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Review Article

A Comprehensive Review of the Management of Acute and Obstructed Gallbladder in Difficult Cholecystectomy

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Abstract

Acute and obstructed gallbladder disease remains one of the most technically demanding challenges in hepatobiliary surgery. Severe inflammation, cystic duct obstruction, fibrosis, and distortion of biliary anatomy significantly increase operative difficulty and the risk of bile duct injury. Although laparoscopic cholecystectomy is the gold standard, difficult cholecystectomy continues to account for a disproportionate share of surgical morbidity. This comprehensive review discusses the pathophysiology, predictors, preoperative assessment, intraoperative challenges, safety principles, bailout strategies, postoperative outcomes, and evolving concepts in the management of acute and obstructed gallbladder, with emphasis on patient safety and evidence-based surgical judgment.

Introduction

Gallstone disease is one of the most prevalent gastrointestinal disorders worldwide, and acute cholecystitis represents its most common surgical complication [1]. Obstruction of the cystic duct by gallstones initiates a cascade of inflammatory changes that may rapidly progress to empyema, gangrene, or perforation of the gallbladder. These pathological changes significantly distort the normal anatomy of the hepatocystic triangle, rendering cholecystectomy technically challenging and hazardous.

The widespread adoption of laparoscopic cholecystectomy has transformed gallbladder surgery, offering superior postoperative outcomes compared to open surgery. However, it has also been associated with a persistent incidence of bile duct injury, particularly in cases of acute inflammation and obstruction [3]. These injuries are associated with long-term morbidity, repeated interventions, impaired quality of life, and substantial medico-legal consequences [2].

The term difficult cholecystectomy describes operative scenarios in which standard dissection techniques fail to safely delineate cystic structures due to inflammation, fibrosis, adhesions, or bleeding [3]. Contemporary surgical practice increasingly recognizes that perseverance with unsafe dissection is a major contributor to bile duct injury. Consequently, modern management emphasizes early recognition of difficulty, adherence to safety principles, and timely adoption of bailout strategies rather than insistence on complete gallbladder removal.

Pathophysiology of Acute and Obstructed Gallbladder

Acute cholecystitis most commonly results from gallstone impaction at the cystic duct or Hartmann's pouch, leading to bile stasis and gallbladder distension. Increased intraluminal pressure compromises venous and lymphatic drainage, resulting in ischemia of the gallbladder wall. Mucosal injury facilitates bacterial invasion, intensifying inflammation and edema.

With persistent obstruction, arterial compromise leads to gangrene and necrosis. Recurrent inflammatory episodes promote fibrosis and scarring, obliterating normal tissue planes and fusing the gallbladder to surrounding organs. The hepatocystic triangle may become completely obscured, creating the so-called "frozen Calot's triangle," which is a hallmark of difficult cholecystectomy and a major risk factor for bile duct injury [3].

Predictors of Difficult Cholecystectomy

Domain	Predictive factors
Patient-related	Male sex, obesity, diabetes, advanced age
Disease-related	Recurrent cholecystitis, empyema, gangrene
Timing	Presentation beyond 72 hours
Imaging	Gallbladder wall >4 mm, pericholecystic fluid, impacted stone
Intraoperative	Dense adhesions, bleeding, frozen Calot's triangle

Table 1. Predictors of Difficult Cholecystectomy [3,5]

Identification of these factors preoperatively allows appropriate surgical planning and patient counseling

Preoperative Evaluation and Optimization

Ultrasonography remains the primary imaging modality and provides valuable information regarding gallbladder wall thickness, distension, stone impaction, and pericholecystic collections [4]. Computed tomography is particularly useful in identifying complications such as perforation or abscess formation, while magnetic resonance cholangiopancreatography is indicated when choledocholithiasis or biliary anomalies are suspected.

Early laparoscopic cholecystectomy within 72 hours of symptom onset is associated with lower complication rates and shorter hospital stay. Delayed surgery may reduce acute inflammation but often results in fibrotic scarring that increases operative difficulty. In critically ill or high-risk patients, percutaneous cholecystostomy provides effective sepsis control and serves as a bridge to definitive surgery [5].

Intraoperative Challenges in Acute and Obstructed Gallbladder

The principal intraoperative challenge is the safe identification of cystic duct and artery. Edema, friable tissue, and distorted anatomy obscure landmarks, while bleeding further compromises visualization. Excessive traction may misalign the bile duct, leading to misidentification injuries. In such situations, the surgeon must avoid persistence in unsafe planes and reassess the operative strategy [6].

