Imaging of the Biliary Tract

Achmad Nurman
Department of Internal Medicine, Faculty of Medicine, University of Trisakti, Jakarta

ABSTRACT

Imaging is central to the investigation and diagnoses of biliary tract disease. Upper abdominal pain, jaundice and abnormal liver function test are common symptoms and signs and imaging of the biliary tract should be performed to make an exact diagnosis of the disease. There are many options in the field of imaging from simple to more sophisticated examinations. Several imaging techniques are obsolete namely oral cholecystography, Intravenous cholangiography and biliary scintigraphy, and should therefore be omitted. These imaging techniques are expensive and we should choose one or two options. Abdominal ultrasound is less expensive and can be performed rapidly without special preparation or contrast agent. It is the imaging of choice in the initial evaluation to evaluate patients with hepatopacreaticobiliary diseases. From the result of abdominal ultrasound examination we can choose further the right imaging technique that can disclose the diagnoses of the disease.

Keywords: *biliary tract, diseases, imaging*

INTRODUCTION

Various biliary tract diseases can be found in clinical practice such as gallstones e.g. cholelithiasis, choledocholithiasis; infections e.g. cholecystitis, cholangitis; tumors e.g. cholangiocarcinoma (CC), gallbladder carcinoma; cystic disease; strictures etc. Imaging is central to the investigation and diagnoses of biliary tract disease. Upper abdominal pain, jaundice and abnormal liver function test are common sign and symptom of biliary tract diseases. Therefore imaging of the biliary tract should be performed to make an exact diagnosis of the disease.[1]

The symptom of jaundice is not specific nor is the physical findings. Jaundice can be due to biliary or non biliary disease. Liver function test only confirm cholestases that can be biliary or non biliary origin.[1] Common bile duct obstruction, for example from stones and tumor, must be distinguished from intra-hepatic cholestasis such as that caused by drugs. Non invasive tests e.g. ultrasonography (US), computed tomography (CT), biliary scintigraphy, magnetic resonance imaging (MRI) scans provide important data on which to choose more invasive and definitive techniques e.g. endoscopic retrograde cholangiography (ERCP), percutaneous transhepatic cholangiography (PTC), endoscopic ultrasonography (EUS), liver biopsy.Interventional endoscopy and radiology provide an alternative therapeutic approach to surgery.

Correspondence:
Achmad Nurman
Department of Internal Medicine
Faculty of Medicine, University of Trisakti
Jl. Kyai Tapa 260-Grogol Jakarta 11440 Indonesia
Phone/Fax: +6221-567 2731 ext .2707
E-mail: nurman_achmad@yahoo.com

NON-INVASIVE DIAGNOSTIC PROCEDURES

Plain Film of the Abdomen

Diagnostic yield is low and this test is usually omitted.[1] However, it may reveal gallstones if it is radioopaque, a calcified gallbladder, pancreatic calcification or rarely the outline of a distended gallbladder.[1,2] Gas in the biliary tree (aerobilia) may be seen after endoscopic sphincterotomy or surgical bile duct/bowel anastomosis. However, abdominal US/CT has been recognized as a more sensitive technique than abdominal plain films for diagnosing biliary tract disease.[2,3]

Oral Cholecystography

Imaging of the gallbladder for cholelithiasis and its complications has changed dramatically in recent decades along with expansion of interventional techniques related to the disease. Now superseded by US as the primary investigation for suspected cholelithiasis, because of greater sensitivity and with availability of transabdominal US, oral cholecystography is no longer performed routinely, and has a limited role in anatomical and functional assessment of the gallbladder.[1,4,5] US and CT are faster and offer

more accurate in diagnosing conditions of the gallbladder.[6] The media common use is sodium ipodate (biloptin) and calcium ipodate (solubiloptin). The contrast agent conjugated with glucuronic acid by the liver and excreted in the bile. In the fasting patient contrast entered the gallbladder if the cystic duct is patent.

Three X-ray films are necessary, control, fasting after contrast, and after gallbladder contraction by fat stimulation or cholecystokinin the gallbladder is seen in 85% of patients. The technique is not valuable if the bilirubin is greater than twice the upper limit of normal because of failure of efficient secretion of contrast by the liver.

Biliary Scintigraphy

Hepatobiliary scintigraphy is performed following intravenous administration of typically 3 to 5 mCi of a 95 mTc labelled hydroxy imino-diacetic acid (HIDA) compound and is cleared from the plasma by hepatocellular organic anion transport and excreted in the bile. Effective concentration in the bile duct is achieved in patients with total serum bilirubin exceeding 20 mg/dL. Hepatobiliary scintigraphy is most frequently used to evaluate the presence of acute cholecystitis, reflected by mechanical or functional obstruction of the cystic duct resulting in absence of gallbladder visualization.[7,8] In the presence of signs and symptoms such as right upper quadrant tenderness, elevated white blood cell count, fever and gall stones, wall thickening on gallbladder sonography, non–visualization of the gallbladder by 60 minutes has sensitivity and specificity greater than 95% for the diagnosis of acute cholecystitis.

