Review

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Current dilemmas in management of common duct stones

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Choledocholithiasis is found in approximately 10–15% of patients presenting for cholecystectomy [25, 60]. Most common duct stones originate in the gallbladder and migrate into the common bile duct. While small stones may spontaneously pass into the duodenum, the narrowed lower end of the choledochus frequently obstructs their passage, resulting in obstructive jaundice or biliary pancreatitis. With the advent of endoscopic and laparoscopic therapeutic alternatives, the management decisions for treating choledocholithiasis have become more complex. This brief overview will focus on some of the controversies in management of common bile duct stones.

Diagnostic alternatives

Open intraoperative cholangiogram

Next to a palpable common duct stone, a positive intraoperative cystic duct cholangiogram is the most reliable indicator for common duct exploration [26, 60, 61]. Kakos et al. [26] and others [61] have suggested that routine cystic duct cholangiography increases the yield of common duct exploration while decreasing the incidence, as well as the morbidity, associated with unnecessary negative common duct exploration. Concerns over cost-effectiveness have fueled the ongoing debate regarding routine vs selective cholangiography during open cholecystectomy [22].

Laparoscopic intraoperative cholangiogram

It is now evident that cholangiography can be readily and reliably obtained during laparoscopic cholecystectomy [4, 5, 11, 12, 22, 41, 44, 52, 53, 57] (Fig. 1). Indeed, recent reports reveal success rates of 79–99% [4, 5, 52, 57, 20, 45, 55]. Various cholangiogram catheters have been utilized including angled metal, olive tip, and balloon tip cholangiocaths as well as ureteral catheters. The debate regarding routine vs selective cholangiography has also reached laparoscopic cholecystectomy. Thus, several authors have demonstrated the apparent safety of a policy of selective laparoscopic cholangiography [5, 22, 42, 43, 55, 63]. Others [12, 44, 52] have argued that above and beyond the issue of unsuspected stones, routine cholangiography may provide vital anatomic information such as the proximity of the common bile duct as well as unappreciated iatrogenic injury to the major biliary ducts. It is interesting to review Phillips et al.'s most recent experience with laparoscopic cholangiography [45]: Having adopted a policy of routine cholangiography, successful studies were obtained in 702 (99%) of 711 attempts. While 78 (11%) were positive, predictive criteria (not including dilated common bile duct) which were analyzed proved imprecise, as indicated in Table 1.

Therapeutic alternatives

Endoscopic sphincterotomy

Endoscopic sphincterotomy, first reported in 1974 [9, 27], is a logical extension of ERCP. Indeed, endoscopic sphincterotomy is now considered the procedure of choice for retained or recurrent common duct stones. In experienced centers, the common bile duct can be cleared in most cases with minimal morbidity and mortality [12, 30]. Serious complications including hemorrhage, perforation, cholangitis, and pancreatitis can occur, however, and may require surgical intervention. Although experienced centers report morbidity and mortality rates of 6.5% and 1.0%, respectively [12, 30], less-experienced operators have reported disturbingly high failure and morbidity rates [12, 13]. Thus, decisions to utilize endoscopic intervention will, and should, be influenced by the local expertise available.

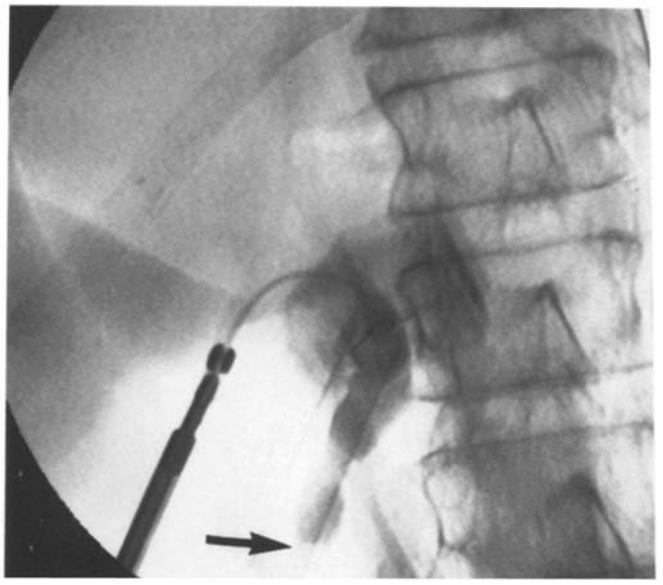

Fig. 1. Initial intraoperative cholangiogram obtained during laparoscopic cholecystectomy demonstrates a small filling defect (*arrow*) in the distal common bile duct

