Hepatobiliary Imaging: Imaging Modalities*

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ABSTRACT

Imaging modalities are a major part of the diagnosis and follow-up to therapy of hepatobiliary disease. Changes of the liver, spleen, gallbladder and pancreas can be assessed by a variety of highly technical and evolving methods. The purpose of this paper is to review briefly some diseases of the hepatobiliary tree and pancreas and how they may be diagnosed through imaging modalities. Hepatic diseases may include those that affect the parenchyma, biliary tree, or gallbladder. The spleen is often altered in size secondary to liver disease. Pancreatic diseases present particular difficulties in diagnosis as they relate to clinical chemistry tests, tumor markers or imaging.

Imaging modalities for hepatobiliary disease include x-ray studies with or without contrast, and with or without computerized tomographic enhancements. Some of the x-ray procedures are done in association with percutaneous or endoscopic retrograde approaches. Ultrasound is an excellent technique for evaluation of cholelithiasis and gives useful information for hepatic and splenic size. Radionuclide studies can be either anatomically or physiologically based. Magnetic resonance imaging is evolving as a very useful, specific and sensitive method of evaluating the liver, gallbladder, spleen and pancreas.

There is a diverse armamentarium of imaging modalities available for the evaluation of hepatobiliary disease. Ultrasound is the first choice for cholelithiasis. Endoscopic retrograde cholecystography (ERCP) is a definitive method for evaluating the biliary tree. Radionuclide studies with the iminodiacetic acid (IDA) derivatives are very useful for functional disorders of the gallbladder. Computer assisted tomography and magnetic resonance imaging (MRI) provide optimal anatomic resolution for tumors, abscesses, and other metastatic lesions involving the liver and spleen.

Introduction

Hepatobiliary diseases are associated with a variety of anatomic and morphologic abnormalities. The liver, spleen, gallbladder, and pancreas may be increased or decreased in size, may be invaded by tumor or infection, abnormal because of congenital abnormalities or trauma. The gallbladder is a common site of disease particularly in the middle aged and older patient. The pancreas is
difficult to assess by historical information, routine physical exam, laboratory tests or plain x-rays. Liver and spleen abnormalities may be suggested by the patient history and/or physical examination.

The purpose of this paper is to examine the sensitivity and specificity of ultrasonography, x-ray examinations, magnetic resonance imaging and radionuclide studies in hepatobiliary diseases of the liver, gallbladder, spleen and pancreas.

Methods

Major techniques for hepatobiliary tree imaging will be outlined (Table I).

ULTRASONOGRAPHY

Ultrasonography can be performed in the A, B, M or real time modes. Modern ultrasound equipment can provide images in real time and resolution of lesions to two millimeters in size. "Echoes" of different tissues may produce similar images. It is, therefore, difficult to separate tumors or abscesses from surrounding parenchymal tissue, at times.

X-RAYS

X-ray studies of the hepatobiliary tree include plain films of the abdomen and a

<table>
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<tr>
<th>TABLE I</th>
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<tbody>
<tr>
<td>Hepatobiliary Imaging Methods</td>
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</tr>
<tr>
<td>Ultrasonography</td>
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<td>X-Ray</td>
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<td>Contrast</td>
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<td>Endoscopic retrograde</td>
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<td>Radionuclide</td>
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<td>Tc-99m - Sulfur colloid</td>
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<tr>
<td>Tc-99m - Iminodiacetic acid (IDA)</td>
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<tr>
<td>Single photon emission computerized tomography (SPECT)</td>
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<td>Computerized tomography</td>
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<td>Magnetic resonance imaging</td>
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MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging is a fairly recent technology. During the past five years, the availability of MRI has become wide-spread. Magnetic resonance imaging provides excellent contrast between different tissues and is extremely useful for anatomical evaluation of liver, spleen and pancreas. Magnetic resonance imaging is one of the best non-invasive methods for examining the porta hepatitis, the pancreas and hepatic parenchymal detail.

RADIONUCLIDE STUDIES

Radionuclide studies are considered in two categories. The first provides anatomical information. Examples of this type of evaluation are the technetium 99M sulfur colloid studies of the hepatic parenchyma. Studies of the liver and spleen using sulfur colloid have been in place for almost 20 years. The resolution is for lesions as small as approximately two centimeters in size. Unfortunately because of columination, interposed parenchyma or differential uptake, lesions of significant size may be missed.

The second category is that of physiologic function. Iminodiacetic acid studies are frequently used methods for examining the gallbladder. These are particu-
larly useful for differentiating cholecystitis from non-inflammatory gallbladder disease.

The pancreas can be imaged using radiolabeled selenomethionine. Pancreatic radionuclide studies require careful technique and attention to details. The yield of radionuclide pancreatic studies is less than 75 percent. Magnetic resonance imaging is a better method for imaging the pancreas.

