Publisher Name: ZenToks Books
Editorial Book: Applied Healthcare Science
ISBN: 978-81-958975-0-6

Chapter 8

The Surgical Management of Acute Calculus Cholecystitis: An Update

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Abstract

The surgical management of acute calculus cholecystitis primarily involves cholecystectomy, with laparoscopic cholecystectomy being the current gold standard. This procedure can be categorized into early and delayed laparoscopic cholecystectomy, with the former increasingly being performed. Delayed laparoscopic cholecystectomy is now reserved for patients who are unable to undergo early intervention. Additionally, single-incision laparoscopic cholecystectomy and robotic-assisted laparoscopic cholecystectomy have emerged as novel techniques in the surgical management of acute calculus cholecystitis. In this chapter, we will examine the roles of conventional laparoscopic cholecystectomy, single-incision laparoscopic cholecystectomy, and robotic-assisted laparoscopic cholecystectomy in managing acute calculus cholecystitis.

Keywords: Acute calculus cholecystitis, Complications, Delayed laparoscopic cholecystectomy, Early laparoscopic cholecystectomy, Tokyo Guidelines, Single-incision laparoscopic cholecystectomy, and robotic cholecystectomy.

1. Introduction

Acute calculus cholecystitis is a condition characterized by inflammation of the gallbladder, secondary to obstruction of the cystic duct by gallstones. It represents the most prevalent complication of gallstone disease, occurring in 25% of patients with symptomatic gallstones. Clinically, it presents as pain in the right hypochondrium, with tenderness observed in the same region upon abdominal examination. Diagnosis is confirmed by leukocytosis, and ultrasound imaging typically reveals inflammation of the gallbladder and surrounding tissues. Management involves cholecystectomy, which can be performed laparoscopically; however, initial treatment requires intravenous antibiotics and analgesics. For patients unfit for surgery, percutaneous cholecystostomy may be employed to stabilize the patient before cholecystectomy [1–4].

The 2016 guidelines issued by the World Society of Emergency Surgeons (WSES) for the management of acute calculus cholecystitis advocate for the performance of early laparoscopic cholecystectomy within 7 days following the onset of symptoms. In cases where symptoms have persisted for more than 10 days, a delayed laparoscopic cholecystectomy is recommended after a period of 12 weeks. For patients deemed unfit for surgery, percutaneous cholecystostomy is advised to stabilize the patient, allowing for an elective laparoscopic cholecystectomy at a later stage [5]. The 2020 WSES guidelines on the diagnosis and management of acute calculus cholecystitis reaffirm that laparoscopic cholecystectomy should be the primary treatment modality. They recommend early laparoscopic cholecystectomy within 7 days of symptom onset and within 10 days of hospital admission. If early laparoscopic cholecystectomy is not feasible, a delayed approach is suggested. Additionally, gallbladder drainage is recommended as a bridging procedure for patients who are not suitable candidates for immediate surgery, serving to stabilize them [6].

The Tokyo Guidelines of 2013 categorized acute calculus cholecystitis into mild, moderate, and severe classifications. Patients with mild acute cholecystitis (grade 1) were managed with elective laparoscopic cholecystectomy, while those with moderate acute cholecystitis (grade 2) underwent early laparoscopic cholecystectomy. In cases of severe acute cholecystitis, management involved percutaneous drainage followed by elective laparoscopic cholecystectomy once the patient was stable [7, 8]. The Tokyo Guidelines of 2018 further updated and reaffirmed these recommendations for managing acute calculus cholecystitis based on the severity of the condition. Additionally, they recommended gallbladder drainage for patients with moderate acute cholecystitis (grade 2) if they exhibited cardiovascular or respiratory compromise [9, 10].

How To Cite: K.K. Rajah. *The Surgical Management of Acute Calculus Cholecystitis: An Update.* In A. Kaur (Ed). Applied Healthcare Science. Pages 67-72, 2026. ZenToks Books, India. ISBN: 978-81-958975-0-6

The management of acute calculus cholecystitis has experienced a minor evolution, with the implementation of early laparoscopic cholecystectomy. This chapter examines the roles of both early and delayed laparoscopic cholecystectomy in the treatment of acute cholecystitis. Additionally, it evaluates the contributions of single-incision laparoscopic cholecystectomy and robotic-assisted cholecystectomy in managing acute calculus cholecystitis. A comprehensive literature review was conducted utilizing PUBMED, the Cochrane Database of Clinical Reviews, and Google Scholar, focusing on clinical trials, observational studies, cohort studies, systematic reviews, and meta-analyses from 1990 to 2025. The search employed the following keywords: "Acute calculus cholecystitis," "early laparoscopic cholecystectomy," "Tokyo Guidelines," "delayed laparoscopic cholecystectomy," "single incision laparoscopic cholecystectomy," "Robotic cholecystectomy," and "complications." All articles were restricted to the English language. Additional articles were identified through manual cross-referencing of the literature. Exclusion criteria included case reports, studies with fewer than 10 patients, and editorials. The study included adult male and female patients, while pregnant and pediatric patients were excluded.

