

CT AND ULTRASOUND IN ABSCESS DETECTION AT SPECIFIC ANATOMIC SITES: A STUDY OF 198 PATIENTS

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(Received 17 July 1986; in revised form 26 September 1986; received for publication 18 October 1986)

Abstract—Records of 902 patients with possible abdominal abscess were reviewed and of these 198 had abscesses on at least one occasion imaged either with ultrasound (US) or computed tomography (CT). There were 235 episodes of either one or simultaneous multiple abscesses. Sensitivities of CT and US were analyzed according to anatomic site. The nature of errors made was tabulated. CT was significantly more sensitive than US for the detection of abdominal abscess. Causes of CT and US error in abscess detection are discussed, and recommendations regarding choice of exam and means of improving performance are made.

Abdominal abscess Computed tomography Ultrasound Sensitivity Enteric fistulae

INTRODUCTION

The high sensitivity of US and CT in the detection and localization of abdominal abscesses has been established [1-3]. However, there are anatomic regions and disease processes where the sensitivity of each may be less than in general. To address these issues, we retrospectively reviewed the medical, CT, and US records of 902 patients with possible abdominal abscesses.

METHODS

Patients with either clinical history or imaging results consistent with abscess were identified by review of computerized diagnostic codes and compiled CT/US reports at the University of Michigan Hospital.

Real time was performed in almost all US cases. CT was usually performed as an exam of the abdomen and pelvis.

Abscesses were classified according to anatomic compartments (Table 1). Pus identified in at least three intraperitoneal sites was classified anatomically as a diffuse abscess.

Table 1. CT and US sensitivity at anatomic sites

Location	Patients/imaging sessions	CT sensitivity	US sensitivity
<i>Intraperitoneal</i>			
Diffuse	28/28	10/13 (77%)	11/25 (44%)
Right subphrenic	3/3	2/2 (100%)	1/3 (33%)
Left subphrenic	15/16	8/9 (89%)	11/17 (65%)
Paracolic	14/15	4/5 (80%)	8/12 (67%)
Subhepatic	5/6	2/3 (67%)	4/6 (67%)
Lesser sac	9/9	5/5 (100%)	3/8 (38%)
Interloop	11/11	3/5 (60%)	4/10 (40%)
Pelvis	57/64	14/15 (93%)	42/56 (75%)
<i>Visceral organs</i>			
Hepatic	19/23	11/13 (85%)	16/21 (76%)
Renal	5/5	0/0	1/5 (20%)
Splenic	2/2	1/1 (100%)	0/2 (0%)
Pancreatic	15/17	11/12 (92%)	7/13 (54%)
<i>Retroperitoneal</i>	22/25	15/15 (100%)	18/24 (75%)
<i>Miscellaneous</i>			
Body Wall	6/6	4/5 (80%)	2/4 (50%)
Psoas	18/24	21/23 (91%)	5/17 (29%)
Incisional	28/30	7/8 (88%)	16/31 (52%)
Groin	9/10	1/1 (100%)	9/10 (90%)

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Table 2. CT vs US errors^a

<i>US errors</i>		<i>CT errors</i>	
Sensitivity—60% (158/264)		Sensitivity—89% (119/134)	
106 misses in 264 imaging episodes		15 misses in 134 imaging episodes	
Technical	62 (58%)	Technical	7 (47%)
Interpretive	40 (38%)	Interpretive	6 (40%)
Perceptive	6 (6%)	Perceptive	4 (27%)
Communication	11 (10%)	Communication	3 (20%)
Location	7 (7%)	Location	0 (0%)
Sampling	9 (8%)	Sampling	0 (0%)
Unknown	2 (2%)		

^aPercentages indicate the frequency with which a given error type was thought to have contributed to a misdiagnosis. In some cases, there were multiple contributing factors.

Table 3. US technical errors

62/106 total US errors—(58%)	
Acoustic access impediment	43/62 (70%)
Gas containing abscess	12/62 (20%)
Obesity	9/62 (15%)
Near field noise	7/62 (11%)
Small size	2/62 (3%)
Non-specificity	2/62 (3%)
Pre-existing lesion	1/62 (1%)
Ileus	1/62 (1%)

Errors were classified as either sampling (region of abscess not studied), technical (accepted limitation of the technique), perceptive (lesion identified in retrospect), location (anatomic location incorrect), interpretive (lesion identified, but thought to be nonabscess), communication errors (misleading use of a benign term i.e. ascites), or a combination of these.

