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# **Ultrasound in Emergency Medicine**

## POINT-OF-CARE ULTRASOUND TO DIAGNOSE COLITIS IN THE EMERGENCY DEPARTMENT: A CASE SERIES AND REVIEW OF THE LITERATURE

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**Abstract—Background:** Colitis refers to an inflammatory process of the colon, composed of a variety of different etiologies including inflammatory bowel disease, infectious colitis, ischemic colitis, and allergic colitis. Usually, abdominal computed tomography (CT) is the gold standard in diagnosing the various forms of colitis. However, by the use of point-of-care ultrasound (POCUS), one may occasionally be able to discern wall thickening, pericolic fluid, and adjacent hyperechoic mesenteric fat. One may also see abscesses, fistulae, or ascites. **Case Series:** This is a series of 6 patients who had findings consistent with colitis seen on POCUS performed by an emergency physician. These were confirmed by abdominal CT with contrast. Early detection by POCUS was able to lead to a rapid diagnosis and to expedite treatment. **Why Should an Emergency Physician Be Aware of This?:** The ability to detect findings of colitis by POCUS can be quickly learned by the emergency physician with a strong background in basic ultrasound. For many of the different subtypes of colitis, the initial treatment in the emergency department is the same: i.v. antibiotics, i.v. fluids, and “bowel rest” by maintaining the patient in nothing-by-mouth status. For the stable patient with high clinical suspicion of an infectious etiology of colitis, ultrasound can help confirm the diagnosis and rule out other etiologies. This may be especially important in certain populations such as children and young women, where one can avoid a significant amount of radiation being directed toward the pelvic area. © 2019 Elsevier Inc. All rights reserved.

**Keywords—**colitis; ultrasonography; point-of-care ultrasound; emergency department

## INTRODUCTION

Colitis refers to an inflammatory process of the colon, comprised of a variety of different etiologies, including inflammatory bowel disease, infectious colitis, ischemic colitis, and allergic colitis. In severe cases, it can cause life-threatening conditions such as gastrointestinal bleeding, bowel perforation, and septic shock. Colitis is in the differential diagnosis for the patient who presents to the emergency department (ED) with nonspecific abdominal pain, especially with diarrhea and fever. According to current practice, contrast-enhanced multidetector computed tomography (MDCT) is widely used and recommended as the imaging modality of choice for patients with acute nonlocalized abdominal pain with or without fever, as well as for patients with a suspicion of a new-onset or a re-exacerbation of Crohn's disease (1,2).

Abdominal point-of-care ultrasonography (POCUS) is most commonly used by the emergency physician to determine if there is evidence of intraabdominal bleeding after trauma, as well as to evaluate for the possible presence of cholecystitis, cholelithiasis, hydronephrosis, or an enlarged abdominal aortic aneurysm (3). However, beyond specific intestinal pathologies such as appendicitis and small-bowel obstruction, its utility for routine imaging assessment of the colon in the ED is less well established.

This case series describes six examples in which a provisional diagnosis of colitis was made by POCUS in the

ED by an emergency physician. These were later confirmed by either MDCT, endoscopy, or serologic tests. The existing literature evaluating the use of ultrasound (US) for diagnosing colitis will then be discussed.

## CASE SERIES

### Case 1

A 27-year-old woman presented to the ED with 24 h of periumbilical abdominal pain. One month prior to her ED visit, she underwent elective cholecystectomy for suspected biliary colic. She was noted to have right lower quadrant abdominal tenderness. Laboratory test results revealed mild leukocytosis and an elevated C-reactive protein (CRP) level. POCUS was performed to look for suspected appendicitis. Instead, the right lower quadrant area revealed a prominent ascending colon, thickening of the wall of the terminal ileum, pericolic fluid, and hyperechoic adjacent mesenteric fat (Figure 1A). In light of these findings, emergent MDCT of the abdomen and pelvis was performed and confirmed these findings (Figure 1B).

The patient received i.v. antibiotics but refused admission. Subsequent outpatient colonoscopy demonstrated a “cobblestone” pattern of the intestinal mucosa, suspicious for Crohn’s disease. The pathology report showed fragments of moderate, chronically active patchy colitis, which confirmed the diagnosis for this patient.

