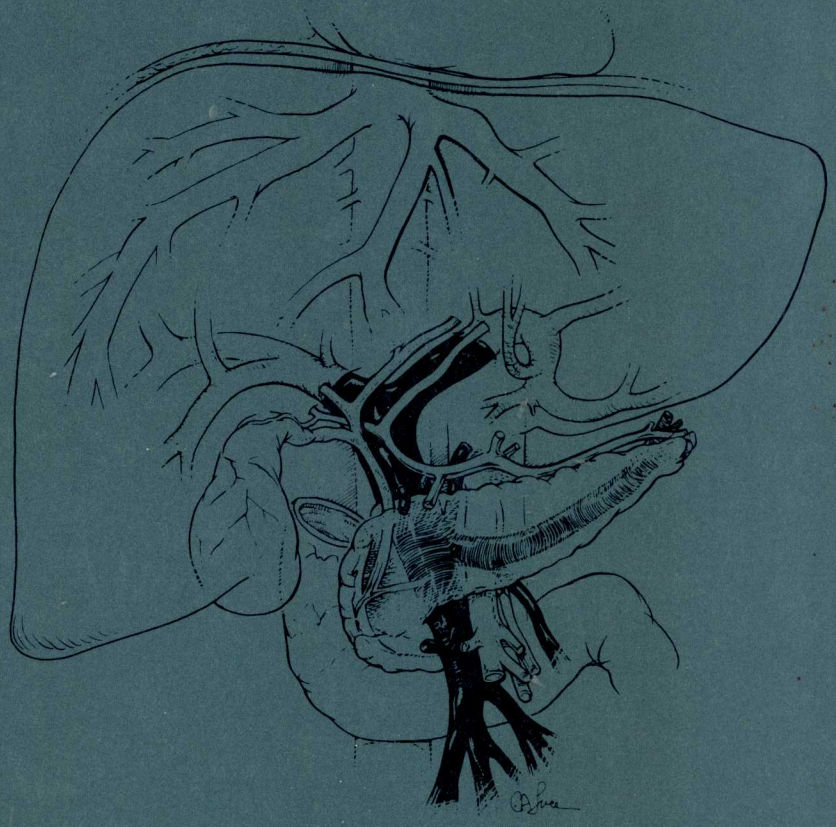
ATLAS OF LIVER AND BILIARY SURGERY

R. SCOTT JONES

Illustrated by Craig A. Luce



Atlas of Liver and Biliary Surgery

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Preface

The successful care of patients with liver and biliary disease depends upon many factors, such as a complete understanding of the principles of hepatobiliary pathophysiology, diagnostic acumen, and the ability to apply skillfully diagnostic methods, provide careful supportive care, and correct the pathologic anatomy. Scientific and technological advances of the past decade and a half have in some way improved all aspects of the care of patients with disabling hepatobiliary disease. With judicious use of imaging tests, scans, arteriography, cholangiography, and percutaneous biopsy techniques, most patients can expect an accurate diagnosis soon after evaluation with history and physical examination. This permits careful planning for the proposed therapy. Endoscopic techniques and biliary manipulations during radiographic monitoring have contributed immensely to the effective treatment of many liver and biliary diseases. The application of many of the operations described in this book have changed greatly in the past few years. Surgical operation, however, will continue to provide the preferred therapy for a large portion of patients with liver and biliary disease for the forseeable future. The recent technological advances have increased the effectiveness of biliary surgery while simultaneously decreasing surgical morbidity and mortality. The future will permit surgical successes not presently contemplated.

Mr. Craig A. Luce, the artist, witnessed most of the procedures described and prepared sketches in the operating room for all but a few of the operations. Several operations regularly used by many surgeons are absent here. We have included neither side-to-side portocaval shunt nor any of the non-shunting operations for portal hypertension. The infrequency of their use in our practice dictated their omission. To be current, any book on liver and biliary surgery should contain information on liver transplantation. A section on liver transplantation was omitted for the obvious reason that many other surgeons are much better qualified to describe that topic.

