Table 1 Characteristics of the four patients with subsequent biliary malignancy following choledochal cyst excision in the current series

Case	Gender	Choledochal cyst		Subsequent biliary malignancy after cyst excision			
		Age at cyst excision (years)	Type of cyst†	Age at detection (years)	Anatomical site	Treatment	Outcome (months)
1	F	14	IV-A	27	Intrapancreatic	Pancreaticoduodenectomy	15; DOD
2	M	12	IV-A	44	Intrahepatic	Left trisectionectomy	35; DOD
3	M	50	I	65	Hilar	Left trisectionectomy	9; DOD
4	F	15	I	38	Intrahepatic	Chemo-radiotherapy	43; AWD

†According to Todani's classification.[31]
AWD, alive with disease; DOD, died of disease.

standard surgical procedure in 48 patients with type I cysts and 45 patients with type IV-A cysts. In the remaining one patient with a type I cyst, a combined partial hepatectomy and cyst excision was performed due to suspicion of coexisting gallbladder carcinoma before surgery. Hepaticojejunostomy, hepaticoduodenostomy, and hepaticoduodenostomy with jejunal interposition were performed as a reconstructive procedure in 86, six, and two patients, respectively.

Patient follow-up. The median follow-up time after cyst excision for congenital choledochal cysts was 181 months (range, 7–484 months). By the time of disease status assessment, three patients had died of subsequent biliary malignancy following cyst excision. One patient was alive with intrahepatic cholangiocarcinoma following cyst excision, and the remaining 90 patients were alive with no evidence of disease.

Review of the literature. The English language literature (PubMed, National Library of Medicine, Bethesda, MD, USA), from January 1966 through December 2011, was reviewed using the following Medical Subject Heading (MeSH) terms: "choledochal cyst" or ["cysts/surgery" and "bile duct"] in combination with "cholangiocarcinoma," "bile duct neoplasms," "liver neoplasms," "postoperative complications," "treatment outcome" and "follow-up study." The references from the included articles were searched to identify additional cases, and revealed that a total of 30 patients who had undergone choledochal cyst excision (two of whom were included in our earlier reports[11,17]) suffered from subsequent biliary malignancy following cyst excision.[8–30]

Statistical analysis. Medical records and survival data were obtained for all the 94 patients. The causes of death were determined based on the medical records. The Kaplan–Meier method was used to estimate both the cumulative incidence of subsequent biliary malignancy following cyst excision and the cumulative patient survival rates after treatment for subsequent biliary malignancy following cyst excision. All statistical analyses were performed using PASW Statistics 17 software (SPSS Japan, Tokyo, Japan). All tests were two-sided, and P 0.05 was considered to be statistically significant.

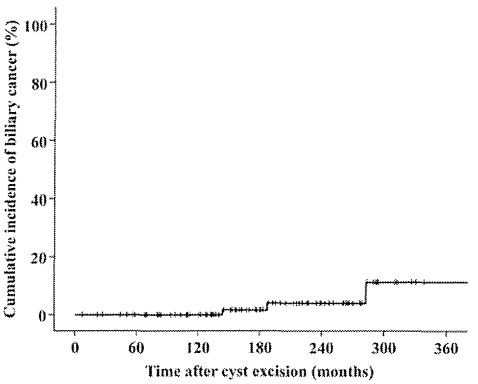

Figure 1 The cumulative incidence of biliary tract cancer after cyst excision for congenital choledochal cysts among 94 patients in the current series. The cumulative incidences of biliary tract cancer were 1.6%, 3.9%, and 11.3% at 15, 20, and 25 years after cyst excision, respectively.

Results

Cumulative incidence of subsequent biliary malignancy following cyst excision for congenital choledochal cysts. Four of 94 patients (4.3%) had subsequent biliary malignancy following cyst excision for congenital choledochal cysts at 13, 15, 23, and 32 years after surgery during the follow-up period (Table 1). The anatomical sites of biliary tract cancer were the intrahepatic ($n = 2$), hilar ($n = 1$), and intrapancreatic ($n = 1$) bile ducts. The cumulative incidences of biliary tract cancer were 1.6%, 3.9%, and 11.3% at 15, 20, and 25 years after cyst excision, respectively (Fig. 1).

Treatment outcome for subsequent biliary malignancy following cyst excision for congenital choledochal cysts. Of the four patients with subsequent biliary malignancy following cyst excision, three patients underwent surgical resection (Table 1). Surgical resection procedures included left trisectionectomy ($n = 2$) and pancreaticoduodenectomy ($n = 1$). Adenocarcinoma was identified as the primary tumor in these three patients. The tumors were well differentiated in Case 1 and moderately differentiated in the others. The tumor of Case 1 showed direct invasion to the duodenum and pancreas without lymph node metastases. The tumor of Case 2 showed invasion to

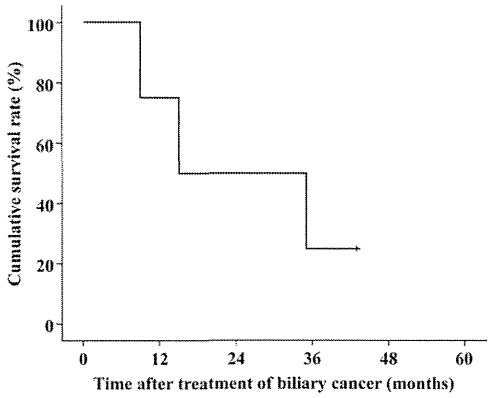

Figure 2 Kaplan–Meier survival estimates in four patients with subsequent biliary malignancy following choledochal cyst excision. The overall cumulative survival rates after treatment were 50% at 2 years post-treatment and 25% at 3 years post-treatment, with a median survival time of 15 months.

