MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
STATE INSTITUTION OF HIGHER EDUCATION
«UZHHOROD NATIONAL UNIVERSITY»
FACULTY OF MEDICINE
DEPARTMENT OF SURGERY DISEASES

ACUTE CHOLECYSTITIS

Methodological matherials for independent study for students

UZHHOROD

2024

UZHHOROD NATIONAL UNIVERSITY
FACULTY OF MEDICINE
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Methodical matherials are devoted to issues of etiopathogenesis, symptoms, diagnosis and treatment methods of acute cholecystitis. The authors also tried to highlight, aim questions that also concern various complications of acute cholecystitis. The methodical matherials are intended for senior year students of higher medical educational institutions.

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Background

Cholecystitis is defined as an inflammation of the gallbladder that occurs most commonly because of the presence of stones in the gallbladder or an obstruction of the cystic duct by gallstones arising from the gallbladder (cholelithiasis). 90% of cases involve stones in the gallbladder (ie, calculous cholecystitis), with the other 10% of cases representing acalculous (without stones) cholecystitis.

It is one of the most commonly encountered surgical disorders and takes second place after appendicitis, approximately 10% of all urgent abdominal diseases. Uncomplicated cholecystitis has an excellent prognosis; the development of complications such as gangrene or perforation renders the prognosis less favorable.

Gallstones (gallstone disease, cholelithiasis) involves the presence of gallstones, which are concretions, that form in the biliary tract, usually in the gallbladder. Choledocholithiasis refers to the presence of one or more gallstones in the common bile duct (CBD).

Epidemiology

An estimated 10-20% of Americans have gallstones, and as many as one third of these people develop acute cholecystitis. Cholecystectomy for either recurrent biliary colic or acute cholecystitis is the most common major surgical procedure performed by general surgeons, resulting in approximately 500,000 operations annually.

Gallstone disease is responsible for about 10,000 deaths per year in the United States. About 7,000 deaths are attributable to acute gallstone complications, such as acute pancreatitis. About 2,000-3,000 deaths are caused by gallbladder cancers (80% of which occur in the setting of gallstone disease with chronic cholecystitis). Although gallbladder surgery is relatively safe, cholecystectomy is a very common procedure, and its rare complications result in several hundred deaths each year.

Age distribution for cholecystitis. The incidence of cholecystitis increases with age. The physiologic explanation for the increasing incidence of gallstone disease in the elderly population is unclear. The increased incidence in elderly men has been linked to age-related changes in the androgen-to-estrogen ratios.

Sex distribution for cholecystitis. Gallstones are 2-3 times more frequent in females than in males, resulting in a higher incidence of calculous cholecystitis in females. Elevated progesterone levels during pregnancy may cause biliary stasis, resulting in higher rates of gallbladder disease in pregnant females. Acalculous cholecystitis, however, is observed more often in elderly men.

Prevalence of cholecystitis by race and ethnicity. Cholelithiasis, the major risk factor for cholecystitis, has an increased prevalence in people of Scandinavian descent, Pima Indians, and Hispanic populations, whereas cholelithiasis is less common among individuals from sub-Saharan Africa and Asia. In the United States, white people have a higher prevalence than black people.

Anatomy

The gallbladder is a pear-shaped organ located in the right upper quadrant of the abdomen. It measures approximately 7 cm to 10 cm in length and 4 cm in width. Even though the organ is small, it is a common cause of abdominal pain due to gallstones, which often require surgical removal. Anatomically, the gallbladder is located anteriorly on the undersurface of liver segments IV and V. There are many variants of the anatomy of the biliary system making exact knowledge of these anatomic possibilities crucial when performing gallbladder and biliary surgery. The gallbladder has an inferior peritoneal surface and a superior liver

surface. It has no capsule however some authors describe an extension of the liver capsule (Glisson's capsule) covering the exposed surface of the body of the gallbladder.

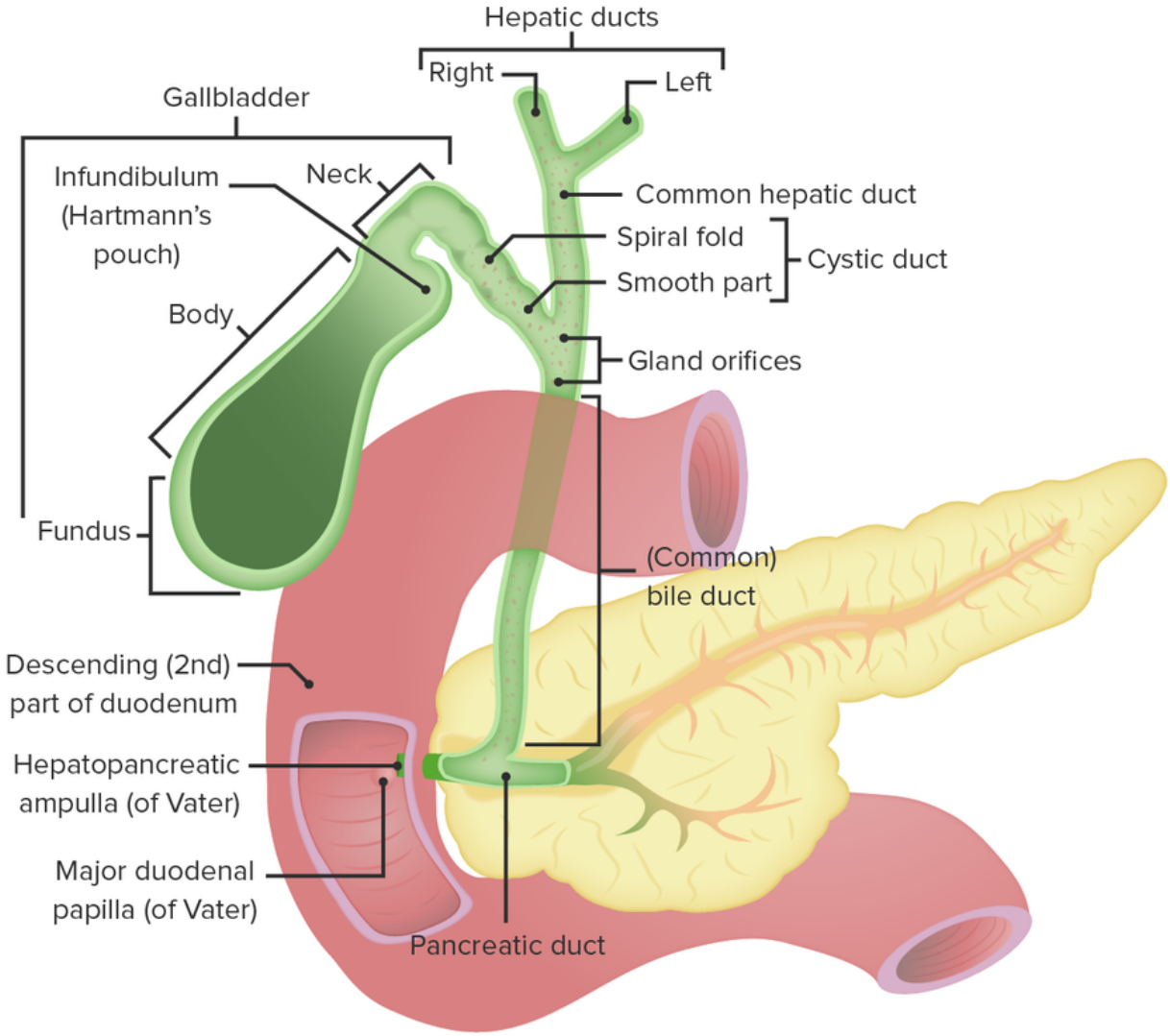

Fig. 1. Gallbladder and bile ducts anatomy.

Parts of the gallbladder include fundus, body, infundibulum and neck. The gallbladder fundus is wide, and as it continues into the main body, it narrows in diameter. The gallbladder body tapers into the infundibulum, which then connects to the neck and cystic duct. At the distal portion of the gallbladder and into the cystic duct are spiral valves of Heister. These valves may be responsible to aide gallbladder emptying with neural and hormonal stimulation. In most people, there is an inferior outpouching of the gallbladder infundibulum or neck called Hartmann's Pouch. Occasionally there is a paucity located at the top of the gallbladder fundus. This is called a Phrygian cap and has no pathologic or surgical significance.

The main *functions of the gallbladder* are to store and concentrate bile. At any one time, 30-60 millilitres of bile is stored within the gallbladder. Contraction of the gallbladder with the release of bile into the biliary tree and duodenum is caused by gastric distension and fatty food content.

Bile, a digestive fluid produced and secreted by the liver, is transported by a series of branching bile ducts known collectively as the biliary tree. At the cellular level, several narrow tubular channels called canaliculi collect the bile generated by each hepatocyte. These canaliculi drain into an intralobular bile duct which collects all the bile from each lobule, the functional unit of the liver. Intralobular ducts then drain into the interlobular ducts which are located between lobules. The interlobular ducts merge to form the two main bile ducts of the liver: the right hepatic duct (RHD) and the left hepatic duct (LHD). Extrahepatically, the RHD and LHD coalesce to form the common hepatic duct (CHD) which travels within the hepatoduodenal ligament until coming into contact with the cystic duct, the bile duct which connects to the gallbladder. The CHD and cystic duct merge to form the common bile duct (CBD). The hepatopancreatic ampulla, also called the hepatopancreatic duct or ampulla of Vater, is a spherical structure located at the site of the confluence of the common bile duct and pancreatic duct, marking the entry point of bile into the second portion of the duodenum. This is controlled by the smooth muscle fibers of the *sphincter of Oddi* which opens at the duodenal papilla, allowing bile to flow into the small intestine. Alternatively, bile can travel into the gallbladder for storage via the cystic duct.

Blood supply and lymphatics. The gallbladder receives most of its blood supply from the *cystic artery*. The cystic artery is a branch of the right hepatic artery which arises from the common hepatic artery. Anatomic variants of this vascular supply are also frequently encountered. The common bile duct receives blood from the proper hepatic, the right gastric, the gastroduodenal, and the posterior superior pancreaticoduodenal arteries. These small vessels must be preserved during surgery to ensure adequate perfusion of the cystic and common bile ducts. Disruption of these vessels will increase rates of duct ischemia and leaks. There is no formal cystic vein. *Venous drainage* is by direct emptying into the gallbladder bed of the liver by short venules from the gallbladder into the liver parenchyma. Larger venous sinuses of the liver can also be encountered during cholecystectomy, and these can be problematic when trying to control bleeding. Subserosal and submucosal *lymphatics* drain the gallbladder to the cystic lymph node of Lund or node of Calot located in the Calot triangle. Cancer of the gallbladder often bypasses this lymph node and spreads directly to nodes located in the porta hepatis.

Nerves. The gallbladder and cystic duct receive innervation from the following three nerves: 1) the right phrenic nerve conveys sensory information, 2) the hepatic branch of the right vagus nerve provides parasympathetic innervation, and 3) the celiac plexus provides sympathetic information. Gastric surgeries such as resections or bariatric procedures, or vagotomies done for peptic ulcer disease will de-innervate the gallbladder and cause dysfunctioning of the organ. This will, in turn, lead to the formation of gallstones and cholecystitis. Many times when such surgeries are performed, prophylactic cholecystectomies are done simultaneously to prevent cholecystitis.

