Complicated Cholecystitis and Choledocholithiasis

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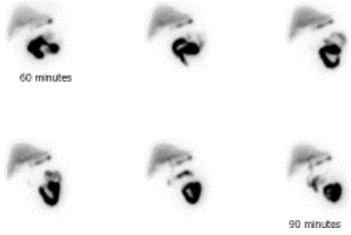
Background

- The first cholecystectomy, with recovery, was recorded in *Lancet* by HW Shettle in 1896.
- After WWI, Max Thorek devoted considerable research efforts to the question of cholecystectomy. In the 1930's, he perfected the surgical technique of subtotal cholecystectomy, which greatly reduced the mortality rate from gallbladder operations

    - Subtotal cholecystectomy remains the best bail out option in difficult cholecystectomy
- There are an estimated 1,000,000 cases annually of gallstone-related pathology.
    - 800,000 operations are performed annually for gallstones and the medical cost approaches $5 billion annually

Evaluation & Diagnostics

- Ultrasound and computed tomography are the primary imaging modalities
- HIDA scan is primarily utilized to guide surgical decision-making in equivocal cases



    - HIDA compared to ultrasound has a higher sensitivity (97% vs 70%) and specificity (94% vs 86%)
    - Specificity is even higher at the 3 hour mark
- Utility of MRI is primarily for evaluation of choledocholithiasis
    - The decision to pursue MRCP versus ERCP is center-specific and is made in conjunction with gastroenterology. Evaluation of choledocholithiasis typically benefits from protocolization, as multiple services are involved
    - Depending on surgeon comfort, going directly to the OR for cholangiogram +/- common duct exploration may be the best option

Non-Operative Management Considerations

- While there is uniform agreement the literature that a cool down period does not decrease complications, there is still no uniform definition of 'early.' ACS models allow for the possibility of surgical therapy within hours, instead of times defined by day or night.
    - For example, one practice is to post all cholecystitis cases as semi-emergent (within 4 hours). In some centers, this has been shown to reduce hospital days, costs and increases patient satisfaction without an increase in conversion rate or operative complications.

- Cholecystostomy tubes are valuable adjuncts in patients with acute cholecystitis or cholangitis who are not able to undergo cholecystectomy. Indications for cholecystostomy tube over surgical cholecystectomy may include hemodyamic instability, hostile abdomen and comorbidities that preclude anesthesia.
    - The cholecystostomy tube may be a temporizing measure or a permanent treatment, depending on patient condition.

AAST Grade for Acute Cholecystitis

C. Acute Cholecystitis

AAST Grade	Description	Clinical Criteria	Imaging Criteria (CT/US/HIDA findings)	Operative Criteria	Pathologic Criteria
I	Acute cholecystitis	Right upper quadrant (RUQ) or epigastric pain; Murphy's Sign; leukocytosis	Wall thickening; distention; gallstones or sludge; pericholecystic fluid; non-visualization of gallbladder (GB) on hepatobiliary iminodiacetic acid (HIDA) scan	Inflammatory changes localized to GB; wall thickening; distention; gallstones	Acute inflammatory changes in the GB wall without necrosis or pus
II	GB empyema or gangrenous cholecystitis or emphysematous cholecystitis	RUQ or epigastric pain; Murphy's Sign; leukocytosis	Above, plus air in GB lumen, wall or in the biliary tree; focal mucosal defects without frank perforation	Distended GB with pus or hydrops; necrosis or gangrene of wall; not perforated	Above, plus pus in the GB lumen; necrosis of GB wall; intramural abscess; epithelial sloughing; no perforation
III	GB perforation with local contamination	Localized peritonitis in RUQ	HIDA with focal transmural defect, extraluminal fluid collection or radiotracer but limited to RUQ	Perforated GB wall (non-iatrogenic) with bile outside the GB but limited to RUQ	Necrosis with perforation of the GB wall (non-iatrogenic)
IV	GB perforation with perichole-cystic abscess or gastrointestinal fistula	Localized peritonitis at multiple locations; abdominal distention with symptoms of bowel obstruction	Abscess in RUQ outside GB; bilio-enteric fistula; gallstone ileus	Pericholecystic abscess; bilio-enteric fistula; gallstone ileus	Necrosis with perforation of the GB wall (non-iatrogenic)
V	GB perforation with generalized peritonitis	Above, with generalized peritonitis	Free intra-peritoneal bile	Above, plus generalized peritonitis	Necrosis with perforation of the GB wall (non-iatrogenic)

