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Endoscopic versus laparoscopic treatment for choledocholithiasis: a prospective randomized controlled trial

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Background and study aims: Overall, 5 % to 15 % of patients undergoing cholecystectomy for cholelithiasis have concomitant bile duct stones, and the incidence of choledocholithiasis increases with age. There is no clear consensus on the best therapeutic approach (endoscopic versus surgical).
Patients and methods: A prospective randomized controlled clinical trial was performed to compare three treatment options for patients with choledocholithiasis at the National Center for Minimally Invasive Surgery in Havana, Cuba from November 2007 to November 2011. The patients were randomized in three groups. Group I: patients who underwent intraoperative cholangiography (IOC) to confirm the choledocholithiasis followed by laparoscopic cholecystectomy (LC) associated with intraoperative endoscopic retrograde cholangiopancreatography (ERCP), group II: patients who underwent preoperative ERCP followed by LC during the same hospital admission and group III: patients who underwent IOC to confirm the choledocholithiasis followed by LC associated with laparoscopic common bile duct exploration (LCBDE).
Results: A total of 300 patients with suspected choledocholithiasis were included in the trial and were randomized. As a result, a total of 134 patients were diagnosed with the presence of choledocholithiasis and treated during the study period. There were no significant differences in success rates of ductal stone clearance, but retained stone, postoperative complications and length of hospital stay were better in group I.
Conclusions: Intraoperative ERCP/ES shows a higher rate of common bile duct stones clearance, a shorter hospital stay, and lower morbidity, but further research with a larger study population is necessary to determine the additional benefits of this procedure. The results to date suggests that in appropriate patients, single-stage treatments are the best options.

Introduction

Overall, 5 % to 15 % of patients undergoing cholecystectomy for cholelithiasis have concomitant bile duct stones, and a small percentage of patients will develop common duct stones after cholecystectomy.[1] Incidence of choledocholithiasis increases with age. About 20 % to 25 % of patients older than age 60 with symptomatic gallstones have stones in the common bile duct and in the gallbladder [1, 2].
Thus, bile duct stones and their management constitute an important clinical problem. The primary goal in management of choledocholithiasis is to obtain complete clearance of the common duct and cholecystectomy, when indicated [1, 2].
Options for management of common bile duct stones (CBDS) are increasing with development of new technologies for diagnosis and treatment. Management of symptomatic or incidentally discovered choledocholithiasis is still controversial. There is no clear consensus on the best therapeutic approach (endoscopic versus surgical) [3 – 7].
Preoperative endoscopic retrograde cholangiopancreatography (ERCP) and endoscopic sphincterotomy (ES) are safe and effective options for removing CBDS in most cases, but even when clinical, biochemical, and ultrasound criteria are used, only 10 % to 60 % of patients will have stones on ERCP. As a result, far too many unnecessary ERCP are being performed [8]. In fact, one of the best preventive measures to reduce ERCP complications is not to perform it if it is unnecessary.
Laparoscopic surgery of CBDS was introduced over 15 years ago and various surgical groups have shown that it has a high success rate [9, 10] and is just as efficient and safe as preoperative or postoperative ERCP associated with laparoscopic cholecystectomy (LC), thereby avoiding the need to perform additional procedures [11]. Neverthe-

less, its technical difficulties, long and difficult learning curve and the need for the allocation of technical resources (high-quality fluoroscopy and choledochoscopes), which are not available at many operating theaters, has curtailed its expansion [10].

Use of intraoperative ERCP has slowly increased among various endoscopic groups, because the transition of ERCP from the endoscopy unit to the operating room has a short learning curve (endoscopic groups with expertise in preoperative and postoperative ERCP) without the high technical requirements needed by laparoscopic management of the bile duct [12 – 14].

The aim of this prospective, randomized controlled trial was to compare the efficacy, safety, and surgical outcomes of the intraoperative ERCP plus LC (ERCP + LC), preoperative ERCP + LC and laparoscopic common bile duct exploration (LCBDE) plus LC (LCBDE + LC), and determine the most appropriate approach for patients with choledocholithiasis.

Patients and methods

A prospective, randomized controlled clinical trial was performed to compare 3 treatment options for patients with choledocholithiasis. The study was conducted at the National Center for Minimally Invasive Surgery, Havana, Cuba. This is a tertiary referral university-affiliated center specializing in endoscopic and laparoscopic surgery (Multidisciplinary work group). All the procedures were performed by the 5 authors who are very experienced in both ERCP and laparoscopy. Surgical and endoscopic techniques were standardized before starting the protocol; 2 experienced biliary endoscopists (J. R. T, R. B. Q) performed all ERCP in both groups of patients, while 3 experienced laparoscopic surgeons (J. E. B. G, R. T. P, M. A. M. A) performed LC and LCBDE. The protocol for anesthesia was the same in all patients.

