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# Utility of point-of-care ultrasound in patients with suspected diverticulitis in the emergency department

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#### INTRODUCTION 1

In emergency department (ED) cases with clinically suspected diverticulitis, diagnostic imaging is often needed for diagnostic confirmation, to exclude complications, and to direct patient management. Patients typically undergo a CT scan in the ED; however, in a subset of cases with suspected diverticulitis, point-of-care ultrasound (POCUS) may provide sufficient data to confirm the diagnosis and ascertain a safe plan for outpatient management. We review the main sonographic features of diverticulitis and discuss the diagnostic accuracy and potential benefits of a POCUS First model.

#### KEYWORDS

Abstract

bowel, diverticulitis, emergency department, gastrointestinal system, point-of-care ultrasound

In patients with suspected diverticulitis, diagnostic imaging is performed to establish the correct diagnosis, exclude complications, and direct patient management. A CT scan should be obtained in patients with signs of complicated diverticulitis including patients with clinical suspicion of perforation, peritonitis, or abscess, and those with complex anatomy and broader differentials.<sup>1,2</sup> A shift in the understanding of the underlying disease process of diverticulitis along with advances in medical and surgical management has led gastroenterologists and surgeons to increasingly adopt a more conservative approach to treatment.<sup>2,3</sup> As such, patients with a high pretest probability of uncomplicated diverticulitis in whom CT imaging is of uncertain added value are therefore potentially subject to high rates of unnecessary radiation, long wait times, and costly ED visits.<sup>4,5</sup> The utility and scope of point-of-care ultrasound (POCUS) for evaluating and managing abdominal complaints in the emergency department (ED) have grown rapidly with little change in physician practice or patient awareness.<sup>6</sup> Several retrospective reviews and a meta-analysis have established the ability of POCUS to accurately diagnose uncomplicated diverticulitis.<sup>4,6,7</sup> These studies combine clinical decision scores with US features of diverticulitis and have similar accuracy to CT, showing a sensitivity of 92-94% and a specificity of 90%-99%. (Table 1).

US remains underutilized in EDs and radiology suites alike, despite its potential to provide adequate diagnostic information.<sup>4,7-10</sup> POCUS is a reliable, safe, inexpensive, and accurate initial imaging modality to detect both acute and recurrent diverticulitis. Using POCUS to identify cases of uncomplicated diverticulitis may decrease the need for CT examinations, saving patients time, money, and exposure to contrast and ionizing radiation. As diverticulitis is known to recur in up to 22% of patients, many patients are subject to multiple CT scans over their lifetime for the same clinical entity, which could be avoided using a "POCUS First" model.<sup>4,8</sup> Additionally, the use of POCUS as an initial imaging modality may reduce the time burden that ED and radiology providers face in obtaining CT examinations and having them read.

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Study	# Cases	Setting	Final diagnosis	Sensitivity	Specificity	PPV/PLR	NPV/NLR	Sonographer
King et al <sup>4</sup>	253	ED	CT Scan	89%	78%	89%	79%	ED physicians
Van Randen et al <sup>9</sup>	118	ED	Follow-up (6 months)	61%	99%	1.00	NA	Radiologists
Moll et al <sup>10</sup>	247	ED	CT Scan	76	97	25	0.25	Radiologists
Hollerwerger et al <sup>20</sup>	175	ED	CT Scan	94	97	31	006	Radiologists
Andeweg et al <sup>12</sup>	Meta-analysis			90%	90%	84-98%	82-92%	Meta-analysis
Lameris et al <sup>7</sup>	Meta-analysis			92%	90%	9.63	0.009	Meta-analysis
Liljegren et al <sup>13</sup>	Meta-analysis			84-85%	80-93%	NA	NA	Meta-analysis

TABLE 1 Summary of studies using ultrasound in patients with acute diverticulitis

Abbreviations: ED, emergency department, NLR, negative likelihood ratio, NPV, negative predictive value, PLR, positive likelihood ratio, PPV, positive predictive value.

#### 2 | ULTRASOUND SCANNING PROTOCOL

Portable US scanners including the Sonosite X-Porte (Sonosite, Bothell, WA) or the Zonare z.one ultra (Zonare, Mountain View, CA) scanners equipped with a 1-4 or 1-5-MHz curved-array abdominal transducer (1 to 4 or 5 MHz) are used with abdominal presets. A high-frequency (3-8 or 6-15-MHz) linear transducer is used to evaluate the sigmoid wall, diverticula, and surrounding soft tissues in patients whose habitus allows it. Scanning is initiated by positioning the probe in the left lower quadrant (LLQ) so that the lower end of the probe is close to the anterior superior iliac spine; then scanning of the colon is done in a circular direction. The scan is continued medially and caudally toward the bladder in an attempt to visualize the distal part of the sigmoid behind the bladder. After scanning the LLQ and retro-vesicular areas, areas of the colon, and sigmoid displaying wall edema and pericolonic stranding are identified. The thickness of the colonic wall from inner to outer wall is measured. The presence of diverticula with echogenic foci and pericolonic stranding also is also documented.

