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Selective Endoscopic Cholangiography for the Detection of Common Bile Duct Stones in Patients with Cholelithiasis

Background and Study Aims: The detection and management of common bile duct (CBD) stones in patients undergoing laparoscopic cholecystectomy continues to be controversial. Several diagnostic and therapeutic strategies have been suggested. These include intraoperative cholangiography, selective endoscopic retrograde cholangiopancreatography (ERCP), magnetic resonance cholangiopancreatography, and endoscopic ultrasonography. The aim of this study was to evaluate the efficacy of selective ERCP in detecting CBD stones in patients with cholelithiasis before laparoscopic cholecystectomy.

Patients and Methods: In a prospective study, patients with cholelithiasis who presented during a 6-year period were assessed on a selective basis with ERCP for suspected CBD stones before laparoscopic cholecystectomy. ERCP was carried out if the patient had any of the following criteria: a dilated CBD on ultrasound, gallstone pancreatitis, or abnormal liver function tests. Intraoperative cholangiography was not performed in any of the patients. Long-term follow-up was undertaken.

Results: The study included 427 patients. On the basis of selective criteria, ERCP was carried out in 41 patients (9.6%), with confirmed CBD stones in 22 cases (53.7%). The most useful predictor of CBD stones on ERCP was the presence of a dilated CBD in association with abnormal liver function tests. In this situation, CBD stones were identified in 14 of 17 cases (82%). Abnormal liver function tests alone had a sensitivity of 50% (four of eight). All other parameters used in isolation had a lower detection rate. During a median follow-up period of 6 years (range 1–10 years), six of 386 patients (1.6%) with initially normal imaging and biochemical tests presented again with retained stones. All were successfully managed by ERCP and sphincterotomy. There were no major complications.

Conclusions: Preoperative selective ERCP is effective in detecting clinically significant CBD stones. However, there is a high false-negative rate when a single criterion is used to guide therapy. Multivariate analysis of preoperative parameters for risk stratification, in conjunction with other imaging modalities, may make it possible to minimize unnecessary ERCPs.

Introduction

The detection and management of common bile duct (CBD) stones in patients undergoing laparoscopic cholecystectomy are controversial. Several diagnostic and therapeutic strategies have been suggested, ranging from routine intraoperative cholangiography or selective endoscopic retrograde cholangiography (ERCP) to magnetic resonance cholangiopancreatography and endoscopic ultrasonography (EUS), more recently. Some of these options have been used in isolation or in combination with each

other, but there is as yet no single universally endorsed management strategy [1–6].

The present study assessed the value of selective ERCP in the management of CBD stones in a prospective group of patients with cholelithiasis before laparoscopic cholecystectomy. In addition, the study aimed to assess whether omitting intraoperative cholangiography results in a clinically significant rate of retained stones during the follow-up period.

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Table 1 Indications for endoscopic cholangiopancreatography and findings

Patients (n)	Dilated CBD >10 mm	CBD stones on ultrasound	Abnormal serum liver enzymes	Pancreatitis	Positive ERCP for CBD stones
2	-	-	-	+	0 (0 %)
4	-	-	+	+	2 (50 %)
10	+	-	-	-	2 (20 %)
2	+	+	+	-	2 (100%)
15	+	-	+	-	12 (80 %)
8	-	-	+	-	4 (50 %)

CBD: common bile duct; ERCP, endoscopic cholangiopancreatography.

Patients and Methods

A prospective study was conducted, including 427 consecutive patients who presented to one surgeon with symptomatic gallstones between 1993 and 1998. All of the patients had had gallstones documented on ultrasonography and had been referred for assessment and consideration for laparoscopic cholecystectomy. Preoperative ERCP was considered to be indicated if any of the following criteria were present:

- *Transabdominal ultrasound findings.* CBD diameter of more than 10 mm and/or direct visualization of CBD stones.
- *Abnormal liver function tests (LFTs).* Bilirubin > 30 $\mu\text{mol/l}$ (normal range <21 $\mu\text{mol/l}$); alkaline phosphatase (ALP) > 130 mmol/l (normal range < 110 mmol/l); γ -glutamyltranspeptidase (GGT) > 80 mmol/l (normal range 0–60 mmol/l); and alanine transferase (ALT) > 60 mmol/l (normal range 0–40 mmol/l).
- *Pancreatitis.* A history suggestive of pancreatitis and biochemical evidence (amylase > 1000 mmol/l, five times the normal laboratory value) or radiographic verification (by computed tomography) in patients with confirmed gallstones on ultrasonography.

The ERCP procedures were carried out by a single endoscopist (C.C.). Only patients with documented stones on ERCP proceeded to endoscopic sphincterotomy before laparoscopic cholecystectomy. All patients consented to the management protocol. Intraoperative cholangiography was not performed in this series.

The scheduled follow-up consisted of clinical consultations with the operating surgeon after 6 weeks, and then after 6 and 12 months. Clinical, biochemical, and radiographic assessments were undertaken when indicated. The final follow-up data were obtained either during a direct clinical consultation or by phone consultation with the patient or treating doctor.

