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Laparoscopic cholecystectomy in acute cholecystitis: indication, technique, risk and outcome

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Abstract *Background:* Laparoscopic cholecystectomy (LC) has become the treatment of choice for symptomatic cholelithiasis. However, the laparoscopic approach has remained controversial for patients with acute cholecystitis (AC) because of technical difficulties that, compared with open cholecystectomy (OC), might lead to higher complication rates, particularly common bile duct (CBD) injuries and infection. *Methods:* We reviewed recent clinical findings on feasibility, safety and potential benefits of LC in patients with AC. An electronic search using the PubMed and MEDLINE databases was performed using the terms laparoscopic cholecystectomy, open cholecystectomy and acute cholecystitis. Pertinent references from articles and books not identified by the search engines were also retrieved. Relevant surgical textbooks were also reviewed. *Conclusions:* The early laparoscopic approach has been shown to be technically feasible and at least equally as safe as the open approach. However, extensive inflammation, adhesions and consequent increased oozing can make laparoscopic dissection of Calot's triangle and recognition of the biliary anatomy hazardous and difficult. Therefore, conversion to OC remains an important treatment option to secure patient safety in such difficult conditions. The question of whether intraoperative cholangiography (IOC) should be used routinely or only selectively has never been resolved. Proponents for each side have put forward compelling arguments.

Keywords Acute cholecystitis · Laparoscopic cholecystectomy · Indication · Technique · Complications

Introduction

Since Carl Langenbuch performed the first open cholecystectomy (OC) in 1882 [1], this technique has remained the "gold standard" for the treatment of symptomatic cholelithiasis and acute cholecystitis (AC) for more than 100 years. The first laparoscopic cholecystectomy (LC) was achieved by Mühe, another German surgeon, in 1985 [2], and, by 1988, Dubois had started to perform LC regularly [3]. Since then, LC, owing to its perceived efficacy in both rapid recovery and cosmesis, has rapidly become the treatment of choice for symptomatic gallstones in industrialised nations [4–8]. However, even though LC for treating symptomatic cholelithiasis had already gained wide acceptance, AC was still considered as a relative contraindication, because a high incidence of common bile duct (CBD) injuries (1.3%–5.5%) had been reported in several series [9, 10].

Today, the considerable experience acquired in minimal invasive surgery has led to LC's being the treatment of choice for AC [11–14]. Similar mortality rates [15–17] to those historically observed in OC [18], but significantly lower morbidity rates, are reported.

Diagnosis, indication and timing of surgery

Clinical findings and symptoms

Clinically, AC is defined mainly by acute onset of abdominal pain in the right upper quadrant, often radiating through the right shoulder, with fever and mild leukocytosis (12,000–14,000 cells/mm^3). Clinical examination shows a positive Murphy's sign.

Imaging techniques

Ultrasound is the initial imaging modality of choice for the assessment of suspected acute gallbladder disorders and is often sufficient for correct diagnosis [19]. Computed tomography (CT) is particularly useful in situations where ultrasound findings are equivocal. CT is also extremely valuable in the assessment of suspected complications of AC, particularly emphysematous cholecystitis, haemorrhagic cholecystitis and gallbladder perforation, which are often very difficult diagnoses to establish with sonography [19, 20].

Common bile duct stones

Common bile duct stones (CBDS) are reported in 10%–15% of patients who undergo gallbladder surgery [21]. Therefore, every patient with suspected AC also has to be assessed preoperatively for the presence of concomitant CBDS.

Numerous indicators (symptoms and signs, laboratory parameters and imaging techniques) have been examined for their ability to predict the presence of CBDS. Among laboratory findings, only elevated alkaline phosphatase and bilirubin yield sensitivities greater than 50%. The presence of cholangitis, preoperative jaundice, CBDS or dilatation of the CBD > 7 mm during ultrasonography are the indicators with the greatest discriminatory power [22, 23].

Although CT has no routine role in the diagnosis of CBDS, magnetic resonance cholangiopancreatography (MRCP) is an excellent tool, with a sensitivity of 91.6%, and 100% specificity [24], but with disadvantages that include high costs and low availability.

Endoscopic retrograde cholangiopancreatography (ERCP) is a valid diagnostic and therapeutic tool. The success rate of ERCP is 95% in experienced hands, with a sensitivity and specificity of 80%–90% and 95%–100%, respectively [21]. However, one has to keep in mind that ERCP is an invasive procedure with a significant morbidity rate of 14% and mortality rate of 2% [25]. These findings argue for a selective use of preoperative ERCP only for patients with a "high risk" of CBDS and/or cholangitis.

A high positive predictive value (<85%) is reported [25] for the presence of CBDS during ERCP in patients with acute cholangitis, persistent obstructive jaundice, or in the acute phase of gallstone pancreatitis. Santucci et al. demonstrated in a prospective study a 95% probability of CBDS in patients who presented with elevated levels of alkaline phosphatase (ALP) (over 300 IU/l) and alanine aminotransferase (ALT) (over 40 IU/l) and CBD dilation over 8 mm on ultrasound [26]. Patients with a "medium" or "low" risk for CBDS should directly undergo LC with a selective use of intraoperative cholangiography (IOC).

