Percutaneous Management of Biliary Emergencies

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ABSTRACT

Most biliary emergencies can be classified as either infectious or obstructive. Infectious complications include acute cholecystitis and cholangitis. Many of these can be treated either surgically or endoscopically, but in some instances, less-invasive percutaneous techniques can be utilized to successfully treat these conditions. Obstructive complications, especially in the setting of liver transplant, can be serious if not treated quickly. Percutaneous drainage is sometimes the only acceptable treatment alternative for these patients.

KEYWORDS: Cholecystitis, cholangitis, biliary obstruction

Objectives: Upon completion of this article, the reader should be able to identify and discuss the complications of various biliary emergencies.

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The most common types of biliary emergencies include acute cholecystitis, acute cholangitis, and acute pancreatitis.¹ In the setting of a liver transplant, untreated biliary obstruction can lead to acute failure of the transplanted organ.² Traditionally, the treatment of these conditions has involved surgeons and gastroenterologists, but interventional radiologists have played an increasing role in the management of these disease processes through various percutaneous drainage procedures.

ACUTE CHOLECYSTITIS

Acute cholecystitis can be divided into two groups: acute calculous cholecystitis and acute acalculous cholecystitis. Gallstones are present in ~90% of cases of cholecystitis and are thought to incite the process by obstructing the

outflow of bile from the gallbladder.^{3–5} In the remaining 10% of cases, gallstones are not found, therefore are referred to as “acalculous cholecystitis.”

In calculous cholecystitis, obstruction of the gallbladder results in distention and edema of the gallbladder wall, which if severe may progress to ischemia and necrosis. Obstruction of the gallbladder also predisposes to secondary infection by microorganisms, although bacteria are found in bile cultures only in 20 to 75% of cases.^{6,7} The most common organisms found are *Escherichia coli*, *Klebsiella*, and *Enterococcus*.^{6,7}

In contrast, acalculous cholecystitis has typically been associated with critically ill patients and those with long stays in the intensive care unit (ICU). It has also been described in patients with diabetes, malignancies, vasculitis, and congestive heart failure.⁸ Although not entirely clear, the inciting event appears to be related to

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Interventional Radiology On-Call; Guest Editor, Thuong G.

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Semin Intervent Radiol 2006;23:249–257. Copyright © 2006 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA. Tel: +1(212) 584-4662. DOI 10.1055/s-2006-948764. ISSN 0739-9529.

Figure 1 (A) Ultrasound shows a thickened gallbladder wall (arrows) and pericholecystic fluid (arrowheads) as well as a large gallstone (curved arrow). (B) CT of the same patient also shows the pericholecystic fluid (arrowheads) and gallstone (S).

ischemia as well as the effect of proinflammatory mediators. These result in bile stasis within the gallbladder and gallbladder wall edema. This may also result in secondary superinfection of the bile within the gallbladder. Similar to calculous cholecystitis, cultures of bile are positive in only 28% of cases.⁹

The clinical presentation of acute cholecystitis is that of abdominal pain, fever, nausea, and vomiting. Patients can also show an elevated leukocyte count and C-reactive protein. Radiographically, ultrasound demonstrates gallbladder distention, gallstones, gallbladder wall thickening (> 3 mm), pericholecystic fluid, and a sonographic Murphy's sign. Ultrasound is the most common modality used to diagnose cholecystitis, however, similar findings can be seen on computed tomography (CT) and magnetic resonance imaging (MRI) (Fig. 1).

Immediate treatment consists of conservative medical management. Fluid and electrolytes are replaced and gastric decompression through a nasogastric tube is performed if there is nausea and vomiting. The standard of care for acute cholecystitis has been laparoscopic cholecystectomy.¹⁰ This procedure has been shown to be safe and effective in the treatment of acute cholecystitis, and once the patient is stabilized from a medical standpoint, early cholecystectomy is performed.¹¹

In certain high-risk patients where surgery would carry a high mortality, percutaneous cholecystostomy has been shown to be useful in treating the acute phase of acute cholecystitis. Percutaneous cholecystostomy is a procedure with a relatively low mortality and high technical and clinical success rate ($> 90\%$),¹²⁻¹⁷ which can be performed portably at the patients' bedside in the event that the patient is too unstable to be transported outside the ICU.