Etiology

Gallstones (cholelithiasis). Gallstone formation occurs because certain substances in the bile are present in concentrations that approach the limits of their solubility (fig. 2).

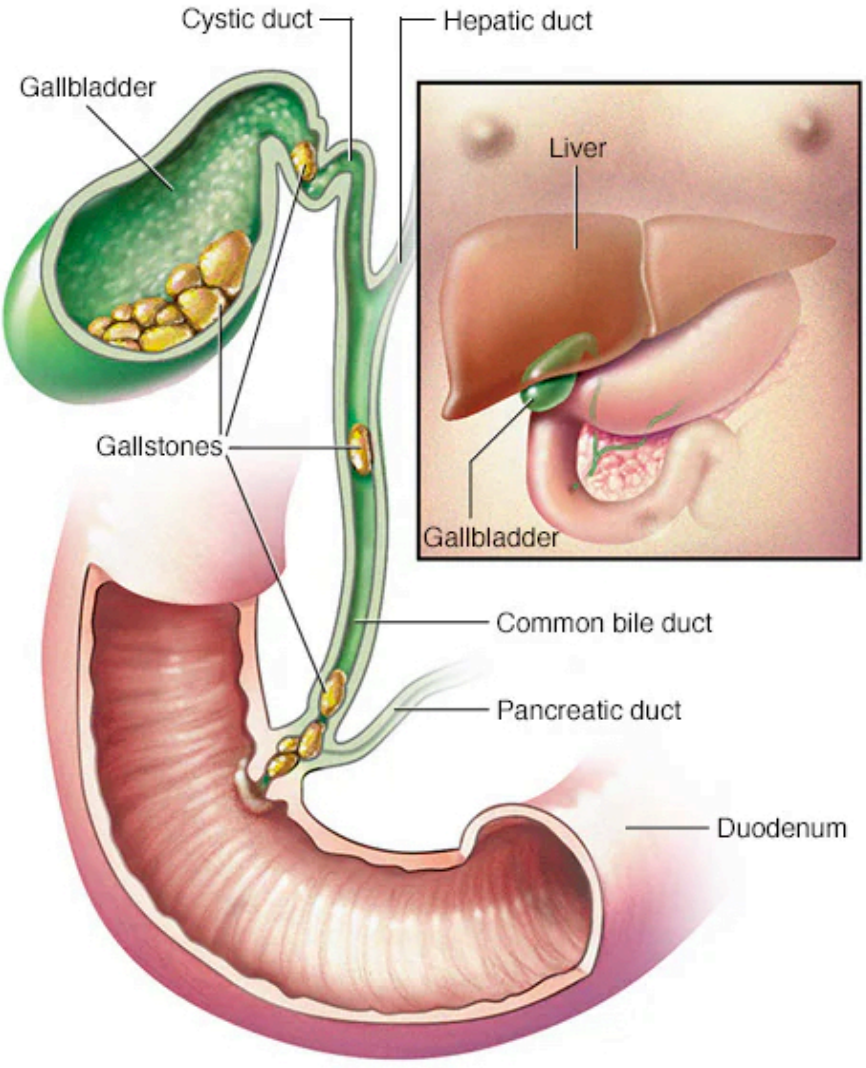

Fig. 2. Gallstones in biliary system.

When bile is concentrated in the gallbladder, it can become supersaturated with these substances, which then precipitate from the solution as microscopic crystals. The crystals are trapped in the gallbladder mucus, producing gallbladder sludge. Over time, the crystals grow, aggregate, and fuse to form macroscopic stones. Occlusion of the ducts by sludge and/or stones produces the complications of gallstone disease.The two main substances involved in gallstone formation are cholesterol and calcium bilirubinate.

Cholesterol gallstones, black pigment gallstones, and brown pigment gallstones have different pathogeneses and different risk factors (fig. 3).

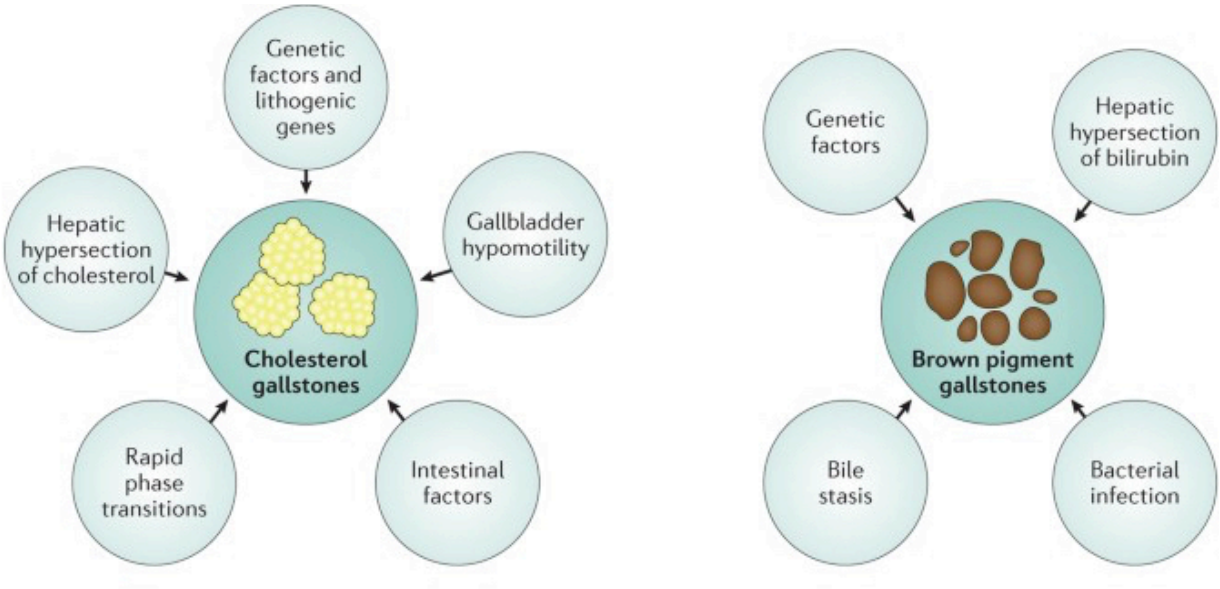

Fig. 3. Gallstones types.

Cholesterol gallstones are associated with female sex, European or Native American ancestry, and increasing age. Other risk factors include the following:

- Obesity.
- Pregnancy.
- Gallbladder stasis.
- Drugs.
- Heredity.

The metabolic syndrome of truncal obesity, insulin resistance, type II diabetes mellitus, hypertension, and hyperlipidemia is associated with increased hepatic cholesterol secretion and is a major risk factor for the development of cholesterol gallstones.

Cholesterol gallstones are more common in women who have experienced multiple pregnancies. A major contributing factor is thought to be the high progesterone levels of pregnancy. Progesterone reduces gallbladder contractility, leading to prolonged retention and greater concentration of bile in the gallbladder.

Other causes of gallbladder stasis associated with increased risk of gallstones include high spinal cord injuries, prolonged fasting with total parenteral nutrition, and rapid weight loss associated with severe caloric and fat restriction (eg, diet, gastric bypass surgery).

A number of medications are associated with the formation of cholesterol gallstones. Estrogens administered for contraception or for the treatment of prostate cancer increase the risk of cholesterol gallstones by increasing biliary cholesterol secretion. Clofibrate and other fibrate hypolipidemic drugs increase hepatic elimination of cholesterol via biliary secretion and appear to increase the risk of cholesterol gallstones. Somatostatin analogues appear to predispose to gallstones by decreasing gallbladder emptying.

About 25% of the predisposition to cholesterol gallstones appears to be hereditary, as judged from studies of identical and fraternal twins. At least a dozen genes may contribute to the risk. A rare syndrome of low phospholipid–associated cholelithiasis occurs in individuals with a hereditary deficiency of the biliary transport protein required for lecithin secretion.

Pigment stones. Black pigment gallstones occur disproportionately in individuals with high heme turnover. Disorders of hemolysis associated with pigment gallstones include sickle cell anemia, hereditary spherocytosis, and beta-thalassemia. In cirrhosis, portal hypertension leads to splenomegaly. This, in turn, causes red cell sequestration, leading to a modest increase in hemoglobin turnover. About half of all cirrhotic patients have pigment gallstones.

Prerequisites for the formation of brown pigment gallstones include intraductal stasis and chronic colonization of bile with bacteria. In the United States, this combination is most often encountered in patients with postsurgical biliary strictures or choledochal cysts.

In rice-growing regions of East Asia, infestation with biliary flukes may produce biliary strictures and predispose to formation of brown pigment stones throughout intrahepatic and extrahepatic bile ducts. This condition, termed hepatolithiasis, causes recurrent cholangitis and predisposes to biliary cirrhosis and cholangiocarcinoma.

Mixed stones constitute about 80% of gallstones. Cholesterol gallstones may become colonized with bacteria and can elicit gallbladder mucosal inflammation. Lytic enzymes from the bacteria and leukocytes hydrolyze bilirubin conjugates and fatty acids. As a result, over time, cholesterol stones may accumulate a substantial proportion of calcium bilirubinate and other calcium salts, producing mixed gallstones. Large stones may develop a surface rim of calcium resembling an eggshell that may be visible on plain X-ray films.

Acute cholecystitis.

Risk factors for *calculous cholecystitis (with gallstones)* mirror those for cholelithiasis and include the following:

- Increasing age.
- Female sex.
- Pregnancy.
- Certain ethnic groups (eg, Native American Indians).
- Obesity or rapid weight loss.
- Drugs (especially hormonal therapy in women).

Acalculous cholecystitis (without gallstones) is related to conditions associated with biliary stasis, and include the following:

- Critical illness.
- Major surgery or severe trauma/burns.
- Sepsis.
- Long-term total parenteral nutrition (TPN).
- Prolonged fasting.

Other causes of acalculous cholecystitis include the following:

- Cardiac events, including myocardial infarction.
- Sickle cell disease.
- *Salmonella* infections.
- Diabetes mellitus.
- Patients with AIDS who have cytomegalovirus, cryptosporidiosis, or microsporidiosis.

Patients who are immunocompromised are at an increased risk of developing cholecystitis from a number of different infectious sources. Idiopathic cases also exist.

The phrase "fair, female, fat, and fertile" summarizes the major risk factors for development of gallstones. Although gallstones and cholecystitis are more common in women, men with gallstones are more likely to develop cholecystitis (and more severe cholecystitis) than women with gallstones.

Children are more likely than adults to have acalculous gallstones. If stones exist, they are more likely pigmented stones from hemolytic diseases (eg, sickle cell diseases, spherocytosis, glucose-6-phosphate dehydrogenase [G-6-PD] deficiency) or chronic diseases (eg, total parenteral nutrition, burns, trauma).

Pathophysiology

Ninety percent of cases of cholecystitis involve stones in the gallbladder (ie, calculous cholecystitis), with the other 10% of cases representing acalculous cholecystitis.

Acute calculous cholecystitis is caused by an obstruction of the cystic duct, leading to distention of the gallbladder. As the gallbladder becomes distended, blood flow and lymphatic drainage are compromised, leading to mucosal ischemia and necrosis.

