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Single-step treatment of gall bladder and bile duct stones: A combined endoscopic–laparoscopic technique

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ABSTRACT

Introduction: The advent of endoscopic techniques changed surgery in many regards. In the management of cholelithiasis; laparoscopic cholecystectomy (LC) is today the treatment of choice. This has created a dilemma in the management of choledocholithiasis. Today a number of options exist, including endoscopic sphincterotomy (ES) before LC in patients with suspected common bile duct (CBD) stones, laparoscopic common bile duct exploration (LCBDE) by the transcystic approach or laparoscopic choledocotomy, open CBD exploration and postoperative ERCP. A major concern regarding both pre- and postoperative extraction of CBD stones (CBDS) by the ERCP is the risk of development of pancreatitis, also more than 10% of the preoperative ERCP is normal. More recently the alternative technique of combined LC with intraoperative ERCP and ES is emerging in an attempt to manage cholecysto-choledocholithiasis in a single-step procedure.

Objectives: The aim of this work was to assess the treatment of common bile duct stones (CBDS) in a one-stage operation by laparoscopic cholecystectomy (LC) and intraoperative endoscopic retrograde cholangiopancreatography (LC + IO-ERCP) and endoscopic sphincterotomy (ES).

Patients and methods: This study was carried out on 45 patients with gall bladder stones and with suspected or confirmed CBDS at the Gastrointestinal Surgery Unit in the Main Alexandria University Hospital. They were treated by a single-step procedure combining LC and IO-ERCP. Laparoscopic intraoperative cholangiography (IOC) was carried out to confirm the presence of CBDS. A soft-tipped guide-wire was passed through the cystic duct and papilla into the duodenum. A papillotome was inserted endoscopically over the guide-wire. Endoscopic sphincterotomy was performed and the stones were extracted with a retrieval balloon or with a Dormia basket. The surgical operating time, surgical success rate, postoperative complications, retained CBDS, and postoperative length of hospital stay were assessed.

Results: There were 30 females and 15 males. Their mean age was 45.07 + 11.3 years (ranging from 27 to 65years). Twenty-seven patients had confirmed CBDS by preoperative ultrasound (US) and/or MRCP. Eighteen patients were suspected for CBDS on clinical, laboratory and/or US basis. Conversion to open cholecystectomy occurred in one case due to severe adhesions at the Calot's triangle. IOC revealed the presence of CBDS in 36 patients. IO-ERCP with ES was performed successfully in 33 patients and stones were extracted endoscopically. Passage of the guide-wire through the papilla failed in three patients. Cholecystectomy was completed laparoscopically in 44 patients. The mean operative time was 119 + 14.4 min (ranging from 100 to 150 min). Minor postoperative complications occurred in 15 patients. No postoperative complications related to the procedure, i.e., pancreatitis, bleeding, perforation, were encountered. Patients regained their bowel motion on the next day and were discharged after a mean hospital stay of 2.55 + 0.89 days. None of the patients presented on the postoperative follow-up with symptoms, signs, laboratory or radiological evidence of retained CBDS. The mean duration of the postoperative follow-up was 9 + 4.07 months (ranging from 3 to14 months).

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Conclusion: The current study suggests that LC + IO-ERCP for the management of cholecysto-choledocholithiasis is a safe and aneffective technique with a low rate of post-ERCP pancreatitis. It offers another alternative for surgeons especially those who do not practice LCBDE to treat patients in a single setting. However, additional studies with larger patient populations are needed keeping in mind that the limiting characteristic is the proximity and availability of the endoscopic settings.

1. Introduction

The reported incidence of common bile duct stones (CBDS) varies between 7 and 20%.[1–4] Management of suspected choledocholithiasis is changing with the rapid acceptance of laparoscopic cholecystectomy (LC) as the conventional method for treatment of patients with symptomatic gall bladder stones (GBS). All patients with symptomatic GBS need to be assessed for CBDS.[3,5,6]

The use of preoperative endoscopic retrograde cholangiopancreatography (ERCP) with the aim of detecting CBDS, should not be carried out routinely since it is not cost-effective. Even with the most strict selection criteria more than 10% of the preoperative ERCP are normal,[7,8] and the risk of development of post-ERCP pancreatitis in recent prospective studies varied between 1 and 13.5%.[9–12]

Routine intravenous cholangiography (IVC) has proved to be effective for the detection of bile duct stones in asymptomatic patients and is an optimal test for the identification of those patients who need to undergo ERCP. However, only 8.6% of patients who underwent IVC benefited from it: the majority of patients underwent IVC unnecessarily.[4]

Recently, the development of magnetic resonance cholangiopancreatography (MRCP) and endoscopic ultrasonography (EUS) has provided sensitive and specific methods for detecting CBDS. They are expensive tools that seem to be unnecessary in many cases.[13–15]

The development of reliable predictors of CBDS based on the patient's clinical, biochemical, and ultrasound (US) presentation could allow for a more appropriate use of ERCP, IVC or MRCP.[12,16,17] When CBDS are symptomatic (acute cholangitis, obstructive jaundice, or acute gallstone pancreatitis) diagnosis is relatively simple.[18] It is a more complex matter to recognize asymptomatic CBDS.[16]