This book contains no references and simultaneously contains no original or new information. Everything described here was taken from others. My teachers, your teachers, and their teachers produced the techniques depicted in this book. The lore of surgery passes from one generation to the next. Every reader will disagree with various points in the described procedures, and in fact the author will continue to change as he learns new lessons. This book is for residents and young surgeons who we hope will take this material and make it better through their own study and practice.

R. Scott Jones, M.D.

Acknowledgments

The author wishes to thank Carole Hoadley, Marjorie Pennington, and Sharon Jordan for their assistance in preparation of this book. Dan Doody and Nancy Chorpenning of Year Book Medical Publishers skillfully guided the manuscript into publication. It was a pleasure to work with both of them.

Without a talented and expert artist there can be no surgical atlas. Mr. Luce's creativity and perseverance made this book possible.

R. Scott Jones, M.D.

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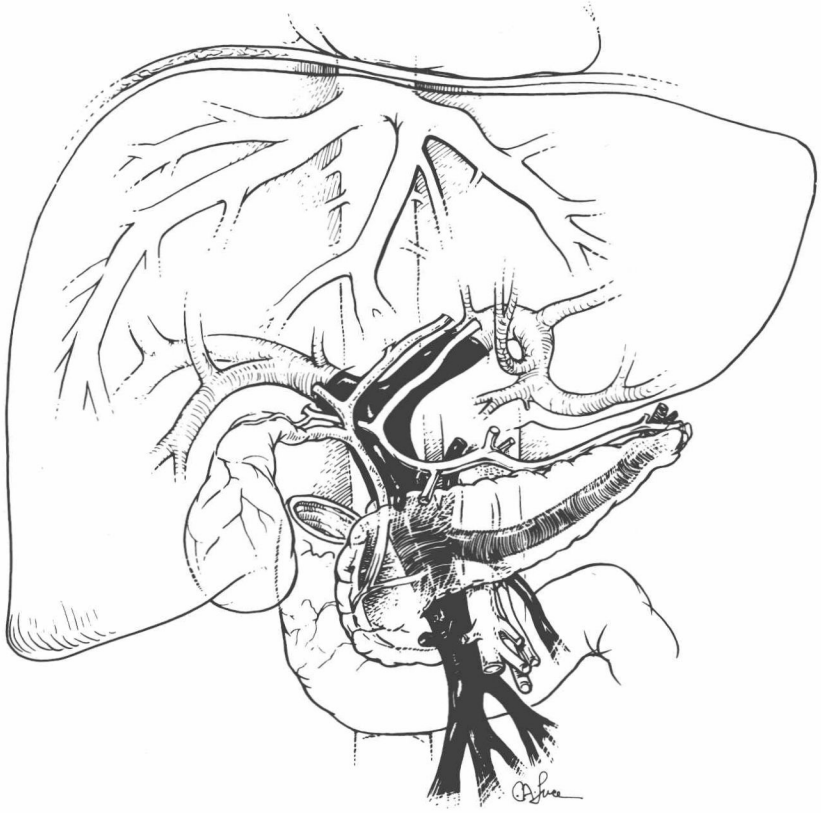
General Considerations



Diagnosis

The array of syndromes associated with hepatobiliary disease after initial clinical evaluation includes the following categories for differential diagnosis or management: jaundice, liver mass, hepatobiliary infection, bleeding, or symptomatic gallstones.

Evaluation of Jaundice (Table 1)

When the serum bilirubin concentration exceeds approximately $2^1/_2$ to 3 mg/dL, clinical jaundice usually becomes evident. The yellowish tint to the skin, sclerae, or mucous membranes reflects elevated serum bilirubin concentration. Patients with obstructive jaundice frequently have other accompanying signs, including pruritis, deeply pigmented urine, and gray-colored feces. Jaundice, of course, can occur from acute or chronic hemolysis and hepatocellular disease, as well as from extrahepatic biliary obstruction. The diseases that produce obstructive jaundice often require surgical treatment, while, with the exception of liver transplantation, surgery should be avoided or approached cautiously in patients with hepatocellular disease (Table 2). Recognizing biliary obstruction, rather than hepatocellular disease or hemolysis, is an important step in the evaluation of jaundice. A careful history and physical examination, plus easily obtainable laboratory tests, can detect obstructive jaundice with approximately 80% accuracy. Marked elevation of serum alkaline phosphatase or 5' nucleotidase, accompanied by normal or mildly elevated serum glutamic-oxaloacetic transaminase or serum glutamic-pyruvic transaminase, strongly suggests biliary obstruction.

