adequately perform this procedure is essential, especially in patients with septic shock in need of source control.

**Keywords:** cholecystostomy, percutaneous, cholecystitis, biliary, gallbladder

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## 1. Introduction

Acute cholecystitis is a serious condition, which requires rapid treatment. The gold standard treatment for acute cholecystitis is surgical cholecystectomy [1–3]. In modern practice, this is most commonly performed via a laparoscopic approach [3]. Surgical resection, whether open or laparoscopic, requires general anesthesia, and therefore a certain level of patient

stability. In patients who are not operative candidates, percutaneous cholecystostomy (PC) is an alternative approach.

Percutaneous cholecystostomy is a minimally invasive, image-guided intervention. The goal of PC is to quickly decompress the gallbladder to prevent gallbladder rupture and resultant peritonitis, as well as to provide infection source control. When combined with antibiotics, this is an effective way to give the body time to lessen the inflammatory response in preparation for surgery. In patients with acalculous cholecystitis, PC can obviate the need for surgery [1, 2]. Furthermore, it makes possible the ability to perform diagnostic cholangiography and access for intervention to eliminate common bile duct stones [4]. Options for image guidance include ultrasound, computed tomography, and fluoroscopy. When performed at the bedside, this procedure is done with ultrasound guidance and has the advantage of avoiding the need to transfer patients to the operating room or Interventional Radiology suite [1, 2, 6].

## 2. History

The first open cholecystostomy was performed in 1684 followed by the first open cholecystectomy in 1878 [5]. A diagnostic test in 1921 placed dye in the gallbladder by way of a cholecystostomy tube. Percutaneous cholecystostomy was first described by Radder as an alternative to immediate open or laparoscopic cholecystectomy on the basis that initial drainage of the gallbladder will result in decompression of the biliary system and subsequent resolution of gallbladder inflammation [4]. He then performed the first percutaneous cholecystostomy (PC) using ultrasound guidance in 1979 for empyema of the gallbladder [6]. Other imaging modalities including CT and fluoroscopic guidance were used starting in 1985 [17].

## 3. Indications

Acute cholecystitis is a clinical diagnosis based on history, physical exam, laboratory values and imaging. The most common cause of acute cholecystitis is cystic duct obstruction from biliary stones (calculous cholecystitis) [3]. Once the diagnosis of acute calculous cholecystitis is made, a surgical evaluation is warranted. The majority of patient will go on to surgical resection of the gallbladder. For patients with acute cholecystitis who are not surgical candidates, percutaneous cholecystostomy is indicated. The majority of PC's placed are done in the IR suite or Radiology procedure room with CT or US and Fluoroscopy image guidance [7]. Bedside cholecystostomy is indicated in patients who are too unstable to travel to IR suite for tube placement [7, 19].

There are no absolute contraindications to emergent PC placement if the procedure is life-saving. Relative contraindications include uncorrectable coagulopathy. In some cases it may

not be possible to access the gallbladder percutaneously due to intervening bowel or because of gallbladder rupture and decompression.

In addition to calculous cholecystitis, percutaneous cholecystostomy is also indicated for acalculous cholecystitis, seen often in patients in intensive care, and pregnant women where medical treatment alone is unsuccessful [7]. Acute acalculous cholecystitis is associated with a high morbidity and mortality and is thought to be a manifestation of systemic disease rather than a process confined to the gallbladder alone [8]. Because it can be difficult to recognize clinical signs of acute acalculous cholecystitis and intensive care patients are often on antibiotics and pain medication as well as parenteral nutrition (increasing their risk), percutaneous cholecystostomy can be used as diagnostic and therapeutic procedure in patients with unexplained sepsis [9]. For some, PC may be a definitive treatment for acalculous cholecystitis [1, 10].

In elderly patients with multiple comorbidities or poor general condition, percutaneous cholecystostomy can be performed safely and after removal a cholecystectomy can be performed with acceptable conversion rate [10].

