Operative Cholangiography:

A Case For Its Routine Use

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THE VALUE of operative cholangiography has remained a controversial subject since its introduction by Mirizzi[9] in 1932. Although its use in the complicated case is rarely questioned, there is less agreement as to its value as a routine in cholecystectomy or even in common duct exploration. Many have used it primarily on specific indication, to avoid overlooking stones at common duct exploration and to reduce the number of unnecessary explorations. Only a few have advocated its routine use.

The strides made in roentgenological technic over the past 10 to 15 years may be translated into improved cholangiographic technic in the operating suite. The ability to obtain high quality roentgenograms with a minimum of delay in the surgical procedure has influenced us to rely increasingly on operative cholangiography. Basic operative decisions may depend primarily on the cholangiogram. While not a substitute for judgment, it becomes an added if not essential factor in judgment.

To assess the justification for this impression, 1,460 cases were studied in which cholecystectomy was performed at the Virginia Mason Hospital during the 11-year period from 1955 to 1966.

Materials

All patients who required removal of the gallbladder in the Virginia Mason Hospital for nonmalignant disease during the period from 1955 to 1966 were included. Fourteen hundred and sixty patients satisfied this criterion. Eighty per cent were operated upon by four general surgeons with a special interest in biliary surgery and a close cooperation between specialists in a clinic setting. Seventy-two per cent were women and 22% were over age 65 years. Thirty-two per cent had one or more procedures performed involving other organ systems at the time of cholecystectomy. Complications developed after operation in 103 patients (7%) and 12 patients died (0.8%).

The patients were divided into four groups as follows:

Group A. Five hundred and eighty-eight patients with a diagnosis of chronic cholecystitis did not have operative cholangiography. Of this number, 533 had cholecystectomy and 35 had cholecystectomy plus common duct exploration. Cholangiograms were not obtained before nor after opening the common duct.

Group B. Six hundred and seventy-nine patients with chronic cholecystitis had cystic duct cholangiograms prior to or in lieu of opening the common bile duct.

Group C. Two hundred and twenty-six patients with chronic cholecystitis had completion cholangiograms after common bile duct exploration. Included in this group are 122 patients from Group B who also had cystic duct cholangiograms.

Group D. Ninety-seven patients had acute cholecystitis and were analyzed separately. Some required emergency operation. All were in the acute clinical phase at the time of operation.

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In order to arrive at an estimate of the number of patients spared bile duct instrumentation and of those harboring unsuspected common bile duct stones, it was necessary to assign arbitrary clinical indications for choledochotomy. Any of the following were accepted as a clinical indication for common bile duct exploration:

1. Preoperative history of jaundice, pancreatitis, or cholangitis.
2. Preoperative elevation of the serum bilirubin or alkaline phosphatase.
3. Dilatation of the common bile duct greater than 10 millimeters, palpable common bile duct stone, or evidence of pancreatitis.

The common bile duct was measured or its diameter estimated in most of the patients in the series. The size of the gallbladder stones were recorded in most cases. It was not always possible to determine whether the small stone was used as a basis for duct exploration because the cystic duct caliber usually was not listed. Because of this limitation, the presence of small gallstones was not included in the above listed indications and was treated as a secondary indication for choledochotomy. Frequent attacks of biliary colic, dilated cystic duct, and other established clinical criteria may be important in evaluating the necessity of common duct exploration in the individual case. The indications listed are meant to serve as guide lines for evaluating both the positive and negative aspects of operative cholangiography. These were not necessarily the indications applied in each individual case.

An effort was made to evaluate the results of operation in all 1,460 patients. Follow-up data were obtained by review of clinical records, by questionnaire sent to the patient, and occasionally by contacting the referring physician. Removal of a common bile duct stone at reoperation or at autopsy, and definite visualization of a stone on intravenous cholangiogram were accepted as evidence of proven recurrence. Typical biliary colic, elevation of the bilirubin or alkaline phosphatase without other explanation, and cholangitis were accepted as evidence of probable stone recurrence. Those patients with vague upper abdominal complaints not substantiated by objective studies were listed as having possible common bile duct stone recurrence. The final group consisted of those patients who had remained free of postcholecystectomy symptoms. In this report, the term "recurrent stone" encompasses both the reformed stone and the overlooked stone. A distinction between these two categories cannot be made with certainty. The length of the patient follow-up study was also evaluated. Those patients with no information beyond 2 months after cholecystectomy were considered inadequately studied. The numbers of patients with clinical data from 2 to 12 months, from 1 to 5 years, and from 5 to 13 years after operation were determined in an effort to evaluate the significance of the late clinical data.