Informed consent was obtained from patients before study participation. The study was approved by our Institution Ethical Committee and by The Cuban Public Registry of Clinical Trials (Unique ID number: RPCEC00000013). The trial was perfomed in compliance with the Helsinki Declaration and ICH-GCP (efficacy section).

The sample size calculation is as follows: With 3 groups and a binary endpoint (success-failure), we constructed a 3 × 2 contingency table. We used the Grizzle, Starmer, and Koch method [15]. The hypotheses tested were:

$$\begin{cases} H_0 : \pi_1 = \pi_2 = \pi_3 \\ H_1 : \pi_1 \neq \pi_2 \text{ ó } \pi_1 \neq \pi_3 \end{cases}$$

Here π_1, π_2, π_3 are the expected success rates in each population group. We employed information from Rochon's paper [16], that is, p' = [π1 (1-π1) π2 (1-π2) π3 (1-π3)] outcomes vector); φ'(p) = [π1 π2 π3] (subset of measures of interest); *X* = Identity matrix of order 3 (design matrix);

C = $\begin{pmatrix} 1 & -1 & 0 \\ 1 & 0 & -1 \end{pmatrix}$; h = 0. Substitution produced the following formula:

$$n = \lambda_0 \frac{\pi_1(1-\pi_1)\pi_2(1-\pi_2)+\pi_1(1-\pi_1)\pi_3(1-\pi_3)+\pi_2(1-\pi_2)\pi_3(1-\pi_3)}{\pi_1(1-\pi_1)(\pi_2-\pi_3)^2+\pi_2(1-\pi_2)(\pi_1-\pi_3)^2+\pi_3(1-\pi_3)(\pi_1-\pi_2)^2}$$

where λ_0 is the non-centrality parameter of the non-central χ^2_{2,λ_0} that satisfies the area lying to the right of the critical point $\chi^2_{2;1-\alpha}$ is the desired power 1-β for the design, and where $\chi^2_{2;1-\alpha}$ represents the 1-α percentil of the central χ^2 with 2 degrees of freedom (the number of degrees of freedom is the number of rows of the matrix C; α is the significance level of the test); *n* represents the sample size in each of the three treatment groups.

We chose the values: $\alpha = 0.05$, $\beta = 0.2$, $\pi_1 = 0.85$, $\pi_2 = 0.8$, $\pi_3 = 0.94$. We get $\lambda_0 = 9.635$, n = 90. Assuming a possible 10 % of missing data due to protocol violations, we concluded that we should include 100 patients per group, for a total of 300 patients.

The primary endpoint was the rate of success in clearing ductal stones.

From November 2007 to November 2011, 404 patients with suspected CBDS admitted to the hospital were evaluated prospectively for study eligibility. The intake was restricted to appropriate patients [American Society of Anesthesiologists (ASA) I, II and III] in whom choledocholithiasis was suspected on the basis of clinical features (biliary colic with jaundice and recent acute pancreatitis), liver function tests (elevated bilirubin, alkaline phosphatase, gamma-glutamyltranspeptidase), and external ultrasound findings (showing possible CBDS or a dilated common bile duct > 8 mm).

Further exclusion criteria included cholangitis or pancreatitis, age < 18 years, ASA IV and V, suspected common bile duct (CBD) malignancy, previous cholecystectomy, previous ERCP and/or ES, and contraindications to ERCP or laparoscopic surgery. Moreover, patients treated with total or partial gastric resection were excluded.

After obtaining consent, eligible patients were randomized in 3 treatment groups using computer-generated random number sequences in concealed envelopes with block randomization design.

Group I patients underwent intraoperative cholangiography (IOC) to confirm choledocholithiasis followed by LC associated with intraoperative ERCP, ES and endoscopic stone extraction (ESE). All patients were placed in the usual supine position for LC. LC with IOC was always attempted and images were obtained during this step. ERCP and ES were performed during LC. The surgeon carried out LC without completely dissecting the gallbladder from its bed. This maneuver facilitated ending LC after ERCP, because bowel distention during this procedure limits gallbladder dissection. Besides, in case of ERCP failure, traction of the vesicular bottom facilitated CBD visualization.

