Right upper quadrant (RUQ) pain is a common complaint that typically stimulates a workup of the hepatobiliary system. In particular, evaluation of the gallbladder (GB) is important because cholelithiasis and its complications are a frequent cause of RUQ pain. For this reason, tests used in this condition must be capable of providing accurate information about the GB. This chapter focuses on the imaging evaluation of the patient with RUQ pain and illustrates why the use of ultrasound is so important.

**Differential Diagnosis**

Gallstone disease is one of the most common causes of RUQ pain. Gallstones are present in ~10% of the population. In North America, 75% of gallstones are cholesterol stones; the rest are pigment stones. In women, factors that predispose to gallstones are increased weight, increased age, and increased parity. In men, increased age also predisposes to gallstones.

Although gallstones are one of the most common causes of RUQ pain, the majority of patients with gallstones are asymptomatic. Imaging studies performed for other reasons often discover patients with asymptomatic (silent) gallstones. Silent gallstones tend to become symptomatic at a rate of ~2% per year. The overall risk after 20 years is 18%. Patients with gallstones are unlikely to develop symptoms after 10 to 15 years of being asymptomatic. Those patients who ultimately do develop symptoms almost always have episodes of biliary colic first. It is very unusual for a patient to develop acute cholecystitis as the initial symptom of gallstone disease without previous incidents of colic. Based on these statistics and the known risk of cholecystectomy, it has been shown that performing prophylactic cholecystectomy in asymptomatic patients actually decreases their overall life expectancy and increases the cost of treatment. For these reasons, asymptomatic gallstones are generally not treated surgically.

Approximately one third of all patients with gallstones will develop symptoms. Patients with symptomatic gallstone disease generally first seek medical attention due to bouts of biliary colic. As already mentioned, patients that first present with acute cholecystitis will generally describe previous episodes consistent with biliary colic. Dyspeptic symptoms (pyrosis, flatulence, vague abdominal discomfort, and fatty food intolerance) may occur in patients with gallstones but it is hard to prove a cause-and-effect relationship because these symptoms are also very common in patients without gallstones.

The symptom complex of biliary colic is produced when a stone obstructs the cystic duct or GB neck. Classically, these patients experience acute RUQ or epigastric pain that increases in intensity over several seconds or minutes and then persists for several (usually 4 to 6) hours. The pain may begin in the RUQ and radiate to the epigastrium or vice versa. It may occasionally be most severe in the left upper quadrant, precordium, or even the lower abdomen. Periodic exacerbations may occur during a given episode, but, in general, the pain is fairly steady (colic is a misnomer). In most cases, there is no obvious cause of biliary colic. In some patients, the pain is provoked by a meal. Tenderness to palpation is unusual.

Biliary colic may be relieved if the obstructing stone spontaneously disimpacts from the cystic duct or GB neck. It may also be relieved if the stone passes through the cystic duct and into the bile duct. If the stone subsequently obstructs the common bile duct, a second episode of biliary colic may occur. The interval between attacks of biliary colic is very unpredictable and can vary from weeks to months to years.

Acute cholecystitis develops if there is persistent cystic duct or GB neck obstruction. This diagnosis should be considered when the patient’s symptoms persist beyond 6 hours. Acute cholecystitis is manifest as persistent RUQ pain that may radiate to the right shoulder, right scapula, or interscapular area. Nausea, vomiting, chills, fever, and RUQ tenderness and guarding are common. Leukocytosis and elevations of alkaline phosphatase, aminotransferase (transaminase), and amylase may occur. Mild hyperbilirubinemia is seen in as many as 20% of cases. Bilirubin levels greater than 4 mg/100 mL may occur if there is common bile duct obstruction.

In addition to GB disease, many other disease processes can potentially produce RUQ pain. These are listed in Table 1–1. In particular, liver diseases should be strongly considered, including diffuse hepatic parenchymal diseases such as hepatitis (viral, alcoholic, drug induced, or toxin induced) or passive hepatic congestion, or focal hepatic diseases. Focal liver tumors can produce pain due to rapid growth, bleeding, or infarction. Hepatic abscesses, perihepatitis (Fitz-Hugh-Curtis syndrome), hematomas, and hemorrhagic cysts are also capable of producing RUQ pain.
ally presents primarily as RUQ pain. Peptic ulcer disease, colitis, ileitis, intestinal obstruction, irritable bowel syndrome, and intestinal tumors are additional considerations.

