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Review Article

The Surgical Management of Acute Calculus Cholecystitis: An Update: Review Article

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Abstract: The surgical management of acute calculus cholecystitis involves performing a cholecystectomy, and laparoscopic cholecystectomy is the current gold standard in the management of acute calculus cholecystitis. Laparoscopic cholecystectomy can be divided into early laparoscopic cholecystectomy and delayed laparoscopic cholecystectomy, and early laparoscopic cholecystectomy is increasingly being performed. Delayed laparoscopic cholecystectomy is now performed for patients who have failed to undergo early laparoscopic cholecystectomy. Single incision laparoscopic cholecystectomy and robotic -assisted laparoscopic cholecystectomy are new procedures that have been included for the surgical management of acute calculus cholecystitis. In this review, we will investigate the role of conventional laparoscopic cholecystectomy, single-incision laparoscopic cholecystectomy, and robotic -assisted laparoscopic cholecystectomy in the management of acute calculus cholecystitis.

Keywords: "Acute Calculus Cholecystitis"," Complications"," Delayed Laparoscopic Cholecystectomy"," Early Laparoscopic Cholecystectomy"," Tokyo Guidelines"," Single-Incision Laparoscopic Cholecystectomy", and "Robotic Cholecystectomy".

INTRODUCTION

Acute calculus cholecystitis is a condition that is characterized by inflammation of the gallbladder secondary to obstruction of the cystic duct due to stones. It is the most common complication of gallstone disease and is seen in 25% of patients with symptomatic gallstone disease. The clinical presentation is that of pain in the right hypochondrium, and there is tenderness at the right hypochondrium on abdominal examination. The diagnosis is confirmed by the presence of leukocytosis, and imaging in the form of ultrasound will reveal inflammation of the gallbladder and its surrounding area. The management of acute calculus cholecystitis is by performing a cholecystectomy, which can be done laparoscopically, although initial management will warrant the use of IV antibiotics and analgesics. For patients who are not fit for surgery, percutaneous cholecystostomy can be used to stabilize the patient before performing a cholecystectomy (Chung & Duke, 2018; Elwood, 2008; Indar & Beckingham, 2002.; Schuld & Glanemann, 2015)

The World Society of Emergency Surgeons (WSES) has recommended in its 2016 guidelines for the management of acute calculus cholecystitis that early laparoscopic cholecystectomy be performed within 7 days of the onset of symptoms, and delayed laparoscopic cholecystectomy be performed after 12 weeks if the onset of symptoms is more than 10 days. Percutaneous cholecystostomy is performed for patients who are not fit for surgery, to stabilize them, and perform an elective laparoscopic cholecystectomy(Ansaloni *et al*., 2016). The 2020 World Society of Emergency Surgeons (WSES) guidelines on the diagnosis and management of acute calculus cholecystitis recommend that laparoscopic cholecystectomy is the first-line treatment for acute calculus cholecystitis, with early laparoscopic cholecystectomy being performed within 7 days from the onset of symptoms and 10 days from admission. Delayed laparoscopic cholecystectomy was recommended if an early laparoscopic cholecystectomy could not be performed, and gallbladder drainage was done for patients who were not fit for surgery, acting as a bridging procedure to stabilize them(Pisano *et al*., 2020).

The Tokyo Guidelines of 2013 have classified acute calculus cholecystitis into mild, moderate, and severe, with patients with mild acute cholecystitis (grade

1) being managed with elective laparoscopic cholecystectomy, and patients with moderate acute cholecystitis (grade 2) were managed with early laparoscopic cholecystectomy, while severe acute cholecystitis was managed with percutaneous drainage followed by elective laparoscopic cholecystectomy once they were stable(Harai *et al*., 2019; Takada *et al*., 2013)The Tokyo Guidelines of 2018 further updated and reaffirmed the recommendations for managing acute calculus cholecystitis based on the severity of the condition. There was, however, a recommendation for performing gallbladder drainage for patients with moderate acute cholecystitis (grade 2) if they exhibited cardiovascular or respiratory compromise(Mayumi *et al*., 2018; Okamoto *et al*., 2018).

The management of acute calculus cholecystitis has undergone a slight change, with early laparoscopic cholecystectomy being performed. In this review, we will look at the role of early laparoscopic cholecystectomy and delayed laparoscopic cholecystectomy in the management of acute cholecystitis. We will also review the role of single incision laparoscopic cholecystectomy and robotic-assisted cholecystectomy in the management of acute calculus cholecystitis. We conducted a literature review using PUBMED, Cochrane database of clinical reviews, and Google Scholar, looking for clinical trials, observational studies, cohort studies, systematic reviews, and meta-analyses from 1990 to 2025. We used 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 in the English language only. Further articles were obtained by manually cross-referencing the literature. Case reports and studies with fewer than 10 patients, as well as editorials, were excluded. Adult male and female patients were included in this study; pregnant and pediatric patients were excluded.

