15 Acute Cholecystitis

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Case Presentation

A previously healthy 44-year-old female presents to the emergency department with severe constant pain located in the right upper quadrant. The patient reports her pain began 10 h ago, is slowly worsening with time, and is now associated with nausea and 1 episode of emesis. She reports prior pain in this region, often after eating fatty foods, but it has always been self-limited and she has never pursued further evaluation. On exam the patient is noted to be febrile to 38.7 °C, her heart rate is 107, and she has tenderness and guarding localized to the right upper quadrant.

Introduction

Acute calculous cholecystitis is a complication of cholelithiasis, a condition that afflicts more than 20 million Americans annually with approximately 120,000 cholecystectomies performed for acute cholecystitis every year in the United States [1–3]. Gallstones have been documented to account for 90–95% of cases of acute cholecystitis [4]. Gallstone formation is known to be a multifactorial process associated with body mass index (BMI), diet, family history, diabetes and hemolytic disease with a prevalence of gallstones approximately 10–15% of the population [4]. Because of the asymptomatic nature of cholelithiasis (81%), diagnosis is based upon a combination of physical exam findings, laboratory evaluation and imaging studies. Classic symptoms for presentation of acute cholecystitis include nausea, vomiting, fever, right upper quadrant or epigastric pain, right shoulder pain and a positive Murphy's sign (patient "catches" their breath during inspiration while right upper quadrant palpated). Laboratory evaluation typically demonstrates elevated white blood cell count but also may show an increase in C—reactive protein and liver function tests.

Imaging

Abdominal pain remains one of the most common presenting symptoms to the emergency department (ED) with right upper quadrant pain accounting for a significant number of visits. Following physical exam and laboratory evaluation, imaging studies are often performed for further patient evaluation. Recently, a meta-analysis was performed to analyze the accuracy of imag-

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ing studies in the diagnosis of acute cholecystitis. They found that ultrasound was frequently used to detect cholecystitis but demonstrated a large margin of error [4, 5]. When using ultrasound for evaluation, a convex multifrequency probe is used to evaluate the right upper quadrant. Multiple sonographic signs have been developed, and when several of these signs are present together, sensitivity for acute cholecystitis rises. The major sonographic signs associated with acute cholecystitis include gallbladder wall thickening (>3 mm), a positive Murphy's sign, pericholecystic fluid, distended gallbladder, gallstones, and sludge. When combining the findings of clinical presentation with a positive sonographic Murphy's sign and gallbladder wall thickening (>3 mm), sonography has a positive predictive value of up to 94% [6, 7]. However, the sensitivity of ultrasound for acute cholecystitis in the literature has been reported from 40 to 91% [7–9].

Computed tomography (CT) imaging is being used increasingly in the ED for evaluation of patient's with abdominal pain. When evaluated for its diagnostic accuracy, however, there is a lack of definitive evidence for its accuracy in the diagnosis of acute cholecystitis [5, 10]. There are multiple reasons for the shortcoming of CT for the diagnosis of acute cholecystitis. First, in contrast to ultrasonography, CT has demonstrated limited ability to detect gallstones and is unable to evaluate for focal tenderness. Second, the risks of radiation must be considered as an abdominal CT exposes the patient to significantly more radiation that may not be worthwhile for a test demonstrating sensitivity of 65–75% [11].

Hepato-imino diacetic acid (HIDA) scan is a well-established scintigraphic imaging technique that is considered by many to be the gold standard imaging technique for the diagnosis of acute cholecystitis. It has been shown to have a higher sensitivity and specificity compared to other imaging techniques and seen to be as high as 97% in recent reviews [5]. A recent study compared histopathologic findings post cholecystectomy with HIDA results demonstrating a sensitivity of 91.7% for acute cholecystitis [7]. In 2012, Kiewiet et al. demonstrated in a large meta-analysis that the sensitivity of abdominal ultrasound was 81% compared to a sensitivity of 96% for HIDA. [5].