RESULTS

Of 902 charts reviewed, 198 patients had 235 instances of one or more intra-abdominal abscess. 189 instances involved abscesses in a single location, 23 involved diffuse intraperitoneal abscesses and 23 involved abscesses in multiple locations with at least one site not peritoneal. There were 294 imaging episodes with CT and/or US exams of a given abscess.

Of 294 times that CT, US, or both were used to image an abscess, 226 (77%) had surgical or autopsy proof, 48 (16%) were proven by aspiration and/or culture, and 20 (7%) were on the basis of clinical evaluation.

Errors were made by US in 106 of the 264 abscesses it examined (Tables 2 and 3). Technical sources of error predominated.

Errors were made in 15 of the 134 cases examined by CT (Table 2). Technical errors were primarily related to poor bowel opacification and patient movement. Interpretive errors involved abscesses mistaken for bowel or ascribed to other diseases. Perceptive errors were due to abscesses mistaken for bowel (Figs 3 and 4).

Specific anatomic sites

The use of the diffuse classification decreased the number of abscesses listed in other categories, but was necessary since both radiologists and surgeons failed to enumerate all diffuse abscess locations, precluding accurate retrospective identification of each abscess site. These diffuse abscess cases were qualitatively different than others since they were uniquely almost always related to pre-existing fluid, or intestinal leak. Of the 28 diffuse abscesses, ten were related to infection of pre-existing ascites, and fourteen were related to intestinal perforation. The most common error in this group was mislabeling infected fluid as ascites.

In the left subphrenic space, US missed six abscesses, 4 in post splenectomy patients. In the 8 asplenic patients with left subphrenic abscesses, US missed 4 and detected 4.

In the pelvis, US errors were related to sampling error, echogenic abscesses, and gas containing abscesses. The general category of pelvic abscesses, especially in complex oncology cases, were not detected by US as well as CT, except those occurring in patients with noncancerous gynecologic disease.

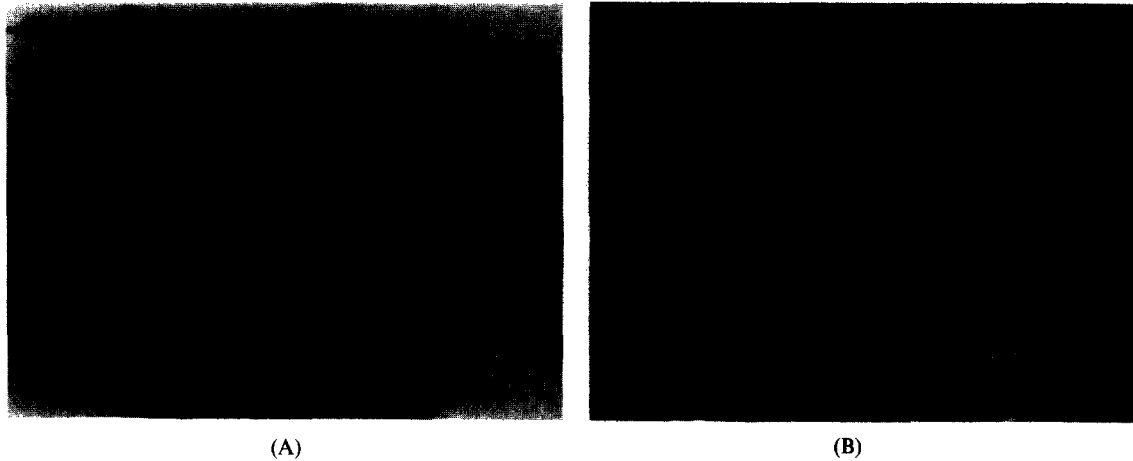


Fig. 1. (A) Left upper quadrant fluid collection thought to be stomach at real time US. (B) At CT this is a large subphrenic abscess (arrows). Medial compression of the spleen (cursor) denies its use as an acoustic window.

CT outperformed US in the retroperitoneum except for the peritransplant “perinephric” space. US was poor in diagnosing psoas abscesses, with errors related to acoustic access impediments and sampling errors occurring when the psoas was not evaluated as part of groin exams. US evaluation of localized groin abscesses due to IV drug abuse or vascular surgery was excellent. Hyperechoic abscesses and a noisy near field caused US error in incisional abscesses.