Many biliary endoscopists and surgeons have accepted precholecystectomy ERCP and sphincterotomy in patients believed to have choledocholithiasis with coexistent severe biliary disease (e.g., suppurative cholangitis) or associated medical illnesses. For example, Leung et al. [31] performed urgent or emergent endoscopic drainage in 105 patients (mean age 68 years) with acute suppurative oriental cholangitis. On admission, 40% of their patients were in shock. Endoscopic drainage was performed at a mean interval of 1.5 days after admission; 30% were done as emergencies. Endoscopic drainage was successful in 102 of the 105 patients (97%). Three patients in whom endoscopic drainage failed underwent emergency surgery — one died. Three other patients died of sepsis despite successful endoscopic drainage, and one patient succumbed following a stroke. Overall mortality in this series was 4.7%, which is vastly superior to rates reported following urgent (mortality = 16%) or emergent (mortality = 40%) surgical intervention for suppurative cholangitis [8]. These findings suggest that endoscopic intervention should be considered as the first therapeutic option in patients presenting with suspected suppurative cholangitis.

Similarly, Neoptolemos et al. [36], recently reported a prospective randomized trial comparing early ERCP (<72 h) and endoscopic sphincterotomy with conservative management in patients with acute gallstone pancreatitis. All patients underwent ultrasound and biochemical testing within 24 h and severity prediction (modified Glasgow scale, 28) within 48 h of admission. Patients with acute or chronic ethanol abuse or an identified secondary cause of pancreatitis were excluded. After screening, if gallstones were suspected, patients were randomized to early ERCP and sphincterotomy (59 patients) or conservative management (62 patients). Local and systemic complications and mortality were compared in each group. Overall complications were significantly decreased in patients treated endoscopically (17% vs 34%). Results were particularly striking in those patients with predicted severe attacks (Table 2).

Table 1. Experience with intraoperative laparoscopic cholangiography (from Phillips et al. [45])

Presentation	Patients (%)	Positive IOC (%)
Abnormal liver function tests	20	30
H/O recent abnormal liver function tests	12	20
Acute cholecystitis	10	18

Table 2. Endoscopic vs conservative treatment of severe acute gallstone pancreatitis (from Neoptolemos et al. [36])

	Endoscopic treatment	Conservative treatment
Complications	6/25 (24%)[a]	17/28 (61%)
Hospital stay, days	9.5[a]	17.0
Mortality	1/25 (2%)	5/28 (18%)

[a] $P < 0.05$ vs conservative treatment

It must be acknowledged that these results come from a truly *expert* center. If confirmed, however, these findings would suggest that on admission, pancreatitis severity should be assessed by using one of the objective prognostic factor systems [1, 6, 7, 16, 34, 47]. Urgent ultrasonographic evaluation should then be undertaken to determine whether gallstones can be detected unequivocally. If *expert* endoscopic support is available, patients with severe disease and definite gallstones should be considered for urgent ERCP and endoscopic sphincterotomy if clinical deterioration continues or rapid resolution fails to occur.

Endoscopic sphincterotomy may also be indicated for patients who present with symptomatic choledocholithiasis but who are unacceptable candidates for cholecystectomy. Numerous series [14, 17, 20, 50, 54] have documented the efficacy of endoscopic sphincterotomy in this setting. While the ultimate fate of the gallbladder is often debated, most data suggest that the risk of future gallbladder problems is no greater than 10–15% when these patients are followed for up to 10 years [14, 20, 50, 53]. There appears to be little risk in following these patients expectantly until they develop recurrent symptoms. It must be remembered that in this setting, rapid resolution of symptoms is to be expected following successful endoscopic bile duct clearance. Failure to observe rapid clinical improvement raises the concern of acute cholecystitis and should prompt consideration of cholecystectomy.