Analysis of Questionnaire

The membership of the American Surgical Association was polled by questionnaire in an attempt to evaluate the current status of operative cholangiography in the referral centers of the United States. Three hundred and eighty-three or 78% of the members responded. Eighty-one surgeons performed no biliary procedures and 16 listed no percentage of patients receiving operative cholangiography. Two hundred and eighty-six estimated the frequency with which operative cholangiography was used in their departments (Table 1). This response confirms the suspicion that the place of operative cholangiography is by no means uniformly established. Many of those using it in less than 50% of cholecystectomies rely on cholangiograms in specific situations, such as avoiding the overlooked stone after common duct exploration and avoiding the unnecessary choledochotomy. Eighteen per cent use cholan-

giography almost routinely. Many of those who use it 50 to 90% of the time would rely on it even more if the procedure were more easily available and technically satisfactory. Only 124 surgeons responding were willing to use cholangiography in the patient with acute cholecystitis. "Relatively untried" and "fear of pancreatitis" were objections listed for its use in the acute disease.

TABLE 1. *Results of Questionnaire to Members of the American Surgical Association*

No. of Replies—383 (78% response).
Utilization of Operative Cholangiography

Estimated % Usage	in 286 Pertinent Replies*
0– 10%	41 (14%)
10– 50%	154 (54%)
50– 90%	40 (14%)
90–100%	51 (18%)

* 81 surgeons not involved in biliary surgery.
16 surgeons listed no percentage.

Technic of Operative Cholangiography

A specific technic of operative cholangiography has slowly evolved at our institution in an effort to eliminate various deficiencies.* We still use portable x-ray equipment. It should generate 100 kilovolts at 200–300 milliamperes. It is important to employ the smallest radiographic extension cylinder which will encompass the area under investigation in order to protect the surgical team and to obtain maximum film detail. The extension cylinder attaches to the collimator which, in our experience, is not sufficient in itself. Explosion proof equipment is not essential unless explosive anesthetics are used. A movable grid in a small "Bantam Bucky" is positioned by the technician under each patient undergoing cholecystectomy prior to preparation of the operative field. Control films may be of assistance to establish precholangiogram film quality but are not required by the experienced technician. Cannulation of the cystic duct is done early in the procedure prior to removing the gallbladder. The small polyethylene tube ** is guided into the cystic duct or into the common bile duct, for sufficient stability, taking care that it not be passed into the duodenum. The tubing is ligated to the cystic duct (Fig. 1). All packs and instruments are removed from the field. Three to six milliliters of 50% Hypaque (diluted half and half with normal saline) is injected slowly and a film is exposed after the anesthesiologist has produced apnea. A second film is taken after an additional eight to ten milliliters of contrast material has been injected. Two initial films make the interpretation more reliable. We have not found it necessary to tilt the operating table or to invoke sphincter of Oddi spasm as a routine.

The films are developed in the operating suite and interpreted by the radiologist while the gallbladder is being removed. Consultation with the surgeon, who also views the films, is provided by a two-way intercom system. Since most small gallstones are not quite round, artifacts produced by air bubbles which are round in appearance can be recognized. If there is doubt concerning the interpretation, repeating the study may save a common duct exploration. Completion cholangiograms are performed through the T-tube if the common bile duct has been explored. A small polyethylene tube is inserted to the depth of the T-tube and irrigation is through the polyethylene tube so that air bubbles may escape via the T-tube (Fig. 2). Direct irrigation of the T-tube is not as satisfactory.

While the surgeon is the final arbiter in interpretation of the cholangiogram, the report of the radiologist was accepted for

* Two of the authors, Joel W. Baker and John H. Walker have a movie available in the American College of Surgeons film library which describes this technic in detail.

** An 18-gauge Teflon cholecystography catheter with an expanded bead, supplied by Becton, Dickinson, and Company, facilitates cystic duct cannulation in the difficult case.

TABLE 2. *Acute and Chronic Cholecystitis. Profile of Late Clinical Data* 1,460 patients*

Clinical Status	Length of Patient Followup 2–12 Mo.	1–5 Yr.	5–13 Yr.
Proven Recurrence	7	8	5
Suspected Recurrence	4	14	8
Possible Recurrence	17	98	76
No symptoms	75	390	473
Totals	103 (7%)	510 (35%)	562 (38%)

* 285 (20%) patients inadequately evaluated.

TABLE 3. *Chronic Cholecystitis: Analysis of Late Clinical Data*

	Original Common Duct Exploration Positive	Negative
Proven Recurrence	12 (7%)	2 (2%)
Probable Recurrence	6 (3%)	4 (4%)
Possible Recurrence (vague postcholecystectomy symptoms)	10 (6%)	15 (15%)
No Symptoms	116 (65%)	51 (50%)
Inadequate Followup	34 (19%)	29 (29%)
Totals	178	101

the purpose of analysis of these data. In practice, the surgeon usually relies heavily on the opinion of the radiologist and follows his recommendations. The films are observed carefully for the presence of lucent stones, spillage into the duodenum, caliber of the ductal system, and normal taper in the ampullary region. Abnormalities in any of these areas should lead to common bile duct exploration unless the duct is cleared by repeating the study.