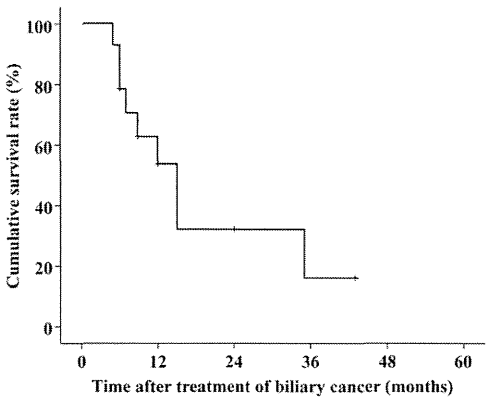

Figure 3 Kaplan–Meier survival estimates in 14 patients identified from the literature review (including our four patients) suffering from subsequent biliary malignancy following choledochal cyst excision with documented outcomes after treatment. The overall cumulative survival rates after treatment were 32% at 2 years post-treatment and 16% at 3 years post-treatment, with a median survival time of 15 months.

the main portal vein without lymph node metastases. The tumor of Case 3 had periaortic lymph node metastases. These three patients died of disease 9, 15, and 35 months after surgical resection of the subsequent biliary malignancy following cyst excision.

The remaining patient (Case 4 in Table 1) underwent exploratory laparotomy. Histological examination of excisional biopsy specimen of an inferior mediastinal lymph node showed moderately differentiated adenocarcinoma. Radical resection was contraindicated due to distant nodal disease. The patient (Case 4) was still alive with intrahepatic cholangiocarcinoma after receiving chemo-radiotherapy. The overall cumulative survival rates after treatment in the four patients with subsequent biliary malignancy following cyst excision were 50% at 2 years post-treatment and 25% at 3 years post-treatment, with a median survival time of 15 months (Fig. 2).

Review of the literature on subsequent biliary malignancy following choledochal cyst excision. An analysis of the 32 reported patients (including our two previously reported cases[11,17] and the two new cases from our present study) with subsequent biliary malignancy following choledochal cyst excision revealed that the anatomical sites of biliary tract cancer were the hilar ($n = 17$), intrahepatic ($n = 9$), and intrapancreatic ($n = 6$) bile ducts (Table 2). Thus, the hilar region was the predominant site of subsequent biliary malignancy following cyst excision. The median interval between cyst excision and the detection of this complication was 6 years (range, 1–34 years). Of the 32 reported cases, 12 patients were treated with supportive care and 14 patients received either surgical resection ($n = 11$), chemo-radiotherapy ($n = 2$) or chemotherapy ($n = 1$) (Table 2). There were no 4-year survivors among the 32 patients with subsequent biliary malignancy following cyst excision. In the 14 patients who received treatment for subsequent biliary malignancy following cyst excision, the overall cumulative survival rates after treatment were 32% at 2 years post-treatment and 16% at 3 years post-treatment, with a median survival time of 15 months (Fig. 3).

Table 2 Characteristics of 32 patients with subsequent biliary malignancy following choledochal cyst excision: A literature review

Variable	No. patients
Age at cyst excision (years)†	28 (0.4–68)
Age at detection of biliary malignancy (years)†	41 (18–70)
Gender (M/F/ND)	8/18/6
Type of choledochal cyst (I/IV-A/ND)‡	17/12/3
Site of subsequent biliary malignancy	
Hilar	17
Intrahepatic	9
Intrapancreatic	6
Treatment for subsequent biliary malignancy	
Surgical resection	11
Chemotherapy or chemo-radiotherapy	3
Supportive care	12
ND	6
Survival status	
DOD	24
NED	5
DOO	2
AWD	1

†Values are median (range).
‡According to Todani's classification.[31]
AWD, alive with disease; DOD, died of disease; DOO, died of other causes; ND, not described; NED, (alive with) no evidence of disease.

Discussion

Cyst excision is the standard of care for congenital choledochal cysts.[6,7] Although sporadic cases of subsequent biliary malignancy developing in the remnant bile duct after cyst excision have been reported,[8–30] there is a paucity of clinical evidence regarding the risk of subsequent biliary malignancy in patients undergoing cyst excision for congenital choledochal cysts. This prompted us to conduct the current study at a single institution. This is the first to demonstrate that the risk of subsequent biliary malignancy in

patients undergoing cyst excision for congenital choledochal cysts seems to be relatively high in the long-term.

Coexisting carcinomas most commonly arise in choledochal cysts classified as types I and IV and are uncommon in types II, III, and V.[3] Todani *et al.*[32] reported that the risk of carcinoma remains, perhaps related to dysplasia and metaplasia of the epithelium. Therefore, complete cyst excision is essential to prevent subsequent biliary malignancy for congenital choledochal cysts with APBDJ. In type I and IV cysts, cyst excision involves complete excision of the bile duct from the confluence of the hepatic duct proximally up to the pancreaticobiliary junction distally.[18,30,33] Biliary-enteric anastomosis at larger caliber duct is recommended for prevention of postoperative biliary strictures and subsequent biliary malignancy following cyst excision.[34] It is also necessary for hepatobiliary surgeons to be careful not to damage the main pancreatic duct when the intrapancreatic portion of the dilated bile duct is excised.

The incidence of subsequent biliary malignancy after cyst excision was 4.3% in the current series. Some studies of subsequent biliary malignancy after cyst excision have reported incidence rates from 0.7% to 5.4%.[23,30,35] Tocchi *et al.*[36] reported that chronic inflammatory changes consequent to biliary-enteric anastomosis for benign biliary diseases should be closely monitored for the late development of biliary malignancies, suggesting that the risk of subsequent biliary malignancy may be associated with bilioenteric anastomosis itself. As the development of biliary cancer after cyst excision may depend on follow-up time, we applied the Kaplan–Meier method to estimate the risk of subsequent biliary malignancy following cyst excision. New results from our current study found that the cumulative incidences of subsequent biliary malignancy were 1.6% at 15 years, 3.9% at 20 years, and 11.3% at 25 years after cyst excision, suggesting that the risk of biliary malignancy in the remnant bile duct increases more than 15 years after cyst excision. Therefore, long-term follow-up is recommended for patients undergoing cyst excision for congenital choledochal cysts.

