Endoscopic Retrograde Cholangiopancreatography Prior to Laparoscopic Cholecystectomy

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**Objective:** To establish the extent to which preoperative endoscopic retrograde cholangiopancreatography (ERCP) is practiced by a representative group of surgeons in the United Kingdom, and to determine its safety and efficacy when compared with a policy of routine intraoperative cholangiography (RIOC), without preoperative ERCP, employed by a single surgical unit.

**Design:** Comparison study between patients undergoing laparoscopic cholecystectomy and patients undergoing laparoscopic cholecystectomy with RIOC.

**Setting:** Four hospitals in the Pennine Acute Hospitals NHS Trust in the northwest of England.

**Patients:** A total of 1622 patients undergoing laparoscopic cholecystectomy during the period from 2005 to 2007.

**Results:** Of the 1622 patients included in our analysis, 463 patients had an RIOC performed by a single surgical unit. Of the remaining 1159 patients, 188 (16.2%) underwent a preoperative ERCP for suspected common bile duct stones, 107 (56.9%) of whom had negative results. Three patients, 2 of whom had no common bile duct stones, developed post-ERCP pancreatitis. The median duration between ERCP and laparoscopic cholecystectomy was 75 days. Of the 463 patients who underwent an RIOC, 36 (7.8%) had common bile duct stones, 18 (50% of common bile duct stone cases, 3.9% of all 436 RIOC cases) of whom had no preoperative markers for common bile duct stones. There were no bile duct injuries among patients who underwent an RIOC.

**Conclusions:** Preoperative ERCP is widely used in the United Kingdom, but it frequently results in negative findings and therefore is unnecessary. It is associated with significant morbidity, which can be avoided when a policy of RIOC is employed.

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STONE MIGRATION INTO THE common bile duct (CBD) is the most dangerous common complication of gallstone disease, and yet no standard approach exists for identifying CBD stones in patients undergoing laparoscopic cholecystectomy (LC). Preoperative endoscopic retrograde cholangiopancreatography (ERCP) is widely employed but has significant complication rates as highlighted by a recent audit of ERCP practice in the United Kingdom, with a procedure-related mortality rate of 0.4%, which is higher than that of LC itself. Magnetic resonance cholangiopancreatography (MRCP) is not universally available in UK hospitals and not reliable in detecting small CBD stones. In addition, neither ERCP nor MRCP is necessarily performed immediately before surgery, allowing time for preoperative stone migration. Conversely, routine intraoperative cholangiography (RIOC) can eliminate the need for preoperative ERCP and allows “real-time” diagnosis without an increase in operative risk, provided a strategy is available for the safe management of identified CBD stones. Our study aimed to examine the approach of a single surgical unit that employs RIOC in an attempt to avoid preoperative ERCP, and to compare it with the practice of other units in our institution.

**METHODS**

The setting was 4 hospitals in the Pennine Acute Hospitals NHS Trust in the northwest of England, serving a patient population of 800 000 and performing between 1.5% and 2% of all LCs annually in the United Kingdom. Patients un-
dystrophic cholecystectomy (LC). The terms "positive" and "negative" refer to the presence and absence of CBD stones, respectively. ERCP indicates endoscopic retrograde cholangiopancreatography; MRCP, magnetic resonance cholangiopancreatography; RIOC, routine intraoperative cholangiography; and SIOC, selective intraoperative cholangiography. *Includes 8 patients excluded from our analysis. †Includes 3 patients who underwent an ERCP that failed.

**RESULTS**

A total of 471 patients underwent an RIOC, and this procedure was performed by a single unit dedicated to gallbladder surgery. Eight patients who were admitted for acute care with suspected CBD stones underwent preoperative ERCP owing to the unavailability of operating-theater time, and these 8 patients were excluded from our analysis. The female to male ratio was 4:1. The mean (SD) age was 47.8 (14.8) years. All procedures were performed by a single consultant (ie, a serum alkaline phosphatase level of >150 U/L [to convert to microkatal per liter, multiply by 0.0167] and an alanine transaminase level of >35 U/L [to convert to microkatal per liter, multiply by 0.0167]), to have had a dilated CBD or CBD stone detected on a magnetic resonance imaging scan, or to have had gallstone pancreatitis. However, absolute indications varied between the clinicians who cared for these patients.

SPSS version 15.0 (SPSS Inc, Chicago Illinois) was used to statically analyze our data. A P value of less than .05 was considered to be statistically significant. Numerical data were analyzed using a 2-tailed t test when the data were normally distributed and the Mann-Whitney test when the data were not normally distributed. The χ² test was used for nominal data.