POCUS findings consistent with diverticulitis include thickening of the colonic wall which appears as a hypoechoic ring, pericolonic hyperechoic fat stranding (indicating edema or inflammation), and extraluminal hyperechoic foci likely representing trapped colonic contents or air bubbles.<sup>6,7,8</sup> Typical diverticulitis has the appearance of a small sac-like outpouching of bowel with a peripheral hypoechoic ring and central echogenicity (the pseudokidney sign). Presence of extraluminal hyperechoic foci of trapped air is not necessarily a sign of free colonic perforation<sup>1,4</sup> (Figures 1 and 2).

#### 3 | CASES

#### 3.1 | Case 1

A 59-year-old male with no significant past medical history presented with 2 days of moderate LLQ abdominal pain and constipation that had improved with Bisacodyl. He had no nausea, vomiting, or fever. His vital signs were normal and laboratory findings unremarkable; he



**FIGURE 1** Case 1. A, Transverse ultrasound image of sigmoid colon in patient with acute diverticulitis (Video 1) demonstrating thickened colonic wall (arrowhead), outpouching of colonic contents through the wall of the colon and echogenic foci (arrow). B, Contrast-enhanced CT scan depicts thickened inflamed junction of descending and sigmoid colon (arrow) with adjacent edema



**FIGURE 2** Case 2. A, Transverse ultrasound image of the sigmoid colon in a patient with acute diverticulitis showing colonic wall edema (arrowhead) and adjacent diverticula outpouching (arrow) (Video 2). B, Contrast-enhanced CT scan depicts marked focal concentric thickening and adjacent inflammation of the sigmoid colon (arrow)

was found on physical exam to have minimal tenderness in the LLQ without guarding or rebound. An abdominal US revealed a thickened colonic wall and pericolic stranding appearing as haziness of the adjacent fat) (Figure 1). There was no obvious evidence of abscess formation. A CT scan confirmed the diagnosis of sigmoid diverticulitis by showing scattered colonic diverticula. The patient was discharged on ciprofloxacin and metronidazole.

## 3.2 | Case 2

A 53-year-old male presented with 1 day of LLQ abdominal pain exacerbated by movement and palpation. His last bowel movement the night before was normal. He had no nausea, vomiting, diarrhea, fever, or bloody stools. Vital signs were unremarkable, and physical examination revealed severe tenderness in the LLQ without guarding or rebound. Laboratory tests showed a leukocytosis of  $12 \times 10^9$ /L but were otherwise unremarkable. An abdominal US examination with a linear 3-8 MHz transducer revealed colonic wall edema and colonic outpouching with trapped extraluminal air typical of diverticulitis

(Figure 2). A CT scan revealed fat stranding around diverticula at the junction of the sigmoid and descending colon with trace fluid in the paracolic gutter. The patient was diagnosed with acute diverticulitis, admitted for observation and IV antibiotics, and discharged on oral antibiotics on day two.

#### 3.3 | Case 3

A 34-year-old male with history of diverticulitis and *Clostridium difficile* (*C. Diff*) infection presented with 1 day of worsening abdominal pain. He had been discharged 10 days earlier after an admission for diverticulitis and had completed his course of oral antibiotics the day before his symptoms recurred. He had no fever, nausea, vomiting, or diarrhea. His vital signs were unremarkable, and physical examination was significant for tenderness in the LLQ with guarding but without rebound. Laboratory testing showed a mild leukocytosis of  $11.6 \times 10^{9}$ /L but was otherwise unremarkable. An abdominal US performed with a high-frequency linear transducer showed an eccentric short segment of wall thickening of the sigmoid colon associated with an inflamed diverticulum. The inflammation resulted in increased



**FIGURE 3** Case 3. A, Longitudinal ultrasound image of the sigmoid colon in patient with acute diverticulitis demonstrates an eccentric thickening of a short segment of the sigmoid colon (arrowhead), associated with an inflamed diverticulum (not shown). (Video 3). B and C, Axial and coronal reconstructed CT scans showing thickening and inflammation of a relatively long segment of the proximal sigmoid colon with adjacent edema (arrow)



**FIGURE 4** Case 4. A, Transverse ultrasound image of the sigmoid colon in a patient with acute diverticulitis demonstrating asymmetric thickening of the hypoechoic wall (arrowhead) (pseudokidney sign) with adjacent air in a diverticulum (arrow) (Video 4). B, Axial contrast-enhanced CT scan of the LLQ shows marked thickening of the junction of the descending and sigmoid colon and adjacent inflammation

edema (Figure 3). CT showed a short segment of sigmoid colonic wall thickening with stranding and inflammation of the sigmoid mesentery. He was diagnosed with diverticulitis and admitted for IV antibiotics given the failure of previous outpatient therapy. He improved with treatment and was discharged on hospital day seven.

