Review article

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RADIOLOGICAL DIAGNOSIS OF BILIARY TRACT OBSTRUCTION

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Biliary obstruction refers to an interruption in the normal flow of bile through the ducts that connect the liver, gallbladder, and small intestine. Intrahepatic cholestasis generally originates at the level of the hepatocytes or within the canalicular network of the liver. In contrast, extrahepatic obstruction may arise from blockages inside the ducts themselves or due to pressure from surrounding structures. Radiological imaging plays a vital role in identifying the presence and cause of obstruction. Ultrasonography (US) is typically the first-line imaging tool due to its accessibility and effectiveness in detecting bile duct dilation. Computed tomography (CT), while more precise in identifying the cause and site of the obstruction, is less frequently used as a routine method. Magnetic resonance cholangiopancreatography (MRCP) is a non-invasive imaging modality that allows detailed visualization of the biliary and pancreatic ducts without exposure to ionizing radiation. It is particularly useful in patients with a moderate or low likelihood of choledocholithiasis and in cases where endoscopic procedures are contraindicated. Endoscopic retrograde cholangiopancreatography (ERCP) is widely regarded as both a diagnostic and therapeutic tool for managing bile duct stones, performing stenting, and enabling biliary drainage. When ERCP is not feasible, percutaneous transhepatic cholangiography (PTC) may be utilized, especially for evaluating lesions near or above the level of the common hepatic duct. Endoscopic ultrasonography (EUS) provides excellent imaging of the biliary tree without radiation exposure and has a sensitivity comparable to that of ERCP and MRCP in detecting choledocholithiasis, with a relatively low complication rate.

Key words: biliary obstruction, diagnostic imaging, radiological methods

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RADIOLOŠKA DIJAGNOSTIKA OBSTRUKCIJE BILIJARNOG TRAKTA

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Opstrukcija žuči se odnosi na blokadu bilo kog kanala koji prenosi žuč iz jetre u žučnu kesu ili iz žučne kese u tanko crevo. Intrahepatična holestaza se uglavnom javlja na nivou hepatocita ili bilijarne kanalikularne membrane. Ekstrahepatična opstrukcija toka žuči može se pojaviti unutar kanala ili kao posledica spoljne kompresije. Radiološke metode su značajne u dijagnostici bilijarne opstrukcije. Ultrasonografija (US) je metoda izbora za inicijalnu detekciju bilijarne opstrukcije. Kompjuterizovana tomografija (CT) se smatra tačnijom od US u određivanju specifičnog uzroka i nivoa opstrukcije. Metoda je manje pogodna za rutinsku upotrebu u odnosu na US. Magnetno rezonatna holangiopankreatografija (MRCP) je neinvazivan način za vizuelizaciju hepatobilijarnog stabla, sa odsustvom zračenja. MRCP se može koristiti kod pacijenata sa niskim i srednjim rizikom od holedoholitijaze i kod onih sa kontraindikacijama za endoskopske procedure. Endoskopska retrogradna holangiopankreatografija (ERCP) je jedan od zlatnih standarda u dijagnozi i tretmanu kamena žučnih puteva, plasiranju stentova i drenaža. Perkutana transhepatična holangiografija (PTC) je rezervisana za upotrebu ako ERCP ne uspe i posebno je PTC od koristi za lezije proksimalno od zajedničkog jetrenog kanala. Endoskopska ultrasonografija (EUS) zbog odsustva zračenja predstavlja odličan metod za ispitivanje žučnih kanala. EUS ima približnu senzitivnost kao ERCP i MRCP za detekciju kamena u zajedničkim bilijarnim kanalima, sa minimalnim rizicima koji su direktno povezani sa procedurom.

Ključne reči: bilijarna opstrukcija, dijagnostika, radiološke metode

Introduction

Disorders of the biliary tract impact a considerable segment of the global population, with the majority of cases being associated with cholelithiasis. Bile, an exocrine secretion of the liver, is continuously synthesized by hepatocytes. It is composed of cholesterol and various substances, including bilirubin and bile salts, which facilitate the digestion of dietary fats. Approximately 50% of the bile produced is secreted directly from the liver into the duodenum through the biliary ductal system, ultimately via the common bile duct. The other half is stored within the gallbladder. Upon food intake, this stored bile is discharged into the duodenum. When bilirubin accumulates in the bloodstream and is subsequently deposited in the skin, it leads to the development of jaundice (icterus). Jaundice is characterized by a yellow discoloration of the skin, sclerae, and mucous membranes, resulting from bilirubin deposition in the tissues. Scleral icterus becomes clinically evident when total serum bilirubin exceeds 2 mg/dL, whereas yellowing of the skin is typically visible when levels surpass 3 mg/dL (1). These thresholds may vary depending on skin pigmentation and environmental lighting (2, 3).