Although LC is now widely accepted as the treatment of choice of symptomatic GBS, things are not quite so clear-cut when it comes to managing CBDS and debate continues among surgeons about the optimal method of use.[19] The main options include selective preoperative ERCP, postoperative ERCP, open explorations, and laparoscopic common bile duct exploration (LCBDE).[19–22]

Preoperative ERCP and endoscopic sphincterotomy (ES) are a safe and effective option for removing CBDS in most cases, but even when clinical, biochemical, and US criteria are used, only 10–60% of patients will have stones on ERCP.[1,2,17,19,23,24] As a result, far too many unnecessary ERCP are being performed.[8,19]

Postoperative ERCP and ES are also effective in clearing the CBD stones. It avoids unnecessary examinations but has a failure rate of 7–14%. Along with preoperative ES it exposes the patient to the risks of complications, e.g., bleeding, perforation, and pancreatitis[9–12,19] and those resulting from the disruption of the intact sphincter of Oddi.[25,26] In younger patients, concerns have been raised about the long term sequel of ES, but as yet the evidence is not conclusive and does not preclude its usefulness in this group.[27]

Laparoscopic CBD exploration (LCBDE) by either the transcystic approach (small stones) or via a choledochotomy allows for a more selective approach for the removal of CBDS, and thus the avoidance of unnecessary preoperative ERCP.[28–31] It has the advantage of combining two procedures into a single minimally invasive operation. It is a relatively new technique and a few centers regularly use this specialized option. Overall ductal clearance rates range from 75 to 92%, and there is a slightly higher rate of retained stones. In recent randomized trials comparing LCBDE with two separate two-stage procedures, their efficiency and morbidity rates in treating CBDS were found to be equal.[32,33] The only significant advantage of the one-stage method was a shorter hospital stay.

The intraoperative approach of ERCP in a single-step treatment of CBDS during LC also benefits the patient by reducing the treatment from a two-step procedure to a single-step procedure under general anesthesia. It minimizes the risk of induction of pancreatitis and avoids exploration of the CBD.[8]

The aim of this study was to assess the treatment of common bile duct stones (CBDS) in a one-stage operation by laparoscopic cholecystectomy (LC) and intraoperative endoscopic retrograde cholangiopancreatography (LC + IO-ERCP) and endoscopic sphincterotomy (ES).

2. Patients and methods

In the period between March 2005 and March 2008, 45 patients with cholelithiasis and evident or suspicious CBDS were scheduled for a single-step treatment combining laparoscopic cholecystectomy (LC) and endoscopic retrograde cholangiopancreatography (ERCP) [LC + IO-ERCP] for the management of their GBS and suspected or evident CBDS.

Patients were selected for this study when their preoperative US or MRCP examinations showed evident stones in the CBD. Also included in this study on patients symptomatic for CBDS were acute cholangitis, obstructive jaundice, or acute gallstone pancreatitis, and those with criteria highly suspicious for CBDS, i.e., dilated CBD on US examination $>$ 7 mm in diameter without evident CBDS, high serum bilirubin level and/or high serum alkaline phosphatase level. All patients were informed about both the procedure and the technology to be used.

Laparoscopic cholecystectomy was performed using four trocars according to the standard technique.[34,35] LC was started before ERCP to avoid distension of the bowel with air at the time of ERCP. The Calot's triangle was dissected and the cystic artery was identified, clipped and cut. Then, the cystic duct was clipped high near the GB and a small incision performed near the clip for introduction of the cholangio-catheter (Figs. 1–3). Catheterisation of the cystic duct was performed using a cholangio-catheter (4 Fr. ureteric catheter) (Fig. 4) and intraoperative cholangiogram (IOC) was obtained after injection of 10 cc of diluted urografin using a C-arm X-ray.

When the IOC revealed the presence of a CBDS or when the anatomy of the CBD was suspicious for the presence of a CBDS, the decision to perform IO-ERCP was taken. The surgeon introduced through the cystic duct a 0.035 inch guide-wire and advanced it down through the sphincter of Oddi and into the duodenum. The duodenoscope was introduced by the surgeon with the patient remaining in the supine position. The duodenoscope was advanced to the second part of duodenum and on recognition of the papilla, the guide-wire was encountered (rendez-vous technique)[12] and was used to guide cannulation of the CBD by a sphincterotome

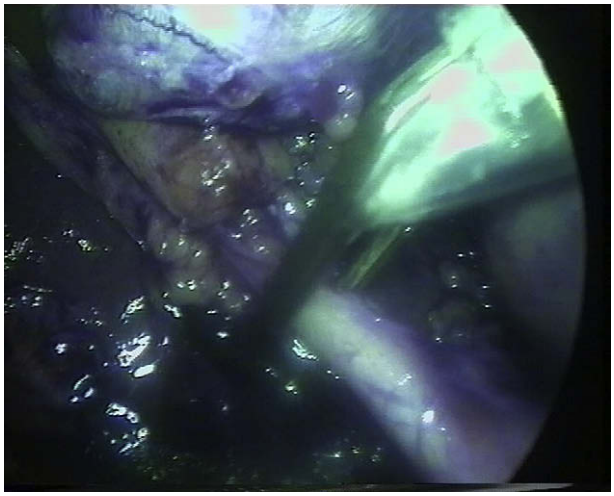

Fig. 1. Clipping of the cystic duct.