#### 3.4 | Case 4

A 69-year-old female with history of diverticulitis presented with worsening LLQ abdominal pain. She had recently been diagnosed with a flare of diverticulitis and started on antibiotics by her primary care doctor 2 days prior to her ED presentation. Her vitals and laboratory findings were unremarkable, and she was found to have moderate LLQ tenderness. An abdominal US performed with a high-frequency linear transducer revealed asymmetric hypoechoic thickening, and pericolic stranding of the sigmoid colon with presence of air in the adjacent soft tissues (Figure 4). CT showed focal segmental wall thickening and pericolonic fat stranding adjacent to an inflamed diverticulum in the distal descending colon. The patient was diagnosed with acute diverticulitis and discharged home to continue on oral antibiotics. One month later, she underwent a nonemergent low-anterior resection of bowel with colorectal anastomosis.

#### 4 | DISCUSSION

The authors seek to contribute to the Ultrasound First Campaign's mission by recounting the feasibility of using POCUS as first-line imaging in ED patients with suspected uncomplicated diverticulitis. Nearly all developing countries as well as many European nations use POCUS as first-line imaging for identifying uncomplicated acute diverticulitis, and several studies have also retrospectively supported a POCUS First model.<sup>8-13</sup>

All patients in this case series presented with LLQ abdominal and all had unremarkable initial vital signs. None presented with rebound or frank peritonitis consistent with an acute surgical abdomen. As such, our target population largely reflected a target population of mild diverticulitis. The diagnoses were confirmed by subsequent CT examinations, all reflecting a Hinchey classification of 0 or 1a. Two of the four patients required hospital admission. The patient in Case 3 was slightly more complicated given his recent hospitalization and *C. diff* infection and CT examination likely would have been warranted in this patient regardless of US findings. The patient was admitted despite his reassuring CT mainly because of a high risk of being lost to follow-up and his reluctance to complete the entire antibiotic course as an outpatient rather than because of a need for urgent or emergent surgical intervention.

# 5 | WHY "ULTRASOUND FIRST" IN DIVERTICULITIS?

There is an undeniable need for CT examination in complicated cases of diverticulitis as management is largely determined by the extent and nature of these complications. CT also plays a pivotal role in establishing classification systems for the management of diverticulitis and in ruling out other diagnoses. However, approximately 75% of diverticulitis cases are simple with only localized inflammation and no complications, and some studies suggest that approximately 85% of these cases recover with nonoperative interventions alone.<sup>1,11,14</sup> Overall, only 14%-20% of patients with acute diverticulitis undergo emergent or semiurgent surgical or radiological interventions during their initial hospitalization.<sup>15,16</sup> In the absence of high fever, clinically significant laboratory or radiologic abnormalities, or immunosuppression, the condition can be managed on an outpatient basis, and randomized trials have shown no significant benefit to IV over oral antibiotics.<sup>3,17,18</sup> A meta-analysis of 19 studies with over 2300 patients demonstrated successful outpatient treatment in 93.0% of

selected patients, with rare (0.2%) progression requiring percutaneous drainage of an abscess or emergency surgery.<sup>18</sup>

While CT remains the most common first-line imaging modality performed for abdominal pain in the United States, advances in POCUS are leading more clinicians to utilize this modality to evaluate GI pathology.<sup>6,8,19,20</sup> This series of four representative patients with diverticulitis highlights an underutilized application of abdominal POCUS for appropriate patients who can be quickly diagnosed and treated without the use of ionizing radiation. In our increasingly overburdened and over-capacitated hospitals and EDs, utilizing US as the first imaging modality may benefit a large population of patients for whom we can decrease time to diagnosis and treatment, visit costs, and radiation exposure.

Accurate US examination of the diverticular disease relies on detecting characteristic and potential complications such as abscess, perforation, or obstruction. It is important to keep in mind the risk of false-negative results, which primarily arise from failure to visualize an inflamed colonic segment, most commonly in the lower sigmoid where the lesion cannot be easily visualized by US. Other false-negative findings on US can result from missing perforated diverticulitis or perforated colonic carcinoma; US can also be limited in its ability to detect small bubbles off extraluminal air, as well as difficulty in differentiating small pericolonic abscesses which can be obscured by adjacent gascontaining loops.

The advantages of CT scanning—such as its relative BMI independence and ability to rule out additional diagnoses—ensure that a small percentage of predictably complicated patients (eg, those with peritonitis, complex anatomy and broader differentials) still require CT imaging. CT scanning may also prove critical for detecting alternative diagnoses in patients who present with atypical LLQ pain and therefore have a broader differential diagnosis, such as epiploic appendagitis, renal colic, and, rarely, colon cancer. In these cases, a "diverticular US only" protocol may result in a missed diagnosis and potentially improper management. Again, the authors emphasize the importance of limiting the Ultrasound First Protocol to individuals with narrow differential diagnoses and a high pretest probability of uncomplicated diverticulitis.

## 6 | CONCLUSION

The recent paradigm shift in the management of acute, uncomplicated diverticulitis supports the use of POCUS as a cost-effective method of decreasing ED length of stay and patient radiation exposure. CT scans play a critical role in the diagnosis and management of diverticulitis, especially when complications are suspected; however, POCUS is a valuable, cost-effective modality to evaluate patients without risk factors for complicated disease.

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#### SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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