### Case 2

An 86-year-old woman with a recent history of pacemaker implantation presented to the ED with persistent abdominal pain and watery diarrhea for 3 weeks. Two months prior to her ED visit she was treated with antibiotics for

a suspected pacemaker site infection. Her physical examination revealed diffuse abdominal tenderness without peritoneal signs. Laboratory tests were unremarkable. POCUS revealed areas of colonic wall thickening up to 8 mm along most of the large bowel, but most prominent in the descending colon (Figure 2A). Pancolitis was suspected and i.v. antibiotics were initiated. MDCT performed the same day confirmed the diagnosis of pancolitis (Figure 2B) and the patient was admitted to the hospital. Stool samples were PCR positive for *Clostridium difficile*. After several days of i.v. antibiotics, she improved clinically and was discharged home.

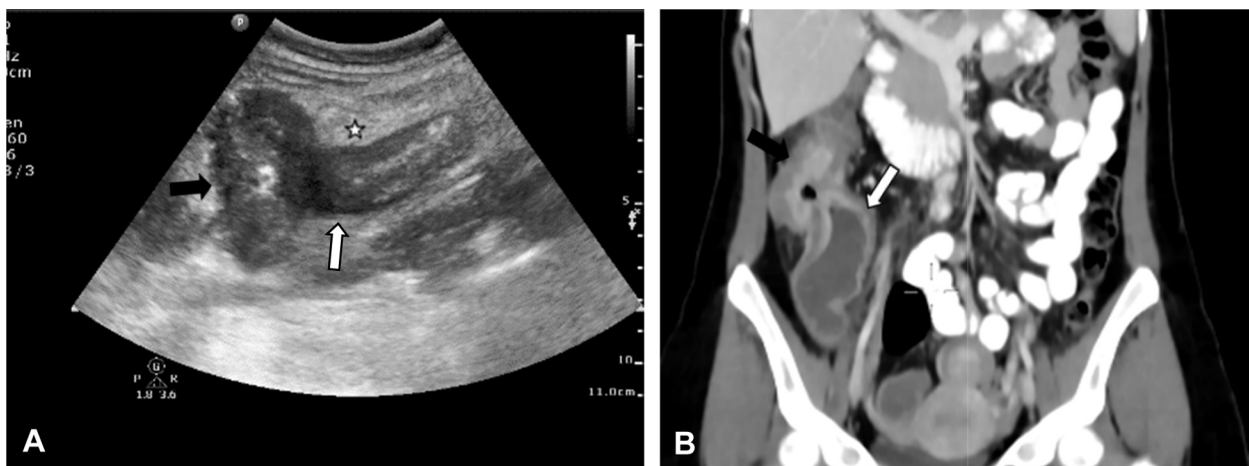
### Case 3

A 74-year-old woman with a past medical history of hypertension presented to the ED with general weakness, periumbilical pain, and recurrent watery diarrhea for the past 2 days.

At presentation, she was hemodynamically stable with a temperature of 38.5°C. On examination, she was noted to have diffuse abdominal tenderness. Laboratory results included a normal white blood cell count but elevated CRP. An abdominal x-ray study was unremarkable. POCUS revealed thickening of the wall of the ascending colon (Figure 3A). Intravenous antibiotics were initiated. MDCT performed 2 h later confirmed the findings of mild colitis (Figure 3B). She improved after receiving i.v. antibiotics for suspected infectious colitis. Stool cultures and PCR were negative.

### Case 4

An 84-year-old woman with a past medical history of recurrent biliary pancreatitis presented to the ED with



**Figure 1.** (A) Longitudinal sonogram demonstrating thickening of the wall of the cecum (black arrow), thickening of the wall of the terminal ileum (white arrow) and adjacent hyperechoic mesenteric fat (white star). (B) Multidetector computed tomography coronal image demonstrating thickening of the wall of the cecum (black arrow) and thickening of the wall of the terminal ileum (white arrow).



