Effectiveness of Choledochoduodenostomy and Transduodenal Sphincterotomy in the Treatment of Benign Obstruction of the Common Duct

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OBSTRUCTION of the common bile duct due to non-malignant disease is most often a consequence of stenosis at the sphincter of Oddi, stricture of the common duct or pancreatitis. It is commonly associated with cholelithiasis, choledocholithiasis, bile sludge and infrequently, hepatic calculi and biliary cirrhosis. Rarely is the obstruction complete and the most common manifestations are those of pain, pruritis, intermittent jaundice with or without cholangitis. Except in sclerosing cholangitis,[14, 26, 30] the common duct is usually dilated with disappearance of the normally tapered distal end. Two therapeutic procedures have been commonly employed for the correction of these lesions, namely transduodenal sphincterotomy and choledochoduodenostomy. This report is based upon an evaluation of 110 patients operated upon at the North Carolina Memorial Hospital during the years 1952–1970, with postoperative

diagnoses of benign extrahepatic biliary tract obstruction. It examines the morbidity and mortality of transduodenal sphincterotomy and choledochoduodenostomy as well as their effectiveness in overcoming obstruction and stasis in the common duct. Specific indications or contraindications for these procedures have been determined by the immediate results of therapy as well as the survivorship of each group of patients.

Physiologic Considerations

The common duct can be regarded as a semi-passive fibroelastic conduit for the delivery of bile from the liver to the gastrointestinal tract. It has an intrinsic nerve supply by way of the autonomic system, but there are insufficient muscle fibers to result in effective peristalsis.[26] Bile flow is regulated by the secretory pressures of the liver, contractile properties of the gallbladder and the terminal sphincter mechanism provided by the muscles of the duodenum and the sphincter of Oddi. The vagal sys-

TABLE 1. *Indications for Operation in Patients Undergoing Sphincterotomy and Choledochoduodenostomy*

Indications for Surgery	Sphincterotomy (53)	Choledochoduodenostomy (57)
Cholelithiasis	31	24
Choledocholithiasis	25	33
Stenosis or stricture	13	17
Pancreatitis	7	12
Inflammatory obstruction	3	1
Cyst	0	1
	79	88
Previous biliary tract surgery	24	22

tem is the dominant extrinsic mechanism responsible for the maintenance of normal choledochal sphincter tone.[7] Using cine cholangiometry, the contractions of the distal Vaterial segment can be demonstrated to be precise and rhythmic consisting of a systolic and diastolic phase.[8] During diastole there is a passage of bile. The duration of systole ranges from 0.5–4.3 seconds, diastole 1.5–5.3 seconds. Thus, under normal conditions, bile does not flow freely into the gastrointestinal tract except with increased pressures brought about by gallbladder contraction and/or associated relaxation of the sphincter of Oddi.[35, 45]

The contents of the extrahepatic bile ducts are usually sterile.[12, 36] Ablation of the sphincter or choledochoduodenostomy creating a patulous opening with free access of duodenal content into the common duct is likely to be associated with bacteria within the intrahepatic bile ducts.[12] However, despite this reflux of duodenal content in the absence of bile stasis or obstruction in the small intestine there is no increased incidence of cholangitis or biliary cirrhosis.[2, 11, 21, 40] Partial common duct obstruction; however, produces dilatation, stasis of bile and is commonly associated with a positive culture of organisms indigenous to the gastrointestinal tract, thereby increasing the likelihood of cholangitis. Particularly is the latter true after manipu-

lation or instrumentation of the bile ducts.[12] *Escherichia coli* is of additional importance because of the production of beta-glucuronidase by this bacterium and the conversion of the soluble bilirubin-diglucuronide to glucuronic acid and insoluble bilirubin. The formation of sodium bilirubinate calculi is therein promoted.[38]

The role of partial common duct obstruction in the genesis of the choledocholithiasis has not been sufficiently emphasized. Although most common duct stones originally migrate from the gallbladder, they may provoke spasm, edema and ultimately fibrosis at the ampullary end of the duct.[37] The resulting obstruction and stasis of bile may be an important factor in both primary and recurrent choledocholithiasis. This has been nicely documented in the experimental animal by both Wangensteen and Dunphy.[22, 32] Mere removal of the stones from the common duct without consideration of etiologic mechanisms is no more appropriate than cholecystolithotomy in the management of cholelithiasis. Partial choledochal obstruction, particularly in association with biliary calculi and infection may also contribute to the development of recurring pancreatitis and biliary cirrhosis.