HIDA can detect high grade biliary obstruction prior to ductal dilatation. HIDA also aids in the diagnosis of partial obstruction due to stone, biliary strictures and sphincter Oddi obstruction. It can confirm biliary leakage post cholecystectomy and hepatic transplantation.[8,9] In the early post operative period among patients who received liver transplants from living related donors, hepatobiliary scintigraphy which is non-invasive is useful to assess the graft.[10,11] Hepatobiliary scintigraphy also has the potential to assess the graft function and predict the recipients outcome.[12] In biliary scintigraphy the resolution is much less compared with other forms of bile duct visualization and the role is therefore limitted.[13]

Ultrasonography

Abdominal ultrasonography (US) is the most important screening investigation in all patients with liver function test abnormality or cholestasis.[1] US is usually the initial imaging test performed to evaluate patients with biliary obstruction.[14] It is the imaging method of choice in the initial evaluation of all suspected gallbladder and biliary duct diseases.[15] It is particularly valuable and is the recommended initial imaging test in patients with acute right upper quadrant pain, jaundice and possible acute cholecystitis, no prior preparation is necessary and patients can be imaged directly from the emergency room.[15-17] US is highly reliable in detecting tiny gallstones and is useful for evaluating focal or diffuse abnormalities of the gallbladder wall. The characteristic US findings of gallstones are a highly reflective echo from the anterior surface of the gallstone, mobility of the gallstone on repositioning the patient, and marked posterior acoustic shadowing. It is highly valuable in differentiating jaundice, whether the jaundice is of biliary origin or liver parenchyma origin by detecting the dilatation of the bile duct. Sonography is also very sensitive in detection mechanical obstruction although less sensitive for detection of obstructing tumors including pancreatic carcinoma and CC.[15,18] The sensitivity and accuracy of US for extra hepatic cholangiocarcinoma (ECC) diagnosis are 89% and 80-95%, respectively.[19,20,21] On the other hand, intra hepatic cholangicarcinoma (ICC) are difficult to distinguish from other solid intra-hepatic masses as they lack specific US features. The ability of US to detect the dilated bile duct and the level of obstruction and in some instances the cause of the obstruction, makes it the technique of choice for evaluating jaundiced patients.[22]

US is less expensive compared to CT and can be performed rapidly without patient preparation or contrast agent. For examining the gallbladder, the examination should be performed 6 hours after fasting which result in a distended gallbladder full of bile to ensure adequate distention of the gallbladder to visualize small stones and imaging the gallbladder wall.

US examination of the gallbladder and liver may detect gallbladder polyps or carcinoma or congenital biliary anomalies such as Caroli's disease or choledochal cysts. US can also detect the cause of obstruction albeit with less accuracy. Bile duct stones are harder to detect than gallstones, the difficulty related to gas sometimes obscuring the distal duct and the lack of echo free bile around impacted stones.[23]

Sonography is also the imaging procedure of choice for biliary tract intervention, including cholecystostomia, guidance for percutaneous transhepatic cholangiography and drainage of peribiliary abscesses.[15] The use of contrast agent in ultrasonography improves the diagnostic power of ultrasonography imaging.[3] The role of US in the characterisation of focal liver lesions has been transformed with the introduction of specific contrast media and the development of specialized imaging techniques.[23] Ultrasonography now can fully characterized the enhancement pattern of hepatic

lesions, similar to that achieved with contrast enhanced multiphasic CT and MRI. Most US contrast agent are intravenously injected microbubbles smaller than a red blood cell and thus capable of passing through capillary beds. US contrast agents are safe, well-tolerated and have very few contraindications. Furthermore, real-time evaluation of the vascularity of focal liver lesions has become possible with the use of the newer microbubble contrast agents.[24] Contrast enhanced ultrasonography (CEUS) clearly showed the presence/absence of blood supply lesion and offered real-time imaging of the microcirculation perfusions in the lesions. It also offered useful information to differentiate biliary tumors from stones, bile mud, and/or blood clots. It distinctly displayed the size and contour of the lesions as well as the infiltrated range, depth, and the involved area.

Computed Tomography

The most common CT findings in cholecystitis are gallbladder wall thickening (> 3 mm) and cholelithiasis.[5,6] Other findings include increased attenuation of the bile (> 20 Hounsfield) and loss of clear delineation of the gallbladder wall.

Increased attenuation in the adjacent hepatic parenchyma is useful indicator of acute inflammation. Air within the gallbladder wall or lumen is pathognomonic of complicated cholecystitis. A low attenuation halo around the gallbladder may indicate edema or minimal fluid collection and is a useful clue in differentiating complicated cholecystitis from carcinoma on CT scan. In the hands of the experienced, CT are accurate noninvasive methods of imaging the common bile duct. This is particularly true when there is a low clinical and laboratory probability of a common bile duct stone being present.[25] CT shows dilated bile ducts distinguishing obstructive from non obstructive jaundice in 90% of cases, but as a screening procedure it has no advantage over US. To identify dilated bile ducts, an evaluation for strictures or filling defects is necessary and it is best performed with thin-section imaging. Smooth, concentric short-segment strictures suggest benign cause; while abrupt, eccentric long-segment strictures indicate a malignancy.[26]

The sensitivity of CT in differentiating hepatocellular carcinoma from obstructive jaundice and in the level and cause of obstruction parallel that of US. Hilar cholangiocarcinoma usually presents centrally near the portal hepatis producing obstruction of the main hepatic duct and intra hepatic branches.