The right kidney is another source of RUQ pain. Renal colic may present with atypical symptoms and be confused with GB disease. Pyelonephritis, renal abscess, hematoma, hemorrhagic cysts, tumors, and ischemia are other renal diseases that can cause RUQ pain.

Miscellaneous other processes to be considered in patients with RUQ pain are right-lower-lobe pneumonia and pulmonary infarction, myocardial ischemia, local chest and abdominal wall lesions, local musculoskeletal lesions, right adrenal lesions, and herpes zoster.

The relative prevalence of the different causes of RUQ pain varies from institute to institute. Table 1–2 categorizes these causes by their approximate prevalence.

### Diagnostic Evaluation

#### Nonimaging Tests

In many patients with RUQ pain, a careful history and physical examination will help guide the workup in the appropriate direction. However, the signs and symptoms of the many conditions potentially capable of causing RUQ pain overlap greatly. For this reason, there is a multitude of useful diagnostic tests. The most common tests are (1) liver function tests (LFTs), (2) amylase levels, (3) urinalysis, (4) white blood cell counts, and (5) electrocardiograms (ECGs).
LFTs are among the most useful initial laboratory tests because certain abnormalities strongly suggest hepatobiliary disease. In addition, the pattern of abnormality on LFTs can point toward liver parenchymal processes or biliary processes. (Please see the chapter on evaluation of abnormal LFTs.) Renal, pancreatic, and cardiac abnormalities can be identified in many cases by obtaining a urinalysis, a serum amylase level, and an ECG.

**Imaging Tests other than Ultrasound**

The initial imaging tests in patients with RUQ pain should be radiographs of the chest and abdomen. These are rapid and inexpensive ways of evaluating the patient for pulmonary and intestinal sources of pain. In addition, abdominal radiographs can detect calcifications in the kidney, ureter, appendix, and pancreas. Gallstones that are sufficiently calcified to be radiopaque (10 to 15% of cases) can also be detected. Rarely, gallstones will contain enough gas to be visible on radiographs. Therefore, although abdominal radiographs may reveal gallstones, a negative study does not exclude the diagnosis.

If the patient presents with suspected biliary colic and the preliminary tests fail to suggest an alternative source of pain, then the GB should be evaluated to determine the presence or absence of gallstones. In addition to abdominal radiographs, there are several imaging tests that are capable of detecting gallstones. The sensitivity of these various tests is indicated in Table 1–3.

Computed tomography (CT) is much better at detecting small degrees of calcification than plain radiography and is therefore more sensitive at detecting gallstones. CT can also detect some cholesterol stones that are less dense than surrounding bile as well as stones that contain gas. In addition, unlike abdominal radiography, CT can determine the anatomical location of a calcification and confirm that it is in the GB. Unfortunately, at least 20% of gallstones have the same attenuation as bile and are not detectable with CT. For this reason, CT is useful when positive but not useful when negative.

Oral cholecystography (OCG) was the preferred means of diagnosing gallstones for many years. When the GB is well opacified, OCG is similar to sonography in its ability to detect and exclude gallstones. Sensitivity decreases somewhat if opacification is faint on an OCG. In ~25% of OCGs, the GB is not opacified. If nonvisualization of the GB is considered a positive result, then the sensitivity of OCG for detecting stones is as high as 90 to 95%. Unfortunately, there are many nonbiliary causes of nonvisualization. These include failure to take the contrast, vomiting, diarrhea, fasting, hiatal hernia, proximal intestinal obstruction, proximal intestinal diverticulum, malabsorption, and liver disease. Therefore, nonvisualization of the GB is less specific for gallstones than the typical finding of a mobile filling defect in a well-opacified GB. If a nonvisualized GB is considered an inconclusive result, then the sensitivity of OCG is 65%. Currently, OCG is mostly of historic significance and is almost never performed.

**Ultrasound Imaging**

Many investigations performed in the late 1970s and early 1980s analyzed the effectiveness of sonography in detecting gallstones. Despite using static scanners and first-generation real-time equipment, these studies almost all showed that sonography was highly accurate (> 90%) in detecting gallstones. Since then, sonography has essentially replaced the OCG for the detection of gallstones. Data from slightly more recent studies continue to support this approach. One blinded prospective comparison of these techniques showed a sonographic sensitivity of 93% and an OCG sensitivity of 65%. In this same study, if a nonvisualized GB on OCG was considered positive for gallstones, then the sensitivity of OCG increased to 87%. Another study on patients who were morbidly obese showed a sonographic sensitivity of 91% and specificity of 100%. In this patient population, which is not ideal for sonography, the negative predictive value was still very high at 97%.