The procedure occupied an average of 19 minutes of operative time for the entire series of patients receiving cholangiography. In recent years, this time has been reduced and is utilized for cholecystectomy and reperitonealization of the gallbladder bed. The cystic duct remains intubated until a satisfactory interpretation is made and no additional films are needed. Then the tube is removed and the remainder of the cystic duct amputated.

Results

The common bile duct was explored in 305 (21%) of the 1,460 patients. Common duct stones were recovered in 192 (13%) of the patients. Choledocholithiasis was present in 63% of those patients who had the common duct opened. Operative cholangiography was obtained in 813 (56%) of the patients. There was no increased morbidity or mortality in those patients having operative cholangiography. Transient rises in serum amylase were observed in some patients after opacification of the pancreatic duct. Late clinical data regarding common duct stone recurrences and length of patient follow-up study for the entire series are summarized in Table 2. Recurrent common duct stones were more likely to be a problem if the original common duct exploration had been positive (Table 3).

Group A—No Operative Cholangiography. There were four (0.7%) proven recurrences and seven (1.3%) suspected recurrences of common bile duct stones in the 553 patients who had only cholecystectomy. Table 4 provides late clinical data in these 553 patients. Comparisons may be made with the 531 patients in Group B who did not have common duct instrumentation because of a negative cystic duct cholangiogram, and the 101 patients who had negative choledochotomy.

Common duct stones were recovered in 12 of 35 patients submitted to cholecystectomy and common duct exploration without cholangiography. There were two proven (6%) and three suspected (9%) late recurrences of common duct stone. The small size of this group reduces the significance of these figures. Thirty-five of these patients were combined with 23 from Group B who had common duct exploration despite negative cystic duct cholangiograms, and 104 patients from Group C who had common duct exploration fol-

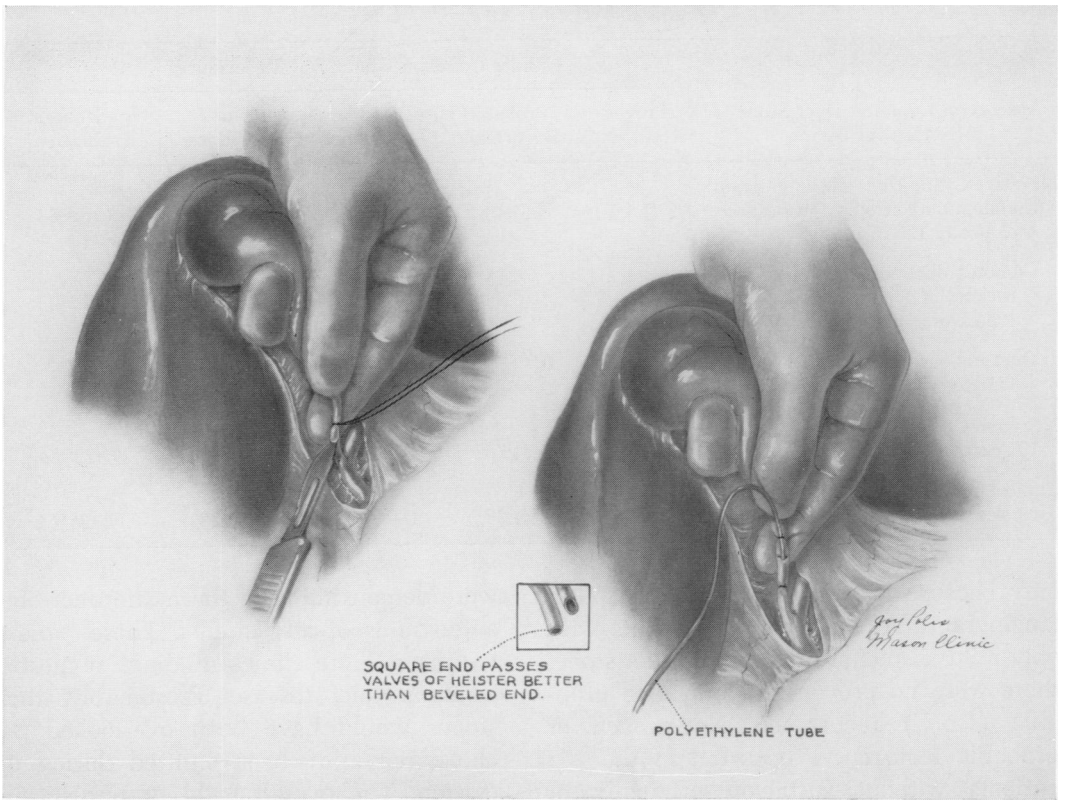

FIG. 1. Technic used for introducing and stabilizing the cystic duct catheter.

lowed by completion cholangiograms (Table 5). All 162 patients had common bile duct exploration performed because of clinical criteria. A more meaningful comparison can be made with those patients who had common duct instrumentation with the assistance of cystic duct cholangiography.

