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ORIGINAL ARTICLE

Open Cholecystectomy Has a Place in the Laparoscopic Era: a Retrospective Cohort Study

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Abstract Laparoscopic cholecystectomy (LC) is considered the gold standard for treatment of symptomatic gallbladder stones and has replaced the traditional open cholecystectomy (OC). The aim of this study is to evaluate the proper indications of the primary OC and conversion from LC and their predictive factors. This study includes all patients who underwent cholecystectomy between January 2011 and June 2016, whether open from the start (group A), conversion from laparoscopic approach (group B), or laparoscopic cholecystectomy (group C). There were 3269 patients underwent cholecystectomy. LC was completed in 3117 (95.4%) patients. The overall conversion rate was 83 (2.5%). The main two causes of conversion were adhesion in 35 (42.2%) patients and unclear anatomy in 29 (34.9%) patients. Primary OC was indicated in 69 (2.1%) patients due to previous history of upper abdominal operations in 16 (23.2%) patients and anesthetic problem in 21 (30.4%) patients. Age >60 years, male sex, diabetic patients, history of endoscopic retrograde cholangiopancreatography, dilated common bile duct, gallbladder status, adhesion, and previous upper abdominal operation were demonstrated to be independent risk factors for OC. Open cholecystectomy still has a place in the era of laparoscopy. Conversion should not be a complication, but it represents a valuable choice to avoid an additional risk. Safe OC required training because of the causes of conversion, usually unsafe anatomy, occurrence of complications, or anesthetic problems, in order to prevent disastrous complications.

Keywords Gallbladder stone · Open cholecystectomy · ERCP · Laparoscopic cholecystectomy

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Introduction

Gall stone disease is a common health problem. The management of symptomatic gall stone disease was improved by the introduction of laparoscopic cholecystectomy (LC) [1]. Nowadays, LC is considered the gold standard for treatment of symptomatic gallbladder stones and has replaced the traditional open cholecystectomy (OC) [2, 3]. The laparoscopic technique has many advantages over the open approach such as decrease in postoperative pain, reduction of postoperative complications, shorter hospitalization with earlier mobility and return to normal work activity, and better cosmotic results. The duration of LC has continuously decreased as a result of increasing the learning curve of surgeons [4].

In spite of these advantages, open cholecystectomy still has a place in the laparoscopic surgery [5, 6]. Open cholecystectomy is principally preserved for the challenging cases in which laparoscopy fails [5]. Most open cholecystectomies are performed as a result of conversion from laparoscopic cholecystectomies [7]. Conversion rates for laparoscopic cholecystectomy vary widely, with a reported range of 2 to 15% in previous series, mostly due to bleeding and unclear anatomy [5, 8, 9]. Conversion should not be a complication, but it represents a valuable choice to avoid an additional risk [10]. Risk factors of conversion to open cholecystectomy included old age, male sex, obesity, acute cholecystitis, previous upper abdominal surgery, the presence of diabetes and high glycosylated hemoglobin levels, and a less experienced surgeon [11].

Open cholecystectomy is still indicated from the start in selected cases without any laparoscopic trials. Some indications for open operation include suspected or confirmed gallbladder cancer preoperatively or intraoperatively anticipating the possibility of a portal lymph node dissection, as well as an en bloc resection of the gallbladder, a portion of the liver, and perhaps a segment of the bile duct [12–15]. The older patients with comorbidities are more susceptible for OC from the start. [16]. In patients with bleeding disorders and portal hypertension, potential bleeding may be difficult to control laparoscopically, and an open approach may be mandatory [14].

Although laparoscopic cholecystectomy has been proven to be safe in all trimesters of pregnancy, an open operation should be considered, especially in the third trimester, since laparoscopic port placement and insufflation may be difficult. Consequently, OC is generally necessary during the late stages of pregnancy, if the operation cannot be delayed until after delivery of the baby [15]. An open operation is also necessary in type II Mirizzi syndrome (cholecystobiliary fistula) and gallstone ileus [16].

Few studies in the literature have reported the role of open cholecystectomy in the management of gallbladder stones in the laparoscopic era. So, the aim of this retrospective study is to evaluate the proper indications of the primary open cholecystectomy and conversion from laparoscopic cholecystectomy and their predictive factors for treatment of gallbladder stones in large-volume tertiary referral centers.