In pregnant patients, acute cholecystitis is seen with lower frequency, 0.1%. The traditional management during pregnancy is conservative treatment; however, this may lead to prolonged treatment and more complications. Laparoscopic cholecystectomy is also available, though risks with anesthesia and surgery still provide significant drawbacks. For those patients with failure to respond to conservative management, percutaneous cholecystostomy is used as a temporizing measure, until the patient is able to have abdominal surgery post partum [10].

#### **4. Pre-procedural evaluation**

Prior to the procedure, confirm diagnosis by obtaining history and performing physical exam. All imaging available should be reviewed to confirm indication for the procedure. Cross sectional imaging should be obtained prior to bedside placement, except in emergent cases, to assess gallbladder anatomy and plan safe route to the gallbladder. Review all prior procedure notes if available.

Blood count, liver panel and coagulation profile need to be obtained and reviewed. Usually, septic patients are on broad-spectrum antibiotics. If not, broad-spectrum IV antibiotics should be given 1–4 h prior to the procedure. Some examples of acceptable antibiotics include levofloxacin 1 g, Unasyn (ampicillin plus sulbactam) 3 g IV, and ertapenem 1 g IV [11]. Analgesia and sedation should be arranged according to patient comfort and institution protocols [11].

Obtain informed consent outline the risk and benefits of the procedure. A “time out” should be performed to ensure the correct patient, procedure, and location [11].

## 5. Techniques

Percutaneous cholecystostomy may be performed using ultrasound, CT, or fluoroscopic guidance. Fluoroscopy and computed tomography generally have limited availability, increased expense, exposure to radiation, and perhaps the limiting factor, the need to transfer critically ill patients to the radiology suite. A 2010 study performed by Donkol et al. demonstrated success rates for CT (93%), US (46%), and fluoroscopy (62%). Though US had the lowest success rate, it remains the only option for those critically ill who cannot tolerate transportation outside the intensive care unit or an immediate cholecystectomy. Also, at most experienced centers that rate of procedural success with ultrasound guidance is far higher than 46%.

The patient is positioned supine with arm abducted to an arm board. Using a convex probe at frequency range 2.5–6 MHz, the gallbladder is evaluated for the best approach. Confirm liver anatomy is as expected [1, 2, 11].

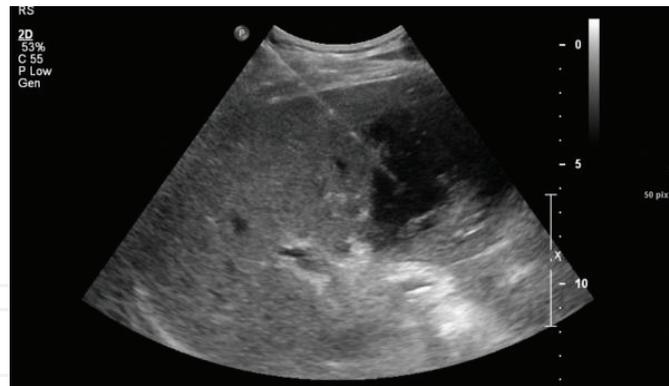
In the transhepatic approach, the catheter is to pass via the bare area of the liver in order to access the gallbladder. This may be done subcostally, though the intercostal approach is preferred to minimize tube dislodgement and kinking. When using an intercostal approach, care must be taken to avoid puncturing the diaphragm, pleura or the intercostal neurovascular bundle as it passes inferior to the rib. The transhepatic approach decreases the risk of bile leaks and colon injury, which are more common in the transperitoneal approach [1, 2, 12, 19]. Higher rates of bleeding are associated with the transhepatic approach [13].

The transperitoneal approach is a direct puncture of the gallbladder, often used in patients who have coagulopathies, which preclude the transhepatic approach. The gallbladder must be distended and in close proximity to the abdominal wall [1, 2, 12, 19]. In the author's opinion, the transhepatic, intercostal approach is the safest and preferred method.

Once a trajectory has been planned, the patient is then sterilely prepped and draped in a supine position with right arm abducted [11]. The entry site is anesthetized with 1–2% buffered lidocaine.

There are two techniques used for placement of the pigtail catheter into the gallbladder—the modified Seldinger technique, and the trocar technique.