Percutaneous cholecystostomy is performed using radiological guidance. Ultrasound is the modality of choice because of the ready availability of the device in all radiology departments, the portability of the machine, and real-time imaging during the procedure. If the patient is stable enough to be transported out of the ICU to the radiology department, the procedure could also be performed using a CT scanner, which would have the advantage of excellent spatial resolution. Compared with ultrasound, however, using CT guidance can be more cumbersome. The gallbladder is punctured with an access needle (22 to 18 gauge) and a guide wire advanced through the needle into the gallbladder. An 8F or 10F catheter is most commonly used and is advanced over the wire into the gallbladder. The gallbladder is decompressed, the bile sent for appropriate cultures, and the catheter left to gravity drainage (Fig. 2). A cholecystogram can be performed at the time of the procedure; however, there is controversy regarding the utility of this procedure at this time. This is only an issue when performed in a suite with fluoroscopic capability rather than at the bedside. Cholecystography at a later date is always useful and performed to evaluate catheter position and cystic duct patency.

One issue that continues to be debated is the approach to the gallbladder. By far the most common route to the gallbladder is through a transhepatic approach, where the needle first traverses through the liver parenchyma before entering the gallbladder. The benefits to this approach are that it decreases the risk of bile leak, avoids injury to colon, and more rapidly promotes fibrin sheath formation, facilitating earlier catheter removal. The so-called "free-wall" puncture, or transperitoneal approach, is a direct puncture of the gallbladder. In some instances, the gallbladder is positioned in such a

Figure 2 (A) Ultrasound-guided placement of an 18-gauge needle (arrowheads) into the gallbladder. (B) Guide wire coiled within the gallbladder under fluoroscopy. (C) Cholecystostomy tube (10F) placed over a guide wire. Minimal contrast was injected to check for adequate placement.

way that transhepatic access is difficult and this is the only reasonable route. This approach can avoid the potential risks of pneumothorax, intrahepatic hemorrhage, or hemobiliary fistula^{15,18,19} and has been shown to be safe²⁰ as well.

Patients who are resistant to medical therapy should be acutely treated with percutaneous cholecystostomy until the episode of cholecystitis resolves. Traditionally, this has been followed by elective laparoscopic cholecystectomy. Some patients are still poor surgical candidates and are managed with percutaneous cholecystostomy alone. This approach has demonstrated up to 90% effectiveness in treating cholecystitis²¹; however, the recurrence risk of calculous cholecystitis has been reported to be ~25%,²² thus the standard practice has

been to perform a definitive laparoscopic cholecystectomy in those who can undergo the surgery safely.

Complications of acute cholecystitis include gallbladder perforation, gangrene, emphysematous cholecystitis, empyema, and sepsis. Gallbladder perforation can be one of the most serious complications. It has a reported incidence of 2 to 15%^{3,23–27} and is associated with a relatively high morbidity and mortality. Gallbladder perforations are classified into three types.²⁸ Type I is where there is free perforation into the peritoneum with generalized peritonitis. Type II is a localized perforation, usually with a pericholecystic abscess. Type III is a cholecystoenteric fistula with or without gallstone ileus. Type II perforations are the most common and are generally subacute in nature.

Type I perforations are less common but also carry a much higher morbidity.²⁹ Patients with type I perforations typically have other comorbidities that can complicate their hospital course. Prospective diagnosis of these perforations can be difficult; therefore, early intervention based on clinical judgment is important. In the past, early cholecystectomy had been performed; however, more recently, percutaneous cholecystostomy has been shown to be effective in treating gallbladder perforations.³⁰ In patients with significant comorbidities, this procedure is a favorable alternative to traditional surgeries.

Both gangrenous cholecystitis and emphysematous cholecystitis are severe sequelae of acute cholecystitis. In gangrenous cholecystitis, there is necrosis of the gallbladder wall, which then predisposes the gallbladder to perforation. Emphysematous cholecystitis is a variant where the gallbladder wall is superinfected with gas-forming organisms such as anaerobes, coliforms, and clostridia species (Fig. 3). This is generally seen in patients with other comorbidities such as diabetes mellitus and in older and immunosuppressed patients. Free perforation is also a complication of these patients and when it occurs, urgent treatment is necessary.

The management of acute acalculous cholecystitis is complicated by the fact that many of these patients have significant comorbidities.^{31,32} Most often, patients are critically ill, have a prolonged course in the ICU, suffer from vascular disease, sepsis, diabetes, immuno-

suppression, and have been on long-term total parenteral nutrition. These patients are poor surgical candidates to begin with; therefore, percutaneous cholecystostomy is usually the preferred treatment method. The procedure can be performed at the bedside if necessary and has a high success rate.^{22,33} In many cases, percutaneous cholecystostomy alone may be the only intervention needed.