TABLE 1.

Evaluation of jaundice

History, physical examination, laboratory studies

↓

Ultrasound examination

Dilated ducts		Non-dilated ducts	
Proximal obstruction	Distal obstruction	No obstruction	Obstruction
↓	↓	↓	↓
PTC*	ERCP†	Liver biopsy	Treat

*PTC = Percutaneous transhepatic cholangiography.
†ERCP = Endoscopic retrograde cholangiopancreatography.

Jaundiced patients should undergo ultrasound examination early in the diagnostic evaluation. Ultrasonography, a rapid, inexpensive, noninvasive test requiring no drugs or ionizing radiation, provides important information about the liver and the biliary structures. The principal disadvantage of an ultrasound exam is that overlying intestinal gas can prevent adequate examination of extrahepatic biliary structures. Optimal ultrasonography requires a skilled person to conduct and evaluate the examination. Clinicians should approach ultrasonography of jaundiced patients with several specific questions in mind:

1. Does the patient have gallstones? Ultrasound exams reveal gallstones with an accuracy of greater than 90%. Patients with gallstones have a 15% risk of harboring concomitant common duct stones, a risk that may be higher in jaundiced gallstone patients. Unfortunately, ultrasound allows visualization of only 20% of common duct stones.

TABLE 2.
Obstructive Jaundice

Proximal obstruction
Cholangiocarcinoma
Gallbladder cancer
Metastatic cancer
Sclerosing cholangitis
Strictures
Benign tumor
Distal obstruction
Choledocholithiasis
Ampullary cancer
Cancer of pancreas
Cholangiocarcinoma
Benign stricture
Pancreatitis
Lymphoma
Benign tumor

2. Does the patient have dilated bile ducts? Ultrasound can accurately delineate the caliber of the intrahepatic and extrahepatic bile ducts. The normal extrahepatic bile duct should have a diameter of 10 mm or less. Because of normal anatomical variability, the criteria for intrahepatic dilatation are more difficult to quantify; nevertheless, in most cases, ultrasound exams make it possible to easily recognize intrahepatic ductal dilatation. Factors that determine ductal dilatation include duration of obstruction, degree of obstruction, and the compliance of the ducts and surrounding structures. If the examination reveals dilated ducts, it then is important to observe the configuration of the dilation to aid in detecting proximal versus distal obstruction (Table 3). For example, a sonogram showing marked intrahepatic ductal dilatation but no extrahepatic dilatation suggests obstruction in the lobar duct confluence or in the common hepatic duct. A sonogram showing intrahepatic dilatation in continuity with dilatation of a long portion of common bile duct strongly suggests distal common bile duct obstruction.
3. Does the patient have masses in the liver, porta hepatis, or pancreas? Ultrasound detects intrahepatic masses as small as 1 to 2 cm in diameter, and can detect pancreatic masses—for example, pancreatic adenocarcinoma, a common cause of obstructive jaundice.

Computed tomographic (CT) scans often aid in the evaluation of jaundice. CT scanning can confirm the presence of dilated ducts, but in that regard is no more effective than ultrasound. CT scanning helps in evaluating further the presence of pancreatic masses and liver masses, but discloses gallstones less accurately than ultrasound. CT scanning may detect common duct stones with approximately 80% accuracy.

Hepatoiminodiacetic acid (HIDA) scanning helps in evaluating obstructive jaundice in infants and small children, but in general is less useful in adults. The HIDA scan may provide evidence of cystic duct obstruction to support the diagnosis of acute cholecystitis.