Clinical Observations

One hundred and ten patients were operated upon because of obstructive biliary tract disease as associated with one or more of the following: cholelithiasis, cholangitis, common duct stenosis or stricture and pancreatitis (Table 1). Either choledochoduodenostomy or transduodenal sphincterotomy was performed. Cholelithiasis did not constitute an indication without evidence of common duct obstruction or suspected choledocholithiasis. Choledocholithiasis was the most common cause for these procedures and of the 58 patients with common duct calculi, 16 had undergone previous choledocholithotomy. In association with one or more of the conditions cited, the specific indication for either operative pro-

cedure was the finding of common duct dilatation, the failure of radiopaque dye to pass into the duodenum during operative cholangiography, an inability to pass a 3 mm. probe through the ampulla of Vater or stasis of bile as manifest by bile sludge or bilirubinate calculi. In a limited number of patients, manometry indicated pressures in excess of 20 cm. of saline. However, experience with this method of appraisal has not been sufficient to utilize it as a criterion of common duct obstruction. One patient had a choledochal cyst. A history of previous cholecystectomy or choledocholithotomy was common—namely, 23 of 53 patients who underwent sphincterotomy and 22 of 57 patients who underwent choledochoduodenostomy had had previous biliary tract operations because of cholelithiasis, choledocholithiasis or pancreatitis (Table 1).

With several surgeons participating in the care of these patients, it was inherent that based upon previous experience and clinical impressions, there be some prejudice as to the more effective of these procedures. In general, however, choledochoduodenostomy was performed for the same conditions as was transduodenal sphincterotomy. As a consequence, there is a re-
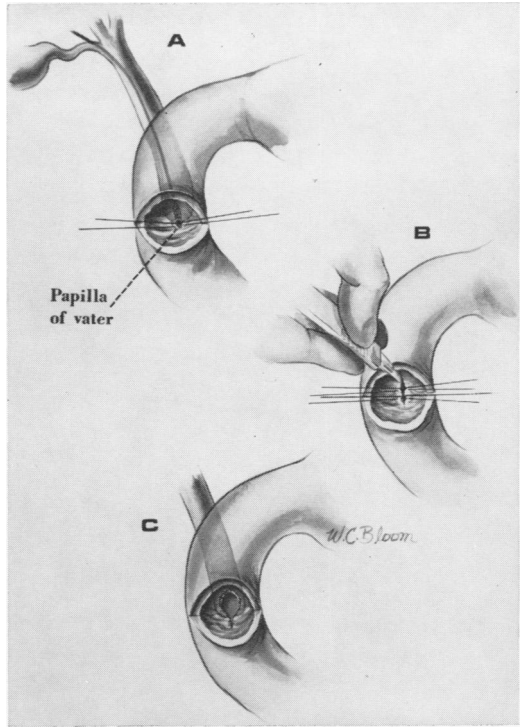

FIG. 2. Technic of sphincterotomy.

markable frequency of the operative procedures for each disease category. To place this experience in perspective, during the same period of time 816 patients underwent cholecystectomy and in 84 patients choledochotomy was performed without sphincterotomy or choledochoduodenostomy.

The sex and age incidence of this patient population was essentially the same for the two procedures; 24 men and 29 women underwent sphincterotomy and 34 men and 23 women underwent choledochoduodenostomy. These problems occurred primarily in the older age groups (Fig. 1), e.g., 16% in the 5th decade 25% in the 6th; 21% in the 7th and 17% in the 8th decade. Eighty per cent of the patients were in these four decades. The mean age for patients undergoing sphincterotomy was 55 years, for choledochoduodenostomy 58 years.
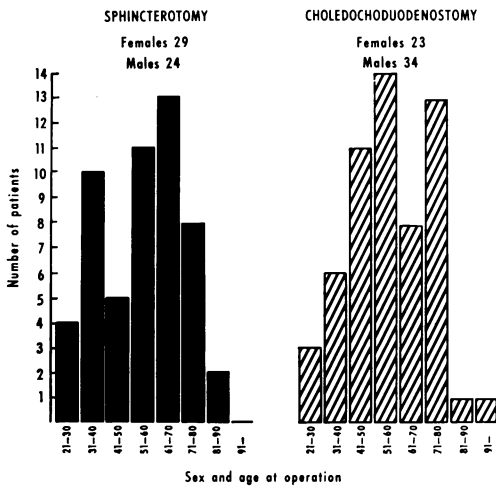

FIG. 1. Age and sex incidence of patients undergoing sphincterotomy and choledochoduodenostomy.