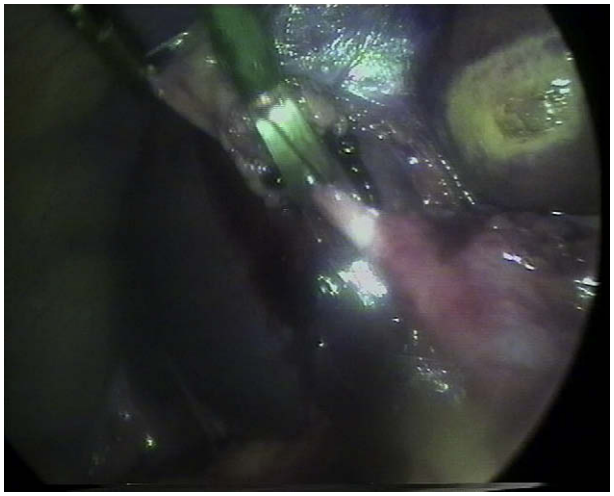

Fig. 3. Incision of the cystic duct.

(Fig. 5). Diluted urografin was administered through the sphincterotome to perform endoscopic retrograde cholangiography (ERC).

When a CBDS was identified, a sphincterotomy was performed (Fig. 6). A retrieval balloon (8.5 or 11.5 mm) or a stone retrieval Dormia basket was then used to remove the CBDS. A completion cholangiography was then performed to confirm freedom of the CBD from stones.

At the end of each ERCP, care was taken to remove all the gas from the stomach so as to facilitate the completion of the LC. Prophylactic antibiotic was given to all patients.

The following criteria were recorded: ERCP cannulation rate, total operative time in minutes, surgical success rate, timing of postoperative return of peristaltic activity and food intake, and the prevalence of CBD retained stones. A follow-up US evaluation was done 6 weeks after surgery for all patients. Patients were instructed to notify after discharge about any clinical symptoms or signs or any laboratory or any imaging data that they have obtained because of the possibility of a postoperative biliary disease. Patients were followed for a mean period of 9 ± 4.07 months (average 3–14 months). Data are presented with numbers, percentage, arithmetic mean (X) and standard deviation (SD).

3. Results

Between March 2005 and March 2008, 45 patients with evident or suspicious CBDS besides their GBS were included in this study. They were assigned for a single-step treatment combining LC and IO-ERCP for the management of their cholelithiasis and CBDS. Their ages ranged between 27 and 65 years (mean 45.07 ± 11.3). There were 30 females and 15 males.

All patients presented with abdominal pain in the epigastrium or right hypochondrium that was assessed as biliary colic. Thirty patients presented with a definite history of preoperative obstructive jaundice that clinically resolved spontaneously in 18 of them. Twenty-one patients had cholangitis with high white blood cell count and elevation of liver enzymes (ALT, AST). They received medical treatment with antibiotics and their attack subsided. Three patients had a history of biliary pancreatitis with elevation of serum amylase and lipase. Their attacks were mild and resolved on medical treatment without any sequel as confirmed on follow-up CT abdomen.

Ultrasound (US) examinations showed the presence of multiple small stones in the GB of all patients. The CBD was dilated more

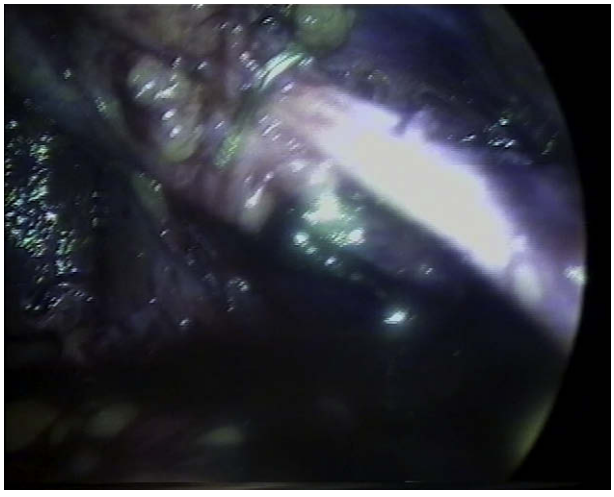

Fig. 2. Clipping of the cystic duct.

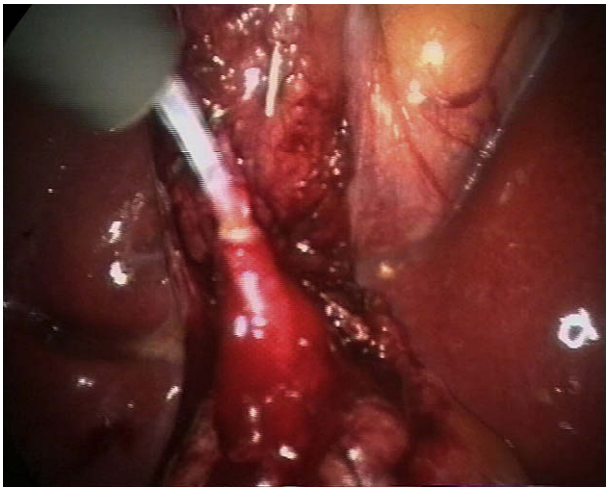

Fig. 4. Insertion of IOC catheter into the cystic duct.