Indication and timing of surgery

Many surgeons still prefer to treat patients with AC by initial conservative management and delayed cholecystectomy [27]. Nevertheless, approximately 15% require emergency surgery, and another 25% of patients are re-admitted prior to elective surgery. A third of re-admissions are within 3 weeks of the first hospital discharge [27]. Those results document the high incidence of complications experienced by patients waiting for delayed cholecystectomy. Therefore, early cholecystectomy might help to reduce costs by preventing recurrent emergency admissions and shortening overall hospital stays [28, 29]. A recently published meta-analysis that compared early versus delayed open and laparoscopic cholecystectomy showed that there are no significant differences between the perioperative morbidity and mortality rates in patients who undergo either early or delayed surgery. However, a trend towards the lowest conversion rates with the shortest overall hospital stay is reported for early LC, with no differences regarding the incidence of CBD injuries [30–40]. The results of prospective trials that compared early versus delayed open and minimally invasive cholecystectomy are summarised in Tables 1 and 2.

It is now generally accepted that early LC is not only technically feasible but is the preferred method of treatment, as it effectively short-circuits the illness. As for OC, the boundary for early LC is postulated to be 4 days after the initial symptoms occur [41–43]. Therefore, every patient with AC should undergo open or laparoscopic surgery within the first 96 h of the onset of symptoms. Critically ill patients who are unfit for emergency surgery might be candidates for percutaneous cholecystostomy. This procedure, in experienced hands, has been shown to have low complication and high success rates. Patients often improve clinically, so total or subtotal cholecystectomy can be done electively [44].

Technique of laparoscopic cholecystectomy

Preoperative preparation

Prior to surgery, dehydration or electrolyte imbalance is corrected by intravenous fluid administration and broad-spectrum antibiotic treatment (e.g. second-generation ceph-

Table 1 Randomised trials that addressed early versus delayed OC (*MHS* mean hospital stay)

Author	Year	Arm	No. of patients	Mortality *n* (%)	Morbidity *n* (%)	CBD injuries *n* (%)	MHS (days)
Jarvinen and	1991	Early	80	0	11 (13.7)	0	10.7
Hastbacka [31]		Delayed	75	1 (1.3)	13 (17.3)	0	18.2
Schaefer et al. [32]	1980	Early	28	0	8 (28.6)	0	12.0
		Delayed	25	1 (4.0)	9 (36.0)	0	22.0
Norrby et al. [33]	1983	Early	101	0	15 (14.8)	1 (1.0)	15.5
		Delayed	106	1 (0.9)	14 (13.2)	2 (1.9)	11.6
Singh et al. [34]	1984	Early	54	0	7 (12.9)	0	11.6
		Delayed	54	0	5 (9.2)	0	22.1
Misra et al. [35]	1988	Early	24	0	2 (8.3)	0	7.0
		Delayed	23	0	2 (8.7)	0	22.9
Ahmad [36]	1992	Early	50	1 (2.0)	11 (22.0)	0	10.0
		Delayed	50	2 (4.0)	9 (18.0)	2 (4.0)	15.0

alosporin and metronidazole) is given. A nasogastric tube should be placed as early as possible if there are any clinical symptoms of ileus. Otherwise, a tube can be inserted prior to the surgical intervention to decompress the stomach and to optimise exposure.

Technique of laparoscopic cholecystectomy

LC is generally performed under general anaesthesia with endotracheal intubation. We prefer the "French" position, where the surgeon stands between the patient's legs with the video-monitor positioned at the patient's right side. An angled (30°–45°) camera with high resolution is used. The pneumoperitoneum is established by either an open access (Hasson) technique with a blunt-tipped 12 mm trocar or by a Veress needle, placed below the umbilicus. In obese patients, with sub-umbilical access the working distance to the gallbladder is often too long. Therefore, in such patients, depending on the patient's anatomy, the Hasson trocar or Veress needle is placed between the xyphoid and the umbilicus. The pneumoperitoneum is then established by insufflation with carbon dioxide at a working pressure of up to 12 mmHg. Three further trocar sleeves are inserted under direct vision. Before trocar puncture is performed, the abdominal wall is trans-illuminated with the camera light beam so that epigastric vessel injury is avoided. A 5 mm trocar is inserted in the right anterior axillary line approximately 15 cm distal to the gallbladder. A second 5 mm trocar sleeve is inserted sub-costally, paramedially left or, in accordance with Dubois's technique, to the right paramedian [3]. A 10 mm sleeve for the working instruments is inserted in the left medioclavicular line, somewhat cranial to the umbilicus. In the ideal situation, the trocars form a semi-circle around the gallbladder. Additional or alternative trocar sites can be selected, according to anatomical variations. Care must be taken that the distance between the trocars is sufficient for the instruments not to obstruct each other. The trocar sleeves must also be far enough from the gallbladder to ensure that there is an adequate working radius that allows proper handling of the forceps.