In the patient with clinical findings of obstructive jaundice and ultrasound findings that suggest obstructive jaundice, direct cholangiography usually provides an accurate anatomical diagnosis. In most cases, percutaneous transhepatic cholangiography (PTC) effectively evaluates intrahepatic and extrahepatic bile ducts and provides detailed delineation of biliary anatomy. Generally speaking, radiologists should avoid transhepatic cholangiography in patients with clotting disorders and in patients with allergy to iodinated contrast material. The transhepatic technique usually produces satisfactory cholangiograms even in patients with normal caliber bile ducts. Patients who have had previous

TABLE 3.
Treatment of Obstructive Jaundice

- Proximal obstruction
  - Cholangiocarcinoma
    - Resection
    - Bypass
    - Stent
      - Operative
      - Percutaneous transhepatic
      - Endoscopic
    - Radiation
      - Intraoperative
      - External
      - Intraductal
  - Gallbladder cancer
    - Cholecystectomy
    - Resect gallbladder fossa plus lymph node dissection
    - Segmentectomy V–VI
    - Stent
  - Metastatic cancer
    - Stent
    - Radiation therapy
    - Supportive care
  - Sclerosing cholangitis
    - Hepaticojejunostomy Roux-en-Y
    - Transplant
  - Benign tumor
    - Excise
  - Stricture
    - Hepaticojejunostomy Roux-en-Y
    - Balloon Dilatation
- Distal obstruction
  - Choledocholithiasis
    - Common duct exploration
    - Endoscopic papillotomy
    - Basket extraction
    - Dissolution
    - Extracorporeal shock wave lithotripsy
  - Ampullary cancer
    - Pancreaticoduodenectomy
    - Bypass
    - Stent
      - Percutaneous transhepatic
      - Endoscopic
  - Pancreatic cancer
    - Bypass
    - Pancreaticoduodenectomy
    - Stent
      - Percutaneous transhepatic
      - Endoscopic
  - Pancreatitis
    - Bypass
    - Stent
  - Stricture
    - Excise
    - Choledochojejunostomy Roux-en-Y
    - Choledochoduodenostomy
  - Lymphoma
    - Stent
    - Radiation
    - Chemotherapy
  - Benign tumor
    - Excise

gastric surgery such as a Bilroth II gastrectomy generally require PTC because the surgical deformity makes endoscopic manipulation of the ampulla of Vater difficult. In addition to allowing excellent cholangiograms, the transhepatic technique usually permits intubation of the bile ducts in almost all cases, including those with radiographically complete obstruction. Tubes passed through obstructive lesions can restore the flow of bile into the intestine. This palliates certain obstructive lesions, and may contribute to the preparation of patients for surgical operations.

Endoscopic retrograde cholangiopancreatography (ERCP) provides an important adjunct to the evaluation of patients with obstructive jaundice. This technique provides good cholangiograms in patients with normal- or small-caliber bile ducts, even in patients with sclerosing cholangitis. In addition, endoscopic papillotomy following ERCP can allow definitive treatment of common duct stones. Also, the endoscopic approach permits insertion of biliary stents for palliation of malignant bile duct obstruction.

If ultrasound discloses proximal bile duct obstruction, PTC is indicated because in these cases treatment planning depends upon careful analysis of bile duct anatomy on the cephalad side of the obstruction. On the other hand, when ultrasound shows distal bile duct obstruction, use ERCP to allow endoscopic inspection of the ampulla of Vater to diagnose or exclude ampullary carcinoma. In addition, if the ERCP shows common duct stones, papillotomy at that time can allow stone extraction with greater than 90% efficacy, with low morbidity and mortality.

Evaluation of Liver Masses (Table 4)

The widespread application of ultrasound and CT scanning will detect increasing numbers of asymptomatic liver masses, and many physicians and surgeons must analyze these problems. In addition, available diagnostic techniques allow anatomic or pathologic evaluation of most liver masses that occur in any circumstance, including evaluation of symptoms or during follow-up evaluations. The algorithm in Table 4 may aid evaluation of liver masses. First, ascertain whether the lesion is cystic or solid; abdominal ultrasound usually accomplishes this best. Cystic lesions may represent solitary congenital liver cysts, multicystic disease of the liver, parasitic cysts, or, in some cases, abscesses. Ultrasound can also help to discriminate among the various cystic or cavitary lesions. Congenital solitary cysts appear round and well-circumscribed, and exhibit smooth walls. Multiple cysts of variable size distributed in a large volume of liver characterize multicystic disease.