Patients and Method

Study Design

This is a retrospective study of patients who underwent cholecystectomy for gallbladder stones between January 2011 and June 2016 in the Gastroenterology Surgical Center (GEC), Mansoura University.

This study includes all patients who underwent cholecystectomy whether open from the start, conversion from laparoscopic approach, or laparoscopic cholecystectomy. In all patients, cholecystectomy was done for gallbladder stones. Patients who underwent cholecystectomy for any other indications are excluded. Patients who underwent common bile duct (CBD) exploration for CBD stones are not included in this study.

The patients will be divided into three groups: group A, open cholecystectomy from the start; group B, conversion from the laparoscopic approach; and group C, laparoscopic cholecystectomy.

Data Collection

Data for this study will be retrieved from the internal web-based registry system supplemented by medical records of the patients included in the medical archive of the Gastroenterology Surgical Center, Mansoura University.

Preoperative Data Included

Demographic data of the patients include age, gender, BMI, associated comorbidities, and previous abdominal surgery. Clinical history suggestive for acute cholecystitis, jaundice, and classic biliary colic is included, as well as history of endoscopic retrograde cholangiopancreatography (ERCP) with or without stone extraction, papillotomy, and stent placement. Preoperative laboratory investigations include complete blood picture, liver function tests, serum creatinine, and random blood sugar. Radiological investigations include abdominal ultrasonography for detection of gallbladder pathology, number of stones whether multiple or single or whether impacted in the Hartmann's pouch or not, presence of pericholecystic fluid, dilatation of common bile duct (CBD), and evidence of pancreatitis.

Operative Data Included

The procedure whether laparoscopic, conversion to open, or open surgery from the start; indications; intraoperative findings which include liver status; gallbladder pathology; any dilatation in CBD and degree of adhesions; intraoperative cholangiogram and its findings; operative time; and blood loss are included.

Postoperative Data Included

Postoperative data included the day of start of oral intake, hospital stay, any postoperative mortality and postoperative complications such as bile leak, collection, internal hemorrhage, chest infection, and wound complications as infection and incisional hernia, and their management.

The primary outcome is the incidence and indications of primary open cholecystectomy. The secondary outcomes are rate and predictive factors of conversion from the laparoscopic approach as well as comparison between the open, conversion, and laparoscopic approaches as regard operative time, blood loss, and postoperative complications.

Data Analysis

All statistical analyses will be performed using IBM SPSS v.20 software. A P value of less than 0.5 will be considered statistically significant. The Shapiro-Wilk test is used to assess normality of data. Numerical data are presented as means and standard deviations or as medians with ranges. Chi-square test and Mann-Whitney U test are used when appropriate.

Variables suspected to be a risk factor for open approach from the start or conversion from the laparoscopic approach will be analyzed by univariate analysis using the Mann-Whitney and χ^2 tests. Variables with statistical significance at a level of $P < .05$ on univariate analysis will be subjected to stepwise logistic regression analysis to identify the independent predictors of open approach from the start or conversion from laparoscopic approach in the three groups.

Results

Patient Characteristics

This retrospective study will include 3269 patients who underwent cholecystectomy between January 2011 and June 2016 in Mansoura Gastroenterology Surgical Center (GEC). Patients' characteristics are shown in Table 1. Patients in group A were older and more commonly had undergone a previous history of abdominal operations. Patients in group C were younger and rarely had undergone a previous history of abdominal operations.

The overall conversion rate was 83 (2.5%). The causes of conversion were listed in Table 2; the main two causes were adhesion in 35 (42.2%) patients and unclear anatomy in 29 (34.9%) patients. Primary open cholecystectomy was indicated in 69 (2.1%) patients due to previous history of upper abdominal operations in 16 (23.2%) patients and anesthetic problem in 21 (30.4%) patients as shown in Table 2.

Operative Data

Liver cirrhosis was significantly noticed more in group A than in the other two groups. Adhesion was significantly less in group C than in group A and group B. Lateral bile duct injury occurred in 10 (0.32%) cases in group C (8 cases managed by laparoscope and 2 cases required conversion to open). Operative time is significantly longer in group A and group B (Table 3).

Postoperative Data

The overall complications rates were 12.9, 12, and 1.05% for groups A, B, and C, respectively. Biliary complications were noticed in group C in 12 (0.4%) patients in the form of bile leakage. The source of bile was cystic duct stump in 7 cases (4 cases managed conservatively and 3 cases required ERCP and stent application), accessory duct in 3 cases managed by ERCP and stent, and the last 2 cases from CBD (lateral injury) which need surgical management. The hospital stay was significantly less in group C compared with groups A and B (Table 4).