Operative Technics

Transduodenal sphincterotomy (Fig. 2) is performed after identification of the
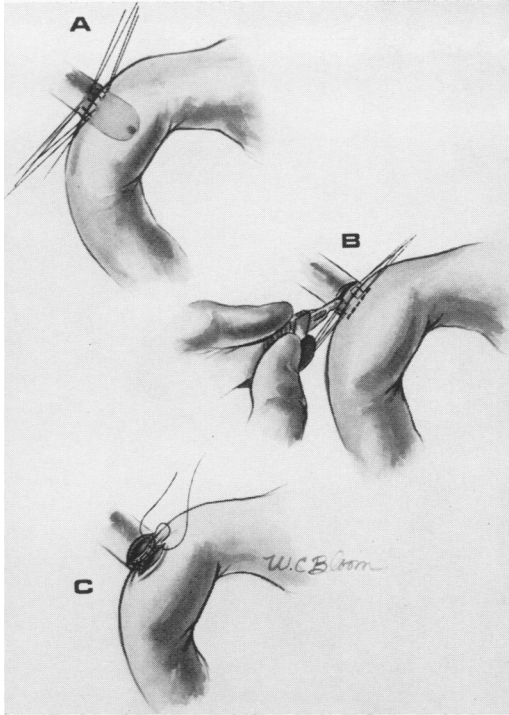
FIG. 3. Technic of choledochoduodenostomy.

sphincter of Oddi by the gentle passage of a probe through the cystic duct (coincident with cholecystectomy), through the site of choledochotomy or by palpation of a stone lodged at the ampulla of Vater. The duodenum is mobilized by a Kocher maneuver, incised transversely overlying the site of the ampulla through ⅓–½ of its circumference. Traction sutures are placed through the relatively tough ampulla and the sphincter divided superiorly and laterally for a distance of approximately 1–1.5 cm. insuring division of the area of stenosis and opening the common duct to the point of dilatation. Incision at this juncture avoids damage to the medially located pancreatic duct of Wirsung. Excision of a segment of the ampulla for biopsy is advisable to determine the nature of the obstructive lesion and to avoid overlooking an occult carcinoma. Through such an incision, a choledocholithotomy may be performed without a proximal choledochotomy.[18] In order to avoid stricture at the site of sphinc-

terotomy, the duodenal mucosa is sutured to the incised common duct with a single layer of interrupted sutures of fine (00000) silk. The duodenostomy incision is closed with a single layer of inverting seromuscular sutures (Lembert) of fine silk. Drainage of the common duct either by simple catheter through the cystic duct or by a T-tube was carried out in early years. More recently, such drainage has been regarded as not only unnecessary, but undesirable because of foreign body reaction promoting stasis and infection.[40] In 53 patients, 15 catheters were placed in the cystic duct and 15 T-tubes inserted.[*] In debilitated or elderly patients, a temporary gastrostomy was performed.[41]

The direct approach to the ampulla without previous catheterization of the common bile duct as advocated by Hardy [18] was used only when a stone was palpable in the ampulla.

Choledochoduodenostomy (Fig. 3) is performed by mobilizing the duodenum with a Kocher maneuver, reflecting the posterior wall of the duodenum from the anterior wall of the common duct for a distance of 1–1.5 cm. Widespread stripping of the common duct should be avoided to prevent ischemic necrosis.[40] After placing a posterior row of fine silk sutures (0000) between the most distal common duct and the duodenum, the dilated common duct is incised transversely through two thirds of its circumference. With the incision at this site, the common duct and duodenum then retain essentially their normal anatomical relationship without tension or distortion after completion of the anastomosis. Choledocholithotomy is performed and the region of the ampulla of Vater is carefully examined to insure removal of all calculi and the absence of neoplasms. Any thick-

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[*] In patients undergoing both sphincterotomy and choledochoduodenostomy a small polyethylene catheter was sometimes placed through the cystic duct, not so much as to provide decompression of the duct, but to permit postoperative manometric studies and the performance of cholangiograms.

ening of the common duct or sphincter warrants biopsy; however, biopsy of the ampulla of Vater is more difficult with this approach than with sphincterotomy. A parallel incision of comparable length is made longitudinally through the duodenal wall excising the pouting duodenal mucosa. Unless additional sutures are needed posteriorly for hemostasis, the anastomosis is completed by an anterior layer of through and through inverting sutures of fine silk. Tube drainage of the common duct is usually considered unnecessary. In 57 patients T-tubes were inserted three times and simple catheters through the cystic duct seven times.

Results

Mortality (Table 2). The overall mortality rate was 5.5%. Two patients died following choledochoduodenostomy.