**Figure 2. (A) Longitudinal sonogram, demonstrating thickening of the wall of the sigmoid (white arrow). (B) Multidetector computed tomography axial image demonstrating thickening of the wall of the sigmoid colon (white arrow).**

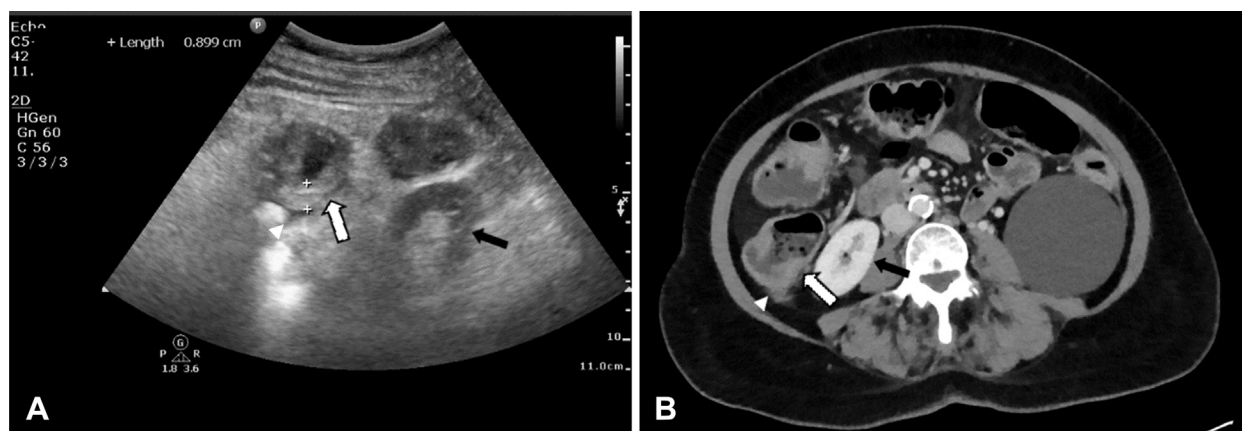
right upper quadrant pain for 2 days. She had visited the ED 2 days earlier, when she had POCUS performed demonstrating gallstones without sonographic signs of cholecystitis. She was discharged but returned due to persistent pain. Repeated POCUS revealed prominent thickening of the wall of the distal part of the ascending colon, the proximal segment of the transverse colon (hepatic flexure), and adjacent hyperechoic mesenteric fat. These findings were suspicious for colitis (Figure 4A). Laboratory test results revealed an elevated white blood cell count and CRP. Intravenous antibiotics were initiated and MDCT confirmed these findings (Figure 4B). The patient later clinically improved and was discharged.

### Case 5

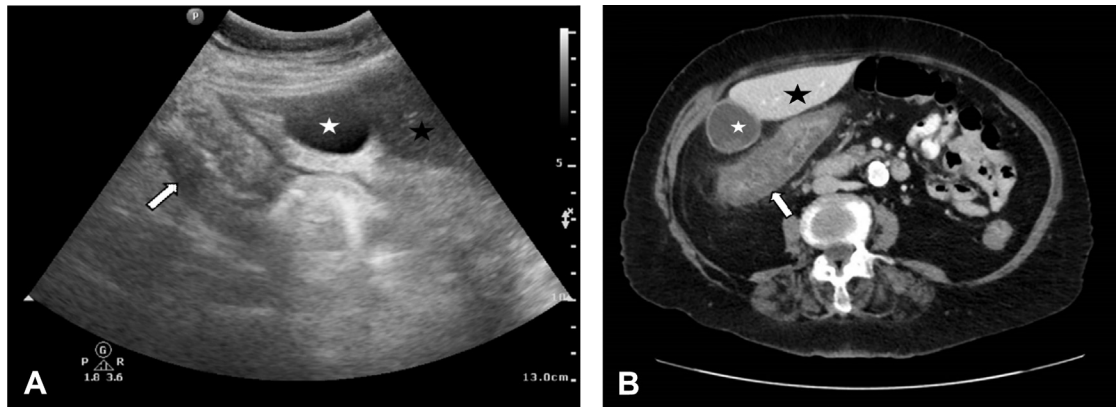
A 78-year-old woman with a past medical history of diabetes mellitus and chronic obstructive pulmonary disease presented to the ED with right-sided abdominal pain and bloody diarrhea for 24 h. Physical examination revealed localized right lower quadrant pain. Her laboratory test

results included mild leukocytosis and a mildly elevated CRP.

