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DISEASES OF GALLBLADDER AND BILE DUCTS

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ

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ЗАБОЛЕВАНИЯ ЖЕЛЧНОГО ПУЗЫРЯ И ПРОТОКОВ

DISEASES OF GALLBLADDER AND BILE DUCTS

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MOTIVATIONAL CHARACTERISTIC OF THE TOPIC

Total in-class hours: 6.

Since antiquity, gallstones have been of interest to physicians. The first description of gallstones as «dried up humors concreted like stones» and their relation to hepatic obstruction is ascribed to the Greek physician Alexander of Tralles (5th century). Antonio Benivieni successfully diagnosed gallstone disease in a patient suffering from abdominal pain. His clinical impression was confirmed at autopsy. However, it was Jean Fernel (1581), physician to the King of France, who provided the most accurate clinical description of symptoms associated with cholelithiasis. Gallstones were removed from a living patient for the first time in 1618 by the German surgeon Wilhelm Fabry. Two and a half centuries later, another German physician, Carl Langenbuch, performed the first cholecystectomy. The composition of gallstones was essentially unknown until the end of the 18th century. It was through the excellent work of researchers such as Antonio Vallisneri, Pouilletier de la Salle, and Vicq d'Azyr that the chemical composition and variability in the components of gallstones were determined.

Although signs and symptoms of gallstones and extrahepatic biliary obstruction have been recognized for centuries, the surgical management of biliary tract disorders has evolved only recently. Advances in anesthesia, a better understanding of biliary anatomy and physiology, and improved surgical technique have allowed surgeons to manage both benign and malignant biliary disorders with increasing frequency and success in the past 10 years.

The purpose is to study main surgical diseases of gallbladder and bile ducts, their causes, varying presentations, diagnostics and treatment.

Objectives are:
1) to learn current methods of investigations of gallbladder and biliary tract system;
2) to learn main congenital anomalies and variations of biliary tract system;
3) to learn main functional disorders of gallbladder and bile ducts;
4) to know the way of gallstone formation and classification;
5) to know symptoms, management and treatment of patients with biliary lithiasis;
6) to know clinical features and management of patients with bile duct strictures and cholangitis;
7) to make diagnosis of acute and chronic cholecystitis.

Requirements for the initial knowledge level.
The student must know:
− propaedeutics of internal diseases (methods of clinical evaluations of abdominal organs);
− human anatomy (embryogenesis, localization and structure of the liver, gallbladder and bile duct);

– topographic anatomy and operative surgery (main surgical approaches to gallbladder and bile ducts);

– normal physiology (functions of liver and gallbladder);

– pathologic physiology (physiologic changes in liver diseases);

– general surgery (basic principles of surgical infections and peritonitis);

– biochemistry (cholesterol, bilirubin and bile salt structure and metabolism).

Test questions from related disciplines:

1. Normal and topographic anatomy of liver, gallbladder, extrahepatic biliary ducts.
2. Embryogenesis of the liver and biliary system.
3. Function of the liver, gallbladder.
4. Cholesterol, bilirubin and bile salt structure and metabolism.
5. Clinical evaluation of gallbladder and biliary duct pathology.
6. Surgical approaches to gallbladder and bile ducts.

Test questions:

1. Diagnostic studies.
2. Classification of gallbladder and biliary duct diseases.
3. Congenital anomalies of gallbladder and extrahepatic biliary tree.
4. Functional disorders (biliary diskinesia).
5. Gallstone formation and classification.
6. Chronic calculous cholecystitis.
7. Acute cholecystitis.
8. Choledocholithiasis and cholangitis.
9. Bile duct strictures.

STUDY MATERIAL

EMBRYOGENESIS

The biliary tree and liver develop from a diverticulum of the embryonic foregut at approximately 18 days of gestation. Between the fourth and fifth weeks, the diverticulum consists of a solid cranial portion and a hollow caudal portion. The solid cranial portion differentiates into the liver with the development of hepatocytes and intrahepatic bile ducts, while the hollow caudal portion gives rise to the gallbladder, the extrahepatic bile ducts, and the ventral pancreas (fig. 1).
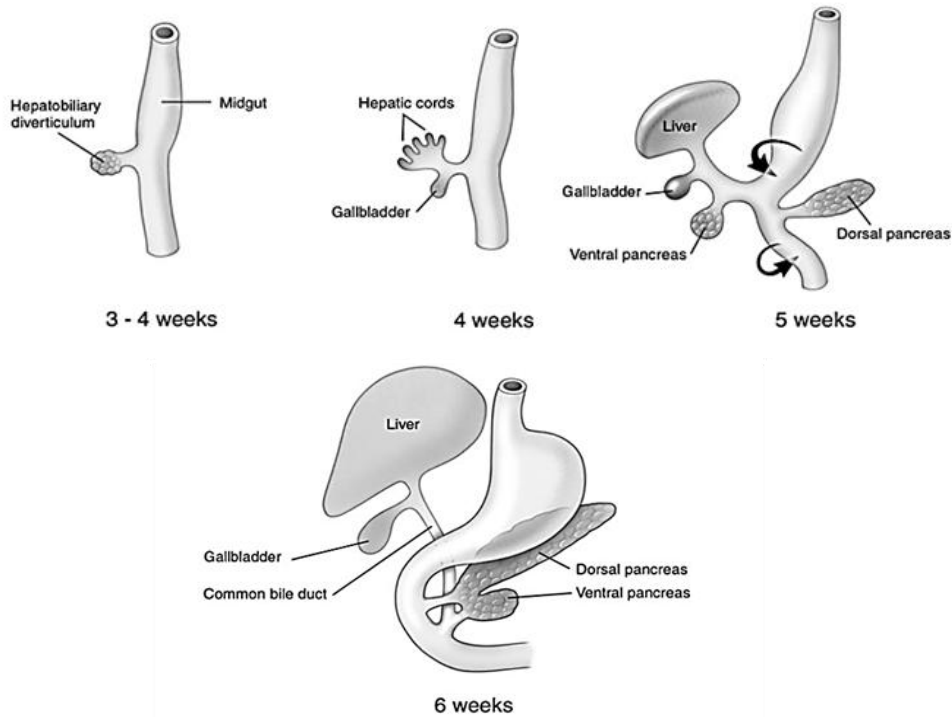
Fig. 1. Embryogenesis of the liver and bile ducts

ANATOMY OF EXTRAHEPATIC BILIARY SYSTEM

Gallbladder. The gallbladder is an elongated sac that lies in a fossa on the inferior surface of the right hepatic lobe. In adults, it measures 7 to 10 cm in length, and 3 cm at its widest part, with an average capacity of 30 to 50 mL. When obstructed, the gallbladder can distend markedly and contain up to 300 mL. The gallbladder is located in a fossa on the inferior surface of the liver and in close relation to the duodenum and the colon (fig. 2).
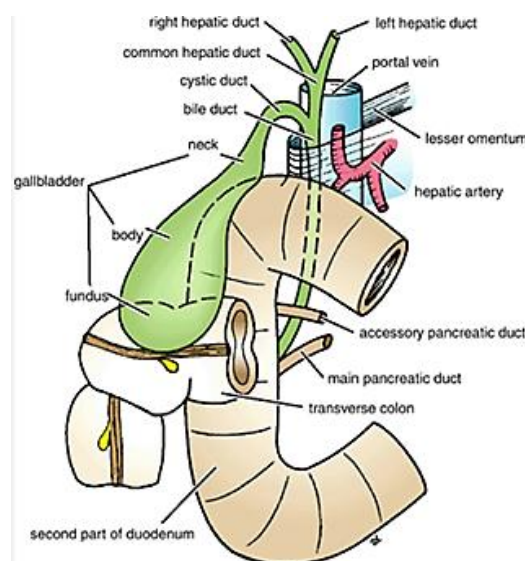

Fig. 2. Relationships of the gallbladder

The gallbladder is divided into four anatomic areas: the fundus, the corpus (body), the infundibulum, and the neck (fig. 3). The domelike *fundus* projects beyond the inferior border of the liver, projecting slightly downward, and is covered entirely with peritoneum. The *body* projects upward, backward, and to the left, approaching the porta hepatis. The *neck* corresponds to the tapered portion of the gallbladder. It curves backward and abruptly downward to enter the delicate connective tissue investment of the porta hepatis. At the most proximal end of the cystic duct, there is a discrete area of narrowing that helps regulate flow of bile into and out of the gallbladder.

The neck usually follows a gentle curve, the convexity of which may be enlarged to form *the infundibulum or Hartmann's pouch* (fig. 4). The *cystic duct* measures about 3 to 4 cm in length, and joins the common hepatic duct to form the common bile duct. This junction lies at the lowest region of the porta hepatis. A partial folding of the fundus may result in the *«Phrygian cap»* deformity, named by Bartel after the Greek term for the liberty cap, the widely used symbol of the French Revolution. Two to six percent of gallbladders have this shape.
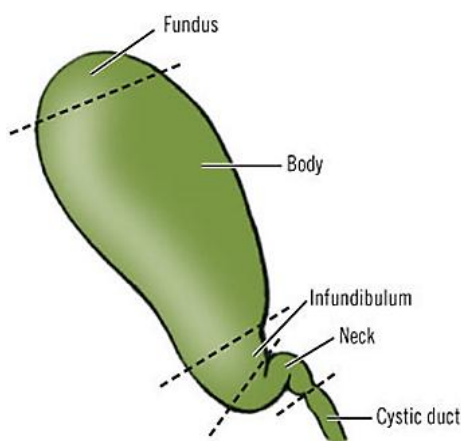

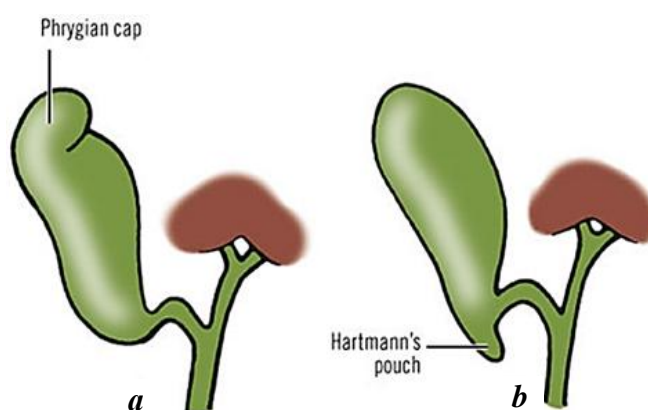Fig. 3. Anatomical areas of the gallbladder

Fig. 4. The gallbladder: *a* — Phrygian cap deformity; *b* — Hartmann's pouch

The gallbladder epithelium is arranged into numerous interlacing folds, which imparts a honeycombed pattern to the surface. In the neck of the gallbladder, these folds coalesce to form the spiral *valves of Heister*, which extend into the cystic duct (fig. 5). In combination with cystic duct muscle action, the valves of Heister may assist in retaining bile between meals.