The technique for patients undergoing RIOC was standardized. Dynamic fluoroscopy was used in all instances. The cystic duct was identified, and a Weck Horizon titanium ligation clip (Teleflex Medical Ltd, Hampshire, England) was placed at the Hartmann pouch. A cystic ductotomy was performed using laparoscopic scissors. The cystic duct was massaged in a retrograde fashion to ensure that no debris or stones were propelled into the CBD on insertion of the catheter. A C-arm x-ray device was placed in position after which Niopam 200 (Bracco UK Ltd, Buckinghamshire, England) was infused via a cystic duct catheter. Patients who were found to have CBD stones after an RIOC were treated with 2 laparoscopic transcystic biliary stents to secure biliary drainage followed by postoperative ERCP for CBD stone removal. This included patients who had no preoperative markers for CBD stones but who subsequently had a positive finding on cholangiogram (ie, CBD stones were present). The reasoning behind this was to reduce the risk of these asymptomatic CBD stones becoming symptomatic in the time between LC and postoperative ERCP. From a cost-benefit viewpoint, the cost of inserting 2 stents is minimal compared with that of hospitalization secondary to acute pancreatitis or cholangitis.

Although long-term efficacy has yet to be established, alternative methods such as laparoscopic CBD exploration have been shown to be as effective as ERCP for clearing CBD stones.10 However, we have adopted the approach described above for the management of CBD stones because it is simple and safe. Furthermore, our local resources and allotted operating-theater time favor this approach, and we find that repetition of one technique improves overall efficiency in the operating theater.

In total, 1630 patients underwent LC between August 2005 and August 2007. The results are summarized in the **Figure**.

**LC WITH RIOC**

A total of 471 patients underwent an RIOC, and this procedure was performed by a single unit dedicated to gallbladder surgery. Eight patients who were admitted for acute care with suspected CBD stones underwent preoperative ERCP owing to the unavailability of operating-theater time, and these 8 patients were excluded from our analysis. The female to male ratio was 4:1. The mean (SD) age was 47.8 (14.8) years. All procedures were performed by or in the presence of a single consultant (ie,
an upper-gastrointestinal tract surgeon). Of 463 patients who underwent an RIOC, 394 (85.1%) were admitted electively and 69 (14.9%) were admitted for acute care. Indications for surgery were biliary colic (350 patients), acute cholecystitis (36 patients), and suspected CBD stones (77 patients, 20 of whom had acute pancreatitis).

The median (interquartile range [IQR]) duration of operation was 74 (63-92) minutes. Cannulation for RIOC was successful in 459 of the 463 patients (99.1%). There were no direct intraoperative complications secondary to RIOC. Of the 463 patients, 10 (2.2%) had their procedure converted to open cholecystectomy (8 had their procedure converted owing to severe cholecystitis and 2 for open bile duct exploration). The median (IQR) postoperative length of hospital stay was 2 (1-2) days. Four (0.9%) of the 463 patients had significant complications (3 had bile leaks and 1 had an intra-abdominal collection). There were no CBD injuries.

Of 77 patients who were preoperatively suspected of having CBD stones on the basis of National Institutes of Health criteria, 18 (23.4%) were found to have CBD stones. Another 18 patients, with no preoperative markers for CBD calculi, were found to have stones on cholangiogram. Two patients had open bile duct exploration because their CBD stones were deemed too large to be easily removed at postoperative ERCP. For the remaining 34 patients with CBD stones, 2 biliary stents were inserted laparoscopically, and their stones were cleared postoperatively during ERCP (with no complications) after a postoperative interval sufficient for wound healing (median [IQR], 49.5 (23-65) days).

### LC WITHOUT RIOC

A total of 1159 patients underwent LC without RIOC, and this number represents all LCs not undertaken by the single unit performing RIOC. The female to male ratio was 4:1. The mean (SD) age was 50.2 (15.7) years. The median (IQR) duration of operation time was 72 (55-93) minutes, the median (IQR) postoperative length of hospital stay was 2 (1-3) days, and 83 patients (7.2%) had their procedure converted owing to open cholecystectomy. Twelve patients (1.0%) had significant complications, 4 had common bile duct injuries, 3 had bile leaks, 3 had an intra-abdominal hemorrhage, and 1 had a small-bowel injury that resulted in death (Table).

A total of 188 patients (16.2%) underwent preoperative ERCP for suspected CBD stones. There were 3 failed ERCPs. Of these 188 patients, 107 (56.9%) tested negative for CBD stones. Three patients developed post-ERCP pancreatitis, 2 of whom were found to have no CBD stones during ERCP and had hospital stays of 3 and 6 days, respectively. The patient with post-ERCP pancreatitis who was found to have CBD stones stayed in the hospital for 11 days and required a period of stay in the high-dependency unit. The median (IQR) time to surgery following ERCP was 75 (28.75-147.75) days.