In this review paper, the goal is to present a systematic approach to the patient with biliary obstruction, especially from the aspect of the role of radiological diagnostic methods.

Extrahepatic causes of biliary obstruction

Numerous etiologies can lead to extrahepatic biliary obstruction, broadly categorized into intraductal and extraductal origins (4, 5, 6).

Among the primary intraductal causes are biliary stones, both benign and malignant tumors, strictures within the biliary system, and parasitic infestations. Primary sclerosing cholangitis (PSC) is a distinct pathological entity that may also be classified under intraductal causes. Additionally, AIDS-related cholangiopathy can produce cholangiographic findings that closely mimic those of PSC.

Biliary stones represent the most frequent cause of obstructive jaundice. Calculi may migrate into the common bile duct and further into the distal choledochus, resulting in obstruction and increased pressure within the ductal system. Mirizzi syndrome describes a condition in which a stone lodged in the cystic duct or gallbladder neck exerts external pressure on the common hepatic duct, leading to proximal biliary obstruction. Furthermore, biliary calculosis is a predominant factor in the development of biliary strictures and subsequent obstruction (7, 8).

Extraductal causes involve compression from surrounding structures and include tumors of adjacent organs, pancreatic pseudocysts—especially those in close proximity to the bile ducts—and inflammation of the pancreas in both acute and chronic forms. In cases of chronic pancreatitis, fibrosis, pseudocysts, and firm inflammatory processes in the pancreatic head can cause distal bile duct obstruction. Moreover, in portal hypertension, markedly dilated collateral veins may exert compressive effects on the biliary tree (9, 10, 11).

A variety of tumors may result in biliary blockage. Neoplasms originating from the biliary epithelium (cholangiocarcinomas), tumors of the ampulla of Vater, and gallbladder carcinomas extending into the common bile duct are known intraductal causes. IgG4-related cholangiopathy may present with features that closely resemble cholangiocarcinoma. In approximately 60% of cases, pancreatic cancers are found in the head of the pancreas and can produce early biliary obstruction. Metastases, particularly from gastrointestinal malignancies, may reach the hepatic hilum and compress the extrahepatic bile ducts. Additionally, enlarged lymph nodes in the liver hilum can also exert pressure on these ducts (12, 13).

Parasitic infections, most commonly due to *Ascaris lumbricoides*, may lead to obstruction when the worms migrate from the intestinal lumen into the biliary tract, resulting in blockage of the extrahepatic bile ducts.

Complications arising from biliary obstruction include pruritus, impaired nutrient absorption, cholangitis, nutritional deficiencies, coagulation abnormalities, renal dysfunction, and eventually progressive hepatic failure (14, 15, 16).

Radiological diagnosis of biliary obstruction

The diagnostic approach to biliary obstruction should encompass a thorough medical history, detailed physical examination, laboratory analysis, and instrumental diagnostic procedures. Among the instrumental techniques, radiological imaging holds a central role. Key imaging modalities include abdominal ultrasonography (US), contrast-enhanced computed tomography (CT), magnetic resonance cholangiopancreatography (MRCP), endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangiography (PTC), and endoscopic ultrasonography (EUS). In cases where these evaluations fail to yield a definitive diagnosis, liver biopsy may be considered as a supplementary diagnostic measure (Figure 1) (17, 18).