Small tubular channels (*ducts of Luschka*) are occasionally found buried in the gallbladder wall adjacent to the liver. These channels communicate with the intrahepatic biliary tree. Small outpouchings of the gallbladder mucosa may penetrate into, and occasionally through, the muscle layer and are termed *Rokitansky-Aschoff sinuses* (fig. 6). Their prominence in the setting of inflammation and gallstone formation suggests that they are a type of acquired pathologic herniation. In this sense, they are analogous to intestinal diverticula (pseudodiverticula).
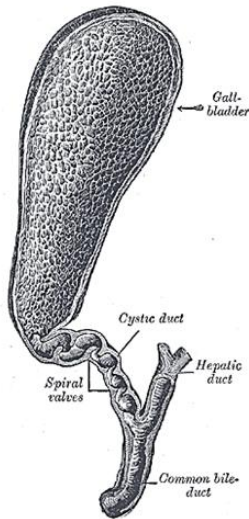
Fig. 5. Spiral valves of Heister
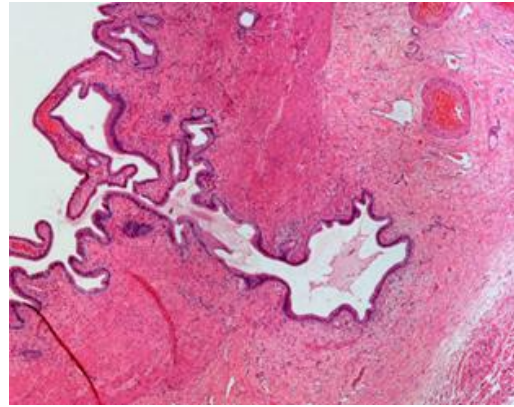
Fig. 6. Rokitansky-Aschoff sinuses. Herniation of the mucosa through the discontinuous muscle bundles of the muscularis of the gallbladder - a consequence of increased intraluminal pressure

The gallbladder is supplied by the cystic artery that usually (in 95 %) arises from the right hepatic artery. Reaching the gallbladder behind the common hepatic duct, the cystic artery usually branches into an anterior superficial branch and a posterior deep branch. VARIATIONS of the hepatic artery and the cystic artery are quite common, occurring in as many as 50 % of cases (fig. 7).
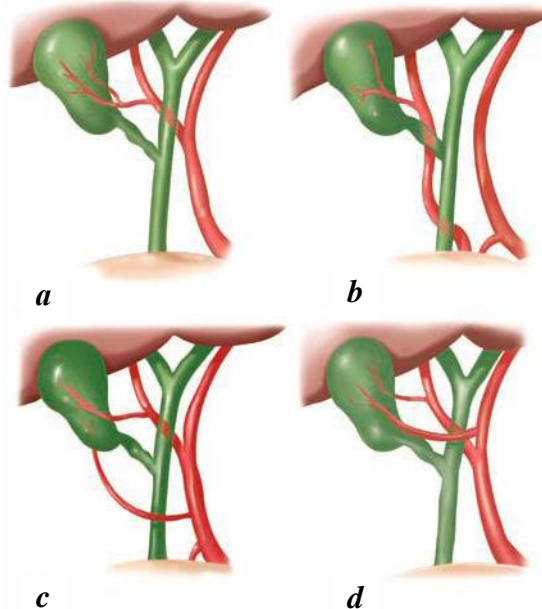
Fig. 7. Variations in the arterial supply to the gallbladder: *a* — cystic artery from right hepatic artery, about **80–90 %**; *b* — cystic artery from right hepatic artery (accessory or replaced) from superior mesenteric artery, about 10 %; *c* — two cystic arteries, one from the right hepatic, the other from the common hepatic artery, rare; *d* — two cystic arteries, one from the right hepatic, the other from the left hepatic artery, rare

Calot's triangle is the space bordered by the cystic duct inferiorly, the common hepatic duct medially and the superior border of the cystic artery. This was described in 1891 by Jean-François Calot. It is an important surgical landmark and should be identified by surgeons performing a cholecystectomy to avoid damage to the extrahepatic biliary system. The area included in the triangle has enlarged over the years. The hepatocystic triangle is formed by the proximal part of the gallbladder and cystic duct to the right, the common hepatic duct to the left, and the margin of the right lobe of the liver superiorly (fig. 8).
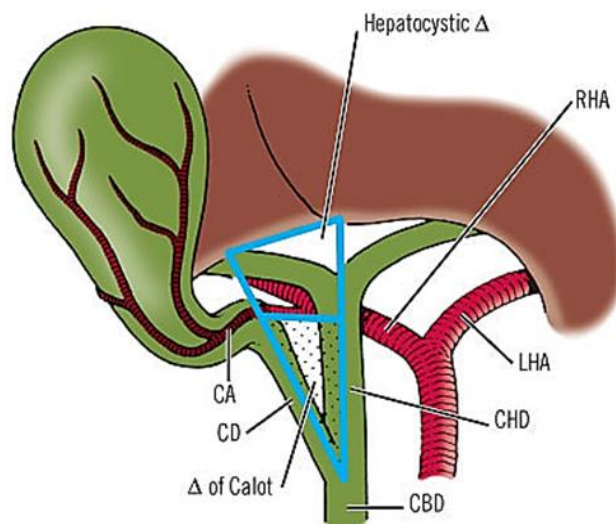
Fig. 8. Hepatocystic triangle and triangle of Calot. Upper boundary of hepatocystic triangle is inferior border of liver. CA, Cystic artery. CD, Cystic duct. CHD, Common hepatic duct. CBD, Common bile duct. LHA/RHA, Left and right hepatic arteries

Hepatic surface of the gallbladder is drained by numerous small veins passing through the gallbladder bed that break up into capillaries within the liver (fig. 9). They do not form a single «cystic vein». Veins from the hepatic surface drain directly into the liver. Veins on the free surface open directly or follow the hepatic ducts into the liver.
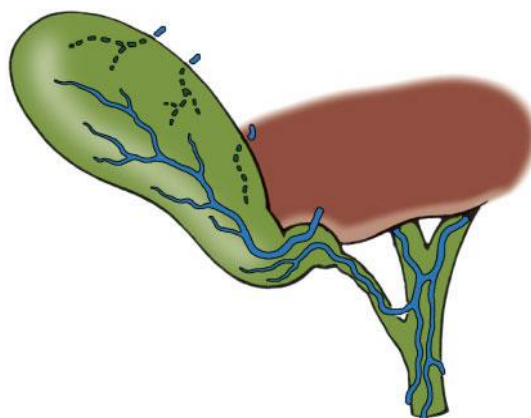
Fig. 9. Veins of the gallbladder

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Bile Ducts. The ***common hepatic duct*** is usually less than 2.5 cm long and is formed by the union of the right and left hepatic ducts. The ***common bile duct*** is about 7.5 cm long and formed by the junction of the cystic and common hepatic ducts. It is divided into four parts (fig. 10):

− *Supraduodenal portion* is bout 2.5 cm long, running in the free edge of the lesser omentum;

− *Retroduodenal portion*;

− *Pancreatic portion* lies in a groove, but at times in a tunnel on the posterior surface of the pancreas;

− *Intramural portion* passes obliquely through the wall of the second part of the duodenum, where it is surrounded by the sphincter of Oddi, and terminates by opening on the summit of the ampulla of Vater.
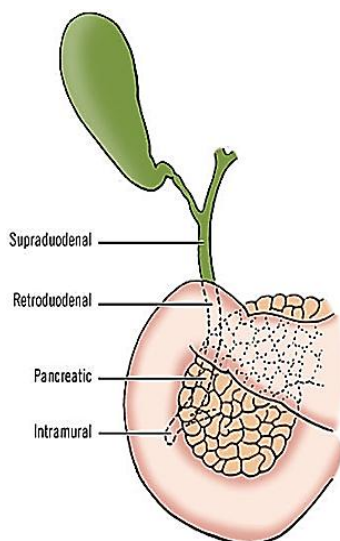
Fig. 10. Parts of common bile duct

Before emptying to the duodenum the common bile duct joins with a main pancreatic duct and may have different types of anastomoses (fig. 11):

− *Y-shape* — 60–70 %. Distinct common channel – the hepatopancreatic ampulla (of Vater). This common channel drains into the duodenum through a single orifice;

− *V-shape* — 20–25 %. Common channel is short. No ampulla present;

− *U-shape* — 10–15 %. The common bile and pancreatic ducts have separate openings at the tip of the papilla.

Fig. 11. Variations of pancreaticobiliary junction

Sphincter of Oddi is circular and longitudinal smooth muscle fibers that surround terminal parts of the common bile and pancreatic ducts, the common channel, 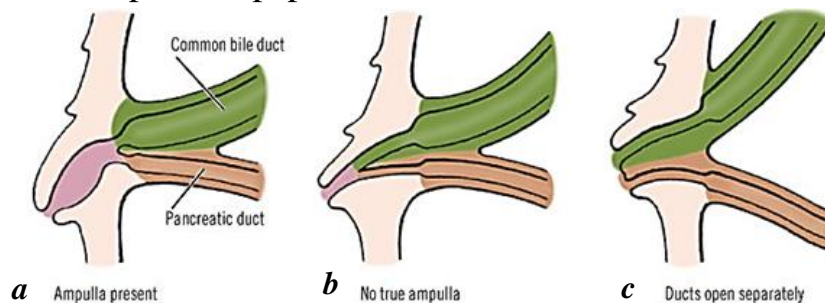and the major duodenal papilla of Vater (fig. 12). The main functions are regulation of the bile and pancreatic juice flow and prevention of the duodenal reflux.
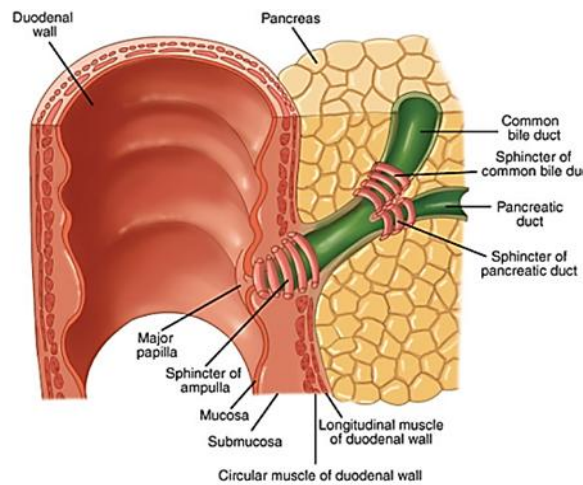

Fig. 12. Sphincter of Oddi structure

FUNCTION OF EXTRAHEPATIC BILIARY SYSTEM

Healthy adult produces 500 to 1000 mL of bile a day. The secretion of bile is responsive to neurogenic, humoral, and chemical stimuli. Vagal stimulation increases secretion of bile, whereas splanchnic nerve stimulation results in decreased bile flow. Bile flows from the liver, through the hepatic ducts, into the common hepatic duct, through the common bile duct, and finally into the duodenum. The gallbladder, the bile ducts, and the sphincter of Oddi act together to store and regulate the flow of bile. The main function of the gallbladder is to *concentrate and store hepatic bile* and to *deliver bile into the duodenum in response to a meal*.

Absorption and Storage. In the fasting state, approximately 80 % of the bile secreted by the liver is stored in the gallbladder. This storage is made possible because of the remarkable absorptive capacity of the gallbladder, as the gallbladder mucosa has the greatest absorptive power per unit area of any structure in the body. It rapidly absorbs sodium, chloride, and water against significant concentration gradients, concentrating the bile as much as 10-fold and leading to a marked change in bile composition.

Motor Activity. During fasting, the gallbladder is filled passively and repeatedly empties small volumes of bile into the duodenum. This process is mediated at least in part by the hormone motilin. In response to a meal, the gallbladder empties by a coordinated motor response of gallbladder contraction and sphincter of Oddi relaxation. One of the main stimuli to gallbladder emptying is the hormone cholecystokinin (CCK, fig. 13). The vagus nerve stimulates contraction of the gallbladder too, and splanchnic sympathetic stimulation is inhibitory to its motor activity
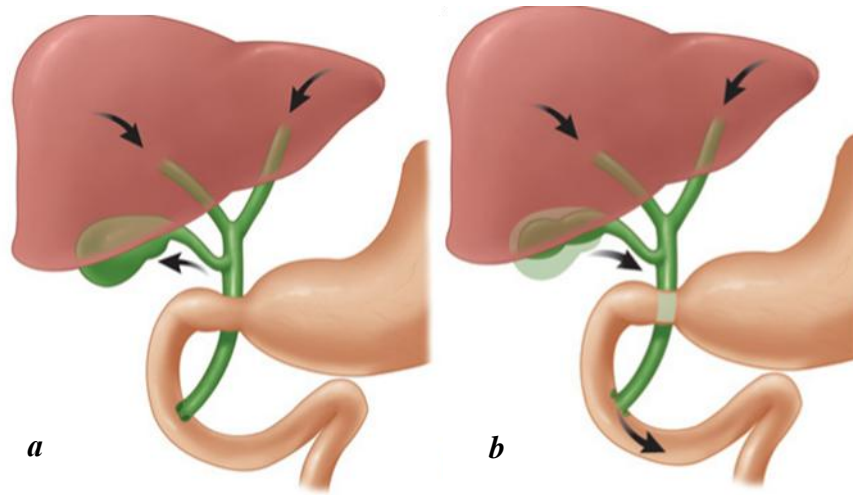
Fig. 13. The effect of cholecystokinin on the gallbladder and the sphincter of Oddi: *a* — during fasting, with the sphincter of Oddi contracted and the gallbladder filling; *b* — In response to a meal, the sphincter of Oddi relaxed and the gallbladder emptying

DIAGNOSTIC STUDIES

Blood Tests. An elevated white blood cell count may indicate or raise suspicion of cholecystitis. If associated with an elevation of bilirubin, alkaline phosphatase, and aminotransferase, cholangitis should be suspected. Cholestasis, an obstruction to bile flow, is characterized by an elevation of bilirubin (i. e., the conjugated form), and a rise in alkaline phosphatase. Serum aminotransferases may be normal or mildly elevated. In patients with biliary colic or chronic cholecystitis blood tests will typically be normal.