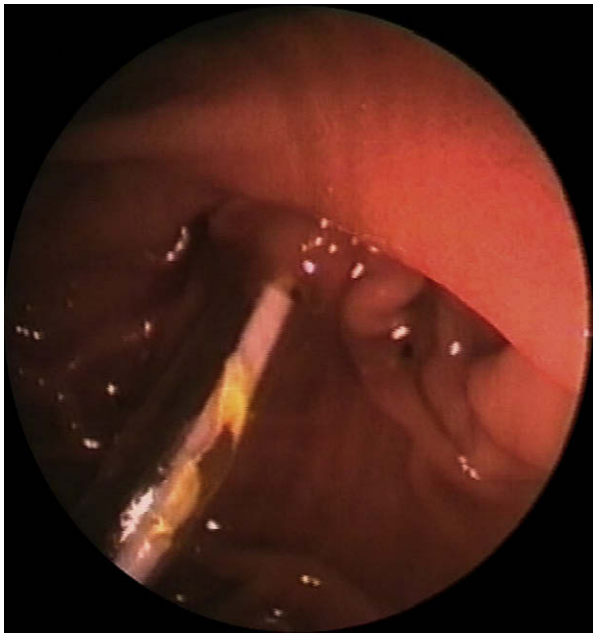

Fig. 5. Appearance of IOC catheter and guide-wire at the papilla.

Table 1
Patients' characteristics and ultrasound findings.

Mean age (years)	45.07 ± 11.3 (range: 27–65)
Sex	
• Male	15
• Female	30
Clinical presentations	
• Biliary colic	45
• Preoperative jaundice	30
• Cholangitis	21
• Biliary pancreatitis	3
Ultrasound findings	
• GBS	45
• Dilated CBD	30
• Ectatic CBD	9
• Dilated CBD + CBDS	24
• Normal CBD	6
• Dilated IHBD	15

than 10 mm in 30 patients with visualization of stones or gravels in 24 of them. The CBD was ectatic (around 7 mm in diameter) in nine patients and in six patients the CBD had a normal diameter. The intrahepatic bile ducts were dilated in association with the CBD in 15 patients. The CBD stones' diameter ranged from tiny gravels to 11 mm. Table 1 shows patients' characteristics and the findings of US examination.

Magnetic resonance cholangiography (MRCP) was performed in nine cases. It showed the presence of a tiny stone at the terminal end of the CBD in patients with pancreatitis who had a normal CBD on US examination. In the other six patients, the MRCP confirmed the dilatation of the CBD and the presence of CBDS previously seen on US examination.

Patients with normal CBD on US examination had history of pancreatitis, preoperative jaundice, and/or elevated serum bilirubin or alkaline phosphatase denoting suspicion for the presence of CBDS.

Laparoscopic cholecystectomy was started in all patients. However, in one patient severe inflammation and adhesions were present at the Calot's triangle, and during dissection the cystic duct was avulsed from its attachment near the CBD. Because of the intense adhesions and as the CBD was seen evidently dilated on laparoscopy we decided to convert the procedure to open cholecystectomy with open exploration of the CBD. On laparotomy, dissection of the Calot's triangle was continued with difficulty, the cystic duct was sutured and ligated near the CBD, the cystic artery was identified, ligated and cut and the CBD was opened. Exploration of the CBD revealed the presence of a tightly impacted stone at the papilla that did not dislodge in spite of all trials. We decided to perform a transduodenal sphincteroplasty with successful extraction of the stone. Cholecystectomy was completed with closure of the CBD over a T-tube. The postoperative course was smooth and the patient was discharged on the seventh postoperative day. Postoperative T-tube cholangiogram revealed patency of the CBD. The conversion rate in this study was accordingly 2.2%.

Intraoperative cholangiography (IOC) was performed in 44 patients (97.8%) and revealed dilatation of the CBD with evident stones or gravels in 36 patients (81.8%). In eight patients (18.2%) the IOC was normal and no IO-ERCP was performed and LC was continued in the conventional way. The postoperative course of these eight patients was smooth with normal US examination on follow-up.