2. Discussion

2.1. Laparoscopic cholecystectomy for acute cholecystitis

Laparoscopic cholecystectomy has supplanted open cholecystectomy as the preferred treatment modality for acute cholecystitis. Since its introduction in the 1990s, it has emerged as the favored surgical approach for managing this condition. The primary consideration remains the timing of the procedure, with early laparoscopic cholecystectomy being performed within seven days of symptom onset and delayed laparoscopic cholecystectomy occurring after twelve weeks [11, 12]. Kao et al. conducted a randomized controlled trial on early laparoscopic cholecystectomy for acute cholecystitis, involving a total of 86 patients. The study demonstrated that early laparoscopic cholecystectomy was associated with reduced morbidity, shorter hospital stays, and lower costs [13]. Several retrospective studies have also evaluated the efficacy of early laparoscopic cholecystectomy, consistently finding associations with reduced morbidity, decreased length of hospital stay, lower costs, and diminished analgesic usage [14–16].

The Acute Cholecystitis: Early versus Delayed Cholecystectomy Multicenter Randomized Controlled Trial (ACDC study), conducted by Gutt et al., involved the randomization of 618 patients, with 304 undergoing early laparoscopic cholecystectomy and 314 undergoing delayed laparoscopic cholecystectomy. The study found that the morbidity rate was significantly lower in the early laparoscopic cholecystectomy group (11.8% vs. 34.4%), and the length of hospital stay was also reduced (5.4 vs. 10 days). No differences were observed in the conversion rates and mortality between the groups [17]. Several other randomized studies comparing early versus delayed laparoscopic cholecystectomy for acute cholecystitis have similarly concluded that early laparoscopic cholecystectomy is associated with reduced mortality, shorter hospital stays, and lower costs [18–20].

A systematic review and meta-analysis conducted by Coccolini et al. compared open versus laparoscopic cholecystectomy for acute cholecystitis. This analysis included 10 studies with a total of 1,248 patients, of whom 677 underwent laparoscopic cholecystectomy and 697 underwent open cholecystectomy. The findings indicated that the laparoscopic cholecystectomy group experienced reduced postoperative morbidity, mortality, wound infection rates, and shorter hospital stays [21]. Wu et al. conducted a meta-analysis comparing early versus delayed laparoscopic cholecystectomy for acute cholecystitis, incorporating 16 studies with 1,625 patients. The results demonstrated that early laparoscopic cholecystectomy was associated with reduced wound infection, shorter hospital stays, and earlier return to work, with no significant differences in mortality and bile duct injury between the groups [22]. Papi et al. conducted a meta-analysis on the timing of cholecystectomy for acute calculus cholecystitis, including 12 studies with 1,255 patients. The operative complication rate was 3.11%, and the conversion rate was 7.99% for the early laparoscopic cholecystectomy group, which also had shorter hospital stays [23]. Loozen et al. conducted a systematic review and meta-analysis on early cholecystectomy for acute cholecystitis in the elderly, including 8 studies with 592 patients. The study reported a morbidity rate of 24% and a mortality rate of 3.5%, concluding that early cholecystectomy is feasible in the elderly, although careful patient selection is essential [24].

Borzellino et al. conducted a meta-analysis of randomized controlled trials to examine the timing of early laparoscopic cholecystectomy for acute calculus cholecystitis. This study incorporated 15 studies with a total of 1251 patients, revealing that performing early laparoscopic cholecystectomy within 72 hours of symptom onset was associated with a reduction in postoperative complications and a decreased risk of conversion [25]. Similarly, Shikata et al. performed a meta-analysis of randomized controlled trials comparing early versus delayed cholecystectomy for acute cholecystitis. This analysis included 10 studies with 1014 patients and found no significant differences in morbidity, length of hospital stay, or conversion rates between the two procedures [26]. Furthermore, Gurusamy et al. conducted a meta-analysis of randomized controlled trials to assess the safety and effectiveness of early versus delayed laparoscopic cholecystectomy for acute cholecystitis. This study included 5 studies with 451 patients and reported no differences in bile duct injury and conversion rates between the groups, while early laparoscopic cholecystectomy was associated with a shorter hospital stay [27].