The patient is now placed in an anti-Trendelenburg position and turned slightly to the left side to optimise exposure. Adhesions between the gallbladder, liver, duodenum and the omentum are divided by blunt dissection or with scissors. Dense adhesions are dissected with a hook electrode. The gallbladder is then exposed, and the diagnosis and grade of inflammation of the gallbladder are confirmed. A careful inspection of the entire abdominal cavity is routinely performed prior to the start of the gallbladder dissection. Often, it is difficult for the surgeon to

Table 2 Randomised trials that addressed early versus delayed LC (*MHS* mean hospital stay)

Author	Year	Arm	No. of patients	Mortality *n* (%)	Morbidity *n* (%)	Conversion *n* (%)	MHS (days)	CBD injuries *n* (%)
Lo et al. [37]	1998	Early	45	0	6 (13.3)	5 (11.1)	6.0	0
		Delayed	41	0	12 (29.3)	9 (21.9)	11.0	1 (2.4)
Lai et al. [38]	1998	Early	53	0	5 (9.4)	11 (20.7)	7.6	0
		Delayed	46	0	3 (6.5)	11 (23.9)	11.6	0
Chandler	2000	Early	21	0	2 (9.5)	5 (23.8)	5.4	0
et al. [39]		Delayed	22	0	2 (9.1)	8 (36.4)	7.1	0
Johansson	2003	Early	74	0	13 (18.8)	23 (31)	5.0	0
et al. [40]		Delayed	69	0	7 (10.1)	20 (29)	8.0	1 (1.5)

grasp the distended, oedematous and necrotic gallbladder with the grasping tools. In such cases, gallbladder decompression is indicated. Decompression can be established with either an aspiration needle, inserted through a trocar sleeve, or with a spinal needle, guided percutaneously into the cystic fundus. After decompression, the surgeon can seal the puncture site by grasping the gallbladder opening with atraumatic forceps.

If the gallbladder is pulled cephaled and laterally, Calot's triangle and its structures (i.e. cystic duct, cystic artery, inferior border of the liver and CBD) are put under tension. Care must be taken not to apply too much tension, which can change the natural course of the CBD. Dissection of the peritoneal cover starts near the fundus of the gallbladder and proceeds upwards to the liver. The dissection is continued close to the gallbladder wall by blunt dissection or the hook dissector. After identifying the transition of the gallbladder into the cystic duct at the area of the Mascagni lymph node (landmark transition gallbladder/cystic duct), the surgeon retracts the gallbladder in a slightly ventral position and exposes the cystic duct, using mainly blunt dissection. Calot's triangle is now completely exposed by blunt dissection. No structure presumed to be ductal or vascular should be divided until all the anatomical features have been identified. If the ductal or vascular structures are too inflamed for safe dissection to be performed, laparoscopic subtotal cholecystectomy offers a simple and safe solution that prevents bile duct injuries and decreases the rate of conversion in anatomically difficult situations [45, 46]. Subtotal cholecystectomy is performed by leaving the posterior wall of the gall bladder intact. The gall bladder is incised adjacent to its anterior attachment to the liver, and its contents are evacuated. The incision is carried out around to the posterior wall, both incisions meeting medially, and the intraperitoneal gall bladder being removed. The posterior wall of the gall bladder is left undisturbed, attached to the liver. The cystic duct, if accessible, is controlled in the usual way [47]. A closed suction drain left in place of the gallbladder bed for some days postoperatively is recommended. However, the open approach remains the gold standard in difficult cases.

A clip is applied to the cystic duct at the neck of the gallbladder. Then, the cystic duct is incised proximal to the clip, with scissors, and then "milked" back into the gallbladder with atraumatic forceps (Fig. 1). In the case of IOC, a 14-gauge polyethylene IV-type needle is now advanced through the abdominal wall in a slight cranial direction. The insertion site is slightly medial to the midclavicular portal. Through this sleeve, the cholangiography catheter is then inserted into the peritoneal cavity. The catheter is grasped with forceps and introduced into the cystic duct. The position of the catheter is then fixed with a partially closed clip that is placed across the catheter and the cystic duct. The patency of the catheter is monitored during its fixation by continuous application of saline solution through the catheter. IOC is performed as a next step.

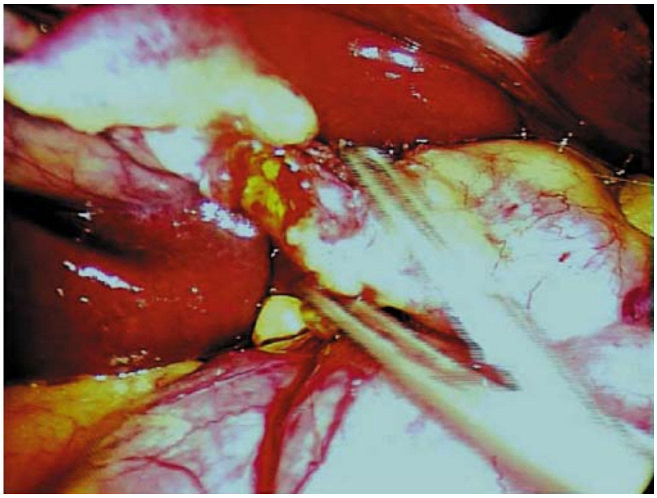

Fig. 1 "Milking" back of small gallstones in the cystic duct prior to catheter insertion

The contrast dye is gently injected to monitor the opalescence of the distal bile duct and to identify CBDS. The patient is then placed in a Trendelenburg position and further contrast dye is injected to visualise the intrahepatic bile ducts. Care must be taken not to inject any air bubbles, which can mimic CBDS. After IOC has been completed, the cystic duct is routinely clipped with two titanium clips. The cystic duct is divided with scissors. In the case of thick or scarred cystic duct, the occlusion by titanium clips might be difficult. As an alternative option, larger clips such as Laparo clips, Röder loops or an endo-GIA can be used.