In the current series, the overall cumulative survival rates after treatment in four patients with biliary tract cancer were 50% at 2 years post-treatment and 25% at 3 years post-treatment, with a median survival time of 15 months (Fig. 2). A review of the literature revealed that there were no 4-year survivors among 32 patients with subsequent biliary malignancy following cyst excision. In 14 of these patients who received treatment for subsequent biliary malignancy, the overall cumulative survival rates after treatment were 32% at 2 years post-treatment and 16% at 3 years post-treatment, with a median survival time of 15 months (Fig. 3). Despite an aggressive treatment approach, subsequent biliary malignancy shows an unfavorable outcome. Patients undergoing resection for subsequent biliary malignancy are therefore clear candidates for adjuvant chemotherapy such as cisplatin plus gemcitabine.[37]

The main limitation of this study is the retrospective analysis of a small number of patients undergoing cyst excision for congenital choledochal cysts. The relatively small number of patients with subsequent biliary malignancy after cyst excision ($n = 4$) limits firm conclusions being drawn. To our knowledge, however, this is one of the largest series with the longest follow-up time dealing with subsequent biliary malignancy following cyst excision for congenital choledochal cysts; in addition, we evaluated both the cumulative incidence of subsequent biliary malignancy and the cumulative patient survival rates after treatment using the Kaplan–Meier method.

In conclusion, the risk of subsequent biliary malignancy in patients undergoing cyst excision for congenital choledochal cysts seems to be relatively high in the long-term. The risk of biliary malignancy in the remnant bile duct increases more than 15 years after cyst excision. Despite an aggressive treatment approach for this condition, subsequent biliary malignancy following cyst excision for congenital choledochal cysts shows an unfavorable outcome.

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CHAPTER 111

Cystic Disorders of the Bile Ducts

Hisami Ando | Tadahiro Takada

CLASSIFICATION OF CYSTIC DISORDERS OF THE BILE DUCTS

In 1959, Alonso-Lej[1] first classified extrahepatic bile duct cysts into the following three types: type I is congenital cystic dilation of the common bile duct (choledochal cyst) where the intrahepatic tree is usually normal; type II is a congenital diverticulum of the common bile duct and is extremely rare; type III is choledochocele, a cystic dilation of the distal segment of the common bile duct protruding into the duodenal lumen. Alonso-Lej's classification, however, did not include intrahepatic bile duct cysts or pancreaticobiliary maljunction, the abnormal union between the pancreatic and common bile duct. Todani et al[2,3] refined the classification of bile duct cysts into five types and included the concept of pancreaticobiliary maljunction. Type IV-A is a choledochal cyst associated with intrahepatic duct dilation. Type V is multiple intrahepatic duct dilations. The frequencies of the types of bile duct cyst are as follows: type I, 73%; type IV-A, 24%; type III, 1.1%; type V, 1.1%; and type II, 0.4% of patients.[4]

CHOLEDOCHAL CYST (TYPES I AND IV-A)

GENERAL DESCRIPTION OF CHOLEDOCHAL CYST

The first authentic case of choledochal cyst was reported by Douglas in 1852.[5] Choledochal cysts have generally been considered a rarity, but recently the number of cases reported in the literature has steadily increased. The incidence of choledochal cysts in Western countries is 1 in 100,000 to 190,000 live births,[6] while the incidence is higher in the Japanese population.[7] The preponderance of female patients is well known, with the female-to-male ratio being 3 or 4 to 1.[7,8] Choledochal cysts may be found at any age, but more than two-thirds of cases are diagnosed in children younger than 10 years of age, and some cases are diagnosed prenatally by ultrasonographic examinations as early as the fifteenth week of gestation.[9]

Choledochal cysts are characterized by localized dilation of the common bile duct and are associated with pancreaticobiliary maljunction (Figure 111-1). Pancreaticobiliary maljunction, which was first noted by Kozumi and Kodama[10] in an autopsy case with choledochal cyst in 1916, is a congenital anomaly defined as an abnormal union of the pancreatic and biliary ducts. This initial observation did not attract attention for many years. However, since Babbitt[11] reported the anomaly in 1969, the concept has been accepted widely.[12] Pancreaticobiliary maljunction is thought to develop as a misarrangement of the embryonic connections in the pancreaticobiliary ductal system, with the terminal bile duct joined to the second branch of the ventral pancreas.[13,14] As a consequence, the pancreaticobiliary junction is located outside the duodenal wall, where the normal sphincter does not work (Figure 111-2). This permits reflux of pancreatic juice into the biliary tree and destruction of the bile duct wall. Diagnostic criteria for pancreaticobiliary maljunction by radiography are that (1) the pancreatic duct and choledochus connect with an obviously long common channel or (2) the ducts unite in an apparently anomalous form.[15]

Choledochal cysts have been subdivided into those exhibiting cystic, cylindrical, or fusiform dilation of the common bile duct but there is no difference in symptoms, signs, complications, or surgical care among the types. Many theories have been proposed to explain the origin of bile duct dilation and can be divided into two groups: (1) that due to an obstructive factor localized at the junction of the choledochus with the duodenum as an abnormal angularity or congenital stenosis of the terminal common bile duct and (2) that due to a condition originating in the common bile duct proper. However, the mechanism of bile duct dilation remains uncertain.

The cyst wall is usually 1 to 2 mm thick and composed mainly of a fibromuscular layer. This layer is made up of dense connective tissue that is fibrocollagenous and sometimes contains smooth muscles and elastic elements (Figure 111-3). The epithelium is sometimes lacking, but columnar epithelium is identified by gently manipulating the cyst during surgery. On rare occasion, ectopic pancreatic tissue may be found in the cyst wall.[16]

SYMPTOMS AND SIGNS

Patients with choledochal cysts, including type IV-A, most often present with nonspecific symptoms, and half of the patients appear asymptomatic, particularly adults. In children, the major clinical symptoms are recurrent abdominal pain (82%) that may occur repeatedly for several days, nausea and vomiting (66%), mild jaundice (44%), an abdominal mass (29%), and fever (29%). The simultaneous occurrence of symptoms may be explained by the disturbance in bile and pancreatic secretory flow caused by a protein plug, which resolves spontaneously, in the common channel.[17] The classic triad of abdominal pain, jaundice, and abdominal mass occurs in less than 10% of patients.

DIAGNOSIS

There are no specific laboratory tests to identify a choledochal cyst. Patients with choledochal cysts sometimes temporarily show abnormal values for serum bilirubin levels, serum amylase, and serum hepatic transaminases.