POCUS evaluation in the ED using curvilinear and linear transducers revealed prominent thickening of the wall of the ascending colon (up to 1.9 cm), hyperechoic adjacent mesenteric fat, and pericolic free fluid (Figure 5A). Intravenous antibiotics were initiated for suspected colitis. MDCT confirmed these findings (Figure 5B) and she was admitted to the hospital. She subsequently developed severe abdominal pain with peritonitis and was taken to the operating room for emergent exploratory laparotomy. Findings included thickening and hyperemia of the wall of the ascending colon, with a moderate amount of peritoneal free fluid. A right colectomy was performed with primary anastomosis of the terminal ileum to the transverse colon. After prolonged i.v. antibiotic therapy and hospitalization, she recovered and was discharged to a rehabilitation institute. The pathology report showed patchy colitis with focal distal small vessel thrombosis consistent with ischemic colitis.



**Figure 3. (A) Transverse sonogram, demonstrating thickening of the wall of the ascending colon (white arrow) and adjacent pericolic fluid (white arrowhead). Right kidney is also demonstrated (black arrow). (B) Multidetector computed tomography axial image demonstrating thickening of the wall of the ascending colon (white arrow) and adjacent pericolic fluid (white arrowhead). Right kidney is also demonstrated (black arrow).**



**Figure 4.** (A) Longitudinal sonogram, demonstrating thickening of the wall of the transverse colon (white arrow) adjacent to the gallbladder (white star) and to the right liver lobe (black star). (B) Multidetector computed tomography axial image demonstrating thickening of the wall of the ascending colon wall (white arrow) adjacent to the gallbladder (white star) and to the right liver lobe (black star).

### Case 6

A 67-year-old man with a history of lung transplantation 3 years prior presented to the ED with lower abdominal pain, bloody diarrhea, and vomiting for 2 days. Physical examination revealed tenderness in the left lower quadrant. Laboratory findings included mild leukocytosis and an elevated CRP.

POCUS revealed prominent thickening of the wall of the descending colon with hyperechoic adjacent mesenteric fat, suspicious for colitis (Figures 6A and 6B). He was treated with i.v. antibiotics and i.v. fluids. Subsequent MDCT confirmed the diagnosis of colitis (Figure 6C).

He was admitted to the hospital. The stool diagnostic molecular assay was positive for *entero-hemorrhagic Escherichia coli* (EHEC) - O157:H7. After consultation with the infectious disease service, antibiotics were

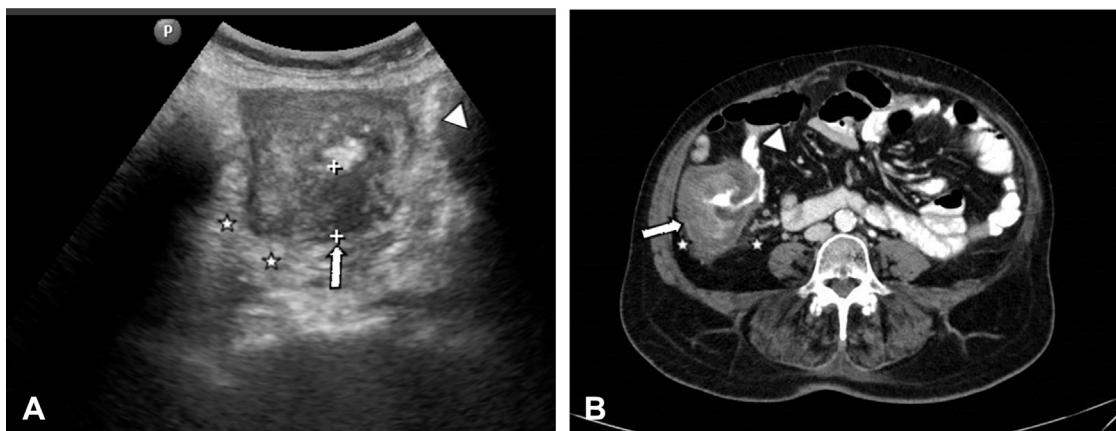
stopped to reduce the risk of hemolytic uremic syndrome. The patient improved and was discharged.

