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Diagnostic ultrasound of acute colonic diverticulitis by surgical residents

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Abstract

Background: Recent studies have documented the feasibility of ultrasonography (US) to diagnose acute colonic diverticulitis (ACD). This prospective observational trial determined the sonomorphology of ACD and evaluated the diagnostic accuracy of routine US performed on admission by surgeons in training.

Methods: Fifty-seven consecutive patients with a confirmed episode of ACD were entered into this study, and the sonomorphology of the involved colon was assessed. US findings were compared to the results of the clinical evaluation and correlated to the clinicopathological outcome.

Results: The sonomorphology of ACD was characterized by segmental inflammatory transformation of the colon averaging 9.9 ± 3.2 cm (range, 6–20) in length and visualized as target phenomena of a mean 3.5 ± 0.8 cm (range, 2.4–4.8) width. Targets were caused by hypoechogenic thickening of the colonic wall of an average 7.7 ± 2.6 mm (range, 4–18). In 40% of cases, a hyperechogenic halo representing peridiverticulitis (average width, 2.3 ± 0.6; range, 1.2–3 cm) was noted. Diverticula were seen in almost half of the cases. Of the 57 cases with confirmed ACD, the diagnosis was made by US in 48, for a global accuracy of 84.2%. US was false negative in nine patients, suggesting perforated appendicitis in five cases and acute appendicitis in one (the final diagnoses were perforated sigmoid diverticulitis in five cases and cecal diverticulitis in one case). In three patients, US was nondiagnostic.

Conclusion: In the hands of sonographically trained surgeons, ultrasound is a useful modality to image acute colonic diverticulitis. US reveals diagnostic sonomorphology in most cases of ACD and therefore facilitates early confirmation of the diagnosis and assessment of severity.

Key words: Ultrasound — Acute colonic diverticulitis

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Ultrasound (US) is a new method for imaging acute colonic diverticulitis (ACD) [10, 14, 16]. If performed by an expert sonographer, it can be very accurate in establishing the diagnosis [13]. However the diagnostic sonomorphology of ACD is not yet fully established. Moreover, it is unclear whether surgeons trained in US imaging can successfully utilize the method to diagnose ACD. We therefore studied the sonomorphology as well as the overall diagnostic accuracy of routine ultrasonography performed by surgeons in training in patients with confirmed episodes of ACD.

Patients and methods

Over a 4-year period, all patients admitted to the surgical clinic with a possible diagnosis of acute colonic diverticulitis underwent US evaluation and were entered into this study. Patients with generalized peritonitis requiring emergent surgery were excluded. Only those patients in whom the diagnosis of ACD was proven by either surgery or at least one established diagnostic modality other than US were accepted for analysis. Ultrasound was performed on admission, after the physical examination.

Eleven surgeons in training (2nd- to 6th-year residents) were involved in this study; all of them had received standardized training in abdominal ultrasound, as described in detail elsewhere [6]. Training included an average of 400 supervised investigations of the abdomen, as well as an introduction to the method of graded compression [6]. ''Graded compression'' refers to a technique of handling the ultrasound probe in a way closely resembling that of a surgeon's palpating hands during physical examination: Gentle compression graded by the patients tolerance for pain is applied with the probe, which is then slowly moved. Compression of the abdominal wall reduces the distance between the transducer and bowel, displaces gas and intraluminal residue, interposing bowel or mesentery and eliminates (or at least reduces) interfaces. Graded compression was also used in the area of greatest abdominal tenderness.

The US investigator was chosen arbitrarily and had supplied with the details of the clinical indications for the study. For the purpose of this study, individual investigators were asked to deliver a definite diagnosis. Sonograms were interpreted immediately at the time of the procedure, and there was no supervision until a definite ultrasonographic diagnosis was established.

Patients were scanned using commercially available electronic real-time scanners (3.5- and 5.0-MHz transducers; Siemens SL100, Erlangen, Germany). Visualization of a hypoperistaltic segment with hypoechogenic mural thickening, presenting as a poorly compressible target in transverse view, was considered diagnostic of acute diverticulitis and thus recorded as