Although the exact mechanism of acalculous cholecystitis is unclear, several theories exist. Injury may be the result of retained concentrated bile, an extremely noxious substance. In the presence of prolonged fasting, the gallbladder does not receive a cholecystokinin (CCK) stimulus to empty; thus, the concentrated bile remains stagnant in the lumen.

A study by Cullen et al demonstrated the ability of endotoxins to cause necrosis, hemorrhage, areas of fibrin deposition, and extensive mucosal loss, consistent with an acute ischemic insult. Endotoxins also abolish the contractile response to CCK, leading to gallbladder stasis.

Classification

Tokyo guidelines for grading the severity of acute cholecystitis (2018)

Severity	Criteria
Grade 1 – Mild	• Acute cholecystitis not meeting other severity criteria • Mild gallbladder inflammation, no organ dysfunction
Grade 2 – Moderate	Acute cholecystitis with any of the following but no organ/system dysfunction: • Elevated whide blood cell count (>18,000/mL) • Palpable tender mass at right upper quadrant • Duration of complaints exceeding 72 h • Marked local inflammation (such as biliary peritonitis, pericholecystic abscess, hepatic abscess, gangrenous cholecystitis, emphysematous cholecystitis)
Grade 3 – Severe	Acute cholecystitis with dysfunction of any one of the following organs/systems: • Cardiovascular dysfunction (hypotension requiring treatment with dopamine > 5 mg/kg/min of body weight or any dose of norepinephrine)

	• Neurological dysfunction (decreased levels of consciousness) • Respiratory dysfunction (ratio of $PaO_2/FiO_2 < 300$) • Renal dysfunction (oliguria, creatine > 2.0 mg/dL) • Hepatic dysfunction (PT-INR > 1.5)

I. Chronic cholecystitis (calculous/acalculous).

1. Primary chronic cholecystitis (which has appeared without onset of the acute attack).

2. Chronic recurrent uncomplicated cholecystitis.

3. Chronic recurrent cholecystitis complicated by:

- impaired patency of the bile ducts;
- septic cholangitis;
- obliterating cholangitis;
- pancreatitis;
- hepatitis and biliary cirrhosis of the liver;
- gallbladder sclerosis;
- bilio-digestive fistula.

II. Acute cholecystitis (calculous/acalculous).

1. Simple (catarrhal, infiltrative, ulcerative).

2. Gangrenous.

3. Perforated.

4. Complicated acute cholecystitis:

- biliary peritonitis;
- paracystic infiltrate;
- paracystic abscess;
- obstructive jaundice;
- liver abscess;
- septic cholangitis;
- acute pancreatitis.

History

The most common presenting symptom of acute cholecystitis is upper abdominal pain. In some patients, the pain may radiate to the right shoulder or scapula. Frequently, the pain begins in the epigastric region and then localizes to the right upper quadrant (RUQ). Although the pain may initially be described as

colicky, it is not a true colic and becomes constant in virtually all cases. Nausea and vomiting are generally present, and patients may report fever.

Most patients with acute cholecystitis describe a history of biliary pain. Some patients may have already documented gallstones. Acalculous biliary colic also occurs, most commonly in young to middle-aged females. The presentation is almost identical to calculous biliary colic with the exception of reference range laboratory values and no findings of cholelithiasis on ultrasound. **Cholecystitis is differentiated from biliary colic by the persistence of constant severe pain for more than 6 hours.**

Patients with acalculous cholecystitis may present similarly to patients with calculous cholecystitis, but acalculous cholecystitis frequently occurs suddenly in severely ill patients without a prior history of biliary colic. Often, patients with acalculous cholecystitis may present with fever and sepsis alone, without a history or physical examination findings consistent with acute cholecystitis.

Symptoms

Biliary colic. Typical gallbladder colic generally includes 1-5 hours of constant pain, most commonly in the epigastrium or right upper quadrant. Peritoneal irritation by direct contact with the gallbladder localizes the pain to the right upper quadrant. The pain is severe, dull or boring, constant (not colicky), and may radiate to the right scapular region or back. Patients tend to move around to seek relief from the pain. The onset of pain develops hours after a meal, occurs frequently at night, and awakens the patient from sleep. Associated symptoms include nausea, vomiting, pleuritic pain, and fever.

Cholecystitis. Persistence of biliary obstruction leads to cholecystitis and persistent right upper quadrant pain. The character of the pain is similar to gallbladder colic, except that it is prolonged and lasts hours (usually >6 h) or days. Nausea, vomiting, and low-grade fever are associated more commonly with cholecystitis. Up to 70% of patients with cholecystitis report having experienced similar episodes in the past that spontaneously resolved.

Cholelithiasis. Most gallstones (60-80%) are asymptomatic at a given time. Smaller stones are more likely to be symptomatic than larger ones. However, almost all patients develop symptoms before complications, such as steady pain in the right hypochondrium or epigastrium, nausea, vomiting, and fever. An acute attack often is precipitated by a large or fatty meal.

Indigestion, belching, bloating, and fatty food intolerance are thought to be typical symptoms of gallstones; however, these symptoms are just as common in people without gallstones and frequently are not cured by cholecystectomy.

Physical examination

The physical examination may reveal **fever, tachycardia, and signs of peritoneal irritation** (eg, tenderness in the right upper quadrant (RUQ) or the epigastric region), often with guarding or rebound. **The Murphy sign**, described as tenderness and an inspiratory pause elicited during palpation of the RUQ as the patient takes a deep breath, is widely used in the diagnosis of acute cholecystitis. Some debate exists over the sensitivity of the Murphy sign, with some sources citing a very low sensitivity (20%) and others indicating a sensitivity range of 58-71% (systematic review) and 48-97% (evidence-based review). The sonographic Murphy sign, however, remains an important sign of cholecystitis.

A **palpable gallbladder** or **fullness of the RUQ** is present in 30-40% of cases. **Jaundice** may be noted in approximately 15% of patients.

The absence of physical findings does not rule out the diagnosis of acute cholecystitis. Many patients present with diffuse epigastric pain without localization to the RUQ. Patients with chronic cholecystitis frequently do not have a palpable RUQ mass because of fibrosis leading to a contracted gallbladder.

Elderly patients and patients with diabetes frequently have atypical presentations, including the absence of fever and localized tenderness with only vague symptoms.

Vital signs and appearance. Vital signs parallel the degree of illness. Patients with cholangitis are more likely to have fever, tachycardia, and/or hypotension. Patients with gallbladder colic have relatively normal vital signs. Fever may be absent, especially in elderly patients.

Patients with cholecystitis are usually more ill appearing than simple biliary colic patients, and they usually lie still on the examination table, as any movement may aggravate any peritoneal signs. In elderly patients and those with diabetes, occult cholecystitis or cholangitis may be the source of fever, sepsis, or mental status changes.

Jaundice is unusual in the early stages of acute cholecystitis and may be found in fewer than 20% of patients. Frank jaundice should raise suspicion of concomitant choledocholithiasis or Mirizzi syndrome (obstruction of the bile duct as a result of external compression of a stone in the gallbladder or cystic duct).

Abdominal assessment. As in all patients with abdominal pain, perform a complete physical examination, including rectal and pelvic examinations in women.

Abdominal examination in gallbladder colic and cholecystitis is remarkable for epigastric or right upper quadrant tenderness and abdominal guarding. The Murphy sign (an inspiratory pause on palpation of the right upper quadrant) on

abdominal examination is widely used in the diagnosis of acute cholecystitis. In elderly patients, sensitivity of the Murphy sign may be decreased.

When observed, peritoneal signs should be taken seriously. Most uncomplicated cholecystitis does not have peritoneal signs; thus, search for complications (eg, perforation, gangrene) or other sources of pain.

Local symptoms.

1. *Murphy's sign* is described as tenderness and an inspiratory pause elicited during palpation of the RUQ as the patient takes a deep breath.
2. *Mussei-Georgievsky's sign* – tenderness at the point of the phrenic nerve, between the heads of the sterno-cleidomastoid muscle.
3. *Ortner's sign* – increased pain during tapping of the right costal arch.
4. *Boas's sign* – hyperesthesia or pain felt by the patient to light touch in the right lower scapular region or the right upper quadrant of the abdomen (approimately the level of 8-10 intercostal spaces).
5. Upper abdominal guarding and tenderness.
6. A mass consisting of inflamed gallbladder, omentum, inflammatory exudate can be felt sometimes in the RUQ of abdomen (palpable gallbladder).

Diagnosis

The workup for cholecystitis includes history and physical examination, laboratory tests (though these are not always reliable), plain X-ray of the abdomen, ultrasonography (US), computed tomography (CT), magnetic resonance imaging (MRI), and endoscopy.

Laboratory tests. Although the laboratory criteria are not reliable in identifying all patients with cholecystitis, the following findings may be useful in arriving at the diagnosis:

- *Leukocytosis* with a left shift may be observed in acute cholecystitis.
- *Alanine aminotransferase (ALT)* and *aspartate aminotransferase (AST)* levels are usually used to evaluate for the presence of hepatitis and may be elevated in acute cholecystitis or with common bile duct obstruction.
- *Bilirubin* and *alkaline phosphatase (ALP)* assays are used to evaluate for the presence of common bile duct obstruction caused by the inflammatory edema of acute cholecystitis.

- *Amylase/lipase* assays are usually used to evaluate for the presence of acute pancreatitis and may also be elevated mildly in acute cholecystitis.
- An elevated ALP level is observed in 25% of patients with acute cholecystitis.
- *Urinalysis* is used to rule out pyelonephritis and renal calculi.
- All females of childbearing age should undergo *pregnancy testing*.

Abdominal radiography (X-ray). The advantages of abdominal radiographs include their readily availability and low cost. However, abdominal radiographs have low sensitivity and specificity in evaluating biliary system pathology, but they can be helpful in excluding other abdominal pathology such as renal colic, bowel obstruction, perforation. Between 10% and 30% of stones have a ring of calcium and, therefore, are radiopaque (fig. 4). A porcelain gallbladder also may be observed on plain films (the condition in which the inner gallbladder wall is encrusted with calcium).

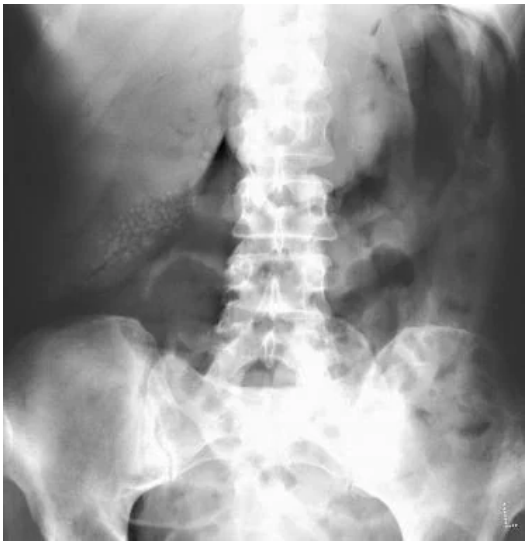

Fig. 4. Plain abdominal radiograph. *There are multiple calculi distributed in a pyriform shape in the right upper quadrant; these are suggestive of gallstones.*

Emphysematous cholecystitis, cholangitis, cholecystic-enteric fistula, or postendoscopic manipulation may show air in the biliary tree. Air in the gallbladder wall indicates emphysematous cholecystitis due to gas-forming organisms such as clostridial species and Escherichia coli.