Group B—Cystic Duct Cholangiography. Five hundred and fifty-four patients had negative cystic duct cholangiograms. Common bile duct exploration was performed in 23 of these patients because of compelling clinical reasons and reluctance of the surgeon to accept the cholaniogram as sufficient evidence to avoid duct exploration. Common duct stones were recovered in two patients. Twenty-one explorations were negative. Six of these patients later had mild postcholecystectomy symptoms, five were inadequately evaluated, and 12 had no further symptoms. Of the remaining 531 patients, 175 were believed to have definite clinical indications for common bile duct exploration. If the presence of small stones in the gallbladder is accepted as a criterion for common duct exploration, 198 additional patients had clinical reason to suspect common duct stones. These patients were spared the increased morbidity and mortality of common duct exploration. The average operative time necessary for common duct exploration in this series was 45 minutes. Cholangiogram required an average of 19 minutes. Each of these 373 patients theoretically was saved 26 minutes of surgical time.

There were two proven (1.1%) and six probable (3.4%) late recurrences of common duct stones in the 175 patients who had strong clinical suspicion of choledocholithiasis and who were spared choledochot-

TABLE 4. *Chronic Cholecystitis: Analysis of Late Clinical Data*

Absence of Common Duct Stone Established By:	Late Common Duct Stone Recurrences				
	Proven Recurrence	Probable Recurrence	Possible Recurrence	No Symptoms	Inadequate Evaluation
Negative Cystic Duct Cholangiogram					
Common duct strongly suspect clinically 175 cases	2 (1.1%)	6 (3.4%)	17 (9.2%)	120 (69%)	30 (17.3%)
Common duct suspect clinically because of small stones only 198 cases	0	1 (0.5%)	24 (12%)	144 (73%)	29 (14.5%)
Duct not suspect clinically 158 cases	0	0	34 (22%)	97 (61%)	27 (17%)
Negative Choledochotomy 101 cases	2 (2%)	4 (4%)	15 (15%)	51 (50%)	29 (29%)
Clinical Judgment					
Cholecystectomy only—553 cases	4 (0.7%)	7 (1.3%)	81 (15%)	344 (62%)	117 (21%)

omy because of negative cystic duct cholangiograms. Among the 198 patients with only mild suspicion of common duct stone, there were no proven and only one probable (0.5%) recurrence. No proven or probable recurrences occurred in the 158 patients without suspicion originally of common duct disease. Late clinical data for these patients are analyzed in Table 4.

The cystic duct cholangiogram was positive in 117 patients and the common duct explored in 116 patients. One patient with positive cholangiogram interpretation who did not have a common duct exploration at cholecystectomy required removal of a common duct stone 18 months later. Common duct stones were recovered in 91 patients. There were 25 false positive studies (Table 5). Fourteen of the 25 patients with false positive cholangiograms had clinical indications for common duct exploration. There were, therefore, only 11 unnecessary duct explorations. In the 91 patients with confirmed common bile duct stones, seven (8%) later developed proven recurrences and two (2%) probable recurrences. Five patients (5%) had vague postcholecystectomy symptoms and 14 (16%) were insufficiently evaluated.

Unsuspected common bile duct stones were demonstrated in the cystic duct cholangiograms of 24 patients. These patients had no definite clinical findings suggesting common duct disease. Presumably, these stones would have been overlooked had cholangiography been omitted during operation. The overall yield of unsuspected stones was 6.3% of those 380 patients receiving cystic duct cholangiography without definite clinical indication for common duct exploration (Table 6).

Group C—Completion Cholangiography. Common bile duct stones were recovered in 161 (71%) of the 226 patients who had subsequent completion cholangiograms. The completion cholangiogram was believed to be negative for retained stones in 201. Late clinical data in these 201 patients revealed seven (3.5%) proven and seven (3.5%) probable recurrent stones (Table 7). There were 25 positive completion cholangiograms. Twenty-two were obtained after removal of common duct stones. Additional stones were recovered in 11 patients and one of these was left with a hepatic duct stone which required removal 4 months later after migration into the common duct. One other late recurrence developed among the 11 patients. The presence of additional stones was not

confirmed in 14 patients. The ducts of seven of these patients were not reopened either due to doubt or to the patient's condition. Two of these seven patients, however, later developed stone recurrences necessitating removal. In four patients, stones were suspected in the hepatic radicals, but because of inaccessibility were not removed. No known recurrences have developed in these four patients.

