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Учебно-методическое пособие
для студентов 5 и 6 курсов факультета по подготовке специалистов
для зарубежных стран медицинских вузов

MECHANICAL JAUNDICE

The educational methodical work for 5-th and 6-th year students
of the Faculty of preparation of experts for foreign countries
of medical higher educational institutions

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CONTENTS

I. DEFINITION, CLASSIFICATION OF JAUNDICE

Jaundice — it is a syndrome characterized by icteric staining of the skin, mucous membranes and sclera due to increased accumulation of bilirubin in the blood serum and other body fluids and tissues. Jaundice is clinically detected when serum bilirubin is greater than 40 mmol/l.

Detection of jaundice is not difficult, because this is a highly visible sign, attracting attention not only health professionals, but also the patient and those around him. Always much more difficult to figure out the cause, because jaundice is observed at many of both infectious and noninfectious diseases. Most patients with obstructive jaundice mistakenly hospitalized in the infectious hospital with suspected infectious character, leading to delayed diagnosis and missed time for optimal intervention.

Depending on the localization of the primary pathological process, leading to the development of jaundice, and the mechanism of occurrence, jaundice is divided into following types:

• **Suprahepatic or hemolytic jaundice** — mainly caused by increased production of bilirubin due to the increased disintegration of red blood cells and less often in impairment of the plasma transport of bilirubin. It includes various types of hemolytic jaundice — congenital defects of red blood cells , autoimmune hemolytic jaundice associated with B12 (folic acid) deficiency anemia , absorbing of massive hematoma , heart attacks , various kinds of intoxication, poisoning. The increased hemolysis regardless of its etiology always leads to a characteristic clinical triad: anemia, jaundice (lemon shade) and splenomegaly.

• **Hepatic or parenchymal Jaundice** — is caused by pathology of hepatocytes and / or cholangioles . There are several variants of hepatic jaundice. It may be associated with impaired excretion and capture of bilirubin and its regurgitation. This is observed in acute and chronic hepatitis, heptoses, cirrhosis of the liver (hepatocellular jaundice). In other cases, the excretion of bilirubin is impaired and its regurgitation. A similar type seen with cholestatic hepatitis, primary biliary cirrhosis, idiopathic benign recurrent cholestasis with hepatocellular lesions (cholestatic liver jaundice).

• **Obstructive (mechanical) or surgical jaundice** — it is due to mechanical obstruction of the common bile duct (CBD). It may be a life threatening condition because of the interplay of various factors, e.g. ascending cholangitis, acute renal failure, poor antibiotic penetration, peripheral and portal endotoxaemia.

II. METABOLISM OF BILIRUBIN IN THE ORGANISM

The main source of bilirubin — hemoglobin. It converts to bilirubin in the reticulo-endothelial cells of spleen, mainly, and in the liver and bone marrow. Roughly, in 24 hrs, 1 % of red blood cells breakdown and hemoglobin forms

about 10–300 mg bilirubin. Approximately 20 % of the bilirubin, is not formed from hemoglobin of mature red blood cells, is formed from other heme-containing compounds and this is called early bilirubin. It is formed from the hemoglobin of erythroblasts broken-down in the bone marrow, immature reticulocytes, from the myoglobin etc.

At destruction of erythrocyte hemoglobin is split into globin ferrous-containing hemosiderin and non-ferrous hematoidin. Globin splits into amino acids and then goes on to build body proteins. Iron is oxidized and again used by the body in the form of ferritin. Hematoidin (porphyrin ring) turns through the stage biliverdin into bilirubin.

Formed bilirubin enters the blood. As it is not soluble in the water at physiological pH of blood, for transportation into the blood it binds to the carrier — mainly albumin.

The liver performs three important functions in metabolism of bilirubin: capture of bilirubin from the blood by hepatocytes, the binding of bilirubin with glucuronic acid and excretion of conjugated bilirubin from the hepatocytes into the bile capillaries. Transfer of bilirubin from the plasma into hepatocytes occurs in the liver sinusoids. Indirect (unconjugated) bilirubin from albumin is cleaved in the cytoplasmic membrane and intracellular proteins of hepatocyte capture and accelerate the transfer of bilirubin into the hepatocyte.

Having entered in the hepatocyte, indirect (unconjugated) bilirubin is transferred to the membrane of the endoplasmic reticulum, where it binds to glucuronic acid under the influence of the enzyme- glucuronyl transferase. Binding of bilirubin to glucuronic acid makes it soluble in water, which makes it possible to transition in the bile, filtration in the kidneys.

Further bilirubin released from the liver into the bile. Excretion of bilirubin from the hepatocytes into the bile is controlled by hormones of the pituitary and thyroid glands. Bilirubin in bile is consists of macromolecular aggregates (micelles) composed of cholesterol, phospholipids, bile acids, and a minor amount of protein.

Bile flows according to the pressure gradient: the liver excretes bile at a pressure of 300–350 mmH_2O, then it accumulates in the gallbladder, which on contraction creates the pressure 200–250mmH_2O, which is enough to free flow of bile into the duodenum, while the sphincter of Oddi is relaxed.

Bilirubin enters the intestine and under the action of bacterial dehydrogenases turns into urobilin and stercobilin . The basic amount of urobilin from the intestine is excreted in feces as stercobilin (60–80 mg daily), the air converts into stercobilin, which colours feces brown. Part of urobilin absorbed through the intestinal wall into the portal vein and then to the liver where it breaks down. A healthy liver completely breaks down the urobilin, so in normal it is not found in urine.

A small amount of the reabsorbed urobilinogen is excreted in the urine following further oxidation to urobilin which gives urine its characteristic yellow colour.

Normal level of bilirubin in the blood

Total: 5,1–21,5 mmol / l.

Indirect (unconjugated) 4–16 mmol / l (75–85 % of the total).

Direct (conjugated) 1–5 mmol / l (15–25 % of the total).

Elevation of bilirubin in the blood (hyperbilirubinemia) more than 27–34 mmol / l leads to the binding of bilirubin to elastic fibers of the skin and conjunctiva, which is manifested icteric staining. The severity of jaundice usually corresponds to the level of bilirubinemia (mild — up to 85 mmol / l, moderate — 86–169 mmol / l, severe — more than 170 mmol / l). At full block of the bile ducts bilirubin elevates 30–40 mmol / hr daily (up to 150 mmol / l, then the speed of elevation is reduced).

The intensity of jaundice depends on the organ or tissue perfusion. First of all the yellow coloration of the sclera and then skin is detected. Being accumulated in the skin and mucosa, bilirubin in combination with other pigments gives a light yellow color with a reddish tinge. Later on, due to oxidation of bilirubin into biliverdin, jaundice becomes greenish. With long-term existence of jaundice skin becomes blackish- bronze color. Thus, examination of the patient allows us to solve the question of the duration of jaundice.

III. AETIOLOGY OF OBSTRUCTIVE JAUNDICE

Obstructive jaundice is caused by an impairment of outflow of bile from the liver to the duodenum. There can be obstruction inside the biliary tract or compression from outside. The most common cause of obstructive jaundice are stones in the bile duct (50 %) and tumors (40 %) in the ducts, large duodenal papilla, pancreas, gall bladder. Jaundice may be caused by other reasons (10 %) stenosis of the large duodenal papilla (LDP), stricture of duct, biliary atresia, cholangitis, pancreatitis and liver tumors.

Currently causes of jaundice are studied well enough. According to etiology they can be combined in several major groups:

1. Malformations:

• biliary atresia;

• hypoplasia of the bile ducts;

• choledochal cyst;

• duodenal diverticula located near LDP.

2. Benign diseases of the biliary tract:

• cholelithiasis, complicated by choledocholithiasis;

• impacted stones of LDP;

• stricture of the bile ducts;

• stenosis of LDP.

3. Inflammatory diseases:
• acute cholecystitis;
• cholangitis;
• pancreatitis (acute or chronic indurative);
• cyst of the pancreatic head with compression of the common bile duct;
• acute papillitis.
4. Tumors:
• carcinoma of head of pancreas;
• extra hepatic CBD carcinoma;
• carcinoma ampulla of Vater;
• primary duodenal carcinoma.
5. Parasitic diseases of the liver and bile ducts:
• echinococcosis and alveococcosis in the porta hepatis.