After double titanium clip ligation in the same manner as described for the cystic duct, the artery is divided with scissors. The next step is for the gallbladder to be dissected from its liver bed. We use electrocautery with monopolar current to mobilise the gallbladder. Care must be taken to perform the dissection in the right plane to avoid gallbladder perforation or severe bleeding from the liver. Bleeding from the gallbladder bed should be controlled immediately. Superficial bleeding is controlled by electrocautery. Bleeding from deeper vessels can, in most cases, be managed with a laparoscopic argon-enhanced device. During coagulation with such a device, the intra-abdominal pressure must be carefully monitored to prevent fatal gas embolism by over-pressurisation [48]. As a final alternative, an attempt to control liver-bed bleeding can be made by the insertion of deep-biting liver sutures.

In the case of gallbladder perforation, the lesion might be closed by being grasped with the forceps. If this manoeuvre is not appropriate, the gallbladder content is completely aspirated, and smaller stones are aspirated. Larger stones are removed with an endobag. The operation site is then extensively irrigated and "lost" stones are removed either by aspiration or with an endobag.

After dissection from the liver bed, the gallbladder is then extracted in an endobag. The abdomen is carefully inspected and irrigated with saline solution. The operating field is checked for bleeding or bile leaks from the cystic artery, liver bed, or the cystic stump. Drainage is not routinely performed; however, if it is used, a closed suction drain is preferred.

In the next step, the trocar sleeves are removed under direct vision to detect abdominal wall bleeding and, if necessary, to perform haemostasis. The sub-umbilical fascia and the fascia at the 10 mm trocar sleeve are closed with a resorbable suture. The other incisions require only skin closure [49, 50].

Risks and outcome

Conversion rate and risk factors

Nowadays, an average conversion rate of between 11% and 30% has been reported in several published prospective and retrospective series [37–40]. However, higher rates of conversion, up to 75%, must be expected in patients with gangrenous cholecystitis or gallbladder empyema [51]. Although the conversion rate for AC is high when compared with elective LC (4.5%–5.0%) [52, 53], it is far lower than in early series of patients with AC (35%–45%) [54, 55]. Several factors and conditions associated with an increased risk for conversion to open surgery can be identified. Delayed surgical intervention after the first 96 h of symptom onset is associated with a significant increased risk for conversion (23%–32%) when compared with early LC [41, 56]. Furthermore, higher conversion rates should be expected in: male patients [52, 57]; age over 65 years [37]; gallbladder thickness > 5 mm during ultrasound examination [58]; inexperienced surgeons [37]; severe gallbladder inflammation [42]. The latter, with or without perforation (Fig. 2), should be suspected in male patients with prolonged duration of symptoms, ASA classification > II, white blood count (WBC) > 15,000 cells/mm^3 and C-reactive protein levels > 100 mg/l [59].

Based on the patient's clinical history and risk factors, and the laboratory and ultrasound findings, the likelihood for conversion can already be estimated preoperatively. Patients with a high risk for conversion can be informed and their operation scheduled appropriately.

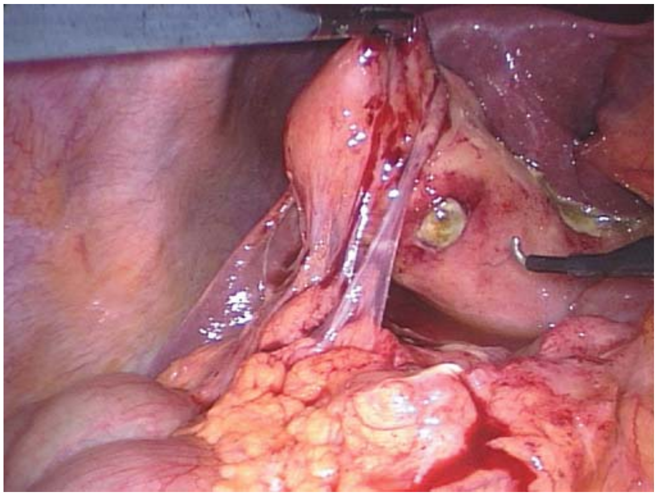

Fig. 2 Severe gallbladder inflammation with perforation and dense adhesions

Intraoperative complications

The most common intraoperative complications of laparoscopic surgery are related to needle and trocar insertion and bleeding. The reported incidence for Veress needle and trocar injuries in several large retrospective studies, including a variety of different laparoscopic interventions, is reported as between 0.18% and 1% [60, 61]. Whereas perioperative bleeding complications in patients who underwent LC for symptomatic cholelithiasis are observed in only approximately 1% of patients [62], some authors report complications from bleeding > 500 ml as high as 8% during LC for AC [40]. In fact, these complication rates are still relatively low when compared with those observed for early OC, where 7% of patients received blood transfusions [33].