In 36 patients, IO-ERCP was attempted. Cannulation of the papilla by a sphincterotome guided on the guide-wire was

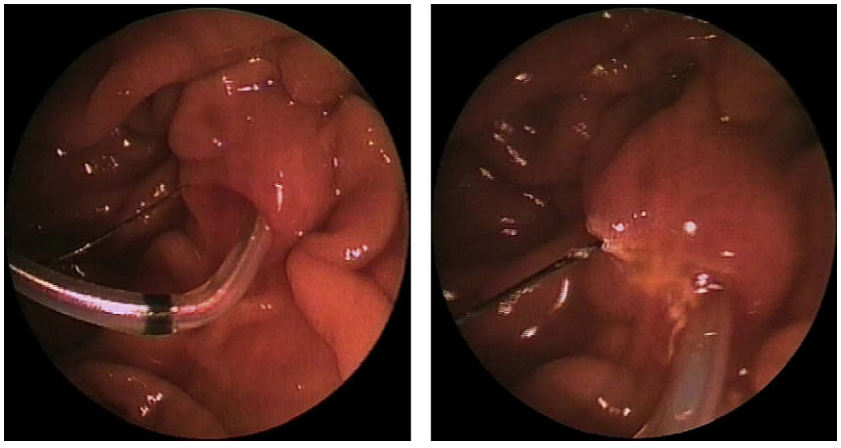

Fig. 6. Endoscopic sphincterotomy.

successful in 33 patients only (91.7%). ERCP cholangiography was performed and confirmed the findings of the IOC. Endoscopic sphincterotomy was performed successfully in all the 33 patients. Gravels were cleared by saline irrigation using the cholangiography catheter in 18 cases (Fig. 7). Larger stones were removed using a retrieval balloon or Dormia basket in 15 cases (Fig. 8). Completion cholangiography was performed to ensure patency of the duct. Passage of the guide-wire through the papilla failed in three patients and their CBDS were managed in the same setting intra-operatively by the conventional ERCP and sphincterotomy and stone retrieval using Dormia basket. Cholecystectomy was completed laparoscopically in 44 cases (97.8%). Distension of the bowel with gases caused mild difficulty but did not interfere with safe completion of the LC. The operative mean time was calculated and found to be 119.1 ± 14.4 min (ranging from 100 to 150 min).

The postoperative course was smooth in all patients. Return of peristaltic activity was noted on the same evening with passage of flatus on the next day with immediate start of feeding in all the 44 patients who had their cholecystectomy completed laparoscopically. No postoperative complications related to the LC + IO-ERCP procedure were noted, i.e., pancreatitis, bleeding, or perforation. However, minimal postoperative complications were noted in the form of mild basal lung atelectasis, mild fever, and mild post-operative pain in 15 patients. These complications were minor and did not require special interference and patients were discharged in good health. The mean postoperative hospital stay was 2.55 ± 0.89 days (ranging from 2 to 5 days).

All patients were well at 6 weeks follow-up interval and US examination at this time confirmed patency of the common bile duct with no dilatation or residual stones. No perioperative mortality was encountered in patients of this study. Patients were followed to a later date; with a mean late follow-up duration of 9 ± 4.07 months (ranging from 3 to 14 months). None of them showed symptoms or signs of retained CBDS or late postoperative complications specifically related to the procedure, and all were satisfied and in good health. Table 2 summarizes the patients' results and operative data.

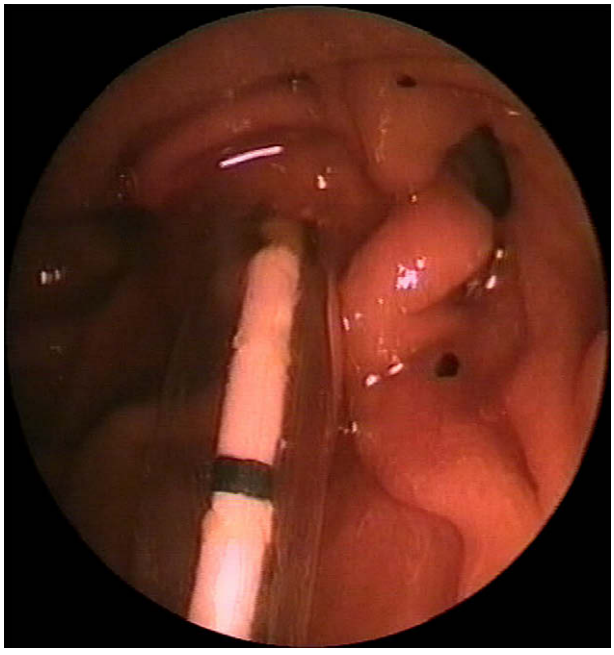

Fig. 7. Passage of gravels on saline irrigation.

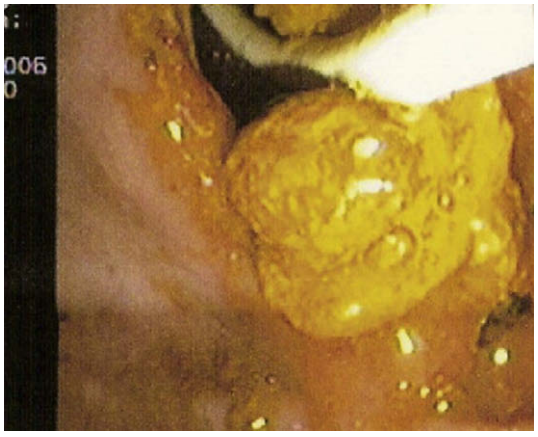

Fig. 8. Extraction of stone using Dormia basket.