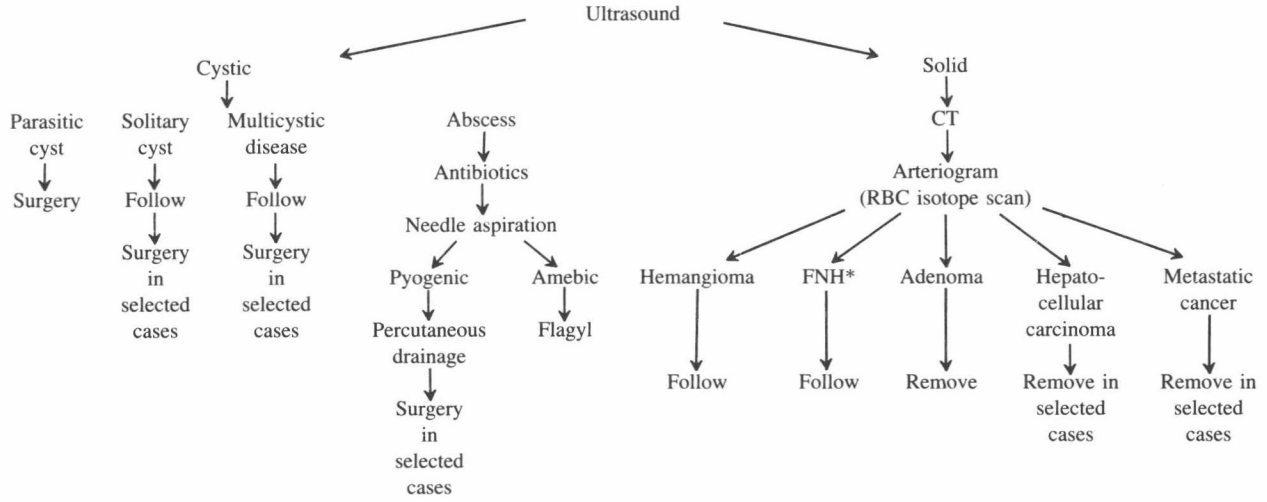
Most liver cysts produce no symptoms and pose no risks to the patient. Patients with extensive cystic liver disease will exhibit normal liver function. Fewer than 10% of patients with cysts have jaundice. Polycystic kidneys accompany 40% to 50% of cases of polycystic liver disease, and chronic renal failure will complicate those cases. Liver cysts should remain undisturbed unless they cause symptoms or complications.

Ultrasound of parasitic cysts *(Echinococcus, granulosas)* can show the main cystic lesion containing daughter cysts to suggest the diagnosis. Immunological tests will verify the diagnosis of echinococcal disease. Patients with echinococcal liver disease should usually be treated surgically to alleviate symptoms, when present, and to prevent the complication of thoracic penetration, intrabiliary drainage, or intra-abdominal rupture.

Liver abscesses appear as single or multiple focal defects, have less distinct margins than cysts, and show central debris or loculation. The appearance of liver abscesses depends upon the time they are observed during the natural history of the disease. Clinically, the symptoms of fever associated with leucocytosis suggest abscess. It is important to remember that solid tumors such as hepatocellular carcinomas characteristically cause fever. Patients suspected of harboring liver abscesses should be given antibiotics. Needle aspiration of pus confirms the diagnosis. Thick brown pus suggests amebic abscesses. Evacuate the pus as completely as possible and continue antibiotic

TABLE 4.

Evaluation of liver masses



*FNH = focal nodular hyperplasia.

therapy; this will allow healing and resolution in some cases. If symptoms continue, drain the cavity by inserting a percutaneous catheter. Some patients, however, may remain ill and require open surgical drainage.