DISCUSSION

Laparoscopic Cholecystectomy for Acute Cholecystitis

Laparoscopic cholecystectomy has replaced open cholecystectomy as the treatment of choice for acute cholecystitis. Since its introduction in the nineties, it has become the preferred surgical approach for the treatment of acute cholecystitis. The only issue is the timing of performing the surgery, with early laparoscopic cholecystectomy being performed within 7 days from the onset of the symptoms, and delayed laparoscopic cholecystectomy, which is done after 12 weeks from the onset of symptoms(Koti *et al*., 2015; Thangavelu *et al*., 2018). A randomized controlled study was conducted by Kao et al on early laparoscopic cholecystectomy for acute cholecystitis. A total of 86 patients were included in this study, and early laparoscopic cholecystectomy was associated with reduced morbidity, length of hospital stays, and cost(Kao *et al*., 2018). Several retrospective studies have been done to evaluate the effectiveness of early laparoscopic cholecystectomy, and they found that it was associated with reduced morbidity, length of hospital stay, reduced cost, and reduced analgesia usage(Acar *et al*., 2017; Agrawal *et al*., 2015; Bundgaard *et al*., 2021).

The Acute Cholecystitis: Early versus Delayed Cholecystectomy Multicenter Randomized Controlled Trial (ACDC study) was conducted by Gutt *et al*., A total of 618 patients were randomized, with 304 undergoing early laparoscopic cholecystectomy and 314 undergoing delayed laparoscopic cholecystectomy. The morbidity rate was lower in the early laparoscopic cholecystectomy group (11.8% vs. 34.4%), and the length of hospital stay was also shorter (5.4 vs. 10 days). There were no differences in the conversion rates and mortality between the groups(Gutt *et al*., 2013).Several other randomized studies that compared early versus delayed laparoscopic cholecystectomy for acute cholecystitis also concluded that early laparoscopic cholecystectomy was associated with reduced mortality, length of hospital stays, and cost(Kolla *et al*., 2004; Özkardeş *et al*., 2014; Tzovaras *et al*., 2006).

A systematic review and meta-analysis comparing open versus laparoscopic cholecystectomy for acute cholecystitis was conducted by Coccolini *et al*., A total of 10 studies with 1248 patients were included, of which 677 underwent laparoscopic cholecystectomy and 697 underwent open cholecystectomy. The postoperative morbidity, mortality, wound infection rate, and length of hospital stay were reduced in the laparoscopic cholecystectomy group(Coccolini *et al*., 2015). A meta-analysis comparing early versus delayed laparoscopic cholecystectomy for acute cholecystitis was conducted by Wu *et al*., A total of 16 studies with 1625 patients were included in this study. Early laparoscopic cholecystectomy was associated with reduced wound infection, shorter stay in hospital, and earlier return to work. There were no differences in mortality and bile duct injury between the groups(Wu *et al*., 2015).A meta-analysis on the timing of cholecystectomy for acute calculus cholecystitis was conducted by Papi et al. A total of 12 studies with 1255 patients were included in this study, and the operative complication rate was 3.11%, and the conversion rate was 7.99% for the early laparoscopic cholecystectomy group. The length of hospital stay was shorter in the early laparoscopic cholecystectomy group(Papi *et al*., 2004).A systematic review and meta-analysis on early cholecystectomy for acute cholecystitis in the elderly was conducted by Loozen *et al*., A total of 8 studies with 592 patients were included, and the morbidity was 24%, and the mortality was 3.5%. This study showed that early cholecystectomy was feasible in the elderly, but careful patient selection was essential(Loozen *et al*., 2017).

Borzellino *et al*., conducted a meta-analysis of randomized controlled trials on the timing of early laparoscopic cholecystectomy for acute calculus cholecystitis. A total of 15 studies with 1251 patients were included in this study, and early laparoscopic cholecystectomy being performed 72hours from the onset of symptoms, was associated with reduced postoperative complications and reduced risk of conversion(Borzellino *et al*., 2021). Another meta-analysis of randomized controlled trials comparing early versus delayed cholecystectomy for acute cholecystitis was conducted by Shikata *et al*., A total of 10 studies with 1014 patients were included in this study, and there were no differences in morbidity, length of hospital stays, and conversion rates between the procedures(Shikata *et al*., 2005). Gurusamy *et al*., conducted a meta-analysis of randomized controlled trials on the safety and effectiveness of early and delayed laparoscopic cholecystectomy for acute cholecystitis. A total of 5 studies with 451 patients were included in this study. There were no differences concerning bile duct injury and conversion between the groups, and early laparoscopic cholecystectomy was associated with a shorter stay in the hospital(Gurusamy *et al*., 2010).