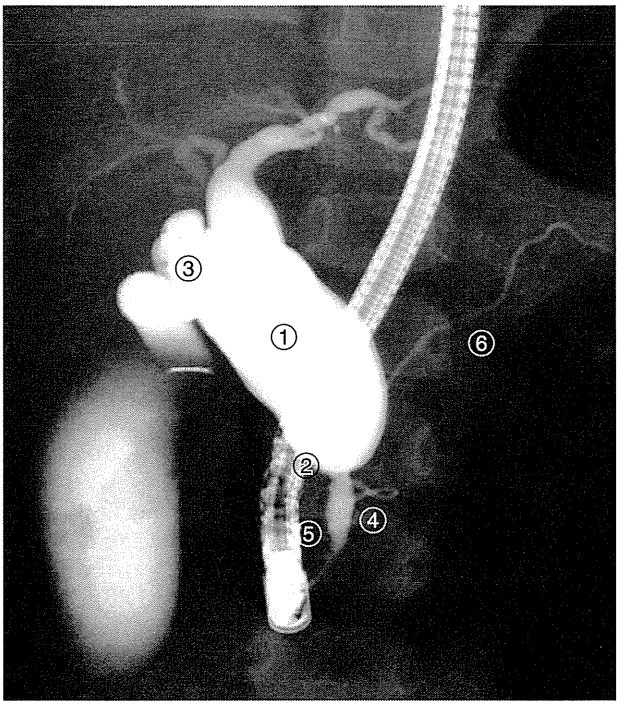

FIGURE 111-1 Endoscopic retrograde cholangiopancreatography provides characteristic images of choledochal cysts: (1) cystic dilation confined to the common bile duct, (2) stenoses at the lower portion of the cyst, (3) dilated cystic duct, (4) abnormal junction of the pancreatic and bile ducts away from the papilla, (5) dilated common channel, and (6) normal dorsal pancreatic duct.

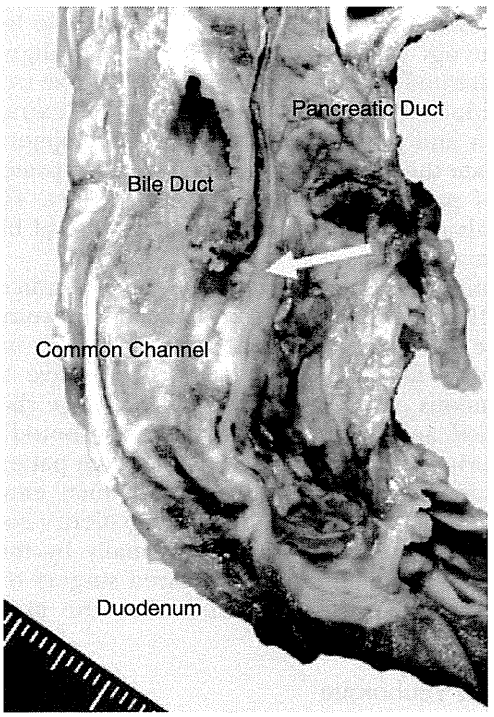

FIGURE 111-2 Gross dissection shows the long common channel and pancreaticobiliary junction *(arrow)* in the extraduodenal region.

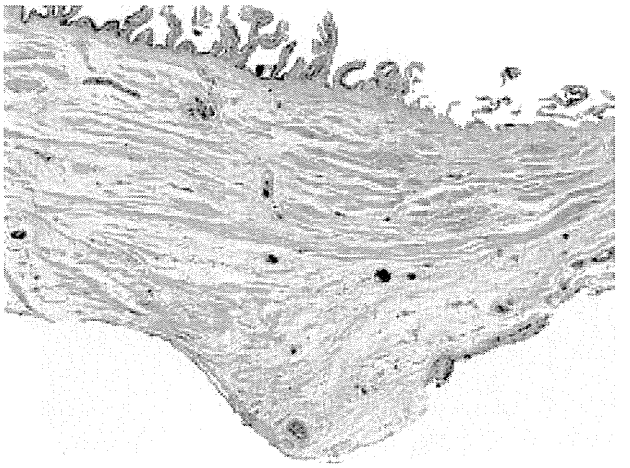

FIGURE 111-3 Hematoxylin-eosin section shows numerous smooth muscle bundles in the lower part of the choledochal cyst wall.

The noninvasiveness and accuracy of ultrasonography support its use as the initial investigative procedure. Ultrasonography typically shows the dilated common bile duct. Biliary sludge or stones within the cyst also can be identified in some cases. Focal thickening of the cyst wall raises the suspicion of carcinoma.

Endoscopic retrograde cholangiopancreatography (ERCP) gives an excellent visualization of the cyst, duct anatomy, and pancreaticobiliary maljunction (see Figure 111-1). This examination is important in order to avoid intraoperative injury of the pancreatic duct and to recognize protein plugs within the common channel. However, ERCP is invasive and associated with a small risk of complications such as ERCP-induced pancreatitis and must be performed under general anesthesia in children. In adults, ERCP has been used less frequently in recent years.

Magnetic resonance cholangiopancreatography (MRCP) provides a noninvasive method to assess the extrahepatic biliary tree and is an attractive alternative to ERCP.[18] However, MRCP can be hindered by the technical difficulty of children holding their breath.[19]

Computed tomography (CT) combined with intravenous cholangiography is useful for the demonstration of a cyst or postoperative evaluation for intrahepatic bile ducts and bilioenteric anastomoses. Helical CT cholangiography is useful for identifying the anastomotic site of hepaticojejunostomy and hepatic ductal stenosis in postoperative followup.[19]

COMPLICATIONS

Stones

Stones are the most frequent complication associated with choledochal cysts. The prevalence of intracystic stones ranges from 11% in children to 41% in adults, with the stone site being cholecystolithiasis in 11%, choledocholithiasis in 21%, and hepatolithiasis in 7% of cases.[20]

Protein Plug

The association of pancreatitis with choledochal cysts is well recognized. A history of clinical pancreatitis is