Pearls from the Experts

Key points:

1. *A difficult laparoscopic cholecystomy are performed safely with at least 4 or 5 ports.*
2. *Decompression of a tense gallbladder should be the initial step is handling a thickened gallbladder.*
3. *It is always better to do a "bail out" procedure that proceeding blindly or when you are lost.*
4. *Laparoscopic peanut or blunt dissection in general should be used to dissect in an inflamed field*
5. *Laparoscopic common bile duct exploration has a short learning curve with minimal additional laparoscopic skills and is effective in 85% of the patients,*
6. *The laparoscopic argon bean should be considered for hemostasis of an acutely inflamed liver bed.*
7. *DOCUMENT, DOCUMENT, DOCUMENT what you did in your operative note. Laparoscopic cholecystectomy is the most litigious operation done in the USA and most suits involve a failure to document what was done*

Anatomy Review

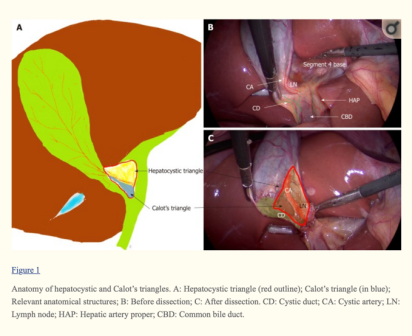


Figure 1

Anatomy of hepatocystic and Calot's triangles. A: Hepatocystic triangle (red outline); Calot's triangle (in blue); Relevant anatomical structures; B: Before dissection; C: After dissection. CD: Cystic duct; CA: Cystic artery; LN: Lymph node; HAP: Hepatic artery proper; CBD: Common bile duct.

- Know normal anatomy and anticipate the congenital variants and variations secondary to inflammation
- Major area of dissection is the hepatocystic triangle (CBD, Cystic duct, and liver surface, Figure 4) with the cystic node being the most superficial landmark. The artery usually lies to the right of the node
- Cystic plate is the area under the gallbladder and the base must be exposed to have a critical view to avoid an anomalous right duct or artery entering the liver

- Rouviere's sulcus – present in 80% of patients it is the cleft in the right lobe of the liver that typically contains the right portal pedicle. Above this line is a safe area of dissection, dissection should start above this landmark (Figure 5).

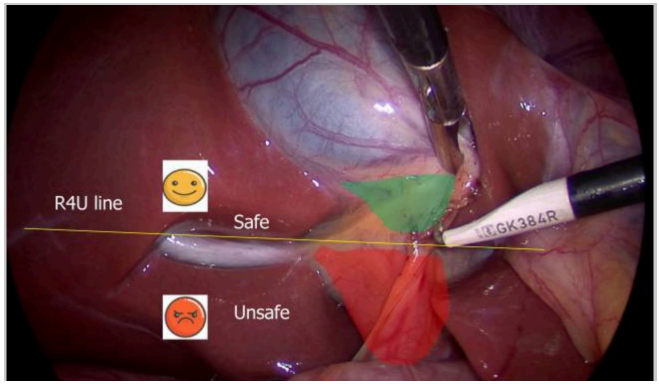
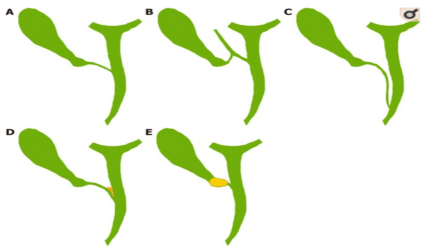


Figure 5

- Vascular anomalies – cystic duct is single vessel in 79% of the time. It can be anterior to the duct (17.9%) or short (<1cm, 9.5%). A replaced right hepatic artery will travel close to the cystic duct and insert high on the cystic plate.
- Biliary duct anomalies – multiple variations are possible (Figure). Anything abnormal should be investigated by cholangiogram.
    - The duct may be large but anything bigger than 5mm (medium large clip) should raise concerns that it is the CBD and not the cystic duct.