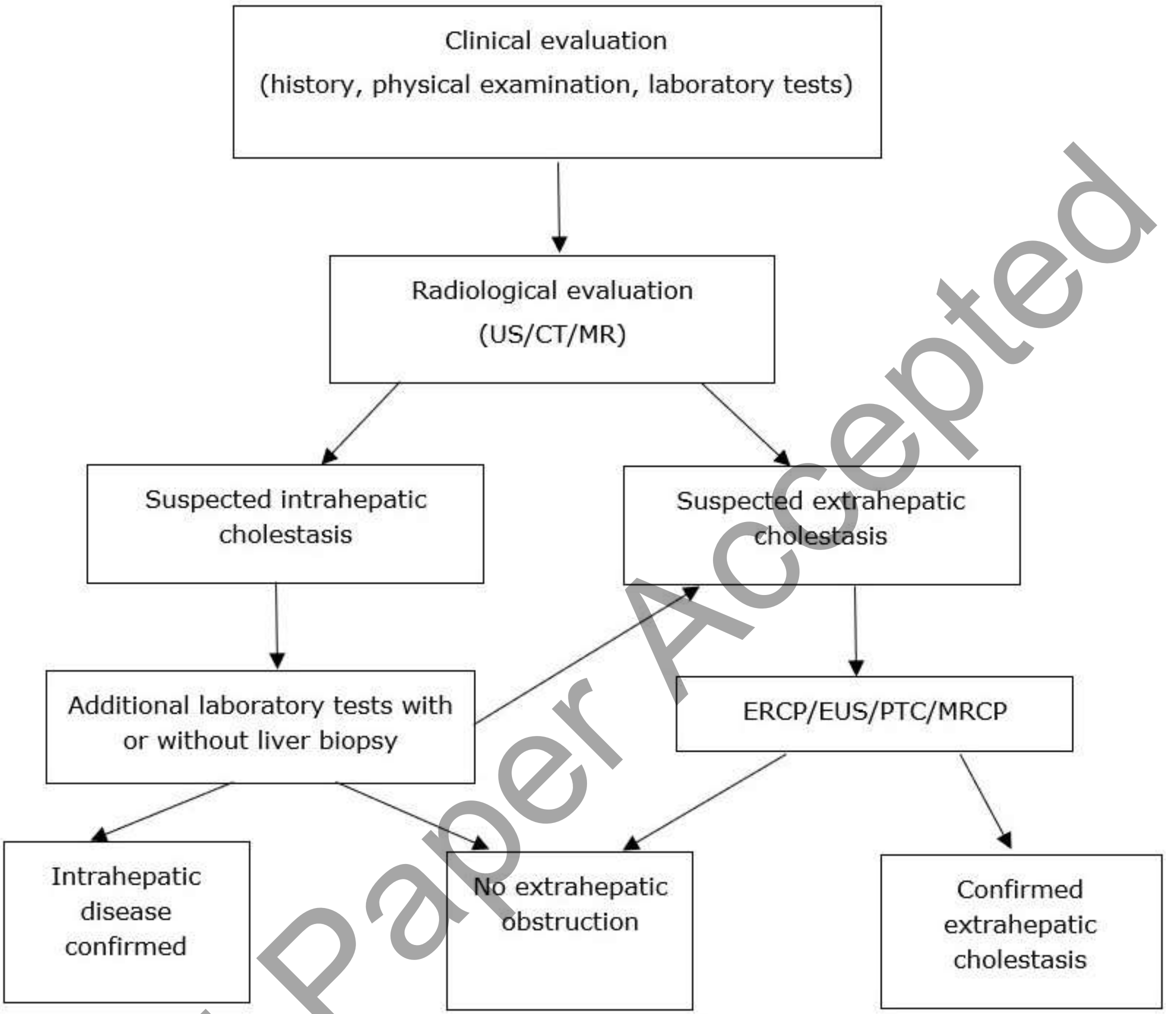

Figure 1. The role of radiological methods in the cholestasis examination algorithm. US, ultrasonography; CT, computed tomography; MR, magnetic resonance; ERCP, endoscopic retrograde cholangiopancreatography; EUS, endoscopic ultrasonography; PTC, percutaneous transhepatic cholangiography; MRCP, magnetic resonance cholangiopancreatography (18).

Ultrasonography (US) is particularly suitable for evaluating acute abdominal conditions due to its simplicity, absence of ionizing radiation, and the advantage of being safely repeatable. It is the primary imaging modality for diagnosing acute cholecystitis. In such cases—often caused by gallstone-induced bile duct obstruction—findings may include gallbladder distension, possible hydrops formation, wall thickening (typically greater than 3 mm) with layered appearance, pericholecystic fluid, and a positive sonographic Murphy sign, which has an estimated sensitivity of 88%. When this sign is observed alongside evidence of gallstones, the positive predictive value increases to approximately 92%. Acute cholecystitis generally presents as an acute flare-up of chronic cholecystitis, usually resulting from cystic duct obstruction by a gallstone (19).