ACUTE CHOLANGITIS

The clinical presentation of acute cholangitis can vary from a mild recurrent illness to sepsis. Charcot's triad of fever, right upper quadrant pain, and jaundice is only seen in 50 to 70% of patients.³⁴ Fever is the most common presentation, seen in over 90% of cases, followed by jaundice and pain in 60 and 70%, respectively. In severe cases, this is associated with altered mental status and hypotension. Along with Charcot's triad, these have been referred to as Reynauld's pentad.¹⁰

There are many causes of biliary obstruction ranging from bile duct stones, malignancies, as well as various iatrogenic causes. Biliary obstruction alone does not necessarily constitute an emergency; however, it does predispose to superinfection of the bile duct. Cholelithiasis and choledocholithiasis are the most common causes of cholangitis in the United States.³⁴ When severe, it can have almost 100% mortality if not treated quickly.

The most common organisms involved in cholangitis in the United States are *Escherichia coli*, *Enterococcus*, *Klebsiella*, and various other coliform bacteria.³⁵ Bacteria such as *E. coli* have been associated with common bile duct stone formation in up to 30% of cases. In a self-perpetuating cycle, stones cause obstruction of the bile ducts, which in turn is associated with infection, which is a contributing factor to more stone formation. In developing countries, parasitic infections such as *Clonorchis sinensis* and *Ascaris lumbricoides* have been reported to cause cholangitis. The increasing utilization of endoscopic biliary interventions has also been associated with an increase in incidence of cholangitis.³

Radiographically, ultrasound demonstrates dilated bile ducts and in the setting of choledocholithiasis can show the location of stone impaction. Other cross-sectional modalities like CT and MRI can demonstrate the presence of biliary ductal dilatation and in many instances can show the point of obstruction. Recently, magnetic resonance cholangiopancreatography (MRCP) has been used more frequently as a noninvasive replacement for traditional endoscopic retrograde cholangiopancreatography (ERCP) (Fig. 4).

Treatment of acute cholangitis includes fluid resuscitation as well as prophylactic broad-spectrum antibiotics. Approximately 10 to 15% of patients do

Figure 3 Fluoroscopic image shows the gallbladder wall infiltrated with gas (arrowheads).

Figure 4 (A) MRCP of a transplanted liver shows an apparent stricture at the biliary anastomoses (arrow). Intrahepatic biliary ductal dilatation is also seen. (B) Corresponding image from a percutaneous transhepatic cholangiogram from the same patient redemonstrates the stricture (arrow) and dilatation.

not improve with medical management and will subsequently require emergent biliary drainage. This is especially true if the patients are already septic and hemodynamically unstable. Surgical decompression carries a significant morbidity and mortality and therefore is performed only if all other methods are not available. The most common procedure is endoscopic decompression of the bile ducts. ERCP has a high success rate and has been shown to be superior to either surgical or percutaneous drainage.^{36–39}

Percutaneous transhepatic biliary drainage has been used for biliary decompression in patients, where the papilla is absent or inaccessible due to prior surgery. In the presence of intrahepatic bile duct stones, or very peripheral obstruction, central drainage via ERCP may not be helpful; therefore, percutaneous drainage may be of benefit in this situation. This procedure involves puncturing the intrahepatic bile ducts with an access needle (22 to 18 gauge) through a transhepatic route. In our institution, the approach dictates the technique we use to access the bile ducts. When puncturing a left-sided bile duct, we prefer to use ultrasound guidance and a subcostal route. Ultrasound guidance is preferred because of the real-time visualization as well as the ability to accurately visualize the target bile duct. Once the bile duct has been punctured, contrast is injected through the needle to confirm needle position. A guide wire is advanced into the bile ducts and, when possible, directed through the common bile duct into the duodenum. The tract is then dilated and a catheter advanced over the wire (Fig. 5). When accessing the right-sided bile ducts, an intercostal approach is utilized with fluoroscopic guidance. A needle is advanced blindly into the liver and contrast injected as the needle

is withdrawn. Once contrast opacifies a bile duct, a guide wire is passed into the duct and subsequently the duodenum as before (Fig. 6). This approach can be cumbersome as the ducts are not directly visualized and can be time-consuming if the bile ducts are not dilated. Overall, percutaneous transhepatic biliary drainage has a success rate of ~90%.⁴⁰ The complication rate is higher than that for endoscopic drainage. The reported rates vary throughout the literature due to the varying comorbidities of patients with severe cholangitis,^{1,39–41} but overall complication rates of 7 to 21% have been described. Although it is not considered a first-line treatment for acute cholangitis, percutaneous therapy may be preferred in certain situations.