CT and US both negative

Of eight abscesses missed by both CT and US, three were communication errors labeling diffuse infected fluid as ascites. Of these, two involved infection of pre-existing ascites. Bowel perforation and peritonitis were detected by gallium scan in the third. An IN111WBC scan diagnosed a left upper quadrant abscess mistaken for bowel by CT and US. Two gas containing abscesses with enteric communications were mistaken for bowel (Fig. 4). CT and US twice failed to distinguish abscess from pre-existing tumor or pseudocyst.

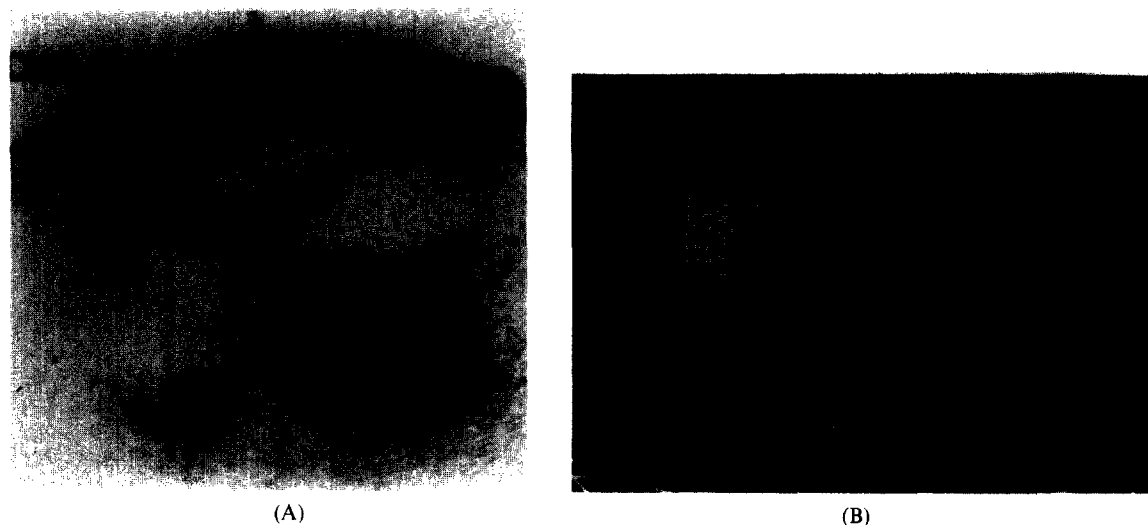
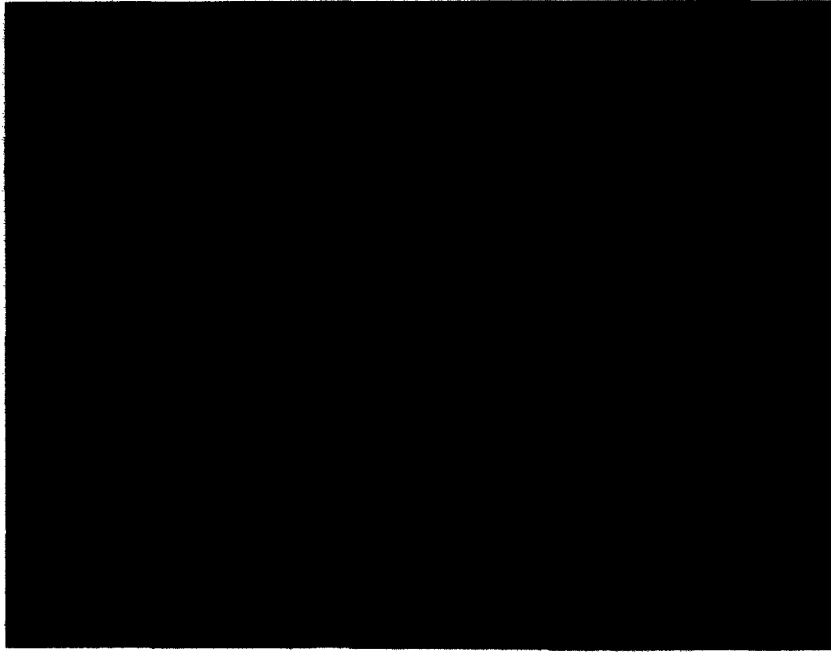
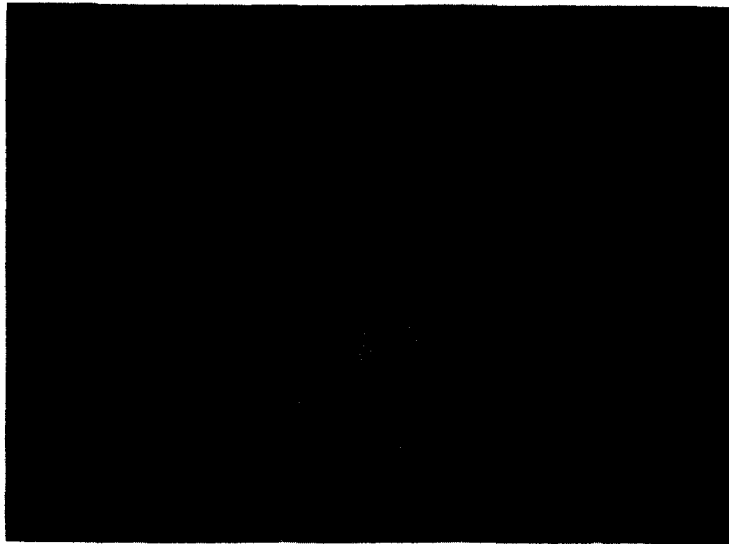