1. A 79-year-old man underwent removal of common duct stones and the establishment of a choledochoduodenostomy and a temporary gastrostomy. Associated with the choledocholithiasis there was stenosis of the sphincter of Oddi and cultures from the common bile duct disclosed *Escherichia coli, Enterococci* and *Clostridium perfringens*. The patient died on the ninth postoperative day of peritonitis and endotoxic shock. Autopsy indicated necrosis at the site of anastomosis. It could not be determined whether this was a con-

TABLE 2. *Causes of Mortality in Patients Undergoing Sphincterotomy and Choledochoduodenstomy*
Mortality—5.45%

	Postop. Day
Sphincterotomy	
1. Pancreatitis	5
2. Choledocho-Peritoneal fistula, uremia, G.I. hemorrhage	12
3. Pancreatitis, retroperitoneal abscess, septicemia	16
4. Cholangitis, liver abscesses, renal failure, pulmonary embolism	41
Choledochoduodenostomy	
1. Bacterial peritonitis and endotoxic shock	9
2. Cholangitis, wound necrosis, renal hepatic failure	31

TABLE 3. *Complications in Patients Undergoing Sphincterotomy and Choledochoduodenostomy*
Morbidity—40%

	Sphincterotomy	Choledochoduodenostomy
Number of patients	23	21
Complications		
Wound infection	10	8
Atelectasis or pneumonitis	3	6
Subphrenic or subhepatic abscess	3	3
Wound dehiscence	1	0
Pancreatic fistula	1	2
Duodenal fistula	0	1
Urinary tract infection	3	1
Wound hemorrhage	0	3
Miscellany	2	2
	23	26

sequence of infection or malconstruction of the anastomosis.

2. A 45-year-old woman with a history of cholangitis associated with complete common bile duct obstruction due to calculi underwent cholecystectomy, choledocholithotomy, choledochoduodenostomy, choledochostomy, gastrostomy and liver biopsy (biliary cirrhosis).

Contents of the common duct and gallbladder cultured *Escherichia coli* and *Aerobacter klebsiella*. The patient's subsequent course was characterized by severe cholangitis, endotoxic shock and renal failure complicated by massive upper gastrointestinal bleeding. Infection and necrosis of the wound ensued and the patient ultimately died of hepatic failure on the 31st postoperative day.

In 53 patients undergoing sphincterotomy, there were four postoperative deaths, one due to pancreatitis on the fifth day, one due to pancreatitis with a retroperitoneal abscess and septicemia on the 16th day, a third secondary to a choledochal-peritoneal fistula with bile peritonitis and the fourth due to cholangitis and liver abscesses terminating in pulmonary embolism on the 41st day.

1. A 65-year-old woman died of acute fulminating pancreatitis 5 days after cholecystectomy and sphincterotomy for cholelithiasis and stenosis at the ampulla. The pancreatitis was thought to be initiated by the passage of a probe through the posterior wall of the common duct in the region of the pancreas.

2. A 71-year-old woman with a history of acute cholecystitis, cholangitis and jaundice under-

TABLE 4. *Deaths from Cancer*

Time (Mos.)	Site	Previous Diagnosis
	Sphincterotomy	
1½	Common duct	Stenosis with "mud"
4	Pancreas	Chronic pancreatitis
	Choledochoduodenostomy	
7	Pancreas	Pancreatitis
11	Pancreas	Pancreatitis and C.D. stricture
30	Pancreas	Choledocholithiasis with pancreatitis

went cholecystectomy, choledocholithotomy and transduodenal sphincterotomy with drainage of the common duct by a T-tube. A choledochal peritoneal fistula developed with bile peritonitis. Death occurred on the 12th postoperative day due to uremia, cardiac failure, gastrointestinal hemorrhage and bronchopneumonia.

3. An 84-year-old man underwent choledochotomy and transduodenal sphincterotomy and choledocholithotomy because of stenosis of the ampulla and a 3 mm. pigmented stone in the dilated common duct. The common duct was intubated with a straight catheter through the cystic duct stump. The operative site continually drained pus with a heavy growth of *Hemolytic Staphylococcus aureus* and a moderate growth of *Aerobacter klebsiella*. Death from septicemia occurred on the 16th postoperative day. Autopsy disclosed a large ramifying retroperitoneal abscess in the right upper quadant in the region of the operative site. This was associated with foci of pancreatic fat necrosis. The ampulla of Vater was widely patent.