The modified Seldinger technique consists of inserting a needle into the gallbladder under direct US guidance (**Figure 1**). The most common needle is an 18 G 10 cm hollow core needle, although smaller gauge needles can be used with 0.018 inch access systems. Aspiration of the needle should confirm bilious return. A 0.035 inch guidewire is then inserted through the needle into the gallbladder lumen. The wire should be seen looping in the gallbladder lumen with ultrasound. Use a scalpel to create a skin nick at the needle entry site and bluntly dilate this with a Kelly clamp or curved snap. The needle is removed and dilators of increasing diameters are advanced over the wire just into the gallbladder in order to dilate a tract large enough to accommodate a drain. The most common drain sizes are 8, 10 and 12 F, with larger sizes chosen for more viscous fluid. The catheter is advanced over the wire under ultrasound guidance. Once the tip enters the gallbladder, the catheter is unlocked from the inner stiffener and further advanced over the wire. The wire and stiffener are then removed, and pulling on the drain string forms



**Figure 1.** Ultrasound guided Seldinger technique with needle in the gallbladder lumen.

the catheter. This is locked into place by various mechanisms, depending on catheter manufacturer. Straight drains should be avoided, as the pigtail mechanism will help to prevent tube malposition or withdrawal. The catheter should then be aspirated to ensure bilious return. The catheter course should also be imaged with ultrasound to confirm intraluminal location of all of the sideholes. The advantage to the Seldinger technique is the use of a small needle for initial access, reducing risk of damage to surrounding structures and bleeding if the initial attempt is not successful. The biggest disadvantage to this technique is that through the multiple exchanges there is mixing of infected bilious material from the gallbladder and blood from the transhepatic tract, potentially increasing the risk for sepsis. In the case of the transperitoneal approach, this technique would allow for spillage of bilious material into the peritoneum and increase the risk of peritonitis. Furthermore, this technique requires multiple steps from initial puncture to catheter placement, making it more time consuming than the trocar technique [1, 2, 12, 19].

The second technique is the trocar technique, in which a stiff trocar needle is inserted through the drain as the inner stiffener, and they are advanced as a unit in a single pass into the gallbladder lumen under ultrasound guidance. While eliminating steps in the procedure compared with the Seldinger technique, there is a high risk of bleeding if the initial pass is not successful, as this would require multiple 8–12 F holes in the liver capsule. Damage to adjacent structures, if this does occur, would be more severe than with the Seldinger technique [1, 2, 12, 19].

After access is gained into the gallbladder (confirmed by aspiration of bile), bile is withdrawn for culture and the drain is connected to gravity drainage.

The drainage catheter is fixed to the skin with suture and a sterile dressing is applied.

Technical failure can be seen with porcelain gallbladder, thickened gallbladder wall, or small gallbladder lumen (from stones or one that is too small to accommodate a pigtail catheter) [9].

## 6. Post-procedural care

Procedure-associated morbidity can be extremely high in a critically ill patient population [14]. Although this is the best alternative to preventing/treating biliary sepsis aside from surgery,

great care must be taken post procedure to avoid complications. Bed rest is needed (typically 2–4 h) with regular monitoring of vital signs and adequate pain control. The patient should be monitored for new or worsening chest /right upper quadrant pain, dyspnea, shortness of breath, and red or tarry stool. These typically occur 1–72 h after the procedure [11]. Catheter dislodgement is the most common complication and may be due to patient movement, failure to protect the catheter during transportation, or inadequate fixation of the catheter. Timely removal of the catheter after mature tract formation can decrease biliary peritonitis secondary to bile leakage [9].

The catheter should be flushed daily with 5–10 mL with sterile saline to avoid occlusion [9].

Cholangiography can be used to assess patency of the cystic duct, presence of gallstones, and catheter position days after the procedure or when the patient has stabilized [11]. Using the tube for diagnostic studies is not recommended until the patient has clinically improved from their infection.