IV. PATHOGENESIS OF OBSTRUCTIVE JAUNDICE

Mechanical obstruction of bile outflow leads to stagnation (extrahepatic secondary cholestasis) and an increase in pressure of bile above 270 mmH_2O, expansion and rupture of the bile capillaries and the flow of bile into the blood or through lymphatic system. The appearance of bile in the blood causes a direct hyperbilirubinemia (an increase of the content of conjugated bilirubin), hypercholesterolemia, development of cholemic syndrome due to bile acids in blood circulation, bilirubinuria (coloration of urine — color of beer) and the presence of bile acids in the urine. Absence of bile in the intestine due to mechanical obstruction in the bile duct leads to the fact that stercobilin is not formed and therefore not excreted in the feces (pale stool).

In the early days of jaundice observed level rise in transaminases. This is explained by short-term (3–5 days) increased permeability of the hepatocyte membrane and release of the indicator enzymes.

Hyperbilirubinemia in obstructive jaundice is characterized by an increase in blood mainly conjugated bilirubin and a lesser degree unconjugated. As in obstructive jaundice at early stage after the development of bile duct obstruction damage of liver function is insignificant, the bile excretion by hepatocytes continues. Evolved into the lumen of the bile ducts together with bile bilirubin is absorbed through their wall and gets into space of Disse through communication in the bile capillaries. From the space of Disse through the lymphatic system bilirubin releases into the blood. A longer rise in pressure in the bile ducts leads to dysfunction of the liver cells and therefore arise paracholia (return of bilirubin from hepatocyte into the blood). With declining functions of hepatocytes also suffers capture function and in the blood increases level of unconjugated bilirubin. In this period necrosis of hepatocytes can be observed and transaminases level is again increased the blood.

V. BASIC CLINICAL SYNDROMES

1. Jaundice — prominent clinical symptom manifested yellowing of the skin, mucous membranes and eye sclera. All tissues, exudates and transudates get yellow coloration. Only saliva, tears and gastric juice do not change their color. Yellow coloration of the skin, mucous membranes and other tissues is due to high concentration of bilirubin in the blood. Patients with anemia and fair skin detect jaundice early, while in dark-skinned patients it goes unnoticed for longer. Inspection should be carried out in a well-lit room, better in the daylight.

2. Cholestasis — syndrome, characterized by impaired or complete cessation of bile or certain components of bile in the intestine, their accumulation in the ducts and possible release into the blood. Manifested as biochemical markers of cholestasis, cholaemia and acholia.

1) **Biochemical markers of cholestasis:** increase in blood conjugated bilirubin, cholesterol, lipoproteins, phospholipids and increased activity of the excretory enzymes: alkaline phosphatase, gamma glutamyl transpeptidase, leucine amino peptidase, 5-nucleotidase.

2) **Cholaemia** occurs by ingestion of bile acids in the blood. It is characterized by bradycardia and low blood pressure because of bile acids effecting on receptors and the center of the Vagus nerve, the sinus node of the heart and blood vessels (impairment of ATP synthesis and the weakening of muscle contractions). Toxic effect of bile acids on the central nervous system manifested as asthenic-vegetative disorders: irritability replacing depression, sleepiness during the day and at night insomnia, headache and fatigue. Irritation of sensory nerve endings of the skin by bile acids leads to itching. The appearance of bile acids in the urine leads to a decrease in surface tension and foaming (beer urine). The increase of bile acids in the blood can cause hemolysis of erythrocytes, hemolytic jaundice associated with impaired (decrease) osmotic resistance of erythrocytes, reduced blood clotting, increased membrane permeability and the development of the inflammatory process (hepatic necrosis, acute pancreatitis).

3) **Acholia** — syndrome caused by the absence of bile flow into the intestine in biliary tract obstruction. Thus there is a disorder of intestinal digestion. Due to the absence of bile acids in the intestine lipase is not activated, fats are not emulsified, do not form soluble complexes of bile acids with fatty acids and therefore 60–70 % of the fat is not digested, not absorbed and eliminated from the body together with the faeces (steatorrhoea). Impairs the penetration of enzymes in the bolus and digestion of proteins, which leads to presence of muscle fibers in stool. By malabsorption of fat-soluble vitamins (retinol, tocopherol, phylloquinone) leads to the development of avitaminosis. Without phylloquinone (vitamin K1) prothrombin is not formed, so blood clotting is decreased resulting in increased bleeding. Decreasing of bile bactericidal properties leads to dysbiosis (dysbacteriosis). Absence of bile acids leads to impairment of intestinal motility: weakened peristalsis leads to constipation. However, the latter is

often replaced by diarrhea due to increased putrefaction and fermentation processes in the gut and decreases the bactericidal properties of bile. Stool is discolored because stercobilin is not formed, which also disappears from the urine.

3. Dyscholia — a syndrome in which the bile acquires lithogenic properties.

VI. COMPLICATIONS OF OBSTRUCTIVE JAUNDICE

Structural defects in liver and cholaemia lead to the formation of toxic substances and the accumulation of ammonia, phenol, acetone, acetaldehyde etc. in the body. Impair antitoxic liver function and toxic substances exert their harmful effects on all organs and systems, resulting in a syndrome «Endotoxemia». Developing of microvascular thrombosis in the kidneys with constriction of resistance vessels and increase in functional disorders. In the blood increases the level of urea and creatinine, amplified impairment of antitoxic liver function and enterohepatic circulation of bile. Hepatocytes depleted and are degenerated.

Nephron function decreases and all this leads to the development of hepatic-renal syndrome in patients with obstructive jaundice. Toxic substances penetrate the blood-brain barrier, which is manifested as hepatic encephalopathy. Direct toxic effects on nerve fibers lead to violations of neuromuscular conduction, causing bradycardia. Develops thrombo-hemorrhagic changes due to intravascular coagulation — disseminated intravascular coagulation (DIC).

Bile acids alter pulmonary surfactant (submicroscopic lining of the alveoli), which impairs the permeability of the alveoli. All this leads to decrease in oxygen transport and results in hypoxia.

Prolonged jaundice leads to such changes in the organs and systems that restoring of normal bile outflow surgically may not break the vicious circle and progression of hepatico-renal failure, which is the most frequent cause of death in this group of patients.

VII. DIAGNOSIS OF OBSTRUCTIVE JAUNDICE

Diagnosis of obstructive jaundice includes two fundamental points: the confirmation of the nature of obstructive jaundice and definition of the specific cause of biliary tract impaired patency.

Diagnosis of obstructive jaundice is based on clinical assessment, physical examination, laboratory and instrumental methods of examination.

Clinical assessment

History: Age, occupation (hydatid disease in farmers), alcohol intake (cirrhosis), surgery (strictures), drugs and contraceptive pills, biliary colic with fever and jaundice (Charcot triad), injections or transfusions (Hepatitis B). Family history of anaemia, splenectomy and gallstones (hereditary spherocytosis). Pre-

sent illness history, e.g. fluctuating obstructive jaundice (CBD stone and ampullary carcinoma) or progressive obstructive jaundice (other malignant causes), the sudden onset (gallstones) or gradual onset (cirrhosis or malignancy), painful (CBD stone) or painless obstructive jaundice (malignancy or viral hepatitis).

INSTRUMENTAL METHODS

1. ULTRASONOGRAPHY (USG)

A. Classical transabdominal USG

Ultrasound plays role of screening method in the differential diagnosis between obstructive and hepatic jaundice and should be first choice instrumental method. If showing diffuse liver lesions and unaltered bile ducts, most likely diagnosis is hepatic jaundice, causes of which can be determined by liver biopsy.

Important advantages of this method:

• screening character, noninvasive, no complications;

• can be used with any degree of severity of the patient and during pregnancy;

• simultaneous assessment of the bile ducts and other anatomical structures (liver, pancreas, retroperitoneum);

• possibility of ultrasound-guided puncture techniques with decompression and biopsy;

• objective choice of biliary tract decompression.

Ultrasound criteria of obstructive jaundice are:

• increasing the diameter of the common bile duct greater than 10 mm, and intrahepatic ducts more than 4 mm;

• thickening of the wall of the common bile duct and the slurry in its lumen (cholangitis);

• increase in size and deformation of gallbladder, inhomogeneous contents, small stones, visualization of stone in the duct;

• visualization pathology of the pancreatic head;

• visualization pathology of LDP - difficult.

Traditional ultrasound reveals the cause of obstructive jaundice not more than 75 % of cases (Figure 1).

