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# Point-of-care ultrasound findings in the diagnosis and management of Superior Mesenteric Artery (SMA) syndrome

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ABSTRACT

Superior mesenteric artery (SMA) syndrome is a potentially fatal condition that can be difficult to diagnose for emergency medicine physicians due to its rarity and vague gastrointestinal symptom presentation. Patients arriving at the emergency department (ED) with this condition may encounter delays in proper supportive care and treatment. We present the case of a 21-year-old female who was seen in the ED for nausea, non-bloody vomiting, and rapid weight loss. Through point-of-care ultrasound (POCUS) findings, she was diagnosed with SMA syndrome and received appropriate, supportive care for her condition before catastrophic complications could occur. This case demonstrates the utility of POCUS in SMA syndrome and the importance of considering this diagnosis despite its rarity.

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## 1. Introduction

Superior mesenteric artery (SMA) syndrome is an uncommon etiology for small bowel obstruction. It typically occurs when there is rapid weight loss over a short period of time, resulting in narrowing of the aortomesenteric angle [1]. The true incidence of SMA syndrome is unknown, but previous literature has estimated its incidence to be approximately 0.1% to 0.3%, with the highest frequency among teenagers and young adults [1]. SMA syndrome is often a challenging diagnosis to establish and identifying it early can reduce the associated complications such as malnutrition, dehydration, electrolyte abnormalities, gastrointestinal hemorrhage, and gastric perforation [2]. While the prevalence of SMA syndrome is low, in a disease that affects predominantly females of childbearing age [3] prompt diagnosis with ultrasound is optimal. At the time diagnosis is finally made in patients, post-prandial abdominal pain, nausea, vomiting and anorexia cause patients to be notably underweight. It has been suggested that this etiology be suspected in patients with chronic wasting diseases who lose weight associated with frequent vomiting [4]. Following appropriate treatment patients are able to correct their pre-treatment weight loss, so prompt diagnosis is key [5].

SMA syndrome is classically diagnosed through both clinical presentation and computed tomography (CT) evidence of vascular compression of the duodenum [1]. A case review has explored the use of CT and aortogram in the diagnosis of SMA syndrome, as well as POCUS findings for SMA syndrome in the pediatric population [6]. Few have elaborated on POCUS in the acute diagnosis of SMA syndrome within the adult population [6]. Although not in the acute setting utilizing POCUS, a retrospective cohort study performed in Italy demonstrated the effectiveness of ultrasound to assess for SMA syndrome in the outpatient setting. [7]. We present a case in which POCUS findings were predominantly used in the acute diagnosis of SMA syndrome.

## 2. Case presentation

A 21-year-old female without any significant past medical history presented to the ED with nausea and non-bloody vomiting. She stated that these symptoms had been occurring for the past two to three weeks while she had been on vacation. She was also having abdominal fullness and non-bloody diarrhea, which she had attributed to food poisoning. Over the next few days from symptom onset, her diarrhea resolved, but she continued to have nausea and vomiting. Her symptoms were more prominent after meals and could be partially relieved by fasting. Later, she developed abdominal distention, early satiety, and chest pressure. She tried omeprazole without any improvement and noted that her symptoms became worse with dairy products.

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Further history showed an unintentional 6-pound weight loss within the last 2 weeks, and an unintentional 25-pound weight loss within the last year. She denied any fevers or significant abdominal pain, and there was no family history of inflammatory bowel disease or personal history of gastrointestinal problems.

On physical examination, the patient was tachycardic but normotensive and afebrile. She did not appear diaphoretic or in acute distress, and on cardiac auscultation, a regular rhythm and rapid rate were heard with no murmurs. Distention was noted during an abdominal examination, but the patient displayed normal bowel sounds and a soft abdomen with no tenderness. Neurological examination showed no abnormalities, and the patient was oriented to person, place, and time. Patient's weight was 92 lbs., height 5′1″ and BMI was 17.46 kg/m$^2$. Preliminary labs were unremarkable including liver function test results.