The typical sonographic appearance of a gallstone is a mobile, shadowing, echogenic structure in the lumen of the GB (Fig. 1–1). The positive predictive value of this triad of findings is 100%. When shadowing is not detected, the differential includes gallstones and tumefactive sludge. Small, mobile, nonshadowing intraluminal structures are generally gallstones (Fig. 1–2). On the other hand, tumefactive sludge generally forms larger masslike aggregates (Fig. 1–3). There is some degree of overlap in the appearance of small gallstones and sludgeballs and, occasionally, a follow-up sonogram is helpful in distinguishing these two possibilities. Nonmobile, nonshadowing structures represent adherent sludge balls or polyps (Fig. 1–4). GB cancer can appear as a polypoid mass and can potentially simulate a benign polyp or tumefactive sludge (Fig. 1–5A). Detection of mobility and vascularity is important in distinguishing these possibilities (Fig. 1–5B, C).

As already indicated, the documentation of acoustic shadowing is very important in the differential diagnosis of gallstones. To optimize the detection of acoustic shadowing requires a transducer of the highest possible frequency focused at the depth of the gallstone. Changes in the patient’s position may help by clumping multiple stones together and thereby increasing the collective at-

### Table 1–3 Sensitivity of Imaging Tests for Gallstones

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity (%)</th>
</tr>
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<tbody>
<tr>
<td>Radiography</td>
<td>15</td>
</tr>
<tr>
<td>Computed tomography</td>
<td>80</td>
</tr>
<tr>
<td>Oral cholecystography</td>
<td>65 to 90</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>95</td>
</tr>
</tbody>
</table>
**Figure 1–1** Typical gallstone. (A) Longitudinal scan shows a shadowing echogenic structure (arrow) near the neck of the gallbladder. (B) Longitudinal scan with the patient in a left lateral decubitus position documents mobility of this stone (arrow), which is now seen in the body of the gallbladder.

**Figure 1–2** Small nonshadowing gallstones. (A) Longitudinal scan using a 4 MHz transducer shows several small (2 mm) echogenic foci in the fundus of the gallbladder. No acoustic shadowing is apparent. (B) Longitudinal scan using a 7 MHz linear array transducer shows similar findings. Although this sonographic appearance can, in general, be seen with sludge and stones, it is common to be unable to detect shadowing in stones this small. It is very uncommon for sludge to aggregate into multiple, small, well-formed foci like this.

**Figure 1–3** Tumefactive sludge. (A) Longitudinal scan with the patient in a supine position demonstrates a nonshadowing masslike structure (s) in the gallbladder neck. The differential diagnosis based on this single image is primarily that of a gallbladder tumor versus tumefactive sludge. (B) Longitudinal scan with the patient sitting documents mobility of this mass (s) and confirms that it represents tumefactive sludge.
tenuation. Changing the transducer position may alter the tissues displayed behind the GB and make shadowing easier to visualize.

Although sonography is very good at detecting gallstones, false-negative exams do occur. Up to one out of 20 patients with gallstones will be missed by sonography. Therefore, if the clinical suspicion is extremely high, it is reasonable to do a follow-up ultrasound after a negative ultrasound. Reasons for a false-negative ultrasound exam include a contracted GB (Fig. 1–6), a GB in an anomalous or unusual location, small stones, stones impacted in the GB neck or cystic duct (Fig. 1–7), immobile patients, obese patients, or patients with extensive RUQ bowel gas.

Once gallstones are documented in a patient with RUQ pain, the next issue is whether the patient should undergo cholecystectomy. If the RUQ pain is clinically consistent with biliary colic, then ~40% of patients will have continued symptoms and 25% will have worsening symptoms. Because of this, surgery is ultimately necessary in ~45% of these patients.4 The percentage of patients opting for surgery is likely to go up now that laparoscopic cholecystectomy is so widely available. Surgery is usually performed when the episodes of biliary colic are frequent or severe enough to seriously interfere with a patient’s lifestyle or when there is a history of complications such as acute cholecystitis, pancreatitis, or cholangitis.