Ultrasonography. An ultrasound is the initial investigation of any patient suspected of disease of the biliary tree. It is noninvasive, painless, does not submit the patient to radiation and can be performed on critically ill patients. Ultrasound will show stones in the gallbladder with sensitivity and specificity of > 90 % (fig. 14). A thickened gallbladder wall and local tenderness indicate cholecystitis. When a stone obstructs the neck of the gallbladder, the gallbladder may become very large, but thin-walled. A contracted, thick-walled gallbladder indicates chronic cholecystitis. Dilation of the extrahepatic ducts in a patient with jaundice establishes an extrahepatic obstruction as a cause of the jaundice.
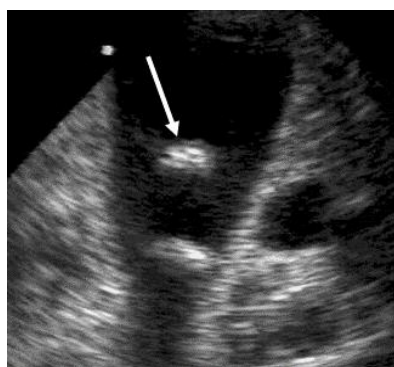

Fig. 14. Gallstone in the gallbladder on ultrasound (arrow)

Endoscopic Ultrasound (EUS). An endoscopic ultrasound requires a special endoscope with an ultrasound transducer at its tip. The results offer noninvasive imaging of the bile ducts and adjacent structures (fig. 15).
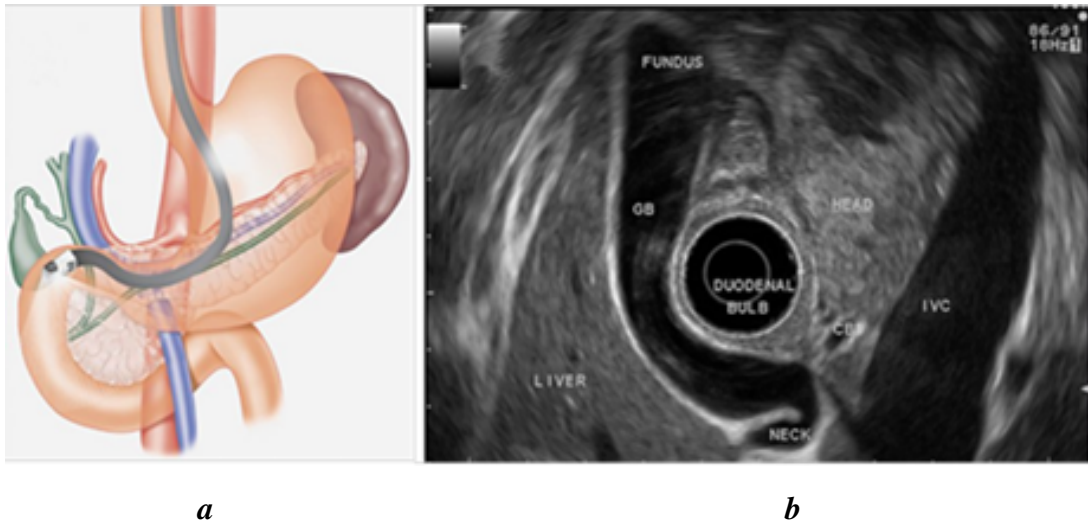
| a | b |

Fig. 15. Endoscopic ultrasound: *a* — the endoscope; *b* — ultrasound picture of gallbladder

Oral Cholecystography. It involves oral administration of a radiopaque compound that is absorbed, excreted by the liver, and passed into the gallbladder (fig. 16). Nowadays, oral cholecystography has been largely replaced by ultrasonography.

Fig. 16. Oral Cholecystography

Biliary Radionuclide Scanning (Hida Scan). Biliary scintigraphy provides a noninvasive evaluation of the liver, gallbladder, bile ducts, and duodenum with both anatomic and functional information (fig. 17). 99 m Technetium-labeled derivatives of dimethyl iminodiacetic acid (HIDA) are injected intravenously, cleared by the Kupffer cells in the liver, and excreted in the bile. The sensitivity and specificity for the diagnosis are about 95 % each.
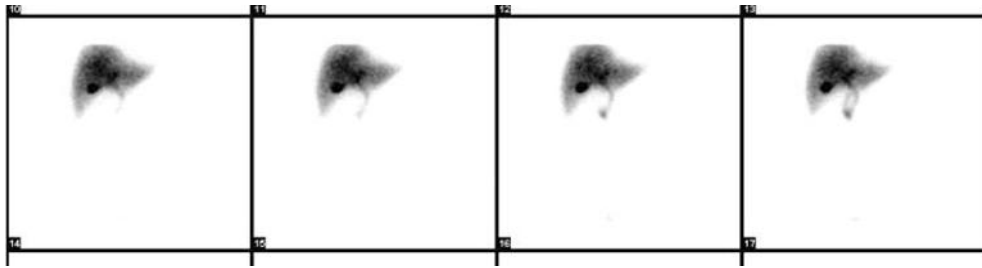
Fig. 17. Biliary Radionuclide Scanning (Hida Scan)

Computed Tomography. The major application of CT scans is to define the course and status of the extrahepatic biliary tree and adjacent structures (fig. 18). It is the best of choice in evaluating the patient with suspected malignancy of the gallbladder, the extrahepatic biliary system, or nearby organs, in particular, the head of the pancreas. The use of CT scan is an integral part of the differential diagnosis of obstructive jaundice.

Fig. 18. CT scan. A stone in the gallbladder (arrow)

Magnetic Resonance Imaging. MRI provides anatomic details of the liver, gallbladder, and pancreas similar to those obtained from CT (fig. 19).

Fig. 19. MRI scan. Distended gallbladder

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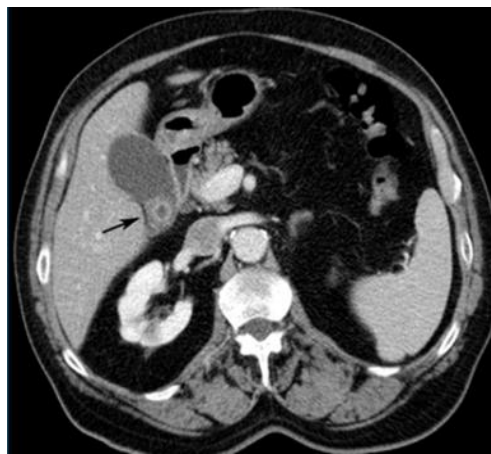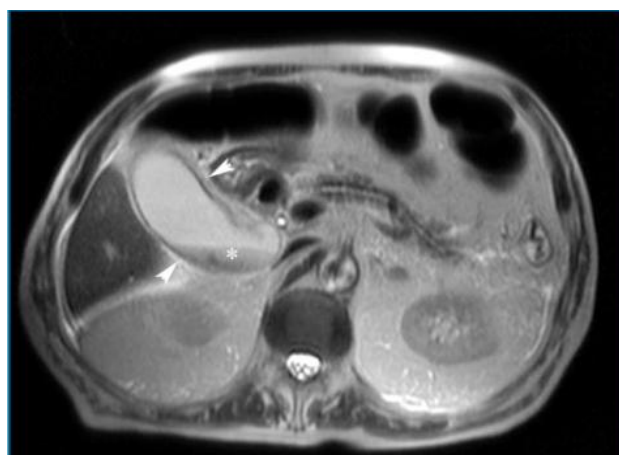Many MRI techniques can generate high resolution anatomic images of the biliary tree and the pancreatic duct (magnetic resonance cholangiopancreatography, MRCP, fig. 20). MRI with magnetic resonance cholangiopancreatography (MRCP) offers a single noninvasive test for the diagnosis of biliary tract and pancreatic disease. It has a sensitivity and specificity of 95 and 89 %, respectively, at detecting choledocholithiasis. Current progress in visualization technique presented the three dimensional (3D) visualization of patient anatomy from medical images (fig. 21).
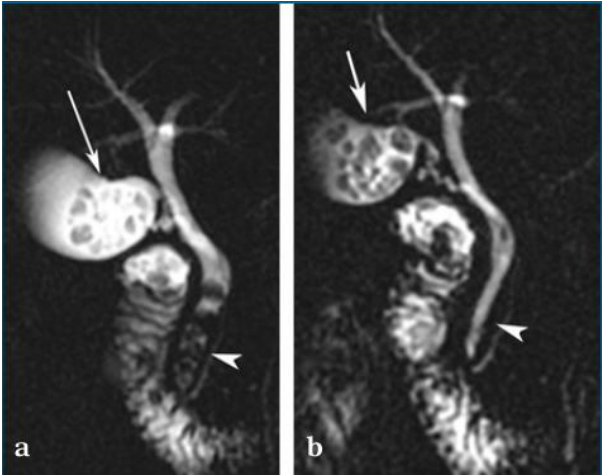
Fig. 20. Magnetic resonance cholangiopancreatography (MRCP), gallstones in the gallbladder and common bile duct (arrows)
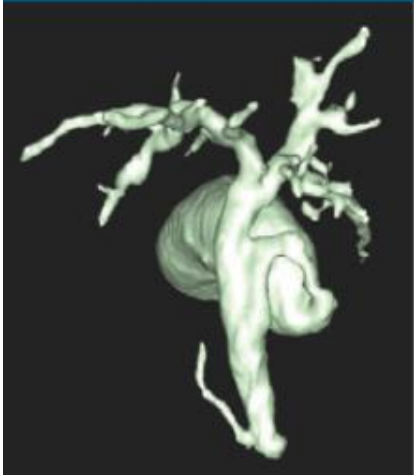
Fig. 21. 3D visualization of biliary system

Virtual Navigation Endoscopy. Virtual endoscopy is the navigation of a virtual camera through the 3D reconstruction of a patient's anatomy enabling the exploration of the internal structures to assist in surgical planning (fig. 22). Virtual exploration through patient-specific data can help the surgeon perform a diagnosis without having to operate on the patient.
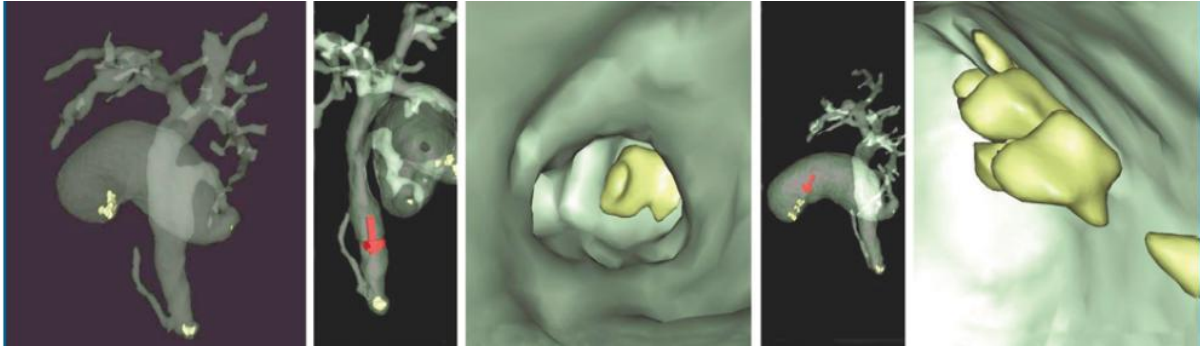
Fig. 22. Virtual cholangioscopy from MRCP. The virtual navigation provides two views allowing internal structures such as stones and the virtual endoscope position to be seen (red arrow in a transparent biliary tract)

Endoscopic Retrograde Cholangiography (ERC). With the help of an endoscope the common bile duct can be cannulated and a cholangiogram is performed using fluoroscopy (fig. 23). The advantages of ERC include direct visualization of the ampullary region and direct access to the distal common bile duct, with the possibility of therapeutic intervention. Once the endoscopic cholangiogram has shown ductal stones, sphincterotomy and stone extraction can be performed, and the common bile duct cleared of stones with the success rate of common bile duct cannulation and cholangiography is > 90 %. Complications of diagnostic ERC include pancreatitis and cholangitis, and occur in up to 5 % of patients.