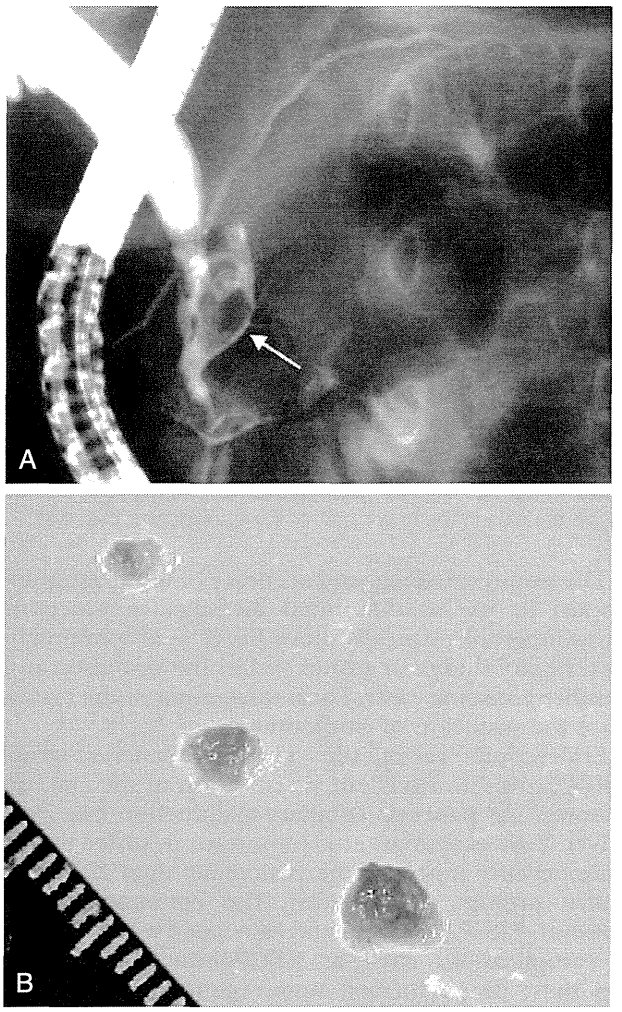

FIGURE 111-4 **A,** Protein plugs present at the common channel *(arrow)*. **B,** The plugs consist mainly of protein, and most are soluble.

present in nearly 30% of patients.[8] The pattern of pancreatitis can be acute, relapsing, or mild and may be caused by protein plug impaction within the common channel or bile duct, where the plug acts like a ball-valve, producing a transient and abrupt elevation in the intraluminal pressure in both the bile and pancreatic ducts (Figure 111-4).[17]

Spontaneous Perforation of the Bile Duct

Spontaneous perforation of the bile duct is a relatively rare complication of choledochal cysts and has been found in 26 (1.8%) of 1433 patients with choledochal cysts reported in the Japanese literature.[7] Most patients are children, with 60% being younger than 1 year of age. Clinical symptoms and signs are abdominal distention, pain, nausea, vomiting, fever, jaundice, and light-colored stool. Preoperative laboratory investigations show elevated white blood count and serum bilirubin levels, serum amylase, and transaminases. Preoperative diagnosis is based on the examination of samples of biliary fluid obtained by paracentesis. An abdominal ultrasound examination, biliary radionuclide scan, or MRCP can be used to make a rapid diagnosis.[21] Perforation of the bile duct occurs as a small, punched-out hole and although found mainly in the anterior aspect, can be found in any part of the cyst. In many cases, cholangiography reveals the presence of protein plugs.[22]

Carcinoma

The association of bile duct carcinoma with choledochal cysts was first reported in 1944.[23] Tumors may develop anywhere within the intrahepatic and extrahepatic bile ducts, but more than one-half occur within the cyst itself. The incidence of hepatobiliary malignancies associated with choledochal cysts ranges from 3.2% to 39.4%.[7,24,25] Malignant degeneration according to age at initial operation has also been reported, and it has been estimated that the risk of cancer in patients who had choledochal cyst diagnosed in the first decade is 0.7%, whereas in those who had choledochal cyst diagnosed at 11 to 20 years of age and at more than 20 years of age it is 6.8% and 14.3%, respectively.[26] The youngest reported patient with primary adenocarcinoma associated with a choledochal cyst was an 11-year-old male.[27] The pancreaticobiliary maljunction results in free reflux of pancreatic juice into the bile duct and inflammatory changes in the epithelium of the bile duct, and may be a key factor in the pathogenesis of malignant changes in cysts.[28]

SURGICAL MANAGEMENT

General Treatment before Operation

Historically, internal drainage by cystenterostomy was performed as the standard operation for choledochal cysts. However, internal drainage, particularly cystoduodenostomy, increased the frequency of cholangitis, biliary stones, and the risk of malignant changes in the retained cyst or gallbladder.[29,30] The mean age of the affected patients was approximately a decade less than the mean age of patients who developed malignancy in an unoperated cyst.[29] Currently, the definitive treatment of choledochal cysts is to excise the whole extrahepatic bile duct and perform Roux-en-Y hepaticojejunostomy to separate the bile and pancreatic ducts to prevent free reflux of pancreatic juice into the bile duct. This procedure also removes the most common site of bile duct carcinoma.

In patients with biliary infection and jaundice, intravenous fluid administration and broad-spectrum antibiotics are recommended. In patients whose infection or jaundice fails to resolve with conservative therapy, percutaneous or endoscopic biliary drainage should be performed, and the infection or jaundice should be controlled prior to the definitive operation. In patients with spontaneous perforation of the bile duct, emergency treatment is designed to improve the patient's condition and treat the biliary peritonitis (usually by means of T-tube drainage), followed by delayed surgery once the inflammation has subsided and after the anomalous anatomy has been defined.[22]

Operative Technique

First, the gallbladder is mobilized. Intraoperative choledochoscopy via the cystic duct may be useful to exclude

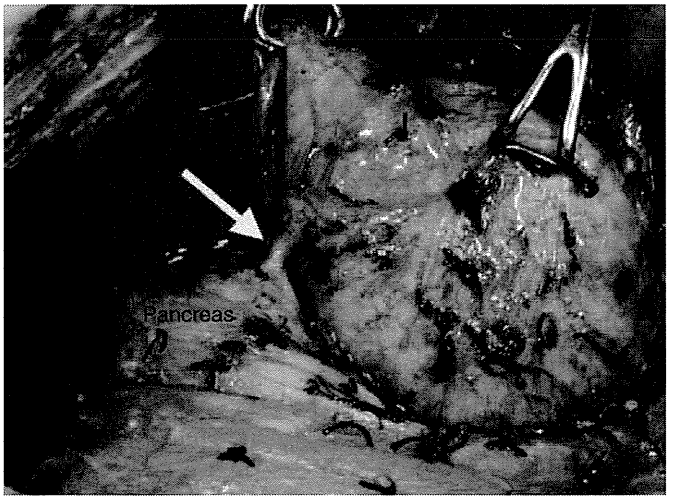

FIGURE 111-5 Operation for choledochal cyst shows the narrow segment *(arrow)* connecting the cyst and the main pancreatic duct, which is located not at the bottom of the cyst but almost always to the right and ventral to the cyst.