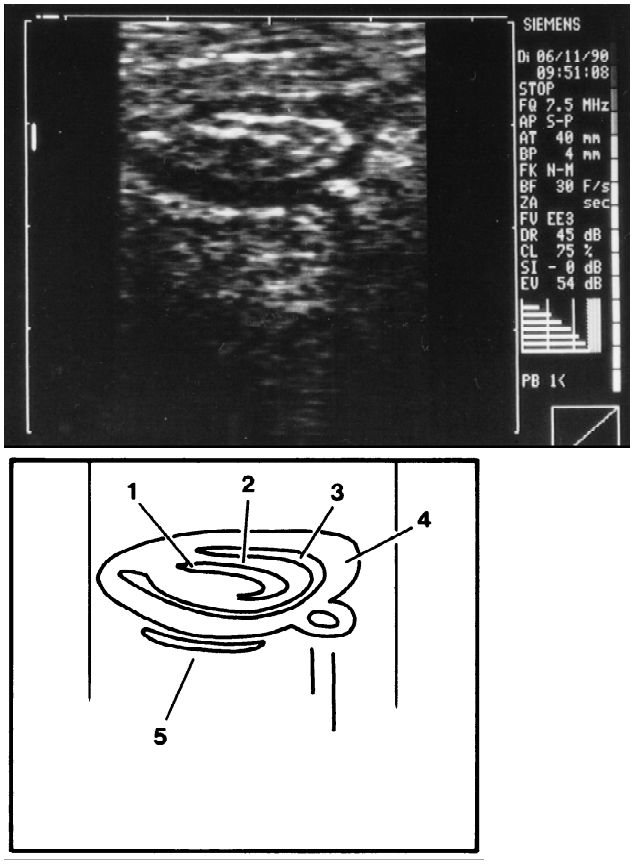

Fig. 1. Transverse section in the left lower quadrant exemplifying postinflammatory sigmoid diverticulosis. Note the target pattern of the sigmoid colon, revealing marked hypoechogenicity of the wall. Five concentric layers of the bowel wall can be readily identified: The innermost bright layer is produced by residue and air present within the lumen of the colon (1); the next layer is representative of the mucosa (2); the next bright layer represents an interface between mucosa and muscularis (3); the hypoechogenic outer layer represents the muscularis (4); the next bright layer [(5) appreciated between 6 and 9 h] is yet another interface between muscularis and serosa. To the right of the target pattern, at 5 h, a small grape-like structure with a central hyperechogenic reflection and faint dorsal acoustic shadowing represents a noninflamed diverticulum.

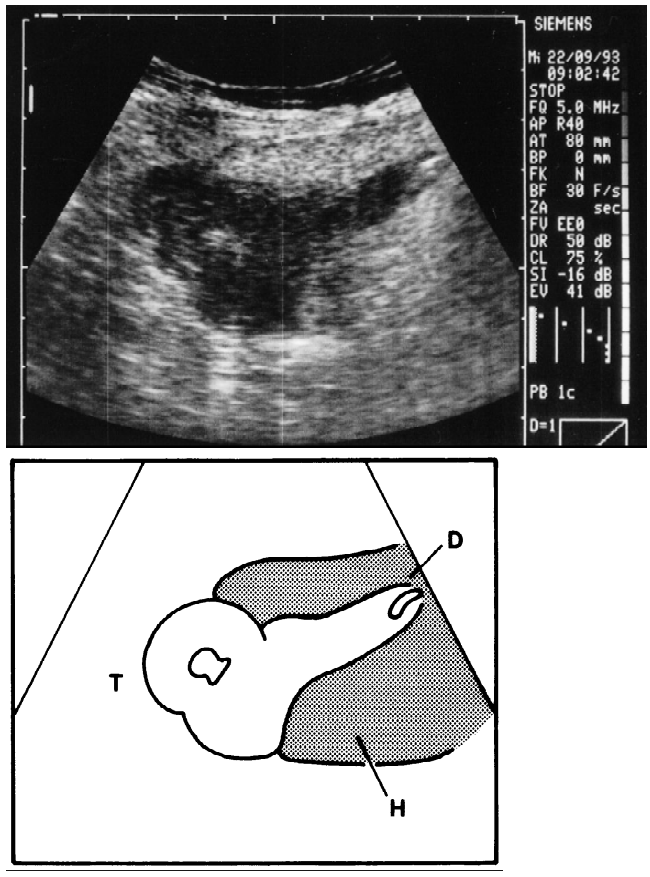

Fig. 2. Transverse section in the left lower quadrant in a case of uncomplicated acute sigmoid diverticulitis. Acute diverticulitis is characterized by an asymmetric inflammatory target pattern of the sigmoid colon (T) caused by hypoechogenic thickening of the wall, narrowing of the lumen, and decreased peristalsis in dynamic view. To the right of the target, at 3 h, a tubular structure with a bright apical reflection represents an inflamed diverticulum (D). It is surrounded by a hyperechogenic mass of homogenous sonolucency, which is caused by inflammatory edema of the pericolic fat and indicates peridiverticulitis (hyperechogenic halo, H).

a positive finding. Nonvisualization of such a segment was regarded as a negative result. The largest diameter of the segment, its length, and mural thickness were measured by calipers. Diverticula, peridiverticulitis, and other signs of diverticulitis were recorded.

