ORIGINAL ARTICLE

Surgical management of acute cholecystitis in a nationwide Danish cohort

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Abstract

Purpose In the Danish national guidelines from 2006 on the treatment of acute cholecystitis, early laparoscopic operation within 5 days after the debut of symptoms was recommended. The aim of this study was to analyze the outcome in patients with acute cholecystitis subjected to cholecystectomy in Denmark in the five-year period hereafter.

Methods All patients undergoing cholecystectomy in the period 2006–2010 were registered in the Danish Cholecystectomy Database, from which outcome data were collected. The effect of potential risk factors such as age, gender, BMI, American Society of Anesthesiologists (ASA) score, previous pancreatitis, previous abdominal surgery, year of operation, surgical approach, and surgeon experience was analyzed.

Results Of 33,853 patients registered with a cholecystectomy, 4667 (14%) were operated for acute cholecystitis. In 95% of the patients, laparoscopic cholecystectomy was intended and in 5% primary open access was chosen. The frequency of conversion from laparoscopic to open surgery was 18%. High age and ASA score, operation in the early years of the period, and open or converted procedure all increased the risk of hospital stay to > 3 days or readmission. High age and ASA score, converted or open operation, and previous pancreatitis increased the risk of additional procedures. Postoperative mortality was 1.2%, and significant risk factors for postoperative death were age, low BMI, high ASA score, early year of operation, and open procedures.

Conclusions Acute cholecystectomy was safely managed laparoscopically in most patients after the introduction of national guidelines, with an increasing rate of laparoscopically completed procedures during the study period.

Keywords Acute cholecystitis · Laparoscopy · National guidelines · Postoperative complications · Cholecystectomy

Introduction

Gallstones are common in Western countries with an estimated point prevalence of 10 to 15% [1–3]. In most people, gallstones do not cause symptoms and only 2 to 4% of persons with gallstone experience symptoms within 1 year. Symptoms vary from biliary colic, acute cholecystitis, obstruction of the biliary ducts, or pancreatitis [4]. One of the most common complications of gallstone disease is acute cholecystitis with an incidence of < 1%/year [5].

The primary treatment of symptomatic gallstone disease is surgical removal of the gallbladder. In the 1990s, open cholecystectomy was rapidly replaced by laparoscopic cholecystectomy. It reduced the hospital stay and time of convalescence considerably. In Denmark, nearly half of the patients in 2009 could be treated ambulatory and 74% had a hospital stay of ≤ 1 day without readmission [6]. Initial reports raised concerns about more bile duct injuries, but the rate of bile duct injuries today is not different from similar rates in the pre-laparoscopic era [7, 8].

It has been debated whether the laparoscopic approach could be applied safely also to the patient with acute cholecystitis, and the timing of operation has been another point of debate. A comprehensive review of the literature and a consensus conference within the World Society of Emergency Surgery (WSES) resulted in the 2016 WSES Guidelines on

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This paper is not based on a previous communication to a society or meeting.

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acute cholecystitis, recommending a laparoscopic approach as early as possible after diagnosis and within 10 days [9].

In 2006, the Danish National Board of Health introduced updated guidelines for the treatment of patients with gallstone disease. The guidelines recommended that patients with acute cholecystitis underwent laparoscopic cholecystectomy within 5 days of symptom debut [10].

The aim of this study was to report the national outcome in patients who underwent laparoscopic or open cholecystectomy due to acute cholecystitis between January 1, 2006, and December 31, 2010.

Material and methods

The Danish Cholecystectomy Database (DCD) was started in January 2006 [11] in order to follow the nationwide quality of cholecystectomy and monitor compliance with the guidelines. All patients undergoing cholecystectomy were reported to the database.