Principles of Safe Cholecystectomy

The Critical View of Safety (CVS) is the cornerstone of bile duct injury prevention. It requires clearance of the hepatocystic triangle, separation of the lower gallbladder from the liver bed, and visualization of only two structures entering the gallbladder [6]. Failure to achieve CVS mandates immediate consideration of bailout techniques rather than continued dissection.

Bailout Strategies in Difficult Cholecystectomy

Technique	Indication	Safety advantage
Subtotal cholecystectomy	Frozen Calot's triangle	Minimizes bile duct injury
Fundus-first approach	Dense lower adhesions	Avoids early Calot's dissection
Conversion to open surgery	Bleeding, unclear anatomy	Improved exposure and control

Table 2. Bailout Techniques and Indications [7–9]

Subtotal cholecystectomy has emerged as the preferred bailout strategy and is associated with significantly reduced rates of bile duct injury [7].

Case Study

A 58-year-old male with diabetes presented with right upper quadrant pain and fever for five days. Ultrasonography demonstrated a distended gallbladder with wall thickness of 6 mm, pericholecystic fluid, and an impacted Hartmann's pouch stone. Laboratory evaluation revealed leukocytosis and elevated CRP.

Operative Findings

Laparoscopy revealed dense adhesions between the gallbladder, duodenum, and transverse colon. Calot's triangle was completely obliterated by inflammation. Attempts to define cystic structures were abandoned due to bleeding and poor visualization.

Surgical Strategy

A subtotal cholecystectomy was performed using a fundus-down approach. The anterior gallbladder wall was excised, stones removed, and the remnant mucosa cauterized. A drain was placed.

Outcome

The patient developed a low-output bile leak managed conservatively. He recovered uneventfully and remained asymptomatic at six-month follow-up.