4. A 65-year-old man had continued cholangitis after two previous operative procedures, namely, a cholecystectomy and choledochostomy. A cholangiogram procured through the indwelling T-tube indicated intermittent obstruction with "bile mud." Drainage from the common duct yielded a heavy growth of *Pseudomonas aeruginosa*. A transduodenal sphincterotomy and liver biopsy were performed. Postoperatively, the patient continued to have severe cholangitis and developed renal failure. Death on the 41st day was due to pulmonary embolism. Autopsy disclosed purulent cholangitis with multiple liver abscesses, a large duodenal ulcer and a well-differentiated carcinoma involving the entire length of the extrahepatic bile ducts.

The mortality incidence was not significantly different for the two procedures.*

* Chi square.

There have been no postoperative deaths in the last 5 years.

Morbidity. The overall morbidity was 40% representing principally wound infection, atelectasis or pneumonitis, subphrenic or subhepatic abscess. Some type of morbidity was present in 23 patients undergoing sphincterotomy (23 complications) and in 21 patients undergoing choledochoduodenostomy (26 complications) (Table 3). There was no appreciable difference in the incidence of these complications.

Long Term Results. Patients were followed by direct contact or communicating with their physician for evidence of recurrent disease as manifest by pain, cholangitis, pancreatitis or choledocholithiasis. The mean period of observation was 3.7 years for patients undergoing sphincterotomy and 3.3 years for patients undergoing choledochoduodenostomy. No patient required re-operation because of stones, pancreatitis or jaundice. One patient died 2 years after sphincterotomy of hepatic failure and progressive biliary cirrhosis, but without evidence of obstructive jaundice. Three patients who had recurrent symptoms were particularly instructive. One was re-operated upon 2 years after choledocholithotomy and sphincterotomy because of recurring cholangitis with the intravenous cholangiogram suggesting the presence of intrahepatic calculi. The operative cholangiogram, however, disclosed marked dilatation of all bile ducts (cholangiectasis) (Fig. 4), but no intrahepatic calculi or obstruction at the site of sphincterotomy. A subsequent cine cholangiogram demonstrated adequate emptying of the biliary tree and some residual sphincteric mechanism at the ampulla. This patient has remained asymptomatic on 250 mg. tetracycline daily. The second patient had symptoms of pain and minimal cholangitis. She had undergone a previous choledochoduodenostomy with one stone having been retained in the distal segment at the site of the ampulla (Fig. 5). This patient has

had one attack of discomfort in a follow-up period of 3 years. With present indications, a stone at the ampulla would be an indication for sphincterotomy and this stone should have been removed or passed. A third patient developed right upper quadrant pain with symptoms of mild colangitis without jaundice 5 years after choledocholithotomy and sphincterotomy for recurrent choledocholithiasis. An intravenous cholangiogram disclosed no calculi or dilatation of the common duct. An upper gastrointestinal x-ray revealed reflux into the common duct. This patient's symptoms have not been satisfactorily explained. An additional patient illustrates the role of partial common duct obstruction in the genesis of cholangitis and choledocholithiasis. He had undergone cholecystectomy with choledochoduodenostomy elsewhere 5 years previously. He was reoperated upon because of continued cholangitis with the findings of stricture of the anastomosis and choledocholithiasis. A choledocholithotomy was carried out in conjunction with a revision of the choledochoduodenostomy. There have been no recurrent symptoms during the ensuing 2 years.

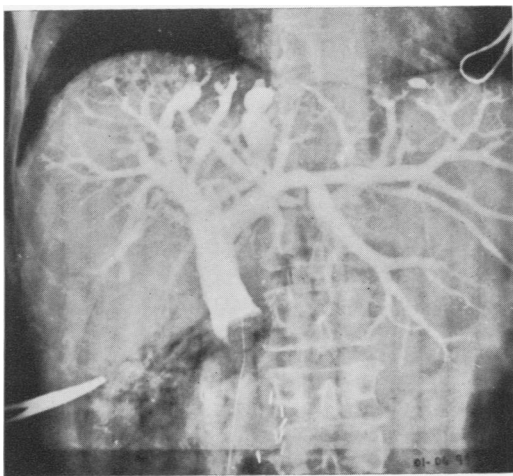An analysis of late deaths disclosed the subsequent identification of cancer in five

FIG. 5. Retained common duct stone as demonstrated by intravenous cholangiogram following choledochoduodenostomy as a cause of continued, but minimal symptoms.

patients (Table 4). These were at intervals as to suggest that the neoplasms had been the cause of the common duct obstruction. Three patients who underwent choledochoduodenostomy, two for pancreatitis and common duct obstruction and one for pancreatitis and choledocholithiasis died postoperatively of pancreatic cancer at 7 months, 11 months and 2½ years, respectively. A biopsy had been performed in each instance revealing only interstitial pancreatitis. Two patients undergoing sphincterotomy were subsequently found to have cancer. In one, common duct "mud" was present and the patient died of sepsis and pulmonary embolus on the 41st day. Carcinoma of the common duct was found at autopsy. A second patient with a postoperative diagnosis of pancreatitis (biopsy) without jaundice died 4 months later of pancreatic cancer.