In the DCD, clinical data (disease state, preoperative morbidity, and operative details) were registered by the operating surgeon and merged with administrative data (hospital stay, readmission, additional procedures within 30 days, and mortality) from the National Patient Registry (NPR) [12]. Outcome indicators were length of postoperative stay (LOS) 0–1 day, 2–3 days, and > 3 days, with and without readmission, the frequency of additional surgical procedures (including procedures for the treatment of bile duct lesions), and mortality. Validation of the indicators has shown that LOS 0–1 day (without readmission) indicates an uncomplicated course of high quality, whereas LOS > 3 days or readmission were associated with postoperative complications (18%), prolonged recovery after open procedure (21%), or treatment of bile duct stones (19%) [12]. Additional procedures within 30 days also correlated well with the occurrence of a complication, a suspicion of one or a treatment of bile duct stones. In the database, BDI were identified as lesions requiring reconstructive surgery (the severe/major bile duct injuries) or lesions that could be treated without reconstructive surgery, for instance with drainage, ERCP stenting, or primary suturing of side lesions.

In the present study, these outcome indicators were, together with 30-day mortality, used to characterize the postoperative course in patients operated for acute cholecystitis. Acute cholecystitis was identified and registered in the database by the operating surgeon and defined as an acute inflammation of the gall bladder with thickening of the gall bladder wall and/or presence of pus. Potential confounding variables including age, gender, year of operation, surgeons experience, and intraoperative cholangiography were included. In 2010, the DCD was closed due to insufficient funding.

Statistics

Comparisons were performed using χ^2 and Mann-Whitney tests for categorical and continuous variables, respectively. Univariable and multivariable logistic regression models were used to calculate associations between independent and dependent variables. Odds ratios (ORs) of more than 1.00 with 95% confidence intervals (CI) indicted increased likelihood of LOS longer than 3 days or readmission, additional procedures within 30 days, biliary lesions, and 30-day mortality. Variables expressing a p value of < 0.100 in the univariable analyses were included in the multivariable models. All variables were simultaneously included in the multivariable analyses. Missing values were disregarded and thus not replaced. Number and percentage of missing values are provided in Table 1. According to Danish law, no written consent from patients or IRB approval was needed. The study was approved by the Danish National Data Protection Agency.

Results

Between January 1, 2006, and December 31, 2010, 33,853 patients were registered in the DCD. Of these, 4667 patients (13.8%) were operated for acute cholecystitis, had complete data, and were included in the study (Fig. 1). Median age was 55 years (range 13–101 years), and 2738 patients (59%) were women.

Surgical approach

In 228 patients (5%), a primarily open cholecystectomy was planned. Indications for the open approach were acute cholecystitis ($n = 78$), prior abdominal surgery ($n = 24$), simultaneous surgery on the common bile duct ($n = 10$), and other ($n = 100$) including patients with peritonitis and suspicion of appendicitis. In 16 patients, the reasons for primary open procedure were not stated.

In 4439 patients, a laparoscopic procedure was intended, but conversion to open surgery was necessary in 18%. Reasons for conversion were unclear anatomy ($n = 602$), surgical complications ($n = 146$), and others ($n = 105$). Data about this was unavailable for 1 patient. During the study period, the conversion rate decreased from 24.0% in 2006 to 22.6%, 18.4%, 16.2%, and 15.9% in the following years, respectively ($p < 0.001$).

Patient characteristics in relation to surgical approach are shown in Table 1. Risk factors for conversion or primary open operation were high age, male gender, high ASA score, previous abdominal surgery, and early year of operation. A laparoscopic procedure was completed in 816 out of 1015 patients (80.4%) in 2010 compared with 620 of 878 (71%) in 2006.