As with biliary colic, sonography is very valuable in patients presenting with suspected acute cholecystitis. Sonographic findings in acute cholecystitis are (1) gallstones,
Figure 1–7 Cystic duct stones. (A) Initial longitudinal view of the gallbladder demonstrates a contracted gallbladder (gb) but no evidence of gallstones. (B) Repeat view of the gallbladder (gb) better demonstrates the gallbladder neck and cystic duct (arrowheads) and confirms the presence of two small gallstones (arrows) within the cystic duct. Stones in this location are one potential cause of false-negative sonograms. For this reason, careful attention to the gallbladder neck is very important during real-time scanning. (From Kurtz AB, Middleton WD, eds. Ultrasound: The Requisites. St. Louis: Mosby Yearbook; 1996. Reprinted with permission.)
(2) GB wall thickening of greater than 3 mm, (3) GB enlargement greater than 4 × 10 cm, (4) positive sonographic Murphy’s sign, (5) pericholecystic fluid, and (6) impacted gallstones. The diagnostic value of several of the most important individual findings is shown in Table 1–4.14,15 The diagnostic value of different combinations of these findings is shown in Table 1–5.

Approximately 95% of cases of acute cholecystitis are related to cystic duct obstruction due to gallstones. Therefore, detection of gallstones is very important in the sonographic diagnosis of acute cholecystitis. In most cases, freely mobile stones will be seen in the GB lumen, and the actual obstructing stone in the cystic duct will not be seen. When a stone is impacted in the GB neck, it is usually visible. Occasionally, small stones impacted in the cystic duct can also be detected. Acalculous cholecystitis may occur in extremely sick patients following major surgery, serious trauma, extensive burns, or prolonged parenteral nutrition. Therefore, in this patient population the absence of stones is not a reliable means of excluding the diagnosis, and secondary sonographic signs of cholecystitis, described later, must be relied upon. Although some centers have reported good results in the sonographic diagnosis of acalculous cholecystitis,16 it is often a difficult diagnosis to make or exclude by sonography or any other means.

GB wall thickening (defined as 3 mm or greater) occurs to some degree in the majority of cases of acute cholecystitis (Fig. 1–8). The positive predictive value of gallstones and wall thickening is as high as 94%. However, it is important to remember that asymptomatic gallstones are common and there are many causes of GB wall thickening besides cholecystitis (Table 1–6). In fact, the nonbiliary

<table>
<thead>
<tr>
<th>Sonographic Findings</th>
<th>Predictive Value (%)</th>
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</thead>
<tbody>
<tr>
<td>Positive</td>
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</tr>
<tr>
<td>Stones and positive Murphy’s sign</td>
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</tr>
<tr>
<td>Stones and thickened gallbladder wall</td>
<td>94</td>
</tr>
<tr>
<td>Stones, positive Murphy’s sign, and thickened gallbladder wall</td>
<td>92</td>
</tr>
<tr>
<td>Negative</td>
<td></td>
</tr>
<tr>
<td>No stones and negative Murphy’s sign</td>
<td>97</td>
</tr>
<tr>
<td>No stones and normal gallbladder wall</td>
<td>98</td>
</tr>
<tr>
<td>No stones, negative Murphy’s sign, and normal gallbladder wall</td>
<td>99</td>
</tr>
</tbody>
</table>


Table 1–6 Causes of Gallbladder Wall Thickening

<table>
<thead>
<tr>
<th>Biliary</th>
<th>Nonbiliary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholecystitis</td>
<td>Hepatitis</td>
</tr>
<tr>
<td>Adenomyomatosis</td>
<td>Pancreatitis</td>
</tr>
<tr>
<td>Cancer</td>
<td>Heart failure</td>
</tr>
<tr>
<td>Acquired immunodeficiency syndrome cholangiopathy</td>
<td>Hyponatremia</td>
</tr>
<tr>
<td>Sclerosing cholangitis</td>
<td>Cirrhosis</td>
</tr>
<tr>
<td></td>
<td>Portal hypertension</td>
</tr>
<tr>
<td></td>
<td>Lymphatic obstruction</td>
</tr>
</tbody>
</table>
wall thickening, assessment of the sonographic Murphy’s sign is critical. Hepatobiliary scintigraphy is also an extremely valuable technique in this type of situation (Fig. 1–9).

GB enlargement is also commonly present in patients with cholecystitis (Fig. 1–10A). The upper limits of normal for the size of the GB are 8 to 10 cm in length and 4 to 5 cm in width. The width is clearly the more important dimension due to the normal variation in GB length. In other words, a long, thin GB is much less worrisome than a short, wide GB.