US is also the preferred initial imaging method for detecting biliary obstruction, with a diagnostic accuracy ranging from 77% to 94%. In the early stages of acute obstruction, bile duct dilatation may not be visible for up to 4 hours to 4 days. Additionally, partial or intermittent obstructions may not lead to ductal dilation, and 20–40% of patients with choledocholithiasis may show a normal bile duct diameter. The normal diameter of the common bile duct (CBD) ranges from 4 to 6 mm, while measurements exceeding 8 mm suggest dilatation. It is important to consider that a mildly enlarged CBD may be physiological in post-cholecystectomy patients or the elderly.

A choledochal stone typically appears as a hyperechoic structure with posterior acoustic shadowing. However, intestinal gas—especially from the duodenum—can obscure visualization of the mid and distal CBD. Shifting the transducer and having the patient ingest water to create an acoustic window can improve imaging quality. A classic indirect indicator of CBD obstruction is the "parallel channel sign," where a dilated bile duct runs parallel to the portal vein. This sign may also be observed in distal obstructions caused by ampullary or pancreatic head tumors. In certain cases, choledocholithiasis may exist without upstream biliary dilatation, especially if the stone is mobile.

Obstruction of bile flow may lead to cholangitis, which can be visualized sonographically as echogenic bile—suggestive of pus—within dilated ducts, often accompanied by thickened ductal walls due to inflammation. Nevertheless, US has limitations in precisely locating the obstruction, especially in the distal CBD, and its effectiveness is reduced in patients with significant bowel gas or obesity.

Transabdominal ultrasonography remains the first-line diagnostic tool in suspected choledocholithiasis, although complete visualization of the extrahepatic bile ducts is only achieved in 60–80% of cases (20, 21). Reported sensitivity for detecting bile duct stones ranges from 25% to 82%, with specificity between 56% and 100%, and positive and negative predictive values of approximately 69% and 78%, respectively (22). Such variability can be attributed, in part, to operator dependence and variations in skill and experience (23).

Further detail may be obtained with Color Doppler US or contrast-enhanced ultrasonography, particularly in evaluating portal hypertension and detecting small neoplastic lesions (2).

Computed Tomography (CT)

Computed tomography (CT) is generally regarded as more precise than ultrasonography (US) when it comes to identifying the exact etiology and anatomical location of biliary obstruction. It also provides enhanced visualization of hepatic structures. The use of intravenous contrast further improves delineation of both vascular anatomy and the biliary tree. CT imaging is particularly indicated when US findings are inconclusive or ambiguous.

However, CT has limited diagnostic value for biliary calculi, as many stones are radiolucent and can only be detected if they are calcified. Its utility is also reduced in diagnosing cholangitis. Furthermore, the method is associated with higher costs, involves exposure to ionizing radiation, and is therefore less suitable for routine evaluation compared to US.

The development of spiral (helical) CT scanning has improved biliary imaging by allowing acquisition of overlapping images in a shorter scanning time, thereby enhancing spatial resolution and minimizing respiratory motion artifacts (Figure 2).

Figure 2. MSCT of the abdomen shows the presence of calculus in the choledochus and gallbladder (Radiology Center, Clinical Center Niš)

Spiral CT cholangiography is frequently employed to visualize the biliary system, offering the capability to detect radiolucent stones and a range of biliary abnormalities. Nevertheless, one of its limitations is the potential for adverse reactions to contrast agents. Additionally, elevated serum bilirubin levels can impair the visualization of the biliary tree using this technique (24).

Magnetic resonance cholangiopancreatography (MRCP)

MRCP is a non-invasive imaging technique that allows for detailed visualization of the hepatobiliary system without the use of ionizing radiation. It is particularly useful in patients with a low to intermediate probability of choledocholithiasis or in those for whom endoscopic procedures such as ERCP are contraindicated. MRCP enables radiologists to evaluate raw source data, along with both two-dimensional and three-dimensional reconstructions. While some imaging protocols may require breath-holding to optimize image quality, advancements in technology have reduced scanning time and introduced methods that accommodate image acquisition between respiratory cycles. The MRCP protocol relies on heavily T2-weighted sequences that highlight static fluid, making dilated biliary and pancreatic ducts easily identifiable. Thanks to the development of rapid imaging techniques and advanced 3D reconstructions, post-processed images can closely resemble those obtained via direct cholangiographic methods such as ERCP or PTC.