For diagnosing and staging CC, a triple-phase CT scan is frequently used since it gives valuable data about local spread, vascular invasion, lymph node involvement including the presence of distant metastases.[27,28,29] ICC usually appear as hypodense lesions with irregular margins on the initial images of CT scans with some degree of delayed venous phase enhancement.[33] Such characteristics have been demonstrated to be associated with prognosis, i.e. hyperattenuating CC is more aggressive.[34] ICC on CT findings may be presented as dilating and thickening of peripheral intra-hepatic bile ducts with retraction of liver capsule.[30] In contrast, ECC may appear as a focal thickening of the ductal wall with numerous enhancement patterns.[35] Nevertheless, in many ECC cases, neoplasm is not clearly visualize since their size is too small to be noticed.

The reported CT sensitivity for common duct stone detection varies from 45-90%.[31] Non contrasts CT may improve the recognition of choledocholithiasis to more than 90%. The CT appearances of common duct stones parallel that of gallstones and depend on the chemical composition for each stone. Densely calcified stone can be seen as high attenuation structures within the duct lumen, but most duct stones are iso-attenuating with soft tissue or bile on CT scan. The coronal reconstruction of CT imaging did not increase its diagnostic efficacy on choledocholithiasis. The stone size affects the diagnostic rate of abdominal CT for detecting choledocholithiasis. The CT diagnostic rate was significantly lower in patients with choledocholithiasis of less than 5 mm than in patients with choledocholithiasis of 5 mm or more (56.5 vs 81.2%).[32]

Imaging is most useful in evaluating for post-transplantation complications, which are broadly classified into vascular, biliary, and other complications. Hepatic artery thrombosis is the most significant complication and is often associated with graft failure. When US findings are indeterminate or there is persistent clinical suspicion for an abnormality, CT is often performed. The major indications for CT are detection of bile leak, hemorrhage, and abscess, but CT is also useful in the assessment of the vasculature. T-tube cholangiography and magnetic resonance cholangiopancreatography (MRCP) are the best noninvasive imaging tools for evaluating biliary stricture.[36]

Magnetic Resonance Cholangiopancreatography

MRCP was first described by Walner et al, and is a noninvasive method of imaging the biliary and pancreatic ducts.[37] The basic principle underlying MRCP is that body fluids such as bile and pancreatic secretions, have high signal intensify in heavily T2-weighted magnetic resonance i.e. they appear white, where as background tissues such as the surrounding liver and flowing blood generated little signal i.e. they appear dark. As a result of this combination of imaging characteristics, MRCP provides optimal contrast between the hyperintense

signal of the bile and pancreatic secretions and the hypointense signal of the background tissue (solid organs), and blood vessels have no measurable signal. On these images the intrinsic fluids of the biliary and pancreatic ducts give the cholangiogram and pancreatogram. MRCP is used with increasing frequency as a non-invasive alternative to ERCP and the diagnostic results are comparable with high accuracy in various hepatobiliary pathologies.[38]

In most of patients with right upper quadrant or epigastric pain with or without jaundice or jaundiced patients with or without upper abdominal pain, abdominal US and CT scan were mostly used as an initial evaluation. In these cases the roadmap of the biliary tract and the pancreatic duct is needed. The next examination will be the choice of ERCP or MRCP.[39] If the complaint was due to biliary diseases e.g. choledochal stone or stricture of the bile duct, it is easy to find the dilatation of the bile duct on abdominal US/CT; in these cases ERCP will be the choice because it can be followed by therapeutic endoscopy i.e. sphincterotomy and stone extraction, stent/ nasobiliary tube installment. The choice of imaging will be ERCP when it is assumed that it will be followed by therapeutic endoscopy. If the complaints were due to parenchyma liver diseases there is no dilatation or abnormality of the bile duct. In these cases it will not be followed by therapeutic endoscopy and MRCP will be the choice; hence unnecessary ERCP is here avoided.[40]

No special patient preparation is required but the usual contraindications to MRI scanning apply.[37,40] Patients with cardiac pacemaker, neurostimulator, ferromagnetic aneurism clips are excluded. The examination is usually performed after fasting for several hours. No sedation is required, no hospital admittance is needed. In some patients claustrophobia might be a problem.[41] Oral contrast agent are not administered, no intravenous contrast agents are needed, and there is no radiation exposure.[42] It is an ideal imaging method for patients with allergies to ioded based contrast or those with a general history of atopy, and prevents the occurrence of contrast nephropathy.[31]

MRCP is an alternative diagnostic technique for the imaging of the bile tree and the pancreatic duct, but it is not a therapeutic procedure.[37] While ERCP is used both for diagnosis and treatment, it has untoward effects including mortality i.e. pancreatitis, bleeding from sphincterotomy sites and duodenal perforation.[43]

MRCP is a non invasive tool that is suitable in patients suspected to have pancreatic biliary diseases where there is no likelihood or little possibility to perform therapeutic intervention e.g. patients with asymptomatic cholelithiasis without clinical evidence of clinical bile duct disease like the presence of jaundice and abnormalities of liver function test.