Table 1 Characteristics of 4667 patients subjected to cholecystectomy for acute cholecystitis

	Laparoscopic completed		Converted from laparoscopic to open		Primary open		p
	n = 3585 (77%)		n = 854 (18%)		n = 228 (5%)		
Age, median (range)	52	(13–97)	62	(19–101)	69	(16–94)	< 0.001[a]
Gender							0.003[b]
Female	2198	(61.3)	428	(50.1)	112	(49.1)	
Male	1387	(38.7)	426	(49.9)	116	(50.9)	
BMI, median (range)	27	(14–65)	28	(16–60)	26	(14–48)	0.001[a]
Missing, n (%)	204	(5.7)	59	(6.9)	27	(11.8)	
ASA score							< 0.001[b]
I	1839	(51.3)	293	(34.3)	29	(12.7)	
II	1506	(42.0)	420	(49.2)	99	(43.4)	
III	230	(6.4)	127	(14.9)	68	(29.8)	
IV	10	(0.3)	13	(1.5)	32	(14.0)	
Missing	0	(0)	1	(0.1)	0	(0)	
Previous pancreatitis	89	(2.5)	18	(2.1)	9	(3.9)	0.285[b]
Previous abdominal surgery	59	(1.6)	30	(3.5)	31	(13.6)	< 0.001[b]
Year of operation							< 0.001[b]
2006 (n, 878)	620	(17.3)	196	(23.0)	62	(27.2)	
2007 (n, 889)	662	(18.5)	193	(22.6)	34	(14.9)	
2008 (n, 934)	731	(20.4)	165	(19.3)	38	(16.7)	
2009 (n, 951)	756	(21.1)	146	(17.1)	49	(21.5)	
2010 (n, 1015)	816	(22.8)	154	(18.0)	45	(19.7)	
Surgeons' experience							0.049[b]
< 50 cholecystectomies	351	(9.8)	60	(7.0)	16	(7.0)	
50–200 cholecystectomies	1151	(32.1)	303	(35.5)	75	(32.9)	
> 200 cholecystectomies	2082	(58.1)	491	(57.5)	137	(60.1)	
Missing	1	(< 0.1)	0	(0)	0	(0)	
Operation used for teaching	774	(21.6)	204	(23.9)	44	(19.3)	0.215[b]
Intraoperative cholangiography n = 564 (12%)	337	(9.5)	178	(21.6)	49	(21.7)	< 0.001[b]

Values are number and (percentages) unless indicated otherwise (for age and BMI)

[a] Kruskal-Wallis

[b] χ^2 test

An overview of the key outcomes in relation to surgical approach is shown in Table 2. About two-thirds (63.7%) of the patients were discharged within 3 days without readmission indicating an entirely uncomplicated course. Additional procedures were performed in 4.4% of the patients. Biliary lesions occurred in 0.7% (major lesions in 0.1%). The 30-day mortality was 1.2% in total and 12.3% in the open group.

Hospital stay

The median duration of hospital stay was 2 days (IQR 1–4 days). A LOS more than 3 days or readmission indicates a not completely smooth course and factors that might predict such a course was investigated. A total of 1712 patients (37%) had a hospital stay beyond 3 days or were readmitted.

Advanced age, high ASA score, primary open surgery, and intraoperative cholangiography were all associated with hospital stays longer than 3 days in the multivariable analysis (Table 3). Operation after the year 2006 was associated with a decreased likelihood of prolonged hospital stay (Table 3).

Additional procedures

Additional procedures were in the postoperative period performed in 205 patients (4.4%) (Fig. 2). About half were ERCP procedures with stone extraction, stent, or sphincterotomy. The multivariate analyses showed that high age and ASA score, converted or primary open operation, and previous pancreatitis increased the likelihood of additional procedures (see Table 4).

