The Rim Sign: Association with Acute Cholecystitis

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In a retrospective analysis of 218 hepatobiliary studies in patients clinically suspected of acute cholecystitis, a rim of increased hepatic activity adjacent to the gallbladder fossa (the "rim sign") has been evaluated as a scintigraphic predictor of confirmed acute cholecystitis. Of 28 cases with pathologic confirmation of acute cholecystitis in this series, 17 (60%) demonstrated this sign. When associated with nonvisualization of the gallbladder at 1 hr, the positive predictive value of this photon-intense rim for acute cholecystitis was 94%. When the rim sign was absent, the positive predictive value of nonvisualization of the gallbladder at 1 hr for acute cholecystitis was only 36%. As this sign was always seen during the first hour postinjection, it can, when associated with nonvisualization, reduce the time required for completion of an hepatobiliary examination in suspected acute cholecystitis.

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Radioisotope imaging of the hepatobiliary system using technetium-99m- (^{99m}Tc) labeled iminodiacetic acid derivatives is considered to be a valuable diagnostic tool for detection of acute cholecystitis (*1–6*). We have occasionally recognized an unusual band or rim of increased hepatic parenchymal activity adjacent to the gallbladder fossa in certain studies with a nonvisualized gallbladder (Fig. 1). Brachman et al., in a series of five patients, recently reported an association between this pericholecystitic activity and acute gangrenous cholecystitis (*7*). To evaluate the significance of this scintigraphic pattern as it relates to cholecystitis, we reviewed all hepatobiliary examinations performed in patients with clinical evidence of acute cholecystitis over the 2-yr period from June 1982 to July 1984. Our findings suggest that a photon-intense rim of activity adjacent to the gallbladder fossa is an important cholescintigraphic indicator of acute cholecystitis which can reduce the time required to complete the hepatobiliary examination.

MATERIALS AND METHODS

All hepatobiliary examinations performed on patients with suspected acute cholecystitis in the 2-yr period between June 1982 and May 1984 at our institution were reviewed. Each case was evaluated for the presence of gallbladder activity and/or the rim sign along with time of appearance. The images were assessed for pericholecystic activity (rim sign) in those scans depicting a nonvisualized gallbladder at 1 hr or more. Data analysis was performed only on the subset of these examinations where verification of the gallbladder status could be ascertained. Pathologic confirmation of the presence or absence of acute cholecystitis was available in 39 of these cases. Only the results of those surgical specimens obtained within 7 days of cholescintigraphy were included in the study. The pathologic criteria for acute cholecystitis used in this study were neutrophilic infiltration, necrosis, hemorrhage, or edema of the gallbladder wall. Ten additional cases with delayed gallbladder visualization were also included in the data analysis with the presumption that these individuals did not have acute cholecystitis.

All studies were independently reviewed by two nuclear medicine physicians. Cases in which the reviewers disagreed were interpreted by a third nuclear medicine physician. Data was statistically evaluated using the chi-square test.

Hepatobiliary studies were performed using 4 mCi (148 MBq) of technetium-99m disofenin (DISIDA). All patients had been fasting a minimum of 2 hr prior to i.v. administration of the radiopharmaceutical. Imaging was done using a large field gamma camera equipped with a low-energy, parallel hole collimator

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FIGURE 1
Anterior image of liver at 45 min postinjection demonstrating narrow strip of activity adjacent to gallbladder fossa with superior border of this activity indicated by arrow and inferior border outlined by arrowheads

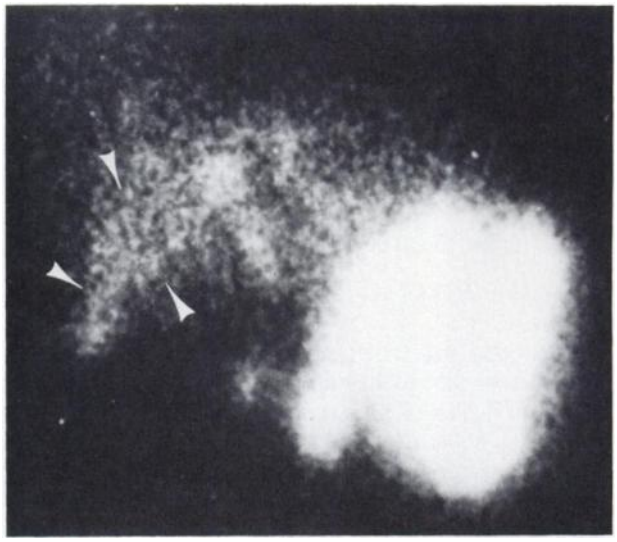

FIGURE 2
Anterior image of liver at 60 min postinjection. As opposed to image in Fig. 1, pericholecystic activity seen here is more diffuse (arrow heads)

using a 20% energy window centered at 140 keV. Anterior, and usually right lateral and right anterior oblique projections were obtained immediately postinjection and approximately every 15 min through 1 hr. Delayed images were performed in nearly all cases if the gallbladder was not visualized by 1 hr.