The survivorship of the patients undergoing these procedures was determined [4] and compared to that of a "normal population" of comparable age. Survivorship curves over a period of 6 years did not depart from normal.

FIG. 4. Operative cholangiograms demonstrating cholangiectasis as a cause of recurrent cholangitis following sphincterotomy.
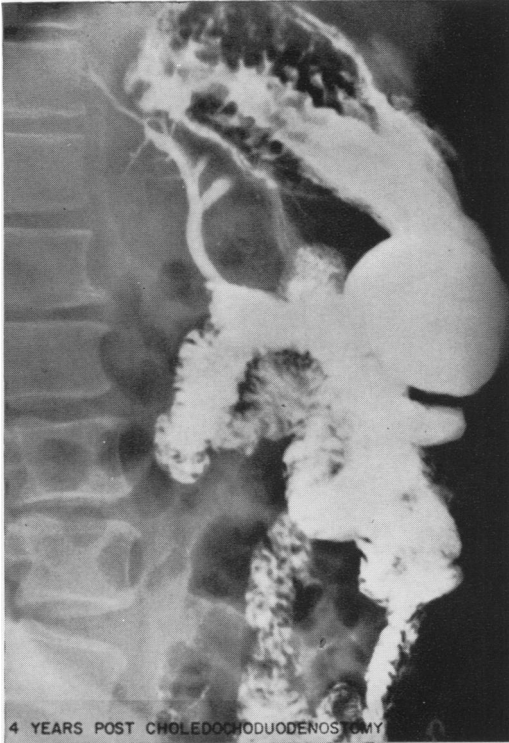
FIG. 6. An upper gastrointestinal x-ray shows reflux of barium into a normal appearing common duct 4 years after choledochoduodenostomy for choledocholithiasis and stenosis of the terminal common duct.

Discussion

Both choledochoduodenostomy and sphincterotomy have been used for many years to overcome obstruction of the common duct. There have, however, been no comparative studies of their relative effectiveness and the optimal method of common duct drainage has not been established. An appraisal of these patients demonstrated a remarkable similarity in the effectiveness of the two procedures in correcting common duct obstruction and in preventing recurrent disease. A most impressive finding was the absence of any symptoms or evidence of retained stones in all but three of these 110 patients. One individual had a retained stone and one had cholangiectasis. Symptoms in the third patient could not be explained on the basis of abnormal cholangiograms, but were suggestive of cholangitis. The usual incidence of retained or recurrent calculi after choledocholithotomy is between 5 and 10 per cent.[11, 13, 18, 24, 39, 46] The gestational time required for the formation of a stone is unknown. In view of the advanced age of many patients, it may exceed their life expectancy and account in part for the absence of recurrent disease. The lack of symptoms, however, would be further evidence of the continued adequacy of the anastomosis. Such patency could be nicely demonstrated radiographically for both choledochoduodenostomy and sphincterotomy years after the operative procedures (Figs. 6, 7).

The absence of cholangitis is not surprising since the source of bacteria in cholangitis is more likely to be on the basis of transport to the liver by way of the portal venous system and afferent lymphatics with excretion of bacteria in the bile rather than by an "ascending" infection.[9, 36] If this thesis is correct, these patients should develop neither cholangitis nor calculi in the absence of common bile duct obstruction.

In reviewing the overall morbidity and mortality of both procedures, two factors apparently play a determinant role, namely the presence of cholangitis (bactibilia) at the time of operation and the development of postoperative pancreatitis. Shingleton[12] has emphasized the high incidence (91%) of positive bacterial cultures in the biliary tree of patients with partial obstruction of the common bile duct. This is in keeping with the findings of Glenn[15, 16] who noted infection to be the chief cause of morbidity and mortality following biliary tract surgery. Aust[1] has also documented the high operative mortality and morbidity which accompanies surgical repair of common duct strictures due to cholangitis, liver abscess, systemic infection and biliary cirrhosis. These observations indicate the need for the effective treatment of biliary tract infection pre- and postoperatively in conjunction with judicious timing of any sur-