### DISCUSSION

The utility of transabdominal ultrasound (TAU) for investigating colonic pathology has been described in the radiology literature since the 1970s (4). Subsequently, there was much literature supporting the role of TAU in colitis diagnosis, including its different subtypes: inflammatory colitis, infectious colitis, and ischemic colitis (5–8).

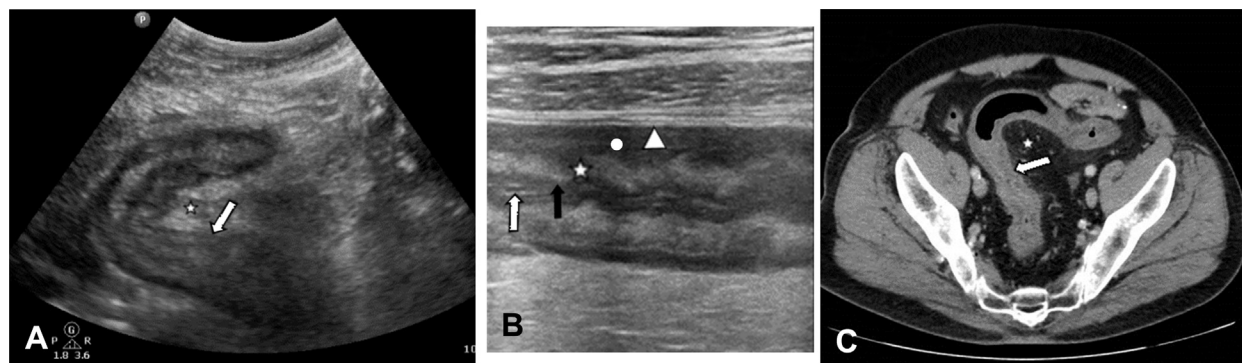
#### *Inflammatory Bowel Disease*

The idiopathic inflammatory bowel diseases (IBD) comprise two types of chronic intestinal disorders: Crohn's disease (CD) and ulcerative colitis (UC). Current guidelines suggest that IBD diagnosis should be based on a



**Figure 5.** (A) Transverse sonogram demonstrating thickening of the wall of the cecum (white arrow) and hyperechoic adjacent mesenteric fat (white stars). Normal appearance of the terminal ileum is also demonstrated (white arrowhead). (B) Contrast-enhanced multidetector computed tomography axial image demonstrating thickening of the wall of the cecum (white arrow) and adjacent fat stranding (white stars). The terminal ileum appears normal (white arrowhead).





**Figure 6.** (A) Longitudinal sonogram with curvilinear transducer demonstrating thickening of the wall of the sigmoid colon and rectum (white arrow). Adjacent mild adjacent fat stranding (white star). (B) Longitudinal sonogram with linear transducer demonstrating thickening of the wall of the sigmoid colon. The different layers of the bowel wall can be clearly identified. From inner to outer layer: lumen (white arrow), mucosa (black arrow), submucosa (white star), muscularis propria (white circle) and serosa (white arrowhead). (C) Contrast-enhanced multidetector computed tomography axial image demonstrating thickening of the wall of the sigmoid colon and rectum (white arrow). Adjacent mild fat stranding (white star).

combination of clinical, endoscopic, histological, radiological, or biochemical findings (9,10). Endoscopy is well established and uniformly performed as a diagnostic examination. Possible imaging modalities include MDCT, magnetic resonance imaging (MRI), and US (11).

The most sensitive sonographic finding for IBD diagnosis (as well for determining the disease activity) is bowel wall thickness ( $>3\text{--}4\text{ mm}$ ). Evaluation of the surrounding structures may reveal hyperechogenicity of mesenteric fat, ascites, lymphadenopathy, and the presence of complications, such as fistula, abscess, or ileus (mainly in CD).