Fig. 1 Patient flow chart
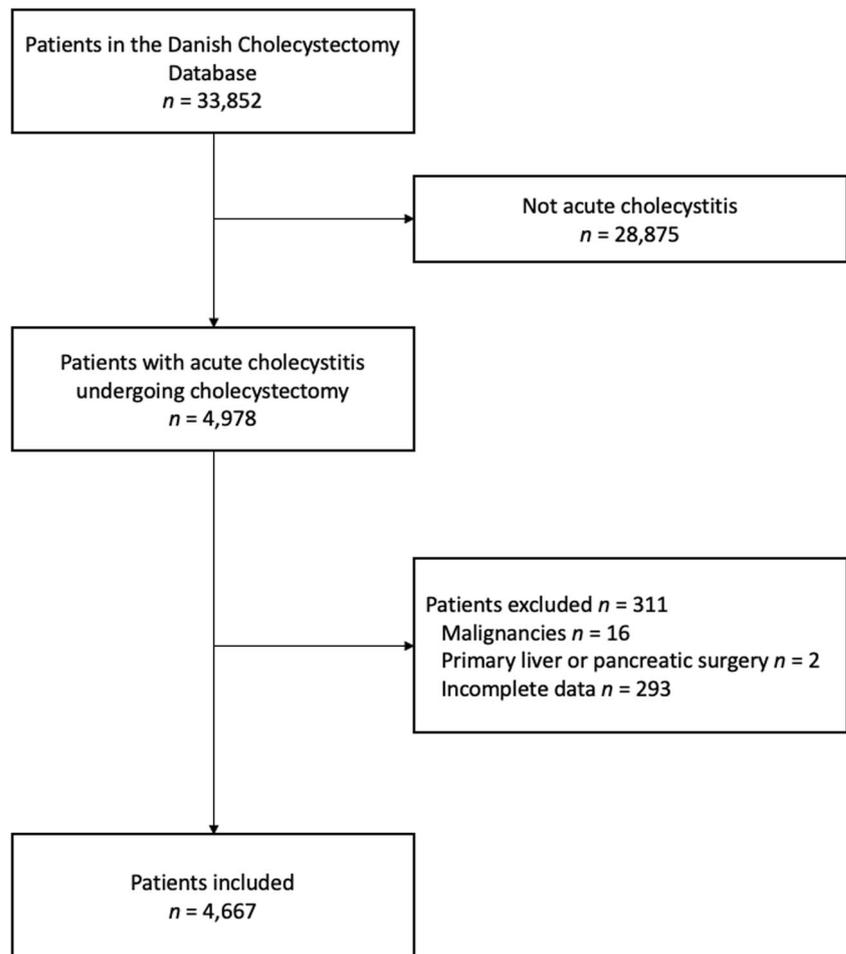
Biliary lesions

The number of intraoperative biliary lesions was 31 (0.7%). However, only five of these were major lesions that required surgical reconstruction. Patients subjected to intraoperative cholangiography or primary open approach had higher rates of biliary lesions (Table 5).

Intraoperative cholangiography

Intraoperative cholangiography was performed in 564 patients (12%). The biliary tree was completely visualized in 502 patients (89%). Only the external bile ducts (common bile- and hepatic) were visualized in 39 (7%) and the common bile duct alone in 22 (4%).

Table 2 Outcome after cholecystectomy for acute cholecystitis

Outcome parameter	Laparoscopic completed $n = 3585$	Converted from laparoscopic to open $n = 854$	Primary open $n = 228$	Total $n = 4667$
LOS ≤ 3 days without readmission	2690 (75.0)	225 (26.3)	40 (17.5)	2955 (63.7)
LOS > 3 days and/or readmission	895 (25.0)	629 (73.7)	188 (82.5)	1712 (36.7)
Additional procedures within 30 days after surgery	95 (2.6)	83 (9.7)	27 (11.8)	205 (4.4)
Biliary lesions	11 (0.3)	16 (1.9)	4 (1.8)	31 (0.7)*
Mortality	15 (0.4)	15 (1.8)	28 (12.3)	58 (1.2)

Values are numbers and percentages (in brackets) *Five lesions (0.1%) were major and required bile duct reconstruction

LOS, length of hospital stay

Table 3 Analyses of factors associated with a length of stay (LOS) > 3 days or readmission after cholecystectomy for acute cholecystitis (n = 1712)