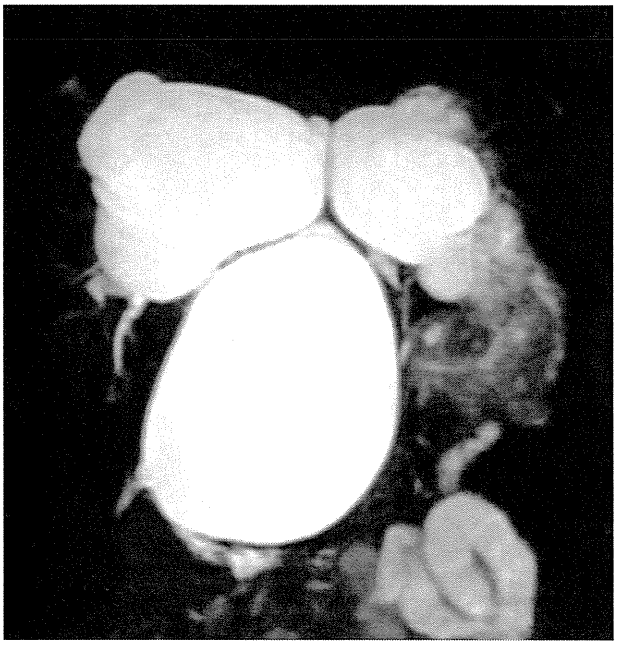

FIGURE 111-6 Magnetic resonance cholangiopancreatography shows the type IV-A choledochal cyst. Characteristics of this type are remarkable dilation of the intrahepatic bile ducts and stenoses at the hepatic hilum.

retained ductal stones and to biopsy the abnormal epithelium to exclude malignancy. A cholangiocatheter can be advanced through the cystic duct for bile aspiration and intraoperative cholangiography, which can be used to confirm the orientation of the pancreatic duct and check for protein plugs in the common channel or stenoses of the intrahepatic bile ducts. Dissection of the intrapancreatic cyst proceeds on the outer plane of the epicholedochal plexus, where only loose fibrous tissue exists, so as to leave the plexus with the cyst wall.[31] Further dissection should reveal that the narrow distal segment connecting the cyst and the main pancreatic duct is located not at the bottom of the cyst but almost always to the right and ventral to the cyst (Figure 111-5). Attention must be directed to the main pancreatic duct just ventral to the cyst. The distal narrow segment is ligated carefully with absorbable suture to prevent narrowing of the pancreatic duct. For patients with protein plugs stuck in the common channel, irrigation with saline solution through a thin tube placed in the common channel or removal using a blunt spoon through the narrow segment is recommended.[32] As incomplete excision of the cyst causes protein plug formation and may permit malignant change, complete cyst excision is recommended.[33]

Next, the cyst is elevated ventrally off the portal vein and mobilized proximally to the common hepatic duct. The hepatic duct near the bifurcation is transversely incised for assessment of possible stenoses at the orifice of the left and right hepatic ducts. If no stenosis is present at the hepatic ducts, the proximal cyst is transected and the cyst is removed. In patients with Todani type IV-A, stenoses are frequently found at the orifice of the left and right hepatic ducts (Figure 111-6). There are two different types of stenosis: membranous and septal (Figure 111-7).[34] When found, stenoses can be corrected by incising the hepatic ducts laterally to obtain a large anastomosis[35] or by resection.[36] Biliary reconstruction is accomplished by a 45-cm retrocolic Roux-en-Y hepaticojejunostomy.

POSTOPERATIVE COMPLICATIONS

Hepatolithiasis

Early complications can include anastomotic leakage, postoperative bleeding, acute pancreatitis, ileus, gastrointestinal bleeding, and pancreatic fistula. However, few reports on the long-term results of extrahepatic cyst excision are reported.[37] Late complications are cholangitis, intrahepatic lithiasis, and pancreatic stones. Recurrent cholangitis from anastomotic strictures occurs in 10% to 25% of patients.[3,38] The incidence of hepatolithiasis, usually occurring in Todani type IV-A, has been reported in as many as 2.7% to 10.7% of cases after long-term followup.[35,39] Although some cases do have a stricture of the anastomosis, in many other cases, especially type IV-A, calculi occur by residual stenoses near the confluence of the left and right hepatic duct.[36,38]

Carcinoma

Cyst excision has been recognized as the definitive operation for choledochal cyst; however, reports of bile duct cancer after cyst excision are gradually increasing.[7,24,40,41] Watanabe et al[24] reported 23 patients with bile duct cancer developing after cyst excision. Indeed malignant changes may occur before cyst excision or cyst enterostomy and may advance after cyst excision. Long-term followup is important, even after complete cyst excision, as the entire residual biliary tree is believed to be at increased risk for cholangiocarcinoma.

DIVERTICULUM (TYPE II)

A type II diverticulum arises laterally from the wall of the common bile duct (Figure 111-8). However, because of