### *Crohn's Disease*

TAU has been used mainly in Europe, as a routine diagnostic tool for CD, reaching a sensitivity and specificity of 75–90% and 75–100%, respectively (12). Generally, the US diagnostic accuracy is not inferior to other acceptable imaging modalities such as CT or MRI (13). Furthermore, US exhibits high diagnostic accuracy for the assessment of disease activity, as well as complications of CD such as strictures, enteric fistulas, and abscesses (14). The sensitivity and specificity of US are highest for the anatomical locations that are easily accessible and are the most frequent sites of involvement, including the terminal ileum and the right and left colon (15).

The major disadvantage of US is the relatively low accuracy in the diagnosis of small bowel loops proximal to the terminal ileum. In addition, US has limitations in the visualization of deep pelvic structures.

### *Ulcerative Colitis*

Although less widely investigated and established, US also has a role in patients with UC, with an overall sensitivity of up to 90% (16). Its sensitivity is higher in the sigmoid and descending colon (up to 97%), but very low for

rectal disease (15%) (15,17). US may be particularly useful in establishing disease extent where full colonoscopy is inappropriate or unsafe, such as in the setting of acute severe UC (12). As with Crohn's disease, bowel wall thickness and intramural Doppler vascularity have been used to evaluate disease activity in UC (17).

### *Ischemic Colitis*

Ischemic colitis (IC) is the most common form of gastrointestinal ischemia. In most cases, nonocclusive ischemia of the bowel is caused by an acute episode of hypoperfusion to the small vessels of the colon, generally secondary to a low-flow state. It is more common in the elderly and patients with cardiovascular disease.

CT findings of IC have been well described in the radiology literature, compared with only a few studies that investigated the role of US (18). According to those studies, the sensitivity of US is very high (up to 93.5%), and positive predictive value in the adequate clinical setting can reach 87.5% (19,20).

Few studies demonstrate the usefulness of early US in the prediction of IC severity, which can be crucial to differentiate between a conservative vs. a surgical approach (21,22).

The sonographic features for IC include symmetrical bowel wall thickening, segmental (length  $> 10\text{ cm}$ ) colon involvement, and left-sided colitis. Altered pericolic fat and pancolitis are sonographic findings significantly related to severe IC (21). There are conflicting data regarding the role of color Doppler flow assessment of the bowel wall in cases of suspected IC, especially in the mild/nongangrenous type (21,22).

### *Infectious Colitis*

Various bacteria, parasites, and viral pathogens are associated with acute infectious enterocolitis. Sonography is

**Table 1. Differentiating Between the Different Etiologies of Colitis**

	Inflammatory Bowel Disease	Ischemic Colitis	Infectious Colitis	Pseudomembranous Colitis
Location	<ul style="list-style-type: none"> <li>• <b>CD: ileocecal region</b> primarily affected although all regions may be affected</li> <li>• <b>UC: colon</b> primarily affected particularly the <b>left colon</b></li> </ul>	<b>Left colon</b> > right colon	<b>Right colon or pancolitis</b> ; <i>Yersiniosis</i> : particularly in the <b>ileocecal</b> region; <i>CMV colitis</i> : particularly right colon; <i>Amebic colitis</i> : pancolitis	Primary <b>pancolitis</b> May affect only left colon
Hyperechoic adjacent mesenteric fat	<b>Very sensitive sign and marker</b> of active inflammation mainly in <b>CD</b> . Less common in UC May be present	May be present, more common in severe cases	May be present	Not well described (present in 50% of patients in one study)
Ascites		May be present. More common in severe cases	Not common	<b>Common</b>
Abscess/fistula	<b>Relatively common in CD</b>	—	—	—
Color Doppler flow	Increased in active disease	<b>May be absent</b>	Not well described	Not well described

CD = Crohn's disease; UC = ulcerative colitis.

used to detect colitis in the common bacterial infections including *Campylobacter*, *Salmonella*, *Yersinia*, EHEC, and *Shigella* (23–25). Conclusive sonographic differentiation between varieties of bacterial infections is not possible, but characteristic findings can raise the suspicion for a specific pathogen. For example, in the case of *Yersinia*, dominant mesenteric lymph nodes in connection with inflammatory mucosal swelling are characteristic (26).