An up-to-date meta-analysis of randomized controlled trials on early versus delayed laparoscopic cholecystectomy for acute cholecystitis was conducted by Lyu *et al*., A total of 15 studies with 1669 patients were included, with 829 patients undergoing early laparoscopic cholecystectomy and 840 undergoing delayed laparoscopic cholecystectomy. There were no significant differences regarding the postoperative complications, bile leak, and conversion to open surgery between the procedures. Early laparoscopic cholecystectomy was associated with a shorter hospital stay, but the duration of surgery was longer(Lyu *et al*., 2018).A meta-analysis of case -control studies by Cao *et al*., showed that early laparoscopic cholecystectomy was superior to delayed laparoscopic cholecystectomy in the management of acute cholecystitis(Cao *et al*., 2016).

Single Incision Laparoscopic Cholecystectomy for Acute Cholecystitis

Single incision laparoscopic cholecystectomy involves the use of a single incision at the umbilicus and the placement of 10mm and 5mm ports through the fascia. The 12mm port is for the camera, and the 5mm port is for the insertion of instruments. Retraction of the gallbladder can be obtained by using sutures to retract the fundus and infundibulum of the gallbladder that are attached to the peritoneum. Some of the problems that are encountered include the lack of space and clashing of instruments, and the absence of triangulation for laparoscopy. This makes performing the cholecystectomy difficult and requires special instruments. The umbilical defect will need to be closed carefully to reduce the risk of port site hernia(Brody *et al*., 2010).

Rivas *et al*., conducted single incision laparoscopic cholecystectomy on 100 patients with a mean operative time of 58 minutes, and up to 87% underwent the two-trocar technique, and there were no conversions(Rivas *et al*., 2010).Raakow *et al*., performed a single incision laparoscopic cholecystectomy on 196 patients, and the average operative time was 62 minutes, the success rate was 98%, and the conversion rate was 1.4%(Raakow & Jacob, 2011).Lee *et al*., conducted a large cohort study comparing single incision laparoscopic cholecystectomy and conventional laparoscopic cholecystectomy. A total of 2080 patients were included in this study, with 1000 undergoing single-incision laparoscopic cholecystectomy and 1080 undergoing conventional laparoscopic cholecystectomy. There were no differences in wound infection rates, bile duct injury, or length of hospital stay between the procedures. This study recommended single incision laparoscopic cholecystectomy for younger patients and those with an American Society of Anesthesiologists (ASA) Score of less than 3(Lee *et al*., 2018).

A systematic review on single-incision laparoscopic cholecystectomy was conducted by Antoniou *et al*., A total of 29 studies with 1166 patients were included in this study, and the success rate was 90.7%, the complication rate was 6.1%, and the mean operative time for the procedure was 70.2 minutes. Acute cholecystitis was a factor for technical failure and longer operative time(Antoniou *et al*., 2011). Another systematic review on single incision laparoscopic cholecystectomy was conducted by Lirici *et al*., A total of 17 studies with 1293 patients were included in this study, and the morbidity rate was similar to that of conventional laparoscopic cholecystectomy, but the operative time and cost were higher in single incision laparoscopic cholecystectomy, and it was technically more difficult(Lirici *et al*., 2016).A systematic review on single incision laparoscopic cholecystectomy was conducted by Hall *et al*., A total of 49 studies with 2336 patients were included in this study. Single-incision laparoscopic cholecystectomy was associated with better wound cosmesis and reduced postoperative pain(Hall *et al*., 2012).

A systematic review and meta-analysis were conducted by Arezzo et al on the safety of single-incision laparoscopic cholecystectomy. A total of 12 studies with 996 patients were included in this study. There was reduced postoperative pain and better cosmetic appearance with single incision laparoscopic cholecystectomy, but the operative time was longer(Arezzo *et al*., 2013).A systematic review and meta-analysis comparing single – incision laparoscopic cholecystectomy versus conventional laparoscopic cholecystectomy was conducted by Evers *et al*., A total of 9 studies with 860 patients were included in this study. Single incision laparoscopic cholecystectomy was associated with better cosmesis and reduced postoperative pain, but the procedure was longer, and

there were no differences with regard to conversion rates between the procedures(Evers *et al*., 2017).