Other findings seen on noncontrast radiography may include renal calculi, intestinal obstruction, or pneumonia.

Ultrasonography (US) is the most common test used in the emergency department for the diagnosis of biliary colic and acute cholecystitis. This imaging modality may be diagnostic for biliary disease, help exclude biliary disease, or may

reveal alternative causes of the patient's symptoms. Ultrasonography is 90-95% sensitive for cholecystitis and has a 78-80% specificity (fig. 5).

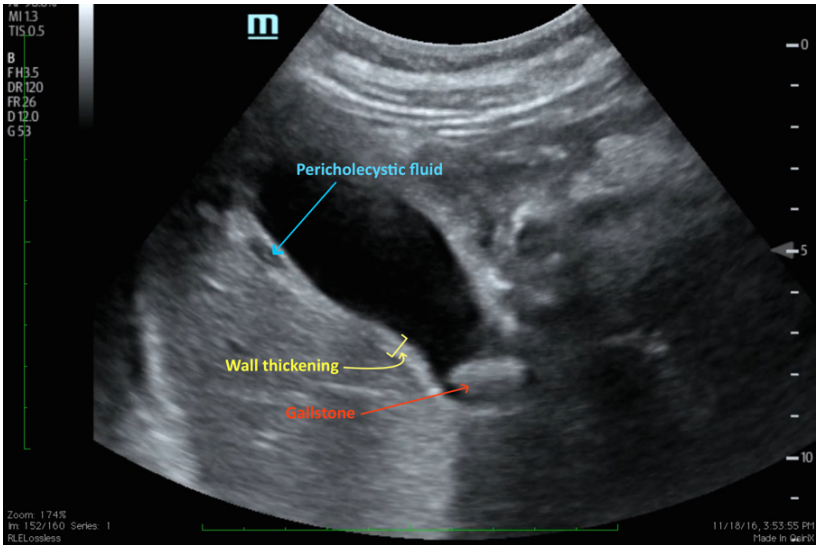

Fig. 5. Ultrasonography. *Acute calculous cholecystitis.*

Findings include gallstones or sludge and one or more of the following conditions:

- Gallbladder wall thickening (>2-4 mm): False-positive wall thickening found in hypoalbuminemia, ascites, congestive heart failure, and carcinoma.
- Gallbladder distention (diameter >4 cm, length >10 cm).
- Pericholecystic fluid from perforation or exudate: May be seen as a hypoechoic or anechoic region seen along the anterior surface of the gallbladder within the hepatic parenchyma.
- Air in the gallbladder wall (indicating gangrenous cholecystitis).
- Ultrasonographic Murphy sign: Pain elicited when the probe is pushed directly on the gallbladder (not related to breathing).

Ultrasonographic Murphy sign and cholelithiasis. Some ultrasonographers recommend the diagnosis of cholecystitis if both a ultrasonographic Murphy sign and gallstones (without evidence of other pathology) are present. The combination of the Murphy sign and cholelithiasis has a high positive predictive value.

Findings with or without cholelithiasis. Additional findings in the presence or absence of gallstones may include a dilated common bile duct or dilated intrahepatic ducts of the biliary tree, which indicate common bile duct stones. In the absence of stones, a solitary stone may be lodged in the common bile duct, a location that is difficult to visualize ultrasonographically.

Advantages and disadvantages of ultrasonography. Advantages of ultrasonography include imaging of other structures (eg, aorta, pancreas, liver), identification of complications (eg, perforation, empyema, abscess), ability to be

rapidly performed at the bedside and in the emergency department, and absence of radiation (important in pregnancy).

Disadvantages of ultrasonography include the fact this imaging modality is operator and patient dependent, it is unable to image the cystic duct, and it has a decreased sensitivity for common bile duct stones. In addition, in the setting of concomitant acute pancreatitis, ultrasonographic findings alone are not adequate to accurately identify acute cholecystitis.

Computed tomography (CT) scanning is not the test of choice and is recommended only for the evaluation of abdominal pain if the diagnosis is uncertain. CT scans can demonstrate gallbladder wall edema, pericholecystic stranding and fluid, and high-attenuation bile (fig. 6). A helical CT scan with fine cuts through the biliary tract has not been well studied but may be useful.

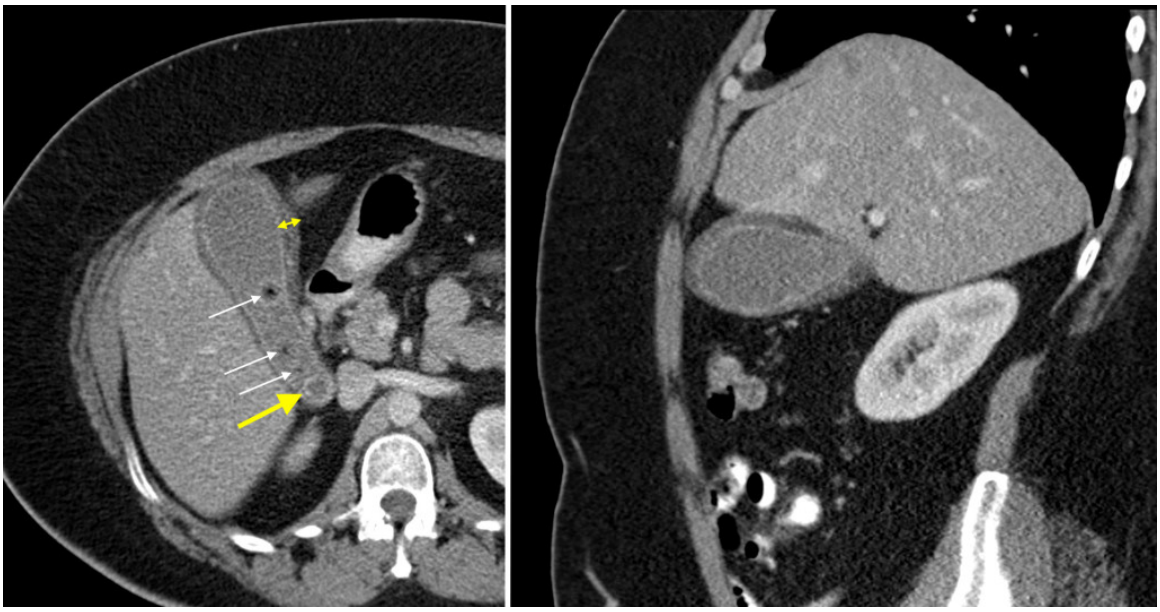

Fig. 6. CT scan of abdomen. *Acute calculous cholecystitis. Thickened, edematous gallbladder wall (indicated by the double-headed arrow). There are multiple gallbladder calculi (white arrows), one of which looks like it's stuck in the gallbladder neck (large yellow arrow). The gallbladder wall is also well seen on the sagittal image on the right.*

Advantages and disadvantages of CT scanning. CT scanning not only provides better information of the surrounding structures than ultrasonography and it is also noninvasive. For complications of cholecystitis and cholangitis, gallbladder perforation, pericholecystic fluid, and intrahepatic ductal dilation, CT scanning may be adequate.

However, CT scanning misses 20% of gallstones, because the stones may be of the same radiographic density as bile. In addition, CT scanning is also more expensive; takes longer because the patient usually has to drink oral contrast; and also, given the radiation dose, may not be ideal in the pregnant patient.

Magnetic resonance imaging (MRI). In cases of acute cholecystitis, MRI may depict the same pathologic features as CT scanning does. Increased blood flow and capillary leakage resulting from inflammatory change are best exhibited by the use of gadolinium enhancement, particularly with fat-suppression techniques.

Endoscopic retrograde cholangiopancreatography (ERCP) provides both endoscopic and radiographic visualization of the biliary tract. This modality can be diagnostic and therapeutic by direct removal of common bile duct stones.

Ultrasonography is 50-75% sensitive for choledocholithiasis; computed tomography and hepatic 2,6-dimethyliminodiacetic acid (HIDA) scanning are not better. Therefore, when a dilated common bile duct is found or elevated liver function test results are present, suspicion should remain high for common bile duct stones, and an ERCP should be considered.

Debate exists as to when an ERCP should be performed. In general, because cholecystitis is caused by obstruction of the ducts, the risk of common bile duct stones is approximately 10%. Given its potential for complications, ERCP should be used when there is a high potential for intervention and it should not be used solely as a diagnostic modality.

Major complications of ERCP include pancreatitis and cholangitis.

Differential diagnosis

Delay in making the diagnosis of acute cholecystitis results in a higher incidence of morbidity and mortality. On rare occasions, acute cholecystitis may coexist with or be misdiagnosed as a cardiovascular disorder.

Pregnant patients. Right upper quadrant pain in pregnancy can be related to a number of different diagnoses, including preeclampsia, appendicitis, and cholelithiasis. Pregnant patients must have a thorough examination because complications can arise quickly and can be life threatening to both the mother and the unborn child. Diseases that must be excluded are the following:

- Abdominal Aortic Aneurysm.
- Acute Gastritis.
- Acute Mesenteric Ischemia.
- Acute Pyelonephritis.
- Appendicitis.
- Biliary Colic.
- Biliary Disease.
- Cholangiocarcinoma.

- Cholangitis.
- Gallbladder Cancer.
- Gallbladder Mucocele.
- Gallbladder Tumors.
- Gallstones (Cholelithiasis).
- Liver Abscess.
- Peptic Ulcer Disease.

Treatment

Conservative treatment. In acute cholecystitis, the initial treatment includes:

- Bowel rest.
- Intravenous hydration.
- Correction of electrolyte abnormalities.
- Analgesia.
- Intravenous antibiotics.

For mild cases of acute cholecystitis, antibiotic therapy with a single broad-spectrum antibiotic is adequate.

The *Sanford Guide* recommendations include piperacillin/tazobactam ampicillin/sulbactam or meropenem. In severe life-threatening cases, the *Sanford Guide* recommends imipenem/cilastatin.

Alternative regimens include a third-generation cephalosporin plus metronidazole.

Bacteria that are commonly associated with cholecystitis include *Escherichia coli and Bacteroides fragilis,* as well as *Klebsiella, Enterococcus,* and *Pseudomonas* species.

Emesis (vomiting) can be treated with *antiemetics* and *nasogastric suction*. Patients with cholecystitis frequently experience nausea and vomiting. Antiemetics can help make the patient more comfortable and can prevent fluid and electrolyte abnormalities.

Anti-inflammatory medications such as ketorolac or indomethacin have been reported to be effective in relieving pain from gallbladder distention. Because the release of prostaglandins results in gallbladder distention, inhibition of these prostaglandins may help alleviate some of the symptoms. However, these agents may not be as effective when biliary colic is complicated by infection.

Antispasmodics: papaverini; atropine to relieve spasm of sphincter of Oddi.

Because of the rapid progression of acute acalculous cholecystitis to gangrene and perforation, early recognition and intervention are required.

Supportive medical care should include restoration of hemodynamic stability and antibiotic coverage for gram-negative enteric flora and anaerobes if biliary tract infection is suspected.