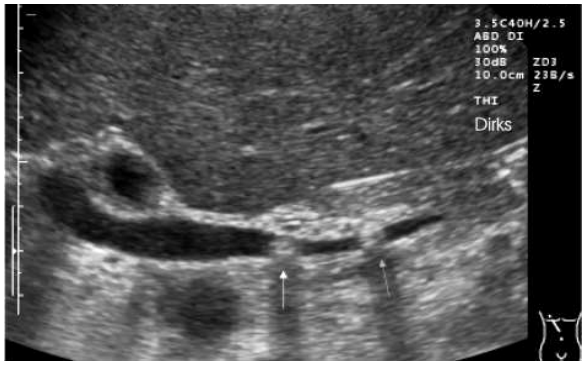


Figure 1 — Classical ultrasound (extension of CBD and visualization of two stones in its distal part)

B. Endosonography

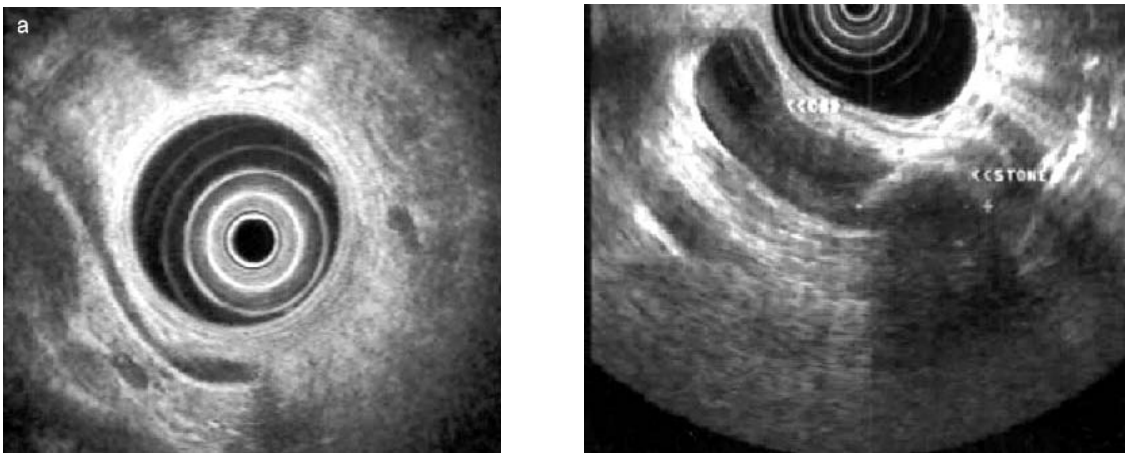
Endoscopic ultrasonography is one of the most informative endoscopic study of pancreatobiliary zone. This study is the most accurate method for the visualization of the distal bile duct and the pancreatic head. However, special equipment is necessary and it is time consuming procedure.

Advantage of endosonography in obstructive jaundice:

• Accurately diagnose choledocholithiasis in patients with negative traditional ultrasound data (bile ducts are not dilated, no stones in the lumen) and soundly reject the assumption of the presence of stones in the bile ducts. This allows you to either avoid unnecessary, costly ERCP, or, conversely, reasonably perform minimally invasive endoscopic procedures on the biliary diseases diagnosed at endosonographic.

• Accurately diagnose such lesions of the pancreas in chronic pancreatitis as cysts (especially less than 3 cm), pancreatic duct stones, pancreatic duct dilatation, without resorting to X-ray imaging techniques (CT and ERCP), and accordingly formulate reasonable indications for endoscopic or surgery on the pancreas or to determine the need for exceptionally conservative treatment.

• Noninvasively diagnose of intra-ampular benign and malignant tumors of LDP and in the early stages of the disease to determine the indications for radical surgical treatment (Figure 2).



A **B**

Figure 2 — Endosonography: A — Normal,
B — Choledocholithiasis: extended CBD, visualized calculus

2. ENDOSCOPIC METHODS OF INVESTIGATION

In the absence of significant reasons explaining jaundice, or expansion of bile duct after ultrasound, fibroesophagogastroduodenoscopy (FEGD) is indicated. It determines upper gastrointestinal pathology: esophageal varices, gastric tumors, papillary pathology, deformation of the stomach and duodenum due to compression from the outside. It is possible to biopsy for suspicious cancer area. In addition, evaluation for technical possibility of ERCP (Figure 3).

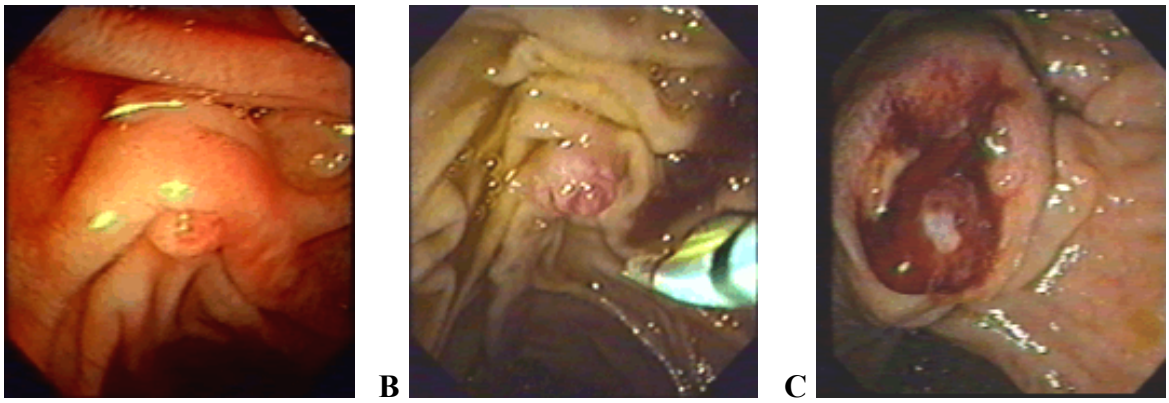


Figure 3 — FEGD with examination of LDP: A — Normal LDP; B — Impacted stone in LDP; C — Cancer of LDP

3. CONTRAST (DYE) X-RAY STUDIES

Methods that allow visualization of the bile ducts using contrast. Here are two basic methods: endoscopic retrograde cholangio-pancreatography (ERCP) and percutaneous transhepatic cholangiography.

1) Endoscopic retrograde cholangio-pancreatography (ERCP)

Diagnostic ERCP is a retrograde contrasting of bile duct and pancreatic duct, carried out through a large duodenal (Vater) papilla (or sometimes through a small duodenal papilla). Along with the possibility of biliary contrast, method allows you to visually assess the condition of the stomach and duodenum, papillary and pre-ampulary region, and also to ascertain the fact of bile flow into the intestine. Furthermore, during ERCP is possible to take a biopsy from the pathologically altered duodenal papilla, stenotic portions of bile duct, as well as mucosal scrape cytology can be obtained (Figure 4).

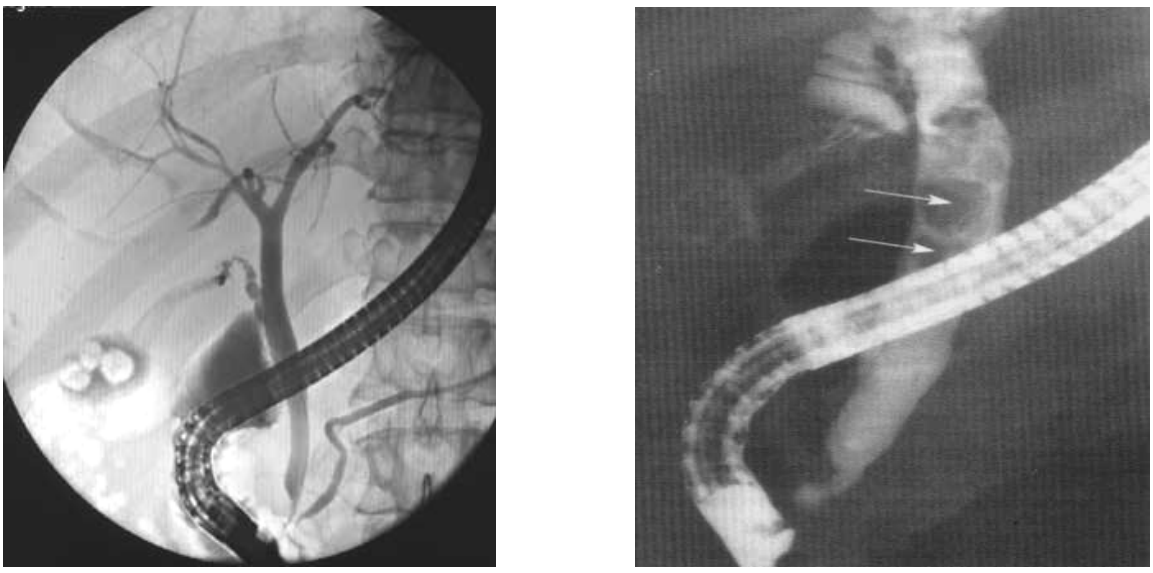
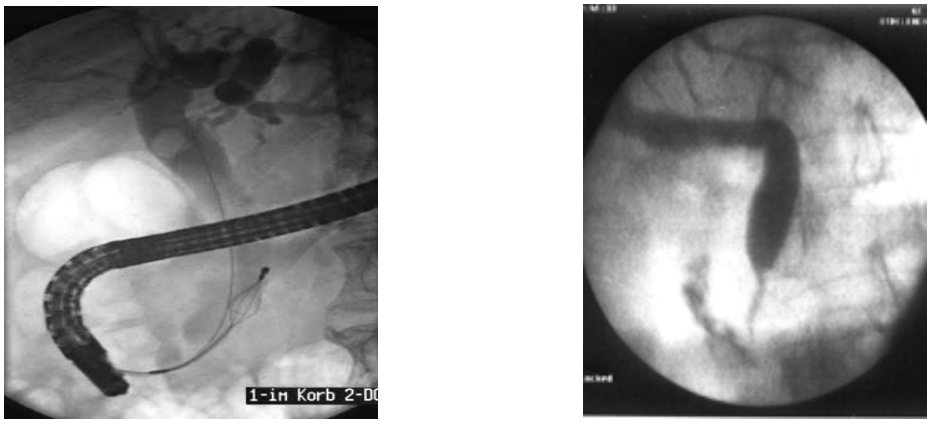