Group D—Acute Cholecystitis. The common bile duct was explored in 27 of the 97 patients with acute cholecystitis. Common duct stones were recovered in 14 instances. Operative cholangiography was utilized in 51 patients and there were no complications caused by the procedure. Forty-three patients had cystic duct cholangiograms performed. In 23 patients with indications for common duct exploration, the x-ray was negative. Three were explored despite the negative x-ray without recovery of stones. The other 20 were spared unnecessary exploration. Eighteen of the 20 were evaluated over 12 months after operation. There were no proven recurrences. One patient had a probable recurrence of stone and three had mild postcholecystectomy symptoms. Ten patients who had no clinical reasons to suspect common duct disease had negative cystic duct cholangiograms and none had later findings suggesting proven or probable common duct stones. Ten cystic cholangiograms were positive and stones were recovered in seven of these patients. There were no unsuspected stones discovered. The three false positive cholangiograms did not result in unnecessary common duct instrumentation since these patients all had clinical indications for exploration. The ten patients with positive cystic duct cholangiograms were all evaluated over 12 months after operation and none had any further symptoms. Forty-six patients had no cholangiograms performed; common duct exploration was performed only six times (13%) and stones were recovered in three. There were no proven recurrences of common duct stone and only one patient had a probable recurrence. Completion cholangiograms were performed after common duct explorations in 17 patients. Sixteen of these studies were negative. The single positive exam resulted in the removal of an additional common duct stone. Fourteen of these patients were followed over 12 months. Thirteen had no further complaints and one had mild postcholecystectomy symptoms.

TABLE 5. *Chronic Cholecystitis*

Common Duct Suspect Because of:	Common Duct Exploration	
	Positive	Negative
Positive Cystic Duct Cholangiogram—117*	91 (78%)	25 (22%)
Clinical Findings—162	87 (54%)	75 (46%)

* One duct not explored—stone removed 18 months later.

24 patients had choledocholithiasis unsuspected clinically.

Discussion

Operative cholangiography can be an important, indeed necessary adjunct to the biliary surgeon. Close cooperation between the surgical and radiological teams is essential if precision and consistency in technic and interpretation are to be achieved. If there has been a compromise in technic resulting in inadequate quality of the films, the radiologist can analyze the problem and advise additional exposures. Repeating the study is advisable rather than immediate exploration of all suspicious common ducts. In addition to information regarding the presence or absence of stones, other findings such as long cystic duct stump, unsuspected carcinoma, congenital variations, and duodenal diverticulum may provide technical assistance. Opacification of the pancreatic ductal system establishes and defines its relationship to the common bile duct. A visual record of the biliary ductal

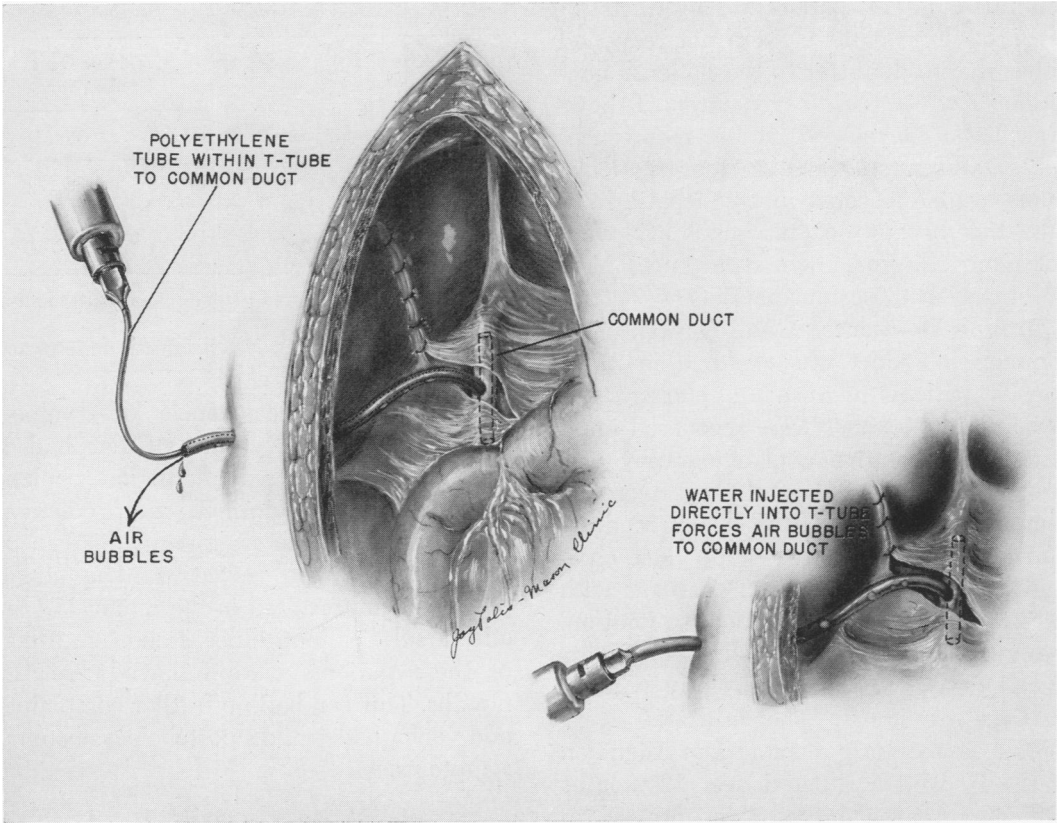

FIG. 2. Technic used to remove air bubbles from the common duct and T-tube prior to completion cholangiography as suggested by G. H. Lawrence, M.D.

system is available for those who may inherit the future care of the patient.