Pericholecystic fluid is present in ∼20% of patients with acute cholecystitis (Fig. 1–11). Recognizing this fluid is important because it implies a more advanced case of cholecystitis. It is usually seen as a focal collection adjacent to the GB wall. It should be distinguished from GB wall edema, which is more concentric, and pericholecystic ascites, which is less masslike and conforms to the shape of the GB and adjacent structures. In addition to sonography, CT is occasionally very helpful in determining the full extent of pericholecystic fluid collections. Although CT is rarely used as the initial imaging test in patients with suspected acute cholecystitis, it can provide useful information in cases of complicated cholecystitis that are difficult to fully sort out with sonography. CT can also be useful in distinguishing complicated cholecystitis from GB carcinoma.

In addition to pericholecystic fluid, other signs of complicated cholecystitis include sloughed mucosal membranes (a rare finding), localized disruption of the mucosal layer of the GB wall (Fig. 1–12), striated intramural sonolucencies (Fig. 1–13), frank perforation of the GB (Fig. 1–14), and intramural gas (Fig. 1–15). Patients with these find-
Figure 1–11  Cholecystitis with pericholecystic fluid. Longitudinal view of the gallbladder in a patient in the intensive care unit demonstrates sludge (sl) and a stone (s) in the gallbladder lumen. Also seen is loculated pericholecystic fluid (f) around the gallbladder fundus and over the anterior surface of the liver (l).

Figure 1–12  Cholecystitis with mucosal disruption. Longitudinal view of the gallbladder demonstrates intraluminal sludge (sl) and stones (s). In addition, there is a region of mucosal disruption (arrow) along the superior wall of the gallbladder with fluid dissecting beneath the mucosa. This is a sign of complicated cholecystitis and indicates gallbladder wall necrosis. (From Kurtz AB, Middleton WD, eds. Ultrasound: The Requisites. St. Louis: Mosby Yearbook; 1996. Reprinted with permission.)

Figure 1–13  Acute cholecystitis with gallbladder wall necrosis. Transverse view of the gallbladder demonstrates stones (s) layering in the dependent portion of the gallbladder. Wall thickening with striated intramural sonolucencies (arrows) is detected along the lateral gallbladder wall. Although striated intramural sonolucencies are typically seen in patients with gallbladder wall thickening due to sources other than acute cholecystitis, in the setting of acute cholecystitis, this appearance suggests gallbladder wall necrosis. (From Kurtz AB, Middleton WD, eds. Ultrasound: The Requisites. St. Louis: Mosby Yearbook; 1996. Reprinted with permission.)

Figure 1–14  Acute cholecystitis with perforation. Longitudinal view of the gallbladder (gb) shows a well defined defect in the anterior wall (arrows). A fluid collection (f) is seen dissecting into the liver parenchyma.
tive when pressure applied with the transducer elicits tenderness only over the GB or when maximum tenderness is located over the GB. A convincingly positive Murphy’s sign is strong evidence of acute cholecystitis. The combination of gallstones and a positive sonographic Murphy’s sign has a positive predictive value as high as 90%. A negative sonographic Murphy’s sign is less helpful. Causes of a false-negative Murphy’s sign include patient nonresponsiveness, pain medication, or inability to press directly on the GB (due to excessive ascites, a GB that is positioned very deep to the liver or a GB that is located deep to the ribs). Another important cause of a negative Murphy’s sign is GB wall necrosis (Fig. 1–16). This occurs presumably due to damage to the GB innervation.17 When the Murphy’s sign is difficult to assess, scintigraphy can be helpful in determining the significance of morphological changes seen on sonography.

The other major means of imaging patients with suspected acute cholecystitis is hepatobiliary scintigraphy. Scintigraphy is an excellent means of determining patency of the cystic duct and presence or absence of acute cholecystitis. Sensitivity of cholescintigraphy has been reported to range from 86 to 97% and specificity from 73 to 100%.18–24 Sonographic sensitivity ranges from 81 to 100%, and specificity ranges from 60 to 100%.14,19–21,24 The bulk of evidence indicates that sensitivity and specificity of sonography and scintigraphy are very similar. Therefore, the choice of initial imaging modalities is often made based on the preferences of the referring clinician and local expertise of the radiologist. Although either approach is acceptable, there are several good reasons to start the imaging evaluation with sonography.

Figure 1–15 Emphysematous cholecystitis. Longitudinal view of the gallbladder demonstrates very bright reflectors (curved arrow) in the nondependent portion of the gallbladder wall. A dirty shadow (s) is seen deep to these bright reflectors. In addition, a ring down artifact (straight arrows) is identified. The ring down artifact is pathognomonic of gas and allows for a confident diagnosis of emphysematous cholecystitis.