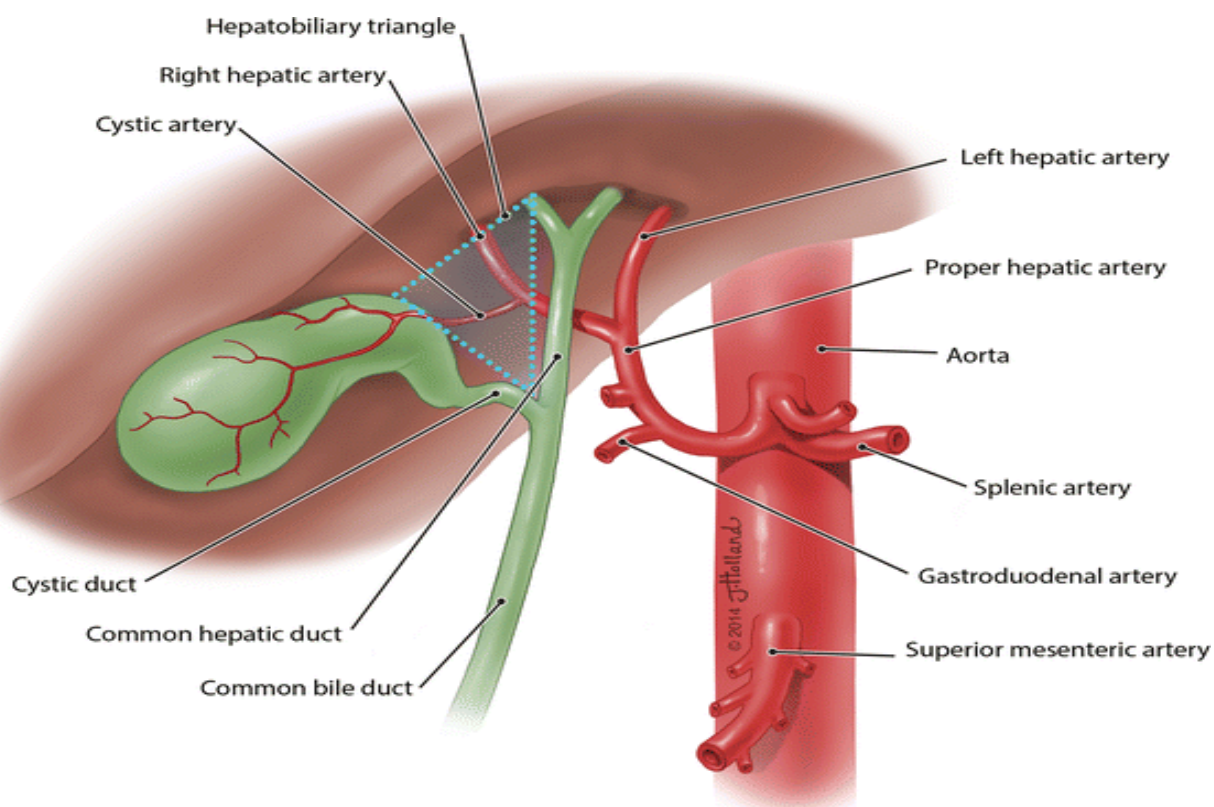


Figure 1. Diagrammatic representation of the Critical View of Safety (CVS) demonstrating complete clearance of the hepatocystic triangle, separation of the lower gallbladder from the liver bed, and identification of only two structures entering the gallbladder.

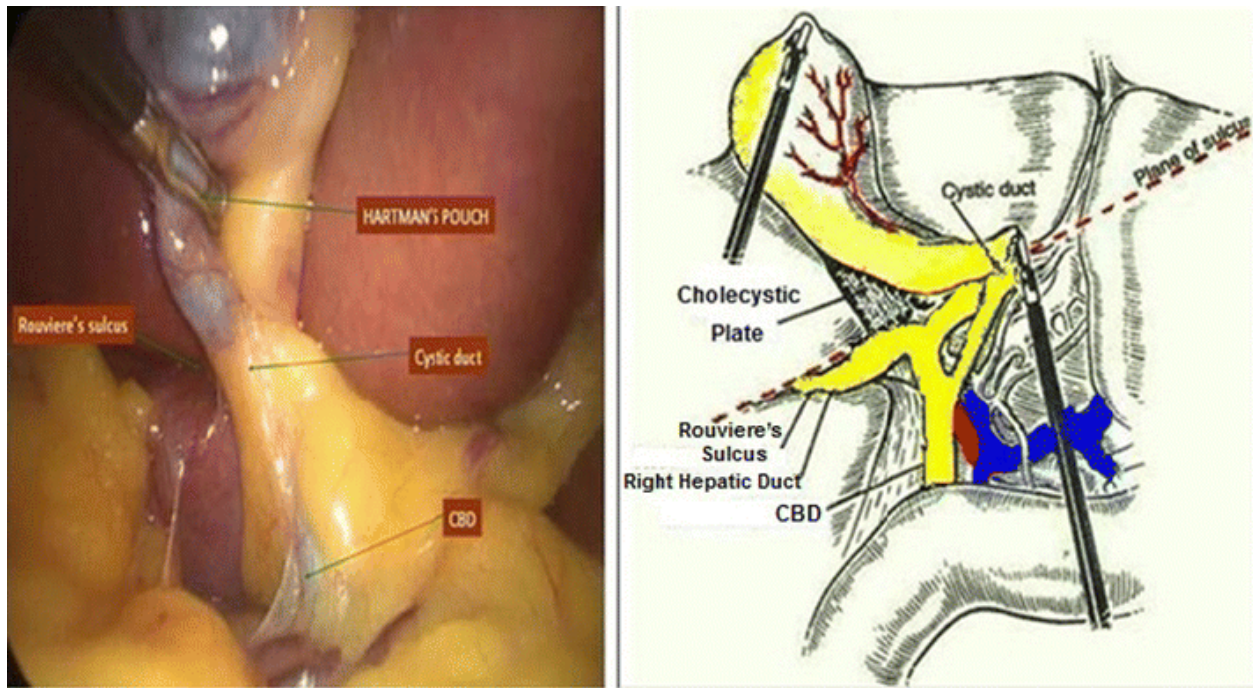


Figure 2. Illustration of a frozen Calot’s triangle resulting from acute inflammation, edema, and fibrotic adhesions, obscuring normal anatomical landmarks and increasing the risk of bile duct injury.