Despite the above, for otherwise healthy patients, the benefit of routine endoscopic resolution of choledo-

Table 3. Preoperative endoscopic sphincterotomy (Group I) vs. surgery (Group II) alone for CBD stones (from Neoptolemos et al. [37])

	Group I (n = 55)	Group II (n = 60)
Major/all risk factors (median/patient)	1/3	1/3
Successful CBD clearance	50/55 (91%)	54/59 (91.5%)
Major/total morbidity	9/55 (16.4%)/18/55 (33%)	5/59 (8.5%)/13/59 (22%)
Median hospital stay	16 (9–59) days[a]	21 (10–52) days

[a] $P < 0.05$ vs conservative treatment

been established. Although several studies have suggested that endoscopic clearance of the common duct before cholecystectomy decreases morbidity and cost [23, 59], this concept has not been not substantiated in prospective, randomized trials [37, 58]. Neoptolemos et al. [37] randomly assigned patients with known cholelithiasis and choledocholithiasis to receive either preoperative endoscopic sphincterotomy and stone clearance followed by surgery (group I) or surgery alone (group II). Patients in both groups were well matched in terms of clinical features and risk factors. The results from this study are tabulated in Table 3.

In a more recent, smaller study, Stain et al. [58] studied 52 patients with gallstones and suspected choledocholithiasis (bilirubin > 2 mg/100 ml, previous hyperamylasemia, or ultrasound revealing CBD > 1 cm and/or probable common duct stones). ERCP was used to establish the presence of choledocholithiasis. Those with common duct stones were then randomized to either preoperative endoscopic sphincterotomy (immediately after ERCP) and surgery or surgery alone. Decisions regarding attempted endoscopic clearance of the common bile duct vs spontaneous stone passage were at the endoscopist's discretion. Similarly, although all patients without technically satisfactory, negative intraoperative cholangiogram underwent duct exploration, decisions regarding performance of common bile duct exploration were left to the surgeon's judgment. It was suggested that three patients with suspected choledocholithiasis were screened by ERCP for each patient who was randomized (exact data not available). Results of this study are reviewed in Table 4.

Many have expressed interest in endoscopic intervention before elective cholecystectomy, seeking to extend the indications for laparoscopic cholecystectomy to those patients with suspected or proven choledocholithiasis. Although this would not appear to be of benefit in "routine" patients undergoing open cholecystectomy (see earlier), this issue must be readdressed relative to laparoscopic cholecystectomy.

While randomized prospective trials remain to be reported, several studies have addressed the role of ERCP before laparoscopic cholecystectomy. Neuhaus et al. [38] reported their experience with routine preoperative ERCP in 250 consecutive patients selected for laparoscopic cholecystectomy. Successful endoscopic studies were obtained in 229 (92%) of these patients. As would be expected, most of the endoscopic cholangiograms (197/229 = 86%) were normal. Choledocholithiasis was identified in 26 patients (11%), but only 8 patients (3.5%) harbored unsuspected stones. Although all stones were able to be removed endoscopically before laparoscopic cholecystectomy, the rate of pancreatitis (6/229 = 2.5%) approximated the incidence of unsuspected stones.

Table 4. Preoperative endoscopic sphincterotomy vs surgery alone for CBD stones (from Stain et al. [58])

	Endoscopic sphx. & surgery (n = 26)[a]	Surgery alone (n = 26)[a]
Residual stones at OR before CBDE	9 (35%)[b]	19 (73%)
Retained stones on follow-up T-tube cholangiogram	3 (12%)	3 (12%)[b]
Major/total morbidity	1 (4%)/4 (15%)	1 (4%)/7 (27%)
Median OR time (min)[c]	151 (80–300)	214 (115–420)
Median hospitalization[c]	5 (2–19)	6 (4–22)
beginning on OR day (days)	5 (2–12) if no CBDE	7 (4–22) with CBDE
Professional cost	$2,952 (assumes no CBDE)	$2,740