Surgical treatment. In approximately 30% of patients with uncomplicated cholecystitis, medical therapy is not sufficient and these patients usually need cholecystectomy within 24-72 hours. Cholecystectomy may be performed after the first 48 hours or after the inflammation has subsided.

Cholecystectomy – surgical removal of the gallbladder. Indications for cholecystectomy, either open or laparoscopic, are usually related to symptomatic gallstones, acute cholecystitis or complications related to gallstones.

Laparoscopic cholecystectomy is the standard of care for the surgical treatment of acute cholecystitis. Studies have indicated that early laparoscopic cholecystectomy resulted in shorter total hospital stays with no significant difference in the conversion rates or complications.

The procedure of choice for most of these indications has shifted from an open approach to a laparoscopic approach. However, some situations still require a traditional open cholecystectomy. Depending on the clinical situation, the procedure can either begin as an open operation or be converted to an open procedure from a laparoscopic one.

Some indications for forgoing laparoscopy and proceeding with an open operation are as follows:

- Suspected or confirmed gallbladder cancer.
- Type II Mirizzi syndrome (cholecystobiliary fistula).
- Gallstone ileus.
- Severe cardiopulmonary disease.

Open cholecystectomy should also be considered in patients with cirrhosis and bleeding disorders, as well as pregnant patients. In patients with advanced cirrhosis and bleeding disorders, potential bleeding may be difficult to control laparoscopically, and an open approach (or a percutaneous cholecystostomy tube) may be more prudent. Also, patients with portal hypertension often have a recannulized umbilical vein, and placing ports in these patients may cause significant hemorrhage.

Open cholecystectomy is also indicated in patients who have trauma to the right upper quadrant and in the rare cases of penetrating trauma to the gallbladder.

Urgent surgical treatment is performed during first 1-2 hours, when any complications occur: a) bile peritonitis; b) purulent cholangitis; c) gangrenous cholecystitis.

Emergent surgical treatment – in cases of ineffective conservative treatment for 48 hours.

Delayed surgical treatment – through 8-10 days after reduction of acute inflammatory process, after detailed workup.

Planned (elective) surgical treatment – 1-3 months after reduction of acute inflammation.

Open cholecystectomy (fig. 7).

Most open cholecystectomies are performed with general anesthesia. Less commonly, the procedure is done with regional (epidural or spinal) anesthesia; in rare instances, it is done with local anesthesia.

Incision. A right subcostal (Kocher) incision is the most often used incision and allows excellent exposure of the gallbladder bed and cystic duct. Alternatively, an upper midline incision can be used when other concomitant operations are planned and a wider exposure is needed. Typically, the midline incision remains above the umbilicus, still allowing adequate exposure of the gallbladder with appropriate retraction. A right paramedian incision is another option but is not often used at present.

Start the subcostal incision approximately 1 cm to the left of the linea alba, about two fingerbreadths below the costal margin (~4 cm). Extend the incision laterally for 10-15 cm, depending on the patient's body habitus.

Incise the anterior rectus sheath along the length of the incision, and divide the rectus and lateral muscles (external oblique, internal oblique, and transversus abdominis) with the electrocautery. Then, incise the posterior rectus sheath and peritoneum and enter the abdomen.

Dissection of the Calot triangle. After opening the abdominal cavity and insertion of two liver retractors, dissection begins below the gallbladder at the Calot triangle. The common bile duct and the cystic duct are dissected toward the gallbladder. For this purpose, the overlying superficial peritoneal reflection is incised, allowing the structures to be clearly displayed (fig. 7-1).

Exposure of the cystic duct. After tile peritoneal reflection is opened, it is recommended to grasp the gallbladder with sponge-holding forceps and draw it ventrally. This puts the cystic duct on stretch. Small accompanying veins (commonly ventral to the cystic duct) are divided between ligatures. The cystic duct is only definitely identified when the common bile duct has been clearly defined above the confluence with the cystic duct. This includes the definite identification of the difference in caliber, its continuation in a cranial direction, and the clearly visible confluence with tile cystic duct. Only then may an Overholt clamp be passed beneath the cystic duct (fig. 7-2).

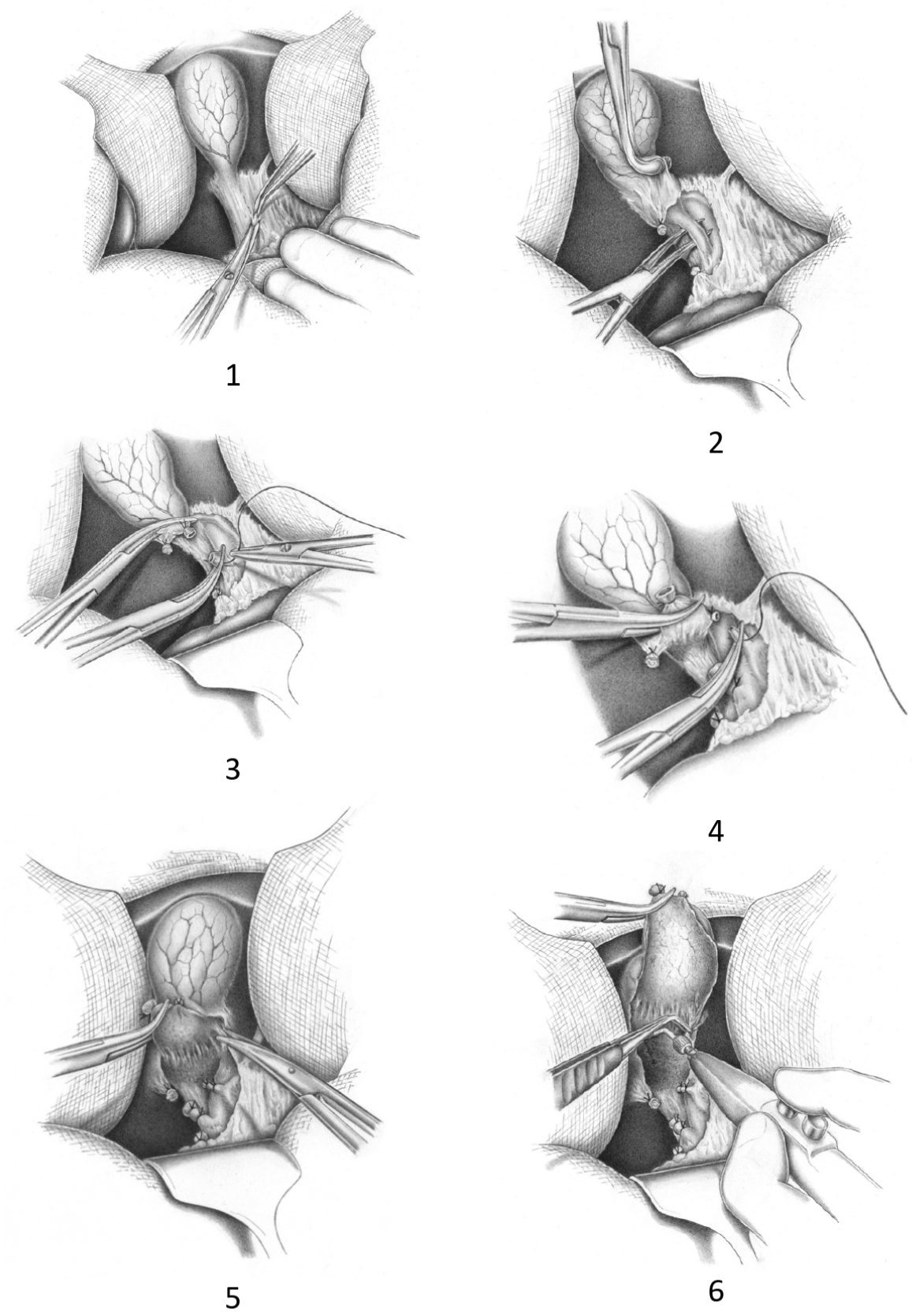

Fig. 7. Open cholecystectomy.

Division of the cystic duct. After definite identification of the cystic duct, it should be divided close to the common bile duct between Overholt clamps. The distal part is secured with a suture ligature; the proximal part may be managed with a simple ligature. If the anatomy is unclear or if there is a hint of a possible gallstone in the common bile duct, then operative cholangiography is performed before division to demonstrate radiographically the common bile duct with its drainage into the duodenum. This also applies to all cases where there is an unclear finding or suspicion of stones in the common bile duct (fig. 7-3).

Division of the cystic artery. The cystic artery usually lies cephalad to the cystic duct, although there are considerable variations, especially common courses with the right hepatic artery and atypical origins from the common hepatic artery. It is important to identify the branch that runs to the gallbladder and to ligate it as close to the gallbladder as possible. This is done between Overholt clamps, while the vessel is secured proximally with a suture ligature (fig. 7-4).

Retrograde dissection of the gallbladder. After the cystic duct and the cystic artery have been divided, the next step is the retrograde separation of the gallbladder from the liver bed. This is accomplished with careful traction on the gallbladder neck in a cranial direction. The fibrous connections with the liver are divided with scissors while hemostasis is achieved with diathermy. Separation from the gallbladder bed can result in considerable bleeding, especially in the presence of severe inflammatory changes, which will require extensive measures to secure hemostasis within the liver parenchyma (suture, coagulation, etc.) (fig. 7-5).

Hemostasis of the gallbladder bed. Separation of the gallbladder from the gallbladder bed is done piecemeal, using scissors and diathermy. Time should be taken to leave behind gallbladder bed that is definitely bloodless. This is not always possible in the presence of severe inflammatory changes, and the surgeon may revert to using local compression and the application of hemostatic material (sutures, tamponade with gauze swabs, etc.) (fig. 7-6).

Drainage of the gallbladder bed. After achieving hemostisis and renewed inspection of the stumps of the cystic duct and cystic artery, a subhepatic drain may be considered, should it seem necessary. The advantage of drains has only been proven for complicated cases.

Antegrade separation of the gallbladder. In cases of a dense fibrotic mass in the region of the Calot triangle, better visualization of the anatomy may be gained by performing an antegrade dissection of the gallbladder (i.e., to identify the cystic duct and artery from an antegrade direction). For this purpose, the gallbladder is dissected off the liver bed, beginning at the fundus, and separated piecemeal in a ventral direction until the Calot triangle is fully exposed. Here, it is important to

definitely identify the hepatic duct and the right hepatic artery to avoid injury to these structures while dissecting and separating the gallbladder.

Laparoscopic cholecystectomy (fig. 8).

Laparoscopic cholecystectomy has rapidly become the procedure of choice for routine gallbladder removal and is currently the most commonly performed major abdominal procedure in Western countries.

Advantages: hospital stay is 2-3 days; recovery is very fast; pain is minimal; mobilization of the patient is much better and easier; it gives an acceptable and better cosmetic result; complications like adhesions and incisional hernias are rare.

Contraindications include very badly contracted, fibrosed gallbladder, stones in common bile duct (choledocholithiasis), abdominal adhesions, suspected gallbladder cancer, signs of gallbladder perforation, such as abscess, peritonitis, or fistula, end-stage liver disease with portal hypertension and severe coagulopathy.