Figure 4 — ERCP: A — gallstones without duct pathology; B — showing choledocholithiasis (extended CBD and stones are visualized)



A B

Figure 5 — ERCP:
A — choledocholithiasis, Dormia basket is introduced for litho-extraction;
B — stricture of the distal part of common bile duct with pre-stenotic expansion

Complications of ERCP

Invasive diagnostic techniques associated with biliary tract contrasting, have operational risk and unsafe in terms of developing complications, which occur in 3–10 % of cases. The most frequent complications in diagnostic and therapeutic ERCP are the development of acute pancreatitis (2–7 %) and cholangitis (1–2 %). Bleeding and perforation of the duodenum rarely occur in diagnostic ERCP, but typical in therapeutic ERCP when performing papillotomy (about 1 %).

2) Percutaneous transhepatic cholangiography (PTC)

For puncture of intrahepatic bile ducts special thin needle are designed, which avoids the complications, typical for this investigation, (blood and bile leakage into the peritoneal cavity). If the patient has expanded intrahepatic bile ducts, percutaneous transhepatic cholangiography can provide information about their condition in more than 90 % of cases, in the absence of expansion in 60 % of cases.

In PTC bile ducts are contrasted in the direction of physiological bile flow unlike ERCP, so location and size of the obstruction is visible. Using a thin needle «Chiba» 0.7 mm allows puncture of extended hepatic ducts and receive information about the extra-and intrahepatic bile ducts, where as the non-invasive methods do not provide clear diagnostic criteria.

Indications for PTC:

• Differential diagnosis of cholestasis with dilated bile ducts and uninformative ERCP (often at «lower» block of the common bile duct);

• Suspected abnormality of the bile ducts in childhood;

• Extrahepatic cholestasis at biliodigestive anastomosis.

Contraindications:

• Allergy to contrast (dye);

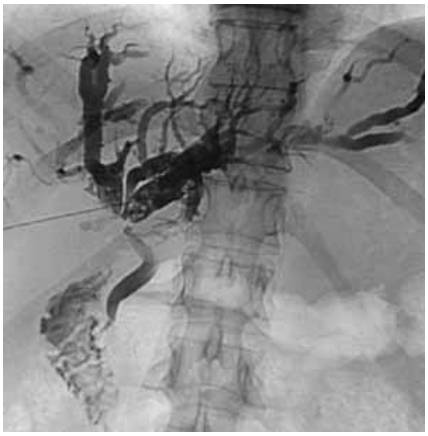
• General serious (severe) condition of the patient;

• Violation of the coagulation system (PTI less than 50 %, platelets less than 50×10×9 / l);

• Renal failure, ascites;
• Hemangiomas of the right lobe of the liver;
• Colon interposition between the liver and the anterior abdominal wall.

Complications:

• Choleperitonitis;
• Bleeding into the abdominal cavity;
• Hemobilia — getting blood into the bile ducts due to pressure gradient (manifested in the right upper quadrant pain, clinical jaundice and bleeding from the upper gastrointestinal tract);
• Formation of fistula between the bile ducts and blood vessels of the liver with penetration of bacteria from the biliary system into the bloodstream and the development of septicemia.



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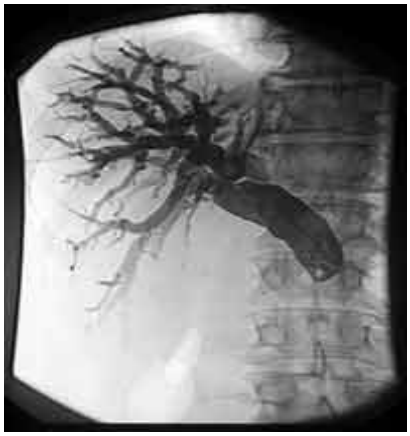


B

Figure 6 — PTC:
A — Cholangiolitiasis (a filling defect with clear smooth contours, extended ducts);
B — Cancer of LDP: narrowing of the terminal CBD by «cigar» type

3) Contrasting through gallbladder (fistula cholecystocholangiography)

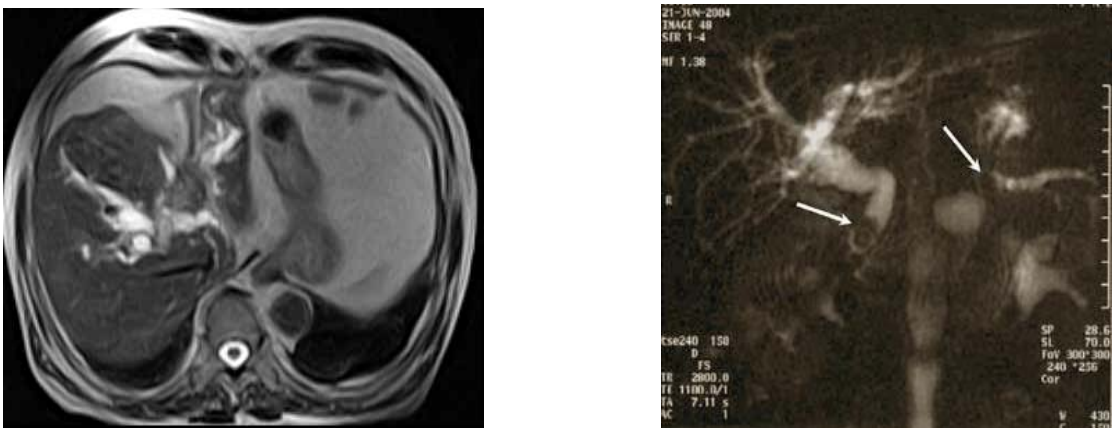
One of commonest way to contrast the biliary tree — using cholecystostomy imposed directly (surgically) or by puncturing under ultrasound control or laparoscopy. Main indication for implementation of such study is the patency of cystic duct. On this, as a rule, evidence is flow of bile on the drainage. Most often, the need for external drainage of the gallbladder occurs at a combination of obstructive jaundice with acute destructive cholecystitis or for tumors of the pancreatic head (distal ducts) when extremely serious condition of the patient does not allow a palliative or radical intervention in the traditional way.

4. COMPUTED TOMOGRAPHY (CT) AND MAGNETIC RESONANCE IMAGING (MRI)

Upon reasonable suspicion of pancreatic cancer CT with contrast is indicated. CT has a high significance, along with allowing the identification of ductal dilatation and the reasons for their obstruction, to perform biopsy or decom-

pression surgery. Unlike ultrasound diagnostic capability of CT is not affected in flatulence, ascites, obesity.

In recent years, widespread use of magnetic resonance cholangiopancreatography (MRCP) is acquired, which has high accuracy in diagnosing the cause of jaundice, particularly in assessing the nature and extent of the strictures of the biliary tract, as well as within the ductal structures (Figure 7).