Figure 1–16 False-negative sonographic Murphy’s sign in the setting of gallbladder wall necrosis. (A) Longitudinal view of the gallbladder with the patient supine demonstrates sludge (sl) in the lumen of the gallbladder. In addition, a gallstone is seen in the region of the gallbladder neck (curved arrow). (B) Similar view with the patient standing upright demonstrates migration of the sludge (sl) into the gallbladder fundus but no motion of the stone (curved arrow) in the gallbladder neck. This suggests stone impaction in the gallbladder neck. Mild gallbladder wall thickening is also present.
Most patients with acute RUQ pain do not have acute cholecystitis. Sonography can rapidly exclude the diagnosis of cholecystitis by showing a stone-free GB (Fig. 1–17 and Fig. 1–18).

Sonography is more likely to provide an alternative diagnosis than is scintigraphy (Fig. 1–17 and Fig. 1–18).

Sonography is more capable of establishing the presence of symptomatic gallstone disease in patients with biliary colic (Fig. 1–19) but without acute cholecystitis. In fact, the positive predictive value of sonography for detecting patients who need a cholecystectomy is ~99%. Occasionally, sonography may falsely classify patients with symptomatic gallstones as having acute cholecystitis, but the impact of this type of false-positive diagnosis is minimal because laparoscopic cholecystectomy is a well-accepted treatment for biliary colic and chronic cholecystitis.

Sonography can provide important preoperative information that is not readily available from scintigraphy (Fig. 1–20). This includes information about the size of...
or a positive hepatobiliary scan (see reason number 4 above). On the other hand, positive and negative sonograms do not need to be followed by scintigraphy.

The ACR guidelines for imaging patients with suspected acute cholecystitis indicate that either sonography or scintigraphy is appropriate. However, sonography is given a higher score than scintigraphy for the reasons already indicated. Practice guidelines issued in 1988 by the American College of Physicians also recommended using sonog-

5. It is common to do sonography after either a negative hepatobiliary scan (see reasons number 2 and 3 above)
Cystitis. Although both of these groups prefer to start theraphy as the first imaging test for suspected acute cholecystitis. Although both of these groups prefer to start theraphy as the first imaging test for suspected acute cholecystitis. Scintigraphy should be recognized as a powerful problem solver when the sonogram is confusing or inconclusive. This may occur in up to 20% of patients with clinically suspected acute cholecystitis in whom ultrasound is done first. Therefore, cholecintigraphy continues to play an important role in the evaluation of acute cholecystitis.

Treatment for acute cholecystitis can initially be conservative with pain medication, IV hydration, and antibiotics. Approximately 75% of patients will respond to medical therapy. The rest either will be refractory to conservative treatment or will develop complications and require surgery. Of the patients that initially respond to medical treatment, recurrent cholecystitis will occur within 1 year in 25% and within 6 years in 60%. Therefore, the current approach is to perform cholecystectomy during or after the first episode of acute cholecystitis. The exact timing of the cholecystectomy is not uniformly agreed upon. It appears that early laparoscopic cholecystectomy is most effective if performed on patients presenting within 48 hours of the onset of symptoms. Early cholecystectomy may also be necessary if the patient fails to respond to medical treatment. Delayed cholecystectomy is generally reserved for patients presenting after 48 hours, for those patients at increased operative risk, or for those patients in whom the diagnosis is unclear. Emergent cholecystectomy is reserved for patients that are clinically unstable or patients with complications identified clinically or on imaging studies.

**Summary**

Sonography is the primary imaging modality for evaluation of RUQ pain. It is more effective at diagnosing and evaluating gallstones than any other imaging test. OCG has been largely abandoned. However, gallstones are well quantified by OCGs and if dissolution therapy or lithotripsy become more popular in the future, OCG may become more important. Sonography is similar in accuracy to scintigraphy in the evaluation of suspected acute cholecystitis and provides additional information that is not available on scintigraphy. Cholecintigraphy is a valuable test of GB function that is very useful in the evaluation of suspected acute cholecystitis when ultrasound is confusing or indeterminate. CT is not a primary modality in the evaluation of RUQ pain but is very useful in further evaluating complicated cholecystitis and GB neoplasm. CT may be useful in the diagnosis of acute acalculous cholecystitis.

**References**