Figure 6



Cystic ductal variations, anatomical and pathological. A: Normal pattern with angular insertion; B: Cystic duct insertion in aberrant right hepatic (sectional) duct; C: Cystic duct - parallel course. Cystic duct may be quiet long and may join the common hepatic duct (CHD) near ampulla; D: Cystic ductal fusion with the CHD due to inflammation; E: Short/effaced cystic duct due to impacted stone in the gallbladder neck. In both situations (D and E), CHD would be at risk of injury during dissection especially when the surgeon tries to expose the cystic duct-common bile duct junction.

Critical View of Safety

- Not the only safe technique but has become the most adopted and effective (alternatives are infundibular techniques, fundus first technique and routine intraoperative cholangiogram)
- Only obtained in 10% of cases despite being mentioned in 80%.

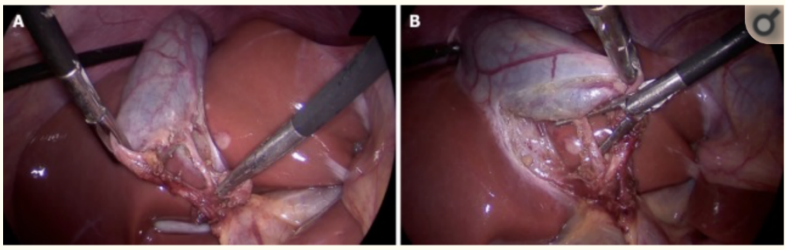


Figure 13

Critical view of safety with all three components: (1) Fibrofatty tissue has been cleared from the hepatocystic triangle; (2) Lower part of the cystic plate has been clearly exposed; and (3) Only two tubular structures are seen entering the gallbladder. A: Anterior view; B: Posterior view (inverted hepatocystic triangle).

- Three components
    - Clearance of the hepatocytic triangle
    - Exposure of the lower third of the cystic plate (the higher you go the safer it gets)
    - Two and only two structures should be seen entering the gallbladder
- Make sure you document it in your note.
- If you cannot obtain a critical view you need to start considering a "bail out" procedure

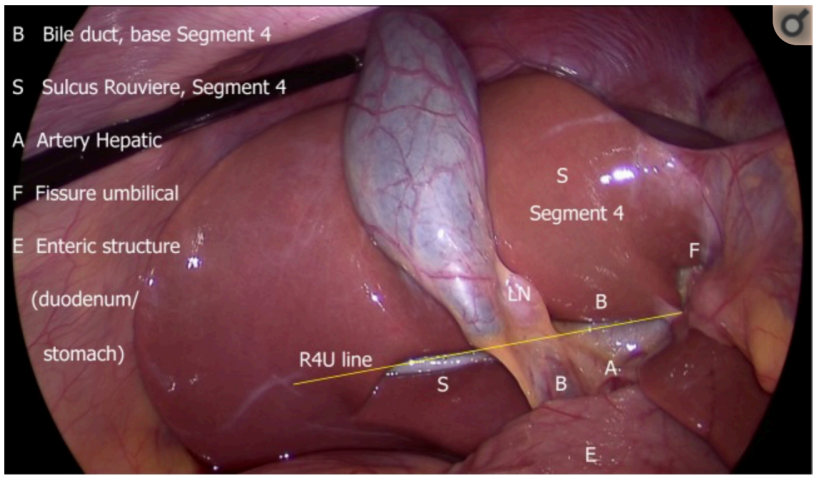
Reasons to STOP

- More than 2 tubular structures entering the gallbladder
- Unusually large presumed cystic artery
- Large artery pulsations present behind the presumed cystic duct (this duct may be common hepatic/bile duct)
- Medium-large clip fails to occlude ductal lumen (this duct may be hepatic/bile duct)
- Large ductal structure that can be traced behind the duodenum (this duct is common bile duct)
- Excessive fibrofatty/lymphatic tissue noted around the presumed cystic duct (this may be common hepatic/bile duct)
- Bile leak seen with intact gallbladder

Advanced Techniques For Difficult Gallbladders

Initial Considerations

- In complicated cholecystectomy, inflammation and anatomic variations can render the field unfamiliar and confusing. If the surgeon is no longer making progress or becomes concerned about the safety of proceeding, some initial steps should include
    - Stop, take a time out, and reorient yourself. Are you in the safe zone above Rouviere's sulcus? Go back and find the 5 fixed landmarks