MRCP is a highly sensitive tool for identifying stones in the biliary and pancreatic ducts, as well as for detecting strictures, ductal dilatations, and tumors (Figure 3). When combined with conventional abdominal magnetic resonance imaging, MRCP can also yield valuable insights into adjacent anatomical structures, such as pseudocysts or masses.

Figure 3. MRCP: calculus in the prepapillary region in the ductus choledochus with dilatation of the ductus choledochus and ductus hepaticus comunis, as well as gallbladder calculus (Radilogy Center, Clinical Center Niš)

Although both ERCP and MRCP are effective in diagnosing malignant hilar and perihilar obstructions, MRCP has demonstrated superior capability in defining tumor type and extent.

Importantly, MRCP visualizes the ductal system without the need for contrast injection, thereby eliminating the risk of contrast-induced complications that can occur with ERCP (25, 26, 27).

Despite its advantages, MRCP has certain limitations, particularly related to magnetic resonance imaging (MRI) contraindications. Absolute contraindications include the presence of pacemakers, cerebral aneurysm clips, ocular or cochlear implants, and intraocular metallic foreign bodies. Relative contraindications may include prosthetic heart valves, neurostimulators, metallic implants, and penile prostheses. MRCP is also susceptible to image artifacts and requires good patient cooperation for optimal results. Fluid-filled structures near the duodenum or the presence of ascites can create artifacts that obscure the biliary tree. The safety of MRCP during pregnancy remains uncertain. Additionally, this modality is relatively costly and its diagnostic quality heavily depends on the examiner's expertise (28, 29, 30).

In contemporary clinical practice, MRCP has become a valuable non-invasive modality for preoperative evaluation in patients presenting with obstructive jaundice. It is increasingly replacing more invasive diagnostic methods like ERCP and PTC, which were previously considered the gold standard. With continued technological refinement, MRCP has proven to be a dependable technique for imaging the biliary system in obstructive jaundice and plays a significant role in surgical planning. Although it does not offer therapeutic intervention like ERCP, MRCP provides crucial diagnostic information with significantly reduced risk to the patient (31).

Endoscopic retrograde cholangiopancreatography (ERCP)

ERCP is an invasive diagnostic and therapeutic procedure that integrates endoscopic and radiological techniques to visualize the biliary and pancreatic ductal systems. It is regarded as one of the gold standard methods for both the diagnosis and management of gallstone-related conditions. During the procedure, the ampulla of Vater is endoscopically located and cannulated, after which a contrast agent is injected into the ducts. Radiographic images are then obtained to evaluate the diameter, length, and trajectory of the biliary and pancreatic ducts (17).

ERCP is especially effective for evaluating lesions located distal to the bifurcation of the hepatic ducts. Beyond its diagnostic utility, ERCP offers several therapeutic capabilities, such as the removal of stones, performance of sphincterotomy, and placement of stents or drainage catheters. One of its key advantages lies in the ability to extract stones using balloon or basket catheters following sphincterotomy. However, small stones may occasionally be overlooked, particularly in cases of markedly dilated common bile ducts. Cholangioscopy using small-diameter endoscopes (commonly referred to as "baby" scopes) can enhance lesion detection during ERCP and allows for targeted intraductal biopsies.

Despite its strengths, ERCP is limited in its ability to visualize portions of the biliary tree proximal to an obstruction. Furthermore, it cannot be performed when anatomical alterations, such as a Roux-en-Y reconstruction, prevent endoscopic access to the ampulla of Vater (18).

Potential complications of ERCP include pancreatitis, perforation, biliary peritonitis, sepsis, hemorrhage, and adverse reactions to contrast media or pharmacological agents used for duodenal relaxation. These complications occur in approximately 3–6% of cases, rising to 5.3–6.5% when papillotomy is performed (32, 33). Severe complications are rare, occurring in less than 1% of procedures, while mortality rates range between 0.1% and 1.3% (34, 35, 36).