a   *b*
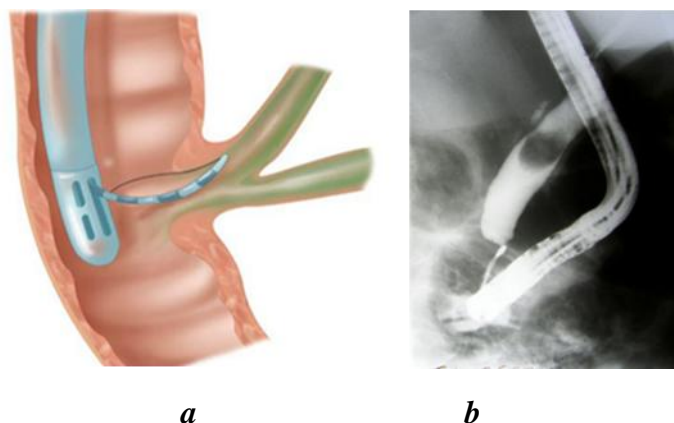
Fig. 23. Endoscopic retrograde cholangiopancreatography: *a* — scheme of the procedure; *b* — stone in the common bile duct on X-ray

Percutaneous Transhepatic Cholangiography. Intrahepatic bile ducts are accessed percutaneously with a small needle under fluoroscopic (or ultrasound) guidance. Through the catheter, a cholangiogram can be performed and therapeutic interventions done, such as biliary drain insertions and stent placements. Percutaneous transhepatic cholangiography (PTC) is particularly useful in patients with bile duct strictures and tumors, as it defines the anatomy of the biliary tree proximal to the affected segment (fig. 24).

a   *b*   *c*

Fig. 24. Percutaneous transhepatic cholangiography: *a* — catheter in right hepatic duct; *b* — cholecystostomy; *c* — cholangiography

Intraoperative Cholangiogram or Ultrasound. During the operation the bile ducts are visualized under fluoroscopy by injecting contrast through a catheter placed in the cystic duct (fig. 25). Their size can then be evaluated, the presence or absence of common bile duct stones assessed, and filling defects confirmed, as the dye passes into the duodenum. An intraoperative cholangiogram can be performed when the patient has a history of abnormal liver 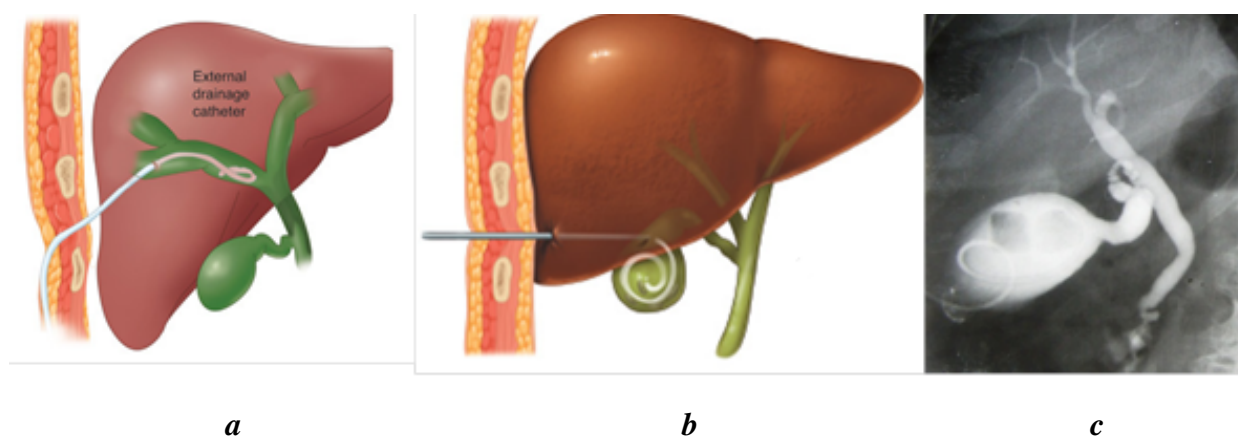function tests, pancreatitis, jaundice, a large duct and small stones, a dilated duct on preoperative ultrasonography, and if preoperative endoscopic cholangiography for the above reasons was unsuccessful. *Laparoscopic ultrasonography* is as accurate as intraoperative cholangiography in detecting common bile duct stones and it is less invasive; however, it requires more skill to perform and interpret.

Fig. 25. Intraoperative cholangiogram

CLASSIFICATION OF GALLBLADDER AND BILE DUCTS DISEASES

1. Functional disorders:
   − Functional gallbladder disease;
   − Sphincter of Oddi dysfunction.
2. Gallstone disease:
   − Acute and chronic calculous cholecystitis;
   − Choledocholithiasis.
3. Cholangitis.
4. Bile duct strictures.
5. Sclerosing cholangitis.

FUNCTIONAL DISORDERS (BILIARY DYSKINESIA)

«Biliary dyskinesia» implies a motility disorder resulting from abnormal motor function of the gallbladder and/or sphincter of Oddi. Its functional nature should be supported by an absence of markers of organic disease: normal liver and pancreatic biochemistries and negative diagnostic imaging. No structural basis

should be evident to explain the pain. The Rome III Consensus (2006) has developed criteria for functional biliary-type pain.

Rome III Diagnostic Criteria for Functional Gallbladder and Sphincter of Oddi Disorders

Must include episodes of pain located in the epigastrium and/or right upper quadrant and all of the following:

1. Episodes lasting 30 minutes or longer.
2. Recurrent symptoms occurring at different intervals (not daily).
3. The pain builds up to a steady level.
4. The pain is moderate to severe enough to interrupt the patient's daily activities or lead. to an emergency department visit.
5. The pain is not relieved by bowel movements.
6. The pain is not relieved by postural change.
7. The pain is not relieved by antacids.
8. Exclusion of other structural disease that would explain the symptoms.

Supportive criteria:

The pain may present with 1 or more of the following:

1. Pain is associated with nausea and vomiting.
2. Pain radiates to the back and/or right infrasubscapular region.
3. Pain awakens from sleep in the middle of the night.

Functional Gallbladder Disease. Biliary-type abdominal pain in the context of a structurally normal gallbladder has been referred to as «biliary dyspepsia». Episodes are recurrent but usually in a sporadic and quite erratic frequency. Functional biliary pain has also been termed: gallbladder dyskinesia, chronic acalculous gallbladder dysfunction, acalculous biliary disease and chronic acalculous cholecystitis.

Gallbladder dysmotility is also associated with other conditions including functional gastrointestinal disorders, pregnancy, diabetes mellitus, obesity, cirrhosis, and the use of various medications (including atropine, morphine, octreotide, nifedipine, and progesterone).

Sphincter of Oddi Dysfunction. Following removal of the gallbladder, biliary pain has been attributed to sphincter of Oddi dysfunction (SOD). SOD represents intermittent obstruction to the flow of biliopancreatic secretions through the sphincter of Oddi in the absence of biliary stones or a ductal stricture.

Treatment of Biliary Dyskinesia. Therapy is primarily focused on the use of smooth muscle relaxants. Nifedipine or Nicardipine (a calcium channel antagonist) use over 3 months decreases pain and once treatment ceases, the effect becomes lost in a week. Trimebutine (a spasmolytic), sublingual nitrates or a combination of both agents provides complete or partial relief of pain in most cases (64–71 %) Several other medications such as anticholinergics (e. g.; hyoscine butylbromide), antispasmodics (e. g.; tiropramide), opioid antagonists (e. g.; naloxone), alpha-2 adrenergic agonists (e. g.; clonidine), and even corticosteroids may

have a potential benefit in managing sphincter of Oddi dysfunction or functional gallbladder disorder.

Botulinum toxin, a neurotoxin, when injected directly into the ampulla of Vater at endoscopy, improves symptoms in 44 % of SOD patients for 6 to 12 weeks after the treatment. Surgical and endoscopic management in type II and type III SOD should be initiated with caution.

BILIARY LITHIASIS

Biliary lithiasis can be defined as the presence of concrements in the gallbladder, the biliary ducts, or both. These concrements can be stones (> 3 mm) or biliary sludge containing particles of smaller size. Biliary lithiasis and gallstone disease are two exchangeable umbrella terms for the same condition.

Gallstone disease is one of the most common problems affecting the digestive tract. Autopsy reports have shown a prevalence of gallstones from 11 % to 36 %. The prevalence of gallstones is related to many factors, including age, gender, and ethnic background (fig. 26). Certain conditions predispose to the development of gallstones. Obesity, pregnancy, dietary factors, Crohn's disease, terminal ileal resection, gastric surgery, hereditary spherocytosis, sickle cell disease, and thalassemia are all associated with an increased risk of developing gallstones. Women are three times more likely to develop gallstones than men, and first-degree relatives of patients with gallstones have a twofold greater prevalence.
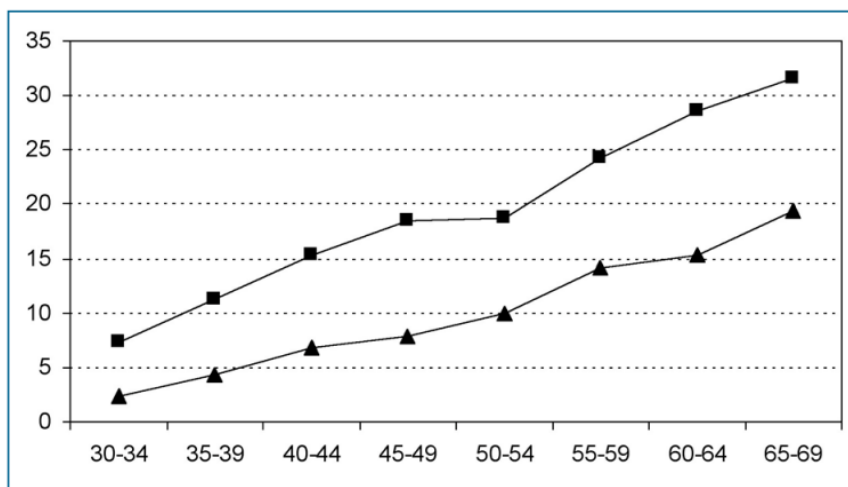

Fig. 26. Prevalence of gallstone disease in men (triangles) and women (squares) with increasing age

CLASSIFICATION OF THE GALLSTONES

By size (fig. 27):
– big
– medium
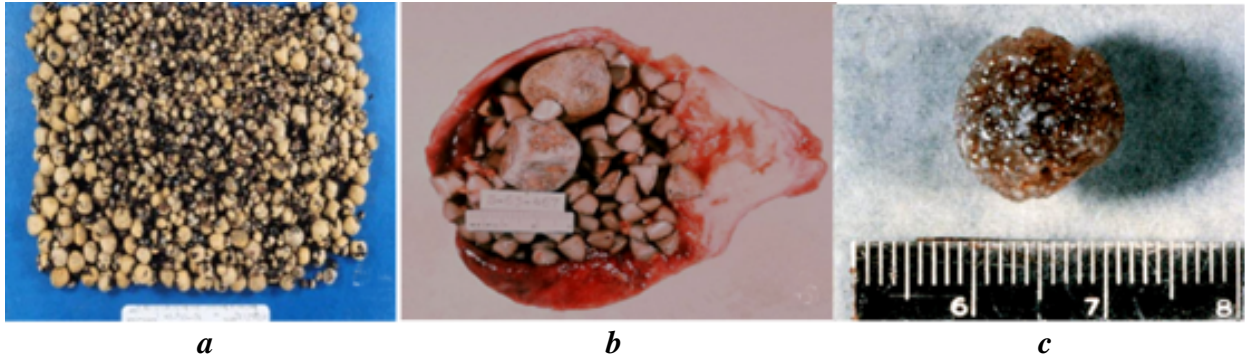– small
– microlithiasis
– sludge

Fig. 27. Gallstones of different sizes: *a* — small and microlithiasis; *b* — medium; *c* — big

Biliary *sludge* is a viscous gel composed of mucin and microscopic precipitates of multilamellar vesicles, cholesterol monohydrate, and calcium bilirubinate. The formation of biliary sludge precedes the formation of macroscopic cholesterol gallstones.

GALLSTONE FORMATION

Gallstones are composed predominantly of cholesterol, bilirubin, and calcium salts, with a lesser amount of other constituents. The most widely used classification system of stones by type is based on the relative amount of cholesterol within stones. There are three main categories: ***cholesterol***, ***mixed stones*** with cholesterol as the main component and noncholesterol (pigment) stones. The latter are further classified as either ***black*** or ***brown pigment*** stones.

Role of gallbladder motility (bile stasis theory). The concentration of biliary cholesterol is directly related to the degree of gallbladder motility impairment. The gallbladder *hypomotility* causes *bile stasis* and provides sufficient time for the nucleation of cholesterol crystals and growth of gallstones in the gallbladder lumen within the mucin gel, which in turn might further worsen motor function by a possible mechanical obstruction of the cystic duct.