	Univariable				Multivariable		
	n	(%)	OR	95% CI	OR	(95% CI)	p
Age, median (IQR)			1.53[a]	(1.46–1.59)	1.27[a]	(1.20–1.34)	< 0.001
LOS ≤ 3 days, no readmission	50	(39–62)					
LOS > 3 days or readmission	64	(49–74)					
Gender							0.435
Female	933/2738	(34.1)	1.00		1.00		
Male	779/1929	(40.4)	1.31	(1.16–1.48)	1.06	(0.92–1.23)	
BMI, median (IQR)			1.00	(0.99–1.01)	1.01	(0.99–1.03)	0.329
LOS ≤ 3 days, no readmission	27	(24–31)					
LOS > 3 days or readmission	27	(24–31)					
ASA							< 0.001
I	539/2161	(24.9)	1.00		1.00		
II	855/2025	(42.2)	2.20	(1.93–2.51)	1.42	(1.20–1.68)	
III	279/425	(65.6)	5.75	(4.60–7.19)	2.54	(1.92–3.35)	
IV	39/55	(70.9)	7.34	(4.07–13.23)	1.07	(0.50–2.30)	
Year of operation							0.019
2006	389/878	(44.3)	1.00		1.00		
2007	331/889	(37.2)	0.75	(0.62–0.90)	0.86	(0.68–1.08)	
2008	311/934	(33.3)	0.63	(0.52–0.76)	0.72	(0.57–0.91)	
2009	341/951	(35.9)	0.70	(0.58–0.85)	0.82	(0.65–1.03)	
2010	340/1015	(33.5)	0.63	(0.53–0.76)	0.71	(0.56–0.89)	
Surgical approach							< 0.001
Laparoscopic	895/3585	(25.0)	1.00		1.00		
Converted	629/854	(73.7)	8.40	(7.09–9.96)	6.37	(5.29–7.68)	
Open	188/228	(82.5)	14.13	(9.56–20.04)	8.38	(5.62–12.50)	
Previous pancreatitis							0.169
No	1662/4551	(36.5)	1.00		1.00		
Yes	50/116	(43.1)	1.32	(0.91–1.91)	1.37	(0.88–2.14)	
Previous abdominal surgery							0.770
No	1645/4547	(36.2)	1.00		1.00		
Yes	67/120	(55.8)	2.23	(1.55–3.21)	1.07	(0.68–1.70)	
Surgeons' experience							0.250
< 50 operations	135/427	(31.6)	1.00		1.00		
50–200 operations	601/1529	(39.3)	1.40	(1.12–1.76)	1.23	(0.93–1.64)	
> 200 operations	976/2710	(36.0)	1.22	(0.98–1.52)	1.11	(0.85–1.45)	
Operation used for teaching							0.482
No	1343/3645	(36.8)	1.00		1.00		
Yes	369/1022	(36.1)	0.97	(0.84–1.12)	0.94	(0.78–1.12)	
Cholangiography							< 0.001
No	1381/4103	(33.6)	1.00		1.00		
Yes	297/564	(52.7)	2.14	(1.79–2.55)	1.51	(1.22–1.87)	

Values are number and (percentages) unless indicated otherwise (for age and BMI)

The number of patients included in the multivariable model was N = 4300

OR < 1 indicates increased likelihood of LOS ≤ 3 days without readmission, whereas OR > 1 indicates an increased likelihood of LOS > 3 days or readmission

IQR, interquartile ranges; CI, confidence interval; LOS, length of hospital stay
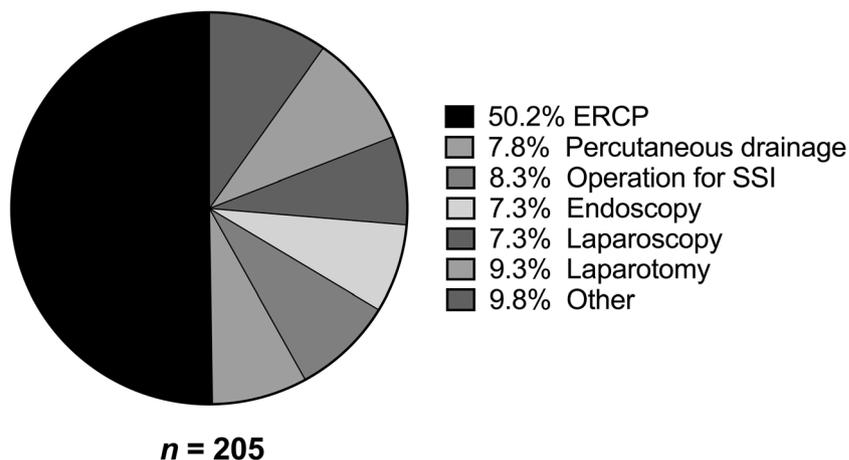
[a] Age per 10 years