We performed a "rendezvous" technique only in those patients, in which endoscopic cannulation of the papilla was difficult (when the papilla is hidden within a diverticulum). We used a guided wire through the cystic duct into the CBD to facilitate bile duct cannulation at subsequent endoscopy.

Group II patients underwent preoperative ERCP, ES with ESE followed by LC (24 to 48 hours later). All patients were placed in prone position.

Group III underwent IOC to confirm the choledocholithiasis followed by LC associated with LCBDE and laparoscopic stone extraction. We performed LCBDE via transcystic, choledochotomy and a few patients underwent flexible choledochoscopy. First, we performed transcystic common bile duct exploration but if a patient had an analomous anatomy, proximal stones and large or numerous stones, we used choledochotomy for common bile duct exploration. LCBDE via choledochotomy required placement of a T-tube and drain.

We did not use magnetic resonance cholangiopancreatography (MRCP) in our institution.

The following criteria were recorded: success rates (ERCP cannulation rate and surgical success rate), success rates of ductal stone clearance, conversion rates, morbidity (complications were defined as any intraoperative or postoperative (30 days) event that

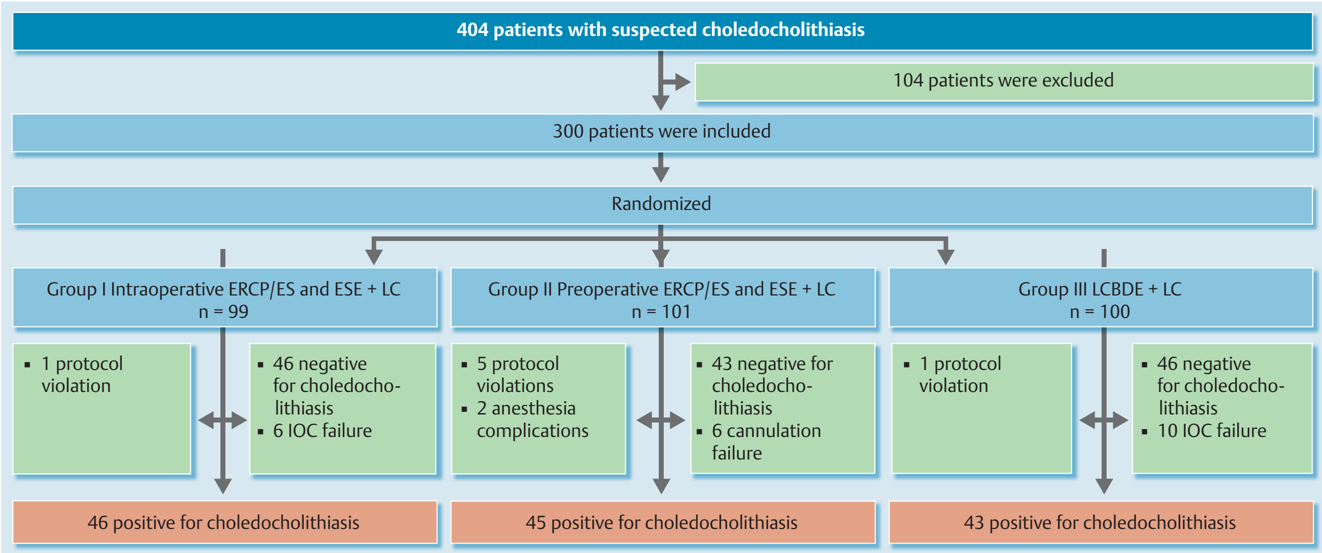

Fig. 1 Clinical outcome of randomized patients.

altered the clinical course such as complications of ERCP including pancreatitis, perforation and bleeding), CBD retained stones, mortality (postoperative mortality was defined as death within 30 days of surgery) , total operative time in minutes, and length of hospital stay.

The level of power for the study was set at 80% with a 5% significance level. Categorical variables were compared by X^2 test, with Yates correction and the Fisher exact test (two-tailed) when necessary. Continuous variables were compared by the Student *t*-test or HSD Tukey, depending on distribution. All *P* values were two-sided. $P<0.05$ indicated a statistically significant difference. Data were analyzed on an intention-to-treat basis. All calculations were performed by using SPSS_ version 21.0.

Table 1 Preoperative variables of the three groups.