To identify dilated bile ducts, an evaluation for strictures or filling defects is necessary and it is best performed with thin-section imaging. Smooth, concentric short-segment strictures suggest benign cause; while abrupt, eccentric long-segment strictures indicate a malignancy. When interpreting the MRI results, caution should be made since the extrabiliary entities such as crossing vessels or metallic clip artifact which may mimic strictures should not be misguided for disease.[26] The most common biliary filling defect is a stone that may arise without any dilated ducts. It is usually found in a dependent portion of the duct and usually has a lamellated geometric shape. Any findings of bile duct wall thickening highly suggest cholangitis or malignancy. Diagnosis of biliary disease can be performed better when we have knowledge about the advantages and limitations of modern MR and CT cholangiographic techniques, together with the use of biliary-excreted contrast material and the numerous postprocessing techniques.[26]

In evaluating bile duct and detecting stones in the common bile duct MRCP is superior compared to US and multi slice computed tomography (MSCT).[44] Preoperative magnetic resonance cholangiography (MRC) may hinder the need for intra operative cholangiography (IOC). MRC has many benefits i.e. reducing operative time and alleviating damage to the common bile duct (CBD) that can occur during IOC. It is also less invasive. Moreover, it can find CBD stones pre-operatively and can help surgeon to prepare save procedure. Routine pre-operative MRC should be performed in patients with clinical or biochemical findings indicating the possibility of CBD stones.[45]

MRCP is especially useful in the clinical situations as follow: (1) Screening of patients with abdominal pain with less likehood of having choledochal stone. In these situations unnecessary ERCP is avoided;[40] (2) Failed or incomplete ERCP;[46] (3) Pre-operative MRC should be done routinely in patients who clinical or biochemical findings suggest the possibility of CBD stones; (4) Post operative anatomy. MRCP has been shown to be useful in demonstrating the bile ducts in patients with surgically altered biliary anatomy such as that associated with biliary-enteric anastomoses and liver transplantation; (5) MRCP is a rapid and accurate non invasive means of showing the presence of intrahepatic stone and is more superior to ERCP for the diagnosis of intra hepatic stone.[47]

The utility of MRCP in evaluating patients with CC has been showed in numerous studies.[48,49] Its diagnostic accuracy is comparable to invasive

cholangiographic techniques, both ERCP and PTC.[50-53] Thus, MRCP and MRI are considered to be the radiological modality of choice for evaluating patients with suspected CC.[54] A hypointense lesion on MRCP, i.e. on T1- and hyperintense on T2-weighted images with pooling of contrast within the tumor on delayed pictures as seen with CT may indicate ICC.[55,56] While ECC on MRCP may be seen as extrahepatic lesions with similar signal intensity of ICC on both T1- and T2-weighted images as well as proximal biliary dilatation.[48,55] Overall sensitivity of 88% and specificity of 95% were demonstrated in a meta-analysis of 67 studies (4,711 patients) evaluating MRCP performance in patients with suspected biliary diseases.[49] Furthermore, another study demonstrated that MRCP may predict the extent of biliary ductal involvement in 96% cases of malignant hilar obstruction.[57]

INVASIVE DIAGNOSTIC PROCEDURES

Intravenous Cholangiography

In intravenous cholangiography contrast material injected intravenously was concentrated by the liver so that hepatic and common bile ducts are demonstrated. However this option had become obsolete.[1,5] Because its poor resolution compared to ERCP, its poor diagnostic accuracy, its morbidity and the advent of ERCP/MRCP and cannot be used if the serum bilirubin level 2 mg% because the contrast material will not be excreted to the bile duct,[3] hence there will be no cholangiogram, this technique is never used again. Besides that, there is risk for allergy with the use of intravenous contrast.

Intra Operative Cholangiography

Intra operative cholangiography (IOC) is cholangiography that performs during surgical procedure. The most common indication of IOC is determination the need for exploration of CBD at the time of cholecystectomy.[1,58] Routine IOC is not necessary at cholecystectomy unless there are indications suggesting that stones are present in the common bile duct.[59] These include a history of jaundice, dilated bile ducts, palpable gallstones or a raised serum bilirubin, alkaline phosphatase or gamma-glutamyl transpeptidase (G-GT) level.

IOC procedure can be performed at open or laparoscopic cholecystectomy by inserting a catheter intra operatively into the cystic duct. Afterward, an injection of diluted (50%) contrast material is done to have the outline of biliary tree. The presence of filling defects, the anatomy and the calibre tree, and the flow of contrast into the duodenum are detected by assessing the films.

The positive predictive value of IOC findings for detecting CBD stones is 60-75%. Such procedure may fail because of (1) lack of ability to cannulate the cystic duct; (2) leakage of contrast during the injection; (3) the presence of air bubbles resembling stones; (4) quick flowing of the contrast into the duodenum, which prevents appropriate filling of the biliary tree; (5) spasm of the sphincter of Oddi. Following exploration of the bile duct, postoperative cholangiography through a T-tube is suggested to confirm that all stones have been removed.[60]

In patients who have no history of pancreatitis, normal liver function test and CBD stone less than 10 mm diameter, laparoscopic cholecystectomy performed without intra operative cholangiography does not result in an increased incidence of retained stone.[61]

Percutaneous Transhepatic Cholangiography

In percutaneous transhepatic cholangiography (PTC) intrahepatic biliary duct is directly punctured with fine flexible Chiba needle with the diameter 0.7 mm (22 Gauge), so that the patient still can normally breath during the procedure.[1] US is used as a guidance in which the puncture was performed into the dilated bile duct. This method is easy and will 100% success if the bile duct is dilated.

PTC may be the modality of choice in whom ERCP is difficult and failed due to the technical difficulties or when ERCP is not possible to perform e.g. in patients with hepaticoenterostomy, post Billroth II or in Klatskin tumor. In patients with complete biliary obstruction, ERCP often cannot assess the proximal biliary tree while PTC cannot assess the distal extent of the tumor.[58]

Complication occurred in 5-6.9%, consisted of bleeding, bile peritonitis, cholangitis and sepsis, less common were pneumothorax and puncture of viscera.[1,61] These complications can be reduced by ensuring fastidious technique, with a single puncture of the liver capsule, avoid over distention of ducts which may allow reflux of infected bile to the circulation through hepatic sinusoid, and ensuring that maneuvers are carried out in suspended respiration.[5]

Uncorrected coagulopathy is a contraindication for PTC, and the normal size of the intrahepatic duct makes the procedure difficult. Prophylactic antibiotics are recommended to reduce the risk of cholangitis.