Fig. 2. (A,B) Patient with diastasis of the symphysis. The aspiration proven hematoma (black arrow) anterior to the bladder drew attention from the abscess (open arrow) compressing the rectum posterolaterally (black arrowhead). Gas and fluid caused it to mimic bowel.



(A)



(B)

Fig. 3. Left paracolic abscess missed by CT. (A) US identified a sausage shaped fluid collection which did not peristaltic (arrows), and was suspicious for abscess. (B) Inflammatory changes in the mesentery and a small abscess (small arrowhead) initially felt to be descending colon (long arrowhead) are seen in retrospect. Surgery demonstrated a paracolic abscess.

DISCUSSION

Regional differences in accuracy [1, 2, 4–8], absolute sensitivity [1, 2, 4, 5, 7], presence of wounds, tenderness, ileus [5], adjacent highly reflective and bony structures [2, 5, 9], poor respiratory co-operation [1, 7], and body habitus help decide whether to use US or CT.

US directed to a specific anatomic area is more effective [5] and less expensive, but may miss unsuspected lesions due to sampling error. US sampling errors might be prevented by scanning of the pelvis and abdomen in every case [8, 10, 11].

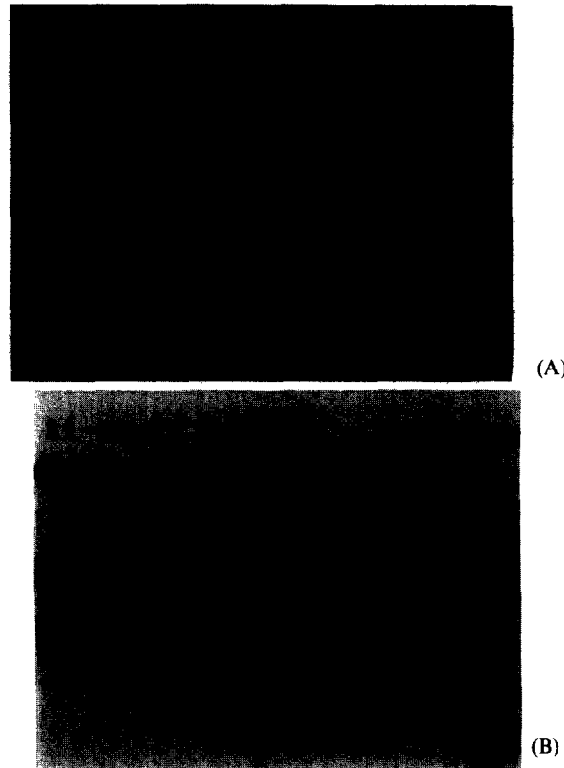


Fig. 4. Negative CT and US in a patient with Crohn's disease, a 15 cm abscess, and a small bowel fistula. (A) A large abscess containing predominantly air was mistaken for bowel. (B) Sagittal US better demonstrates mass effect (arrowheads) superior to the bladder, thought to be an abnormal loop of small bowel.

Inherent technical limitations, primarily related to acoustic access, limit accuracy of US [2, 4, 12] and are unlikely to be overcome in a non directed US survey. CT technical errors are infrequent and usually related to patient motion or poor intestinal opacification.