Preoperative variable	Group		
	Group I Intraoperative ERCP/ES n=99	**Group II Preoperative ERCP/ES n=101**	**Group III LCBDE n=100**
Age (years)	58.4 (23 – 87)	57.7 (20 – 84)	56.3 (22 – 87)
CBD diameter (mm)	8.2 (4 – 20)	8.4 (5 – 12)	7.7 (4 – 20)
Stone size (6 – 10 mm)	23 (50.0 %)	23 (51.1 %)	22 (51.2 %)
Stone number (one stone)	24 (52.2 %)	29 (64.4 %)	31 (72.1 %)

ERCP/ES, endoscopic retrograde cholangiopancreatography plus endoscopic sphincterotomy; LCBDE, laparoscopic common bile duct exploration

Results

A total of 404 patients with suspected choledocholithiasis were admitted to the National Center for Minimally Invasive Surgery of the Havana Medical University, from November 2007 to November 2011. After excluding 104 ineligible cases (acute cholecystitis, cholangitis, pancreatitis and suspected CBD malignancy), 300 patients were included in the trial and randomized to either group I (Intraoperative ERCP/ES) (n=99), group II (Preoperative ERCP/ES) (n=101), or group III (LCBDE) (n=100). Seven patients had protocol violations (management different from that dictated by random allocation) and 2 had anesthesia complications. As a result, a total of 134 patients were diagnosed with presence of choledocholithiasis and treated during the study period (**Fig. 1**).

Table 1 shows the preoperative variables (age, CBD diameter, stone size and stone number) of the three groups.

The success rate for ductal stone clearance in each group was approximately the same. The success rate for stone clearance in the Intraoperative ERCP/ES group (97,8 %) was higher than in the preoperative ERCP/ES group (93,3 %) and similar in the LCBDE group (97,7 %).There were no significant differences among the groups (**Table 2**).

Postoperative complications occurred in 6 patients (13,3 %) in the preoperative ERCP/ES group; 5 with cholecystitis and 1 with pancreatitis due to ERCP/ES. In the LCBDE group, postoperative complications occurred in 2 patients (4,7 %); these patients had bile leak from CBD closure and were treated conservatively with broad-spectrum antibiotics. No postoperative complications were reported in the intraoperative ERCP/ES group. Postoperative complications lasted for a significantly shorter time in the intraoperative ERCP/ES group than in the preoperative ERCP/ES group ($P<0.012$) (**Table 3**).

Retained stones occurred in 1 patient (2.2 %) in the intraoperative ERCP/ES group and 1 patient (2.3 %) in the LCBDE group and were treated with postoperative ERCP. In the preoperative ERCP/ES group, retained stones occurred in 5 patients (11.1 %) and were treated with postoperative ERCP.

The rate of retained stones was significantly lower in the intraoperative ERCP/ES and LCBDE groups than in the preoperative ERCP/ES group. There were no significant differences among the groups (**Table 4**).

Mean operative time was 94.2 minutes (45 – 300), 9.8 minutes (30 – 240) and 117 minutes (40 – 270) for groups I,II and III respectively. Mean duration of the ERCP/ES procedure for groups I and II was 24.7 minutes and 25 minutes, respectively. These

Table 2 Success rates of ductal stone clearance of the three groups.

Diagnosis and treatment of choledocholithiasis	Group		
	Group I Intraoperative ERCP/ES n = 99	Group II Preoperative ERCP/ES n = 101	Group III LCBDE n = 100
Positive for choledocholithiasis	n = 46	n = 45	n = 43
Success rates of ductal stone clearance	45 (97.8 %)	42 (93.3 %)	42 (97.7 %)
Comparison of surgical results among the three groups			
Groups	**RR[1]**	**CI[2]**	***X*[2] (*P* value)**
Group I Versus Group II	1.05	0.96 – 1.5	1.08 (< 0.36)
Group I Versus Group III	1.00	0.94 – 1.07	0,45 (1.00)
Group III Versus Group II	1.05	0.96 – 1.15	0,44 (< 0.61)

ERCP/ES, endoscopic retrograde cholangiopancreatography plus endoscopic sphincterotomy; LCBDE, laparoscopic common bile duct exploration
[1] Relative risk
[2] Confidence Intervals

times were significantly shorter than for LCBDE group III (49.7 minutes) ($P < 0.001$).
There were no deaths or cases of conversion to open surgery. Length of hospital stay was significantly shorter in the intraoperative ERCP/ES group (mean 1.2 days) than in the preoperative ERCP/ES group (mean 3.1 days) ($P < 0.0001$) and LCBDE group (mean 2.1 days) ($P < 0.012$).