Results

A total of 427 consecutive patients (261 women, 166 men; mean age 44.6 years and 56.1 years, respectively) were considered for laparoscopic cholecystectomy. No patients in the series were excluded from the study.

Forty-one patients (9.6%) met one or more criteria for preoperative ERCP (Table 1). Twenty-seven patients had a dilated CBD with a diameter larger than 10 mm, with two having ultrasound evidence of intraductal stones. Six patients had associated pancreatitis, and 29 patients had elevated serum liver enzymes. Twenty-two of the 41 patients (53.7%) undergoing ERCP had detectable CBD stones. Sphincterotomy was carried out in all patients with CBD stones, with successful removal of the stones. There were no major procedure-related complications, and all of the patients proceeded to treatment with laparoscopic cholecystectomy. Only diagnostic ERCP procedures were carried out in all of the other patients.

The strongest predictive factor for CBD stones on ERCP was a dilated CBD in association with abnormal liver function tests (LFTs). CBD stones were identified in 14 of 17 patients (82%) with both of these abnormal variables. This included two patients with CBD stones identified within a dilated biliary tree on ultrasound. As single factors, dilated CBD, pancreatitis, or abnormal LFTs on their own had a low sensitivity for the presence of stones on ERCP.

The median follow-up period after cholecystectomy was 6 years (range 1–10 years). None of the patients was lost to follow-up. The total incidence of documented CBD stones was 28 of 427 (6.6%). This total included six patients (1.4%) who had had normal preoperative imaging and blood tests and who presented with retained CBD stones during the follow-up period. These patients were successfully managed with ERCP and sphincterotomy.

Discussion

The presence of CBD stones in patients undergoing cholecystectomy is a common problem, with a reported incidence of approximately 5–15% [1,7]. The management of these patients continues to be controversial. Predictive factors are used to identify which patients are most likely to have CBD stones and to limit unnecessary investigations in the remaining group without CBD stones. On the basis of these predictive variables, several diagnostic modalities can be used to confirm the presence of stones. The aim of preoperative treatment of CBD stones is to minimize the costs and morbidity associated with laparoscopic cholecystectomy and the potential sequelae of retained stones [1,8–12].

Carrying out routine intraoperative cholangiography increases the operating time. The method has an appreciable false-positive rate (5%) and detects stones that may not subsequently cause any problems [13,14]. It was shown in this study that among patients with cholelithiasis who have no initial imaging or biochemical abnormalities suggesting pathology in the biliary tree, only 1.6% (six of 386) over a median of 6 years present again with retained CBD stones after laparoscopic cholecystectomy. These findings are consistent with those of other published series (1.3%, 17 of 1300, median follow-up 22 months [15]; 0.7%, 12 of 1674, median follow-up 30 months [13]). Routine intraoperative cholangiography therefore has an extremely low yield in detecting potentially symptomatic stones in patients who have no positive predictive factors for CBD stones. Laparoscopic extraction of CBD stones in all relevant cases is also technically difficult and can have a significantly higher morbidity in comparison with surgical treatment [15,16]. The proponents of intraoperative cholangiography suggest that it may help clarify difficult anatomy and reduce bile duct injuries [17]. This might be true for inexperienced surgeons [2], but in general it has not been proved that it reduces the rate of surgery-related complications [13,14]. Furthermore, a randomized controlled trial concluded that, given the additional financial and logistic costs associated with intraoperative cholangiography, routine use of the procedure is not justified [18,19]. Other strategies, such as selective preoperative ERCP based on laboratory tests and imaging, are therefore commonly used to manage suspected CBD stones in many institutions [14,20].

ERCP is a reliable method of diagnosing and treating CBD stones [14,21]. It achieves successful imaging in approximately 90–95% of patients, and stones can be successfully extracted in the vast majority of cases [1,14,20]. In the present series, the extraction rate was 100%. However, ERCP, especially with endoscopic sphincterotomy, is a high-risk procedure with a morbidity rate in the range of 3–6% and a mortality rate of 0.05–0.10% [9]. The morbidity and mortality rates increase to 10% and 0.4%, respectively, when the procedure is accompanied by sphincterotomy [1]. Judicious use of ERCP is therefore prudent, and a selective approach has to be adopted.

Several studies have attempted to evaluate predictive factors capable of maximizing the sensitivity and specificity of ERCPs in patients with a preoperative suspicion of CBD stones [3,15,22–24]. Most studies have developed strategies based on several factors. The present study only included readily obtainable data, to allow ease of application and usefulness at the bedside. Importantly, for ERCP to be performed in this study, only one abnormal parameter was needed, so that the abnormal values used are conservative in comparison with other series [15,20,25,26].

The first-line investigation in patients with suspected cholelithiasis was ultrasonography. Although direct visualization of CBD stones is uncommon, dilation of the CBD is far more likely in the presence of CBD stones [11,15,20,25]. The degree of dilation correlates with the likelihood of CBD stones and the patient's age. In this study, a CBD diameter above 10 mm was considered abnormal and was observed in 6% of patients with cholelithiasis (27 of 427 patients). Overall, 64% of patients with ERCP-confirmed CBD stones (14 of 22 patients) had a dilated CBD. CBD di-

lation on its own was associated with ductal stones in 20% of cases (two of 10 patients). These findings are in keeping with those of other reported studies, showing that the predictive value of an isolated dilated CBD for CBD stones is poor [27,28].