Fig. 7. X-rays show reflux of barium 5 years after sphincterotomy for choledocholithiasis and terminal common duct obstruction.
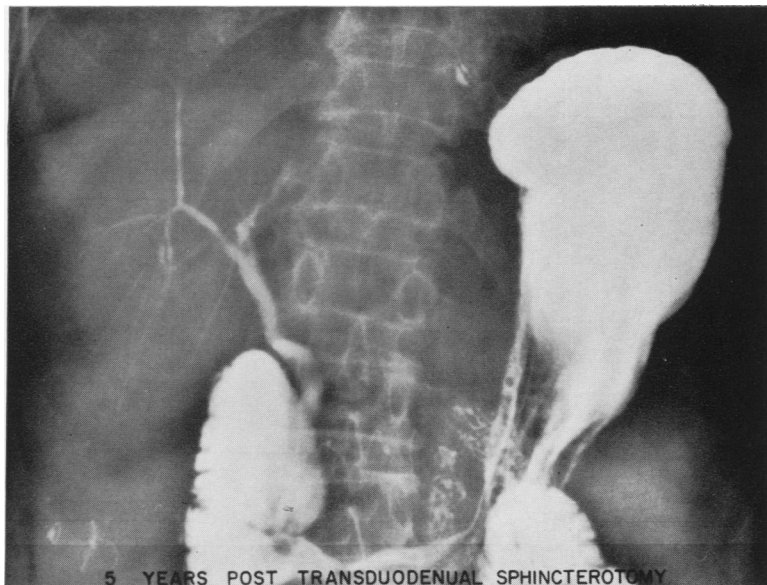
gical procedure. Infection may also play a role in the development of postoperative pancreatitis. The relative incidence of cholangitis in these patients seemed more related to the underlying disease than any particular operative procedure.

Two patients died as a result of pancreatitis. Both of these individuals underwent sphincterotomies and in one there was definitely trauma to the pancreas via the false passage of a probe. In the other, however, a patent duct of Wirsung was clearly visualized and there was no obvious obstruction or manipulation other than that associated with the Kocher maneuver and identification of the sphincter of Oddi. The association of pancreatitis with choledochotomy and/or sphincterotomy has been well documented.[42] The common underlying factor appears to be operative instrumentation within the common bile duct. The presence of a long-armed T-tube through the ampulla of Vater has also been a contributing factor in postoperative pancreatitis.[30] In view of the nature of the lesions to be corrected and particularly with the frequency of choledocholithiasis, both operative procedures are associated with manipulations within the common bile duct. With the need to identify the sphincter of Oddi by

way of a probe or catheter in patients undergoing sphincterotomy, the latter probably required more instrumentation of the common duct than does choledochoduodenostomy. Regardless of the approach, manipulations within the common duct may initiate cholangitis and/or pancreatitis and should be kept at a minimum. The direct approach of Hardy[18] to the sphincter whether or not there is an impacted stone, may be a method of minimizing this hazard. There has been no mortality during the past 5 years, a period during which there was more emphasis on the control of cholangitis preoperatively, less instrumentation, insertion of fewer tubes and perhaps better tailoring of the procedures to the operative findings.

A long standing approach to choledocholithiasis and stenosis of the sphincter has been dilatation of the ampulla by graded metal dilators in conjunction with choledocholithotomy. This would seem inadvisable because of the hazards associated with instrumentation and any forceful dilatation would provoke further injury, edema and eventually fibrous stricture.[37, 40]

The mortality rate for sphincterotomy was comparable to that reported in a collected series of 1,061 patients. The mor-

TABLE 5. *Mortality and Morbidity with Sphincterotomy—Collected Series*

Author	Year	No. of Patients	Postoperative Cholangitis	Pancreatitis (Hospital Deaths)	Total Hospital Deaths
Doubilet[10]	1956	319	0	0	17
Cattell[6]	1957	72	—	0	2
Deucher[8]	1957	36	—	4	(4)
Riddell[33]	1959	31	0	1	4
Goinard[17]	1960	100	0	0	4
Walters[43]	1961	102	—	4	(4)
Marshall[29]	1962	67	0	1	3
Drouin[11]	1964	100	—	—	1
Kourias[25]	1966	113	3	1	8
Hardy[18]	1969	121	4	1	2
		1061	7	12	49
			0.8%*	1.1%	4.6%

* Of 851 patients documented.

tality rate varied from 0–13% with a mean of 4.6% (Table 5). A significant cause of death was the development of postoperative pancreatitis (1.1%). As indicated, in the previous discussion, contributing factors are related to instrumentation of the common duct, trauma to the pancreas and the high incidence of bactibilia in these patients. In the subsequent follow-up, the frequency of cholangitis was 0.8%.