ERCP demonstrates high diagnostic accuracy, with sensitivity and specificity ranging from 89–98% and 89–100%, respectively. In cases focused solely on choledocholithiasis, sensitivity is reported between 73–93%, and specificity between 92–100%. Despite the availability of less invasive alternatives, ERCP remains the reference standard for biliary system imaging, particularly when therapeutic intervention is anticipated (23, 37).

Percutaneous transhepatic cholangiography (PTC)

PTC is a procedure carried out by a radiologist under fluoroscopic guidance. The technique begins with a targeted puncture of the liver to access the peripheral intrahepatic bile ducts. Following this, an iodine-based contrast agent is injected into the biliary system, allowing visualization of bile flow and any obstruction on the fluoroscopic screen. PTC is especially valuable for evaluating lesions located proximal to the common hepatic duct.

Due to its technical complexity, PTC requires a high level of operator expertise. The procedure may be unsuccessful in over 25% of attempts, most commonly when the bile ducts are poorly visualized because they are not dilated.

Complications associated with PTC include allergic reactions to the contrast medium, peritonitis, intraperitoneal hemorrhage, sepsis, cholangitis, subphrenic abscess formation, and pulmonary complications such as lung collapse. Severe complications occur in approximately 3% of cases.

PTC provides excellent diagnostic accuracy—between 90% and 100%—for determining the cause and exact location of biliary obstruction when the pathology lies within the bile ducts. In patients with dilated ducts, successful opacification is achieved in 99% of cases, while in non-dilated ducts, the success rate ranges from 40% to 90%. Nevertheless, ERCP is generally preferred when feasible, with PTC serving as an alternative in cases where ERCP is unsuccessful or anatomical alterations preclude access to the ampulla of Vater.

Today, both ERCP and PTC are used primarily for therapeutic purposes rather than initial diagnosis. For diagnostic evaluation, MRCP is considered the more appropriate and non-invasive alternative (18, 38).

Endoscopic ultrasonography (EUS)

EUS integrates endoscopic and ultrasonographic techniques to generate high-resolution images of the pancreas and biliary tract. By utilizing high-frequency ultrasound waves (typically 20 MHz, compared to 3.5 MHz in conventional ultrasonography), EUS enables superior image clarity and allows for diagnostic tissue acquisition via EUS-guided fine needle aspiration (EUS-FNA). Due to its non-radiative nature, EUS is an excellent modality for evaluating the bile ducts, capable of detecting even subtle findings such as microlithiasis or biliary sludge. In most instances, choledocholithiasis appears on EUS as a rounded hyperechoic structure with characteristic posterior acoustic shadowing. The extrahepatic bile duct can be fully visualized in approximately 96% of cases (20). Numerous studies have reported EUS sensitivity and specificity for bile duct stone detection ranging from 88–97% and 93–100%, respectively. As a minimally invasive technique, EUS is particularly advantageous in patients suspected of choledocholithiasis, offering a safer and more cost-effective alternative to ERCP, as well as to laparoscopic and open surgical bile duct explorations (39, 40).

Patients at low risk for common bile duct stones typically present with normal liver function tests, a bile duct diameter of ≤ 7 mm, and no history of gallstones. Their risk of harboring choledocholithiasis is estimated at 2–3%. Moderate-risk patients may exhibit a history of acute cholangitis or biliary pancreatitis, elevated liver enzymes, or mild ductal dilation (8–10 mm), with a 20–50% chance of choledocholithiasis. High-risk individuals are characterized by recent episodes of cholangitis or pancreatitis, clinical jaundice, marked elevation of alkaline phosphatase, or bile duct dilation ≥ 11 mm, and may carry a 50–80% risk of stone presence (23).

In a prospective study by Polkovski et al. (39), EUS was compared to ERCP in 100 patients, divided into two equal subgroups. EUS or ERCP was initially performed, followed by crossover procedures in cases of failure. Diagnostic success and the rate of moderate to severe complications were similar in both groups. Gallstones were detected in 14 patients by EUS and in 12 by ERCP, with no significant difference in the total number of procedures required over the study period. The authors suggested that EUS may replace diagnostic ERCP in moderate-risk patients, while ERCP should be reserved for therapeutic interventions.

According to Di Angelo et al. (21), ERCP remains the preferred intervention in high-risk patients, whereas EUS should be prioritized in those with low to intermediate risk.