The catheter cannot be removed for at least 6 weeks [11], unless done during a cholecystectomy. Prior to removal, two things must be established: patency of the cystic duct and maturity of the transhepatic/transperitoneal tract. These are accomplished with fluoroscopic evaluation via fistulography. This is performed with injection of contrast material to evaluate patency of the cystic and common bile ducts. To evaluate tract maturity, a guidewire is placed through the catheter and looped in the gallbladder lumen and the catheter is removed. Tract maturation is evaluated by injecting contrast through a sheath as is it withdrawn over the wire. Care must be taken to preserve wire access to the gallbladder. The tract is considered mature if there is no leakage into the peritoneal cavity. If leakage is identified, a new catheter is placed and the process repeated until maturation is confirmed [12]. If the tract is mature and the cystic duct and CBD are patent, then many operators will opt for a clamp trial of the catheter.

## 7. Outcomes

Response rates vary widely in the literature from 8 to 100% [16]. Atara et al. found the success rate to be as high as 79% in their study [4]. Patients with clinical signs and localized symptoms to the right upper quadrant are more likely to respond to PC. Patients in the intensive care unit were less likely to respond to PC [16, 20]. When the gallbladder is the only source of infection, the response is dramatic. Positive response to treatment was seen in up to 59% of critically ill patients according to a study by Boland et al. [9].

A study by Atara et al. suggests that scheduled cholecystectomy after PC may prevent biliary complications over the long term. They demonstrated a post-surgery rate of 5.6% and mortality rate was 2.8%, both significantly lower than found in the literature [4].

While recurrent rates of are low for additional episodes of acute appendicitis in the general population, the populations with high surgical mortality and morbidity have higher incidences of recurrent attacks. Removing the gallbladder ensures further episodes of biliary sepsis that can also carry similarly high mortality rates do not occur [16].

Patients who are not candidates for cholecystectomy and continue to have indwelling cholecystostomy tubes need to have routine exchanges of the catheter to prevent obstruction and/or encrustation. These are typically performed every 8–12 weeks, with shorter intervals in patients who occlude their catheters. In addition to daily normal saline flushes, Ursodiol can be given to thin bile and prevent crystal formation in patients who have issues with catheter patency.

## 8. Contraindications

There are no absolute contraindications to percutaneous cholecystostomy. Relative contraindications of PC include hemorrhage or uncorrectable bleeding diathesis, and pericholecystic abscess. A gallbladder filled with stones might prevent catheter insertion. Presence of gallbladder tumor is also a relative contraindication as tumor seeding might occur.

The presence of ascites was once thought to increase the risk of failed tract maturation; however, a 2015 study demonstrated that it is not increased when compared to patients without ascites [15].

## 9. Complications

Tube dislodgement is a frequent complication (**Figure 2**), seen as high as 80% [13]. Friedrich et al found tube dislodgement to be 59% in their study [14]. The method used for placement was proven to be unrelated to rates of dislodgement [14]. The locking loop catheters are preferred to reduce the risk of dislodgment as the catheter dislodgment tends to occur in a higher rate here



**Figure 2.** Intraoperative fluoroscopic image obtained after cholecystostomy tube placement. Contrast is seen within the gallbladder lumen after injection into the catheter.

than in other organs [4, 9]. This is mostly due to the degree of respiratory motion at this location in the abdomen and, in the author's experience, is encountered less frequently with the intercostal approach compared with the subcostal approach. Critically ill patients are also prone to altered mental status and dislodgement can be secondary to forceful removal by the patient [9].

Complications directly related to placement of a cholecystostomy tube include bile leak, cholangitis, bleeding, tube dislodgment, hematoma, biloma, seroma, pneumothorax, injury to surrounding organs including bowel perforation, abscess formation, and pain at the procedure site [14, 16].

Major complications include sepsis (3%), bile leak leading to peritonitis (4%), major bleeding (3%), and death (10%) [14].

Bradycardia and hypotension can also occur from gallbladder manipulation.