Evaluation of the accuracy of operative cholangiography should be determined in part by the late clinical status of the biliary system. Few authors have attempted to make this correlation and none have provided a detailed analysis. Comparison with patients treated by conventional clinical criteria would seem to be important. The number of proven (20) and probable (26) common duct stone recurrences in the various groups is small. Those patients (191) with mild upper abdominal or postcholecystectomy symptoms are listed as possible stone recurrences. Probably only a small percentage of these patients actually harbor common duct stones. Postcholecystectomy symptoms have been reported by Sandweiss and Fulton[13] to occur in 10 to 25% of patients after cholecystectomy. Only 7% of 100 patients with symptoms had demonstrated recurrences of common duct stone by intravenous cholangiography in their study. Although the follow-up data in our series are incomplete, sufficient information has been obtained from a large number of patients to provide useful comparisons.

The 588 patients in Group A who had biliary surgery without the assistance of operative cholangiography are available for comparison with those patients who had similar procedures but with the addition of operative cholangiography. The incidence of proven (0.7%) and probable (1.3%) late recurrences was small in the 533 Group A patients who had cholecystectomy and no clinical suspicion of common duct pathology. When this clinical judgment was reinforced by a negative cholangiogram,

the same recurrence rate became zero in the 158 patients without any suspicion of common duct disease and only 0.5% probable recurrences in the 198 patients with weak indications for choledochotomy (Table 4). Unsuspected common duct stones were not removed in the 553 Group A patients and most likely account for the higher incidence of recurrent common duct stones. The problem of the unnecessary common duct exploration is analyzed in Table 4.

Several surgeons used operative cholangiography almost routinely when confronted with a common duct suspected of harboring stones. This factor contributed to the large number of Group B patients with indications for common duct exploration. Choledochotomy was avoided on the strength of a negative cholangiogram in many patients who had compelling clinical indications, such as mild jaundice and dilatation of the duct greater than 15 millimeters. These clinical findings suggest that common duct stones may have resided in the ductal system long enough to produce anatomical changes and were later passed spontaneously into the intestinal tract. Table 4 indicates that the 1.1% proven and 3.4% probable stone recurrence in the 175 Group B patients with strong suspicion of choledocholithiasis is less than the 2% proven and 4% probable recurrences in the 101 patients with negative common duct explorations. These recurrences are only slightly greater than the 0.7% proven and 1.3% probable recurrences in the 553 Group A patients who had cholecystectomy without cholangiography and who had no clinical suspicion of common duct disease. This evidence would indicate that a negative cystic duct cholangiogram of acceptable quality is more accurate in excluding common duct stones than exploration of the duct. Nienhuis[11] estimated that only one or two per cent of common duct stones were missed by operative cholangiography in his series of 179 consecutive cases. The operative cholangiogram is the most reliable method available for evaluating the need of choledochotomy. A satisfactory study spares the innocent duct the trauma of an unnecessary exploration and provides a saving of operating room time.

It has been said that operative cholangiography is no substitute for clinical judgment. Colcock and Perey[2] state that a negative common duct exploration does not increase the risk of operation over that of a cholecystectomy. Appleman, Priestley, and Gage[1] share this opinion. Glenn,[5] however, reports a mortality of 0.5% for cholecystectomy and of 2.7% for cholecystectomy plus choledochotomy without recovery of common duct stones. The additional time required for a common duct exploration does prolong operation and increases the morbidity and hospitalization. It seems reasonable to assume that the addition of choledochotomy must increase the mortality slightly, especially in the patient who has acute cholecystitis or who is a poor risk for other reasons.

A positive cystic duct cholangiogram in our experience was associated with a 78% common duct stone recovery rate. When clinical criteria were used, only 54% of the common duct explorations were positive and in many the stones were palpable (Table 5). Appleman, Priestley and Gage[1] report choledocholithiasis in 42.6% of 1,127 patients submitted to common duct exploration, and Colcock and Perey[2] report only 27.6% positive explorations in 503 patients having choledochotomy. There were 25 false positive cholangiograms in our series and in only eleven of these were indications for common duct exploration absent. This small number of unnecessary common duct explorations caused by false positive cholangiograms would seem to be acceptable in view of the many benefits of the procedure. Most of these unnecessary choledochotomies can be avoided by repeating the cholangiogram.

TABLE 6. *Unsuspected Common Duct Stones*

Routine Cystic Duct Cholangiography	Common Duct Exploration	
	Negative	Positive
NO clinical suspicion of common duct stones	158	5
Suspicion only because of small stones in gallbladder	198	19
	356	24

Stones Demonstrated and Recovered in 24 cases—6.3% of 380 cases studied.