A **B**

Figure 7 — A — CT image of cholangiocarcinoma;
B — MRI image of choledocholithiasis

5. RADIOISOTOPE SCINTIGRAPHY

Method which study the distribution of radio nuclides, selectively absorbing by the liver, in order to assess its structure. Scanning reveals intrahepatic defects of accumulation.

Causes of intrahepatic accumulation defects:

• benign and malignant tumors (primary, metastatic);
• abscesses (pus, amoebic, tuberculosis);
• cysts (solitary, polycystic, hydatid disease);
• other reasons (cirrhosis, focal nodular hyperplasia, acute hepatitis, amyloidosis).

Different focal lesions detected on a scintigram as sharp drop zones of accumulation of radio nuclides that looks on black and white scintigram as lesions with rough contour, rare or without shading or region of sharp change of color bar.

6. LAPAROSCOPY

If enumerated diagnostic measures have been insufficient for diagnosis, mainly to confirm the neoplastic process (primary or metastatic) in hepatoduodenal region, if necessary, laparoscopy with biopsy is to be used. The purpose of research is to defined the possibility of surgical intervention of a malignant tumor and biopsy.

During laparoscopy performed for the differential diagnosis of acute inflammatory diseases of abdomen may be done cholecysto-cholangiography, choledochotomy with intra operative cholangiography and subsequent implementation of the decompression of the bile duct by lithoextraction and external drainage.

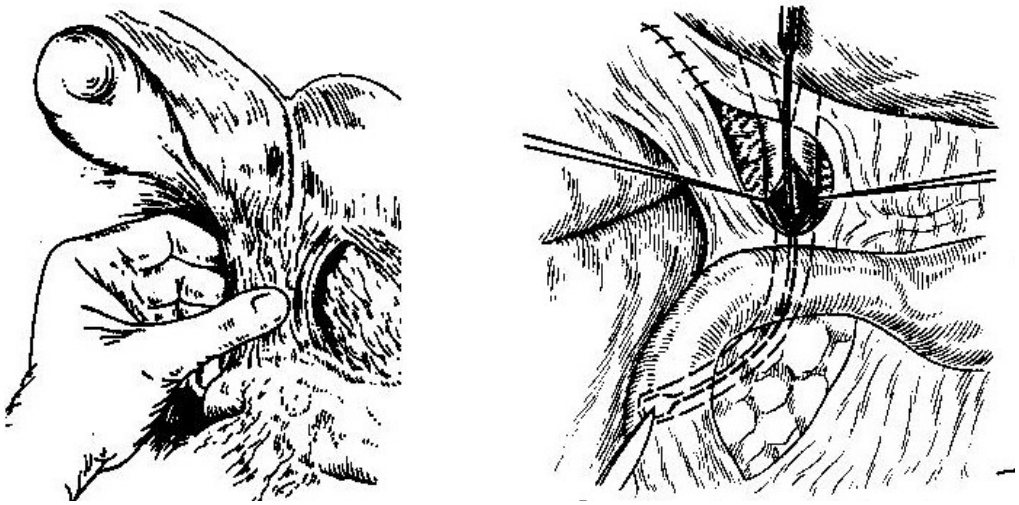
7. INTRAOPERATIVE INVESTIGATIONS OF BILE DUCT

Most often, need for these investigations, arises in emergency and urgent surgical intervention (rarely planned) on the gallbladder in patients with a high probability of choledocholithiasis with inability to perform ERCP and PTC. This group includes patients with extended bile duct or multiple small stones in the bladder (detected by ultrasound), with a history of jaundice, even short-term, following the attack of acute pain in the right upper quadrant or biochemical markers of cholestasis without clinical signs of jaundice.

The methods of intra-operative examination of biliary tract include:

• palpation of the common bile duct in the hepatoduodenal ligament, measuring the diameter of the common bile duct;

• probing through choledochotomic hole with plastic, metallic and other probes (figure 8);



A **B**

Figure 8 — Intra-operative examination of biliary tract:
A — palpation of the CBD; B — Probing of CBD

• intra-operative cholangiography with the introduction of contrast through the cystic duct stump or choledochotomic hole (figure 9);

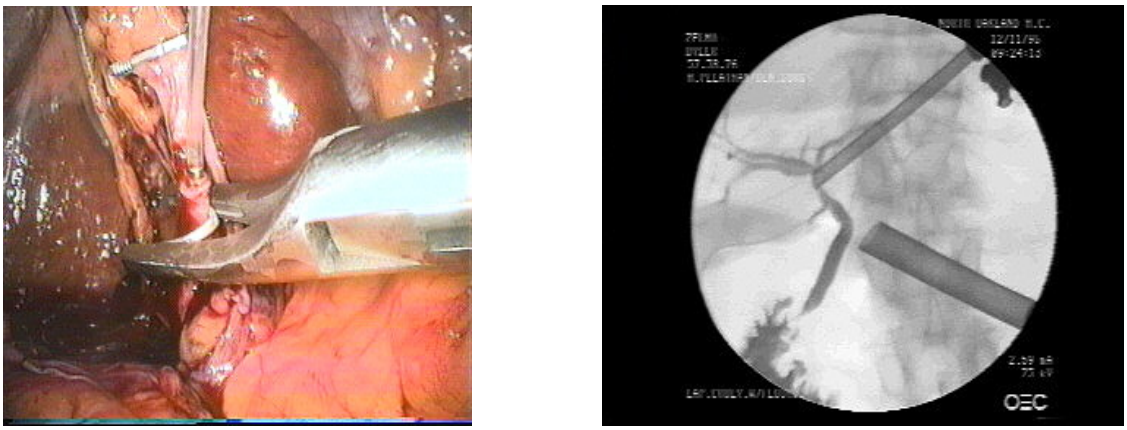


Figure 9 — Intraoperative cholangiography
(isolation of the cystic duct during laparoscopic cholecystectomy, opening its lumen, cannulation and administration of contrast)

• choledochoscope (examination using special miniature endoscopes);
• intraoperative ultrasonography;
• transillumination (translucence of CBD using special lamps) — rare.

VIII. DIFFERENTIAL DIAGNOSIS

Primarily obstructive jaundice should be differentiated from jaundice of other aetiology (haemolytic and parenchymal). Clinical, instrumental and laboratory methods are helpful to make a differential diagnosis.

Table 1 — Differential diagnosis of jaundice

	Haemolytic	Hepatic	Obstructive
History	Jaundice in childhood, similar disease in relatives, increasing jaundice after exposure to cold	Exposure to toxic substances, alcohol abuse, contact with jaundice patients, infections (mononucleosis), injections, blood transfusion	Attacks of pain in the right upper quadrant, often accompanied by jaundice, biliary tract surgery, weight loss
Onset	Rapid, anemia, sometimes fever, chills	Gradually after a period of nausea and loss of appetite	Rapid progression after the onset of pain associated with obstruction of stone. The gradual development in neoplasia
Skin colouring	Pale yellow with lemon shade	Orange, yellow	Green shade of jaundice, yellowish gray
Intensity of Jaundice	Mild	Moderate	From moderate to severe
Skin itching	None	Less persistent	Persistent
Heaviness in the liver area	None	Often in the early stage of disease	Rare, excluding acute cholecystitis
Liver size	Normal, may be a moderate increase	Increased, normal or decreased	Normal or increased
Pain in the right upper quadrant	None	Rare	Often
Spleen size	Increased	Often increased	Usually not increased
Urine colour	Normal. Can be dark at high uro-bilirubinuria	Dark (presence of conjugated bilirubin)	Dark (presence of conjugated bilirubin)
Urobilin content in urine	Highly increased	May be absent for short period, further excessively or moderately elevated	None at full obstruction
Colour of feces	Normal or dark (increased stercobilin)	Usually normal, can be pale (stercobilin reduced, increased amount of fat)	Acholi (pale). No stercobilin, increased amount of fat)
Liver function tests	Elevated levels of unconjugated (indirect) bilirubin in the blood, sediment tests are negative, alkaline phosphatase is not changed	Elevated levels of direct and indirect bilirubin. Alkaline phosphatase activity is increased, increase in transaminases. Sediment samples are positive	Elevated level of conjugated bilirubin in the blood. Increased activity of alkaline phosphatase. Prolonged prothrombin time, correctable with Vit. K injection

	Haemolytic	Hepatic	Obstructive
Special tests	Hemolysis tests positive. Coombs' test. Determination of resistance of erythrocytes. Hemoglobin electrophoresis	Liver biopsy, laparoscopy. Radioisotope study with rose bengal or colloidal gold	A radiograph examination of the gastrointestinal and biliary tract. Laparoscopy. Liver biopsy. EGDS, ERCP, PTC and liver scan. Determination of enzyme (amylase) in blood and urine

PECULIARITIES OF THE CLINICAL PICTURE IN SOME DISEASES

1. Malformations: occur in childhood, congenital jaundice, in the absence of surgical treatment die from biliary cirrhosis.