Endoscopic Retrograde Cholangio Pancreatography

This method of direct cholangiography developed in the year nineteen seventies.[1,2] ERCP is a diagnostic procedure to diagnose problem in the liver, gallbladder, bile ducts and the pancreas, in which X-ray is combined with the use of a flexible scope. With this procedure papilla of Vater is searched endoscopically, followed by canulation of the catheter and contrast material is injected. This method needs high skill

ability.

ERCP is performed to evaluate the liver, gallbladder, bile duct and the pancreas to find out the etiology of the abdominal pain or the unknown cause of jaundice. From ERCP, the blockade and stone in the bile duct, leakage of bile or pancreatic duct, pancreatic obstruction or stenosis, the existence of tumor may be found.

Complications that occurred were morbidity in 1-3%, mortality in 0.22%, and these were directly in connection with skill and the experiences of the operator and to the underlying biliary and pancreatic diseases. The complications might occur are acute pancreatitis, cholangitis, sepsis and duodenal perforation or bleeding due to sphincterotomy and biloma might occur (accumulation of biliary liquid outside the biliary system).[5] In pregnant women, exposure to X-ray may result defect to the delivery, and also there are patients that are allergy or sensitive to the contrast material. ERCP procedure is contraindicated in patients that had gastrointestinal operation in the passed, and in patients with esophageal diverticle or in patients with acute pancreatitis. Although ERCP and PTC necessitate invasive access to the biliary system but they can provide dynamic images. Moreover, they can also detect biliary abnormalities as well as determine the location and extent of ECC within the biliary tree. The selection between PTC and ERCP is usually determined by the availability of local expertise and the anatomical characteristics of the tumor.[62] ERCP often cannot assess the proximal biliary tree in patients with complete biliary obstruction; while PTC cannot assess the distal part of the tumor.[58] The cholangiography sensitivity is 75-85% and the specificity is 70-75% with accuracy of 95%.[51,52,63]

Endoscopic Ultrasonography

Endoscopic ultrasonography (EUS) is an established diagnostic and therapeutic modality in gastroenterology with increasing widespread use. EUS is done using an endoscope which has a miniature ultrasonography transducer on its tip. Most endoscope used for US has mechanical rotating scanners at the tip and are side or oblique viewing. The close proximity of the echo endoscope to the extrahepatic bile duct system and its safety make EUS an excellent method for examining the common bile duct, gallbladder and adjacent structures and for the detection and staging of ampullary tumors, detection of microlithiasis and choledocholithiasis and evaluation of benign and malignant bile-duct strictures.[64,65]

EUS is at least as sensitivity as ERCP in detecting stones and strictures.[66,67] The sensitivity and accuracy of EUS for choledocholithiasis is greater than 90% and is more accurate than transabdominal ultrasonography. EUS is also useful to look for tiny bile duct stones.[5] In patients with clinically suspected biliary stone disease, without initial sonographic documentation of choledocholithiasis , endoscopic ultrasonography or magnetic resonance cholangiopancreatography is the next logical imaging step.[15] Patient with choledocholithiasis demonstrated a sensitivity for stone detection of 97% for EUS compared with 25% for abdominal ultrasonography.[68] EUS also demonstrated microlithiasis with a sensitivity as high as 95% in patients with negative abdominal ultrasonography but in whom there is a strong clinical suspicious of gallstone diseases.[66,69] The EUS-based approach reduces the number of unnecessary ERCP procedures and cost-effective.[70,71] EUS can be also used for guiding fine needle aspiration in the diagnoses of pancreatic cancer.[72]

An unique imaging modality, intraductal ultrasonography (IDUS), is suitable for a narrow ductal cavity, its wall and the neighboring structures. It has a very high image quality within approximately 2 cm range of radius because it uses high-frequency ultrasonography (12-30MHz).[73] Thus, IDUS may provide good assessment for the bile duct and pancreatic duct. In the same session as ERCP, biliopancreatic IDUS is usually performed through the papilla of Vater; whereas biliary IDUS may be also performed through the percutaneous transhepatic route.

The addition of EUS-guided fine needle aspiration (FNA) has improved the ability to detect and staging the benign and malignant lesions in the gastrointestinal tract by obtaining tissue for histologic diagnosis.[74]

CONCLUSION

Imaging of the biliary tract is very important in the investigation and diagnoses of biliary tract disease. There are many options in the field of biliary imaging and abdominal ultrasonography will guide to choose the more sophisticated examination. It is the imaging method of choice in the initial evaluation of all suspected gallbladder and biliary duct diseases. Oral cholecystography and biliary scintigraphy had been left behind.

In patients with dilated bile duct on ultrasonography examination, the next step will be ERCP/MRCP/PTC/CT scan. We should choose the right options, one or two options ,not too much because it is highly cost and may result in confusion if too much options are chosen.

The combination of history of the disease, physical findings, biochemical tests, abdominal US will guide us to choose the more exact and more sophisticated examination to uncover the exact cause of the disease.