The frequency of cholangiography was significantly higher in the open and converted group (21.7% and 21.6%) compared with the laparoscopic group (9.5%) (Table 1).

Mortality

A total of 58 (1.2%) patients died within 30 days postoperatively. Overall, there was a significant difference in the postoperative mortality when comparing laparoscopic and converted and open cholecystectomies ($p < 0.001$). Further, the 30-day mortality was significantly higher after converted compared with laparoscopically completed procedures (1.8% vs. 0.4%, $p < 0.001$). Advanced age, high ASA score, and open surgery were significantly associated with an increased risk of 30-day mortality (Table 5). A lower preoperative BMI was also found in the patients who died postoperatively.

50.2% ERCP
7.8% Percutaneous drainage
8.3% Operation for SSI
7.3% Endoscopy
7.3% Laparoscopy
9.3% Laparotomy
9.8% Other

n = 205

Discussion

In the current nationwide study including procedures on a national scale, it was found that laparoscopic cholecystectomy was performed in 80% of patients undergoing surgery due to acute cholecystitis and further that a laparoscopic compared with open approach was associated with improved postoperative outcomes. The rate of laparoscopically completed cholecystectomies for acute cholecystitis increased throughout the study period from 2006 and onward.

The current study reflects how implementation of nationwide guidelines within a few years can improve the overall outcome of an acute disease. During the study period, the rate of laparoscopically completed cholecystectomies increased, and simultaneously the risk of prolonged length of stay and 30-day mortality decreased, perhaps reflecting the benefits of a laparoscopic approach. The reduced conversion rate during the study period may also reflect an improvement in the laparoscopic skills nationwide, as the rate of biliary complications remained steady throughout the period. In the current study, male gender, high BMI, surgeon inexperience, previous abdominal surgery, comorbidity, and high age were associated with conversion from laparoscopic surgery, which is in accordance with previous studies [8, 13–16]. It has been reported that the most important risk factor for conversion to open cholecystectomy is the Tokyo 2013 cholecystitis grade, which is also an important predictor of postoperative length of stay and postoperative morbidity [17]. Information about the cholecystitis severity was not available from the DCD and thus is a limitation to the current study.

The overall findings of the current study are in accordance with previously published papers on the surgical management of acute cholecystitis. A meta-analysis of randomized trials has thus found laparoscopic compared with open cholecystectomy

to lead to fewer postoperative complications, which was also reflected in the current study in terms of a decreased rate of additional procedures postoperatively [18]. The postoperative LOS found in the current study was lower than that in comparable studies [14, 18]. One reason for prolonged postoperative LOS not examined in the current study may be medical complications, which may also have affected the rate of readmissions. This may be reflected in the confounders high age and ASA score, significantly associated with a prolonged LOS in the multivariable analysis. Increasing age and ASA score were also associated with a significantly higher risk of conversion from laparoscopic to open surgery as well as 30-day mortality. These findings are in accordance with previous studies underlining that caution should be exercised when treating older, comorbid patients with acute cholecystitis [14, 18].