## 10. Peri-procedural imaging

The diagnosis of acute cholecystitis begins with suspicion on the basis of right upper quadrant pain and tenderness. The primary imaging modality is ultrasound, which can demonstrate stones (**Figure 3**), wall thickening, pericholecystic fluid (**Figure 4**), gallbladder distension, and

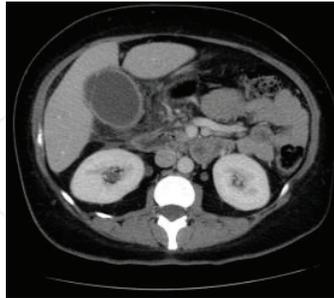


**Figure 3.** Ultrasound imaging demonstrates numerous shadowing stones within a distended gallbladder in a patient with right upper quadrant pain.

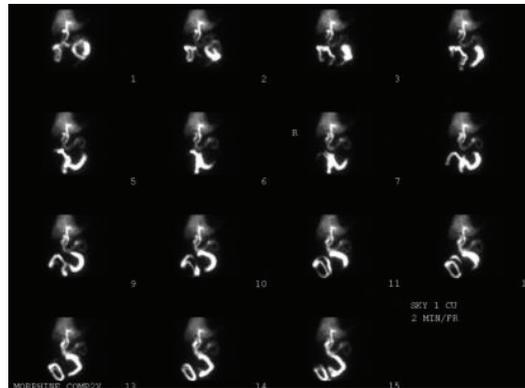


**Figure 4.** Ultrasound imaging demonstrates distended gallbladder with surrounding pericholecystic fluid in a patient with right upper quadrant pain and biliary ductal dilation.

in the absence of stones with these inflammatory findings, acalculous cholecystitis should be considered. These findings can also be seen in computed tomography (**Figure 5**). Hepatobiliary scan is used in equivocal cases (**Figure 6**) [6].



**Figure 5.** Contrast enhanced axial CT image demonstrating a distended gallbladder with wall thickening and surrounding fat stranding.



**Figure 6.** <sup>99m</sup>Tc-HIDA scintigraphy demonstrates nonvisualization of the gallbladder after 1 h. Morphine was then administered with persistent nonvisualization.

## 11. Equipment needed

- Ultrasound machine;
- Sterile probe cover and sterile ultrasound gel;
- Sterile biopsy tray;
- Sterilizing material and applicant (chlorhexidine stick, betadine with swabs);
- Sterile gauze;
- Sterile field cover and/or towels;
- 22 gauge needle;
- 3 10 cc syringes;

- 18 G needle;
- 1–2% buffered lidocaine;
- Kelly clamp;
- Scalpel;
- Trocar technique: 10 F locking pigtail catheter with needle trocar;
- Seldinger technique: 18 G 10–15 cm needle, 0.035' guidewire with 3 mm j-tip, 8 and 10 F dilator, 10 F locking pigtail catheter.

## 12. Bedside set-up tips and pitfalls

As with all bedside procedures, it is vital that you have all materials needed with you. An example of tray set up is given in **Figure 7**. While many bedside procedures require tools that can be found on the ward, most of the items necessary for PC placement are only found in the IR suite or OR. Therefore, it is wise to bring a variety of tools with you, including catheters of various sizes, extra wires, dilators, and gelfoam.

Make sure to position the ultrasound screen in a convenient location that allows you to quickly look from the monitor to the access site.

Having a sterile assistant is very helpful in this procedure. While catheter exchanges over a wire are easy in the IR suite, the sterile field is more limited at the bedside and an assistant can help maintain proper sterile technique during the more challenging portions of the procedure. Have an alcohol wipe available in case the back end of the wire goes off the sterile field.



**Figure 7.** Example of tray set-up for percutaneous cholecystostomy placement.

## 13. Conclusion

The gallbladder is a small organ with much pathology. Possible treatment options for acute cholecystitis include: open versus laparoscopic cholecystectomy or open versus percutaneous

cholecystostomy, sphincterostomy, or gallstone dissolution depending on the etiology. Briefly discussed was the necessity of cholecystostomy, which can be performed at bedside in critically ill patients who are not surgical candidates.

PC is a safe and effective procedure in critically ill patients in the acute phase of cholecystitis with a high technical success rate and gives added benefit of better future surgical survival and ability to remove duct stones without creating additional access [18].

Having the knowledge and skill to adequately perform this procedure is essential, especially in patients with septic shock in need of source control.

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