REFERENCES

1. Sherlock S, Dooley J. Imaging of the biliary tract: interventional radiology and endoscopy. In: Diseases of the Liver and Biliary System. 10th ed. London: Blackwell Science 1997.p.561-77.
2. Helmberger T, Ros PR. Imaging of the liver and biliary tract. In: Kaplowitz N, eds. Liver and Biliary Diseases. 2nd ed. Baltimore: William & Wilkins 1996.p.235-60.
3. Ralls PW, Jeffrey RB Jr, Kane RA, Robbin M. Ultrasonography. In: Yamada T, Alpers DH, Kaplowitz N, Laine L, Owyang C, Powell DW, eds. Textbook of Gastroenterology. Vol 2. 5th ed. Singapore: Lippincott Williams & Wilkins 2009.p.3083-112.
4. Bortoff GA, Chen MY, Off DJ, Wolfman NT, Routh WD. Gallbladder stones: imaging and intervention. Radiographics 2000;20:751-66.
5. Karani J. The biliary tract. In: David Suton, eds. Textbook of Radiology Imaging. Vol 1. London: Churchill Livingstone 2003.p.711-36.
6. Paulson EK. Acute cholecystitis: CT findings. Semin Ultrasound CT MR 2000;21:56-63.
7. Mauro MA, Mc Cartney WH, Melmed JR. Hepatobiliary scanning with Fe-99mPIPIDA in acute cholecystitis. Radiology 1982;142:193-7.
8. Ziesmann HA. Nuclear medicine hepatobiliary imaging. Clin Gastroenterol Hepatol 2010;8:111-6.
9. Al Sofayan MS, Ibrahim A, Helmy A, Al Saghier MI, Al Sebayel MI, Abozied MM. Nuclear imaging of the liver; is there a diagnostic role of HIDA in post transplantation? Transplant Proc 2009;41:201-7.
10. Gencoglu EA, Kocabas B, Moray G, Aktas A, Karakayali A, Haberal M. Usefulness of hepatobiliary scintigraphy for the evaluation of living related liver transplant recipients in the early posoperative period. Transplant Proc 2008;40: 234-7.
11. de Graaf W, Bennink RJ, Vetelainen R, van Gulik TM. Nuclear imaging techniques for the assessment of hepatic function in liver surgery and transplantation. J Nucl Med 2010;51:742-52.
12. Iida T, Isaji S, Yagi S, Hori T, Taniguchi K, Ohsawa I, et al. Assessment of liver graft function and regeneration by galactosyl-human serum albumin (99Tc-Gsa) liver scintigraphy in adult living-donor liver transplantation. Clin Transplant 2009;23:271-7.
13. Freitas JE, Coleman RE, Nagle CE. Influence of scan and pathologic criteria on the specificity of cholescintigraphy: concise communication. J Nucl Med 1983;24:876-9.
14. Saini S. Imaging of the hepatobiliary tract. N Engl J Med 1997;336:1889–94.
15. Foley WD, Quinoz FA. The role of sonography in imaging of the biliary tract. Ultrasound Q 2007;23:123-35.
16. Ralls PW, Colletti PM, Lapin SA, Chandrasama P, Boswell WD Jr, Ngo C, et al. Real-time sonography in suspected acute cholecystitis. Prospective evaluation of primary and secondary signs. Radiology 1985;155:767-71.
17. Stoker J, van Randen A, Lameris W, Boermeester MA. Imaging patients with acute abdominal pain. Radiology 2009;253:31-46.
18. Aljiffry M, Walsh MJ, Molinar M. Advances in diagnosis, treatment and palliation of cholangiocarcinoma: 1990-2009. World J Gastroenterol 2009;15:4240-62.
19. Sharma MP, Ahuja V. Aetiological spectrum of obstructive jaundice and diagnostic ability of ultrasonography: a clinician's perspective. Trop Gastroenterol 1999;20:167-9.
20. Bloom CM, Langer B, Wilson SR. Role of US in the detection, characterization, and staging of cholangiocarcinoma. Radiographics 1999;19:1199–218.
21. Slattery JM, Sahani DV. What is the current state of the art imaging for detection and staging of cholangiocarcinoma? Oncologist 2006;11:913–22.