Tokyo Guidelines for Diagnosis of Acute Cholecystitis

Despite being one of the most common surgical diseases, diagnosis of acute cholecystitis remains problematic as clinical diagnosis can be incorrect in up to 23% of patients [7, 12]. In 2007 discussions by global experts at the Tokyo Consensus Meeting created guidelines for diagnosis and severity of acute cholecystitis. Following validation studies issues with ambiguity were identified, and the criteria were revised in 2013 [13]. With the new diagnostic criteria, the decision was made to designate the presence of local signs of inflammation and systemic signs of inflammation. These new diagnostic criteria, seen in Table 15.1, were validated by a multicenter study of 451 patients with acute cholecystitis, which found that their use improved sensitivity and specificity to 91.2% and 96.9%, respectively [13–15]. The guidelines were again revised in 2018, and after a large literature review including literature with 216 articles, little evidence was found concerning the diagnostic criteria, and thus they were unchanged in the publication of the 2018 guidelines (Table 15.1).

Table 15.1 Tokyo Guidelines 18 diagnostic criteria [14]

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.	1. Wall thickening. 2. Hypoechoic layer. 3. Debris. 4. Distended gallbladder.
Suspected diagnosis	One item in A + one item in B
Definite diagnosis	One item in A + one item in B + C

In summary, the diagnosis of pathologically confirmed acute cholecystitis may be difficult but can most reliably be made with a combination of physical exam findings, laboratory findings consistent with inflammation, and imaging findings. Ultrasound remains the initial imaging test of choice due to its low cost, widespread availability, and relatively high sensitivity and specificity [13–15].

Management of Acute Cholecystitis

Cholecystectomy remains one of the most common surgical procedures performed each year. Prior to the 1800s, patients diagnosed with biliary colic underwent cholecystostomy procedures where the gallbladder was opened and drained and stones were removed as surgeons feared death if the organ was removed. In 1882, Dr. Carl Langenbuch performed the first successful cholecystectomy at the Lazarus Hospital in Berlin, curing his patient who had suffered for 16 years, overnight. By the early 1900s, hundreds of cholecystectomies had been performed, and open cholecystectomy for biliary colic became the gold standard. It wasn't until 1985 this approach was changed when German surgeon Erich Mühe removed the first gallbladder after his construction of the "galloscope," after being inspired by the work of Kurt Semm a German gynecologists [16].

Severity Grading

The initial management of acute calculous cholecystitis is often dictated by the patient's current clinical status, disease severity, and underlying comorbidities. Despite being one of the most common surgical diseases, diagnosis of acute cholecystitis remains problematic as clinical diagnosis can be incorrect in up to 23% of patients [7, 12]. At this time there are multiple severity grading systems which are often used to dictate further care. The two most commonly used severity grading systems include the Tokyo Guidelines (Table 15.2) and the American Association for the Surgery of Trauma (AAST) severity grading (Table 15.3) [17]. In 2007 discussions by global experts at the Tokyo Consensus Meeting created guidelines for diagnosis and severity of acute cholecystitis. These new diagnostic criteria, referred to as the Tokyo Guidelines, were validated by a multicenter study of 451 patients with acute cholecystitis, finding that their use sensitivity and specificity for acute cholecystitis were 91.2% and 96.9%, respectively [7, 14, 18]. In these criteria, acute calculous cholecystitis is broken up into mild, moderate, and severe disease. In a case series published by Yokoe et al., the prognosis for grade 3 patients was found to be significantly worse than for grades 1 and 2 [14, 18]. Additional studies have found that the length of hospital stay is significantly increased in patients with higher TG18 severity grades [19–22]. More recently a multivariate analysis has demonstrated that the TG13 severity grade was an independent predictor of both length of hospital stay and conversion to

Table 15.2 Tokyo Guidelines 18 grading scale [14]

Grade	Classification	Criteria
Grade 1	Mild acute cholecystitis	Acute cholecystitis in a healthy individual without organ dysfunction
Grade 2	Moderate acute cholecystitis	Acute cholecystitis with any one of: 1. WBC >18,000. 2. Palpable tender mass in the RUQ. 3. Duration of symptoms >72 h. 4. Marked local inflammation.
Grade 3	Severe acute cholecystitis	Acute cholecystitis with dysfunction of any one system 1. Cardiovascular dysfunction (hypotension). 2. Confusion or AMS. 3. Respiratory dysfunction PaO_2/FiO_2 <300). 4. Renal dysfunction (oliguria, creatinine >1.5). 5. Hepatic dysfunction (PT/INR >1.5). 6. Hematologic dysfunction (platelets <100,000).