[a] Based on presence of CBD stones on prerandomization ERCP
[b] $P < 0.05$ vs 12% retained stone rate on T-tube cholangiogram following CBDE alone
[c] Increased charges due to significantly increased OR time offset by added facility charges for endoscopic suite. In addition, increased charges due to longer (2 days) postoperative hospitalization following CBDE offset by preoperative hospitalization charges following endoscopic sphincterotomy

Larson et al. [28] surveyed 20 surgeons in 8 clinics from 5 states to assess the experience with selective use of ERCP before laparoscopic cholecystectomy. Preoperative ERCP was performed in 65 of 1983 (3.3%) patients for suspected choledocholithiasis. Twenty of the 61 successful preoperative ERCPs were positive (33%). An additional 50 patients (2.5%) were found to have stones (presumably unsuspected) on laparoscopic cholangiography. Most of these stones were dealt with intraoperatively (20 laparoscopically and 26 open); in four instances, the stones were left for postoperative endoscopic extraction. Finally, retained stones were identified in six patients, four of whom underwent successful endoscopic extraction. The overall rate of successful endoscopic clearance of the common bile duct was 93% (26 of 28). The 8% incidence of post-ERCP pancreatitis reported in this series was clearly lower than the rate of positive ERCP (41%).

Despite these results, the rapid technological growth supporting laparoscopic common bile duct exploration suggests that the very issue of ERCP and laparoscopic cholecystectomy may well be decreasing in significance.

Open surgery

Common bile duct exploration with/or without biliary-enteric bypass is clearly the "gold standard" for treatment of choledocholithiasis. Reports published in the 1960s and 1970s cited mortality and morbidity rates of 3–5% and 25–30%, respectively [10, 29, 35], prompting some to recommend endoscopic extraction of common duct stones either before, or in lieu of, cholecystectomy [23, 33]. Recent reports indicate that open common bile duct exploration can be performed with much lower morbidity and mortality. Pappas et al. [39] reported 100 consecutive common bile duct explorations done between 1982 and 1986 without mortality. Total morbidity rate in this series was 15.7%, which included a 5.3% incidence of retained common bile duct stones. None of the major complications which occurred in 7.4% of patients (deep venous thrombosis, pneumonia, bleeding gastric ulcer) were directly attributable to the common bile duct exploration. All retained stones were removed by endoscopic (via ampulla) or angiographic (via T-tube tract) techniques and did not require reoperation.

The authors maintain that operative cholecystectomy and common bile duct exploration should be the "first-line" therapy for symptomatic cholelithiasis and choledocholithiasis. The authors recommend duodenotomy only in low-risk patients. Postoperative endoscopic extraction is recommended for retained stones intentionally left in patients at high risk for duodenotomy. In addition, endoscopic extraction should be considered as primary therapy for frail and/or elderly patients with symptomatic choledocholithiasis and asymptomatic gallstones. It should be noted that in this series, the rate of positive common duct exploration, which is associated with increased morbidity and mortality [9, 29], was only 13%. Further, duodenotomy or biliary bypass was only performed in two patients with difficult stones. In four of the five cases with retained stones, the surgeon intentionally left the stones for postoperative endoscopic extraction (exceptional endoscopic expertise is available at this center), believing duodenotomy to be of excessive risk.

Laparoscopic surgery

In hopes of decreasing pain and recovery time, numerous alternatives to traditional open cholecystectomy have recently been introduced. Laparoscopic cholecystectomy, developed in France by Mouret [18], Dubois [18,19], and Perissat [40] and in the United States by Reddick and Olsen [48], has introduced a new era in surgical treatment of biliary stone disease. This procedure allows surgical extirpation of the gallbladder without formal laparotomy, thereby facilitating postoperative recovery while eliminating the possibility of recurrent cholelithiasis. This procedure can frequently be performed in an outpatient setting [3, 49, 56, 57]. Patients often return to work within a week of surgery [15, 58, 62]. Preliminary reports confirm that conversion to open cholecystectomy is required in only 1.8–6.3% of cases [3, 15, 18, 42, 53, 55, 57, 63]. This procedure would appear to incur minimal morbidity and mortality [3, 5, 12, 15, 22, 42, 45, 49, 55–57, 63] and to be less expensive than traditional open cholecystectomy [2, 51]. The recent report from the Southern Surgeons Club [56] emphasizes the possibility of increased injury to the common bile duct with laparoscopic cholecystectomy: When the first 13 patients in each of the 20 groups from the series were considered, common bile duct injury occurred in 2.2% of patients. This rate fell to 0.1% in subsequent patients. Thus, this procedure has a steep learning curve which demands *proper training*. However, with appropriate training and proper patient selection, laparoscopic cholecystectomy would now appear to be the procedure of choice for the patient with uncomplicated gallstone disease.