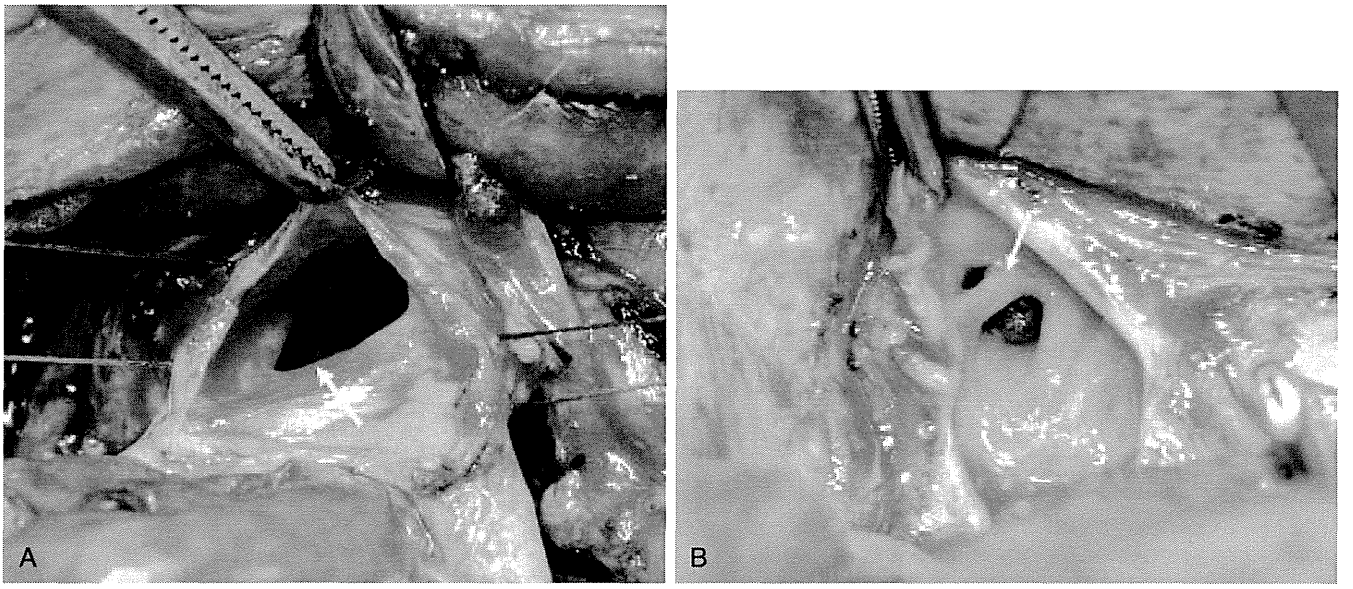

FIGURE 111-7 Two types of stenoses at the right hepatic duct are shown. **A,** The membranous stenosis is characterized by the presence of a thin wall *(arrow)*. **B,** The septal stenosis *(arrow)* is characterized by a slender column of tissue.

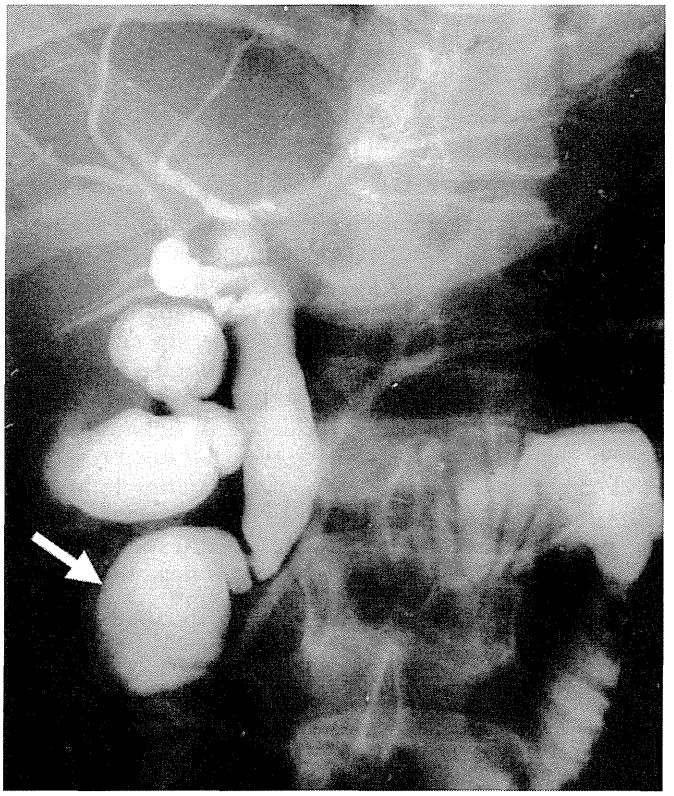

FIGURE 111-8 Endoscopic retrograde cholangiopancreatography shows type II biliary cyst, which is a saccular diverticulum of the common bile duct *(arrow)*.

its rarity, experience with this type is limited.[42] In this type, the weakness factor is limited to one small area of the side of the wall. The treatment of choice is simple cyst excision, a procedure that can be performed open or laparoscopically. Type II diverticulum is not usually associated with pancreaticobiliary maljunction.

CHOLEDOCHOCELE (TYPE III)

Choledochocele is an uncommon abnormality of cystic or diverticular dilation of the terminal intramural portion of the common bile duct, first described by Wheeler in 1940.[43] The term *choledochocele* was introduced by Wheeler, who saw the analogy with congenital ureterocele. The first classification of choledochocele was proposed by Scholz et al in 1976[44] and has been classified by various authors according to this scheme. There are two different types of the internal cyst wall component. One is lined by duodenal mucosa and the other lined by bile duct mucosa. The former type suggests that the choledochocele is a congenital duodenal duplication arising near the main duodenal papilla, which communicates with the common bile duct.[45] The latter type suggests a diverticular enlargement of the terminal portion of the common bile duct.[44] In the latter type, papillary stenosis or congenital or acquired dysfunction of the sphincter of Oddi may cause obstruction of bile flow, resulting in increased pressure within the distal bile duct, which could then evaginate into the duodenum.[46] However, the etiology remains unclear in many cases.

Choledochocele can be diagnosed by duodenoscopic or cholangiographic findings, with a cystic dilation of the distal segment of the common bile duct protruding into the duodenal lumen (Figure 111-9).[47] Some controversy exists concerning the size cutoff for the diagnosis of a choledochocele. Despite the widely recognized view that other biliary cysts are truly congenital, some choledochoceles appear to be acquired. Some authors have stated that an arbitrary 1-cm dividing line may be used to differentiate between a choledochocele and a dilated common channel or normal variants.[48,49] Choledochocele usually shows a normal pancreaticobiliary junction, but is associated with pancreaticobiliary maljunction in rare cases. Patient age may range from 1 to 89 years (median, 40 years), and there appears to be no gender