CHOLESTEROL STONES

Pure cholesterol stones are pale yellow, round to ovoid, and have a finely granular, hard external surface (fig. 28), which on transection reveals a glistening, radiating crystalline palisade.

Fig. 28. Cholesterol stones

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Cholesterol and other lipids in the bile are not water soluble but have to be kept solubilized to prevent them from deposition as a stone. The ingenious mechanism of solubilization depends on transporting cholesterol in the lipophilic core of micelles. The structure of a micelle is shown in fig. 29.
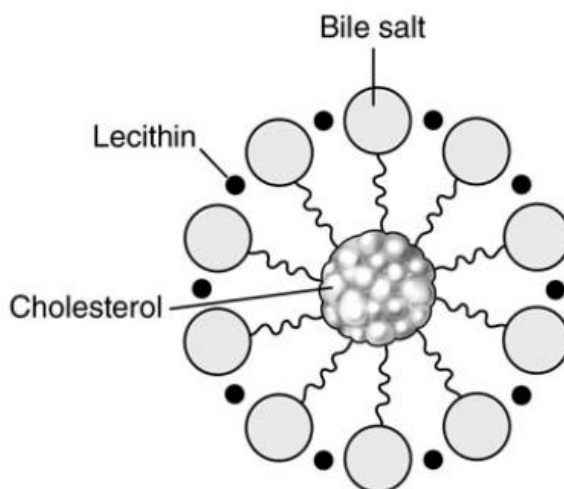

Fig. 29. Structure of a micelle. The micelle is an aggregation of bile salts and lecithin with a lypophyllic core that carries the water-insoluble cholesterol

Bile salts and lecithin are amphoteric and aggregate to form a lipophilic core that carries cholesterol, while their water-soluble ends are arranged peripherally at the circumference of the micelle. The maximal ability of the micelles to carry cholesterol is called the critical micellar concentration (fig. 30).

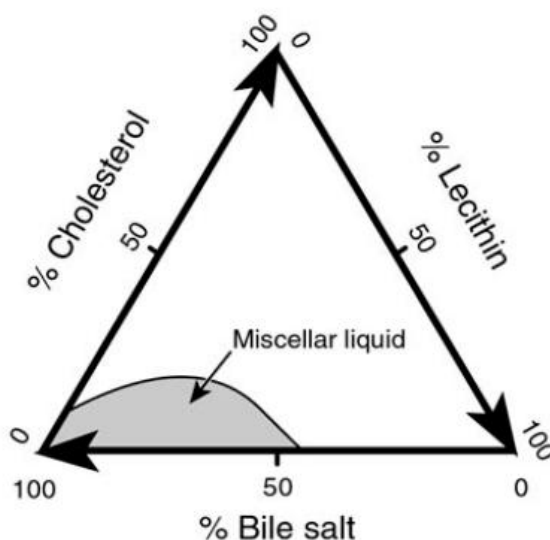*Fig. 30.* Tricoordinate phase diagram for determination of cholesterol saturation index. The shaded area represents micellar liquid in which cholesterol remains solubilized. Beyond this, cholesterol molecules precipitate to form crystals

When the critical micellar concentration is exceeded, a metastable phase is reached at which cholesterol does not precipitate due to vesicular phase in bile.

Beyond this, cholesterol molecules precipitate by first aggregating together and then forming crystals. High calcium content in the bile favors cholesterol precipitation. Cholesterol supersaturated bile from patients with gallstones forms cholesterol crystals more easily than that from individuals with no gallstones.

PIGMENT STONES

Pigment stone is the name used for stones containing less than 20–30 % of cholesterol. They are classified as either **black** or **brown** pigment stones. The former are formed from calcium salts of unconjugated bilirubin in a polymerized matrix.

Black pigment stones are usually small, brittle, black, and sometimes speculated (fig. 31). They are formed by supersaturation of calcium bilirubinate, carbonate, and phosphate, most often secondary to hemolytic disorders such as hereditary spherocytosis and sickle cell disease, and in those with cirrhosis. Like cholesterol stones, they almost always form in the gallbladder.

Fig. 31. Black pigment stones

Brown pigment stones contain bacterial degradation products of biliary lipids, bacterial cell bodies, calcium salts of fatty acids, unconjugated bilirubin, and precipitated cholesterol (fig. 32). Brown stones are usually < 1 cm in diameter, brownish-yellow, soft, and often mushy. They may form either in the gallbladder or in the bile ducts, usually secondary to bacterial infection caused by bile stasis.

Fig. 32. Brown pigment stones

Brown pigment stones are also associated with the presence of foreign bodies within the bile ducts, such as endoprosthesis (stents), or parasites, such as *Clonorchis sinensis* and *Ascaris lumbricoides*.

CLINICAL FORMS OF GALLSTONE DISEASE

Gallstones cause a wide spectrum of disease, ranging from no problems (*asymptomatic gallstones*) to potentially life-threatening complications such as perforated cholecystitis and gangrenous cholecystitis. Autopsy reports have shown a prevalence of gallstones from 11 to 36 %. ***The vast majority of gallstones (> 80 %) are «silent».*** Over a 20-year period, about two thirds of asymptomatic patients with gallstones remain symptom free. Once symptomatic, patients tend to have recurring symptoms in 20–50 % during following year.

Clinical forms of gallstone disease:

− Asymptomatic

− Dyspeptic (belching, bloating, abdominal discomfort, heartburn, and food intolerances)

− Chronic pain (episodic mild upper abdominal and right quadrant pain, dispepsia)

− Biliary colic (constant and increases in severity epigastrium or right upper quadrant pain that frequently radiates to the right upper back or between the scapulae)

− Cardiac (thoracic retrosternal pain in as in stenocardia)

− Complicated (cholecystitis, choledocholithiasis, cholangitis, biliary acute pancreatitis, bile duct strictures etc.)

CHRONIC CALCULOUS CHOLECYSTITIS

The mere presence of gallstones is neither necessary nor sufficient for the diagnosis of chronic cholecystitis (fig. 33). The gallbladder may be distended or shrunken. Fibrous serosal adhesions suggest previous episodes of acute cholecystitis. The wall is usually thickened, but it may be thin in some cases. Sometimes there is a calcification of the gallbladder wall (porcelain gallbladder).
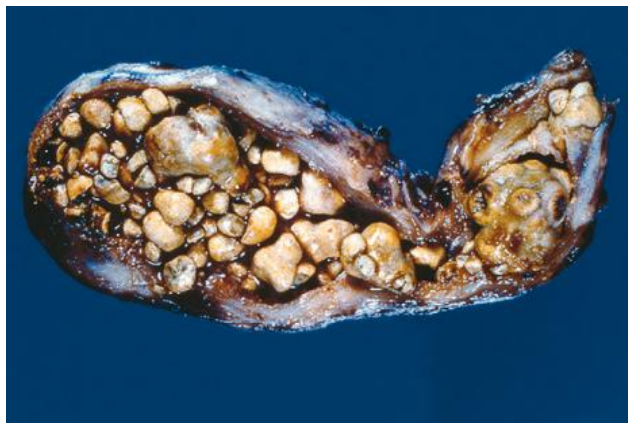
Fig. 33. Chronic calculous cholecystitis

Some patients present with mild, vague symptoms consisting of mild transient chronic pain and/or nausea, flatulence, and dyspepsia, often referred to as «non-specific» symptoms. Although gallstones may be the cause of these symp-

toms, they are just as likely to be caused by other gastrointestinal disorders. In fact, they frequently persist after cholecystectomy.

Most often (in 10–25 per cent of patients) gallstones cause episodes of *«biliary colic»*. It is steady, severe, right upper quadrant or epigastric abdominal pain that may radiate into the back. The pain develops when a stone obstructs the cystic duct, resulting in a progressive increase of tension in the gallbladder wall (fig. 34).

Attacks begin 15–60 min after a meal (almost always the evening meal) and may be associated with nausea and, sometimes, bilious vomiting. Pain can be severe enough to bring the patient to the emergency department. Patients report that episodes are often triggered by specific foods, including dairy products and fatty, fried, or spicy foods. Pain lasting more than 6 h suggests complicated gallstone disease (*acute cholecystitis or pancreatitis*) or another upper abdominal disorder.
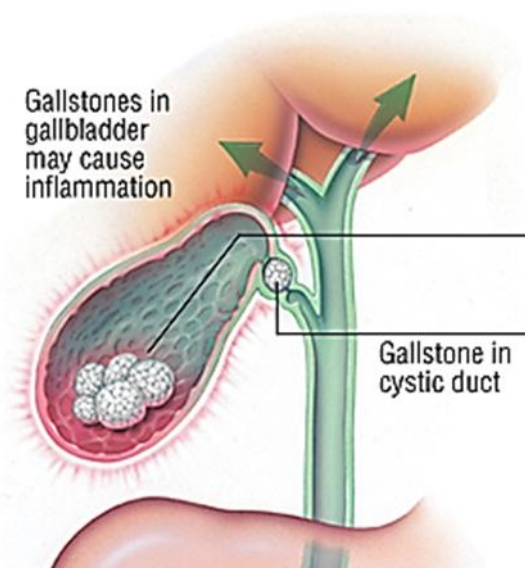

Fig. 34. Biliary colic

As the intensity of biliary pain is usually high patients require immediate medical attention and analgesia. Pain can be alleviated by narcotic analgesics or non-steroidal anti-inflammatory drugs (NSAIDs).

Complication of chronic calculous cholecystitis. Mucocele of the gallbladder (fig. 35). Chronic obstruction of the gallbladder may sometimes cause chronic inflammation. Over a period of time, the lumen becomes filled with a clear or slightly milky fluid due to the mucous secretion of the epithelium. Mucocele of the gallbladder may attain large size and present as a right abdominal mass.

Fig. 35. Mucocele

Cholecystoenteric fistula and gallstone ileus (fig. 36). This complication is seen most commonly in elderly patients. The gallstone in Hartmann's pouch may

erode into adjacent bowel, usually the duodenum, to cause cholecystoenteric fistula. The gallstone causes obstruction as it travels down the intestine by lodging in narrowed segments of the small intestine (e. g., duodenojejunal flexure, areas narrowed by adhesions) until it finally lodges in the ileocecal sphincter. Colicky pain, vomiting, abdominal distension, and dehydration are the clinical features.
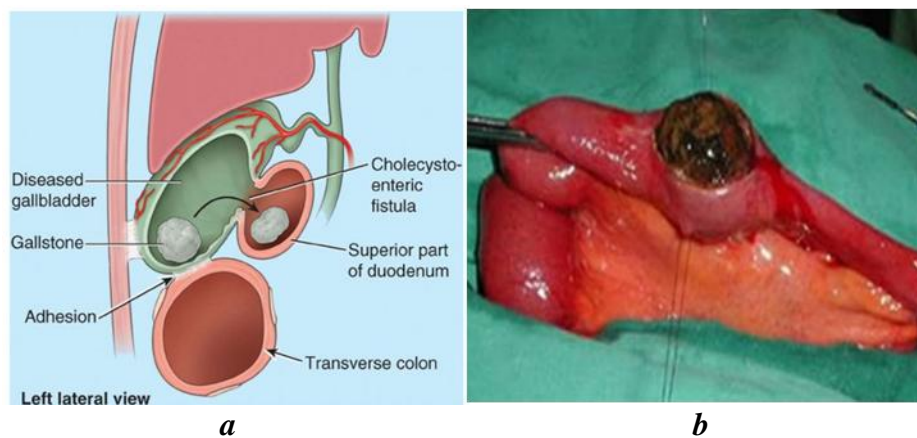

a   *b*

Fig. 36. Gallstone ileus: *a* — cholecystoenteric fistula; *b* — *g*allstone in the small intestine

The impaction of a stone in the infundibulum of the gallbladder or even to the common bile duct is called *Mirizzi's syndrome* (fig. 37). That mechanically obstructs the bile duct.

The overall incidence of *gallbladder cancer* in patients with gallstones is only 0.2 % (fig. 38). The highest risk group are patients with porcelain gallbladder, more than 10 % of whom either have or eventually develop adenocarcinoma.