Discussion

Over the past 20 years, LC has become the gold standard for surgical treatment of symptomatic biliary lithiasis, and its development has favored the appearance of a group of new endoscopic/surgical therapeutic possibilities for patients with choledocholithiasis, namely total laparoscopic treatment of choledocholithiasis versus endoscopic treatment using intraoperative ERCP (both single-stage treatments), or preoperative ERCP and postoperative ERCP with LC (2-stage treatment) [6].
Very few studies are available comparing single-stage treatments (LCBDE and intraoperative ERCP) and 2-stage treatment (preoperative ERCP)[6]. Since the introduction of laparoscopic cholecystectomy in our institution in 1993, the standard treatment for CBDS had been preoperative ERCP/ES, followed by LC and postoperative ERCP/ES. With the advance in technology and laparoscopic techniques, we started to perform LCBDE (1995) and intraoperative ERCP/ES (2003), and this randomized trial compares the results among the 3 preoperative approaches.
The preoperative and noninvasive tests for predicting CBDS such as clinical examination, history, laboratory tests and ultrasound have a high negative predictive value (92 % – 99 %). However, the positive predictive value is less satisfactory, and in patients with high suspicion of choledocholithiasis, this is only shown in 13 % to 58 % of cases. Application of these criteria reveals a high rate

Table 3 Postoperative complications.

Postoperative complication	Group		
	Group I Intraoperative ERCP/ES n = 99	Group II Preoperative ERCP/ES n = 101	Group III LCBDE n = 100
Positive for choledocholithiasis	n = 46	n = 45	n = 43
Postoperative complications	0 (0 %)	6 (13.3 %)	2 (4.7 %)
Comparison of surgical results among the three groups			
Groups	**RR[1]**	**CI[2]**	***P* value**
Group I vs. Group II	0.00	0.00 – 0.86	< 0.012
Group I vs. Group III	0.00	0.00 – 3.84	< 0.23
Group III vs. Group II	0.35	0.07 – 1.63	< 0.26

ERCP/ES, endoscopic retrograde cholangiopancreatography plus endoscopic sphincterotomy; LCBDE, laparoscopic common bile duct exploration
[1] Relative risk
[2] Confidence Intervals

Table 4 Retained stones.

Retained stones	Group		
	Group I Intraoperative ERCP/ES n = 99	Group II Preoperative ERCP/ES n = 101	Group III LCBDE n = 100
Positive for choledocholithiasis	n = 46	n = 45	n = 43
Retained stones	1 (2.2 %)	5 (11.1 %)	1 (2.3 %)
Comparison of surgical results among the three groups			
Groups	**RR[1]**	**CI[2]**	***P* value**
Group I vs. Group II	0.20	0.02 – 1.61	< 0.11
Group I vs. Group III	0.93	0.06 – 14.48	1.00
Group III vs. Group II	0.21	0.03 – 1.72	< 0.20

ERCP/ES, endoscopic retrograde cholangiopancreatography plus endoscopic sphincterotomy; LCBDE, laparoscopic common bile duct exploration.
[1] Relative risk
[2] Confidence Intervals

of false-positive diagnoses and many unnecessary ERCPs (40 % – 50 %) [17]. Currently MRCP and endoscopic ultrasound are used routinely before ERCP to prevent unnecessary procedures but they are not available in our institution [5 – 11, 18].
IOC failure occurred at a rate (8 %) which is similar to other publications. The single most frequent reason for failure to complete IOC in our series was an inability to cannulate the cystic duct.
The success of ERCP cannulation in our study is comparable to others reported (over 85 %) [19, 20]. The success rate for ductal stone clearance in our study is comparable to those in other reported trials [11, 21 – 26]. No statistically significant differences in success rates were seen for endoscopic versus laparoscopic approaches to choledocholithiasis.
We only used the rendezvous technique in some patients, which allows selective bile duct cannulation and avoids manipulation of the papilla as well as unnecessary injection of contrast material into the pancreatic duct. Early in our work (first 100 intraoperative ERCP/ES in 2003) we tried to pass a guidewire through the cystic duct into the CBD to facilitate bile duct cannulation at subsequent endoscopy (the endo-laparoscopic "rendezvous" described by Cavina et al) [27] in all cases, but we found it technically difficult and encountered additional difficulties during LC (due

to bowel insufflations) and the technique's limitations were related to impacted CBD stones, so we omitted this step in most cases in the clinical trial, as had ElGeidie et al [28], because the endoscopist and team were very experienced with ERCP (more than 10 000 ERCP).