Solid masses are somewhat more difficult to evaluate. The combined findings of ultrasound and CT scanning generally aid in identifying hemangiomas, the most common primary benign hepatic neoplasm in the United States. If uncertainty exists about that diagnosis, either a technetium-labeled erythrocyte liver scan or an arteriogram can confirm the presence of a hemangioma. If a solid lesion has the pathognomonic characteristics of a hemangioma but is small and asymptomatic, it should remain undisturbed. Large hemangiomas, particularly those that produce symptoms of abdominal pain, discomfort, or fever, can be safely removed surgically. Hemangiomas in infants and small children pose a different situation because pediatric patients have a high risk of lethal complications such as heart failure or rupture with hemorrhage. Treatment such as surgical removal or hepatic artery occlusion should follow the diagnosis of hemangioma in children. If a large liver mass is not a cyst, an abscess, or a hemangioma, the remaining probable lesions include focal nodular hyperplasia, adenoma, or primary or metastatic cancer. Focal nodular hyperplasia exhibits characteristic findings on isotope scan and on arteriography. About 70% of the lesions in focal nodular hyperplasia show prolonged isotope retention during technetium sulfur colloid scanning when compared with normal hepatic parenchyma. Arteriogram can show a centrifugal pattern of arterial filling through a central artery and a central scar in the lesion, but few arteriograms show pathognomonic signs of focal nodular hyperplasia. Focal nodular hyperplasia usually poses no threat to health. Because the lesion can bleed spontaneously in women taking birth control pills, "the pill" should be discontinued. Focal nodular hyperplasia usually requires no treatment. Indications for surgical treatment of focal nodular hyperplasia include diagnostic uncertainty, bleeding, or pain.

Adenomas occur predominantly in young women, particularly those taking birth control pills, and have a centripetal blood supply with arteries approaching and passing about the lesions' peripheries. Although controversy exists about the etiology, pathogenesis, and preferred management of hepatic adenomas, they should usually be removed surgically, for the following reasons:

1. They may bleed. About 10% of patients with hepatic adenomas experience serious bleeding into the peritoneal cavity, although intraparenchymal bleeding also accompanies hepatic adenomas.
2. Adenomas may harbor microscopic foci of malignancy. Careful microscopic examination reveals cancer in about 10% of lesions diagnosed as adenomas.
3. Adenomas may become malignant.
4. Biopsies may fail to distinguish well-differentiated hepatocellular carcinomas from hepatic adenomas.

Several types of primary liver cancer occur, including hepatocellular carcinoma, cholangiocarcinoma, hepatoblastoma, and sarcomas. Unquestionably, hepatocellular carcinoma is the most common primary liver malignancy in the world. Hepatocellular carcinomas appear as focal solid masses during ultrasound or CT scanning. Hepatocellular carcinomas are more difficult to detect in cirrhotic than in normal livers, and can appear hypervascular during angiography. The diagnosis of hepatocellular carcinoma sometimes becomes a diagnosis of exclusion. Cysts and hemangiomas can usually be excluded easily, and some hepatomas can mimic abscesses. After hemangioma has been excluded, needle aspiration can evaluate the possibility of abscess. Absence of a history of cancer, negative evidence upon investigation of an extant nonhepatic primary cancer, and biopsy of the hepatic lesion, all can exclude the presence of metastatic tumors. Elevated serum alpha fetoprotein supports the diagnosis of hepatocellular carcinoma.

Focal solid liver lesions appearing in a patient with a history of cancer suggest a diagnosis of metastatic disease. The discovery of any liver mass should raise the possibility of a metastatic lesion and prompt a search for a primary tumor. Often patients with previously resected colorectal cancer will develop a rising serum carcinoembryonic antigen (CEA) concentration; investigation of that with ultrasound or CT scan may disclose a liver mass. Such masses most likely represent metastases, especially if a previous liver imaging test showed no masses. Many hepatic metastases, particularly those from colorectal primary cancers, should be removed surgically.