Table 15.3 AAST EGS grade descriptions of acute cholecystitis severity [17]

Grade	Description	Imaging	Operative
Grade 1	Localized GB inflammation	Wall thickening, pericholecystic fluid, non-visualization of GB	Localized inflammatory changes
Grade 2	Distended gallbladder with purulence or hydrops, necrosis/gangrene	Above plus air in gallbladder lumen, wall, or biliary tree	Distended gallbladder with pus/hydrops, non-perforated necrosis
Grade 3	Non iatrogenic perforation with bile in the RUQ	Extraluminal fluid collection limited to RUQ	Non-iatrogenic gallbladder wall perforation with bile limited to RUQ
Grade 4	Pericholecystic abscess, bilioenteric fistula, gallstone ileus	RUQ abscess, bilioenteric fistula, gallstone ileus	Pericholecystic abscess, bilioenteric fistula, gallstone ileus
Grade 5	Grade 4 + generalized peritonitis	Free intraperitoneal fluid	Above with peritonitis

open surgery [19]. Finally both conversion rates from laparoscopic to open cholecystectomy and intraoperative biliary complications are both significantly increased in patients with higher severity grade [14, 19, 20].

The AAST developed a clinical, radiologic, operative, and pathologic grading system for EGS diseases, including acute cholecystitis in an attempt to create a more universal anatomic severity grading system focusing on distinct anatomic changes. A study by Hernandez et al. found that increasing AAST severity score was associated with mortality, morbidity, complication severity, duration of stay, need for cholecystostomy tube, open procedure, and conversion from laparoscopic to open procedure [17]. This same study concluded that the AAST grading system is superior to the Tokyo Severity Grading scale with greater associations for key clinical outcomes. The ability to rapidly assign disease severity from degree of anatomic injury is (1) simple to calculate, (2) does not require multiple laboratory values, and (3) does not require development of organ failure to associate with outcome. A second study again confirmed that anatomic grade is independently associated with multiple patient outcomes; however, it appears to lack the ability to differentiate between lower grades. For example, perforated cholecystitis is represented by grade 3 disease; therefore the majority of disease presentation is classified as grade 1 or grade 2 with limited ability to differentiate and prognosticate differences between these levels [23–26]. While both severity grading scales have pros and cons, universal adoption of any grading system, whether it be the TG or AAST, has the potential to improve prognostication and risk stratification as well as create a common language across health care systems.

Role of Antibiotics for Acute Cholecystitis

Perioperative Antibiotic Therapy

The treatment of mild or low-grade acute cholecystitis with intravenous antibiotics with or without surgical intervention is currently widely accepted and practiced. While it appears there is little data to support this practice, it is currently the recommendation of many guidelines, including the Surgical Infection Society and the Infectious Diseases Society of America, to start empiric antibiotic therapy upon diagnosis of acute cholecystitis [27–30]. This recommendation is based upon consensus of the TG meeting as well as a comprehensive review of the management of acute cholecystitis by Strasberg et al. [1, 27, 30, 31] On close review, these recommendations appear to be based on few small studies that have shown the presence of bactobilia on pathologic specimen. However, the incidence of bactobilia in patients with acute cholecystitis is between 23 and 72%, and a recent retrospective study showed that the prevalence of positive bile cultures was not related to severity of acute cholecystitis or outcome [28, 32–36]. It is clear that early cholecystectomy for patients with mild or moderate cholecystitis is associated with decreased morbidity and shorter hospital length of stay [37]. In these patients, we recommend no need for empiric antibiotic therapy and that only perioperative pre-incision antibiotics necessary to cover skin flora be given.