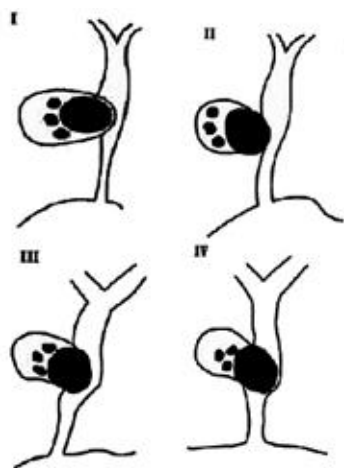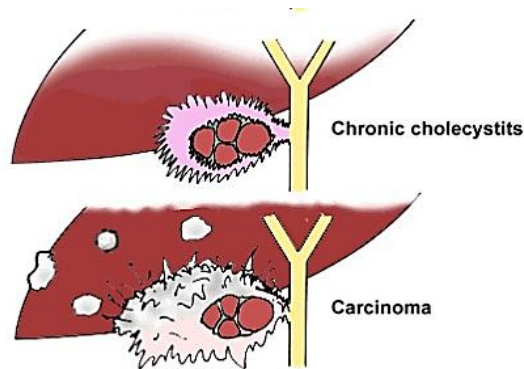*Fig. 37*. Four types of Mirizzi's syndrome   *Fig. 38*. Gallbladder carcinoma

Treatment of patients with asymptomatic gallstones. *Observation of patients with asymptomatic gallstones has a risk less than or equal to operation*. Therefore, in most countries treatment of «asymptomatic» gallstone patients is not routinely recommended, as the overall risk of biliary colic, complications and gallbladder cancer are very low.

However, *prophylactic cholecystectomy is reasonable in:*

a) children (exposed to the long term physical presence of stones);

b) morbidly obese gallstone patients undergoing bariatric surgery;

c) patients at increased risk of gallbladder cancer, including those with large stones (a solitary stone or a stone burden greater than 3 cm in size), a «porcelain» gallbladder or gallbladder polyps that are rapidly growing or that are larger than 1 cm;

d) patients with sickle cell anemia;

e) simultaneously, during elective colonic operations, laparoscopic anti-reflux operations etc.

Nonsurgical treatment of chronic calculous cholecystitis. The only medical *dissolution therapy* currently available is the use of oral litholysis by bile acids (chenodeoxycholic and ursodeoxycholic acid). This approach, however, has a limited role in a small subgroup of patients (less than 10 % of the total), i. e., those who are unfit for surgery, or have small (equal to or less than 5 mm in size), uncalcified (radiolucent), and cholesterol-enriched (i. e., > 80 %) stones in a functioning gallbladder. After one year of dissolution treatment, the success rate is not more than 50–75 % complete dissolution for small stones. In 30–50 % of cases gallstones recur 5 years after bile acid therapy or lithotripsy. Nowadays, medical therapy of gallstones has been largely abandoned.

Surgical treatment of chronic calculous cholecystitis. The standard treatment for symptomatic cholecystitis is early *laparoscopic cholecystectomy (LC)*. Once surgery is scheduled, the patient is advised to adhere to a low-fat diet.

Fig. 39. Dividing of cystic duct and artery during laparoscopic cholecystectomy

Relative contraindications for laparoscopic cholecystectomy include previous upper abdominal surgery, severe obesity and pregnancy, but none of these conditions absolutely contraindicate performing the operation. If significant technical difficulty is encountered the surgeon should convert the procedure to open surgery. LC is performed under general anesthesia. Pneumoperitoneum is created and the gallbladder fundus is grasped with a forceps. The surgeon then dissects the cystic artery and cystic duct as it leaves the gallbladder. Once these structures are identified, the cystic artery and duct are clipped and divided (fig. 39).

Open cholecystectomy is now reserved for difficult and problematic cases and has become an uncommon procedure.

Other interesting, but not widely accepted surgical modalities are.

Mini-laparotomy cholecystectomy (fig. 40) is characterized by lesser operative trauma in compare with open cholecystectomy and close results with laparoscopic cholecystectomy in mortality and complication rate.

Fig. 40. Minilaparotomy cholecystectomy

SILS / N.O.T.E.S. / Robotic cholecystectomy. With the advancement of therapeutic endoscopy and laparoscopic surgery a novel approaches to gallbladder removal with the minimum or absent of any incision over abdominal wall were introduced recently (fig. 41, 42, 43).

a	b

Fig. 41. SILS (single incision laparoscopic surgery) cholecystectomy:
a — Scheme of the procedure; *b* — Instrumental kit
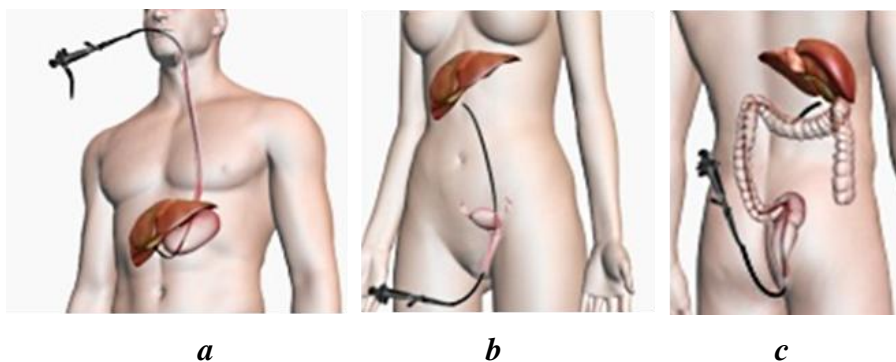

a	b	c

Fig. 42. N.O.T.E.S. (natural orifice transluminal endoscopic surgery) cholecystectomy:
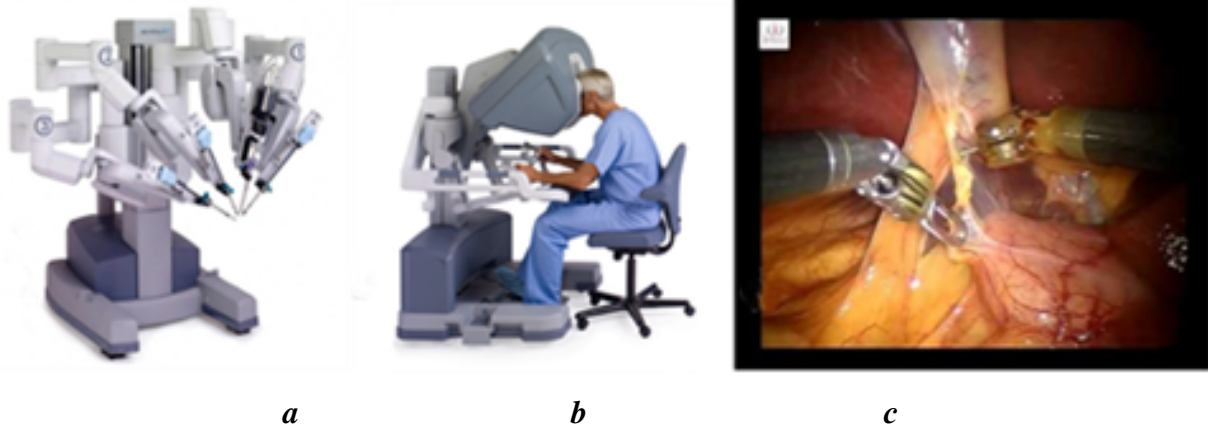*a* —transgastric approach; *b* — transvaginalis; *c* — through rectum

Fig. 43. Robotic cholecystectomy:
a — the robotic arms; *b* — positioning of the surgeon; *c* — the operative view

ACUTE CHOLECYSTITIS

Clinically, acute cholecystitis is defined as an episode of acute biliary pain accompanied by fever, right upper quadrant tenderness, guarding, persistence of symptoms beyond 24 hours, and leukocytosis. Approximately 90 % of cases are associated with gallstones. The three types of acute cholecystitis are separated:

− acute calculous cholecystitis;
− acute acalculous cholecystitis;
− emphysematous cholecystitis.

Acute Calculous Cholecystitis. About 80% of patients with acute cholecystitis give a history compatible with chronic cholecystitis. Most patients who develop acute calculous cholecystitis are women aged 50 to 70. Acute cholecystitis usually results from ***a gallstone impacted in Hartmann's pouch***, obstructing the neck of the gallbladder for ***more than 6 hours*** (fig. 44). The result is distension of the gallbladder, subserosal inflammation with edema and thickening of the gallbladder wall. The process is almost always complicated by secondary bacterial infection, but *the infection is secondary and does not contribute to the onset of acute cholecystitis*. The obstructing stone and ensuing inflammation may also cause ischemic necrosis of the neck of the gallbladder and may result in thrombosis of the cystic artery, leading to gangrenous cholecystitis.
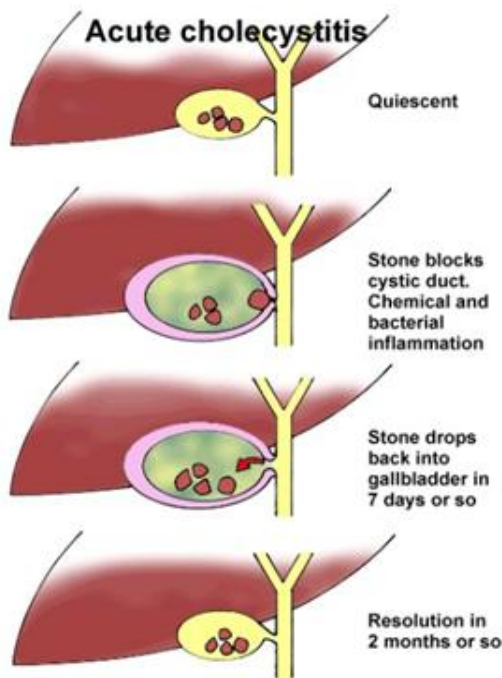

Fig. 44. Natural course of acute cholecystitis

28

The gallbladder is usually enlarged and the wall is thickened by edema, vascular congestion, and hemorrhage, or it may become necrotic. The serosa is dull and often covered by patches of fibrinopurulent exudate (fig. 45).

Fig. 45. Acute cholecystitis

Clinical Features and Diagnosis. Typical symptom is right upper quadrant pain that is of recent onset and typically in the right upper quadrant or epigastrium, and may radiate to the right upper part of the back or the interscapular area. The pain is usually accompanied by abdominal guarding and local tenderness. These symptoms may be deceptively mild, or even absent, in the elderly. There are usual complaints such as anorexia, nausea, and vomiting, and the patient is reluctant to move, as the inflammatory process affects the parietal peritoneum.

Occasionally, an enlarged gallbladder may be palpated and pain may be elicited upon palpation of the right upper quadrant when the patient inhales deeply (*Murphy's sign*).

The local inflammatory process is accompanied by systemic manifestations including tachycardia, fever, and leukocytosis. Jaundice and mild liver dysfunction occur infrequently.

A mild to moderate leukocytosis (12,000 to 15,000 cells/mm3) is usually present. High white blood cells (above 20,000) *suggest* complicated form of cholecystitis such as gangrenous cholecystitis, perforation, or associated cholangitis. Serum liver chemistries are usually normal, but a mild elevation of serum bilirubin, <4 mg/mL, may be present along with mild elevation of alkaline phosphatase, transaminases, and amylase.

Ultrasonography is typically used to confirm the clinical diagnosis. The signs are the distension of the gallbladder and thickening of the gallbladder wall and the pericholecystic fluid.

Complications. *Perforation of the gallbladder* (fig. 46). Areas of perforation are usually sealed off by the omentum, which leads to the formation of *pericholecystic adhesions or abscess*. Free perforation and bile **peritonitis** are rare but may occur in the immunocompromised patient.
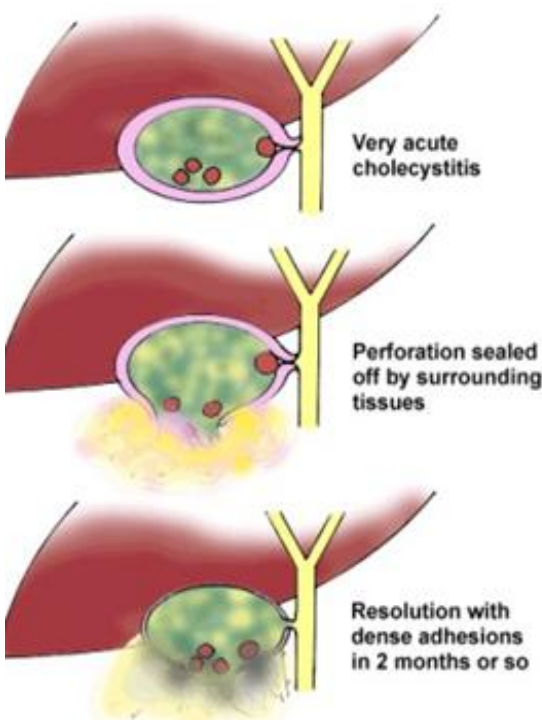

Fig. 46. Natural course of perforation

In *empyema* of the gallbladder (Fig. 47), the gallbladder lumen is filled with pus. The patient becomes acutely toxic, with spiking high fever, chills, and marked leukocytosis.