4. Discussion

There is a broad consensus that all common bile duct (CBD) stones present at the time of cholecystectomy should be removed, since stones that are left in the CBD may cause subsequent abdominal pain, obstructive jaundice, cholangitis, and biliary pancreatitis.[36] The most popular methods of detecting CBD stones include endoscopic retrograde cholangiopancreatography (ERCP), endoscopic ultrasonography, intraoperative cholangiography (IOC), intraoperative ultrasonography, and magnetic resonance cholangiography.[36]

The conventional approach to the removal of CBDS in the laparoscopic era is usually by ERCP, either preoperatively or post-operatively.[17,36–38] However, the extraction of CBDS laparoscopically has gained popularity.[12]

Many surgeons use a stratified approach to deal with suspicious CBDS. Patients deemed to be at low risk on clinical grounds for choledocholithiasis may have an intraoperative cholangiogram at the time of cholecystectomy or they may simply undergo a laparoscopic cholecystectomy without any imaging of the bile duct. While those deemed to be at high risk are typically managed more

Table 2
Patients' operative data.

CBDS known preoperatively	
• Yes	27
• Suspected	18
IOC data	
• CBDS	36
• Normal CBD	8
Operating time (min)	119.09 ± 14.4 (range: 100–150)
Cannulation frequency	91.7%
CBDS clearance rate	100%
Postoperative pancreatitis	0/45 (0%)
Conversion to open cholecystectomy	1/45 (2.2%)
Hospital stay (days)	2.55 ± 0.89 (range: 2–5)
Postoperative retained CBDS	0/45 (0%)
Postoperative follow-up length (months)	9 ± 4.1 (average: 3–14)

aggressively; they may have a preoperative ERCP or an intraoperative cholangiogram, with the intention of proceeding to CBDE or postoperative ERCP if stones are detected.[38]

Selective IOC allows patients with clinical, biochemical, and ultrasonographic findings suggestive of CBDS to be spared an unnecessary preoperative ERCP and its recognized morbidity and mortality. The presence of a CBDS on IOC allows the surgeon not trained in LCBDE to either employ a postoperative ERCP and ES at another visit or to convert to open exploration of the duct. Postoperative ERCP necessitates a second procedure and there is a risk that it will be unsuccessful, requiring reoperation.[12] Open exploration still has its associated morbidity.[19]

The use of preoperative ERCP has been controversial.[16] Some authors report a high percentage of useless procedures (CBDS not confirmed, unsuccessful clearance of CBD, and retained stones) despite no negligible number of procedure-related complications and deaths.[39–42] On the contrary, different authors consider preoperative ERC, with ES when necessary, followed by laparoscopy to be the best two-step approach to cholecysto-choledocholithiasis, allowing both preoperative diagnosis and treatment of choledocholithiasis.[4,16]

Cuschieri et al.[43] compared the conventional two-step procedure (preoperative ERCP followed by LC) with a single-step procedure (LC with simultaneous laparoscopic ductal stone clearance). They found that the efficiency of the laparoscopic single-step procedure was equal to that achieved with preoperative ERCP and LC but had the advantage of lower morbidity and a shorter hospitalization for the patients.

Successful laparoscopic exploration of the common bile duct with laparoscopic duct clearance has been reported in 60–90 % of cases in specialist centers,[3,43–46] and the laparoscopic management of choledocholithiasis has been recommended in the guidelines of EAES.[16] However, it is still a not widely practiced procedure as a matter of routine. It is a hybrid radiologic–endoscopic–surgical procedure that has equipment requirements and technical skills unfamiliar to most surgeons.[47]

Berthou et al.[28] found a 97.1% success rate for laparoscopic common bile duct exploration (LCBDE) by choledochotomy, as compared with a 68.8% success rate for the transcystic approach. The main reasons for the failure of the transcystic method are usually too great a number or size of CBDS or location of the stones above the implantation of the cystic duct into the CBD.[12,28,30] Vecchio and MacFadyen[48] concluded that although LCBDE in experienced hands appears to be the most cost-effective method for treating CBDS, it is a procedure that requires clinical experience as well as advanced laparoscopic skills. They recommended that if such skills are not available among the staff at the hospital, open CBDE or postoperative ERCP should be considered. Enochsson et al.[8] stated that LCBDE is an advanced technique that benefits from the infrastructure at highly specialized academic centers.

ERCP, however, is a high-volume endoscopic technique in academic as well as regional hospitals. It is therefore easy to implement the already familiar technique of ERCP in the operating theater, i.e., combining LC with intraoperative ERCP. An additional advantage with ERCP is that the same technique can be applied irrespective of the diameter of the bile duct stone, whereas large stones cannot be removed by the transcystic laparoscopic approach.[12]

Enochsson et al.[8] reported that in patients undergoing IO-ERCP cannulation of the CBD may be more difficult because the patient is in the supine position. To facilitate cannulation of the CBD Cavina et al.[49] introduced a technique whereby a Dormia basket was passed into the duodenum through the cystic duct; and with a "rendez-vous" technique, the Dormia basket retrieved the sphincterotome from the duodenoscope and guided it into the bile duct. They used this technique in 15 patients of their study and had a CBDS clearance rate of 100%.