Preoperative MRCP for suspected CBD stones was performed for 43 of the 1159 patients (3.7%). This represented 19.5% of those with suspected CBD stones not undergoing RIOC. Eleven of these went on to have an ERCP, only 7 of whom tested positive for calculi. The median (IQR) time to surgery following MRCP was 77 (32-163) days. Selective intraoperative cholangiography was performed for 32 of the 1159 patients (2.8%), 8 (25.0%) of whom tested positive for CBD stones.

### Table. Comparison of Laparoscopic Cholecystectomy (LC) With and Without Routine Intraoperative Cholangiography (RIOC)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>RIOC (n = 463)</th>
<th>LC Without RIOC (n = 1159)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of operation, median (IQR)</td>
<td>74 (63-92)</td>
<td>72 (55-93)</td>
<td>.06</td>
</tr>
<tr>
<td>Postoperative length of hospital stay, median (IQR)</td>
<td>2 (1-2)</td>
<td>2 (1-3)</td>
<td>.54</td>
</tr>
<tr>
<td>Conversions, No. (%)</td>
<td>10 (2.2)</td>
<td>83 (7.2)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Complications, No. (%)</td>
<td>4 (0.9)</td>
<td>12 (1.0)</td>
<td>.75</td>
</tr>
</tbody>
</table>

Abbreviation: IQR, interquartile range.

*aThis complication resulted in the death of the patient.

Approximately 50,000 LCs are undertaken annually in UK National Health Service hospitals.11 Our institution, which serves a population of 800,000, is one of the largest in the United Kingdom and services between 1.5% and 2% of this population. It is therefore our view that our findings reflect common practice in the United Kingdom.

### ERCP AND OTHER PREOPERATIVE INVESTIGATIONS

Endoscopic retrograde cholangiopancreatography is the gold standard against which other methods of investigating the CBD are measured.12,13 Advances in techniques such as MRCP, endoscopic ultrasonography, and laparoscopic ultrasonography may optimize preoperative diagnosis and hence treatment of CBD stones,6,14 but these modalities have limitations. Magnetic resonance cholangiopancreatography is of limited use in identifying CBD stones measuring less than 5 mm in diameter.3,6 In addition, when there is a time delay between MRCP and surgery, there is a theoretical risk of stone migration. Our finding of a median of 77 days between preoperative MRCP and surgery highlights this point. Magnetic resonance cholangiopancreatography is also not universally available. In our institution, it is only available at 2 of the 4 hospitals. An extensive literature search revealed no accurate data relating to the availability or extent of use of this technique in the United Kingdom or elsewhere. Of 11 patients who underwent ERCP on the basis of MRCP findings, 4 tested negative for CBD stones.
stones and were not therefore protected from unnecessary ERCP by MRCP.

Preoperative endoscopic ultrasonography is relatively invasive and not widely available. Intraoperative endoscopic ultrasonography is an attractive option, but it requires training and has a significant learning curve. In our analysis, 23 surgeons performed a median of 29 LCs (range, 10–463 LCs) during the 2-year period. It is our view that to train such a large number of surgeons at differing stages in their careers in a new technique that may not be performed regularly is both costly and unrealistic. This also raises issues regarding who should be performing this operation, but that is a topic outside the scope of this discussion.

Endoscopic retrograde cholangiopancreatography is associated with a recognized risk of complications. Recently published data from the British Society of Gastroenterology’s national audit of ERCP practice in the United Kingdom reported a post-ERCP complication rate of 5.1% and a procedure-related mortality rate of 0.4%. This significant risk was reflected in our findings of 3 cases of post-ERCP pancreatitis. Two of these cases had no evidence of CBD stones during ERCP and thus did not require the procedure in the first instance. All had a significantly increased length of hospital stay, and 1 patient required a period of stay in the high-dependency unit. In spite of this, our study suggests that ERCP is still widely used as a diagnostic tool. Our finding that more than 50% of patients undergoing ERCP tested negative for CBD stones has been demonstrated by several studies, suggesting that this is a widespread problem.