In our series, 24 (6.3%) of the 380 patients submitted to cholangiography without strong clinical reason to suspect common duct disease were found to have unsuspected stones (Table 6). Nienhuis [11] reported 4% unsuspected common duct stones in 171 patients studied. Isaacs and Daves [6] found 8% in 87 patients, and Mehn [8] 10% in 113 patients. These data present a strong case for routine operative cholangiography. Ferris and Weber [3] believe that the detection of unsuspected stones is the most useful aspect of operative cholangiography. We would disagree with this contention only mildly and would suggest the avoidance of unnecessary common duct instrumentation as the prime benefit.

The incidence of overlooked common duct stones has been placed between 8 and 28% when completion cholangiograms are not used after choledochotomy.[7, 12, 14] A completion cholangiogram was obtained in 226 patients in our series after common duct exploration as a precaution against overlooking a stone. There were 53 patients submitted to common duct exploration without completion cholangiography available for comparison. The incidence of false positive completion studies due to air bubbles, failure of the contrast medium to enter the duodenum, and other artifacts related to surgical instrumentation was high. Ginzburg, Geffen, and Friedman [4] noted that in 26 of 56 cases contrast medium would not enter the duodenum at completion cholangiography. We have had a similar experience and believe that spasm and edema of the ampullary sphincter after instrumentation prevents egress of the contrast medium. Cystic duct cholangiography before choledochotomy may avoid error in interpretation demonstrating patency of the ampulla. Completion cholangiograms led to removal of missed common duct stones in 11 patients in our series. Four others were found to harbor hepatic duct stones which were inaccessible. These 15 overlooked stones represent an immediate yield of 6.6% from the 226 studies, Mixter, Hermanson, and Segel [10] reported 13% overlooked stones in 146 completion cholangiograms.

The highest rate of late recurrences (Table 7) was noted in those patients who did not have completion cholangiograms and who, interestingly, had the lowest incidence of common duct stones (32%) at the original operation. Patients are more likely to develop subsequent common duct calculi after a positive common duct ex-

TABLE 7. *Chronic Cholecystitis: Common Bile Duct Opened. Comparative Analysis of Late Clinical Data*

Clinical Findings	Completion Cholangiogram		
	Omitted (53 patients)	Negative (201 patients)	Positive (25 patients)
Proven recurrence	3 (6%)	7 (3.5%)	4 (16%)*
Probable recurrence	3 (6%)	7 (3.5%)	0
Possible recurrence	5 (9%)	19 (9%)	1 (4%)
No symptoms	28 (53%)	123 (62%)	16 (64%)
Inadequate followup	14 (26%)	45 (22%)	4 (16%)

* One patient had an inaccessible hepatic duct stone which later descended into the common duct and required removal.

ploration. In several instances, investigation of abnormalities detected on the cholangiogram was omitted, resulting in a missed stone, which later required removal. Completion cholangiograms, skillfully performed and interpreted, will avoid overlooking most stones and result in a reduction of late recurrences.

We have used cystic duct cholangiography extensively in patients with acute cholecystitis without incurring any complications definitely related to the procedure. Common duct calculi may be expected to occur in about the same frequency as in chronic cholecystitis.[2] Common duct exploration is hazardous in the presence of an acute inflammatory process in an acutely ill patient who may also have pancreatitis. Unnecessary choledochotomy was avoided in 20 patients who had clinical indications for the procedure. In our experience, pancreatitis is more likely to occur after common duct instrumentation than after cholangiography. We believe that one of the prime indications for operative cholangiography is in the patient with acute cholecystitis who is suspected of harboring common duct calculi.

The facility with which we perform operative cholangiography and the quality of the films produced have improved steadily over the years. Close cooperation between the surgical, radiological and anesthesiology departments is necessary as well as repeated experience with an established reliable technic. We do not understand why in many large medical centers cholangiography is used only occasionally in the operating suite. While it is not a substitute for clinical judgment, it does become an important factor in determining the conduct of the biliary surgical procedure. We endorse its routine use wherever there is a large volume of biliary surgery and adequate equipment and personnel are available.

Summary

An analysis of the accuracy of operative cholangiography has been presented by examining the immediate benefits of the procedure and the late clinical status of the patients. Five hundred and thirty-three patients who had biliary surgery without cholangiography were available for comparison. Cystic duct cholangiograms were negative in 554 patients. Unnecessary common duct explorations were avoided in 373 patients, 175 with strong suspicion of common duct stones and 198 with lesser suspicion due to small gallbladder stones. A negative cholangiogram proved more accurate in excluding common duct stones than a negative choledochotomy. The cystic duct cholangiogram was positive in 117 patients and common duct stones were recovered in 78%. There were 24 patients with unsuspected common duct stones or 6.3% of all patients who received a cystic duct cholangiogram and who had no strong suspicion of common duct disease. False positive cholangiograms did not result in a significant number of unnecessary common duct explorations. Late recurrences of common duct stones, either overlooked or reformed, were more common if the original common duct exploration had been positive. Completion cholangiograms are of value in avoiding the overlooked common duct stone. An important indication for the cystic duct cholangiogram is in the patient with acute cholecystitis, especially if there is associated pancreatitis or other suspicion of common duct disease.