Sonographic findings are also described for bacterial infections usually seen in developing countries, including tuberculosis and *Mycobacterium avium* infection (primarily observed in immigrants and immunocompromised patients) (26).

Most viral pathogens mainly cause enteritis, although *Cytomegalovirus* is an important and treatable pathogen in the differential diagnosis of colitis, especially in immunocompromised patients. Sonographic features include weakly echogenic, transmural inflammation, with a more echogenic mesenteric reaction, as in acute CD. The entire intestine can be affected, particularly the ileocecal region, the ascending colon, and the complete duodenum (26).

Sonographic findings suspicious for colitis in *Giardia lamblia* and *Amebiasis* have also been described (26).

### Pseudomembranous Colitis

Pseudomembranous colitis (PMC) is a common subtype of infectious colitis. It is the most common infectious cause of antibiotic-associated diarrhea and health care-related infection in the developed world, usually caused by *Clostridium difficile* toxin (CDT). It can result in life-threatening complications such as toxic colon with sepsis or perforation. Sonographic features include inflammatory wall thickening (initially mucosal and finally

transmural). The wall thickening can appear to be very pronounced, up to >15 mm (7,26). Indications of severe disease include extensive colonic involvement, transmural inflammatory reaction, free pericolic fluid (exudate), and intramural air echoes (26).

In a prospective study of hospitalized patients who developed diarrhea after admission, sonographic findings were compared between patients with positive stool toxin for CDT vs. those with a negative test. Colonic wall thickening was present in 91% of patients with CDT, whereas it was present in only 21% who were negative for CDT (27).

### Neutropenic Enterocolitis (Typhlitis)

Neutropenic enterocolitis (typhlitis) is a potentially life-threatening complication of severe neutropenia. US classically may reveal a hyperechoic edematous thickening of the intestinal wall (28). The presence of intramural gas and pericolic free fluid should raise concerns about imminent perforation (26).

### Limitations

An inherited disadvantage of US is that the image quality and interpretation is user dependent. In addition, an important limitation of sonography is the lack of specific signs for different etiologies of colitis. The most prominent sonographic sign for colitis—bowel wall thickening (typically >3–4 mm)—can be observed in all types. Other findings such as colitis location, the presence of hyperechoic adjacent fat tissue, or ascites, which can suggest specific etiologies, still overlap (Table 1). In addition, there is a differential diagnosis of bowel wall thickening other than colitis, such as diverticular disease and colon carcinoma (29).

However, in many cases of colitis, CT (in the same manner as US) can only narrow the differential diagnosis, whereas endoscopic and pathologic evaluation is still required to confirm the diagnosis. Prospective studies are needed to investigate the accuracy of US for the diagnosis of colitis in the ED.

### *The Role of US for Colitis in the ED*

This case series includes the use of POCUS to accurately diagnose colitis of different etiologies, including CD, IC, infectious colitis (PMC and EHEC - O157:H7), and colitis of unknown origin. The diagnosis in each of those cases was confirmed by abdominal CT, which is currently the gold standard. To our knowledge, only one case report of colitis diagnosis by POCUS in the ED has been published (30).

### **WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?**

The ability to detect findings of colitis by POCUS can be quickly learned by the emergency physician with a strong background in basic US. This report has shown that POCUS may have an additional role for the ED evaluation of patients with acute abdominal pain, beyond evaluation of the aorta, kidneys, gallbladder, and appendix. That additional role is as a tool for evaluation of patients with symptoms suspicious for colitis. For many of the different subtypes of colitis, the initial treatment in the ED is the same: i.v. antibiotics and i.v. fluids. Thus, POCUS can help in expediting the recommended treatment (even prior to laboratory results). For the stable patient with high clinical suspicion of an infectious etiology of colitis, or with exacerbation of already established IBD, this can help to confirm the diagnosis, rule out other etiologies in the differential, and potentially shorten ED wait time. This tool may be especially important in certain populations, such as children and young women, where one could avoid a significant amount of radiation being directed toward the pelvic area.

Prospective study is warranted before POCUS is deployed widely in such cases, but these examples strongly suggest that the use of POCUS to detect colitis deserves further study.

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