CBD injuries during LC remain the most serious complication encountered with this procedure. Especially in the beginning of the laparoscopic area, several studies report much higher rates of CBD injuries (1.3%–5.5%) than in OC [9, 10]. Nowadays, it is accepted that the incidence of CBD injuries during LC is only approximately double the rate for OC, reaching 0.4%–0.7%, as reported in larger trials [17, 63]. Strict adherence to the principles of surgical dissection is obviously of utmost importance for the prevention of CBD injuries. Whether the routine use of IOC decreases the incidence of CBD injuries remains controversial. One has to keep in mind that IOC is not without inherent risks, despite being a safe procedure. A risk of CBD injury due to bile duct avulsion in 0.4% of patients and an incidence of false positive cholangiograms with conversion to open CBD exploration in 0.46% have been reported [64]. Moreover, the selective use of IOC in laparoscopic cholecystectomy will not yield a higher incidence of intraoperatively diagnosed CBDS than routine use [65]. However, when the anatomical features are unclear during surgical dissection, IOC must be performed to give a surgical "road map". CBD injury must be suspected in the presence of contrast material extravasation or lack of opacification of the right posterior intrahepatic bile duct. Hospital mortality rates, postoperative biliary complications and re-interventions can be reduced in patients with early intraoperative CBD injury detection during IOC [66].

Common bile duct stones

In patients who undergo laparoscopic cholecystectomy, CBDS are reported to occur in approximately 4.5%–15% [21, 39]. Preoperatively undiagnosed CBDS are found in only 2.3%–3.5% intraoperatively [63, 67]. The optimal management of CBDS in the laparoscopic area is controversial. The three major treatment options are preoperative ERCP, intraoperative laparoscopic bile duct exploration (trans-cystic or choledochotomy) and intraoperative or postoperative ERCP. Duct clearance and morbidity and mortality rates for these three procedures are similar, except that laparoscopic CBD exploration results in a significantly shorter hospital stay [68, 69].

Intraoperatively, CBDS can initially be treated laparoscopically by the transcystic approach, if possible. If this procedure fails, intraoperative or postoperative ERCP are alternative options. Large stones, amenable neither by the trans-cystic approach nor by ERCP, might be treated by open bile duct exploration. Although laparoscopic choledochotomy is reported to be as safe and effective as the trans-cystic approach [68, 69], it is probable that the true number of bile duct strictures in the long term follow-up after laparoscopic choledochotomy is underestimated, and, secondly, this technique is a technically demanding procedure that requires surgeons with special skills in laparoscopic and biliary surgery. Moreover, the results published for laparoscopic CBD exploration are probably too optimistic, because the studies were conducted by experts in laparoscopic biliary surgery and the patients that were included in these studies had undergone elective surgery for symptomatic choledocholithiasis [68, 69].

The role of laparoscopic CBD exploration has never, as far as we know, been systematic analysed in a prospective, controlled study in the setting of AC with difficult anatomical conditions and increased oozing of the cystic duct and the tissue in Calot's triangle.

Postoperative complications and mortality

Despite the obvious advantages of LC over OC in terms of length of stay, patient discomfort and cosmesis, concern has lingered about the incidence of complications arising during LC. Nowadays, the overall postoperative complication rate for early LC in randomised and non-randomised trials is reported to be between 9% and 16.5% [16, 38, 70], whereas early OC has a reported complication rate of between 8% and 29% [31–36]. Comparing these data, one has to keep in mind that complication and mortality rates are significantly higher for older patients (>65 years), patients admitted to the hospital as emergencies and those with acute or complicated cholecystitis (gangrene, empyema, perforation, etc.). In a large series of 14,582 patients who had undergone OC for acute or complicated cholecystitis, Roslyn et al. found a perioperative complication rate of 19.4% and 25.2% with a mortality rate of 0.26% and 0.6%, respectively [71]. Similar mortality rates of approximately 0.2% are reported in large prospective studies [63]. In a recently published randomised trial, Kiviluoto et al. found that LC for AC does not increase mortality rates but that the morbidity rate seems to be significantly lower than that observed in OC [18]. Complication and conversion rates for early LC are summarised in Table 2.

Conclusions

Early LC is feasible and safe and is today's treatment of choice for patients suffering from AC. A shorter hospital stay and faster recovery are the main benefits for patients who undergo early minimally invasive cholecystectomy. Whereas mortality rates are comparable, the morbidity rates are found to be lower than for OC. However, CBD injuries are still more frequently observed during LC, but the incidence seems now to be acceptably low at approximately 0.4%. In AC, IOC may be hazardous because the tissues are commonly inflamed and friable. Therefore, IOC should be performed only in selected cases, where the bile duct anatomy is unclear or to rule out suspected intraoperative bile duct lesions. However, under difficult conditions, where there is severe inflammation of Calot's triangle and difficult intraoperative anatomical findings, OC remains the treatment of choice.