Hepatobiliary Infection

Pyogenic infection frequently contributes greatly to the pathogenesis of hepatobiliary diseases that require surgical treatment. Because chills, fever, malaise, and leukocytosis reflect several diseases, evaluation of these symptoms assumes considerable importance from the diagnostic standpoint. Non-biliary diseases such as pneumonia and urinary tract infection can mimic biliary infection. Usually, however, patients with pyogenic hepatobiliary infections have abnormal liver tests, dilated ducts, liver masses, or ultrasonic evidence of gallbladder disease. Liver abscesses, empyema of the gallbladder, or acute pyogenic (suppurative) cholangitis can produce similar manifestations. Fortunately, ultrasound examination aids greatly in discriminating among these diseases.

Bleeding in Liver and Biliary Disease

Signs of bleeding or blood loss can reflect complications of liver and biliary disease. Coagulopathy can result from thrombocytopenia caused by hypersplenism associated with portal hypertension. The liver synthesizes all coagulation factors except factor VIII. Therefore, impaired liver synthetic function causes coagulopathy. Biliary obstruction or antibiotic administration can produce vitamin K deficiency, which leads to hypoprothrombinemia. Also, impaired hepatic removal of plasminogen activator produces fibrinolysis. For these reasons, prevention, recognition, and management of coagulopathy are important goals in treating patients with hepatic and biliary disease.

Gastrointestinal bleeding produces major morbidity and mortality in patients with liver disease, and bleeding gastroesophageal varices are a major cause of death in these patients. Hemobilia, a rare cause of gastrointestinal bleeding, can follow blunt or penetrating hepatic trauma.

Any liver tumor can bleed into hepatic parenchyma, but adenomas and hepatocellular carcinomas appear to cause intraparenchymal bleeding more frequently than other tumors. Intrahepatic bleeding usually produces abdominal pain and a decreased hematocrit. Liver imaging, particularly arteriography, shows the hematoma adjacent to the neoplasm.

When they bleed from the surface of the tumor, hepatocellular carcinomas and adenomas can cause massive intraperitoneal hemorrhage.