22. Laing FC, Jeffrey RB Jr, Wing VW, Nyberg DA. Biliary dilatation: defining the level and cause by real–time US. Radiology 1986;160:39-42.
23. Quaia E, Stacul F, Gaiani S, Ricc P, Passariello R, Curzio D, et al. Comparison of diagnostic performance of unenhanced vs Sono Vue-enhanced ultrasonography in focal liver lesions characterization. The experience of three Italian centers. Radiol Med 2004;108:71-81.
24. Morin SH, Lim AK, Cobbold JF, Taylor-Robinson SD. Use of second generation contrast-enhanced ultrasound in the assessment of focal liver lesions. World J Gastroenterol 2007;13:5963-70.
25. Pickuth D. Radiologic diagnosis of common bile duct stones. Abdom Imaging 2000;25:618-21.
26. Yeh BM, Liu PS, Soto JA, Corvera CA, Hussain HK. MR imaging and CT of the biliary tract. Radiographics 2009;29:1669-88.
27. Valls C, Gumà A, Puig I, Sanchez A, Andía E, Serrano T, et al. Intrahepatic peripheral cholangiocarcinoma: CT evaluation. Abdom Imaging 2000;25:490–6.
28. Zhang Y, Uchida M, Abe T, Nishimura H, Hayabuchi N, Nakashima Y. Intrahepatic peripheral cholangiocarcinoma: comparison of dynamic CT and dynamic MRI. J Comput Assist Tomogr 1999;23:670–7.
29. Tillich M, Mischinger HJ, Preisegger KH, Rabl H, Szolar DH. Multiphasic helical CT in diagnosis and staging of hilar cholangiocarcinoma. AJR Am J Roentgenol 1998;171:651–8.
30. Kim TK, Choi BI, Han JK, Jang HJ, Cho SG, Han MC. Peripheral cholangiocarcinoma of the liver: two-phase spiral CT findings. Radiology 1997;204:539–43.
31. Soto JA, Alvarez O, Munera F, Velez SM, Valencia J, Ramirez N. Diagnosing bile duct stones: comparison of unenhanced helical CT, oral contrast-enhanced CT cholangiography and MR cholangiography. AJR Am J Roentgenol 2000;175:1127-34.
32. Tseng CW, Chen CC, Chen TS, Chang FW, Lin HC, Lee SD et al. Can computed tomography with coronal reconstruction improve the diagnosis of choledochlithiasis? J Gastroenterol Hepatol 2008;231:1586-9.
33. Bach AM, Hann LE, Brown KT, Getrajdman GI, Herman SK, Fong Y, et al. Portal vein evaluation with US: comparison to angiography combined with CT arterial portography. Radiology 1996;201:149–54.
34. Asayama Y, Yoshimitsu K, Irie H, Tajima T, Nishie A, Hirakawa M, et al. Delayed-phase dynamic CT enhancement as a prognostic factor for mass-forming intrahepatic cholangiocarcinoma. Radiology 2006;238:150–5.
35. Han JK, Choi BI, Kim AY, An SK, Lee JW, Kim TK, et al. Cholangiocarcinoma: pictorial essay of CT and cholangiographic findings. Radiographics 2002;22:173–87.
36. Sing AK, Nachiappan AC, Verma HA, Uppo RN, Blake MA, Saini S, et al. Postoperative imaging in liver transplantation: What radiologist should now? Radiographics 2010;30: 339-51.
37. Mac Eneaney P, Mitchell MT, Mc Dermoth R. Update on magnetic resonance cholangiopancreatography. Gastroenterol Clin North Am 2002;31:731-46.
38. Hekimoglu K, Unstundag J, Dusak A, Erdem Z, Karademir B, Aydemir S, et al. MRCP vs ERCP in the evaluation of biliary pathologies: review of current literature. J Dig Dis 2008;9:162-9.
39. Wijaya PM. MRCP for biliary obstruction. 7th Hepatobiliary Surgical Update and Workshop on Therapeutic Endoscopy. Jakarta 2006.
40. Romagnuolo J, Bardon M, Rahme E, Joseph L, Reinhold C, Barkun AN. Magnetic resonance cholangiopancreatography.