Predictors for Open Cholecystectomy

Univariate analysis demonstrated 11 factors to be significantly associated with conversion cholecystectomy or primary OC (age >60 years, male sex, cirrhotic liver status, diabetic patient, hypertensive patients, cardiac patients, history of ERCP, previous upper abdominal surgery, adhesion, gallbladder status, dilated CBD). These 11 risk factors of OC identified in univariate analysis were further analyzed in multivariate analysis. Age >60 years, male sex, diabetic patients, history of ERCP, dilated CBD, gallbladder status, adhesion, and abdominal operation were demonstrated to be independent risk factors (Table 5).

Discussion

Laparoscopic cholecystectomy is considered the method of choice for treatment of gall stone disease and has replaced the traditional OC [2, 3]. LC has many advantages over OC (primary open or converted laparoscopic) such as decrease in postoperative pain, reduction of postoperative morbidities,

Table 1 Patient characteristics

Characteristics	Group A (open) 69 (2.1%)	Group B (conversion) 83 (2.5%)	Group C (laparoscopic) 3117 (95.4%)	*P* value
Age	53	54	37	0.001
Age group				
<60 years	53 (76.8%)	55 (66.3%)	2967 (95.2%)	0.01
≥60	16 (23.2%)	28 (33.7%)	150 (4.8%)	
Gender				
Male	41 (59.4%)	47 (56.6%)	845 (27.1%)	0.05
Female	28 (40.6%)	36 (43.4%)	2272 (72.9)	
BMI	30	29.2	29.2	0.49
Comorbidities:				
HTN	13 (18.8%)	25 (30.1%)	532 (17.1%)	0.03
DM	13 (18.8%)	21 (25.3%)	287 (9.2%)	0.01
Cardiac	4 (5.8%)	6 (7.2%)	63 (2%)	0.02
Chest	3 (4.3%)	2 (2.4%	63 (2%)	0.39
History of abdominal surgery	32 (46.4%)	25 (30.1%)	467 (15%)	0.02
ERCP	13 (18.8%)	14 (16.9%)	95 (3%)	0.03
Lab				
WBC	10.8	7	6.7	0.05
BIL	0.9	0.7	0.6	0.57
SGPT	24	25	21	0.2
ALP	4	4.1	4.3	0.5
Cr	0.7	0.8	0.6	0.6

shorter postoperative hospital stay with earlier return to normal work activity, less operative time, and better cosmetic results [4, 17–20].

Table 2 Indication of open cholecystectomy

1. Causes of conversion 83 (2.5%) cases	Frequency (%)
Anesthesia	3 (3.6%)
Dense adhesions	35 (42.2%)
Bleeding	6 (7.2%)
CBD injury	2 (2.4%)
Unclear anatomy at Calot	29 (34.9%)
?? cholecystoduodenal fistula	2 (2.4%)
Anesthesia	1 (1.2%)
GB mass	2 (2.4%)
Failed insertion of trocar	1 (1.2%)
Contracted GB	2 (2.4%)
Total	83 (2.5%)
2. Causes of open cholecystectomy from the start 69 (2.1%) cases	
Previous upper abdominal surgery	25 (36.2%)
Liver cirrhosis	15 (21.7%)
Anesthetic problem	16 (23.2%)
Mirizzi gallbladder	8 (11.5%)
Gallbladder mass	5 (7.2%)
Total	69 (2.1%)

After introduction of LC, an increased cholecystectomy rate was seen in many countries. Nowadays, it is accepted that LC is the gold standard operation for uncomplicated gallbladder disease and early acute cholecystitis, whereas OC is reserved for most complex cases, usually in emergency for acute cholecystitis, associated comorbidities, and previous upper abdominal operations [20–23]. Open cholecystectomy (primary open or converted laparoscopic) has a place in the era of laparoscopy. Conversion is mainly due to safety when the surgeon cannot find clear anatomy in the region of Calot's triangle or when facing complications that cannot be managed laparoscopically such as major bile duct injuries or severe uncontrollable bleeding. Equipment difficulties, technical errors, or anesthetic problems are also possible causes [10–14].