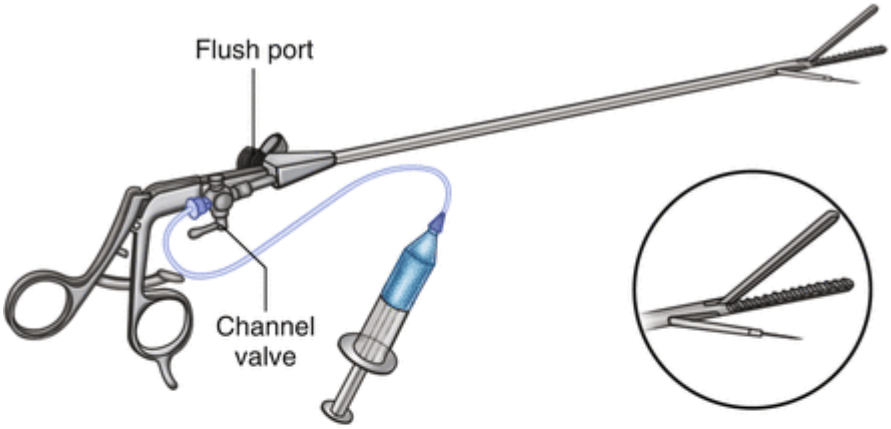
B-SAFE anatomical landmarks and R4U safety line. If Rouviere's sulcus is not present, then the imaginary line passing across the base of the segment 4 from the umbilical fissure may be extended towards right across the hepatoduodenal ligament to ascertain safe zone of dissection (Figure 5).

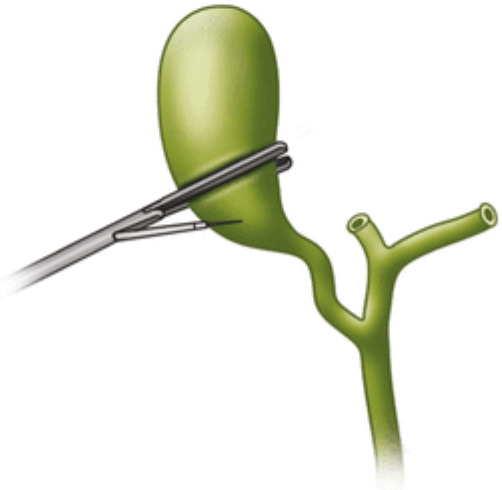
- Call for a second set of eyes, which may provide confirmation or a new perspective on the dissection

Intraoperative Cholangiogram

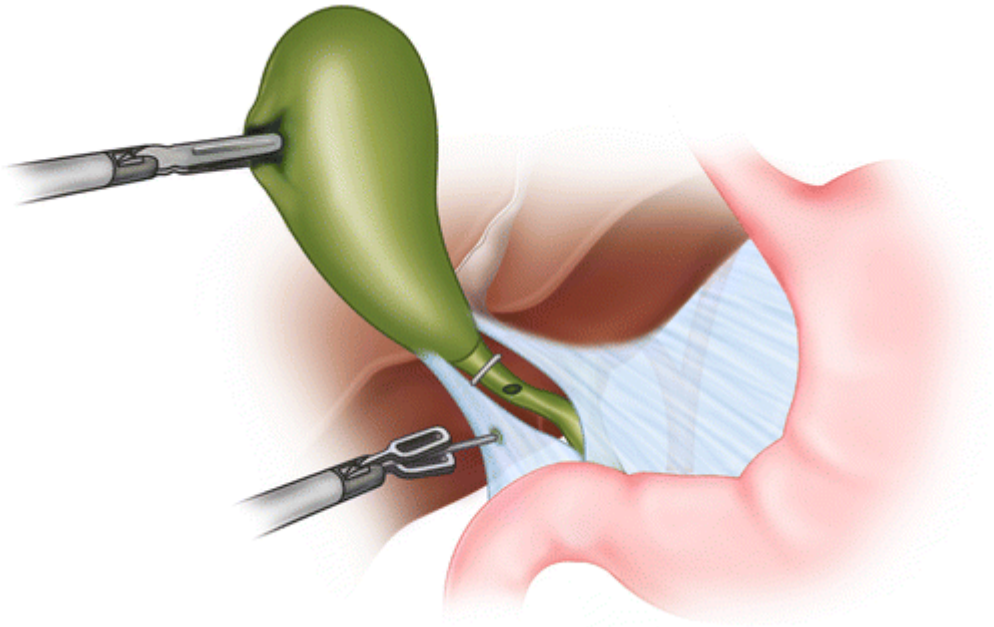
There are several large retrospective studies that would suggest an association between routine cholangiogram and decreased CBD injuries.