Antibiotics for Use with Nonoperative Management

Multiple studies have challenged the need for antibiotics when attempting to perform conservative (nonoperative) management of acute calculous cholecystitis. A prospective randomized controlled trial performed by Mazeh et al. demonstrated little effect of antibiotics in patients managed conservatively, as well as their use being associated with increased LOS during the index admission. During these patients' elective interval cholecystectomy, there was a lower rate of positive cultures in the non-antibiotic group possibly suggesting that antibiotic usage results in bacterial overgrowth [27]. Additionally, we have limited evidence upon whether antibiotics commonly prescribed for acute cholecystitis are able to reach therapeutic levels in bile especially in the case of biliary obstruction. Coccolini and co-workers reported a rise in the prevalence of resistant bacteria in bile cultures from patients with acute cholecystitis. While the recommendations of this chapter are to undergo operative removal or drainage of the gallbladder for management of acute cholecystitis (and not undergo conservative management with interval elective treatment), this discrepancy strongly demonstrates the need for evidence-based guidelines on the use of antibiotics in clinical practice and in individual patients [28]. The most common clinically significant pathogens associated with advanced cholecystitis are *E. coli*, *Klebsiella*, and, in immunocompromised individuals, enterococcus [38]. Commonly prescribed antibiotic regimens, which may be appropriate in patients with moderate to severe cholecystitis who have sepsis or are unable to undergo early cholecystectomy or biliary drainage, targeting the above pathogens can be seen in Table 15.4.

Table 15.4 Antibiotic regimen for acute cholecystitis [17]

Community-acquired moderate acute cholecystitis	Cefuroxime, ceftriaxone
Community-acquired severe acute cholecystitis with physiologic dysfunction or immunocompromised state	Imipenem, meropenem, doripenem, piperacillin-tazobactam, ciprofloxacin, levofloxacin, or cefepime each in combination with metronidazole

Timing of Cholecystectomy

Cholecystectomy, whether open or laparoscopic, remains the gold standard for treatment of cholecystitis either at the time of the initial attack or 2–3 months after the initial attack has subsided. Since the introduction of laparoscopic cholecystectomy, the timing of cholecystectomy in acute disease has been debated as the laparoscopic approach has clear benefits. However, there has been concern for increased technical difficulty in patients with acute cholecystitis and need for conversion to an open procedure. It is difficult to compare outcomes of early vs late cholecystectomy as there remain variable definitions of early timing (24 h–7 days). In 2013, a review performed by Gurusamy et al. compared cholecystectomy at less than 7 days vs greater than 6 weeks demonstrating no significant difference in conversion rate, complication, or the incidence of ductal injuries [39, 40]. Menahem et al. performed a subsequent meta-analysis that included multiple randomized trials which supported these findings and also demonstrated a lower hospital stay in the early cholecystectomy group [41]. In a recent randomized controlled trial performed by Gutt et al., patients who underwent laparoscopic cholecystectomy within 24 h of admission had a lower morbidity, shorter length of stay, and lower hospital costs [37]. Another recent study by Cao et al. compared four groups of laparoscopic cholecystectomy timing, finding that cholecystectomy performed less than 72 h from admission was associated with significant reductions in mortality, complications, bile duct leaks, bile duct injuries, wound infections, conversion rates, length of hospital stay, and blood loss [42]. The findings from the above reports are echoed in the most recent TG18 management bundle which recommends operative intervention or biliary drainage within 72 h or more urgently for severe disease [43].