Although ERCP is a standard method for biliary decompression, anatomical or technical barriers may preclude ductal access. In such cases, interventional EUS-guided cholangiography (IEUC) may serve as an alternative to PTC. In a five-year study by Maranki et al. (40), IEUC was performed in 49 patients after failed ERCP, utilizing either a transgastric-transhepatic or a transenteric-transcholedochal approach. Stent placement was achieved in 84% of cases, with an overall complication rate of 16%. Biliary decompression was successful in 83% of patients overall, 73% via intrahepatic, and 78% via extrahepatic approaches. No procedure-related mortality was reported, highlighting IEUC as a viable option when ERCP is not feasible.

An international multicenter retrospective analysis compared EUS-guided biliary drainage and ERCP in 208 patients with malignant distal bile duct obstruction. Both techniques achieved similarly high success rates in stent placement—94.23% for EUS and 93.26% for ERCP—with comparable adverse event rates (8.65%) and similar procedure durations. However, post-procedural pancreatitis was observed only in the ERCP group (4.8% vs. 0%, $P = 0.059$) (41).

EUS has demonstrated up to 98% diagnostic accuracy in patients with obstructive jaundice, often eliminating the need for ERCP in those without extrahepatic obstruction. It also effectively identifies candidates for surgical biliary drainage without the necessity of further endoscopic evaluation (42).

EUS provides high-resolution images of the pancreas, with greater sensitivity than CT in detecting focal masses, particularly those under 3 cm in size. In the context of biliary strictures, EUS has shown higher specificity (100% vs. 76%) and positive predictive value (100% vs. 25%) compared to MRCP, while both modalities share similar sensitivity (67%).

Neither conventional US nor CT reliably excludes choledocholithiasis. Though ERCP offers high diagnostic accuracy, its use is limited by the risk of procedure-related pancreatitis. EUS, on the other hand, offers diagnostic performance comparable to ERCP and MRCP, with fewer associated risks.

Additionally, EUS is more portable than either ERCP or MRCP, making it advantageous in critically ill patients, such as those in intensive care. When performed under fluoroscopic guidance, EUS can be immediately followed by therapeutic ERCP, streamlining patient management.

Furthermore, the contribution of EUS-FNA for cytological diagnosis in cases of malignant biliary obstruction is substantial, with diagnostic accuracy reaching up to 96% (43).

Conclusion

When biliary obstruction is suspected, the diagnostic workup should begin with a thorough medical history, followed by a comprehensive physical examination and appropriate laboratory investigations. Instrumental diagnostic methods—particularly radiological imaging—play a crucial role in confirming the diagnosis. Transabdominal US remains the first-line modality for the initial assessment of cholestasis. However, its effectiveness is somewhat limited in detecting calculi within the common and cystic bile ducts, and its accuracy may be reduced in patients with excessive bowel gas or obesity.

CT is generally more precise than US in identifying the underlying cause and exact location of the obstruction. Nevertheless, CT is not ideal for routine use due to radiation exposure, potential contrast-related adverse reactions, and diminished visualization of the biliary system in patients with significantly elevated serum bilirubin levels.

MRCP is a highly sensitive, non-invasive technique for identifying biliary and pancreatic duct stones, strictures, dilatations, and tumors. It is particularly useful in patients with a low to intermediate risk of choledocholithiasis or in cases where ERCP is contraindicated or unfeasible.

ERCP continues to be the gold standard for imaging the biliary system, especially when therapeutic intervention—such as stone extraction or stent placement—is required. However, ERCP has limitations in visualizing segments of the biliary tree located proximally to the obstruction and cannot be performed when altered anatomy, such as surgical reconstructions, precludes endoscopic access to the ampulla of Vater.

PTC is particularly advantageous for assessing lesions located above the common hepatic duct and offers superior visualization when bile ducts are dilated. Although both ERCP and PTC are increasingly reserved for therapeutic purposes rather than primary diagnosis, MRCP is preferred for its non-invasive nature and diagnostic efficacy.

EUS, which does not involve radiation exposure, is an excellent imaging tool for the evaluation of the bile ducts. Research has demonstrated that EUS has comparable sensitivity to both ERCP and MRCP in detecting choledocholithiasis, with a favorable safety profile. Furthermore, EUS offers high-resolution visualization of the pancreas and is particularly accurate in detecting tumors under 3 cm in the pancreatobiliary region.

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