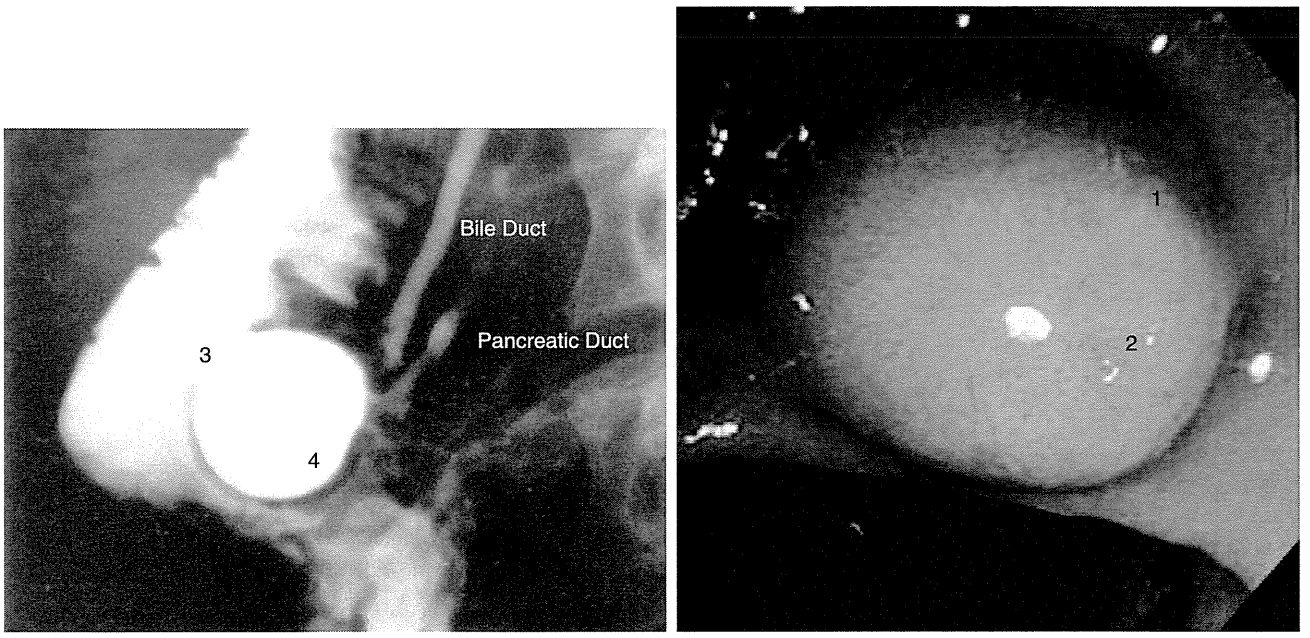

FIGURE 111-9 Endoscopic retrograde cholangiopancreatography **(A)** and endoscopy **(B)** shows characteristic images of a type III choledochal cyst or choledochocele: (1) an intramural segment of the common bile duct protruding into the duodenum in continuation with an enlarged papilla with a spherical shape; (2) soft overlying mucosa with a smooth appearance; (3) ballooning of the papilla during contrast injection; and (4) a rather spherical, cystlike, contrast-filled structure in continuity with the terminal common bile duct.

predominance.[45] Patients with choledochocele clinically present with intermittent episodes of upper abdominal pain accompanied by nausea and vomiting, obstructive jaundice, cholangitis, or recurrent acute pancreatitis.[44,45,49] Associated stone disease occurs in about 20% of cases, but the risk of malignant changes is extremely low.[45]

Although surgical excision of the duodenal luminal portion of the cyst wall has been performed, endoscopic papillotomy has been increasingly chosen as the preferred treatment for this type. Asymptomatic choledochoceles, incidentally identified during ERCP examinations, are best left alone and observed.[45]

CAROLI DISEASE (TYPE V)

In 1958, Caroli described a disease entity characterized by (1) segmental cystic dilation of the intrahepatic ducts; (2) increased incidence of biliary lithiasis, cholangitis, and abscesses; (3) absence of cirrhosis and portal hypertension; and (4) association of renal tubular ectasia or similar renal cystic disease. Still later, Caroli[50] recognized two entities: a "simple" type and a "periportal fibrosis" type. The so-called simple or pure type, originally described in 1958, is a very rare congenital abnormality, whereas the more common type is associated with congenital hepatic fibrosis, which is present in childhood.[51] However, as a term, *Caroli disease* has been applied broadly to describe patients with segmentally ectatic appearance of the intrahepatic bile ducts, identical to that seen in intrahepatic involvement of the choledochal cyst.

Caroli disease is generally considered autosomal recessive, but there are some cases of autosomal dominant inheritance.[52] The male-to-female ratio is 3 to 2, and the age at diagnosis ranges between 1 and 60 years (median, 25 years).[52] Symptoms include cholangitis (64%), portal hypertension (22%), and abdominal pain in the right upper quadrant (18%).[52,53] The dilated hepatic ducts connect with the common hepatic duct and are liable to become infected and contain stones.

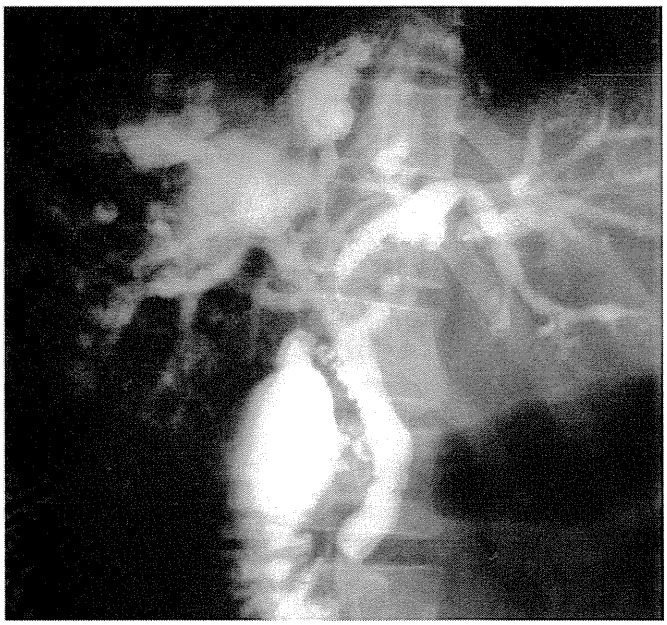

FIGURE 111-10 Endoscopic retrograde cholangiopancreatography shows Caroli disease, with multiple communicating sacculi of the intrahepatic biliary tree. The sacculi are large and are distributed within the right lobe.

Caroli disease can be diagnosed by the cholangiographic finding of a multiple saccular appearance of intrahepatic bile ducts (Figure 111-10).[54] Ultrasound,