An updated meta-analysis of randomized controlled trials conducted by Lyu et al. examined the outcomes of early versus delayed laparoscopic cholecystectomy in the treatment of acute cholecystitis. The analysis included 15 studies encompassing a total of 1669 patients, with 829 patients undergoing early laparoscopic cholecystectomy and 840 undergoing delayed laparoscopic cholecystectomy. The findings indicated no significant differences between the two procedures in terms of postoperative complications, bile leakage, and conversion to open surgery. However, early laparoscopic cholecystectomy was associated with a reduced length of hospital stay, despite a longer duration of surgery [28]. Additionally, a meta-analysis of case-control studies by Cao et al. demonstrated that early laparoscopic cholecystectomy was superior to delayed laparoscopic cholecystectomy in managing acute cholecystitis [29].

2.2. Single Incision Laparoscopic Cholecystectomy for Acute Cholecystitis

Single-incision laparoscopic cholecystectomy is characterized by the utilization of a single incision at the umbilicus, through which 10mm and 5mm ports are inserted into the fascia. The 12mm port is designated for the camera, while the 5mm port facilitates the insertion of surgical instruments. Retraction of the gallbladder is achieved by employing sutures to retract the fundus and infundibulum, which are affixed to the peritoneum. Challenges encountered during this procedure include limited spatial availability, instrument collision, and the absence of triangulation, which complicates the execution of the cholecystectomy and necessitates the use of specialized instruments. It is

imperative to meticulously close the umbilical defect to mitigate the risk of port site hernia [30].

Rivas et al. conducted a single-incision laparoscopic cholecystectomy on 100 patients, reporting a mean operative time of 58 minutes. Notably, 87% of these procedures utilized the two-trocar technique, and there were no conversions [31]. Raakow et al. performed a similar procedure on 196 patients, with an average operative time of 62 minutes, a success rate of 98%, and a conversion rate of 1.4% [32]. Lee et al. conducted a large cohort study comparing single-incision laparoscopic cholecystectomy with conventional laparoscopic cholecystectomy. This study included a total of 2080 patients, with 1000 undergoing single-incision laparoscopic cholecystectomy and 1080 undergoing the conventional approach. The study found no significant differences in wound infection rates, bile duct injury, or length of hospital stay between the two procedures. It recommended single-incision laparoscopic cholecystectomy for younger patients and those with an American Society of Anesthesiologists (ASA) Score of less than 3 [33].

Antoniou et al. conducted a systematic review on single-incision laparoscopic cholecystectomy, incorporating 29 studies with a total of 1166 patients. The findings indicated a success rate of 90.7%, a complication rate of 6.1%, and an average operative time of 70.2 minutes. Acute cholecystitis was identified as a factor contributing to technical failure and prolonged operative time [34]. In a separate systematic review by Lirici et al., 17 studies involving 1293 patients were analyzed. The morbidity rate was found to be comparable to that of conventional laparoscopic cholecystectomy; however, the operative time and cost were higher for single-incision laparoscopic cholecystectomy, which was also deemed technically more challenging [35]. Hall et al. conducted another systematic review, including 49 studies with 2336 patients. This review associated single-incision laparoscopic cholecystectomy with improved wound cosmesis and reduced postoperative pain [36].

A systematic review and meta-analysis conducted by Arezzo et al. examined the safety of single-incision laparoscopic cholecystectomy. This study incorporated a total of 12 studies, encompassing 996 patients. The findings indicated that single-incision laparoscopic cholecystectomy resulted in reduced postoperative pain and improved cosmetic outcomes; however, the operative duration was extended [37]. Similarly, a systematic review and meta-analysis by Evers et al. compared single-incision laparoscopic cholecystectomy with conventional laparoscopic cholecystectomy. This analysis included 9 studies with a total of 860 patients. The results demonstrated that single-incision laparoscopic cholecystectomy was associated with enhanced cosmetic results and diminished postoperative pain, although the procedure required a longer duration. Notably, there were no significant differences in conversion rates between the two surgical approaches [38].

A meta-analysis of prospective randomized controlled trials conducted by Pisanu et al. compared single incision laparoscopic cholecystectomy (SILC) with conventional laparoscopic cholecystectomy (CLC). This study incorporated 12 trials involving a total of 892 patients, with 465 undergoing SILC and 427 undergoing CLC. The findings indicated that SILC was associated with higher patient satisfaction but required a longer operative time [39]. Similarly, a meta-analysis by Garg et al. examined randomized controlled trials comparing SILC and CLC, including 9 studies with 659 patients. This analysis revealed that SILC resulted in a superior cosmetic score but also necessitated a longer operative time. No significant differences were observed in postoperative complications or conversion rates between the two procedures [40]. Another meta-analysis of randomized controlled trials corroborated these findings.[41].