In addition, the 75-day time delay between ERCP and surgery suggests that CBD stones could have been missed at the time of surgery in patients not undergoing RIOC. This time delay is likely due to the fact that, in the United Kingdom, gallbladder surgery is still seen by most surgeons as a procedure that should be performed electively. Furthermore, a large proportion of LCs are performed by surgeons who are not upper gastrointestinal/hepatico-biliary surgeons and therefore may not be keen to proceed with cholecystectomy in the acute phase owing to an inaccurate perception of a higher rate of conversion to an open procedure and complications. In addition, a proportion of patients are initially admitted under the care of medical physicians who may perform ERCP before referring the patient for surgery. Both factors have an adverse effect on the time between ERCP and cholecystectomy. Endoscopic retrograde cholangiopancreatography has also been recognized to cause acute cholecystitis leading to increased operative difficulty, especially when there is significant delay between ERCP and surgery.

The National Institutes of Health suggests that stones in the CBD should be suspected if the patient has undergone testing for deranged liver function, has had a dilated CBD or CBD stone detected on a magnetic resonance imaging scan, or has had gallstone pancreatitis. However, no further guidance is given regarding the timing of preoperative investigations or the degree of derangement of liver function. Some studies have suggested that preoperative risk stratification should be employed before subjecting patients to ERCP. In our study, 3.7% of patients with no preoperative markers for CBD calculi were found to have a positive intraoperative cholangiogram. Preoperative risk stratification would not have been useful in this group, and these findings are supported by other studies. On this basis, each year, an estimated 1850 patients undergoing LC in the United Kingdom therefore have unexpected CBD stones, and many of these will be missed because RIOC is by no means standard practice.

INTRAOPERATIVE CHOLANGIOGRAPHY

Intraoperative cholangiography is a simple technique to learn and perform with negligible complication rates. It allows real-time visualization of the CBD and thus minimizes the need for unnecessary preoperative investigations, provided that a strategy for prevention of perioperative complications from these stones exists. Potential strategies include laparoscopic or open CBD exploration, or transcystic CBD stenting (as in our RIOC group) with postoperative ERCP.

The debate as to whether one should use intraoperative cholangiography selectively or routinely is one that continues to divide opinion among gallbladder surgeons. Those who advocate selective intraoperative cholangiography argue that RIOC simply prolongs the duration of operation and is an unnecessary expense because asymptomatic CBD stones have a benign natural history. However, as our data set suggests, RIOC only adds minutes to the procedure. Where cost is concerned, there is evidence to suggest that RIOC is justified, and up to 50% of patients with asymptomatic CBD stones become symptomatic later in life (sometimes many years after surgery when patients are elderly, at which point pancreatitis or cholangitis poses a greater risk).

Many authors also describe the additional benefit of RIOC in identifying the biliary anatomy. Although we feel that this should not be the primary use for RIOC, there is no doubt that this reassurance is helpful, particularly in difficult dissections. The relationship between bile duct injuries and RIOC has been studied extensively. Although not necessarily protective against all bile duct injuries, intraoperative cholangiography has been shown to reduce the severity and hasten the recognition of the injury, thus reducing the level of associated morbidity.

In conclusion, ERCP is still in widespread use in the United Kingdom as a diagnostic procedure for suspected CBD stones. More than 55% of patients who underwent ERCP in our series tested negative for CBD stones, and therefore ERCP was unnecessary. There is a recognized risk of complications and death with this procedure, quite apart from the discomfort afforded to the patient and the associated costs of around £1000 (1680 US dollars) per procedure. Patients investigated initially by ERCP often face preoperative time delays, during which patients remain symptomatic and some will develop CBD stones. If, as we believe, our experience is representative of the NHS as a whole, we would find approximately 3500 unnecessary preoperative ERCPs annually in the United Kingdom and almost inevitably some deaths among these patients.
In an ideal health service, every patient undergoing LC would have a high-quality, accurately reported MRCP immediately prior to operation by a surgeon equipped to perform intraoperative cholangiography and deal with stones in the gallbladder and in the CBD. However, because MRCP for all patients is an improbable goal, we believe RIOC to be a realistic alternative. A policy of RIOC is safe and can prevent complications associated with ERCP provided a strategy exists for the treatment of CBD stones identified at the time of LC. In addition, RIOC overcomes the problems associated with delay between CBD investigation and operation and can detect unexpected CBD stones. We believe it is no longer appropriate to perform preoperative ERCP in patients who are expected to undergo LC.

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Author Contributions: Dr Alkhaffaf had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Alkhaffaf and Flook. Acquisition of data: Alkhaffaf and Parkin. Analysis and interpretation of data: Alkhaffaf and Parkin. Drafting of the manuscript: Alkhaffaf. Critical revision of the manuscript for important intellectual content: Parkin and Flook. Statistic analysis: Alkhaffaf. Administrative, technical, and material support: Alkhaffaf and Parkin. Study supervision: Flook.

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REFERENCES