US perceptive errors are uncommon. CT perceptive errors are usually due to abscesses that mimic bowel and are rare, but one of the most remediable sources of CT error. Especially in disorders associated with enteric fistulae [13], the radiologist must suspend the usual assumption that gas plus fluid or contrast equals bowel. Careful tomographic analysis with contiguous sections, review of abdominal films or digital scout view, and prone or decubitus views may prevent mislabeling an abscess as bowel [13, 14]. Long air/contrast fluid levels are a clue to large abdominal abscess collections mimicking intestine. Adjacent inflammatory changes may distinguish these from bowel but are not always present [15].

CT and US interpretive errors are caused by low clinical suspicion, failure to perform needle aspiration [14], lack of tissue specificity [3, 15, 13], and inability to distinguish new pathology from pre-existing disease [3, 9, 11].

In some settings, such as the transplant kidney and in groin abscesses due to local factors, US sensitivity is high enough that it can be performed as the initial exam. The patient with infection of pre-existing peritoneal fluid is evaluated adequately by US with fluid aspiration. Pelvic abscess in pelvic inflammatory disease or uncomplicated post-hysterectomy cases can be reliably diagnosed by US because of few acoustic access impediments, simple clinical context, and the tendency for single abscesses confined to the pelvis.

Complex pelvic diseases, post cystectomy cases, and groin abscess without obvious local factors merit CT as the initial exam.

In the pancreas, psoas, retroperitoneum [2], lesser sac, left subphrenic space, and peri-incisional regions, CT is the modality of choice because of its superior sensitivity. Inability of US to diagnose bone infection [16] makes CT preferred in the psoas or other areas where bony infection is likely. Real time transducer pressure, static scanning to display textural symmetry and psoas size, and routine

prone scans [17] may prevent some US errors, but anteriorly placed wounds and the iliac wing impair complete US evaluation of the psoas.

CT is preferable in evaluating peri-incisional regions for abscess, especially with dehiscence. The high proportion of hyperechoic incisional abscesses makes fluid difficult to detect at US. Through transmission, an important sign of fluid [18], may not be demonstrated due to intestinal gas directly behind the abscess. The noisy near field of real time transducers poorly displays otherwise anechoic fluid. Water path scanning, or use of a high frequency real time small parts transducer with an op-site membrane [19] may help US evaluation, but lacks the larger view of static scans which allows comparison of subtle textural differences [20].

When biliary drains, biliary-enteric communication, or a fungal infection [21, 22] are present or suspected, CT is preferred in evaluating the liver. Acoustic access impediments make CT preferred in the left subphrenic space, especially if the spleen is absent. Obscuring of the pancreas and lesser sac by an associated ileus, and the wide spread of inflammatory fluid make CT preferable in pancreatitis.

Patients with possible intestinal perforation should first have CT since it can detect free peritoneal air or elevated CT numbers in the fluid. At either CT or US, the finding of diffuse peritoneal fluid in a patient without pre-existing peritoneal fluid should raise suspicion of an intestinal perforation, since we and others [23, 24] have found that large volumes of infected peritoneal fluid may be related to enteric fistulae.

CT and US both have difficulty diagnosing abscesses in patients with enteric communications and in the background of pre-existing abnormalities such as ascites, cysts [3, 9], hydronephrosis, or neoplasms. Diagnostic aspiration may prevent such errors. Nuclear medicine has a role in the small number of patients with false negative CT and US exams, and should be strongly considered in any patient with negative CT and suspected abscess.

SUMMARY

Poor clinical clues to the abscess site and frequent occurrence of multiple abscesses favor total abdominal imaging [1, 4, 12, 25]. The technical impediments to a practical US abdominal survey preclude complete confidence in a negative result. While both CT and US can reliably detect abscesses, CT is preferred for nondirected abscess search [1, 2, 4, 5], because of its high sensitivity and reliability for drainage route planning. Selection of CT and US according to patient presentation and awareness of the limitations and sources of error of each technique can minimize false negative diagnoses in cases of abdominal abscess.

Acknowledgements—Special thanks is due Dr Alex Aisen, Dr David Pennes, Dr John D. DeMott Jr, Lynn Warren, Margaret Gresham, Dianne Haupt, Cindy Fettes, Ginny Diehl, and the technical and clerical staff at the University of Michigan for their assistance. We also acknowledge the generosity of the Ex-Cello-O Corporation in providing a Laserwriter high resolution printer.

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