References

1. Langenbuch C (1882) Ein Fall von Exstirpation der Gallenblase wegen chronischer Cholelithiasis: Heilung. Berlin Klin Wochenschr 19:725–726
2. Mühe C (1986) Cholecystectomie durch das Laparoskop. Langenbecks Arch Klin Chir 369:804
3. Dubois F, Berthelot G, Levard H (1989) Cholecystectomy by coelioscopy. Presse Med 18:980–982
4. Club TSS (1991) A prospective analysis of 1518 laparoscopic cholecystectomies. The Southern Surgeons Club. N Engl J Med 324:1073–1078
5. Berci G, Sackier JM (1991) The Los Angeles experience with laparoscopic cholecystectomy. Am J Surg 161:382–384
6. Baird DR, Wilson JP, Mason EM, Duncan TD, Evans JS, Luke JP, Ruben DM, Lucas GW (1992) An early review of 800 laparoscopic cholecystectomies at a university-affiliated community teaching hospital. Am Surg 58:206–210

7. Soper NJ, Stockmann PT, Dunnegan DL, Ashley SW (1992) Laparoscopic cholecystectomy. The new 'gold standard'? Arch Surg 127:917–921 (discussion 921–923)
8. National Institutes of Health Consensus Development Conference Statement on Gallstones and Laparoscopic Cholecystectomy (1993) Am J Surg 165:390–398
9. Kum CK, Eypasch E, Lefering R, Paul A, Neugebauer E, Troidl H (1996) Laparoscopic cholecystectomy for acute cholecystitis: is it really safe? World J Surg 20:43–48 (discussion 48–49)
10. Adamsen S, Hansen OH, Funch-Jensen P, Schulze S, Stage JG, Wara P (1997) Bile duct injury during laparoscopic cholecystectomy: a prospective nationwide series. J Am Coll Surg 184:571–578
11. Flowers JL, Bailey RW, Scovill WA, Zucker KA (1991) The Baltimore experience with laparoscopic management of acute cholecystitis. Am J Surg 161:388–392
12. Phillips EH, Carroll BJ, Bello JM, Fallas MJ, Daykhovsky L (1992) Laparoscopic cholecystectomy in acute cholecystitis. Am Surg 58:273–276
13. Miller RE, Kimmelstiel FM (1993) Laparoscopic cholecystectomy for acute cholecystitis. Surg Endosc 7:296–299
14. Cox MR, Wilson TG, Luck AJ, Jeans PL, Padbury RT, Toouli J (1993) Laparoscopic cholecystectomy for acute inflammation of the gallbladder. Ann Surg 218:630–634
15. Unger SW, Nguyen N, Edelman DS, Unger HM (1994) Laparoscopic approach to acute cholecystitis: a four year retrospective review. Int Surg 79:209–212
16. Lujan JA, Parrilla P, Robles R, Marin P, Torralba JA, Garcia-Ayllon J (1998) Laparoscopic cholecystectomy vs open cholecystectomy in the treatment of acute cholecystitis: a prospective study. Arch Surg 133:173–175
17. Navez B, Mutter D, Russier Y, Vix M, Jamali F, Lipski D, Campier E, Guiot P, Leroy J, Marescaux J (2001) Safety of laparoscopic approach for acute cholecystitis: retrospective study of 609 cases. World J Surg 25:1352–1356
18. Kiviluoto T, Siren J, Luukkonen P, Kivilaakso E (1998) Randomized trial of laparoscopic versus open cholecystectomy for acute and gangrenous cholecystitis. Lancet 351:321–325
19. Bennett GL, Balthazar EJ (2003) Ultrasound and CT evaluation of emergent gallbladder pathology. Radiol Clin North Am 41:1203–1216
20. Gore RM, Yaghmai V, Newmark GM, Berlin JW, Miller FH (2002) Imaging benign and malignant disease of the gallbladder. Radiol Clin North Am 40:1307–1323
21. Paul A, Millat B, Holthausen U, Sauerland S, Neugebauer E (1998) Diagnosis and treatment of common bile duct stones (CBDS). Results of a consensus development conference. Scientific Committee of the European Association for Endoscopic Surgery (E.A.E.S.). Surg Endosc 12:856–864
22. Abboud PA, Malet PF, Berlin JA, Staroscik R, Cabana MD, Clarke JR, Shea JA, Schwartz JS, Williams SV (1996) Predictors of common bile duct stones prior to cholecystectomy: a meta-analysis. Gastrointest Endosc 44:450–455