2. **Gallstone disease — choledocholithiasis:** history — detection of calculi in the gallbladder, biliary colic. Prior to the development of jaundice — a pain in the right upper quadrant with typical irradiation, dyspepsia, darkening of the urine, pale stool, skin itching, frequent recurrence. Ultrasound signs of biliary hypertension, detection of stones. ERCP — detection of calculi in the common bile duct or in LDP. No inflammatory changes in the gallbladder.

3. Inflammatory diseases: acute onset, non-compliant diet, severe abdominal pain with typical localization and irradiation (pancreatitis, cholecystitis), fever, signs of inflammatory lesions of the gallbladder or pancreas (clinical, laboratory and instrumental).

In parasitic cysts (intrahepatic obsructive jaundice) a long preceded jaundice is observed, often for many years during the growth of the cyst. Symptoms are often dull pain in the right hypochondrium and foreign body sensation, especially when the body is bending.

4. Neoplastic Diseases: slowly progressive increase of painless jaundice, a manifestation of intense skin itching (poorly controlled by therapy), signs of cancer intoxication, painless palpable enlarged distended gallbladder (Courvoisier sign), chronic pain in the upper abdomen, ultrasound signs of pancreatic tumors, ERCP — visualization of the tumor lesion, CT, MRI, laparoscopy.

5. Postoperative strictures: History of surgeries in the biliaro-pancreatic zone.

It should also be be remembered that the yellow staining of the skin and other tissues of the organism can occur in normal conditions with abundant meal containing coloring agents, such as carrots (carotene), or certain drugs (quinacrine).

In the differential diagnosis of jaundice must be remembered so-called functional hyperbilirubinemia, developing in connection with congenital enzymopathy and impaired bilirubin metabolism, leading to persistently elevated blood levels of unbound bilirubin is known as Gilbert syndrome, Crigler-Najjar, Dubin-Johnson.

Certain complexity is determining the cause of jaundice, which developed in the postoperative period.

Postoperative jaundice may be associated with many **causes**:

1. Surgical mistakes: during the operation stones in common bile duct, swelling or stricture of the distal common bile duct were not detected, incident ligation of CBD.

2. Acute pancreatitis (swelling of the head of the pancreas can cause compression on the CBD).

3. Heart surgery with implantation of artificial valve (possible development of hemolytic jaundice).

4. Resorption of large hematomas, but jaundice only occurs when there are associated disorders of bilirubin metabolism, such as Gilbert's syndrome.

5. Hepatitis, developing due to transfusion of blood.

6. Medicines, particularly use of anesthetics, halothane and its analogues.

7. Unrecognized preoperative liver disease, including latent cirrhosis, which is decompensated due to surgery.

IX. TREATMENT OF OBSTRUCTIVE JAUNDICE

The main goals of treatment:

1) elimination of cholestasis;

2) prevention and treatment of renal and hepatic failure.

Considering the high mortality rate at operations on jaundice, it is advisable to carry out a stage vise treatment.

Stage one: minimally invasive techniques for the elimination of cholestasis, combined with comprehensive conservative therapy. If there is no effect and a progressive jaundice persists, need to perform urgent decompression interventions within 2–3 days of hospitalization.

Stage two: after disappearing of jaundice, under more favorable circumstances, a radical surgery is required; if minimally invasive interventions were not helpful.

1. Conservative treatment

In assessing the clinical manifestations and management of patients with obstructive jaundice, most important fact, consider the degree of liver failure. According to clinical and laboratory indicators can be divided into 3 classes of its severity.

Table 2 — Criteria for assessing the severity of liver failure

Criteria	Degree of liver failure		
	I – Mild	II – Moderate	III – Severe
Duration of jaundice	Up to 7 days	7–14 days	More than 14 days
Encephalopathy	None	Loss of appetite, weakness, insomnia	Lack of appetite, severe weakness, inversion of sleep, euphoria
Haemodynamics	Stable	Stable	Hypotension
Diuresis	Sufficient	Sufficient	Reduced
Serum billirubin	Up to 100	100–200	More than 200
Blood urea	Normal	Normal	Elevated
Reduction of hepatic blood flow	About 25–30 %	30–50 %	More than 50 %
Albumin-globulin ratio	More than 1.2	1.2–0.9	Less than 0.9

In severe liver failure conservative therapy is carried out in the intensive care unit. Carried out a massive infusion therapy (glucose with insulin, saline solutions, rheopolyglucin, protein solutions, blood products) and forced diuresis. Conservative therapy is also included, a complex vitamin therapy and drugs that improve liver function (cocarboxylase, syrepar, essenciale). Amino acids (glutamic acid, methionine), metabolic stimulators (methyluracil, pentoxyl) and anabolic hormones should also be prescribed. Steroids are also advised (prednisolone). An important component of treatment is the prevention of acute erosions and ulcers of the digestive tract. For this purpose parenterally given gastric secretion blockers (famotidine, omeprazole, Pariet etc.) antacids and overlying gastric mucosa preparations (almagel etc.).

In cases of severe endotoxemia methods of extracorporeal detoxification are used (plasmapheresis, hemodialysis, hemosorption). An important task, treating patients with obstructive jaundice, is the prevention of acute cholangitis — infectious-inflammatory complications of obstructed biliary tract, which can cause severe inflammatory response, intrahepatic abscesses, acute hepato-cerebral and renal failure. Use of broad-spectrum antibiotics that penetrate into the bile is advised (3–4 generation cephalosporins, carbapenems, etc).

2. Surgical methods

At the *first stage* perform decompression (drainage) of biliary tract using minimally invasive access (percutaneous, endoscopic). After a slow elimination of jaundice, elimination of intoxication and improving liver function proceeds to a particular type of final treatment.

There are two basic ways to decompress the bile duct: minimally invasive surgery and direct intervention on biliodigestive system.

Minimally invasive instrumental techniques include:

• Endoscopic techniques (therapeutic ERCP with endoscopic papillosphincterotomy (EPST), lithotripsy, lithoextraction, bougienage and drainage of ducts).

• Percutaneous transhepatic cholangiostomy with external or external-internal drainage.

The direct surgical interventions include:

• Drainage through cholecystostomy;

• Laparoscopic common bile duct drainage;

• Reconstructive surgery on the biliary tract and overlay biliodigestive anastomosis (commonly not used at the first stage).

The definitive treatment of diseases accompanied by obstructive jaundice performed by the following methods:

• Duct stenting (endoscopic with ERCP or PTC) as palliative interventions.

• Radical surgery to restore bile flow of the biliary tract.

• Overlay biliodigestive bypass anastomosis.

Minimally invasive instrumental methods

An important advantage of minimal invasive surgical technologies is: a combination of high diagnostic and therapeutic efficacy with low trauma. Indications for use of a particular method of biliary tract decompression must be set in-

dividually, depending on the clinical situation, the nature, level and extent of the obstruction, the possibility of a hospital, qualification and skills of specialists.

a) Endoscopic papillosphincterotomy (EPST) and lithoextraction

EPST is the method of choice to eliminate jaundice caused by choledocholithiasis, impacted stone in LDP, narrowing of LDP (stenosing papillitis). EPST is also the method of choice for patients with suppurative cholangitis, which developed because of choledocholithiasis and jaundice and is the first stage choice of any interventions on the biliary tract. This procedure is possible, even in elderly patients with severe comorbidities.