It has previously been reported that conversion from laparoscopic to open cholecystectomy for acute cholecystitis significantly increased the risk of postoperative complications [14]. In the current study, the rate of surgical re-intervention was increased after converted compared with laparoscopic completed procedures, however still on a level comparable with intended open procedures. This finding may indicate that a laparoscopic approach is safe even in patients with anticipated complicated disease, as conversion does not increase the risk of complications. Further, our data showed that converted and primarily open procedures were associated with significantly higher postoperative mortality, which may reflect both severity of the cholecystitis and the increased comorbidity in patients undergoing either converted or primarily open procedures. The high mortality in patients undergoing emergency open cholecystectomy might have been lowered if preoperative risk assessment scores had been utilized, which we however have no data on in the current study [19]. Lastly, interesting results have been published regarding small-incision

Table 4 Analyses of factors associated with additional procedures within 30 days after cholecystectomy for acute cholecystitis (n = 205)

	Univariable				Multivariable		
	n	(%)	OR	95% CI	OR	(95% CI)	p
Age, median (IQR)			1.33	(1.22–1.46)	1.13	(1.01–1.27)	0.036
No additional procedures	54	(41–66)					
Additional procedure	65	(48–75)					
Gender							0.125
Female	119/2738	(4.3)	1.00		1.00		
Male	86/1929	(4.5)	1.03	(0.77–1.36)	0.78	(0.57–1.07)	
BMI, median (IQR)			0.99	(0.97–1.02)	1.00	(0.97–1.03)	0.908
No additional procedures	27	(24–31)					
Additional procedure	27	(24–31)					
ASA							< 0.001
I	58/2161	(2.7)	1.00		1.00		
II	93/2025	(4.6)	1.75	(1.25–2.44)	1.30	(0.88–1.92)	
III	39/425	(9.2)	3.66	(2.41–5.58)	2.06	(1.23–3.45)	
IV	15/55	(27.3)	13.60	(7.11–26.0)	6.20	(2.63–14.59)	
Year of operation							0.154
2006	51/878	(5.8)	1.00		1.00		
2007	46/889	(5.2)	0.86	(0.59–1.33)	1.10	(0.70–1.71)	
2008	34/934	(3.6)	0.61	(0.39–0.96)	0.83	(0.52–1.32)	
2009	40/951	(4.2)	0.71	(0.47–1.09)	0.82	(0.51–1.32)	
2010	34/1015	(3.3)	0.56	(0.36–0.88)	0.60	(0.36–0.98)	
Surgical approach							< 0.001
Laparoscopic	95/3585	(2.6)	1.00		1.00		
Converted	83/854	(9.7)	3.96	(2.92–5.36)	3.05	(2.17–4.30)	
Open	27/228	(11.8)	4.94	(3.15–7.74)	2.36	(1.34–4.18)	
Previous pancreatitis							< 0.001
No	192/4451	(4.2)	1.00		1.00		
Yes	13/116	(11.2)	2.87	(1.58–5.19)	3.73	(1.97–7.06)	
Previous abdominal surgery							0.258
No	200/4547	(4.4)	1.00		1.00		
Yes	5/120	(4.2)	0.95	(0.38–2.34)	0.58	(0.22–1.50)	
Surgeons' experience							0.799
< 50 operations	12/427	(2.8)	1.00		1.00		
50–200 operations	73/1529	(4.8)	1.73	(0.93–3.22)	1.25	(0.65–2.41)	
> 200 operations	120/2710	(4.4)	1.60	(0.88–2.93)	1.23	(0.65–2.30)	
Operation used for teaching							0.329
No	156/3645	(4.3)	1.00		1.00		
Yes	49/1022	(4.8)	1.13	(0.81–1.57)	1.20	(0.83–1.72)	
Cholangiography							< 0.001
No	153/4103	(3.7)	1.00		1.00		
Yes	52/564	(9.2)	2.61	(1.88–3.62)	1.86	(1.29–2.69)	

Values are number and (percentages) unless indicated otherwise (for age and BMI)

The number of patients included in the multivariable model was n = 4300

OR < 1 indicates decreased likelihood of an additional procedure within 30 days, whereas OR > 1 indicates an increased likelihood of an additional procedure

IQR, interquartile ranges; CI, confidence interval

[a] Age per 10 years

cholecystectomy under local anesthesia, which may be a future alternative to avoid the morbidity and mortality associated with emergency open cholecystectomy [20].