23. Contractor QQ, Boujemla M, Contractor TM, el-Essawy OM (1997) Abnormal common bile duct sonography. The best predictor of choledocholithiasis before laparoscopic cholecystectomy. J Clin Gastroenterol 25:429–432
24. Lomanto D, Pavone P, Laghi A, Panebianco V, Mazzocchi P, Fiocca F, Lezoche E, Passariello R, Speranza V (1997) Magnetic resonance-cholangiopancreatography in the diagnosis of biliopancreatic diseases. Am J Surg 174:33–38
25. Rijna H, Borgstein PJ, Meuwissen SG, de Brauw LM, Wildenborg NP, Cuesta MA (1995) Selective preoperative endoscopic retrograde cholangiopancreatography in laparoscopic biliary surgery. Br J Surg 82:1130–1133
26. Santucci L, Natalini G, Sarpi L, Fiorucci S, Solinas A, Morelli A (1996) Selective endoscopic retrograde cholangiography and preoperative bile duct stone removal in patients scheduled for laparoscopic cholecystectomy: a prospective study. Am J Gastroenterol 91:1326–1330
27. Cameron IC, Chadwick C, Phillips J, Johnson AG (2002) Acute cholecystitis—room for improvement? Ann R Coll Surg Engl 84:10–13
28. Ransohoff DF, Gracie WA (1993) Treatment of gallstones. Ann Intern Med 119:606–619
29. Somasekar K, Shankar PJ, Foster ME, Lewis MH (2002) Costs of waiting for gall bladder surgery. Postgrad Med J 78:668–669
30. Papi C, D'Ambrosio L, Capurso L (2004) Timing of cholecystectomy for acute calculous cholecystitis: a meta-analysis. Am J Gastroenterol 99:147–155
31. Jarvinen HJ, Hastbacka J (1980) Early cholecystectomy for acute cholecystitis. A prospective randomized study. Ann Surg 1991:501–505
32. Schaefer D, Barth H, Thon K, Jostarndt L, Maroske D (1980) Early or delayed operation in patients with acute cholecystitis. Results of a prospective randomized controlled clinical trial. Chir Forum Exp Klin Forsch 1980:149–153
33. Norrby S, Herlin P, Holmin T, Sjodahl R, Tagesson C (1983) Early or delayed cholecystectomy in acute cholecystitis? A clinical trial. Br J Surg 70:163–165
34. Singh NK, Singh RJ, Rai U (1984) Early versus delayed operation for acute cholecystitis. J Indian Med Assoc 82:356–359
35. Misra MC, Khanna S, Khosla A, Berry M, Kapur BM (1988) Emergency versus elective cholecystectomy in acute cholecystitis. Jpn J Surg 4:384–389
36. Ahmad I (1992) Cholecystectomy in acute cholecystitis. J Pak Med Assoc 42:112–115
37. Lo CM, Liu CL, Fan ST, Lai EC, Wong J (1998) Prospective randomized study of early versus delayed laparoscopic cholecystectomy for acute cholecystitis. Ann Surg 227:461–467
38. Lai PB, Kwong KH, Leung KL, Kwok SP, Chan AC, Chung SC, Lau WY (1998) Randomized trial of early versus delayed laparoscopic cholecystectomy for acute cholecystitis. Br J Surg 85:764–767
39. Chandler CF, Lane JS, Ferguson P, Thompson JE, Ashley SW (2000) Prospective evaluation of early versus delayed laparoscopic cholecystectomy for treatment of acute cholecystitis. Am Surg 66:896–900
40. Johansson M, Thune A, Blomqvist A, Nelvin L, Lundell L (2003) Management of acute cholecystitis in the laparoscopic era: results of a prospective, randomized clinical trial. J Gastrointest Surg 7:642–645
41. Eldar S, Sabo E, Nash E, Abrahamson J, Matter I (1997) Laparoscopic cholecystectomy for acute cholecystitis: prospective trial. World J Surg 21:540–545
42. Bickel A, Rappaport A, Kanievski V, Vaksman I, Haj M, Geron N, Eitan A (1996) Laparoscopic management of acute cholecystitis. Prognostic factors for success. Surg Endosc 10:1045–1049
43. Teixeira JP, Saraiva AC, Cabral AC, Barros H, Reis JR, Teixeira A (2000) Conversion factors in laparoscopic cholecystectomy for acute cholecystitis. Hepatogastroenterology 47:626–630