RESULTS

There were 218 hepatobiliary studies reviewed. The gallbladder was not visualized by 1 hr in 88 of these examinations (40%). In ten of these 88 patients, the gallbladder was visualized after 1 hr. Thirty-nine of the 88 patients with a nonvisualized gallbladder had surgery within 7 days of the hepatobiliary study. Data analysis was performed using the results of these 49 examinations. Thirty-six of the remaining 39 cases with a nonvisualized gallbladder never had surgery and three had surgery delayed for more than 1 wk after the scan. Of these 39 cases in which the status of the gallbladder could not be ascertained, a rim sign was present in only three.

Of the 49 patients with nonvisualization of the gallbladder at 1 hr in the data analysis group, 18 had a rim sign present and 17 of these met the pathologic criteria of acute cholecystitis. In all cases, the rim sign was present by 1 hr and usually present prior to this time (Fig. 1-3). Of the 21 cases a rim sign was present in only one patient with histologically proven chronic cholecystitis for which there was no evidence for acute cholecystitis (specificity 95%). The hepatobilary exam revealed a rim sign in 17 of the 28 cases with acute cholecystitis (sensitivity 61%). The calculated positive predictive value for acute cholecystitis in patients with a nonvisualized gallbladder at 1 hr and a positive rim sign was 94% (17/18), whereas the positive predictive value in those cases when the rim sign is absent was found to be only 36% (11/31). This data is summarized in Table 1.

Nine of the 28 patients with acute cholecystitis had a "grossly necrotic" gallbladder (gangrenous cholecystitis), and eight of these had a rim sign (Table 2). There were nine patients with a rim sign who did not have gangrenous cholecystitis. The positive predictive value of the rim sign for gangrenous cholecystitis is 44% (8/18). The two physicians reviewing the cases agreed on the presence or the absence of a rim sign in 46 of 49 cases (interobserver agreement of 93.9%).

DISCUSSION

One of the primary objectives of this project was to determine if there is a significant relationship between the cholescintigraphic rim sign and acute cholecystitis. As shown in Table 1, there is a significant association ($p < 0.0005$).

Cholescintigraphy is regarded by many as the diagnostic method of choice for detection of acute cholecystitis (*1-6*). The sensitivity of this technique for the diagnosis of acute cholecystitis approaches 100% in many clinical series and with delayed imaging, the positive predictive value of a nonvisualized gallbladder for acute cholecystitis is reported to be 75.5-96.6% (*1-3,6*). In our series, the positive predictive value of a nonvisualized gallbladder at 1 hr in the absence of rim sign was rather low (36%). However, the demonstration

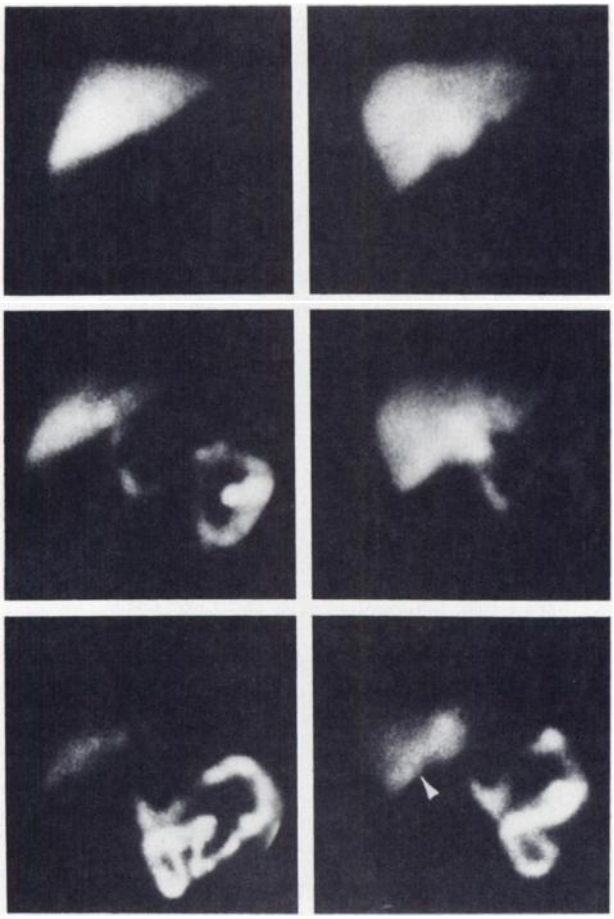

FIGURE 3
Anterior and right anterior oblique images of liver (left column and right column, respectively). Images are, from top to bottom, 5, 30, and 60 min postinjection. As indicated by arrow, rim sign is best appreciated in later phase of study, particularly in this case in 60-min RAO view. Such findings support the concept that delayed clearance of tracer plays a role in genesis of the rim sign

of the rim sign in the presence of gallbladder nonvisualization (at 1 hr) increased the predictive value for acute cholecystitis to 94%, comparing favorably with the results of cholescintigraphy reported in the literature using standard delayed images. Therefore, the appearance of the rim sign, by 60 min, can substantially reduce the time required for completion of the hepatobiliary study by eliminating the need for delayed images. This is an important point as certain authors have expressed their preference for real-time ultrasound as opposed to cholescintigraphy based in part on the extended time required for completion of the latter (*8*). While various methods have been proposed for limiting the time required for successful completion of the hepatobiliary examination, these methods usually involve some type of pharmacologic intervention and/or have not always proven to be reliable (*1,9*).