References

1. Appleman, R. M., Priestley, J. T. and Gage, R. P.: Cholelithiasis and Choledocholithiasis: Factors that Influence Relative Incidence. Mayo Clin. Proc., 39:473, 1964.
2. Colcock, B. P. and Perey, B.: Exploration of the Common Bile Duct. Surg. Gynec. Obstet., 118:20, 1964.
3. Ferris, D. O. and Weber, H. M.: Evaluation of Routine Operative Cholangiography. Arch. Surg., 73:197, 1956.

4. Ginzburg, L., Geffen, A. and Friedman, I. H.: Pseudo-obstruction Following Postcholedochotomy Cholangiography. Ann. Surg., **166**: 83, 1967.
5. Glenn, F., McSherry, C. K. and Dineen, P.: Morbidity of Surgical Treatment for Nonmalignant Biliary Tract Disease. Surg. Gynec. Obstet., **126**:15, 1968.
6. Isaacs, J. P. and Daves, M. L.: Technique and Evaluation of Operative Cholangiography. Surg. Gynec. Obstet., **111**:103, 1960.
7. Johnson, E. V., Waugh, J. M. and Good, C. A.: Residual Stones in the Common Bile Duct: Question of Operative Cholangiography. Ann. Surg., **139**:293, 1954.
8. Mehn, W. H.: Operating Room Cholangiography. Surg. Clin. N. Amer. **34**:151, 1954.
9. Mirizzi, P. L.: Operative Cholangiography. Surg. Gynec. Obstet., **65**:702, 1937.
10. Mixter, C. G., Hermanson, L. and Segal, A. L.: Operative Cholangiography: Evaluation of 406 Cases. Ann. Surg., **134**:346, 1951.
11. Nienhuis, L. I.: Routine Operative Cholangiography: An Evaluation. Ann. Surg., **154**: 192, 1961.
12. Paine, J. R. and Firme, C. N.: The Problem of the Overlooked Common Duct Stone. Ann. Surg., **20**:1171, 1954.
13. Sandweiss, D. J. and Fulton, H.: Intravenous Cholangiography. JAMA, **159**:998, 1955.
14. Smith, S. W., Engel, C., Averbrook, B. and Longmire, W. P., Jr.: Problems of Retained and Recurrent Common Bile Duct Stones. JAMA, **164**:231, 1957.

Discussion

Dr. Frank Glenn (New York City): I have had the opportunity to read this manuscript and I believe what you have heard from Dr. Baker and his associates is a contribution of great interest to all of us as general surgeons. His objectives include the reducing of the incidence of overlooked stones in the common duct to enable us to do a more thorough operation. This paper should have wide ramifications since operations upon the biliary tract are amongst those most frequently performed today.

The morbidity of complications and the mortality rate associated with operations upon the biliary tract has been greatly reduced since the organization of the American Surgical Association. Dr. Baker and his associates have emphasized that exploration of the common duct added to cholecystectomy is associated with an increased morbidity of complications over simple cholecystectomy. While this is commonly attributed to long-standing disease and to associated conditions that render operation a greater risk, it remains that unnecessary choledochotomy should be avoided.

[Dr. Glenn then supplemented his discussion with the following slides.]

On this slide, you may observe the greater mortality rate for common duct exploration with and without recovery of stones. Common duct exploration added on to cholecystectomy is associated with a morbidity of non-fatal complication rate of 14% in contrast to 6.9% for all operations upon the biliary tract amongst almost 7,000 patients we have operated upon over the past 30 years.

Dr. Baker and his group have demonstrated that the inclusion of colangiography at operation can be accomplished without adding to the morbidity of complications and provides information that will enable us to determine whether choledochotomy is indicated. I strongly support this endeavor for I have long advocated that common duct exploration should not be embarked upon except when indicated.

This slide describes the experience of the Seattle group indicating that they have reduced their common duct explorations from 40% to 20% and that the incidence of stone recovery has been about equally reduced. Part of the explanation for this may rest in the current trend to do surgery upon patients with calculous biliary tract disease at a younger age.

Slide 1. Mortality Following Surgery for Non-malignant Biliary Tract Disease

(The New York Hospital-Cornell Medical Center 9.1.50-8.31.66)

	No. of Operations	Deaths No.	Deaths %
Cholecystectomy	2395	13	0.5
Cholecystectomy plus choledocholithotomy	300	20	6.7
Cholecystectomy plus choledochotomy	220	6	2.7
Secondary common duct exploration	138	6	4.3
Cholecystostomy	118	7	5.9
Miscellaneous procedures	46	12	26.1
Total	3217	64	1.9

Slide 2: Incidence of Common Duct Exploration

No. Patients Operated	Common Duct Explorations	Stones Found
V.M.H. 489(1953–56)	199 (40.7%)	107 (22%)
V.M.H. 1,460(1956–66)	305 (21%)	192 (13%)
N.Y.H. 4,677(1932–65)	694 (15%)	416 (8.9%)