To assess the clinical utility of US in ACD, patients were allocated into one of the following three clinical categories after the physical examination: group A, highly likely for diverticulitis; group B, equivocal diagnosis of acute diverticulitis pending further investigation; group C, highly unlikely for diverticulitis. This allowed for a grading of the clinical suspicion of ACD. US results were compared to those obtained during the clinical evaluation and correlated to the discharge diagnoses of the respective patients.

Results

We evaluated 57 patients with a confirmed episode of ACD. This group was comprised of 31 female patients with a mean age of 64.9 years (range, 35–89) and 26 male patients with a mean age of (21–81) 55.6 years (m/f ratio, 1:1.2). The sigmoid colon was the most common site of acute diverticulitis (47/57; 82.4%). Involvement of the descendent colon and left colonic flexure was found in eight cases (14.1%). The cecum and ascending colon accounted for two cases (3.5%). The final diagnosis of ACD was confirmed by radio-opaque enemas in 29 patients (50.8%), surgery in 21 patients (36.9%), colonoscopy in six patients (10.5%), and computed tomography in one patient (1.8%), respectively. Overall, 28 patients underwent operative interventions during the same hospital stay; ACD was confirmed in all cases.

During US evaluation ACD was characterized by hypoechogenic thickening of the wall of an average 7.7 ± 2.6 mm (range, 4–18) accompanied by luminal narrowing and hypoperistalsis of the involved colonic segment during dynamic view. This region was usually appreciable as a poorly compressible segmental target pattern in transverse view and a rigid tubular structure displaying multiple hypoechogenic strata in longitudinal view. The average width and length of the inflamed segments were 3.5 ± 0.8 cm (range, 2.4–4.8) and 9.9 ± 3.2 cm (range, 6–20). In 19 of 48 (39.6%) cases of ACD with a true positive US investigation, a hyperechogenic halo of an average width of 2.3 ± 0.56 cm (range, 1.2–3) was noted (Figs. 1–4). Diverticula were seen with a frequency of 47.9%. Abscesses were present in 11 patients and visualized by US in nine; they ranged from

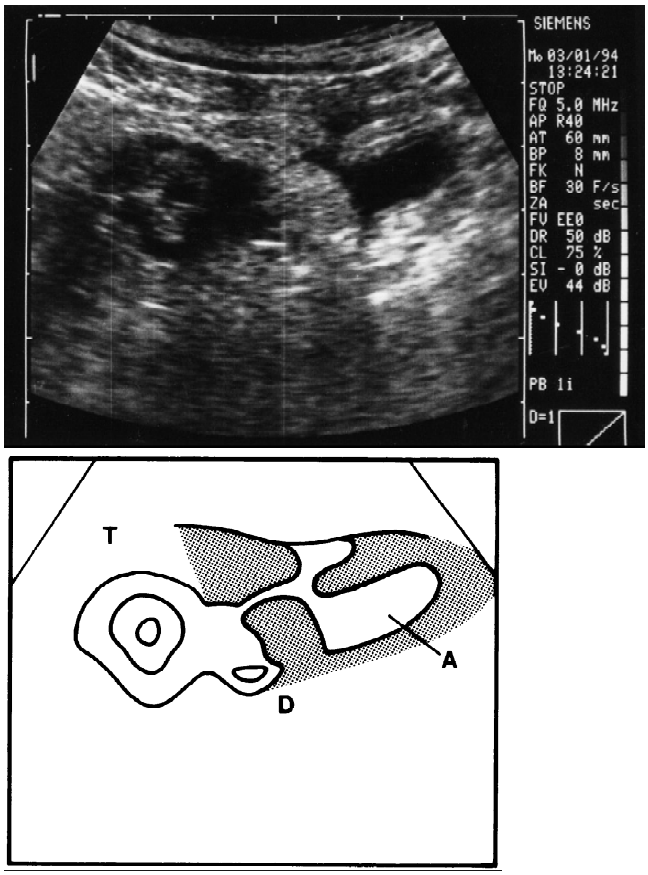

Fig. 3. Transverse section in the left lower quadrant in a case of complicated sigmoid diverticulitis. Note the target pattern of the sigmoid colon with asymmetric hypoechogenic thickening of the wall (T). A small irregular hypoechogenic target with a central air reflection, visualized at 5 h represents an inflamed diverticulum (D). It is surrounded by a hypoechogenic halo (shaded area). A well-confined abscess of 2 × 1 cm can be seen to the right of the diverticulum (A).