Although it is evolving, laparoscopic common bile duct exploration (CBDE) is being reported with increasing frequency and success [24, 41, 44, 45, 46, 51]. Two methods of accessing the common bile duct are described: via the cystic duct and via choledochotomy. In the one technique of transcystic duct CBDE, a 5-Fr, 8-mm ureteral stone basket (or Fogarty balloon) is inserted through the cystic duct into the duodenum, opened, and then "trolled" through the common bile duct under fluoroscopic control (Fig. 2). Hunter [24] reported 100% success with this simple technique in five patients. Others have suggested performing transcystic CBDE under visual control. In this technique, the cystic duct is initially intubated with a guide wire over which balloon dilators are inserted to enlarge the cystic duct. A flexible choledochoscope is then passed over the guide wire into the common duct. Stones are then removed using baskets passed via the working channel of the choledochoscope. Large stones

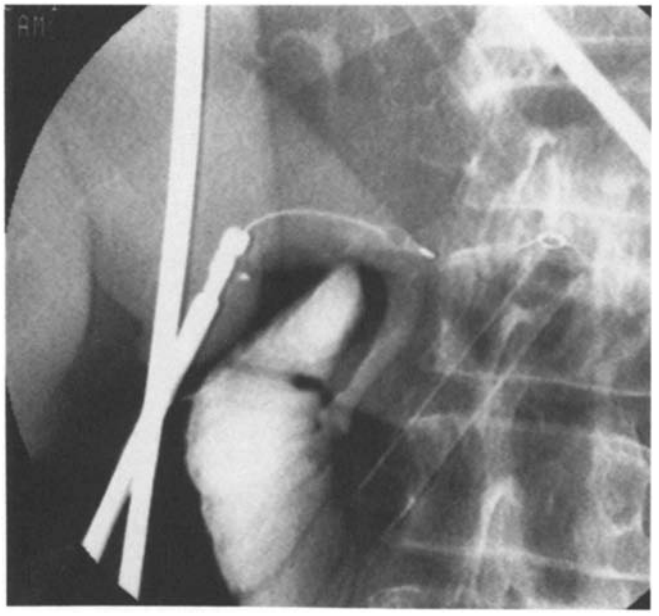

Fig. 2. Laparoscopic common bile duct exploration was performed by "trolling" the common bile duct with an open stone extraction basket. The image demonstrates a small calculus trapped within the stone basket, prior to extraction via the cystic duct

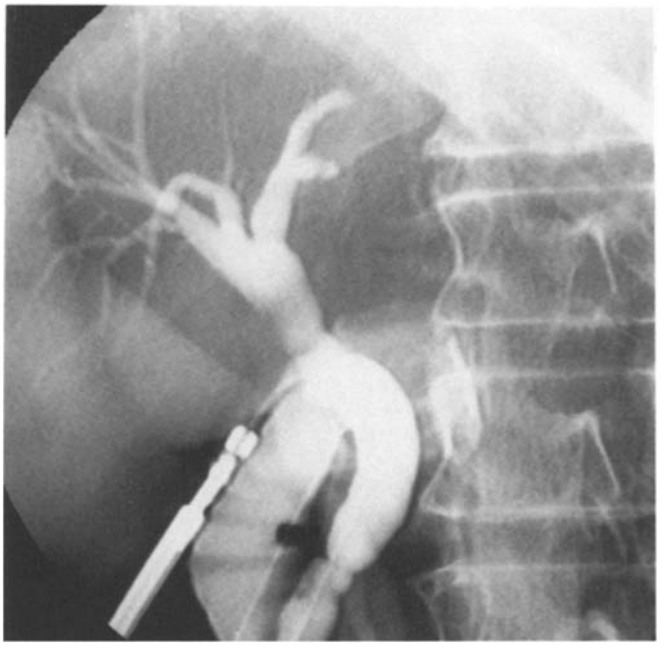

Fig. 3. Completion cholangiogram reveals the common bile duct to be free of filling defects. Contrast now flows into the duodenum