TABLE 1
Relationship Between Rim Sign and Acute Cholecystitis* in Patients with Nonvisualized Gallbladder at 1 hr

Item	Acute cholecystitis	No acute cholecystitis
Rim sign	17	1
No rim sign	11	20

* Chi-square test–$p<0.0005$.

TABLE 2
Relationship Between Rim Sign and Gangrenous Cholecystitis*

Item	Gangrenous cholecystitis	No gangrenous cholecystitis
Rim sign	8	10
No rim sign	1	30

* Chi-square test–$p<0.0005$.

The positive predictive value of gallbladder nonvisualization for acute cholecystitis is markedly reduced in alcoholics, individuals receiving total parenteral nutrition, and patients with severe intercurrent illness, hepatocellular disease, or common bile duct obstruction (*1,10,11*). Under these circumstances, gallbladder visualization often does not occur, even in the absence of cystic duct obstruction, due to an inadequate delivery of radiotracer to the gallbladder. The genesis of the cholescintigraphic rim sign appears to be independent of bile flow into the gallbladder and as such this finding is unlikely to be affected by the aforementioned conditions. Utilization of the rim sign might, therefore, significantly enhance the diagnostic capabilities of hepatobiliary imaging in these particular subcategories of patients.

As mentioned previously, Brachman et al. recently indicated that pericholecystic activity is associated with gangrenous cholecystitis. In our series, 44% of patients whose scan demonstrated a rim sign had extensive necrosis of the gallbladder, whereas of the 31 patients without pericholecystic activity only one had gangrenous cholecystitis. This association may be clinically useful since gangrenous cholecystitis carries a higher morbidity and mortality and urgent cholecystectomy is considered prudent management.

The intensity of the rim sign is variable, ranging from barely perceptible to relatively intense. Further, the activity may be confined to a thin band (Fig. 1) immediately adjacent to the gallbladder or extend into much of the lower portion of the right lobe (Fig. 2). Although the intensity of the activity forming the rim may correlate with the degree of inflammation we did not specifically evaluate this.

The origin of the cholescintigraphic rim sign is uncer-

tain. We suspect, as did Brachman et al. (*7*) that inflammation of the pericholecystic hepatic tissue plays an important role in the genesis of this sign. In particular, tissue edema associated with the inflammatory process may lead to compression of local bile cannuliculi with resultant biliary stasis. In support of this concept, the rim of activity is usually seen on later images (30 to 60 min) when the remainder of the liver parenchyma has effectively cleared the radiotracer (Fig. 3).

An important aspect of any diagnostic imaging technique is the reproducibility of findings between different observers. Minimizing the subjectivity in scan analysis is clearly desirable. With the cholescintigraphic rim sign the interobserver agreement as demonstrated by our data is excellent (46/49).

Several points should be emphasized regarding the methodology of this study. Although excluding the diagnosis of acute cholecystitis based on delayed visualization of the gallbladder is generally a valid conclusion, it has been demonstrated that gallbladder visualization after 1 hr can on rare occasions occur in an individual with acute cholecystitis (*4*). Nevertheless, it is generally accepted that delayed gallbladder visualization is associated with a very high probability that acute cholecystitis is not present. Consequently, it is our belief that this represents a valid method for determining the status of the gallbladder. Further, even pathologic confirmation may not be absolutely reliable as different pathologic criteria exist for diagnosing acute cholecystitis (*6*). The choice of 7 days as the cutoff point for acceptance of surgical specimens was made at the initiation of the study with consideration of the effect on both the accuracy of the diagnosis and the number of cases that could be included in the analysis. Certainly, given enough time, a case of acute cholecystitis could develop into chronic cholecystitis. However, of the 11 patients with pathologically proven chronic cholecystitis, there was only one case in which cholescintigraphy and cholecystectomy were separated by the full 7 days allowed in the protocol. Nine of these patients had surgery within 48 hr after the hepatobiliary examination. Finally, even if several of the cases counted as chronic cholecystitis (as determined by either pathology or delayed gallbladder visualization) had been in reality acute cholecystitis, the positive predictive value of the rim sign would not be adversely affected (see Table 1).

Optimal management of patients with right upper quadrant pain requires a rapid, reliable and safe diagnostic evaluation for acute cholecystitis. This can be achieved with hepatobiliary scintigraphy. Increased radiotracer in the liver parenchyma adjacent to the gallbladder fossa is a very strong indicator of acute cholecystitis and, when present in association with nonvisualization of the gallbladder at 1 hr, can eliminate the need for delayed imaging. The findings of this study demonstrate the diagnostic utility of the cholescintigraphic rim sign and the presence or absence of this activity should be considered in the interpretation of the hepatobiliary examination.

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