Trocar positions. A total of four trocars are required for laparoscopic cholecystectomy, of which the first is inserted in a supraumbilical position and three further ones along the course of a right subcostal incision (superior paramedian, right lateral subhepatic, and on the right over the gallbladder, or alternatively, on the right at the level of the umbilicus in a paramedian position). After a semicircular incision to the right of, and superior to, the umbilicus, the skin incision is elevated ventrally with two towel clips to enable insertion of the Verres needle. The correct position of the Verres needle is verified by aspiration, saline instillation, and the "drop test". Once the needle is in the correct position, a pneumoperitoneum is created. After complete pneumoperitoneum, the optical system can be inserted via the trocar. The operation begins with the inspection of the abdominal cavity for any adhesions or other disorders. The three other trocars are placed under direct laparoscopic control in this order: superoparamedian right (size 10 mm), pararectal below the right subcostal margin (size 10 mm; alternatively at the level of the umbilicus), and right lateral subcostal (size 5 mm). The assistant inserts a grasping forceps via the infrahepatic size-5 trocar to grasp the gallbladder and deliver it cranially.

Grasping and delivering the gallbladder. After grasping the gallbladder at the fundus with a grasping forceps, the gallbladder and liver are drawn cranially. The next step is the definite identification of the Calot triangle where the subsequent dissection is performed.

Opening the Calot triangle. Traction on the gallbladder will allow it to be delivered cranially. The surgeon now grasps the neck of the gallbladder with the grasping forceps in the left hand and retracts it cranially. This puts the peritoneal reflection of the Calot triangle on stretch to allow it to be incised (fig. 8-1).

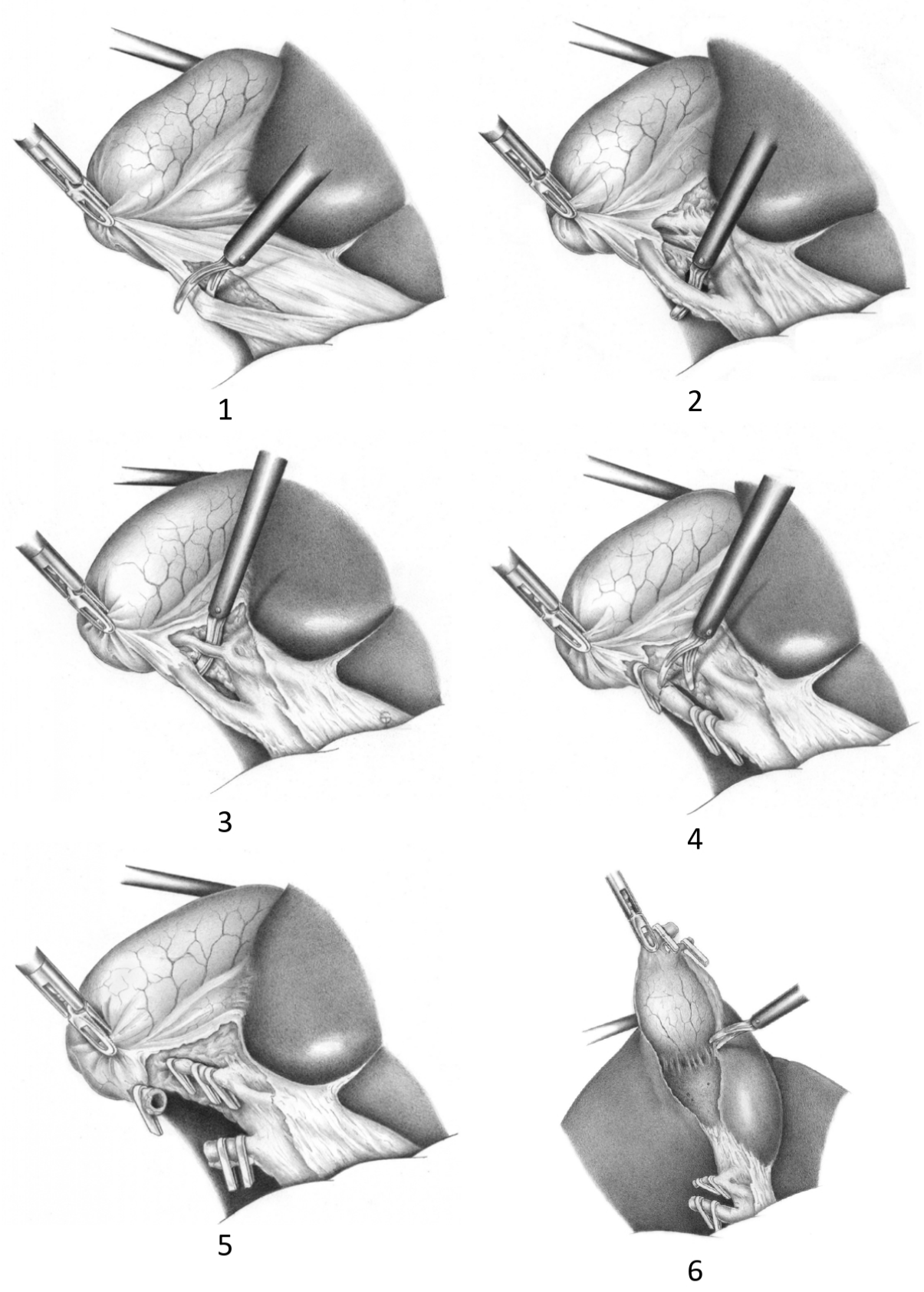

Fig. 8. Laparoscopic cholecystectomy.

Dissecting of the Calor triangle. The Calot triangle is spread out cranially under traction and may now be bluntly dissected with a gauze pledget or scissors. Fibrous cords must be divided under vision. Meticulous hemostasis must be achieved by coagulation to guarantee good visualization.

Passing the clamp or scissors beneath the cystic duct. Once the cystic duct has been identified, a dissecting clamp or scissors is passed beneath it and used to carefully separate it from the adjacent common bile duct. The latter must be dissected free over a distance of at least 1 cm and half its circumference. The confluence of the cystic duct with the hepatic duct must be identified. If its identification is not absolutely certain, then an operative cholangiography is obligatory. This also applies for all cases where the anatomical situation Is uncertain and those where calcificatlons within the common bile duct are suspected (fig. 8-2).

Passing the clamp beneath the cystic artery. Once the cystic duct has been exposed, the cystic artery is identified. Confusion with the right hepatic artery should be definitely excluded (fig. 8-3).

Clipping and dividing the cystic duct. Once the cystic duct has been definitely identified, it is occluded proximally with two clips and distally with one clip. The clips should be at least 0.5 cm apart. The cystic duct is divided under direct vision between the clips with scissors (fig. 8-4).

Clipping and dividing the cystic artery. Division of the cystic artery proceeds in the same manner. It is occluded proximally with two and distally with one clip. Their distance apart should be at least 0.5 cm. The vessel can be divided between the clips with scissors without risk. Careful attention should be paid to definitely identify the right hepatic artery to avoid narrowing or accidentally dividing it (fig. 8-5).

Retrograde dissection of the gallbladder. Once the cystic duct and cystic artery have been divided and secured with clips, the gallbladder is gradually separated from its bed under mild cranial traction. Care should be taken to identify any aberrantt bile ducts and larger vessels, which should be secured with clips. Minor bleeds can be arrested using diathermy (fig. 8-6).

Hemostasis of the gallbladder bed. Dissection of the gallbladder proceeds until it is attached to the liver margin only by a narrow cord, which is used to hold the gallbladder bed under cranial traction, thus allowing meticulous hemostasis of the undersurface of the liver. Each individual vascular clip is checked. The undersurface of the liver is inspected for any aberrant bile ducts. If there is any doubt, further clips are placed. On completion of hemostasis, the last fibrous cord connectlng the gallbladder to the liver is divided with scissors under coagulation.

Extraction of the gallbladder. Once the gallbladder has been completely dissected, preparations are made to extract it via the supraumbilical trocar with the aid of a strong grasping forceps (crocodile forceps). Then a spreading forceps is introduced through the trocar to widen the trocar portal far enough to easily extract the gallbladder. Larger stones will occasionally require the gallbladder to be opened at the extraction site by grasping it with Kocher clamps and sterile draping of the trocar incision, in order to remove the stones or fragment them by direct lithotripsy. Particular care must be taken not to leave small remnants of gallbladder or even small gallstones behind in the abdominal cavity. If the gallbladder is opened during dissection and gall stones are spilled, then each stone must be diligently located and removed. It is imperative to avoid leaving any gallstones behind, given that this could result in delayed abscesses. Otherwise, in individual cases, when it is not possible to remove stones completely by any means, conversion to laparotomy will be required.

Closure of incision. The supraumbilical incision, which has been widened by the extraction, is closed under vision using deep fascia sutures to avoid a subsequent hernia.

Drainage. The operative field may be drained via the right subhepatic trocar canal with an easy-flow drain, which is removed after 48 hours at the latest.

Percutaneous drainage. For patients at high surgical risk, placement of a sonographically guided, percutaneous, transhepatic cholecystostomy drainage tube coupled with the administration of antibiotics may provide definitive therapy, but the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) guideline describes radiographically guided percutaneous cholecystostomy as a temporizing measure until the patient can undergo cholecystectomy.

Intraoperative methods of diagnosis.

Visual assessment and palpation of the bile ducts. Normally, the width of cystic duct is 1-2 mm, common bile duct (CBD) – 4-8 mm, hepatic duct – 4-6 mm. Dilatation of common bile duct to 9 mm or more is a sign of billary hypertension. The distal segment of the CD and CBD are palpated to determine the small stones, formation of bile stasis, as well as CBD walls thickness and density.

Cholangiomanometry. The method is based on measuring the pressure in the biliary tract. It helps to determine the functional state of the sphincters of the distal part of bile duct. Normal pressure is 100-160 mm Hg, pressure of 200 mm Hg and more indicates the presence of obstacles to bile outflow.

Intraoperative cholangiography – radiological method for assessment of bile ducts. It allows to determine the anatomical relationship between parts of billary-excreting system, to identify the nature of the organic changes of the bile ducts (stones, the level and extent of the strictures, infiltrative processes, etc.). During

procedure we use inject contrast into the cystic duct or in the CBD directly, after the introduction of contrast radiography is performed.

Choledochotomy enables to perform manipulations – extract stones, wash out bile stasis.

External drainage of common bile duct (CBD) – it is a temporary decompression of the biliary tract (fig. 9). Indications:

- Mechanical jaundice (visible or hidden) during operation.
- Mechanical jaundice (visible or hidden) in history.
- Purulent cholangitis.
- Acute swelling of the head of the pancreas.
- Dilatation of CBD more than 1.0 cm.
- Multiple small concrements in the gallbladder.
- Stones in bile ducts.
- Stenosis ampulla of Vater.
- After performing diagnostic or therapeutic choledochotomy.