Single-stage treatments facilitate performance of LC simultaneously. Recurrent biliary complications are more common in patients who do not have elective cholecystectomy after management of choledocholithiasis by ES [28,29]. When there is a time lag between ERCP/ES and LC, some patients may develop cholecystitis (5%-22%) [30–32]. That difference can d be partially explained by the length of the interval between the 2 procedures, which is not well defined, as even in the multicenter trial by the European Association for Endoscopic Surgery (EAES) the interval between endoscopic papillosphincterotomy and LC was not specified [33]. Patients awaiting LC are known to have a high rate of readmission and complications due to acute cholecystitis, pancreatitis, empyema, and cholangitis; others showed that in case of delayed cholecystectomy, performed over 2 weeks after ES, there is a higher conversion rate, increasing from 4% when LC was done within 2 weeks, to 31% between 2 and 6 weeks, and 16% after 6 weeks [34]. Therefore, elective cholecystectomy is indicated 24 to 48 hours after clearance of CBD. Nevertheless, some authors report that it is no possible to know whether the acute inflammation is due to pre-ERCP acute cholecystitis or whether it is induced by ERCP [28].

In our study, a significant amount of local inflammation was found in 5 patients and was associated with pain. We consider that clinically relevant because residual local inflammation in patients after ERCP may negatively affect operative outcomes and necessitate a longer hospital stay. Studies have shown that presence of inflammation as an independent risk factor for bile duct injury during LC [35].

At the time of laparoscopic surgery, bile duct stones can be removed with a straightforward transcystic approach or with technically demanding choledochotomy. LCBDE in all candidates offers advantages over preoperative ERCP/ES: equivalent removal of duct stones with fewer procedures, lower cost, and preservation of the biliary sphincter. When laparoscopic bile duct exploration is used, the operation is longer. Consequently, in elderly patients and those with significant comorbidity who may not tolerate longer procedures, the advantage may be lost [36].

Several trials have compared clinical outcomes with the 2-stage approach to those with a single-stage strategy. Rogers and colleagues [36] randomized 122 patients to LC plus LCBDE or to ERCP/ES plus LC. Although the techniques had equivalent efficacy and safety, length of hospitalization was 2 days shorter for those who underwent the combined laparoscopic procedure.

Recently, Lu and colleagues [38] performed a meta-analysis of 9 randomized trials that compared 2-stage ERCP and LC with combined LC and bile duct exploration. In 787 patients, the approaches were found to have equivalent efficacy and safety. The longer hospital stay seen in the ERCP group in the individual trials was not evident; however, significantly more procedures were required in the ERCP group than in the combined laparoscopic group. The problem with applicability of these data, however, is that most surgeons are not trained to perform LCBDE.

Bin Wang and colleagues [39] concluded that with regard to stone clearance and overall complication rates, preoperative ERCP is equal to intraoperative ERCP in patients with gallbladder and common bile duct stones. However, intraoperative ERCP is associated with a reduced incidence of ERCP-related pancreatitis and results in a shorter hospital stay. The total hospital stay was significantly shorter with intraoperative ERCP than with preoperative ERCP (RR 2.22, 95% CI 1.98–246; P<0.01). A longer hospital stay was required for preoperative ERCP as a result of management of complications and organization of scheduling slots for preoperative ERCP and LC. Also residual local inflammation in patients after ERCP may negatively affect operative outcomes and demand more length of hospital stay.

Use of intraoperative ERCP has slowly increased among various endoscopic groups [12–14]. La Greca *et al* [14] reviewed all published studies on intraoperative ERCP and found 27 original papers that included between 8 and 96 patients each, thus analyzing a total of 795 patients. The success rate ranged between 69.2% and 100% and averaged 92.3%. The average duration of intraoperative endoscopy was 35 minutes and the average duration of surgery was 104 minutes. The average conversion rate to open surgery was 4.7% and morbidity was 5.1% (0%-19%). Mortality is extremely rare, and from the 27 publications reviewed, only 3 patient deaths were reported, giving rise to a total mortality rate of 0.37%.

The 3 types of treatment are effective and the choice of approach depends on a patient's particular circumstances and on the experience of the different endoscopic and surgical teams at each center [10].

Conclusions

We conclude that intraoperative ERCP/ES for choledocholithiasis results in a higher rate of choledocholithiasis clearance, shorter hospital stay, and lower morbidity, but further research with a larger study population is necessary to determine the procedure's additional benefits. Results to date suggests that in appropriate patients, single-stage treatments are the best options.