Fig. 47. Gallbladder empyema

Treatment of the Acute Calculous Cholecystitis. Patients with acute cholecystitis will need intravenous fluids, antibiotics, and analgesia. The antibiotics should cover gram-negative aerobes as well as anaerobes. *Early cholecystectomy performed within 2 to 3 days of the illness is gold standard in acute cholecystitis treatment*. After inflammation has been present for more than 72 hours, the development of fibrous adhesions and transmural inflammation makes cholecystectomy more laborious and prone to complications. *Laparoscopic cholecystectomy is the procedure of choice for acute cholecystitis.* The procedure is more tedious and takes longer than in the elective setting and sometimes an open cholecystectomy is preferred.

When patients are unfit for surgery, they can be treated with antibiotics. After medical therapy failure, *cholecystostomy* can be performed either by percutaneous drainage (fig. 48), laparoscopically or with the open technique. Then, laparoscopic cholecystectomy is usually scheduled for approximately 1–2 months later if there are no contraindications.
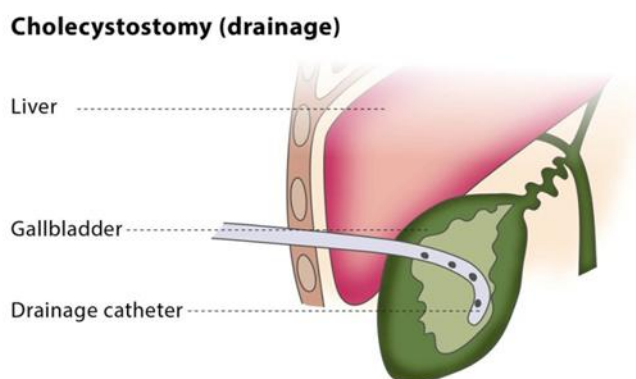

Fig. 48. Transcutaneous cholecystostomy

Acute Acalculous Cholecystitis. Acute inflammation of the gallbladder can occur without gallstones. Acalculous cholecystitis typically develops in critically ill patients in the intensive care unit. Acute acalculous cholecystitis is found in approximately 2 % to 15 % of all patients who have undergone cholecystectomy. Affected individuals often have other associated conditions, such as a history of trauma or nonbiliary surgical procedure, sepsis, burns, parenteral nutrition, mechanical ventilation, multiple blood transfusions, or the use of narcotics or antibiotics.

Gallbladder ischemia plays a major role in patients with an underlying cardiovascular disease or those who develop acute acalculous cholecystitis after trauma, sepsis, or surgical procedure, and reperfusion injury. The second probable mechanism is a bile stasis associated with a clinical history of fasting, narcotic use, dehydration, or recent anesthesia. In rare cases, the disorder may occur *de novo* in patients without any predisposing factors. A high mortality rate, up to 45%, is seen in this group of patients.

Acute Emphysematous Cholecystitis. This is a rare form of acute cholecystitis in which anaerobic infection of the gallbladder develops, causing formation of gas within the lumen and gallbladder wall (fig. 49). This complication is more likely to occur in patients with diabetes. The anaerobic bacteria involved may be clostridia, anaerobic streptococci, or gas-forming *Escherichia coli*.

Fig. 49. Presence of gas in gallbladder

CHOLEDOCHOLITHIASIS

Common bile duct stones (choledocholithiasis) are found in 6 to 12% of patients with stones in the gallbladder. The incidence increases with age. About 20 to 25% of patients above the age of 60 with symptomatic gallstones have stones in the common bile duct as well as in the gallbladder.

The vast majority of ductal stones in patients from Western countries are formed within the gallbladder and migrate down the cystic duct to the common bile duct (secondary common bile duct stones), in contrast to the primary stones that are form in the bile ducts. The *secondary stones* are usually cholesterol stones, whereas the *primary stones* are usually of the brown pigment type. The

primary stones are associated with biliary stasis and infection and are more commonly seen in Asian populations.

Choledochal stones may cause *obstruction*, complete or incomplete, or they may manifest with *cholangitis* or *gallstone (biliary) pancreatitis* (fig. 50). The pain caused by a stone in the bile duct is very similar to that of biliary colic caused by impaction of a stone in the cystic duct. Nausea and vomiting are common. The symptoms may also be *intermittent*, such as pain and transient jaundice caused by a stone that temporarily impacts the ampulla but subsequently moves away, acting as a ball valve. A small stone may pass through the ampulla spontaneously with resolution of symptoms. Finally, the stones may become completely *impacted*, causing severe progressive jaundice.

Elevation of serum bilirubin, alkaline phosphatase, and transaminases are commonly seen in patients with bile duct stones. The ultrasonogram shows a dilated common bile duct (> 6 mm diameter) and sometimes stones within the duct. More definitive evaluation of the common bile duct is provided by either magnetic resonance imaging, EUS or ERC. ERC provides additional advantage of performing sphincterotomy and removing common duct stones.

Fig. 50. Complications of choledocholithiasis

Treatment of Choledocholithiasis. Endoscopic sphincterotomy (fig. 51) and removal of common duct stones using forceps, baskets, or balloons has proven safe and effective. It has a mortality rate of 0.5 % to 1.0 % and a morbidity rate of 8% to 10%. In case of gallbladder lithiasis after the stone removal, the laparoscopic cholecystectomy is scheduled for 7–14 days (two-stage treatment of common bile duct stones).
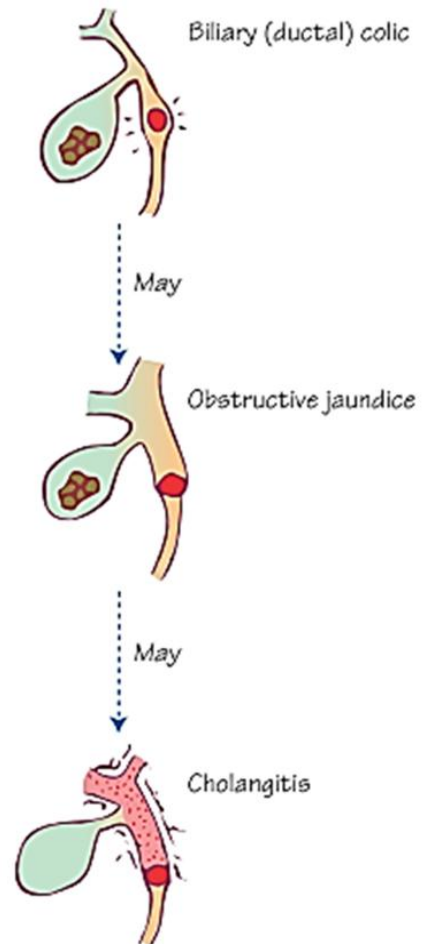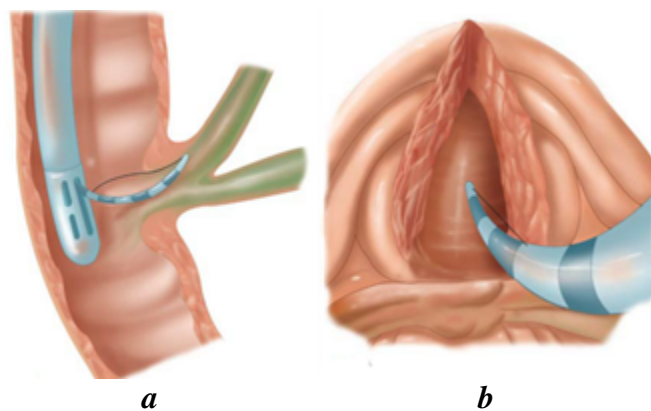

a   *b*

Fig. 51. Endoscopic sphincterotomy: *a* — inserting of papillotome in major duodenal papilla; *b* — view of major papilla after the cutting

Common bile duct stones may also be removed using *laparoscopy* or *open surgery*. The procedure includes cholecystectomy and choledocholithotomy (***synchronous treatment of common bile duct stones***). The experienced laparoscopist can explore the common bile duct and remove stones through the cystic duct or after choledochotomy at the time of laparoscopic cholecystectomy (fig. 52).
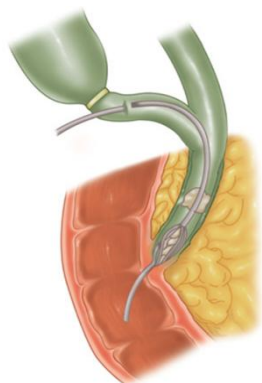

Fig. 52. Laparoscopic stone extraction through the cystic duct

Open stone extraction (fig. 53) *is* performed either in conjunction with open cholecystectomy or, in the patient with retained stones, after previous cholecystectomy, especially where ERC has failed and the laparoscopic approach is either not available or deemed too difficult because of adhesions.
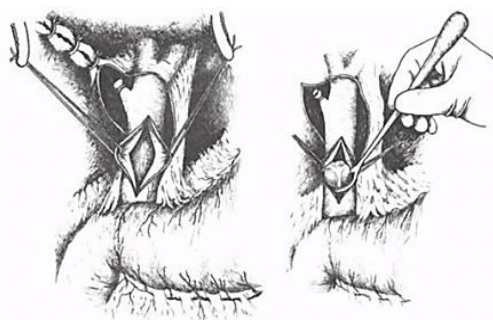

Fig. 53. Open stone extraction

When the common bile duct has been cleared of stones, the choledochotomy is usually closed after external drainage of the duct (most commonly by T-tube, fig. 54).
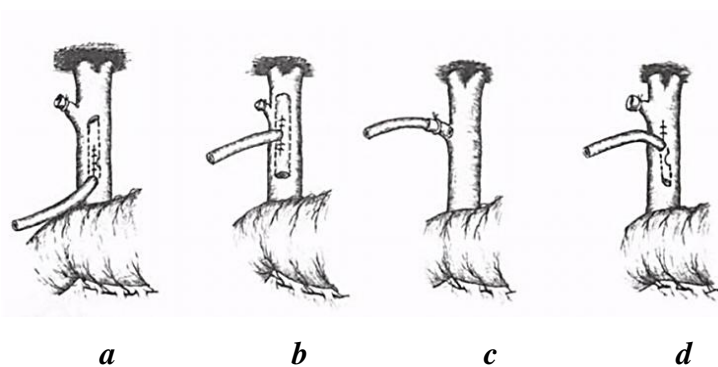

<div align="center">

a   *b*   *c*   *d*

</div>

Fig. 54. Types of External CBD drainage:
*a* — Vishnevskiy; *b* — T-tube (2); *c* — Pikovskiy; *d* — Halsted (4)

The drainage is allowed to drain freely into a bag. The amount of drainage decreases with time. A cholangiogram may be obtained safely after postoperative day 7. If no residual stones are seen and dye flows freely into the duodenum, the drainage is clamped until its removal at about 1–2 weeks, when a well-formed tract has developed.