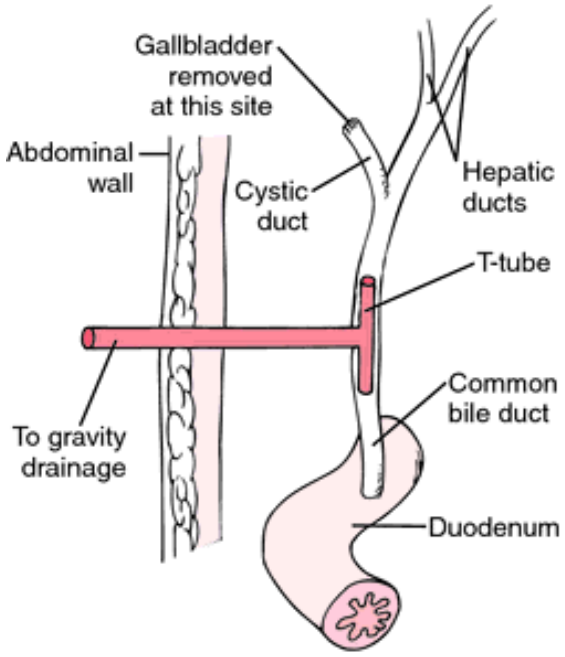

Fig. 9. External T-tube drainage of common bile duct.

Post-operative and rehabilitation care.

Once the gallbladder has been removed, most patients can be discharged on the same day.

The pain is minimal and can be managed by over-the-counter analgesics. The patient may complain of severe shoulder pain due to retained CO2 from laparoscopic insufflation and should be explained that such pain will dissipate as the patient moves and gas is slowly absorbed, which can take up to three days.

Prior to discharge, the patient should be advised on possible intolerance to greasy food, which may cause bloating or diarrhea. This can be temporary or, at some degree permanent, due to the decreased speed of fat emulsification by the loss of stored bile in the gallbladder. Most patients will have an up-regulation in bile production by the liver and will see improvement in symptoms with time.

Follow-up time is between 3-4 weeks from operation.

Complications

Gallbladder gangrene can be a complication in up to 20% of cases of cholecystitis and usually occurs in diabetics, the elderly, or immunocompromised persons.

Complications of cholecystitis and/or biliary colic may also include cholangitis, sepsis, pancreatitis, hepatitis, and choledocholithiasis (10%). In addition, gallbladder perforation occurs in 10% of patients with cholecystitis. When perforation is localized, it may be seen as pericholecystic fluid by ultrasonography. Abscess formation is common. Free perforation also can occur, releasing bile and inflammatory matter intraperitoneally, causing peritonitis.

When perforation occurs next to a hollow viscus, a gallbladder enteric fistula can be formed; fistulas into the duodenum are most common. When gallstones are passed directly through the fistula into the small bowel, if they are greater than 2.5 cm, they can obstruct the ileocecal valve, which causes gallstone ileus. Mortality in these cases can be up to 20%, because the diagnosis is difficult. Treatment includes cholecystectomy, common bile duct exploration, and closure of the fistulous tract.

1. Gallbladder empyema. Empyema of the gallbladder is the most severe complication of acute cholecystitis. It is usually the result of the progression of acute cholecystitis in a background of bile stasis and cystic duct obstruction. This is a surgical emergency that requires prompt treatment with antibiotics and urgent aspiration/removal of the gallbladder to reduce the risk of septic shock.

Frequently empyema of the gallbladder is associated with calculus cholecystitis, where there is an obstructed cystic duct and stasis of bile. The stagnant bile in the gallbladder has superinfection with microorganisms that lead to suppuration in an acutely inflamed gallbladder. Hence the gallbladder lumen becomes filled with exudative material and very often frank pus. Organisms frequently isolated include Clostridia, Bacteroides, Klebsiella, and Escherichia coli.

Diagnosis. An ultrasound is the most commonly used radiological investigation. It is not diagnostic but can raise the suspicion of an empyema when there is a very edematous gallbladder, or there are echogenic contents in the

gallbladder associated with gallstones. A CT scan may reveal an enlarged or distended gallbladder with edematous walls and, at times, pericholecystic collection. When the diagnosis is more difficult, an MRI can be of help. A heavily T2 weighted sequence on MRI can help in distinguishing pus from sludge. An MRI may also show a fluid level with a layering of purulent bile.

An increasing white blood count with a shift to the left in a patient with acute cholecystitis suggests adverse changes. The other relevant investigations are liver enzyme levels and PT (prothrombin time) and aPTT (activated partial thromboplastin time). Radiological findings alone may be insufficient for an accurate diagnosis of empyema of the gallbladder. A combination of clinical, radiological, and laboratory findings are crucial to arrive at a correct final diagnosis of empyema of the gallbladder.

Treatment. Prompt parenteral antibiotic therapy with urgent removal or drainage of the gallbladder should be the goal to prevent increased morbidity and the rare possibility of mortality. A broad-spectrum antibiotic, hydration, and optimizing the patient for surgery should be done as soon as possible.

Although the conventional practice is to perform an open cholecystectomy, it is possible to achieve a laparoscopic removal of the gallbladder by experienced surgeons. The conversion rate from laparoscopic to open cholecystectomy is higher in empyema of the gallbladder than that in uncomplicated acute cholecystitis. The higher rate of conversion is attributed to reduced visualization or distortion of the anatomical structures in the Calot's triangle and increased bleeding due to inflamed friable tissue.

An initial decompression of the distended gallbladder, either under radiological guidance or intraoperative laparoscopically guided, facilitates the more straightforward dissection of the gallbladder. Postoperative complication rates irrespective of approach, either laparoscopic or open, are higher than for cholecystitis for gallstone disease. Postoperative complications, including wound infection, bleeding, cystic duct stump leak, and common bile duct injury, subhepatic abscess, have all been reported. Subtotal cholecystectomy is rarely performed when the surgeon encounters pericholecystic inflammation that makes a safe dissection of the Calot's triangle impossible. In older patients or those who are too ill to undergo surgery due to associated comorbidity, a percutaneous or transhepatic radiologically guided drainage is a temporizing procedure. This initial drainage procedure often leads to a dramatic improvement in the patient's condition, which then permits an elective cholecystectomy when the patient's condition improves.

Antibiotic therapy is usually continued until the fever subsides.

2. Acute cholangitis, also known as ascending cholangitis, is a life-threatening condition that is caused by an ascending bacterial infection of the biliary tree. Delay in diagnosis and treatment can lead to septic shock.

Acute cholangitis occurs most commonly from bacterial infection of the bile ducts. For the development of acute cholangitis, there must be obstruction of biliary flow. Complete obstruction can lead to increased biliary pressure, which frequently leads to bacteremia. The most common cause of biliary obstruction is caused by choledocholithiasis. Other causes include benign or malignant strictures of biliary ducts, pancreatic cancer, ampullary adenoma or cancer, porta hepatis tumor, parasites (Clonorchis sinensis, Fasciola hepatica), roundworm (Ascaris lumbricoides), tapeworm (Taenia saginata), biliary sludge deposits due to biliary stent obstruction, gallstone impaction in the neck of the gallbladder or the cystic duct leading to compression on common bile or common hepatic duct known as Mirizzi syndrome.

Symptoms. There is a spectrum of clinical presentations of cholangitis, ranging from mild forms to severe forms, including overwhelming fulminant sepsis. Symptoms include fever, chills, malaise, rigors, generalized abdominal pain, jaundice, pruritus, and pale stools. Medical history, including cholelithiasis, recent cholecystectomy, post-ERCP, prior history of cholangitis, and history of AIDS, may increase the risk of cholangitis. Individuals with cholangitis tend to appear quite ill and often present with severe sepsis or septic shock. On physical exam, they present with fever, right upper quadrant tenderness, jaundice, abdominal distension, altered mental status, or hemodynamic instability.

The definitive diagnosis of acute cholangitis would include systemic signs of infection as well as confirmatory evidence of purulent bile by endoscopic, percutaneous, or surgical means. Although feasible, it proves invasive and may not be the best use of resources. Therefore clinical tools such as the Charcot triad and Tokoyo guidelines have been implemented in clinical practice.

Charcot triad describes cholangitis as clinical findings of fever, right upper abdominal pain, and jaundice. The Reynolds pentad adds altered mental status and sepsis to the triad.

Diagnosis. Leukocytosis with neutrophil predominance is a common finding, with leukopenia being commonly found in septic or immunocompromised individuals. Liver function results consistent with cholestasis revealing hyperbilirubinemia and increased alkaline phosphatase (ALP) and gamma-glutamyl transverse (GGT).

The first-line imaging study of choice is abdominal ultrasonography. A classic finding of ascending cholangitis is the thickening of the walls of the bile ducts, dilatation of biliary ducts, including the common bile duct, as well as

evidence of cholelithiasis and pyogenic material. It can help differentiate intrahepatic versus extrahepatic obstruction. Abdominal computed tomography (CT) can be performed as an adjunct to investigate co-existing pathologies such as hepatic/pancreatic tumors, metastasis, or hepatic abscess. Dilated intrahepatic and extrahepatic ducts, as well as inflammation of the biliary tree, can be appreciated. Another advantage is CT that can help to investigate differential diagnoses, including diverticulitis and pyelonephritis. One major disadvantage is that CT has poor sensitivity for the diagnosis of choledocholithiasis.

The most sensitive modalities for detecting common bile duct stones are magnetic resonance cholangiopancreatography (MRCP). MRCP is a noninvasive imaging study that can detect the cause and the level of biliary obstruction, including choledocholithiasis, strictures, and biliary dilatations. ERCP is essential to both diagnosis and treatment as it detects the site of obstruction and helps in drainage of the biliary tree and for retrieval of biopsy and culture specimens from the biliary system. ERCP should be used in patients with high clinical suspicion and those that will benefit from therapeutic intervention.

Treatment. The goal of treating acute cholangitis is managing both the biliary infection and the obstruction. The mainstay of treatment is antibiotic therapy directed towards enteric pathogens and biliary drainage. Acute emergency management entails assessing ABC (airway, breathing, circulation), cardiac monitoring and pulse oximetry, obtaining intravenous access, providing aggressive fluid and electrolyte replacement as appropriate, and supportive care. Initiation of early intravenous antibiotics known to achieve high biliary concentrations such as fluoroquinolones, extended-spectrum penicillins, carbapenems, and aminoglycosides is required. In more severe cases, adequate hemodynamic support, including vasopressors, may be needed.

In mild cases, the majority of patients respond to medical therapy. Those who do not respond to medical therapy require immediate decompression. In severely ill patients with sepsis, treatment is immediate or emergent biliary drainage. Those who are clinically improving after medical therapy may be candidates for decompression prior to hospital discharge. Biliary decompression or drainage can be achieved by ERCP, percutaneous transhepatic cholangiography (PTC), endoscopic ultrasonography (EUS)-guided drainage, or surgical drainage. ERCP is the gold standard and treatment of choice for biliary decompression. If a biliary stricture is present, a trans-papillary biliary stent can be placed for biliary drainage. Due to higher rates of complications from surgical intervention, surgery is reserved for patients who decompensate despite optimal medical management and endoscopic/percutaneous biliary drainage.

3. Gallbladder perforation (GBP) is a rare but life-threatening complication of acute cholecystitis. Sometimes GBP may not be different from uncomplicated acute cholecystitis with high morbidity and mortality rates because of delay in diagnosis. Inflammation may progress and cause ischemia and necrosis, thus resulting GBP in 2% to 11% of acute cholecystitis patients. GB fundus, the most distal part with regard to blood supply, is the most common site of perforation.

When GB is perforated at the fundus, it is less possibly covered by the omentum, thus the bile drains into the peritoneal space. If the perforation site is not at the fundus, it is easily sealed by the omentum or the intestines and the condition remains limited in the right upper quadrant with formation of a plastrone and pericholecystic fluid.