Enochsson et al.[8] treated 31 patients with CBDS and applied a slightly modified technique to that of Cavina et al.[49] They introduced a guide-wire through the IOC catheter and into the cystic duct down to the duodenum to direct the sphincterotome over it into the CBD and they reported a bile duct stone clearance rate of 93.5%. Iodice et al.[50] operated on 52 patients suffering from cholecysto-choledocholithiasis and used the same technique as that described by Enochsson et al.[8] and had a success rate of 94% without any complications related to the ERCP or surgery.

We used the same technique as that described by Enochsson et al.[8] and Iodice et al.[50] and we failed to pass the guide-wire through the cystic duct and papilla and cannulate the CBD in three cases (8.3%), and hence our success rate was 91.7%. Our CBDS clearance rate was 100%, and on postoperative follow-up no problems related to a retained stone were encountered.

Meyer et al.[51] treated 60 patients with cholecysto-choledocholithiasis by a combined LC + IO-ERCP technique and reported failure to cannulate the papilla in two cases (3%).

Bago et al.[52] compared preoperative ERCP followed by LC versus LC + IO-ERCP. They reported a success rate of 96.6% in the preoperative ERCP group and 90.2% in the LC + IO-ERCP group.

Hong et al.[46] compared LC + LCBDE versus LC + IO-ERCP. They reported a success rate of 89.36% (126/141 patients) in the LC + LCBDE group and 91.40% success rate (85/93 patients) in the LC + IO-ERCP group. Cannulation of the CBD failed in six patients of their LC + IO-ERCP group due to stone impaction in five cases and due to deformity of the papilla in one case.

Williams and Vellacot[19] failed to cannulate the CBD in two of their 13 patients. They stated that despite initial failure to cannulate the CBD and to deal with the CBDS, perioperative ERCP allowed the surgeon to see if there were any anatomical problems that would prevent successful postoperative ES if needed in the future.

It appears from the review of the previously cited studies that the rate of success we obtained in cannulating the CBD coincides with those reported by several authors in the literature.

We agree with Williams and Vellacot[19] that the presence of an endotracheal tube in the mouth of the anaesthetized patient neither makes IO-ERCP more difficult, nor does the supine position of the patient. Neither is ES made harder to perform in the supine position. Williams and Vellacot[19] found that this technique of LC + IO-ERCP is most advantageous when the same individual acts as both the surgeon and endoscopist. Otherwise; it requires a great deal of time and logistical organization as has been reported in previous studies.[19,53]

Although several studies[8,19] reported some difficulty in visualizing the GB after ERCP by distension of the proximal small bowel loops with air following insufflations during endoscopy, this did not result in failure to complete the procedure safely in any of our patients. We start the cholecystectomy before the ERCP and we took care not to insufflate much air during ERCP and to remove all the gas from the stomach at the end of the ERCP procedure to facilitate completion of the LC.

The mean operating time in our series was 119.09 ± 14.4 min (ranging from 100 to 150 min). Enochsson et al.[8] reported an operating time for LC + IO-ERCP of 192.0 ± 8.9 min. They considered the main disadvantage of this procedure to be the prolonged operating time, as in the hands of their surgeons, the mean operating time was prolonged by 85 min, as compared with LC alone, mainly due to logistic factors, i.e., installation of the endoscopy unit and the C-arm X-ray set, and not so much to the actual operating method. They reported that the operating time was reduced in the second year of their study by 50 min, as a result of improvements in the technique and a more effective organization with better logistics. Several

authors reported a shorter operating time. DePalma et al.[53] reported that the mean duration of the operative time for the combined procedure was 97.7 ± 30.4 min. Williams and Vellacot[19] reported a median total operating time of 75 min (ranging from 50 to 85 min), and considered that perioperative ERCP added 20 min to their total operating time. Meyer et al.[51] reported a mean operating time of 60 min (ranging from 40 to 90 min) for LC only, and found that the general anesthesia had to be prolonged by 40 min (ranging from 30 to 60 min) in order to perform IO-ERCP and ES including the time required for equipment installation. Iodice et al.[50] reported that the operating time in their series was prolonged only by 23 min; they selected only a few patients with suspected ductal stones or stones found incidentally by IOC. We agree with Enochsson et al.[8] that our longer operating time can be explained by the fact that IO-ERCP was performed in all patients having CBDS even if their diameter was larger than 5 mm. We also suggest that the operating time can be reduced as the learning curve for this procedure increases and with gaining of experience in the technique and its logistic requirements. Hong et al.[46] found that the LC + LCBDE technique requires a longer learning curve in training for laparoscopic sutures needed in T-tube placement.

We did not encounter a single case of postoperative ERCP pancreatitis in our series. Bago et al.[52] compared in a prospective study the use of preoperative ERCP followed by LC and LC + IO-ERCP using the "rendez-vous" technique for the management of patients with CBDS. They found that the total morbidity, post-ERCP morbidity and post-ERCP pancreatitis rates were higher in the preoperative ERCP group. Wright et al.[54] in a similar comparative study reported one case with mild ERCP-related complication in the preoperative ERCP-then-LC group. We believe as others[8,52] that the technique of introducing a guide-wire through the cystic duct facilitates selective cannulation of the CBD and minimizes the risk of cannulating the pancreatic duct and hence the risk of post-ERCP pancreatitis. Also, because the number of negative unnecessary preoperative ERCP is reduced significantly when using this technique, we believe as others[8,19] that complication rates will be low. Williams and Vellacot[19] stated that avoidance of post-ERCP pancreatitis is one of the main goals of the LC + IO-ERCP technique in the management of CBDS.