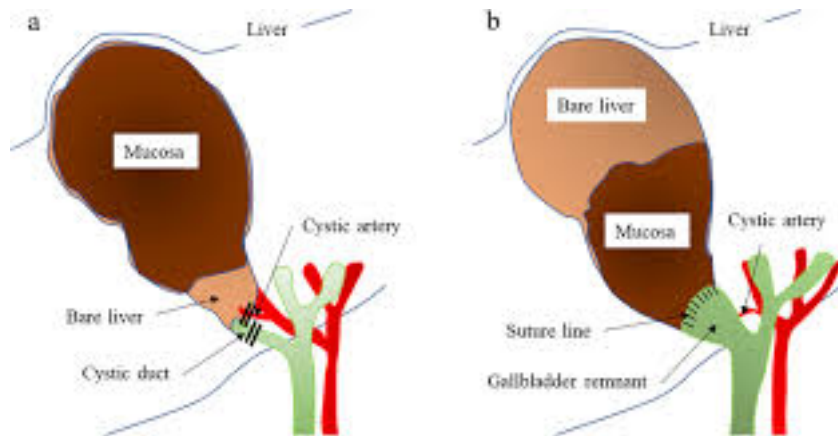


Figure 3. Schematic depiction of subtotal cholecystectomy showing removal of the anterior gallbladder wall with preservation of the posterior wall adherent to the liver bed, employed as a bailout technique in hostile anatomy.



Figure 4. Fundus-first (top-down) cholecystectomy technique demonstrating dissection from the gallbladder fundus toward the infundibulum, avoiding early dissection of Calot’s triangle in cases of severe inflammation.

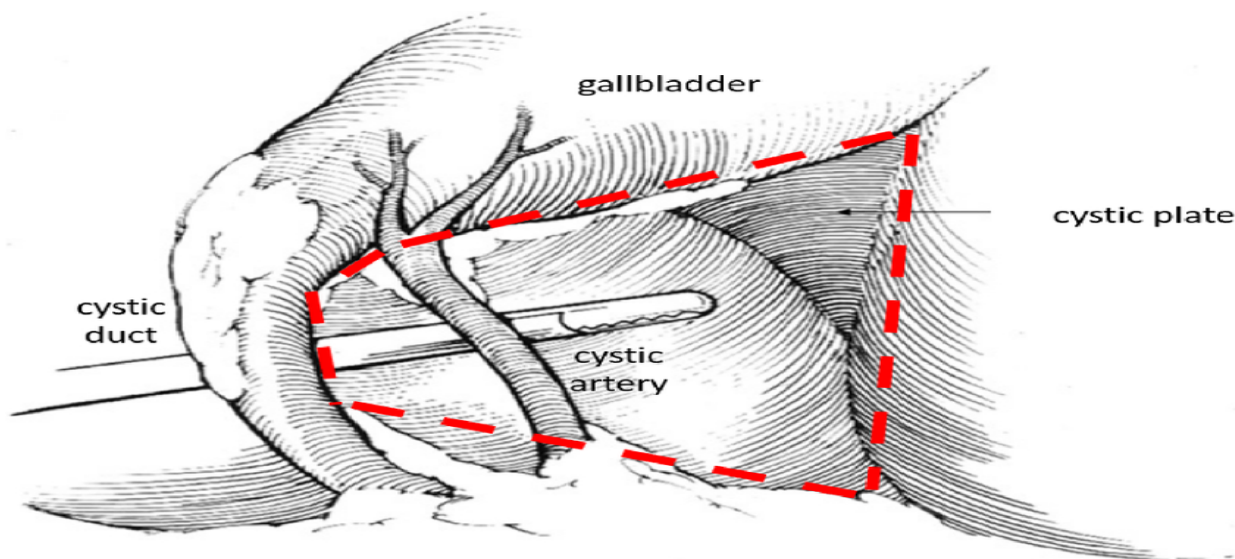


Figure 5. Anatomical changes observed in acute cholecystitis, including gallbladder distension, wall thickening, and cystic duct obstruction, contributing to operative difficulty.

Discussion

Difficult cholecystectomy represents a convergence of disease severity, anatomical distortion, and operative risk, particularly in the setting of acute inflammation and gallbladder obstruction. The present review reinforces the concept that bile duct injury is predominantly a consequence of misinterpretation of anatomy rather than technical incompetence alone, especially when inflammatory changes obscure normal landmarks. The anatomical principles underlying safe dissection are clearly illustrated by the Critical View of Safety, shown schematically in Figure 1, which serves as the fundamental reference point for decision-making during cholecystectomy.