Symptoms and physical examination. Abdominal pain, poor general condition, high fever, nausea, and vomiting. During examination we can find signs of peritoneal irritation such as extensive abdominal tenderness, guarding and rebound tenderness, positive Murphy's sign, palpable right subcostal mass, rarely – jaundice. Usually, these patients have epigastric tenderness and abdominal distension.

Diagnosis. Abdominal X-ray series rarely show air-fluid levels on direct abdominal radiograms. Abdominal US shows gall stones, extensive intraperitoneal free fluid and a small amount of pericholecystic free fluid. Usually, the ultrasonography doesn't show GB wall defect. CT reveales GB wall thickening, gall stones, extensive intraperitoneal free fluid, a small amount of pericholecystic free fluid, and GB perforation sites. Abdominal CT and US help to assess adjacent organs and diseases (liver abscesses, dilated extra and intrahepatic bile ducts, dilated intestinal loops, etc.).

Treatment. Cholecystectomy, drainage of abscess if present, and abdominal lavage are usually sufficient to treat gallbladder perforation. If a cholesystectomy is performed, additional surgical procedures such as repair of the fistula may be required. Laparoscopic cholecystectomy can be performed for acute, gangrenous, and/or perforated cholecystitis as well as uncomplicated cholecystitis, but a conversion may be necessary in case of difficulties like an unclear anatomy.

4. Choledocholithiasis is the presence of stones within the common bile duct (fig. 10). It is estimated that common bile duct stones are present in anywhere from 1-15% of patients with cholelithiasis. The present-day treatment of bile duct stones is endoscopic retrograde cholangiopancreatography (ERCP) or in some cases a laparoscopic cholecystectomy with bile duct exploration. In most US centers, when bile duct stones present, ERCP is usually followed by laparoscopic cholecystectomy.

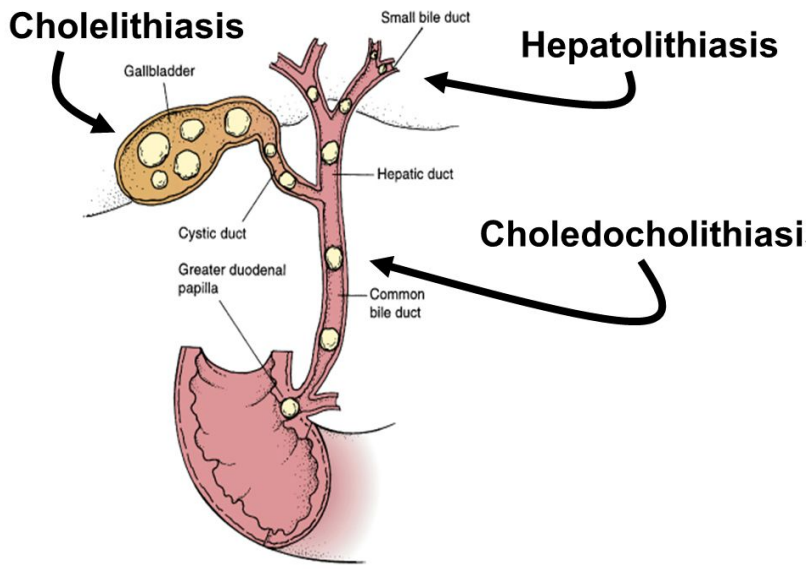

Fig. 10. Locations of stones in bile ducts.

Choledocholithiasis occurs as a result of either the formation of stones in the common bile duct or the passage of gallstones that are formed in the gallbladder into the CBD. Less commonly, stones are formed in the intrahepatic biliary tree, termed primary hepatolithiasis, and may lead to choledocholithiasis. Stones that are too large to pass through the ampulla of Vater remain in the distal common bile duct, causing obstructive jaundice that may lead to pancreatitis, hepatitis, or cholangitis. Primary common bile duct stones are usually brown pigment stones. Obstruction of the CBD by gallstones leads to symptoms and complications that include pain, jaundice, and sepsis.

Symptoms and physical examination. The pain is colicky, located in the right upper quadrant of the abdomen, and moderate in severity. The pain is intermittent and recurrent. Often, patients will endorse a history of episodes of epigastric, right upper quadrant pain, or epigastric pain. A thorough review of systems will reveal that the patient may have noticed a yellowing of his eyes or skin, experienced pruritus, and possibly nausea or vomiting. Jaundice occurs when the stones obstruct the CBD, and conjugated bilirubin enters the bloodstream. A history including, clay-colored stools and urine turning tea-colored is found in such patients. Jaundice can occur in episodes. A patient with cholangitis also may have a fever, chills, and possibly altered mental status (Charcot triad or Reynolds pentad). Gallstones are responsible for approximately half of all cases of pancreatitis. Pancreatitis is precipitated when CBD obstruction is at the level of the ampulla of Vater. Some patients have intermittent pain, which results due to transient blockage within the common bile duct. Transient blockage occurs when due to floating stones or debris within the bile duct.

Tenderness is noted in the right upper quadrant of the abdomen. Systemic signs such as fever, hypotension, and flushed skin, if present is indicative of infection, or sepsis. Courvoisier sign is the presence of palpable gallbladder on the exam and is seen when gallbladder dilation develops due to the obstruction of the common bile duct. Note should be made for any hyperthermia, diaphoresis, jaundice, scleral icterus, tachycardia, hypotension, tachypnea, or right upper quadrant abdominal tenderness.

Diagnosis. In a patient with cholelithiasis, total bilirubin of greater than 3-4 mg/dL (50-70 umol/L), is strongly associated with choledocholithiasis. Gamma-glutamyl transpeptidase is also elevated. Serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) concentrations are elevated in biliary obstruction in a cholestatic pattern, with increases in alkaline phosphatase, serum bilirubin, and gamma-glutamyl transpeptidase (GGT) exceeding the elevations in serum AST and ALT. A lipase should also be checked to assess for gallstone pancreatitis.

In most cases, an abdominal ultrasound will show a dilated common bile duct (more than 8-9 mm) and stones within the common bile ducts. Abdominal ultrasonography has a sensitivity of 15-40% for detecting CBD stones. If a strong suspicion still exists based on history, physical, and laboratory findings in the face of a negative ultrasound, then a magnetic resonance cholangiopancreatography (MRCP) can be ordered. Endoscopic ultrasound also can be used to identify suspected choledocholithiasis. This entails the introduction of an ultrasonic probe into the duodenum under endoscopic guidance. Although diagnostic endoscopic retrograde cholangiopancreatography (ERCP) is more sensitive, it is no longer routinely performed given the approximately 10% risk for post-procedure pancreatitis.

If a patient is undergoing laparoscopic or open cholecystectomy, an intraoperative cholangiogram also can be performed to assess for choledocholithiasis. It is performed by inserting a catheter into the cystic duct, followed by injection of contrast material, which outlines the biliary tree. X-ray films are taken to assess for the presence of filling defects, and the flow of contrast into the duodenum. Intraoperative ultrasound or laparoscopic ultrasound will also identify choledocholithiasis. However, this technique is operator-dependent, and not commonly performed by general surgeons.

Treatment. The treatment for choledocholithiasis is the removal of the obstructing stones via endoscopic means. An ERCP can be performed under general anesthesia, with the patient in either prone, left lateral, or supine position, though prone is the most common position used. The endoscopist will then place a duodenoscope into the second portion of the duodenum and advance a catheter and

guidewire into the common bile duct. A sphincterotome then is used to cut the papilla, using cautery, and enlarge the ampulla of Vater. Often, the stones will be released with this maneuver. A variety of snares and baskets can be used to grasp the stones and remove them if needed. A balloon catheter also can be used to sweep the common bile duct to remove any stones.

If the stones are large, stuck, or there are many stones within the biliary tree, surgical removal is indicated. A laparoscopic or open common bile duct exploration is needed to remove any stones that can not be removed via endoscopic methods. An elective cholecystectomy is also recommended, during the same hospital admission, to prevent future episodes of choledocholithiasis. Cholecystectomy in patients with choledocholithiasis remains controversial, but most experts recommend it.

Cholecystectomy is not indicated for primary CBD stones. Other surgical options include open choledochotomy, transcystic exploration (a technique to clear the CBD of stones during laparoscopic cholecystectomy), percutaneous extraction, and extracorporeal shock wave lithotripsy. The choice of treatment for choledocholithiasis found during surgery being done for cholelithiasis or cholecystitis includes intraoperative common bile duct exploration, intraoperative ERCP, and postoperative ERCP.

Antibiotics are typically not needed for choledocholithiasis unless the patient also has associated cholecystitis or cholangitis.

Multiple choice questions

1. Choose the anatomical parts of the gallbladder:
   A. Fundus, body, neck.
   B. Head, body, tail.
   C. Left lobe, right lobe.
   D. Cardia, body, antrum, pylorus.
   E. Capsule, parenchyma, hilum.

2. Surgical removal of the gallbladder is called:
   A. Cholecystectomy.
   B. Choledochotomy.
   C. Papillo-schincterotomy.
   D. Splenectomy.
   E. Appendectomy.

3. Which structures must be ligated during cholecystectomy?
   A. Cystic duct and common hepatic artery.
   B. Choledochus and cystic artery.
   C. Cystic duct and cystic artery.
   D. Cystic duct and common hepatic duct.
   E. Cystic duct and right hepatic duct.

4. Ultrasound findings in patients with acute calculous cholecystitis:
   A. Stones, which have acoustic shadow.
   B. Gallbladder wall thickening (>2-4 mm).
   C. Gallbladder distention (diameter >4 cm, length >10 cm).
   D. All answers are correct.
   E. None of the answers.

5. Risk factors for cholecystitis include:
   A. Gallstones.
   B. Greasy food.
   C. Pregnancy.
   D. Cardiovascular events.
   E. All answers are correct.

Clinical cases

1. You start an open cholecystectomy due to acute calculous cholecystitis. During the revision you have found small stones in the common bile duct. What will you do?

A. Choledochotomy during operation, removal of stones, external drainage of common bile duct.
B. Endoscopic papillotomy after the operation.
C. Discharge the patient after cholecystectomy, recommend him the second operation.
D. Form a choledocho-duodenal anastomosis.
E. Finish the operation with cholecystostomy.

2. The pain is severe, dull or boring, constant, may radiate to the right scapular region or back. The onset of pain develops hours after a meal, occurs frequently at night. Associated symptoms include nausea, vomiting, pleuritic pain, and fever. These are the symptoms of:

A. Acute appendicitis.
B. Biliary colic.
C. Perforated ulcer of duodenum.
D. Bowel obstruction.
E. Renal colic.

3. A 38 y.o. female patient is presented with pain in right upper quadrant of abdomen, nausea and vomiting. CBC – leucocytosis. Ultrasonography of abdomen revealed enlarged gallbladder with thickened walls, presence of multiple stones in gallbladder. Your diagnosis?

A. Acute pancreatitis.
B. Acute acalculous cholecystitis.
C. Acute calculous cholecystitis.
D. Choledocholithiasis.
E. Cholangitis.

MCQ answers						**Clinical cases answers**			
Question	1	2	3	4	5	Case	1	2	3
Answer	A	A	C	D	E	Answer	A	B	C

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