In recent studies, the overall conversion rate was 2.5–7.7% [10, 19–22]. In our center, the conversion rate decreases from 5.3% in the previous study to 2.8% in the current study. A possible explanation for this is the tendency of young surgeons to spend more time and not covert because they are more adapt with LC than OC with improvement in equipments [10]. Conversion is not a complication per se, but it may prevent disastrous events such as major bile duct injuries. Different risk factors and predictors for conversion were discussed in many reports including male gender, age above 60 years, history of upper abdominal operation, and acute cholecystitis [10, 19–22].

Table 3 Operative data

	Group A (open) 69 (2.1%)	Group B (conversion) 83 (2.5%)	Group C (laparoscopic) 3117 (95.4%)	*P* value
Liver cirrhosis	15 (21.7%)	11 (13.3%)	265 (8.5%)	0.03
GB				
1. Normal	1 (1.4%)	3 (3.6%)	109 (3.5%)	
2. Thick walled	47 (68.1%)	68 (81.9%)	2787 (89.4%)	0.01
3. Acute cholecystitis	6 (8.7%)	3 (3.6%)	12 (0.4%)	
4. Obstructed	4 (5.8%)	5 (6%)	116 (3.7%)	
5. Mirizzi	8 (11.5%)	0	3 (0.1%)	
6. contracted	3 (4.3%)	4 (4.8%)	90 (2.9%)	
Multiple GB stones	51 (73.9%)	63 (75.9%)	2613 (83.8%)	0.14
Dilated CBD	13 (18.8%)	3 (3.6%)	86 (2.8%)	0.04
Cholangiogram				
1. Not done	51 (73.9%)	64 (77.1%)	3033 (97.3%)	
2. Free	15 (21.7%)	15 (18.1%)	62 (2%)	
3. Stones	0	3 (3.6%)	10 (0.3%)	0.01
4. Dilated CBD	2 (2.9%)	1 (1.2%)	12 (0.4%)	
5. Cystic duct stones	1 (1.4%)	0	0	
Adhesion				
1. No	21 (30.4%)	8 (9.6%)	1498 (44.3%)	0.04
2. Mild	22 (31.9%)	14 (16.9%)	1256 (40.3%)	
3. Massive	26 (37.7%)	61 (73.5%)	442 (14.1%)	
Blood loss (ml)	100	100	20	0.02
Blood transfusion	0	0	0	0.91
Operative time	90	90	60	0.03

The decline in the incidence of OC will continue as laparoscopic experience increases and equipments improved. However, conversion or primary OC is still inevitable. Primary OC is indicated from the start due to anesthetic causes, previous upper abdominal operations, cirrhotic liver, Mirizzi gallbladder, and gallbladder mass. OC was difficult in patients who underwent either converted or primary open laparoscopy in certain situations (Mirizzi GB, anesthetic problems, cirrhosis) [20–23]. Patients who underwent OC usually have several comorbidities and who are elderly, urgent, and severely ill whereas patients who underwent LC are healthier and younger and operations are usually elective. Therefore, the differences in these patient characters make the comparison between them unjustified [22, 23].

Current young surgeons are adept at LC but rarely perform or see OC. All junior surgeons should know when conversion is required and how to do an OC safely. This should be an important part of laparoscopic courses and a responsibility of senior staff. The young surgeons tend to try harder into managing complications laparoscopically instead of converting to OC. Laparoscopic surgeons should be familiar with open surgery [11, 22].

Table 4 Postoperative outcome

	Group A (open) 69 (2.1%)	Group B (conversion) 83 (2.5%)	Group C (laparoscopic) 3117 (95.4%)	*P* value
Complications				
1. Bile leak	1 (1.4%)	1 (1.2%)	12 (0.4%)	0.21
2. Internal hemorrhage	0	2 (2.4%)	2 (0.1%)	0.01
3. Collection	6 (8.7%)	3 (3.6%)	15 (0.5%)	0.02
4. Wound infection	4 (5.8%)	2 (2.4%)	1 (0.05%)	0.05
5. Chest infection	0	1 (1.2%)	0	0.08
6. Incisional hernia	1 (1.4%)	0	3 (0.1%)	0.06
Hospital stay	3	3	1	0.01