Elevated liver function tests and serum pancreatic enzyme levels have also been commonly used to predict the likelihood of CBD stones in patients with cholelithiasis. There are conflicting reports in the literature regarding which biochemical abnormalities have higher predictive values [9,22,23,25,27]. In the present study, the results showed a diagnostic yield of 50% (four of eight) when LFTs were raised in isolation. This figure varies widely between reports, depending on the definition of abnormal used for a given LFT and whether individual LFTs are considered separately or simultaneously. As would be expected, the diagnostic accuracy increases with higher normal limits and when more than one LFT is considered in combination [3,6,15]. In addition, normal LFTs are a highly accurate negative predictor of CBD stones [29], while in patients with gallstone pancreatitis, an elevated amylase level on its own correlates poorly with the likelihood of CBD stones [15,22,27,28]. Spontaneous passage of stones occurs in 70–80% of patients with gallstone pancreatitis, especially in mild disease [30,31]. The two patients with pancreatitis and an isolated elevated amylase level in this study had no evidence of CBD stones on ERCP.

In this series, the univariate analysis showed that the highest percentage of detectable CBD stones was 50% when abnormal LFTs were considered in isolation. When a combination of one or more predictive factors was considered, the detection rate was 54% (37–69%). This demonstrates that patients need to be identified even more selectively. A meta-analysis concluded that any strategy for predicting CBD stones should use a multivariate analysis [28]. Several large studies have examined which combination of parameters would result in the highest sensitivity and specificity rates for preoperative CBD stone detection. Many of these parameters have been used to calculate various models such as nomograms, algorithms, or formulas. Regardless of the proposed analysis, however, the variables most commonly used are the CBD diameter in association with one or more LFTs [15,22,25]. In this study, the detection rate for CBD stones on ERCP was 82% (64–100%) in the presence of a combination of a dilated CBD (with or without a visualized stone) and abnormal liver function tests. This figure is similar to those in other series (82% [6] and 72% [15]). In these high-risk patients, it may be prudent to carry out ERCP without additional tests. However, when a predictive model stratifies a patient as being at medium or low risk for CBD stones, further diagnostic investigations may be considered.

Magnetic resonance cholangiopancreatography (MRCP) might be able to serve as a noninvasive method of accurately identifying patients with CBD stones before ERCP [32]. It is effective in the diagnosis of choledocholithiasis, with a high sensitivity and specificity for identifying biliary strictures, dilation, calculi, strictures and biliary tree anomalies [3,32,33]. There are no significant differences between MRCP and ERCP with regard to the methods' sensitivity and specificity for detecting calculi in the CBD or gallbladder [5,33]. The sensitivity and specificity rates with MRCP have been reported as 90–100% and 98–100%,

respectively [26, 33–36]. However, in contrast to ERCP, simultaneous treatment is not possible during MRCP, and the method has been reported to miss small stones (<2–3 mm) [33]. Admittedly, the clinical significance of such stones has yet to be determined, and small stones have been found in nondilated systems [33]. The use of routine MRCP is restricted by the high cost and limited availability of the equipment [7]. Although the costs of ERCP have been reported to be almost half those of MRCP [26], the total costs of the two procedures were found to be approximately equal in the present study when all the different aspects of ERCP (anesthetics, recovery bed, etc.) were taken into account. There are several contraindications to MRCP (such as the presence of pacemakers, cerebral aneurysm clips). More importantly, however, the negative predictive value of MRCP is at least 96% [26, 33–36], and it is therefore a useful alternative to diagnostic ERCP in low-risk or medium-risk patients.

Another purely diagnostic imaging modality that may be able to limit the numbers of unnecessary ERCPs carried out is endoscopic ultrasonography. Overall, EUS has a high accuracy rate, with sensitivities and specificities similar to those of ERCP [37–39]. However, due to the limited availability of EUS, it has not yet been evaluated as thoroughly as other modalities [40, 41]. In addition, it is a somewhat invasive procedure requiring sedation, which may limit its benefits over MRCP. However, EUS is better at detecting biliary sludge and smaller stones than MRCP [4] – although, as mentioned above, the importance of these is questionable.

Conclusions

Selective preoperative ERCP before laparoscopic cholecystectomy is effective in dealing with CBD stones, both in the short term and longer term. Only a multivariate analysis (usually involving analysis of the CBD diameter and abnormal LFTs) is capable of stratifying a patient's risk of having a significant CBD stone when presenting for laparoscopic cholecystectomy. Dilation of the CBD in conjunction with elevation of one or more LFTs in patients with gallbladder stones is highly predictive of CBD stones, and warrants ERCP without further delay or investigations, while isolated dilation or elevated LFTs should be investigated further with MRCP (as the first-line examination) or EUS (as the second-line examination).

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