Competing interests: None

References

1 *Oddsdottir M*, *Hunter JG*. Gallbladder and extrahepatic biliary system. In: Brunicardi FC, editor. Schwartz's Principles of Surgery. Ninth Edition. United States of America: The McGraw-Hill Education; 2010: 821–844
2 *Mori T*, *Suzuki Y*, *Sugiyama M*, *Atomi Y*. Choledocholithiasis. In: Bland KI, Büchler MW, Csendes A et al., editors General Surgery. Principles and International Practice. Second Edition. London: Springer-Verlag London; 2009: 1061–1073
3 *Paul A*, *Millat B*, *Holthausen U* et al. Results of a consensus development conference. Surg Endosc 1998; 12: 856–864
4 *Neugebauer E*, *Sauerland S*, *Fingerhut A* et al. EAES Guidelines for Endoscopic Surgery. Twelve years Evidence-Based Surgery in Europe. Germany: Springer; 2006: 311–333
5 *Clayton ES*, *Connor S*, *Alexakis N* et al. Meta-analysis of endoscopy and surgery versus surgery alone for common bile duct stones with the gallbladder in situ. Br J Surg 2006; 93: 1185–1191
6 *Rábago LR*, *Chico I*, *Collado D* et al. Single-stage treatment with intraoperative ERCP: management of patients with possible choledocholithiasis and gallbladder in situ in a non-tertiary Spanish hospital. Surg Endosc 2012; 26: 1028–1034
7 *Hong DF*, *Xin Y*, *Chen DW*. Comparison of laparoscopic cholecystectomy combined with intraoperative endoscopic sphincterotomy and laparoscopic exploration of the common bile duct for cholecystocholedocholithiasis. Surg Endosc 2006; 20: 424–427
8 *Ghazal AH*, *Sorour MA*, *El-Riwini M* et al. Single-step treatment of gallbladder and bile duct stones: A combined endoscopic–laparoscopic technique. Int J Surg 2009; 7: 338–346
9 *Chander J*, *Vindal A*, *Lal P* et al. Laparoscopic management of CBD stones: an Indian experience. Surg Endosc 2011; 25: 172–181