Rarely, when the stones cannot be cleared and/or when the duct is very dilated (larger than 1.5 cm in diameter), a ***choledochal drainage procedure*** (fig. 55) is performed by anastomosing the duodenum (choledochoduodenostomy) or a 45 cm Roux-en-Y limb of jejunum (choledochojejunostomy) side to side with the common bile duct.

a   *b*
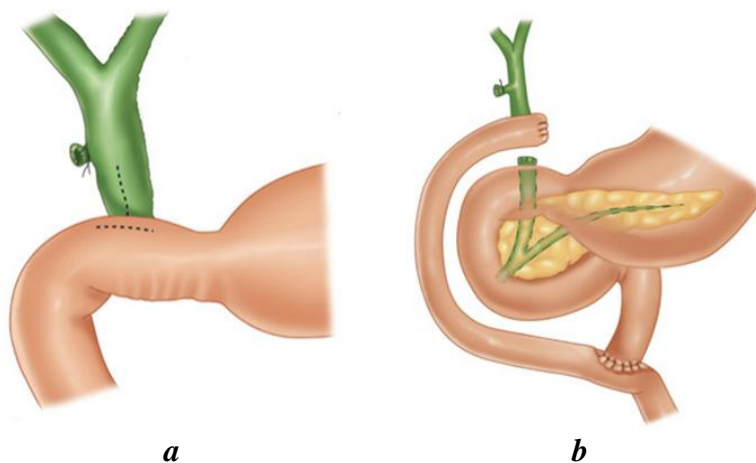
Fig. 55. Choledochal drainage procedures:
a — choledochoduodenostomy. *b* — choledochojejunostomy

If an open procedure for common bile duct stones is being done in which the stones are impacted, recurrent, or multiple, the ***transduodenal sphincterotomy*** (fig. 56) may be feasible. The duodenum is incised transversely. The sphincter then is incised and the impacted stones are removed.


a   *b*   *c*
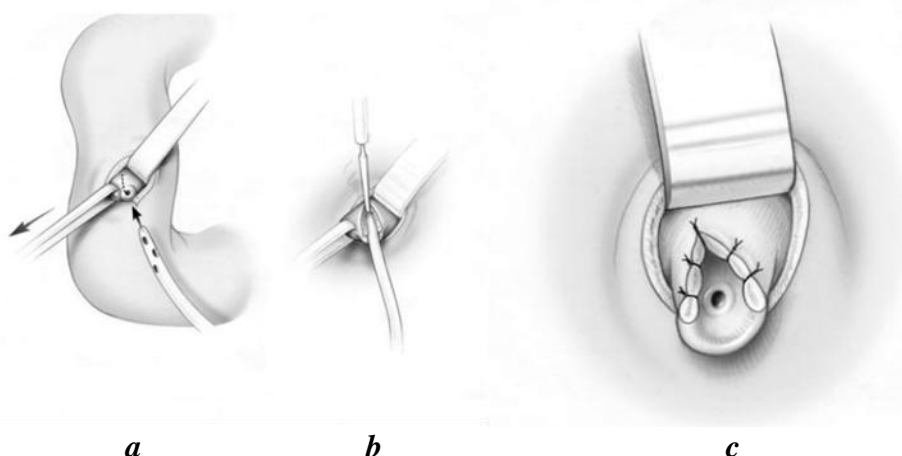
Fig. 56. Transduodenal sphincterotomy*:*
a — Incising the duodenum; *b* — Sphincterotomy; *c* —Suturing the new ampulla

CHOLANGITIS

Acute cholangitis is an ascending bacterial infection in association with partial or complete obstruction of the bile ducts. Hepatic bile is sterile, and bile in the bile ducts is kept sterile by continuous bile flow and by the presence of antibacterial substances in bile, such as immunoglobulin. Mechanical hindrance to bile flow facilitates bacterial contamination. Gallstones are the most common cause of obstruction in cholangitis; other causes are benign and malignant strictures, parasites, instrumentation of the ducts and indwelling stents, and partially obstructed biliary-enteric anastomosis.

Cholangitis may present as anything from a mild, intermittent, and self-limited disease to a fulminant, potentially life-threatening septicemia. The most common presentation is *fever, epigastric or right upper quadrant pain, and jaundice*. These classic symptoms, well known as **Charcot's triad**, are present in about two thirds of patients. The illness may progress rapidly with septicemia and disorientation, known as **Reynolds pentad** (e. g., *fever, jaundice, right upper quadrant pain, septic shock, and mental status changes*).

The initial treatment of patients with cholangitis includes intravenous antibiotics and fluid resuscitation. These patients may require intensive care unit monitoring and vasopressor support. Most patients will respond to these measures. About 15 % of patients will not respond to this treatment and an emergency biliary decompression may be required. Biliary decompression (fig. 57) may be accomplished endoscopically (sphincterotomy as at fig.51, drainage, stent), via the percutaneous transhepatic route, or surgically (decompression of the common bile duct with a tube).
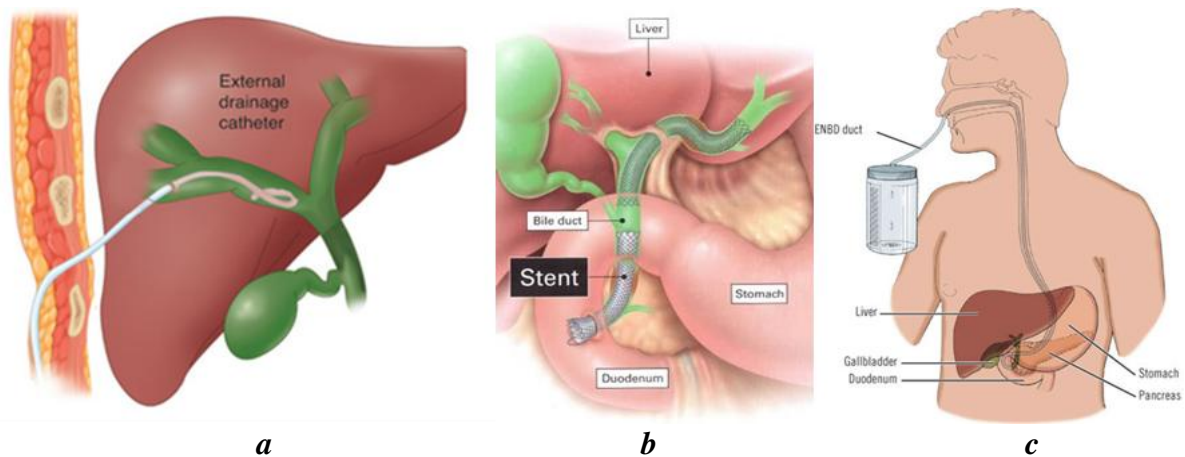
Fig. 57. Biliary decompression:
a — percutaneous transhepatic drainage; *b* — biliary stent; *c* — nasobiliary tube

BILE DUCT STRICTURES

Benign bile duct strictures can have numerous causes. However, the vast majority were caused by operative injury, most commonly by laparoscopic cholecystectomy. Other causes include fibrosis due to chronic pancreatitis, common bile duct stones, acute cholangitis, biliary obstruction due to cholecystolithiasis (Mirizzi's syndrome), sclerosing cholangitis, cholangitis, and strictures of a biliary-enteric anastomosis. Patients with bile duct strictures most commonly present with episodes of cholangitis. Less commonly, they may present with jaundice without evidence of infection.

Percutaneous or endoscopic dilatation and/or stent placement give good results in more than one half of patients. Surgery with Roux-en-Y choledochojejunostomy or hepaticojejunostomy (fig. 55) is the standard of care with good or excellent results in 80 to 90% of patients.

A benign stenosis of the outlet of the common bile duct (***stenosis of the sphincter of Oddi***) is usually associated with inflammation, fibrosis, or muscular hypertrophy. The pathogenesis is unclear, but *trauma from the passage of stones*, *sphincter motility disorders*, and *congenital anomalies* have been suggested. Episodic pain of the biliary type with abnormal liver function tests is a common presentation. However, recurrent jaundice or pancreatitis also may play a role. Endoscopic (fig. 51) or operative (fig. 56) sphincterotomy will yield good results.

PRIMARY SCLEROSING CHOLANGITIS

Sclerosing cholangitis is an uncommon disease characterized by inflammatory strictures involving the intrahepatic and extrahepatic biliary tree (fig. 58). It is a progressive disease that eventually results in secondary biliary cirrhosis. Primary sclerosing cholangitis is a disease with ***no known attributing cause***. It is associated with *ulcerative colitis* in about two thirds of patients. Other diseases associated with sclerosing cholangitis include Riedel's thyroiditis and retroperitoneal fibrosis. Autoimmune reaction, chronic low-grade bacterial or viral infection, toxic reaction, and genetic factors have all been suggested to play a role in its pathogenesis. Patients with sclerosing cholangitis are at risk for developing cholangiocarcinoma. Eventually, 10 to 20 % of the patients will develop cancer.
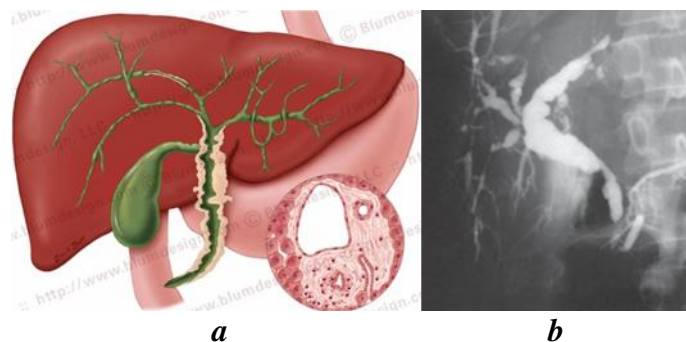

a   *b*

Fig. 58. Sclerosing cholangitis*: a —* scheme of the disease; *b —* cholangiogram

Usual presenting symptoms include intermittent jaundice, fatigue, weight loss, pruritus, and abdominal pain. The clinical course in sclerosing cholangitis is highly variable, but cyclic remissions and exacerbations are typical. However, some patients remain asymptomatic for years, while others progress rapidly with the obliterative inflammatory changes leading to secondary biliary cirrhosis and liver failure.

There is no known effective medical therapy for primary sclerosing cholangitis and no known curative treatment. Corticosteroids, immunosuppressants, ursodeoxycholic acid, and antibiotics have been disappointing. Biliary strictures can be dilated and stented either endoscopically or percutaneously. Surgical management with resection of the extrahepatic biliary tree and hepaticojejunostomy has produced reasonable results in patients with extrahepatic and bifurcation strictures, but without cirrhosis or significant hepatic fibrosis. In patients with sclerosing cholangitis and advanced liver disease, *liver transplantation* is the only option.

TESTS

1. Anatomic areas of a gallbladder are:
    a) fundus;
    b) corpus (body) ;
    c) infundibulum;
    d) isthmus;
    e) neck.

2. What is Hartmann's pouch?
    a) very big fundus;
    b) enlargement of a gallbladder neck;
    c) it's a second name of a gallbladder;
    d) hepatopancreatic ampulla.

3. Calot's triangle is the space bordered by:
    a) cystic duct inferiorly;
    b) common hepatic duct medially;
    c) common bile duct medially;
    d) superior border of the cystic artery;
    e) portal vein inferiorly.

4. The common bile duct is divided into parts:
    a) Supraduodenal portion;
    b) Underduodenal portion;
    c) Retroduodenal portion;
    d) Pancreatic portion;
    e) Gastric portion;
    f) Intramural portion.

5. Clinical forms of gallstone disease are:
   a) asymptomatic;
   b) biliary colic;
   c) acute calculous cholecystitis;
   d) chronic calculous cholecystitis;
   e) choledocholithiasis;
   f) dyspeptic;
   g) biliary pancreatitis;
   h) pancreatic tumor;
   i) primary sclerosing cholangitis.

6. The stones in the gallbladder are better seen by:
   a) Ultrasonography;
   b) Endoscopic cholangiopancreatography;
   c) Computed tomography;
   d) MRI;
   e) Angiography.

7. Dilation of the extrahepatic bile ducts may be caused by:
   a) chronic cholecystitis;
   b) choledocholithiasis;
   c) tumor of pancreatic head;
   d) metastasis in the liver;
   e) stenosis of the sphincter of Oddi;
   f) pyloric stenosis.

8. The current management of chronic calculous cholecystitis is:
   a) early laparoscopic cholecystectomy;
   b) dissolution therapy with bile acids;
   c) lithotripsy;
   d) laparoscopic cholecystectomy only when complicated;
   e) cholecystostomy and removing of stones.

9. Current treatment of an acute calculous cholecystitis is:
   a) early cholecystectomy performed within 2 to 3 days;
   b) when the patient is unfit for surgery, cholecystostomy can be performed by percutaneous drainage;
   c) postponed cholecystectomy after 3-4 weeks of the diseases onset;
   d) aggressive medicament treatment in Intensive care unit.

10. Charcot's triad in acute cholangitis are:
   a) fever;
   b) epigastric or right upper quadrant pain;
   c) jaundice;
   d) vomiting;
   e) leukocytosis;
   f) septic shock;
   g) mental status changes.

11. **The main cause of acute calculous cholecystitis onset is:**
   a) gallstone impacted in Hartmann's pouch;
   b) bacterial inflammation;
   c) reflux of duodenal content.

12. Causes of extrahepatic bile ducts strictures are:
   a) operative injury by laparoscopic cholecystectomy;
   b) fibrosis due to chronic pancreatitis;
   c) portal hypertension;
   d) common bile duct stones;
   e) Mirizzi's syndrome;
   f) sclerosing cholangitis;
   g) hepatic cirrhosis.

Answers: 1 – a, b, c, e; **2** – b; **3** – a, b, d; **4** – a, c, d, f; **5** – a, b, c, d, e, f, g; **6** – a; **7** – b, c, e; **8** – a; **9** – a, b; **10** – a, b, c; **11** – a; **12** – a, f, d, e, f.

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На английском языке

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