Table 5 Predictors of open and conversion cholecystectomy

Coefficients[a]							
Model	Unstandardized coefficients		Standardized coefficients	*t*	Sig.	95.0% Confidence interval for B	
	B	Std. error	Beta			Lower bound	Upper bound
(Constant)	3.338	.059		56.881	.000	3.223	3.453
Age	−.003	.000	−.100	5.580	.000	−.004	−.002
Age group	−.141	.025	−.103	5.709	.000	−.189	−.092
Gender	.091	.012	.126	7.607	.000	.067	.114
DM	−.077	.020	−.070	3.844	.000	−.116	−.037
Hypertension	.024	.016	.028	1.520	.129	−.007	.055
Cardiac	−.071	.036	−.032	1.942	.052	−.142	.001
Chest	.000	.038	.000	−.024	.981	−.075	.073
ERCP	−.129	.030	−.075	4.243	.000	−.188	−.069
Liver status	−.002	.017	−.002	−.138	.890	−.035	.030
GB status	−.033	.007	−.077	4.593	.000	−.047	−.019
CBD	−.201	.045	−.078	4.497	.000	−.289	−.113
Adhesion	−.044	.007	−.100	5.865	.000	−.059	−.029
Previous abdominal surgery	−.105	.015	−.119	7.121	.000	−.134	−.076

[a] Dependent variable: group

After the introduction of LC, the bile duct injuries (BDIs) have increased the incidence and severity. Recent studies have reported that the incidence of BDI has risen from 0.1 to 0.2% in the era of OC from 0.4 to 0.7% in the era of LC [23–26]. Karvonen [23] found that all BDIs in OC were from cystic duct stamp leak whereas more than half of laparoscopic BDIs were major BDIs. BDI is the most serious complication during cholecystectomy which has a significant impact on long-term survival and quality of life and is associated with high rates of subsequent litigation. It has a significant economic impact as the management of a postcholecystectomy bile duct injury costs 4.5 to 26 times the cost of a cholecystectomy [23–26].

There is a reverse relationship between the prevalence of BDI and number of cases performed. However, 30% BDIs still happen when the surgeon has done more than 200 LC procedures. The learning curve does not prevent or decrease the incidence of bile duct injury. The management of a BDI depends on the type of injury and time of diagnosis and possible associated vascular injuries. Only 30% of BDIs are recognized at the time of operation. Detection of bile duct injury during cholecystectomy depends on escape of bile or an abnormal cholangiogram [24–27]. Prevention of BDI can be achieved by identification of clear anatomy, demonstration of Critical View of Safety (CVS) of Strasberg, subtotal cholecystectomy, and conversion at proper time [25–27].

In this study, biliary complications were noticed after LC in 12 (0.4%) patients in the form of bile leakage. The source of bile was cystic duct stump in 7 cases, accessory duct in 3 cases, and the last 2 cases from CBD (lateral injury).

Our results indicate a decline in resident experience with open biliary procedure with increase in laparoscopy. Different studies reported the same finding [28–30].

OC in the era of laparoscopy is difficult and needs experience to carry it out. OC either converting from LC or primary required training because of the causes of conversion, usually unsafe anatomy, occurrence of complications, or anesthetic problems, which need rapid decisions and proper management to prevent disastrous complications. Attention should be focused on prevention and early recognition of BDI, and laparoscopic surgeons should be familiar with open biliary surgery [28–30].

This study has several limitations. First, it is a retrospective study but patient data were recorded in a prospectively maintained database for all patients undergoing cholecystectomy since 2000 in our center. Secondly, the sample size, especially for OC and converted cases, is small. Nevertheless, this is a large series for cholecystectomy in one center and the results are still valuable for evidence.

Conclusion

Open cholecystectomy still has a place in the era of laparoscopy. Conversion should not be a complication, but it represents a valuable choice to avoid an additional risk. Risk factors of conversion to open cholecystectomy included old age, male sex,

obesity, acute cholecystitis, previous upper abdominal surgery, and a less experienced surgeon. Open cholecystectomy is still indicated from the start in selected cases without any laparoscopic trials. Safe OC required training because of the causes of conversion, usually unsafe anatomy, occurrence of complications, or anesthetic problems, which need rapid decisions and proper management to prevent disastrous complications.

Author Contributions Ayman El Nakeeb designed the research.

Ayman El Nakeeb, Youssef Mahdy, Aly Salem, Mohamed El Sorogy, Ahmed abd El Rafea, Mohamed El Dosoky, Rami Said, Mohamed Abd Ellatif, and Mohamed M.A. Alsayed performed the research.

Ayman El Nakeeb and Mohamed El Sorogy analyzed the data.

Ayman El Nakeeb and Ahmed abd El Rafea wrote the paper.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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