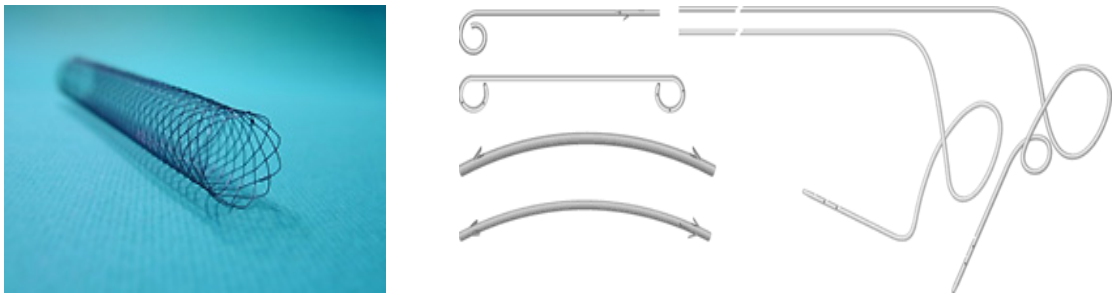
Indications, forecasting and effectiveness of method is based on an accurate representation of the nature of barriers to the outflow of bile (size of calculi, their location, quantity, condition of the CBD). If the size of calculi do not exceed the diameter of CBD, they can be removed by this endoscopic manipulation and thereby restore the passage of bile into the duodenum. Such situation occurs in approximately 90 % of cases, which ensures successful restoring of the bile ducts function using EPST in most patients.

b) Endoprosthesis of bile ducts (bouginage and stenting)

This method is used as a palliative intervention for inoperable tumors of pancreatobiliary zone.

Bouginage (from French, means — Probe, bougie) — introduction of special tools (bougies) in some tubular shape organs with a diagnostic or therapeutic purposes. Bougie — rigid or flexible rod for examination or expanding tubular organs. Stent — a framework for maintaining the patency of the hollow tubular structure. It can be done percutaneously or endoscopically.

Endoscopic stent implantation is less traumatic. First biliary stents were made of Teflon, as this material was sufficiently rigid and could stop tumor invasion without interrupting the internal drainage. In recent years, more soft material stents are widely used (polyethylene, polyurethane). Self-expanding metal (nitinol) is very effective, biliary stent «braided tube cylinder type» delivers in the system in compressed state. Plastic stents, in occlusion of bile ducts, are preferable to metal stents, because there is no tumor invasion and recurrence of jaundice occurs less frequently. However, plastic stents are more prone to deposition of salts of bile acids, which leads to their obstruction, and also have a greater tendency to migrate than metal. Stenting is a relatively safe and effective form of biliary drainage, which improves the quality of life of the patient.



A **B**

Figure 10 — Biliary stents: metal (A) and plastic (B)

c) Nasobiliary drainage

In patients with a high risk of cholestasis after removing stones or if you cannot remove them endoscopically, performe nasobiliary drainage for decompression of bile duct.

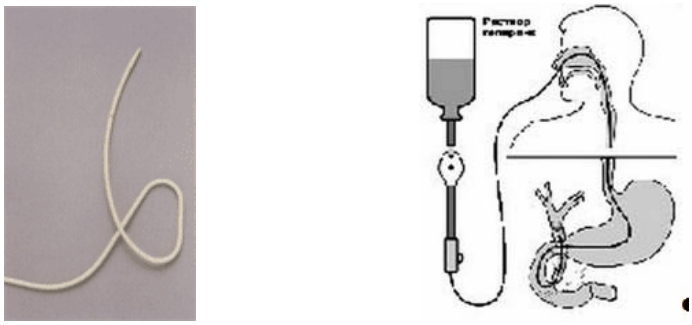


Figure 11 — Nasobiliary drainage and diagram of drainage process

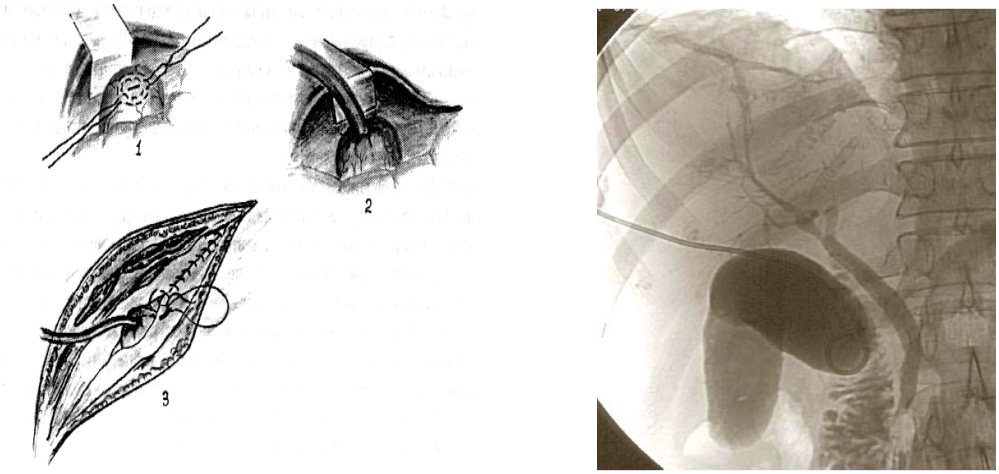
Percutaneous transhepatic cholangiostomy

In the presence of a «high block» of the bile ducts (tumor, stricture, rarely calculus) along with retrograde endoscopic methods of decompression is possible to use ante grade percutaneous transhepatic biliary drainage, followed by the outer, outer-inner (if possible to carry out drainage below the obstruction) biliary drainage.

DIRECT SURGICAL INTERVENTIONS

1) Cholecystostomy with external drainage

External cholecystostomy is most acceptable in the complex therapy of acute pancreatitis complicated with obstructive jaundice. Its implementation is possible only, if the cystic duct is patent. Cholecystostomy can be performed by laparotomy, laparoscopic and gallbladder puncture under ultrasound guidance. Cholecystostomy under ultrasound guidance is relatively easy to perform, safe and highly effective (figure 12).



A **B**

Figure 12 — A — Layout of an open cholecystostomy
(1 — the imposition of purse-string suture,
2 — Introduction of the tube and tightening of the pouch,
3 — fixing the gallbladder to the abdominal wall),
B — performed fistula-cholecystocholangiography)

2) Laparoscopic choledochotomy

As biliary decompression method may be used when is required to conduct a diagnostic laparoscopy for the differential diagnosis of jaundice or diagnosis of acute inflammatory process of the abdominal cavity. In case of non-functioning gallbladder (cystic duct obstruction is confirmed by operating cholecystocholangiography), choledochotomy or puncture of choledoch with its external drainage is possible.

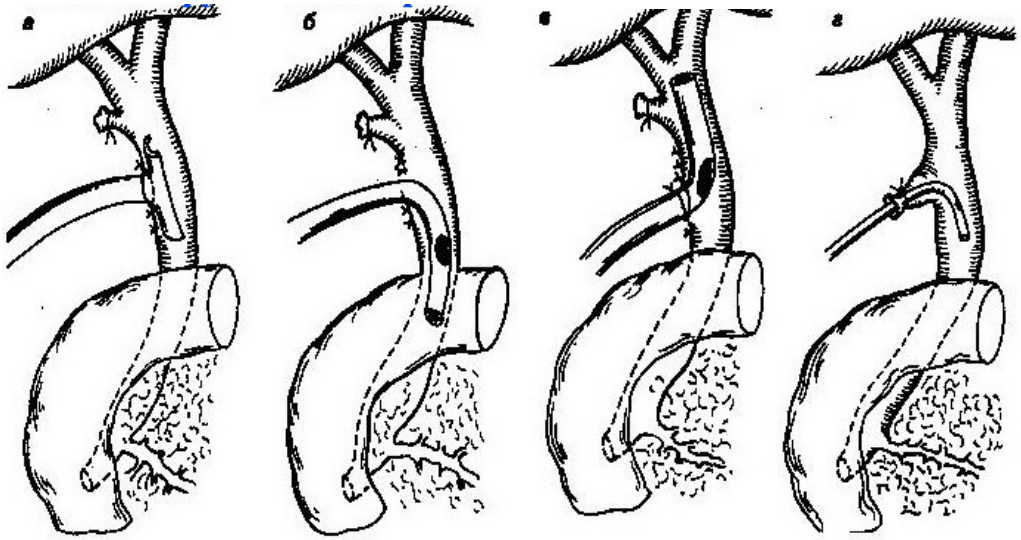


Figure 13 — Types of external drainage of of choledoch:
a) by Qer; b) by Kert; c) by Wisniewski; d) by Halsted

Surgical operations to restore patency of the biliary tract

These operations are typically performed in the second stage after the resolution of obstructive jaundice and stabilization of the patient, either under vital indications with persisting jaundice (destructive cholecystitis complicated by perforation and peritonitis, failure of ERCP, PTC, mental illness, large stone fixed in neck obstructing the CBD). Selecting the method of operation is based on the results of preoperative and intraoperative investigations and subject to the overall condition of the patient. Commonly used variety of options, choledochotomy and litho-extraction in cholelithiasis complicated with choledocholithiasis and overlay biliodigestive anastomosis in tumors of pancreatobiliary zone.