EMERGENT BILIARY DRAINAGE POST-LIVER TRANSPLANTATION

Biliary complications following liver transplantation are unfortunately relatively common, occurring in 10 to 20% of all liver transplants. The most common complications include anastomotic biliary leaks and biliary strictures.^{42–44} Biliary leaks, if left untreated, can result in severe bile peritonitis, localized bile collections, and infection. Surgical treatments are limited. Reoperation in these patients can be difficult and may result in an increase in morbidity and mortality due to the patients' clinical status. Percutaneous transhepatic biliary drainage has been shown to aid in healing of the biliary leaks. In various series, 63 to 88% of bile leaks healed with the assistance of transhepatic drainage.^{45–47}

Biliary obstruction due to strictures can result in secondary infections like acute cholangitis in native livers; however, transplanted livers have the additional

Figure 5 (A) Cholangiogram following ultrasound-guided access shows the needle (arrowhead) in a left-sided bile duct. The common bile duct is occluded distally. (B) A guide wire is manipulated beyond the occlusion into the duodenum. (C) Percutaneous biliary drain placed over the guide wire across the occlusion.

complication of transplant dysfunction and failure as a result of obstruction. The initial presenting symptoms can be nonspecific. Patients can have fevers, abdominal pain, nausea, and vomiting. Subsequent imaging may demonstrate biliary dilatation, suggesting the diagnosis of biliary obstruction due to strictures. The earlier this is recognized and treated, the better the chance of transplant survival.⁴² Following percutaneous drainage, there is an immediate response to the decompression with decreases in serum bilirubin as well as gamma glutamyl transpeptidase.²

Various imaging modalities can be used to evaluate for biliary obstruction in the transplanted liver. As before, ultrasound is a quick and easy modality for accurately assessing the status of the bile ducts. Both CT and MRI can also be used for similar purposes, although both these modalities boast increased spatial resolution and can yield more useful information as to the etiology and nature of the obstruction, presence of a leak, and so on. MRI has the added capability of performing MRCPs, a form of

virtual ERCP that can give a volumetric representation of the bile ducts (Fig. 4).

Endoscopic treatment of transplant biliary complications have shown favorable results with lower morbidity and mortality⁴⁸; however, the presence of a hepaticojejunostomy generally precludes endoscopic access to the transplanted liver. The technique for percutaneous access is essentially identical to that for native livers; the only difference is in whether a whole liver or split-liver was transplanted. As with native percutaneous access, the approach is wholly dependent on liver size, location, and patient body habitus. The duration of drainage, especially for leaks, may be several months, as these processes are slow to heal. Ultimately, these procedures allow for salvage of a threatened transplant and can be lifesaving for the transplant patient.

CONCLUSION

Emergent biliary procedures are not uncommon for the interventional radiologist. Percutaneous procedures have

Figure 6 (A) After several attempts, a right-sided bile duct is opacified by contrast injected through the needle (arrowhead). (B) A guide wire is advanced through the needle into the bile duct and through the stenosis into bowel. (C) An 8F biliary drain is placed across the lesion.

added a new dimension to the treatment of acute biliary emergencies such as acute cholecystitis, acute cholangitis, and transplant biliary obstruction. In all instances, percutaneous biliary drainage procedures have been shown to reduce the risks of subsequent surgical treatments. In many cases, surgery can be avoided altogether and the patient treated exclusively with percutaneous drainage.

Intra-abdominal infections should almost always be managed medically first. Proper fluid and electrolyte replacement should be performed along with stabilization of the patients' vital signs. Empiric antibiotic therapy may be appropriate in the setting of a serious infection where initial broad-spectrum antimicrobial coverage may be needed, whereas in less toxic patients, waiting for culture results to help tailor specific antibiotic therapy may be more appropriate. If the patient responds

to this initial therapy, more definitive procedures can be performed in a less urgent manner. Conversely, if the patient does not respond to therapy or steadily worsens during medical management, emergent treatment may then be necessary.

Most cases of acute cholecystitis can initially be managed medically prior to percutaneous drainage or surgical resection. Complications that put cholecystitis patients at risk for more serious infections include emphysematous cholecystitis and gangrenous cholecystitis, both which predispose to gallbladder rupture. Free intraperitoneal spillage of bile can result in bile peritonitis, which can be a life-threatening condition. Similarly, acute cholangitis can also be managed medically; however, if it progresses to a more serious condition such as acute suppurative cholangitis, more urgent treatment

may be necessary. Even noninfectious complications of liver surgeries, including transplantation, may require urgent attention, depending on that particular clinical situation.

The question of what truly constitutes an emergent case versus an urgent case is always difficult to answer. As with all clinical matters, there is no way to apply a broad guideline to these situations. Every case must be evaluated individually by the referring service and the interventional service together to accurately assess the true urgency of the matter. In most hospitals, surgical suites and interventional radiology suites are not fully staffed 24 hours a day. There are defined "normal working hours" and "off-hour" intervals. The result is the necessity to triage which cases must be performed emergently during the off-hours and what can safely wait until normal working hours; however, because the bottom line is proper patient care, no predetermined guidelines should ever supersede good clinical judgment.

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