A meta-analysis of prospective randomized controlled trials comparing single incision laparoscopic cholecystectomy and conventional laparoscopic cholecystectomy was conducted by Pisanu *et al*., A total of 12 studies with 892 patients were included in this study, of which 465 underwent single incision laparoscopic cholecystectomy, and 427 underwent conventional laparoscopic cholecystectomy. Single incision laparoscopic cholecystectomy was associated with better patient satisfaction but longer operative time(Pisanu *et al*., 2012).A meta-analysis of randomized controlled trials comparing single incision laparoscopic cholecystectomy and conventional laparoscopic cholecystectomy was conducted by Garg *et al*., A total of 9 studies with 659 patients were included in this study. Single incision laparoscopic cholecystectomy was associated with a better cosmetic score but longer operative time. There were no differences in postoperative complications or conversion rates between the procedures(Garg *et al*., 2012).A similar meta-analysis of randomized controlled trials comparing single incision laparoscopic cholecystectomy and conventional laparoscopic cholecystectomy also concluded the same(Geng *et al*., 2013).

Robotic-Assisted Laparoscopic Cholecystectomy for Acute Cholecystitis

The use of robotic technology in performing a cholecystectomy has made it more precise and better since its introduction by the Da Vinci system. Robotic cholecystectomy can be divided into robotic-assisted laparoscopic cholecystectomy and single-incision robotic cholecystectomy. Robotic cholecystectomy has the advantage of providing enhanced dexterity, improved image, and three-dimensional visualization. The disadvantage of robotic-assisted cholecystectomy is the increased cost and the prolonged operative time. The cost of maintaining the robotic system is also an issue for hospitals that use this system(Nam *et al*., 2024; Romero-Talamás & Kroh, 2014).Hooda *et al*., conducted a retrospective study comparing the outcomes between robotic and laparoscopic cholecystectomy for acute cholecystitis. A total of 259 patients were included in this study, with 186 undergoing conventional laparoscopic cholecystectomy and 73 undergoing robotic-assisted laparoscopic cholecystectomies. The robotic-assisted laparoscopic cholecystectomy was associated with a shorter operative time, reduced morbidity, and reduced conversion rates(Hooda *et al*., 2025).

A systematic review and meta-analysis comparing robotic-assisted versus conventional laparoscopic cholecystectomy for benign gallbladder diseases was conducted by Han *et al*., A total of 26 studies with 4,004 patients were included, of which 1,833 underwent robotic cholecystectomy and 2,171 underwent conventional laparoscopic cholecystectomy. There were no differences regarding morbidity, postoperative complications, and length of hospital stay between the procedures. Robotic-assisted cholecystectomy was associated with a longer operative time and a higher rate of incisional hernia(Han *et al*., 2018). Another systematic review and meta-analysis comparing robotic -assisted versus conventional/single-incision laparoscopic cholecystectomy for benign gallbladder disease was conducted by Tang *et al*., A total of 17 studies with 75,866 patients were included, with 37,471 undergoing robotic-assisted cholecystectomy, 38,123 undergoing conventional laparoscopic cholecystectomy, and 272 undergoing single-incision laparoscopic cholecystectomies. There were no differences in the postoperative complications, morbidity, and length of hospital stay, but robotic cholecystectomy was associated with an increased operative time and increased cost(Tang *et al*., 2025).

Table I

Parameter	Conventional 4-port LC	Single-Incision LC (SILC)	Robotic-Assisted LC
Operative time	Typically, ~60–62 min (kao *et al*.,)	~70 min in elective; in acute cholecystitis, like 4-port (~66–86 min) –(Brody *et al*.,)	In acute cases: ~115 vs 102 min.(Nam *et al*.,)
Complication rate	Bile leaks/perforation rates and general morbidity are comparable (Gurusamy *et al*., Shikata *et al*.,)	Comparable to 4-port LC in acute cholecystitis –(Garg *et al*., Geng *et al*.,)	Similar complication and bile duct injury rates. (Hooda et al, Han *et al*.,)
Hospital stays	1–1.5 days-(Lyu *et al*., Cao *et al*.,)	1 to 1.5 days- (Rivas *et al*., Raakow *et al*.,)	1.5 to 2 days- (Han *et al*., Teng *et al*.,)

Table comparing the operative time, complication rate, and hospital stay of conventional laparoscopic cholecystectomy, single incision laparoscopic cholecystectomy, and robotic-assisted laparoscopic cholecystectomy.

CONCLUSION

Laparoscopic cholecystectomy is still the most common surgical procedure for acute cholecystitis, with early laparoscopic cholecystectomy being increasingly performed for patients who present with acute cholecystitis. The advantage of early laparoscopic cholecystectomy is the reduced cost, but it requires training to perform it. Delayed laparoscopic cholecystectomy is still performed in some hospitals where acute cholecystitis is managed conservatively, followed by this. Single incision laparoscopic cholecystectomy is a new procedure that does not offer

any advantage over conventional laparoscopic cholecystectomy, with better wound cosmesis being its only advantage. Robotic-assisted laparoscopic cholecystectomy is still developing, but the major disadvantage is its cost and maintenance of the equipment.

Conflict of Interest: There is no conflict of interest

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