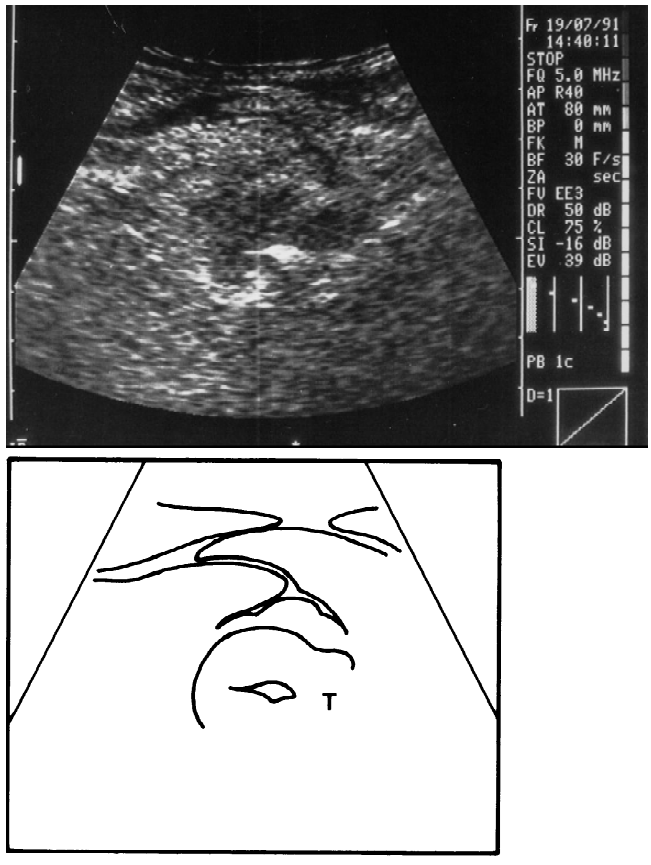

Fig. 4. Transverse section in the left lower quadrant in a case of perforated sigmoid diverticulitis with advanced local peritonitis. Note the faintly visible, poorly defined hypoechogenic target pattern of the sigmoid colon (T), which is surrounded by a noncompressible zone of increased echogenicity. The inflammatory pseudo-tumor has attained a diameter of 7.5 cm and shows evidence of the spread of inflammation to pericolic fat and mesentery. Close to the abdominal wall, the halo is divided by multiple hypoechogenic strata, representing fluid collections between the different layers of edematous epiploic appendices, mesenteric, and pericolic fat (onion-skin appearance).

2 × 4 to 12 × 3 cm (Fig. 3). Enterovesicular fistulas were apparent in two patients; neither was detected by US. One enterocutaneous fistula was correctly diagnosed by US (Table 1).

US made the diagnosis of ACD in 48 of the 57 cases with proven diverticulitis, for an accuracy of 84.2%. False negative results of US were recorded in nine cases (15.8%). The false diagnosis of complicated acute appendicitis was made in five patients; in these cases, the inflamed sigmoid colon was found displaced to the right lower abdominal quadrant. All of these patients underwent surgery for signs of localized peritonitis. Four patients received two-stage sigmoid colectomies and appendectomy for perforated sigmoid diverticulitis, and one patient underwent one-stage sigmoid colectomy without appendectomy. Another case concerned a patient with an inflamed solitary cecal diverticulum and confined local peritonitis, which was also misdiagnosed as acute appendicitis. This patient underwent appendectomy and local resection of the cecal diverticulum. The remaining three cases involved a group of clinically mildly affected patients; in these cases, diagnosis of uncomplicated ACD was made by water-soluble contrast enemas in two patients and CT scanning in one patient, respectively.