Operative Technique

Removal of the gallbladder currently remains the only definitive management of acute cholecystitis. Prior to wide use of the laparoscopic approach this was performed via open cholecystectomy. In the 1990s, performance of laparoscopic cholecystectomy became widespread; however, this was matched with a sharp increase in the number of major bile duct injuries as this new approach was being adopted widely [1]. The critical view of safety is a central tenet of performing safe laparoscopy cholecystectomy involving identification of the cystic duct and artery with their complete dissection off the cystic plate. Calot's triangle is cleared of fat and fibrous tissue, and only two structures, the cystic duct and cystic artery, should be connected to the lower end of the gallbladder (Fig. 15.1). During laparoscopic surgery complete removal from the cystic plate creates difficulty in completing clipping of the ducts, and thus this step was modified to mobilization of the lower 1/3. In terms of validation of this technique, there are several studies including thousands of patients in which the critical view was used for cystic duct identification without any biliary injury due to misidentification [44–46]. Critical view of safety is part of the culture of safety in cholecystectomy (COSIC) which has been taken up by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) in an effort named "Safe Cholecystectomy." In 2014, the so-called SAGES Safe Cholecystectomy Task Force met and performed an expert Delphi consensus to encourage a culture focused on reducing biliary injury. At the conclusion, the top 5 factors for safe practice in laparoscopic cholecystectomy included (1) establishing the critical view of safety, (2) understanding relevant anatomy, (3) appropriate intraoperative retraction and exposure, (4) knowing when to call for help, and (5) recognizing the need for conversion to an alternate procedure [47]. Interestingly, only 2 of the top 5 factors included technical skills highlighting the importance of the need to continue to improve knowledge in these areas and prioritize future trainees' understanding of the anatomy, the critical view, and safe intraoperative decision-making. In 2016 the IRCAD Hepatobiliary and Pancreatic surgical experts also convened to develop a set of recommendations on safe laparoscopic cholecystectomy. These recommendations again emphasized the importance of the establishment of the critical view of safety while also highlighting use on intraoperative cholangiography and the important role that partial cholecystectomy can play during difficult cholecystectomy [48].

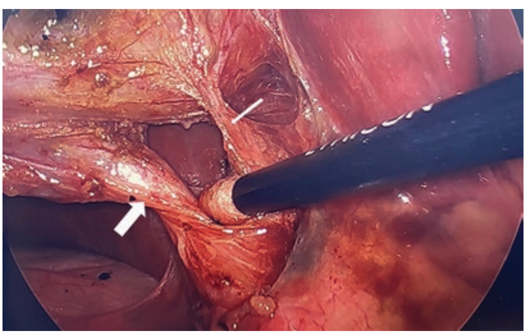

Fig. 15.1 Critical view of safety during laparoscopic cholecystectomy
Critical view of safety demonstrating the cystic duct (wide arrow) and cystic artery (thin arrow) entering the gallbladder with the liver clearly visualized behind the infundibulum

Robotic Cholecystectomy

As technology continues to develop and improve, the robotic surgical system has been introduced as another technique that may be used to perform minimally invasive surgery. Robotic surgery has touted significant benefits to the surgeon including reported lower heart rate and even reduced mental strain; however, in many cases it is associated with increased cost and increased operative time [49, 50]. In a recent review comparing laparoscopic cholecystectomy with robotic cholecystectomy, including five randomized controlled trials, there was no statistically significant differences in intraoperative complications, postoperative complications, readmission rate, hospital stay, estimated blood loss, or a difference in conversion rates. Significant findings demonstrated that robotic cholecystectomy was associated with longer operative time, a higher rate of incisional hernia, and increased hospital costs [49]. Additionally a systematic review performed by Huang et al. also demonstrated the previously seen increased operative time as well as the overall hospital costs being significantly greater when performed robotically [51, 52]. While robotic surgery has been shown to reduce complications, conversion rates, blood loss, and hospital stay compared to laparoscopic surgery in some procedures, it appears that robotic surgery fails to demonstrate any of these benefits when performing cholecystectomy [49, 53–55]. Until procedure length and hospital costs can be reduced, laparoscopic cholecystectomy should remain the approach of choice.