RESULTS

Results of various imaging modalities will be limited to the application of these techniques to gallbladder disease (table II).

ULTRASOUND

Ultrasound is a cost-effective, non-invasive mechanism for evaluating cholelithiasis. With the use of proper criteria, the accuracy of ultrasound evaluation of stones in the gallbladder exceeds 95 percent.\(^9\) Ultrasound is not as good as CT or MRI in differentiating primary hepatic tumors, liver metastases, or hemangiomas because of similar acoustic properties that may exist for these entities and the surrounding hepatic parenchyma.\(^2,3\)

RADIONUCLIDE STUDIES

Radionuclide studies of the gallbladder include the use of IDA and associated compounds. The IDA derivatives are actively transported by hepatocytes and excreted into the biliary tract resulting in a marker for bile flow. Serial images are obtained at intervals of 10 to 15 minutes for up to four hours. The common bile duct, gallbladder and parts of the small intestine may be visualized. Acute cholecystitis is characterized by non-visualization of the gallbladder after three or more hours. Visualization of the gallbladder in less than one hour is associated with absence of acute cholecystitis with 97 percent confidence limits.\(^7,10\) Non-visualization of the gallbladder is also found with chronic cholecystitis, prolonged fasting, total parenteral nutrition and alcohol abuse. Use of cholecystokinin analogs is said to reduce false-positive studies. Where there is a stone occluding the duct, the IDA compound will be excluded from passage into the small intestine. Radionuclide functional studies of the gallbladder are a diagnostic alternative to contrast x-ray studies for patients who have iodine sensitivity or have elevated bilirubins. Radionuclide study of the gallbladder has been used to evaluate patients with gallbladder rupture.\(^8\)

Technetium sulfur colloid imaging of the liver and spleen is useful as a screening method to look for tumors or metastasis. Sensitivity and specificity of radionuclide studies of the hepatic parenchyma are low but may be enhanced using single photon emission computerized tomography (SPECT).

X-RAY

X-ray evaluation of the gallbladder has traditionally been accomplished with oral contrast media. Oral cholecystography cannot be used if there is an elevation of bilirubin above 3.5 mg per dl. Intravenous cholangiography also has limitations in patients who have elevated bilirubins and/or associated renal disease.\(^5\) Percutaneous transhepatic cholan-

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**TABLE II**

**Imaging Results in Gallbladder Disease**

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<thead>
<tr>
<th></th>
<th>Cholelithiasis</th>
<th>Cholecystitis</th>
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<tr>
<td><strong>Ultrasound</strong></td>
<td>+ &gt; 95%</td>
<td>+ &gt; 80%*</td>
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<tr>
<td><strong>Radionuclide</strong></td>
<td>*</td>
<td>+ &gt; 95%</td>
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<tr>
<td>(IDA study)</td>
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<tr>
<td><strong>X-Ray</strong></td>
<td>+ &gt; 90%</td>
<td>+ &gt; 68%*</td>
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<td>with contrast</td>
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* Widely variable results.
* Depends on presence of cholecystitis.
giography with contrast media can be performed, but it requires experience and skill and is not always successful. Roentgenographic evaluation of the pancreatic and biliary tree via ERCP is effective but a complex and expensive approach. Cholelithiasis may be seen on a plain film of the abdomen if calcified. Less than 15 percent of gall stones have sufficient calcification to be seen on routine roentgenographic examination of the abdomen. Contrast material introduced intravenously or intraarterially can be useful for defining the portal and hepatic blood vessels. These techniques can aid in differentiating benign versus malignant tumors and in looking for obstruction, metastases, or space occupying lesions of the liver, spleen or pancreas.  

MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging is a sensitive and accurate tool for evaluating liver, spleen, and pancreas. It is useful for examining the porta hepatitis particularly for enlarged lymph nodes in this region. The MRI studies can be complimentary to CT of the gallbladder.

Conclusion

There is a diverse armamentarium of imaging modalities available to evaluate diseases of the liver, spleen, gallbladder, and pancreas. Ultrasonography is the most cost-efficient, sensitive, and accurate method for screening for acute right upper quadrant pain, particularly in evaluating the gallbladder for the presence or absence of stone and ductal dilation. Radionuclide studies using the IDA compounds are useful for functional evaluation of the gallbladder involved with stones or inflammation. Magnetic resonance imaging provides excellent morphology as it relates to size, shape, and abnormal tissue within the liver, spleen, gallbladder, and pancreas. At the present time, MRI is not applied to functional studies but has the potential for physiologic applications in the future.

Acknowledgments

The typing and assistance of Ms. Maxine Goldstein are gratefully acknowledged.

References