Choledochotomy and litho-extraction

Can be performed as a classic open method, minimal access or laparoscopic. Most popular in the operations on the biliary tract are oblique incision in the right upper quadrant (by Kocher, Fedorov). Rarely used upper-middle laparotomy. Interventions on the bile ducts in patients with cholelithiasis usually performed after cholecystectomy. Choledochotomy is conducted in the supraduodenal part of CBD as distal as possible and below the cystic duct. It is necessary to shorten the channel, administration of instruments and the creation of favorable conditions for the formation of the anastomosis. The front wall is cut for 10–20 mm, further in-

spection of duct is carried out using a round ended forceps, spatulas or tweezers, with which stones are extracted. Balloon catheters are also used, especially for the removal of stones, migrated into hepatic ducts. After removing the stones, make sure ducts patency by probing, intra operation cholangiography or choledochoscopy. The operation ends with suturing of CBD, only if removal of all stones is assured and there are no signs of cholangitis. In other cases, external drainage is recommended. Choledochoduodenostomy or choledochoenterostomy is used in irreversible obstruction of the distal common bile duct, which cannot be resolved by endoscopic papillosphincterotomy (extended scar stenosis, indurative pancreatitis, «adverse» location of para-papillary diverticula).

Laparoscopic choledochotomy and litho-extraction

Performed at the planned laparoscopic cholecystectomy in patients with cholelithiasis, complicated with choledocholithiasis (in the absence of jaundice or its resolution using minimal invasive methods). Choledochotomy is carried out in supraduodenal part. In cases where the stones in the common hepatic duct clearly countered, choledochotomy is carried out directly over the stone. The length of the choledochotomic hole depends on the size of stone, but not less than 5 mm. In cases where choledochotomy is performed on the stone, stones should be removed using dissector or forceps. After removal of the stones choledochoscopy is performed, examined the distal and proximal parts of the biliary system, assesses the condition of the mucous of ducts, presence of stones, the condition of the major duodenal papilla and its patency.

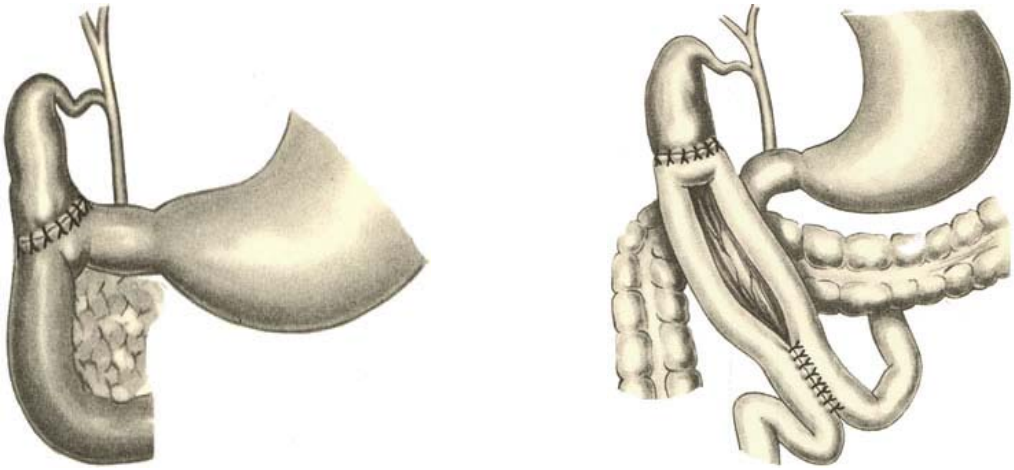
With multiple ductal stones of small and medium diameter, their removal is a more complicated task. In such cases, several techniques of removing stones are used. The most rational method is removal of small stones using Fogarty catheter under control of choledochoscope.

Overlaying of biliodigestive bypass anastomosis

Usually used in cases of tumors of pancreatoduodenal zone or in extended ducat scars with constrictions.

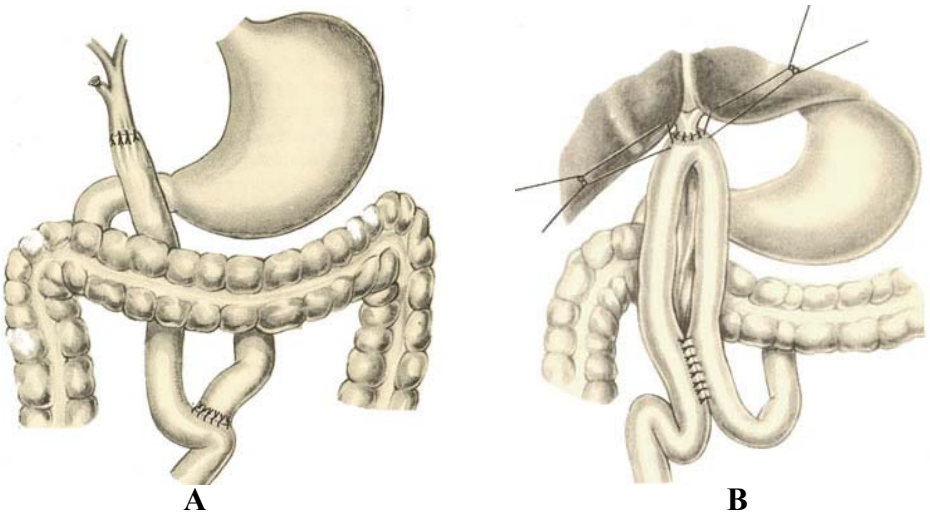
At high bile duct strictures complex reconstructive surgery is performed to restore the outflow of bile. Among them, the most famous biliodigestive anastomosis at different levels of the bile duct with a loop of small intestine is called Roux en Y (choledohojujenostomy).

In cases of tumors after liquidation of jaundice by minimally invasive methods radical or palliative surgery is performed. Opportunity to perform radical surgery in these patients has no more than 15–20 % of cases. In **radical operations** resection of zone, affected by neoplastic process, is performed (choledochal, pancreatoduodenal resection) with hepaticojujeno anastomosis. **Palliative operations** are aimed at creating biliodigestive bypass anastomoses. In the case of cancer of the pancreatic head, choice of operation is cholecystoenterostomy by Mikulicz. The cystic duct patency is a condition for successful decompression of the biliary tract in this operation. Roux en Y procedure almost eliminates recurrence of obstructive jaundice and suppurative cholangitis in the late postoperative period.



A **B**

Figure 14 — A — Cholecystodudenostomy;
B – Cholecystojujenostomy with Brown's anastomosis



A **B**

Figure 15 — A — Roux en Y procedure, B — Hepaticojujenostomy

Thus, the tactics of treatment of obstructive jaundice is as follows: *at the first stage* a comprehensive use of conservative therapy and minimally invasive techniques aimed at eliminating of cholestasis, due to the high risk of intraoperative morbidity and mortality. In the unresolved or increasing jaundice decompression intervention must be completed urgently within 2–3 days from the time of admission. In this case using different endoscopic techniques (EPST, litho-extraction, nazobiliary drainage etc). In some cases (choledocholithiasis) minimally invasive techniques can lead to the complete elimination of obstructive jaundice, rather than just unloading the biliary tract (litho-extraction at ERCP, through the external drainage).

If minimally invasive interventions have not become the ultimate way to treat, at the second stage with the elimination of jaundice in more favorable circumstances, surgical treatment is recommended (removal of stones, resection of tumors and imposing biliodigestive anastomoses).

Under vital indications, surgical interventions can be performed at high level of jaundice using traditional methods to restore biliary tract patency.

PROGNOSIS IN MECHANICAL JAUNDICE

Mortality in obstructive jaundice depends on the cause of obstruction, disease duration and severity of patients. However, most operative deaths usually occur in the malignant group. The overall postoperative mortality of operated obstructive jaundice is directly related to preoperative patient's serum bilirubin(especially greater than 250 mmol/l). The bile culture state (e.g. infection) is directly related to the morbidity, i.e. postoperative complications, rather than to the operative mortality.

Recently eight useful parameters were described in the prediction of risk in biliary surgery and correlate well with mortality. These parameters are given below:

Serum creatinine (more than 130 mmol/l), serum bilirubin (more than 100 mmol/l), serum albumin (less than 30 g/l), WBC (more than 10000), haematocrit (less than 30 %), malignancy, serum alkaline phosphatase (more than 600 units/l), and age (more than 60 years).

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