The timing of cholecystectomy for acute cholecystitis has been subject to debate [8, 16, 21–23]. A recent meta-analysis of 15 randomized trials comparing early (< 7 days from symptom onset) with delayed (at least 6 weeks after symptom onset) laparoscopic cholecystectomy found no difference in the occurrence of bile duct injury, bile leak, wound infection, or conversion rate [24]. In the current study, no data on the time from symptom onset to cholecystectomy was available; however, since the national Danish guidelines recommended surgery within 5 days, we hypothesize that most, if not all, patients were operated within this interval.

Table 5 Factors associated with biliary lesions ($n = 31$) and mortality ($n = 58$) after operation for acute cholecystitis ($n = 31$)

	Factors associated with biliary lesions			Factors associated with 30-day mortality		
	n	(%)	p	n	(%)	p
Age, median (IQR)			0.235[a]			< 0.001[a]
No biliary lesions	55	(41–67)		54	(41–66)	
Biliary lesions	59	(48–73)		80	(72–86)	
Gender			0.163			0.794
Female	22/2738	(0.8)		35/2738	(1.3)	
Male	9/1929	(0.5)		23/1929	(1.2)	
BMI, median (IQR)			0.442[a]			
No biliary lesions	27	(24–31)		27	(24–31)	< 0.001[a]
Biliary lesions	27	(25–32)		24	(22–27)	
ASA			0.388			< 0.001
I	11/2161	(0.5)		0/2161	(0.0)	
II	15/2025	(0.7)		14/2025	(0.7)	
III	5/425	(1.2)		24/425	(5.6)	
IV	0/55	(0.0)		20/55	(36.4)	
Year of operation			0.734			0.011
2006	4/878	(0.5)		14/878	(1.6)	
2007	6/889	(0.7)		15/889	(1.7)	
2008	8/934	(0.9)		6/934	(0.6)	
2009	8/951	(0.8)		18/951	(1.9)	
2010	5/1015	(0.5)		5/1015	(0.5)	
Surgical approach			< 0.001			< 0.001
Laparoscopic	11/3585	(0.3)		15/3585	(0.4)	
Converted	16/854	(1.9)		15/854	(1.8)	
Open	4/228	(1.8)		28/228	(12.3)	
Previous pancreatitis			0.372			0.221
No	31/4551	(0.7)		58/4551	(1.3)	
Yes	0/116	(0.0)		0/116	(0.0)	
Previous abdominal surgery			0.817			0.682
No	30/4547	(0.7)		57/4547	(1.3)	
Yes	1/120	(0.8)		1/120	(0.8)	
Surgeons' experience			0.546			0.540
< 50 operations	2/427	(0.5)		3/427	(0.7)	
50–200 operations	8/1529	(0.5)		21/1529	(1.4)	
> 200 operations	21/2710	(0.8)		34/2710	(1.3)	
Operation used for teaching			0.162			0.587
No	21/3645	(0.6)		47/3645	(1.3)	
Yes	10/1022	(1.0)		11/1022	(1.1)	
Cholangiography			< 0.001			0.719
No	18/4103	(0.4)		52/4103	(1.2)	
Yes	13/564	(2.3)		6/564	(1.1)	

Of the 31 biliary lesions, only 5 were major and required surgical reconstruction

Values are number and (percentages) unless indicated otherwise (for age and BMI)

All analyses are chi-square except [a] Mann-Whitney tests

IQR, interquartile ranges

The current study is limited by the lack of data about complications managed without surgical intervention, as well as the lack of data about the length of symptoms of acute cholecystitis prior to cholecystectomy.

Conclusion

Acute cholecystectomy was safely managed laparoscopically in most patients after the introduction of national guidelines, with an increasing rate of laparoscopically completed procedures during the study period. Nevertheless, primary open cholecystectomy for acute cholecystitis was associated with high postoperative mortality.

Compliance with ethical standards

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent Based on national Danish law, informed consent was not needed from participants included in the study.

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