- Due to the prevalence of pre-operative ERCP, intra-operative cholangiogram is no longer routinely performed in some centers. This may make performance intra-operatively difficult, as staff may not know where to find necessary equipment or how to proceed.
- If the cholecystectomy is anticipated to be difficult, a time-out pre-op to discuss the possibility of cholangiogram is recommended. Operating room staff should be advised of necessary equipment, including the requirement for radiology.
- There are 2 commercial clamps which can assist - the Kumar clamp and the Olson clamp.
    - The Kumar clamp uses a small needle tip to puncher the infundibulum of the gallbladder after the clamp has been applied.





- The Olson clamp requires a cystic ductotomy to place a soft catheter or a ball tip catheter into the cystic duct.



- Contrast should be diluted to 50/50 strength. Less dilute preparations will be thick, difficult to inject and will clog the catheter
- The use of a dynamic technique is best when performing the cholangiogram. Contrast should be seen to fill the cystic duct to CBD, empty into the duodenum, demonstrate retrograde filling of the hepatic duct to the bifurcation and intra-hepatic biliary radicles (especially the right side)
  - Impacted stones may appear as a bubble in the contrast column, may be seen to be mobile or may prevent adequate filling

- In cases in which the cystic duct may be difficult to define, a cholangiogram may be shot by injected contrast into the gallbladder itself. However, this technique is difficult
  - The gallbladder should be accessed as close to the cystic duct as is safe. The distal gallbladder should be occluded to prevent contrast filling of the gallbladder itself
  - Inflammation often leads to scarring and occlusion of the cystic duct orifice, which will prevent a successful study using this technique

Intra-Operative Management of Choledocholithiasis

- Intra-operative management of choledocholithiasis may include the following maneuvers:
  - The surgeon should initially flush the CBD and may use glucagon (1 mg) to relax the sphincter of Oddi, as this might allow small stones to pass.
  - If unsuccessful, the surgeon has the option to plan on a post-operative ERCP or perform a CBD exploration.

- In a patient with large (>1.5 cm) or multiple stones, there is a higher likelihood of open CBD exploration. This is especially true in the setting of an obstructing CBD stone.

- If the surgeon has the skills, a laparoscopic or open trans cystic duct CBD exploration may be performed. This should be done using a scope over a wire.

https://www.youtube.com/watch?v=54-Q3IQjLzA

- Alternatively, balloon dilatation of the cystic duct and Sphincter of Oddi may be performed.
  - These balloon dilators (Mustang OTW balloon dilator 6.0 x 40mm x 0.75 cm) are advanced over a wire (Glidewire, angled 0.35 x 150 cm). As such, the first step is the same as a choledochoscope based technique by placing a guidewire into the CBD through the cholangiogram catheter under fluoroscopy.
  - Selection of the balloon should take into account the diameter of the common bile duct. In general, it is safe to dilate the sphincter up to the diameter of the CBD (e.g. 6-10mm). Other practical issues of proper balloon selection include overall length (75cm is a standard working length for a non-compliant balloon catheter that works best) and the length of the actual balloon (40, 80, 100mm are common lengths).
  - The 40mm balloon length offers the most versatility when working within the confines of the duodenum and navigating the cystic-common duct junction.
  - When positioning the balloon for sphincter dilation, it is helpful to advance it until the entirety of the balloon is in the duodenum and then inflate to the manufacturer's specifications using a rotational inflation device (the inflation pressure to achieve the defined balloon profile diameter is found on the balloon packaging).
  - When pulling back gently, the balloon will hub against the sphincter and allow for better visual and tactile feedback regarding its position. Also during fluoroscopy, either markers on the dilator or use of a 50/50 contrast/saline mix for balloon inflation can assist with positioning.
  - Once hubbed against the sphincter, the balloon should be deflated slightly and then retracted so that it straddles the sphincter. After appropriate positioning, the balloon may be blown back up to full inflation pressure and held there for 3-5 minutes.
  - Following the dilation of the sphincter, the balloon is deflated and pulled back so that it now straddles the cystic duct-common bile duct junction. The retracted balloon is then reinflated to seal the common bile duct. The wire is removed so that a cholangiogram can be performed through the same wire lumen. Sealing the CBD with the balloon allows for a more pressurized system through which to flush debris and stones forward and will prevent unintended flushing of stones proximally into the hepatic ducts.
- One has to consider that there is equivalence in the literature between laparoscopic common bile duct exploration and post-operative ERCP.