Subtotal Cholecystectomy

It has become clear that a deep understanding of the anatomy and clinical decision-making during the procedure are essential in the performance of safe laparoscopic cholecystectomy. In accordance with both the SAGES and IRCAD recommendations, it is essential to understand when it is time to call for help as well as when it is time to perform a "bail out" procedure [47, 48]. Biliary injuries are more common when operations are more difficult secondary to acute or chronic inflammation creating difficulty in establishing the critical view of safety [1, 44, 56]. The first description of a bail out procedure during cholecystectomy was performed in 1898 by Hans Kehr where the posterior wall of the gallbladder and infundibular cuff were left in place. However, throughout the history of cholecystectomy there have been many additional reports of both partial and subtotal cholecystectomy, but the extent of resection has never been defined leading to significant confusion when using these terms. In an attempt to clarify terminology moving forward, Strasberg et al. proposed no longer using the term partial cholecystectomy. Additionally designation whether or not a closed remnant gallbladder is produced by the procedure should determine the use of the modifying term fenestrating (an open gallbladder remnant remains) (Fig. 15.2a) and reconstituting (a closed functional gallbladder remnant remains, Fig. 15.2b) be introduced [57]. On review there is limited data comparing the short- and long-term outcomes of the two techniques, and likely each is associated with their own unique complications. When performing the reconstituting technique, a gallbladder remnant is created. In 1966, Bodvall and Overgaard first defined the term gallbladder remnant in 1966 which was defined as a wider part of

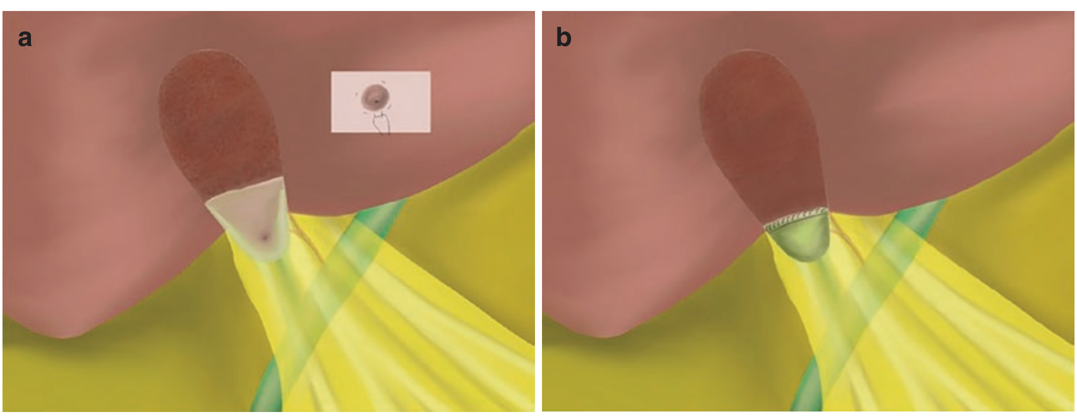

Fig. 15.2 Subtotal cholecystectomy. (**a**) Fenestrating subtotal cholecystectomy with open gallbladder remnant remaining with purse string suture of cystic duct orifice. (**b**) Reconstituting subtotal cholecystectomy with closed gallbladder remnant remaining

the free end of the cystic duct that gives the appearance of a diminutive gallbladder [57, 58]. This description was first applied to a previous case causing symptoms, and the subject was again approached in 2009 by Pernice and Andreoli [59]. On further review it appears gallbladder remnants may become symptomatic requiring a second operation. With regard to the fenestrating subtotal cholecystectomy, biliary leak remains a major concern. However, systematic review and meta-analysis performed by Elshaer et al. in 2015 demonstrated that while fistula was more common with the fenestrating technique, they seemed to resolve spontaneously in most cases when not complicated by a retained CBD stone [33]. More recently a study performed by Van Dijk et al. reviewed both the short-term and long-term complications and morbidity of the two techniques [60]. Fenestrating subtotal cholecystectomy was associated with a higher rate of postoperative bile leak, longer hospital stay, and higher rate of completion cholecystectomies, while reconstituting subtotal cholecystectomy was associated with an increased recurrence of biliary events. Patient-reported outcomes and quality of life were found to be equal between the two groups [60]. It seems both procedures represent viable and safe techniques when difficult anatomy prevents visualization of the critical view of safety, and which technique is used depends on surgeon preference and skill level as well as intraoperative findings.