limit the success of this procedure; they can be crushed with the basket or fragmented using electrohydraulic or laser lithotriptors. Phillips et al. [45] recently reported their experience with transcystic duct CBDE. The procedure was attempted in 62 patients and was successful in 58 (93%); transcystic duct choledochoscopy was utilized in most (56 of 58). Complications were rare and minor, consisting primarily of mild pancreatitis in three cases; no retained common duct stones have been experienced. Mean times to discharge and return to work were 2.6 days (compared to 1.2 days following laparoscopic cholecystectomy without CBDE) and 7 days, respectively.

If patients have large stones or stones above the cystic duct–common duct junction, choledochotomy can be performed. This direct approach to the common duct allows passage of larger choledochoscopes and removal of larger stones. Greater technical proficiency is required since a T-tube must be inserted and sutured in place. Phillips et al. [45] reported successful CBDE via laparoscopic choledochotomy in three patients. Mean hospitalization (7 days) and return to work (25 days) were prolonged in these patients and were comparable to their experience following open CBDE. Other investigators have reported similar experiences with laparoscopic common bile duct exploration [24, 41, 46, 49, 51].

While laparoscopic common bile duct exploration is currently not available in all surgical arenas, familiarity and experience continue to grow. Ultimately, it may become a reliable alternative for dealing with common duct stones, and may greatly decrease preoperative endoscopic evaluation of the common bile duct.

Current recommendations

It is clear that the introduction of laparoscopic cholecystectomy has significantly altered our timing as well as our diagnostic and therapeutic approaches to choledocholithiasis. Guidelines are currently being formulated and will require future testing and verification. Given the low risk (1–6%) of unsuspected stones [32] as well as the inherent risks associated with perioperative endoscopic intervention [12], algorithms as already published [13, 41] or as proposed (as follow) might guide our future approach to cholelithiasis and choledocholithiasis:

If CBD stones are suspected (Symptoms, LFTs, Ultrasound) preoperatively and laparoscopic CBDE is available

APPROACH LAPAROSCOPICALLY WITH INTRAOPERATIVE CHOLANGIOGRAM:

1. If negative, complete laparoscopic cholecystectomy.
2. If positive, attempt laparoscopic CBDE with CBD clearance:
   a. If successful, proceed with laparoscopic cholecystectomy
   b. If unsuccessful, proceed with laparotomy for completion cholecystectomy and CBDE. (Note: Patients' mandates regarding laparotomy and local endoscopic expertise will influence this decision. Thus, if patient absolutely refuses laparotomy and appropriate endoscopic expertise is available, consider completion of laparoscopic cholecystectomy, leaving stones for postoperative endoscopic removal.)

If CBD stones are suspected (Symptoms, LFTs, Ultrasound) preoperatively and laparoscopic CBDE is not available:

PREOPERATIVE ERCP:

1. If negative, proceed with laparoscopic cholecystectomy the next day.

2. If positive, proceed with endoscopic sphincterotomy with CBD clearance:
   a. If successful and without complication, proceed with laparoscopic cholecystectomy next 1–2 days.
   b. If unsuccessful, proceed with open cholecystectomy with CBDE.
3. If local endoscopic expertise is not available, proceed with open cholecystectomy and CBDE or laparoscopic cholecystectomy with IOC, depending on degree of concern re: choledocholithiasis. If the latter option is selected, positive IOC will mandate conversion to open procedure.

If laparoscopic IOC demonstrates unsuspected stones:

TRANSCYSTIC LAPAROSCOPIC COMMON BILE DUCT EXPLORATION:

1. If successful, patient can be discharged when recovered.
2. If unsuccessful or not available, either proceed with postoperative ERCP and sphincterotomy or convert to open procedure with CBDE. This decision will depend on patient's medical condition and desires, local endoscopic expertise, size of the common duct and the stones, etc.

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