A meta analysis of test performance in suspected biliary disease. Ann Inter Med 2003;139:547-57.
41. Kaltenhaler E, Vergel YB, Chilcot J, Thomas S, Blakeborough T, Walters S J, et al. A systematic review and economic evaluation of magnetic resonance cholangio-pancreatography compare with diagnostic endoscopic retrograde cholangio-pancreatography. Health Technol Assess 2004;8:1-89.
42. Barrish MA, Yucell EK, Ferruci JT. Magnetic resonance cholangiopancreatography. N Engl J Med 1999;341:258-64.
43. Leung J. Fundamentals of ERCP. In: Cotton PB, Leung J, eds. Advanced Digestive Endoscopy: ERCP. 1st ed. Blackwell Publishing Massachusets 2006.p.17-80.
44. Maurea S, Caleo O, Mollica C, Imriaco M, Mainenti PP, Palumbo C, et al. Comparative diagnostic evaluation with MR cholangiopancreatography, ultrasonography and CT in patients with pancreaticobiliary disease. Radiology Med 2009;114:390-402.
45. Eshgi F, Abdi R. Routine magnetic resonance cholangiography compared to intra-operative cholangiography in patients with suspected common bile duct stones. Hepatobiliary Pancreat Dis Int 2008;7:525-8.
46. Soto JA, Yucell EK, Barish MA, Chuttani R, Ferrucci JT. MR Cholangiopancreatography after unsuccessful or incomplete ERCP. Radiology 1996;199:91-8.
47. Kim TK, Kim BS, Kim JH, Na JKH, Kim NP, Kim AH, et al. Diagnosis of intrahepatic stones: superiority of MR cholangiography over endoscopic retrograde cholangio-pancreatography. AJR 2002;179:429-34.
48. Guthrie JA, Ward J, Robinson PJ. Hilar cholangiocarcinomas: T2-weighted spin-echo and gadolinium-enhanced FLASH MR imaging. Radiology 1996;201:347–51.
49. Schwartz LH, Coakley FV, Sun Y, Blumgart LH, Fong Y, Panicek DM. Neoplastic pancreaticobiliary duct obstruction: evaluation with breath-hold MR cholangiopancreatography. AJR Am J Roentgenol 1998;170:1491–5.
50. Manfredi R, Brizi MG, Masselli G, Vecchioli A, Marano P. Malignant biliary hilar stenosis: MR cholangiography compared with direct cholangiography. Radiol Med 2001;102:48–54.
51. Rösch T, Meining A, Frühmorgen S, Zillinger C, Schusdziarra V, Hellerhoff K, et al. A prospective comparison of the diagnostic accuracy of ERCP, MRCP, CT, and EUS in biliary strictures. Gastrointest Endosc 2002;55:870–6.
52. Park MS, Kim TK, Kim KW, Park SW, Lee JK, Kim JS, Lee JH, Kim KA, Kim AY, Kim PN, et al. Differentiation of extrahepatic bile duct cholangiocarcinoma from benign stricture: findings at MRCP versus ERCP. Radiology 2004;233:234–40.
53. Varghese JC, Farrell MA, Courtney G, Osborne H, Murray FE, Lee MJ. A prospective comparison of magnetic resonance cholangiopancreatography with endoscopic retrograde cholangiopancreatography in the evaluation of patients with suspected biliary tract disease. Clin Radiol 1999;54:513–20.
54. Manfredi R, Barbaro B, Masselli G, Vecchioli A, Marano P. Magnetic resonance imaging of cholangiocarcinoma. Semin Liver Dis 2004;24:155–64.
55. Choi BI, Lee JM, Han JK. Imaging of intrahepatic and hilar cholangiocarcinoma. Abdom Imaging 2004;29:548–57.
56. Lee JW, Han JK, Kim TK, Kim YH, Choi BI, Han MC, et al. CT features of intraductal intrahepatic cholangiocarcinoma. AJR Am J Roentgenol 2000;175:721-5.
57. Fulcher AS, Turner MA. HASTE MR cholangiography in the evaluation of hilar cholangiocarcinoma. AJR Am J Roentgenol 1997;169:1501–5.
58. Pitt HA, Nakeeb A, Abrams RA, Coleman J, Piantadosi S, Yeo CJ, et al. Perihilar cholangiocarcinoma. Postoperative radiotherapy does not improve survival. Ann Surg 1995;221: 788–98.
59. Barkun AS, Barkun JS, Fried GM. Useful predictors of bile duct stones in patients undergoing laparoscopic cholecystectomy. Ann Surg 1944;220:32-9.
60. Rothlin MA, Schlumpf R, Largiader F. Laparoscopic sonography. An alternative to routine intraoperative cholangiography?. Arch Surg 1994;129:694-700.
61. Oh HC, Lee SK, Lee TY, Kwon S, Lee SS, See DW, et al. Analysis of percutaneous transhepatic cholangiography–related complications and the risk factors for those complications. Endoscopy 2007;39:731-61.
62. Khan SA, Davidson BR, Goldin R, Pereira SP, Rosenberg WM, Taylor-Robinson SD, et al. Guidelines for the diagnosis and treatment of cholangiocarcinoma: consensus document. Gut 2002;51:VI1–VI9.
63. Kumar M, Prashad R, Kumar A, Sharma R, Acharya SK, Chattopadhyay TK. Relative merits of ultrasonography, computed tomography and cholangiography in patients of surgical obstructive jaundice. Hepatogastroenterology 1998;45:2027–32.
64. Yusuf TE, Bhutani MS. Role of endoscopic ultrasonography in diseases of the extrahepatic biliary system. J Gastroenterol Hepatol 2004;19:243-50.
65. O'Neil DE, Saunders MD. Endoscopic ultrasonography in diseases of the gallbladder. Gastroenterol Clin North Am 2010;39:289-305.
66. Palazzo L, Girollet PP, Salmeron M, Silvain C, Roseau G, Canard JM, et al. Value of endoscopic ultrasonography in the diagnosis of bile duct stones: comparison with surgical exploration and ERCP. Gastrointest Endosc 1995;42:225-31.
67. Aljebreen A, Azzam N, Eloubeidi MA. Prospective study of endoscopic ultrasound performance in suspected choledocholithiasis. J Gastroenterol Hepatol 2008;23:741-5.
68. Polydorou AA, Cairns SR, Dowsett JF. Palliation of proximal malignant biliary obstruction by endoscopic endosprosthesis insertion. Gut 1991;32:685-9.
69. Dill JE, Hill S, Callis J, Berkhouse L, Evans P, Martin D, et al. Combined endoscopic ultrasound and stimulated biliary drainage in cholecystitis and microlithiasis: diagnosis and outcomes. Endoscopy 1995;27:424-7.
70. Scheiman JM, Carlos RC, Barnet JL, Elta GH, Nostrant TT, Chey WD, et al. Can endoscopic ultrasound and magnetic resonance cholangiopancreatography replace ERCP in patients with suspected biliary disease? A prospective trial and cost analysis. Am J Gastroenterol 2001;96:2900–4.
71. Buscarini E, Tansini P, Vallisa D, Zambelli A, Buscarini L. EUS for suspected choledochlithiasis: do benefits outweigh cost? A prospective, controlled study. Gastrointestinal Endosc 2003;57:510-18.
72. Agarwal B, Abu-Hamda E, Molke KL, Corea AM, Ho L. Endoscopic ultrasound–guided fine needle aspiration and multidetector spiral CT in the diagnoses of pancreatic cancer. Am J Gastroenterol 2004;99:844-50.
73. Fujita N, Noda Y, Kobayashi G, Ito K, Horaguchi J, Koshita S, et al. Intraductal ultrasonography (IDUS) for the diagnosis of biliopancreatic diseases. Best Pract Res Gastroenterol 2009;23:729-42.
74. Wallace MB, Kennedy T, Durkalski V, Eloubeidi MA, Etamad R, Matsuda K, et al. Randomized controlled trial of EUS-guided fine needle aspiration techniques for the detection of malignan lymphadenopathy. Gastrointest endosc 2001;54:441-7.