2.3. Robotic-assisted laparoscopic Cholecystectomy for Acute Cholecystitis

Table 1: Comparison of outcomes among conventional laparoscopic, single-incision, and robotic-assisted cholecystectomy

Parameter	**Conventional Laparoscopic cholecystectomy** [26, 27]	**Single incision Laparoscopic Cholecystectomy** [26, 28, 31, 41, 42]	**Robotic Assisted Laparoscopic Cholecystectomy** [29, 32, 40, 43]
Op. time	58-95 mins	110-114 mins	120-130 mins
Conversion to open	Low	Like Laparoscopic cholecystectomy	Lower conversion rate compared to Laparoscopic cholecystectomy
Complication rate	Low postoperative complication rates	Comparable to Laparoscopic Cholecystectomy	Comparable overall; some data show increased major postop complications and drains in acute care
Bile duct injury	No significant differences	No significant differences	No significant difference overall
Cosmesis	Baseline	Better cosmetic scores [13, 18]	Not significantly different or not evaluated consistently
Hospital stays Costs	1 to 2 days Baseline	1 to 2 days Slightly higher per op time/instrumentation	Slightly longer-(2 to 3 days) Significantly higher costs
Technical challenge	Routine	Increased difficulty, steeper learning curve	Higher dexterity; potential ergonomic benefits

The implementation of robotic technology in cholecystectomy, particularly since the advent of the Da Vinci system, has enhanced the precision and efficacy of the procedure. Robotic cholecystectomy can be categorized into robotic-assisted laparoscopic cholecystectomy and single-incision robotic cholecystectomy. This approach offers significant advantages, including increased dexterity, superior imaging, and three-dimensional visualization. However, the drawbacks of robotic-assisted cholecystectomy include elevated costs and extended operative times. Additionally, the maintenance expenses associated with the robotic system pose challenges for hospitals utilizing this

technology [44, 45]. Hooda et al. conducted a retrospective study to compare the outcomes of robotic and laparoscopic cholecystectomy in cases of acute cholecystitis. The study encompassed 259 patients, with 186 undergoing conventional laparoscopic cholecystectomy and 73 undergoing robotic-assisted laparoscopic cholecystectomies. The findings indicated that robotic-assisted laparoscopic cholecystectomy was associated with shorter operative times, reduced morbidity, and lower conversion rates [42].

Han et al. conducted a systematic review and meta-analysis to compare robotic-assisted and conventional laparoscopic cholecystectomy for benign gallbladder diseases. The analysis included 26 studies with a total of 4,004 patients, of whom 1,833 underwent robotic cholecystectomy, and 2,171 underwent conventional laparoscopic cholecystectomy. The findings indicated no significant differences in morbidity, postoperative complications, or length of hospital stay between the two procedures. However, robotic-assisted cholecystectomy was associated with a longer operative time and a higher incidence of incisional hernia [43]. In a separate systematic review and meta-analysis, Tang et al. compared robotic-assisted with conventional and single-incision laparoscopic cholecystectomy for benign gallbladder disease. This analysis included 17 studies with 75,866 patients, comprising 37,471 who underwent robotic-assisted cholecystectomy, 38,123 who underwent conventional laparoscopic cholecystectomy, and 272 who underwent single-incision laparoscopic cholecystectomy. The results showed no differences in postoperative complications, morbidity, or length of hospital stay, although robotic cholecystectomy was associated with increased operative time and cost [46].

Table 1 comparing the operative time, complication rate, Bile duct injury, Cost, technical challenge and hospital stay of conventional laparoscopic cholecystectomy, single incision laparoscopic cholecystectomy, and robotic-assisted laparoscopic cholecystectomy.

3. Conclusion

Laparoscopic cholecystectomy remains the predominant surgical intervention for acute cholecystitis, with an increasing trend towards early laparoscopic cholecystectomy for patients presenting with this condition. The primary benefit of early laparoscopic cholecystectomy is its cost-effectiveness; however, it necessitates specialized training for execution. In certain hospitals, delayed laparoscopic cholecystectomy is still practiced, particularly where acute cholecystitis is initially managed conservatively. Single-incision laparoscopic cholecystectomy, a novel technique, does not confer significant advantages over conventional laparoscopic cholecystectomy, except for improved wound cosmesis. Robotic-assisted laparoscopic cholecystectomy is in the developmental phase, with its principal drawbacks being the high cost and maintenance requirements of the equipment.

Article Information

Conflict of interest: There is no conflict of interest.

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