Symptomatic Gallstones

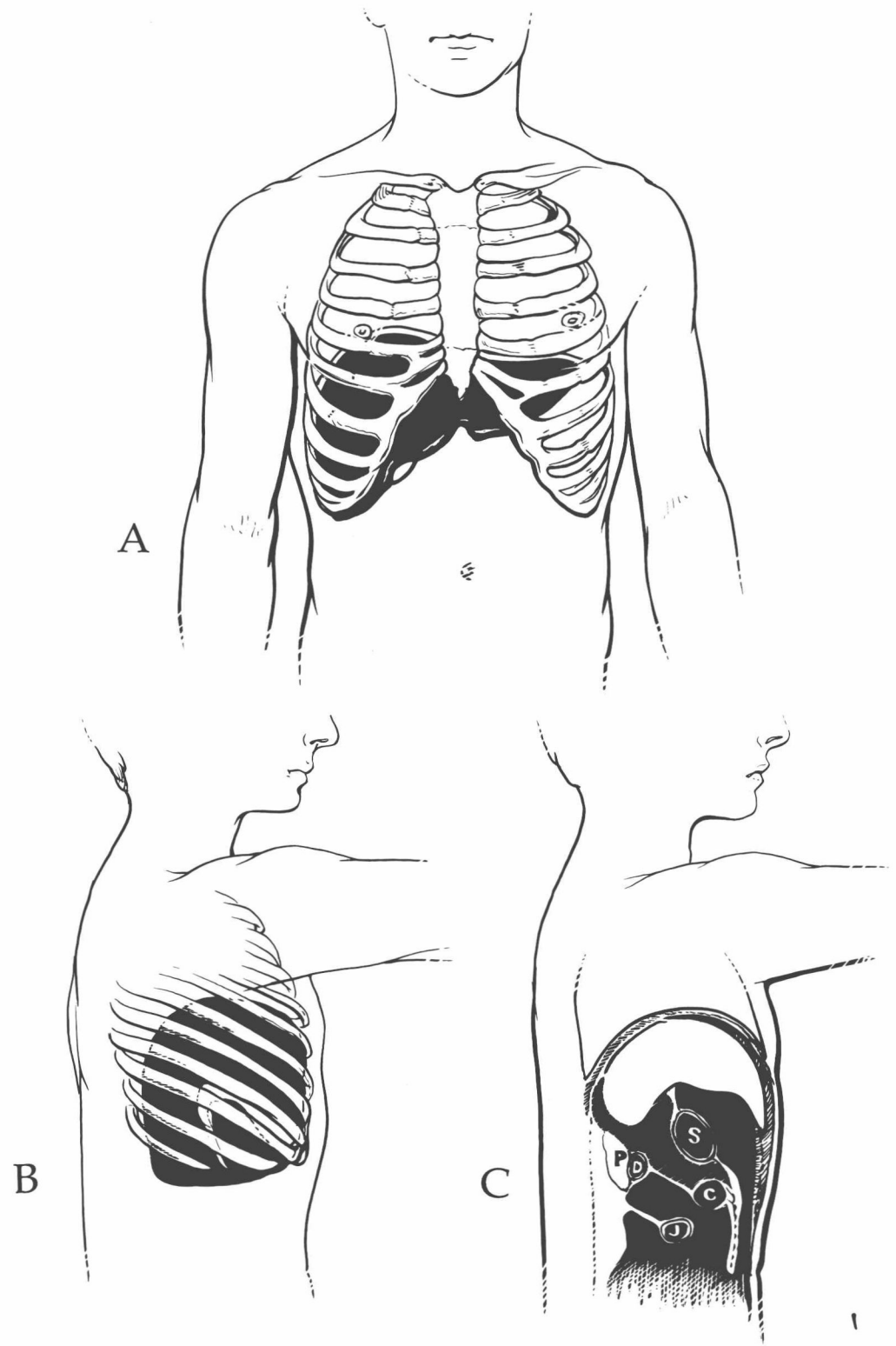
An unknown number of people, but perhaps 20% of those with cholelithiasis, have gallstones that remain asymptomatic. Most gallstones, however, produce symptoms; the most characteristic is an attack of severe right upper quadrant abdominal pain radiating to the scapular area. Other symptoms such as indigestion, gas, heartburn, and fatty food intolerance, do not reliably predict the presence of gallstones. Ultrasound, however, confirms their presence or absence. The traditional treatment of symptomatic gallstones by cholecystectomy remains safe and effective, and for the immediate future should continue to be an important therapy for cholelithiasis. Although previous studies reveal that the oral administration of bile acids can eliminate gallstones in some patients, the low efficacy and long duration required to eliminate the stones predict that this treatment, using currently available agents, will not become the preferred therapy for most patients with gallstones. On the other hand, extracorporeal shock wave lithotripsy shows great promise as a major therapy for gallstones. The direct percutaneous instillation of litholytic agents into the gallbladder may also receive increased attention as a therapy for gallstones.

Hepatic and Biliary Anatomy

FIG 1. A. The adult liver weighs about 1,200 to 1,600 gm and occupies most of the upper abdomen, including the right hypochondriac region, the epigastric region, and some of the left hypochondriac region.

B. The liver relates closely to the diaphragm, particularly the right diaphragm; therefore, the upper portion of the right hepatic lobe reaches the level of the fourth right intercostal space.

C. The rib cage encloses most of the liver except for a portion of the medial segment of the left lobe occupying the epigastrium.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FIGS 2 and 3. The peritoneum covers the liver, except for the gallbladder fossa, the bare area related to the diaphragm, the right kidney, the right adrenal gland, and the inferior vena cava.

The transverse peritoneal reflection from the diaphragm onto the liver forms the coronary ligament. The fusion of the anterior and posterior leaves of the coronary ligament on the right form the right triangular ligament, while the fusion of the anterior and posterior leaves of the coronary ligament on the left form the left triangular ligament, which attaches the left lobe of the liver to the diaphragm.