44. Byrne MF, Suhocki P, Mitchell RM, Pappas TN, Stiffler HL, Jowell PS, Branch MS, Baillie J (2003) Percutaneous cholecystostomy in patients with acute cholecystitis: experience of 45 patients at a US referral center. J Am Coll Surg 197:206–211
45. Beldi G, Glattli A (2003) Laparoscopic subtotal cholecystectomy for severe cholecystitis. Surg Endosc 17:1437–1439
46. Michalowski K, Bornman PC, Krige JE, Gallagher PJ, Terblanche J (1998) Laparoscopic subtotal cholecystectomy in patients with complicated acute cholecystitis or fibrosis. Br J Surg 85:904–906
47. Bornman PC, Terblanche J (1985) Subtotal cholecystectomy: for the difficult gall bladder in portal hypertension and acute cholecystitis. Surgery 98:1–6
48. Stojeba N, Mahoudeau G, Segura P, Meyer C, Steib A (1999) Possible venous argon gas embolism complicating argon gas enhanced coagulation during liver surgery. Acta Anaesthesiol Scand 43:866–867
49. Klaiber C, Metzger A (1995) Manual der laparoskopischen Chirurgie. Huber, Bern
50. Krähenbühl L, Frei E (1996) Five years of laparoscopic cholecystectomy: a reappraisal. In: Büchler MW, Frei E, Klaiber C, Krähenbühl L (eds) Progress in surgery. Karger, Basel, pp 98–102
51. Singer JA, McKeen RV (1994) Laparoscopic cholecystectomy for acute or gangrenous cholecystitis. Am Surg 60:326–328
52. Larson GM, Vitale GC, Casey J, Evans JS, Gilliam G, Heuser L, McGee G, Rao M, Scherm MJ, Voyles CR (1992) Multipractice analysis of laparoscopic cholecystectomy in 1,983 patients. Am J Surg 163:221–226
53. Bailey RW, Zucker KA, Flowers JL, Scovill WA, Graham SM, Imbembo AL (1991) Laparoscopic cholecystectomy. Experience with 375 consecutive patients. Ann Surg 214:531–540 (discussion 540–541)
54. Rattner DW, Ferguson C, Warshaw AL (1993) Factors associated with successful laparoscopic cholecystectomy for acute cholecystitis. Ann Surg 217:233–236
55. Koperna T, Kisser M, Schulz F (1999) Laparoscopic versus open treatment of patients with acute cholecystitis. Hepatogastroenterology 46:753–757
56. Garber SM, Korman J, Cosgrove JM, Cohen JR (1997) Early laparoscopic cholecystectomy for acute cholecystitis. Surg Endosc 11:347–350
57. Russell JC, Walsh SJ, Reed-Fourquet L, Mattie A, Lynch J (1998) Symptomatic cholelithiasis: a different disease in men? Connecticut laparoscopic cholecystectomy registry. Ann Surg 227:195–200
58. Braghetto I, Csendes A, Debandi A, Korn O, Bastias J (1997) Correlation among ultrasonographic and videoscopic findings of the gallbladder: surgical difficulties and reasons for conversion during laparoscopic surgery. Surg Laparosc Endosc 7:310–315
59. Schäfer M, Krähenbühl L, Büchler MW (2001) Predictive factors for the type of surgery in acute cholecystitis. Am J Surg 182:291–297
60. Hashizume M, Sugimachi K (1997) Needle and trocar injury during laparoscopic surgery in Japan. Surg Endosc 11:1198–1201
61. Schäfer M, Lauper M, Krähenbühl L (2001) Trocar and Veress needle injuries during laparoscopy. Surg Endosc 15:275–280
62. Bingener-Casey J, Richards ML, Strodel WE, Schwesinger WH, Sirinek KR (2002) Reasons for conversion from laparoscopic to open cholecystectomy: a 10-year review. J Gastrointest Surg 6:800–805
63. Z'graggen K, Wehrli H, Metzger A, Buehler M, Frei E, Klaiber C (1998) Complications of laparoscopic cholecystectomy in Switzerland. A prospective 3-year study of 10,174 patients. Swiss Association of Laparoscopic and Thoracoscopic Surgery. Surg Endosc 12:1303–1310
64. Sackier JM, Berci G, Phillips E, Carroll B, Shapiro S, Paz-Partlow M (1991) The role of cholangiography in laparoscopic cholecystectomy. Arch Surg 126:1021–1025
65. Soper NJ, Dunnegan DL (1992) Routine versus selective intra-operative cholangiography during laparoscopic cholecystectomy. World J Surg 16:1133–1140
66. Gigot J, Etienne J, Aerts R, Wibin E, Dallemagne B, Deweer F, Fortunati D, Legrand M, Vereecken L, Doumont J, Van Reepinghen P, Beguin C (1997) The dramatic reality of biliary tract injury during laparoscopic cholecystectomy. An anonymous multicenter Belgian survey of 65 patients. Surg Endosc 11:1171–1178
67. Fountain AH, Gotten D, Evans D (1989) The utility of intraoperative cholangiography with acute cholecystitis. Am J Surg 55:392–395
68. Cuschieri A, Lezoche E, Morino M, Croce E, Lacy A, Toouli J, Faggioni A, Ribeiro VM, Jakimowicz J, Visa J, Hanna GB (1999) E.A.E.S. multicenter prospective randomized trial comparing two-stage vs single-stage management of patients with gallstone disease and ductal calculi. Surg Endosc 13:952–957
69. Rhodes M, Sussman L, Cohen L, Lewis MP (1998) Randomised trial of laparoscopic exploration of common bile duct versus postoperative endoscopic retrograde cholangiography for common bile duct stones. Lancet 351:159–161
70. Eldar S, Sabo E, Nash E, Abrahamson J, Matter I (1997) Laparoscopic versus open cholecystectomy in acute cholecystitis. Surg Laparosc Endosc 7:407–414
71. Roslyn JJ, Binns GS, Hughes EF, Saunders-Kirkwood K, Zinner MJ, Cates JA (1993) Open cholecystectomy. A contemporary analysis of 42,474 patients. Ann Surg 218:129–137