Based on the results of the clinical evaluation on admission, the immediate clinical diagnosis of an ACD was made in 29 of 57 patients, for a diagnostic accuracy of 50.8%. Of the six patients who appeared clinically very unlikely for ACD, five cases were misdiagnosed as acute appendicitis and one case as nonspecific acute abdominal pain. All other patients were classified as clinically equivocal cases, including five patients who eventually required emergency surgery for complicated ACD. Overall, of the 28 patients who underwent surgery for ACD, the indication for a laparotomy was clinically evident in 12 cases, including the five patients who were misdiagnosed as acute appendicitis. US identified all cases that subsequently underwent operative therapy although, as already pointed out, six cases were misinterpreted as acute appendicitis. While US and CT were always performed at the day of admission, colonoscopies were performed after a median 3.5 days (mean, 7.7 ± 3.5; range, 0–28), and water-soluble contrast enemas were done at a median 6 days (mean, 6.7 ± 5.4; range, 2–28) after admission.

Discussion

Ultrasound (US) is increasingly used by surgeons in the initial evaluation of the patient with acute abdominal pain

Table 1. Sonomorphology of acute colonic diverticulitis

Finding	Average (mm)	Range (mm)
Wall thickness	7.7 ± 2.6	4–18
Target width	35 ± 8	24–48
Segment length	99 ± 32	60–200
Hyperechogenic halo	23 ± 5.6	12–30

[2, 6, 11]. This study establishes that surgeons trained in ultrasound imaging can effectively use this method to diagnose acute colonic diverticulitis (ACD).

Computed tomography constitutes the current gold standard imaging modality in complicated diverticulitis [1, 9]. Like CT, US imaging allows the physician to define the extent of extramucosal inflammation and identify sequelae of ACD, such as perforation and abscess, without intraluminal procedures or contrast extravasation. The colon was relatively easy to access by US because of its close proximity to the abdominal wall and its size. The inflamed segments usually attained a considerable size; they averaged 3.5 × 9.9 cm in this study.

The diagnostic sonomorphology of ACD established during this study was similar to that reported by other authors [13, 14, 16]. Besides some rather unspecific criteria of inflammatory bowel disease, such as thickening of the colonic wall to 4–18 mm, lack of compressibility, and hypo- or aperistalsis, we observed a number of more specific signs, such as diverticula (50%), local abscesses (20%), and fluid collections or fistulas (5%). Inflamed diverticula ordinarily were visualized as grape-like hypoechogenic structures, surrounded by an often double contoured wall. They frequently displayed bright acoustic reflexes caused by trapped air and feces. With extensive disease, hyperechogenic halos surrounding the involved colonic segment were noted; in addition, there was a lack of synchronous movement with breathing. This finding, which was considered an ultrasonographic sign of peridiverticulitis, was noted in some 40% of patients.

Although no single sonographic criterion was considered diagnostic, it was evident from this study that visualization of an inflammatory target sign in the left lower quadrant, together with hyperechogenic halo and diverticula, is highly suggestive of ACD in a symptomatic patient. Consequently, the 84% accuracy of this study for the sonographic diagnosis is quite comparable to the results from three other prospective trials published by recognized experts in the field of ultrasonography, who reported an overall accuracy of 82–98%, sensitivity of 84–98%, and a specificity of 80–96% [4, 12, 15].

One potential pitfall, however, is the clinical presentation of right-sided colonic diverticulitis, which is either caused by a solitary cecal diverticulum or a displaced sigmoid colon. Both conditions may be impossible to distinguish from acute appendicitis. This presentation accounted for five false clinical diagnoses and six false US results. Previous studies did not comment on this particular difficulty; therefore, this problem may have been a reflection of lack of experience [6, 9]. CT may be a better alternative in these circumstances.

Not unexpectedly, the accuracy for the clinical diagnosis of ACD was low, but this problem is well documented in the literature [10, 16]. The clinical diagnosis is rarely more accurate than 75% [3, 5]. However, assessing the site and severity of the disease is important, particularly in complicated diverticulitis, since the outcome largely depends on a timely diagnosis [7, 8]. The routine use of CT is hampered by its own restrictions—mainly limited availability and high cost [1, 9]. Use of colonoscopy and radio-opaque enema is also limited, due to the increased frequency of complications in ACD. Therefore, they cannot always be employed immediately; the resulting diagnostic time lag of several days was also found in the present study.

Based on the results of this study, it appears that US imaging is a fast, feasible, and effective diagnostic modality for patients in whom ACD is suspected. US imaging facilitates early confirmation of ACD and permits rational management decisions to be made. Whether or not US will alter the surgical management of these patients remains to be seen.

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