Indocyanine Green Cholangiography

New and innovative operative techniques are being established to aid in the safe identification of the biliary tree. Intraoperative visualization of the bile ducts using near infrared light in coordination with the fluorescent dye indocyanine green (ICG) is becoming increasingly common. ICG is given as an intravenous agent prior to the start of the operation. The dye is water soluble and bound to plasma proteins which is metabolized by the hepatic parenchyma and subsequently secreted into bile. With the use of a near infrared laparoscope, the bile ducts are seen to be fluorescent allowing for identification of the cystic duct, common bile duct, and common hepatic duct (Fig. 15.3). There are multiple dosage schemes noted on literature review ranging from fixed dosage of 2.5 mg to a dosage of 0.5 mg/kg. Zarrinpar et al. showed a dose of 0.25 mg/kg administered at least 45 minutes prior to visualization facilitates intraoperative anatomical identification [61, 62]. In a systematic review performed by Vlek et al., visualization rates of the biliary structures with ICG appeared to be equally good for either 2.5 mg fixed dosage or 0.5 mg per kg dosage of ICG. In comparison to intraoperative cholangiography, no ducts need to be incised in patients undergoing ICG cholangiography [63]. Vlek et al. concluded that ICG pro-

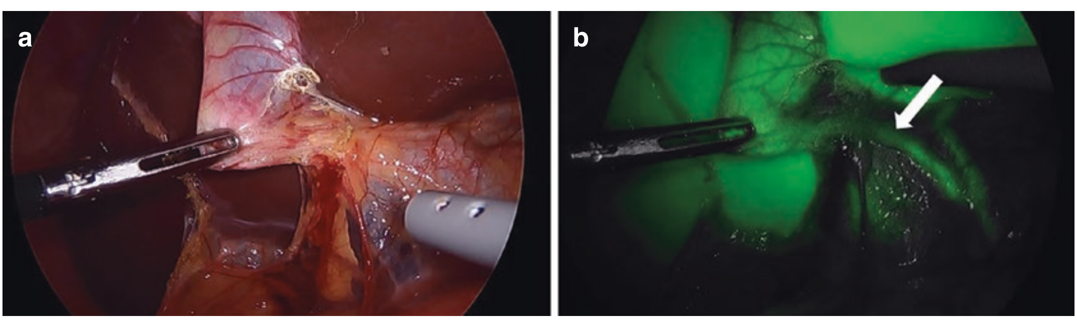

Fig. 15.3 Indocyanine green cholangiography (ICG). (**a**) Gallbladder anatomy visualized during laparoscopic cholecystectomy. (**b**) Gallbladder anatomy viewed after intravenous injection of ICG. The cystic duct (arrow) is identified to aid in visualization of the biliary ducts during laparoscopic cholecystectomy

vided equal visualization of the bile ducts; however no randomized trials have been performed to date. There are several limitations regarding the widespread use of ICG. First, in order to utilize the technology, the laparoscope must be equipped with the near infrared technology and have an accompanying tower. There is also concern that the amount of intra-abdominal adipose tissue can effect visualization. Osayi et al. have reported improved visualization of the cystic duct junction in patients with lower BMI, while other studies have reported no difference across BMI groups [63–65].

Cholecystostomy Tube

Percutaneous cholecystostomy (PC) is considered a treatment option under the TG13 practice guidelines for patients with grade 2 disease with symptoms longer than 96 h and/or patients at high risk for surgery and in grade 3 disease as a temporizing measure for all patients planned for delayed cholecystectomy [43]. A Cochrane review in 2012 included two randomized clinical trials to evaluate the benefits and risks of PC in high-risk surgical patients compared to conservative treatment or emergency laparoscopic cholecystectomy; however, the authors were unable to draw conclusions and create any guidelines given the poor quality of evidence that was available [66, 67]. Chou et al. found that when cholecystostomy was performed within 1 day of admission, there was a lower bleeding rate and shorter hospital stay [68]. In a study by Bala et al., 37% of high-risk patients required permanent cholecystostomy with tube-related complications occurring in 31% of patients, most commonly tube dislodgement [69]. Additionally, while patients undergoing PC were seen to have a significantly elevated mortality rate when compared to those who are not, it is clear that this rate is likely related to selection bias with inability to create an adequate cohort of matched patients to truly analyze the effects of PC. The rate of recurrence of symptoms within 1 year of PC in patients who survive the first episode and did not undergo cholecystectomy varies from 6 to 20% across various studies [66]. A systematic review by Macchini et al. demonstrates a recurrence rate of approximately 12.1% [70]. Up to this point, it seemed that while PC has been generally been accepted as a bridging technique to laparoscopic cholecystectomy, it seems more recent studies have outlined its potential use as definitive treatment with rates of patients not undergoing cholecystectomy after PC ranging from 43 to 94%. The recently performed multicenter, randomized CHOCOLATE trial demonstrated that laparoscopic cholecystectomy is superior to percutaneous catheter drainage in the treatment of high-risk patients (defined as APACHE II score of 7–14) with acute calculous cholecystitis and reduced the rate of major complications as well as reducing healthcare costs questioning the utility of PC [71].