- Use of laparoscopic common bile duct exploration is associated with less procedures, less cost and potentially less days in the hospital. Many of those benefits are seen in the transcystic approach and decrease significantly if done via the common bile duct (biliary leaks via ductal approach 3-14%). If a common bile duct incision is made currently literature would support primary closure rather than t-tube.

Additional Intra-Operative Challenges

- *Tense gallbladder* – early decompression is mandatory for proper manipulation
    - Consider sending fluid for culture
- *Large Right lobe of liver or a floppy Left lobe* – additional ports are appropriate for retraction and safe dissection. A laparoscopic liver retractor can be utilized.
- *Continued oozing* from the gallbladder fossa should be managed either with a laparoscopic argon beam or with the Bovie
- Defining the *"critical view"* should be considered a mandatory step as part of a laparoscopic cholecystectomy.
- *CBD injury* – This is one of the most dreaded and concerning injuries.
    - Most commonly presents laparoscopically when Calot triangle is misidentified and inadequate dissection has occurred or bleeding has obstructed the view during a laparoscopic procedure. I
    - In an open procedure, a CBD injury can occur when dissection is continued medially without initially identifying the cystic duct laterally.
    - If identified at the time of the index surgery, immediate repair is preferred if an experienced surgeon is available. If found post-operatively the surgeon has to consider drainage and allowing the injury to mature.
        - There is evidence that the timing of repair is unimportant but rather operative technique and the repair being done by a hepatobiliary surgeon may predict improved outcomes (Stewart. HPB. 2009).

Rescue Procedures

- Surgeons should be comfortable with a 'bail out" procedure when further dissection would place the patient at risk of catastrophic outcomes.
    - *Abort* – can't see the gallbladder? Consider aborting and getting a cholecystostomy tube and retry in 3 months
    - *Open cholecystectomy* – Opening does not prevent CBD injury, as a difficult laparoscopic gallbladder will be difficult open as well.
        - Conversion is associated with a 100 fold increase in injury. (Mangieri. Surg Endos, 2018).
        - Dissection can ideally be performed in a retrograde manner with a top down approach. Once one approached the infundibulum, dissection should proceed from lateral to medial around the base of the infundibulum.
    - *Partial/Fenestrated Cholecystectomy* -Take what is safe, remove all the stones, ablate the mucosa

- *Fenestrating* cholecystectomy removes all accessible gallbladder but leaves the remnant open
  - As noted, the mucosa should be ablated
  - If the cystic duct orifice is visible/accessible, a figure-of-eight stitch to close the duct may decrease post-operative bile leak
  - A drain must be left by the gallbladder fossa
  - The most likely complication is bile leak post-operatively. The output should be trended and, if it remains high, may require ERCP with stenting for resolution.

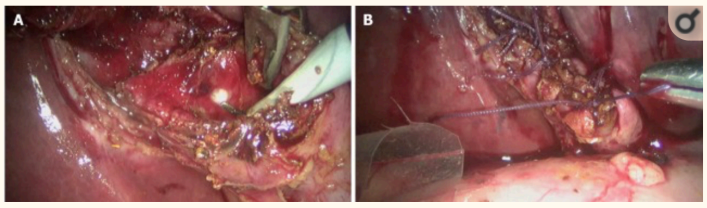


Figure 14

Laparoscopic subtotal cholecystectomy (reconstituting) as a bailout procedure. A: Mucosa of the gallbladder stump is fulgurated after removal of as much gallbladder as safely possible; B: Stump is closed after ensuring no stone is left behind in this stump.

- *Reconstituting* cholecystectomy removes all accessible gallbladder wall, with the remnant sewn closed
  - A drain should be left in situ, though bile leaks are generally less compared to fenestrating
  - Cholecystitis of the remnant gallbladder is possible long-term and is relatively morbid, as completion cholecystectomy is difficult in this field and the remnant may be too small for IR access. This should be considered when considering reconstitution.