Failure to achieve the Critical View of Safety, as depicted in Figure 1, should be regarded as an objective intraoperative warning sign rather than a technical shortcoming. In acute and obstructed gallbladder disease, inflammation, edema, and fibrosis frequently distort the hepatocystic triangle, resulting in the hostile operative field illustrated in Figure 2. The so-called frozen Calot's triangle represents one of the most dangerous scenarios in biliary surgery and is strongly associated with bile duct injury if dissection is pursued aggressively [7]. Recognition of this anatomical state is therefore pivotal in preventing catastrophic complications.

The evolving surgical paradigm emphasizes early transition to bailout strategies when hostile anatomy is encountered. Subtotal cholecystectomy, illustrated in Figure 3, has emerged as the most effective and safest bailout technique in cases where Calot's triangle is obliterated. By avoiding dissection near the common bile duct and preserving the posterior gallbladder wall adherent to the liver bed, this approach significantly reduces the risk of major bile duct injury while achieving adequate disease control. The schematic representation in Figure 3 reinforces its role as a deliberate, evidence-based endpoint rather than an incomplete operation.

Alternative dissection strategies, such as the fundus-first or top-down approach shown in Figure 4, may be useful in selected cases where inflammation predominantly affects the infundibulum and Calot's triangle. However, as emphasized in the figure and supported by the literature, this technique requires heightened anatomical awareness, as medial deviation during dissection can still endanger the bile duct [8]. Consequently, the fundus-first approach should be considered a selective adjunct rather than a universal solution in difficult cholecystectomy.

The pathological basis for these operative challenges is illustrated in Figure 5, which demonstrates gallbladder distension, wall thickening, and cystic duct obstruction characteristic of acute cholecystitis. These anatomical changes explain the loss of tissue planes, increased friability, and vascular congestion encountered intraoperatively, thereby linking disease pathophysiology directly to surgical difficulty. Understanding these changes allows surgeons to anticipate operative risk and reinforces the importance of early surgical intervention before irreversible fibrosis develops [8].

Collectively, the figures in this review function not merely as visual adjuncts but as conceptual anchors supporting a safety-oriented approach to difficult cholecystectomy. By correlating anatomical distortion (Figures 2 and 5) with operative strategy (Figures 3 and 4) and grounding all decision-making in the principles of the Critical View of Safety (Figure 1), this article underscores a unified framework for managing the hostile gallbladder. Such an approach promotes timely recognition of danger, rational selection of bailout techniques, and ultimately improved patient outcomes.

Training programs and institutional protocols should explicitly incorporate these visual and conceptual frameworks to normalize bailout strategies and reduce preventable bile duct injuries. Embedding figure-guided decision pathways into surgical education may play a crucial role in improving consistency and safety in hepatobiliary surgery [9,10].

Conclusion

Acute and obstructed gallbladder disease represents one of the most complex and high-risk scenarios in hepatobiliary surgery, where inflammation-driven anatomical distortion fundamentally alters the safety of standard cholecystectomy techniques. This review underscores that difficult cholecystectomy is not an exceptional circumstance but a predictable consequence of disease severity, delayed presentation, and pathological progression. Successful management therefore depends less on technical persistence and more on informed surgical judgment grounded in anatomical awareness and safety principles.

Adherence to the Critical View of Safety remains the cornerstone of bile duct injury prevention; however, this principle must be coupled with the ability to recognize when its attainment is no longer feasible. In such circumstances, early identification of hostile anatomy such as frozen Calot's triangle and gallbladder distension should prompt timely adoption of bailout strategies rather than continued unsafe dissection. Subtotal cholecystectomy has emerged as a definitive, evidence-based solution in these settings, offering effective disease control while significantly minimizing the risk of catastrophic bile duct injury. Selective use of alternative approaches, including fundus-first dissection or early conversion to open surgery, further reinforces a patient-centered, safety-first operative philosophy.

The integration of anatomical schematics and operative illustrations within this review emphasizes the critical link between pathological changes, intraoperative decision-making, and surgical outcomes. By aligning visual anatomy with operative strategy, the article highlights a unified framework for managing the hostile gallbladder that is both reproducible and teachable. Normalizing bailout procedures and reframing them as markers of sound surgical judgment rather than technical failure is essential for reducing morbidity and improving long-term outcomes.

Ultimately, the management of acute and obstructed gallbladder demands anticipation, adaptability, and respect for altered anatomy. Surgeons who recognize danger early, abandon unsafe dissection, and employ evidence-based bailout strategies are best positioned to achieve optimal patient outcomes. Embedding these principles into surgical training, institutional protocols, and everyday practice is fundamental to advancing the safety and quality of hepatobiliary surgery.

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