10 *Rábago LR*, *Ortega A*, *Chico I* et al. Intraoperative ERCP: What role does it have in the era of laparoscopic cholecystectomy? World J Gastrointest Endosc 2011; 3: 248 – 255
11 *Martin DJ*, *Vernon DR*, *Toouli J*. Surgical versus endoscopic treatment of bile duct stones. Cochrane Database Syst Rev 2006: CD003327
12 *Ghazal AH*, *Sorour MA*, *El-Riwini M* et al. Single-step treatment of gallbladder and bile duct stones: a combined endoscopic-laparoscopic technique. Int J Surg 2009; 7: 338 – 346
13 *La Greca G*, *Barbagallo F*, *Di Blasi M* et al. Laparoendoscopic "Rendezvous" to treat cholecysto-choledocolithiasis: Effective, safe and simplifies the endoscopist's work. World J Gastroenterol 2008; 14: 2844 – 2850
14 *La Greca G*, *Barbagallo F*, *Sofia M* et al. Simultaneous laparoendoscopic rendezvous for the treatment of cholecystocholedocholithiasis. Surg Endosc 2009; 24: 769 – 780
15 *Grizzle JE*, *Starmer CF*, *Koch GG*. Analysis of categorical data by linear models. Biometrics 1969; 25: 489 – 450
16 *Rochon J*. The application of the GSK method to the determination of minimum sample sizes. Biometrics 1989; 45: 193 – 205
17 *Yaghoobi A*, *Salimi J*, *Golfam F* et al. Preoperative clinical and paraclinical predictors of choledocholithiasis. Hepatobiliary Pancreat Dis Int 2008; 7: 304 – 307
18 *Maple JT*, *Ikenberry SO*, *Anderson MA*. ASGE Standards of Practice Committee. et al. The role of endoscopy in the management of choledocholithiasis. Gastrointest Endosc 2011; 74: 731 – 744
19 *Springer J*, *Enns R*, *Romagnuolo J* et al. Canadian credentialing guidelines for endoscopic retrograde cholangiopancreatography. Can J Gastroenterol 2008; 22: 547 – 551
20 *Cohen S*, *Bacon BR*, *Berlin JA* et al. National Institutes of Health State-of-the-Science Conference Statement: ERCP for diagnosis and therapy, January 14-16, 2002. Gastrointest Endosc 2002; 56: 803 – 809
21 *Saccomani G*, *Durante V*, *Magnolia MR* et al. Combined endoscopic treatment for cholelithiasis associated with choledocholithiasis. Surg Endosc 2005; 19: 910 – 914
22 *Guda NM*, *Freeman ML*. 30 years of ERCP and still the same problems? Endoscopy 2007; 39: 833 – 835
23 *Khan OA*, *Balaji S*, *Branagan G* et al. Randomized clinical trial of routine on-table cholangiography during laparoscopic cholecystectomy. Br J Surg 2011; 98: 362 – 367
24 *Petersen BT*. Combined approaches to endoscopic retrograde biliary access after failed transpapillary approach. Gastrointest Endosc 2007; 5: 136 – 140
25 *La Greca G*, *Barbagallo F*, *Di Blasi M* et al. Rendezvous technique versus endoscopic retrogradecholangiopancreatography to treat bile duct stones reduces endoscopic time and pancreatic damage. J Laparoendoscop Adv Surgical Techniques 2007; 17: 167 – 171
26 *Kharbutli B*, *Velanovich V*. Management of preoperatively suspected choledocholithiasis: a decision analysis. J Gastrointest Surg 2008; 12: 1973 – 1980
27 *Cavina E*, *Franceschi M*, *Sidoti F* et al. Laparo-endoscopic "rendezvous": a new technique in the choledocholithiasis treatment. Hepatogastroenterology 1998; 45: 1430 – 1435
28 *ElGeidie AA*, *ElEbidy GK*, *Naeem YM*. Preoperative versus intraoperative endoscopic sphincterotomy for management of common bile duct stones. Surg Endosc 2011; 25: 1230 – 1237
29 *Byrne M*, *McLoughlin M*, *Mitchell R* et al. The fate of patients who undergo "preoperative" ERCP to clear known or suspected bile duct stones. Surg Endosc 2009; 23: 74 – 79
30 *Silviera ML*, *Seamon MJ*, *Porshinsky B* et al. Complications related to endoscopic retrograde cholangiopancreatography: A comprehensive clinical review. J Gastrointestin Liver Dis 2009; 18: 73 – 82
31 *Mallery JS*, *Baron TH*, *Dominitz JA*. Complications of ERCP. Gastrointest Endosc 2003; 57: 633 – 638
32 *Yasui T*, *Takahata Sh*, *Kono H* et al. Is cholecystectomy necessary after endoscopic treatment of bile duct stones in patients older than 80 years of age? J Gastroenterol 2012; 47: 65 – 70
33 *Cuschieri A*, *Lezoche E*, *Morino M* et al. E.A.E.S multicenter prospective randomized trial comparing two stage vs single stage management of patients with gallstones disease and ductal calculi. Surg Endosc 1999; 13: 952 – 957
34 *Byrne MF*, *McLoughlin MT*, *Mitchell RM* et al. The fate of patients who undergo "preoperative" ERCP to clear known or suspected bile duct stones. Surg Endosc 2009; 23: 74 – 79
35 *Georgiades CP*, *Mavromatis TN*, *Kourlaba GC* et al. Is inflammation a significant predictor of bile duct injury during laparoscopic cholecystectomy? Surg Endosc 2008; 22: 1959 – 1964
36 *Noble H*, *Tranter S*, *Chesworth T* et al. A randomized, clinical trial to compare endoscopic sphincterotomy and subsequent laparoscopic cholecystectomy with primary laparoscopic bile duct exploration during cholecystectomy in higher risk patients with choledocholithiasis. J Laparoendosc Adv Surg Tech 2009; 19: 713 – 720
37 *Rogers SJ*, *Cello JP*, *Horn JK* et al. Prospective randomized trial of LC/LCBDE vs ERCP/ES/LC for common bile duct stone disease. Arch Surg 2010; 145: 28 – 33
38 *Lu J*, *Cheng Y*, *Xiong XZ* et al. Two-stage vs single-stage management for concomitant gallstones and common bile duct stones. World J Gastroenterol 2012; 18: 3156 – 3166
39 *Wang B*, *Guo Z*, *Liu Z* et al. Preoperative versus intraoperative endoscopic sphincterotomy in patients with gallbladder and suspected common bile duct stones: system review and meta-analysis. Surg Endosc 2013; 27: 2454 – 2465