- *Intraoperative cholecystostomy tube* is a reasonable option when dissection is unsafe. This may be placed via the most lateral dissecting port and secured as any other drain.
- *Fundus first (dome down) cholecystectomy*
  - In cases where the cystic triangle anatomy is obscured the dome down technique can help define the important anatomy. There is evidence that the risk of conversion to open surgery, and CBD injuries, can be decreased with this technique.
    - You must be very confident in the anatomy, as inflammation will shorten the cystic plate that is required to safely complete the dissection

  - https://www.youtube.com/watch?v=vHFM3nyP3Vs (operative technique starts at 1:43)

Long-term Outcomes

- During most clinical scenarios, only perioperative antibiotics are indicated. Only in the setting of sepsis or perforation should antibiotics be continued for a full course (4+1 days per STOPIT Trial).
- Post-cholecystectomy syndrome can occur 19.8% and is attributed to bile duct injuries, biliary leak, retained common duct stones, recurrent duct stones and bile duct strictures.
    - The most common causes were as follows: No obvious cause in 50 (18.4%) patients, Helicobacter pylori infection in 43 (15.8%), pancreatitis in 42 (15.4%), peptic ulcer disease in 41 (15.1%), recurrent common bile duct (CBD) stone in 26 (9.6%), retained CBD stone in 22 (8.1%), bile leakage in 19 (7%), stenosis of the sphincter of Oddi in 12 (4.4%), cystic duct stump syndrome in 11 (4%), and CBD Stricture in 5 (1.8%). The mortality rate was 0%. (10). It is estimated 10% of patients will continue to have upper abdominal pain. (11).
- Percutaneous Cholecystostomy Tube (PCT): Patients who are unfit for a general anesthetic, or unable to tolerate such, may benefit from a cholecystostomy tube.
    - Difficulty defining the exact population. In the extremes, surgeons generally agree who requires a PCT (multiple prohibitive comorbidities or marked hemodynamic instability), as well as in some pathologies (acalculus cholecystitis) where a tube can be curative.
    - There is little doubt that PCT's work, with most studies report resolution of symptoms and SIRS in 48 hours in over 96% of patients.
        - Failure of symptom resolution with PCT should lead the surgeon to consider an alternate etiology of pathology (ie necrosis) if the patient does not respond to the drain.
    - It is important to remember that even though the patient has a PCT placed it does not mean that they can not improve during the same hospitalization and become a reasonable operative candidate. The majority of patients do eventually get their gallbladder out with times ranging from days to 6 months.

Special Populations

- Elderly patients will commonly present with nonspecific clinical presentations. There is an increased incidence of needing to convert from laparoscopic to open cholecystectomy in older males.
- Morbidly obese patients with BMI greater than 45 may require bariatric laparoscopic instruments and positioning to perform a safe cholecystectomy.
- Cirrhotics do get acute cholecystitis. Cirrhotic patients who get diagnosis with acute cholecystitis and are good surgical candidate (Child A or B or MELD <20) should undergo cholecystectomy.

Ask the Experts

1. How aggressive will you be in elderly patients or those with comorbidities in pursuing cholecystectomy versus cholecystostomy tubes? Do you consider a tube to be a temporizing measure or do you frequently leave them in for life? How do you manage removal of the cholecystostomy tube?

2. How do you know when it is time to convert to open with the difficult gallbladder? Do you have any particular tricks you use to bail out?

Recommended Readings

1. Peitzman AB, Watson GA, Marsh JW. "Acute cholecystitis: When to operate and how to do it safely." J Trauma Acute Care Surg 2015;78(1):1-12.

2. Ackerman J, Abegglen R, Scaife M etal. "Beware of the interval cholecystectomy." J Trauma Acute Care Surg 2017;83(1):55-60.

3. Strasberg SM, Pucci MJ, Brunt LM etal. "Subtotal cholecystectomy – "Fenestrating" vs "Reconstituting" subtypes and the prevention of bile duct injury – Definition of the optimal procedure in difficult operative conditions." J Am Coll Surg 2016;222(1):89-96.

4. Lyu Y, Cheng Y, Li T etal. "Laparoscopic common bile duct exploration plus cholecystectomy versus endoscopic retrograde cholangiopancreatography plus laparoscopic cholecystectomy for cholecystocholedocholithiasis: A meta-analysis." Surg Endosc 2019;33(10):3275-86.

5. Frazee R, Regner J, Truitt MS etal. "The Southwestern Surgical Congress multi-center trial on suspected common duct stones." Am J Surg 2019;217(6):1006-9.