Hong et al.[46] compared LC + IO-ERCP versus LC + LCBDE for the treatment of cholecysto-choledocholithiasis. They found no significant differences between both groups with regard to the incidence of postoperative retained stones or complications. They reported complications in eight cases of LC + IO-ERCP group: four cases of asymptomatic serum amylase elevation, one case of bile leakage treated by US-guided drainage, one case of pneumonia, one case of pancreatic pseudocyst in a patient with preoperative diagnosis of acute biliary pancreatitis, and one patient with recurrent jaundice due to papillary adenocarcinoma. We reported minor complications in the form of mild basal atelectasis, chest infection and mild fever in 15 patients. No mortality was reported in our series. This in accordance with the findings of other series.[51,53]

Patients in our study were discharged after a mean hospital stay of 2.55 ± 0.89 days. This is in concordance with the results of other studies in which it ranged from a mean of 2.5 days (ranging from 1 to 5 days) in Williams and Vellacot series,[19] 2.6 ± 0.4 days (ranging from 1 to 3 days) in Enochsson et al. series,[8] 3 days in Iodice et al.[50] and DePalma et al.[53] series, and 4.6 days (ranging from 3 to 11 days) in Meyer et al.[51] series. Hong et al.[46] comparing LC + IO-ERCP versus LC + LCBDE found no statistically significant difference between both techniques regarding postoperative hospital stay and total hospital charges. On the other hand, although Berthou et al.[28] had a high success rate in their series of LC + LCBDE, their mean hospital stay was 7.8 days (ranging from 2 to 48days). Decker et al.[55] performed LC + LCBDE in 100 patients with primary closure of the CBD without any biliary drainage and reported a median hospital stay of 8 days (ranging from 3 to 32 days). Wright et al.[54] compared LC + IO-ERCP versus preoperative ERCP followed by LC and found that the length of hospital stay and costs were lower in the LC + IO-ERCP group despite the longer surgical times in this group. From the previous results it appears that the LC + IO-ERCP technique does not prolong the postoperative hospital stay significantly and is cost-effective. Williams and Vellacot[19] stated that hospital stay can be kept to a minimum by treating both CBD and GB stones during the same visit using the LC + IO-ERCP technique. This method is similar to the one-stage procedure of LCBDE, but it avoids the potential postoperative management problem associated with T-tube that is required in some cases of LCBDE.

Along the postoperative follow-up period; none of our patients presented with symptoms, signs, laboratory or US evidence of retained CBDS. Meyer et al.[51] using the LC + IO-ERCP technique reported failure of perioperative ES in two patients (3%) due to impossibility of catheterizing the papilla. In the first patient postoperative ERCP was successful to remove the stone, and in the second patient, the small CBDS was left to pass spontaneously. On the other hand, they found a retained stone in two patients on the sixth postoperative day with spontaneous evacuation of the stones 2 weeks later. Wright et al.[54] reported a CBD access and stone clearance in all the 14 patients (100%) they treated using the LC + IO-ERCP technique. Enochsson et al.[8] using the LC + IO-ERCP could not clear the CBD from stones in two out of 31 patients in their series. They performed intraoperative ES and inserted a plastic endoprothesis to secure bile flow until postoperative ERCP was performed successfully. Fanelli et al.[56] stated that laparoscopic endobiliary stent placement during LC ensures selective cannulation during postoperative ERCP and eliminated the need for repeated attempts at ERCP or reoperation for retained CBDS.

Hong et al.[46] concluded that both the LC + IO-ERCP and LC + LCBDE techniques can be used effectively and safely for treating cholelithiasis with CBDS. Although, they were concerned with the presumed and controversial issue of post-ES long term sequel of stone recurrence and biliary carcinoma caused by permanent duodenal and pancreatic fluid reflux.[2,12,13,15] Most of the authors in the different previously mentioned studies concluded that LC + IO-ERCP technique is reliable, effective, safe (low morbidity and mortality), has a short hospital stay, and is cost-effective.[8,19,49,50,52,53,54]

The optimal management of CBDS is dependent on the skills and techniques of the surgical team available at the local hospital. There is no doubt, however, that the single-step procedure has some definite advantages over two-step methods. In the future, there should perhaps be a more diversified approach using the single-step techniques, whereby the laparoscopic transcystic method can be used to remove small distal CBDS and IO-ERCP can be reserved for large CBDS and stones in the common hepatic duct.

In conclusion, the current study suggests that LC + IO-ERCP for the management of cholecysto-choledocholithiasis is a safe and effective technique with a low rate of post-ERCP pancreatitis. It offers another alternative for surgeons especially those who do not practice LCBDE to treat patients in a single setting. However, additional studies with larger patient populations are needed keeping in mind that the limiting characteristic is the proximity and availability of the endoscopic settings.

Conflict of interest

There are no specific conflicts of interest.

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Ethical approval

Ethical approval was given by Ethical Committee of Alexandria Faculty of Medicine.

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