In a collected series of 733 patients undergoing choledochoduodenostomy for both benign and malignant disease, the mortality rate varied from 0–8% with a mean of 3.0% (Table 6). Pancreatitis was here again a significant cause of postoperative mortality (1%). The incidence of subsequent cholangitis was identical to that following sphincterotomy, viz. 0.8%. Although choledochoduodenostomy has been censored because of the blind cul-de-sac distal to the anastomosis [44] no ill effect has been observed in this series as manifest by recurrence of symptoms, stones or pancreatitis except in the one patient with a retained calculus. This apparently has also been true of patients cited in the literature.[27]

The relatively high incidence of ensuing malignant disease further emphasizes the difficulty in differentiating even by biopsy pancreatitis from pancreatic cancer. The need for careful consideration of the possibility of cancer in association with pancreatitis as the etiology of common duct obstruction is obvious.

TABLE 6. *Mortality and Morbidity with Choledochoduodenostomy—Collected Series*

Author	Year	No. of Patients	Postoperative Cholangitis	Pancreatitis (Hospital Deaths)	Total Hospital Deaths
Sanders[34]	1946	22	0	0	2
Plenk[31]	1949	63	1		2
Hosford[20]	1957	21	0		1
Iszak[23]	1958	66	0	0	1
Capper[5]	1961	125	0	1	5
Jones[24]	1963	132	0	3	3
Hurwitz[21]	1964	47	1		2
Magarey[28]	1966	133	3	1	3
Barner[2]	1966	24	1	0	0
Madden[27]	1970	100	0	1	3
		733	6	6	22
			0.8%*	1.0%	3.0%

* Of 602 patients documented.

Physiologically, except for the cul-de-sac accompaning choledochoduodenostomy, there would seem to be little difference between a complete sphincterotomy and choledochoduodenostomy. Both, in essence, ablate or bypass the sphincter and provide a direct communication between the common duct and duodenum. On theoretical grounds, the cul-de-sac should be associated with less stasis if there is drainage through the stenotic sphincter and if the anastomosis is made as distal as possible.

It is concluded that these procedures are both highly effective in overcoming choledochal obstruction. The accompanying morbidity and mortality are related primarily to (a) cholangitis, which in turn reflects the underlying disease and (b) pancreatitis, which is initiated by bile duct instrumentation in the presence of bactibilia, rather than a particular operative procedure. In view of the foregoing and the technical considerations of each approach, transduodenal sphincterotomy would appear to be the procedure of choice in individuals with (1) small or impacted stones in the ampulla of Vater; (2) a small common duct making choledochoduodenostomy technically more difficult; (3) the possibility of an ampullary tumor causing obstruction and (4) recurring pancreatitis associated with choledocholithiasis and the need for precluding a common effect. Choledochoduodenostomy may be equally effective in the management of the last indication (4). Choledochoduodenostomy would appear to be preferable in patients in whom: (1) it is difficult to identify the sphincter of Oddi by either the presence of a stone or facile passage of a probe through the ampulla; (2) because of obesity or other factors, exposure may be difficult; (3) the length of the stenosis may contradict sphincterotomy and (4) suppurative cholangitis may constitute a contraindication to manipulation within the bile ducts.

In many individuals, either operative procedure would be appropriate and here the selection must ultimately be determined by the ease of technical performance and the experience of the surgeon, recognizing the essentiality of avoiding unnecessary instrumentation of the bile ducts with its attendant hazard of cholangitis or pancreatitis. Both procedures have the advantage of avoiding the need for "tube" drainage of the common duct with its associated foreign body reaction contributing to infection, stasis, bile sludge and stone formation.[40] The morbidity and mortality accompanying these operations would not justify either procedure as a routine measure to be used with cholecystectomy.[11]

Summary

A comparative study of transduodenal sphincterotomy and choledochoduodenostomy was carried out in 110 patients undergoing these procedures for "benign" obstruction of the common bile duct. These operations were both highly effective in overcoming such obstruction and in the prevention of recurrent disease. The chief causes of death were cholangitis, septicemia and pancreatitis and seem to be more related to the underlying disease than the operation *per se*. Although in many instances these procedures may be equally applicable, each has certain advantages. Ultimately, the selection of the most appropriate operation will depend upon the pathologic findings and that approach which is most likely to avoid or minimize factors contributing to overall morbidity and mortality.

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