Endoscopic Ultrasound

While laparoscopic cholecystectomy remains the ideal management for patients with acute cholecystitis, some patients presenting with severe disease or severe comorbidity are not candidates for an operative intervention nor candidates for conservative management. While percutaneous cholecystostomy is the most well-established technique, evolving technology endoscopic transpapillary gallbladder drainage (ETGBD) and endoscopic ultrasound-guided-transmural gallbladder drainage (EUS-TGBD), using a transgastric or trans duodenal puncture and drain or stent placement, have been suggested as novel techniques. Inoue et al. evaluated long-term outcomes in high-risk surgical patients, who underwent ET-GBD vs percutaneous drainage [72]. The study demonstrated success rates up to 94% with recurrence rates of 0% compared to 17% in the percutaneous group demonstrating the technique feasibility. EUS-TGBD was initially performed using self-expanding metal stents (SEMS); however, it has now moved toward the use of lumen approximating metal stents (LAMS) (Fig. 15.4). While most of the literature consists

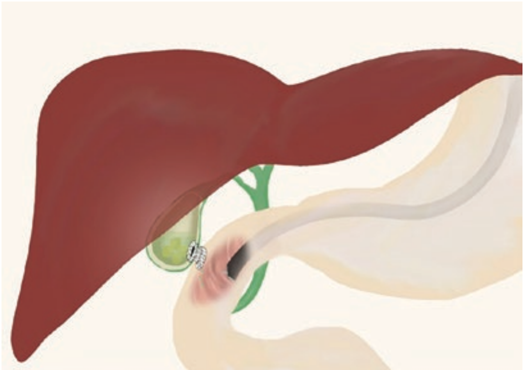

Fig. 15.4 Endoscopic transduodenal lumen apposing metal stent for biliary drainage

of case reports and case series, a recent meta-analysis was performed by Manta et al. that included 62 studies with 226 patients. Overall LAMS were successfully placed in 95% of patients with clinical success in 91% while acting as a definitive treatment with an incidence of adverse events noted to be approximately 10%. In comparison, percutaneous cholecystostomy is associated with biliary peritonitis, bleeding, pneumothorax in up to 12%, and other potential complications from premature tube removal in up to an additional 12% of patients [73, 74]. A study by Kedia et al. found that hospital length of stay, time to clinical resolution, adverse event rate, number of interventions, and post procedure pain scores were significantly higher for the percutaneous compared to endoscopic procedures [75, 76]. Overall while endoscopic biliary drainage may not be widely available, it represents a safe and effective approach in patients that are high risk for operative intervention.

Outcomes

While cholecystectomy is a commonly performed, safe operation, overall complication rates range from 5 to 15% in the literature. The most serious complication is bile duct injury with an incidence 0.3–1.5% [63, 77, 78].There has been many classification systems used to define these injuries; however they are often defined by the classification system created by Strasberg et al. and are also commonly associated with vascular injuries, especially arterial injuries [56, 79, 80]. As previously mentioned, technical skill, operative decision-making, and thorough understanding of the anatomy are all imperative in preventing iatrogenic injury. Complete and early diagnosis of the extent of the injury and possible associated vascular injuries are extremely important for operative planning and better outcomes. While the technical aspects of management of these injuries is complex and outside the scope of this chapter, it is important to understand reconstruction requires expert multidisciplinary teams, and it is best to refer patients to tertiary care centers equipped with advanced endoscopy, advanced interventional radiology, and hepatobiliary surgical techniques.

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