The patient was resuscitated with fluids and provided antiemetics. Upon reevaluation the patient felt no improvement in her symptoms of chest and abdominal pressure. She remained tachycardic and was unable to complete an oral challenge of clear liquids. This response to treatment was atypical for a presumed gastroenteritis. Point of care ultrasound (POCUS) was then performed in a systematic approach to seek clarity for the cause of the patient's symptoms and persistent tachycardia. The following techniques were performed – FAST limited abdominal ultrasound, ECHO, IVC/Aorta, bowel, and gallbladder. It should be noted that all images were easily achieved as the patient had little subcutaneous fat and little air artifact within the abdomen. The limited abdominal ultrasound revealed no free fluid. Echocardiography displayed tachycardia but, no pericardial effusion, a normal ejection fraction, and normal right heart size and function. The bowel exam did not show air/fluid levels or dilation but, the stomach in this patient who was vomiting and who couldn't tolerate oral intake for a prolonged period was distended and easily imaged. The IVC had a normal diameter with less than 50% collapsibility. The aorta was normal in diameter but, when Color Doppler was applied, the SMA and Aorta were seen to be in close proximity. A measurement of this distance was taken. The SMA was noted to have a very small aorta mesenteric distance (AMD) and acute aorta mesenteric angle (AMA) (Figs. 1 and 2). The gallbladder had no stones, wall thickening, or pericholecystic fluid. The common bile duct was normal in diameter. Given these POCUS findings and the patient's poor response to treatment, the patient subsequently underwent an IV/oral contrast-enhanced CT which showed a mildly diffuse thickened wall of the colon, suggestive of mild colitis as well as compression of the third portion of the duodenum between the abdominal aorta and SMA (Fig. 3). The compression of the duodenum by the small AMD is consistent with the diagnosis of SMA syndrome. This anatomic finding resulted in moderate dilatation of the patient's stomach, which was noted to have air-fluid levels on CT. The patient was then admitted for additional testing and evaluated by gastroenterology, surgery, and interventional radiology.

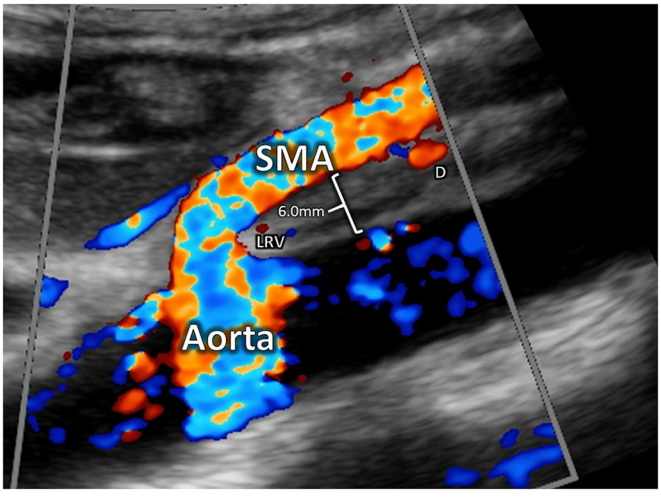


**Fig. 1.** Longitudinal view utilizing color flow of the abdominal aorta and superior mesenteric artery. The distance from the aorta to the superior mesenteric artery was measured at 6.0 mm. LRV = left renal vein, D = duodenum.

During her hospitalization, the patient underwent an additional work-up that confirmed the SMA syndrome diagnosis. This work-up included an upper GI series, which showed mild gastric distention and mild delay of gastric emptying. The third portion of the duodenum exhibited slight extrinsic compression at the midline, but no significant dilation of the second part of the duodenum or bowel obstruction. An enteroscopy was performed and noted a distended second portion of the duodenum with appreciable narrowing from extrinsic compression within the region of the third to fourth portion. The enteroscopy helped to correlate to the radiographic studies. Given her persistent obstructive symptoms and weight loss, the decision was made to initiate enteral feeds via nasojenjunal tube (NJT) which bypassed her narrowed duodenal segment. Following NJT placement and initiation of enteral feeds, she was ultimately discharged after a 7-day hospital stay with plans for close outpatient follow-up. The patient returned approximately one week later for an office visit with NJT still in place receiving tube feeds and resolved symptoms. She was able to gain three pounds in that time.

## 3. Discussion

SMA syndrome is an uncommon but well recognized digestive condition that occurs by definition by compression of the third or transverse portion of the duodenum between the aorta and the superior mesenteric artery [8]. This compression causes partial or complete blockage of the duodenum [8] and may be difficult to recognize and rapidly diagnose due to its association with vague gastrointestinal symptoms such as nausea, vomiting, abdominal pain, anorexia, and weight loss. If SMA syndrome is not recognized in a timely manner, it can result in a duodenal obstruction, which would lead to additional complications [9]. Immediate treatment such as fluid resuscitation, electrolyte correction, total parenteral nutrition, and nasogastric tube (NG) insertion can be crucial in some cases once SMA syndrome is detected. The goal of treatment is to increase the mesenteric fat pad and improve symptoms [2]. A study has shown that approximately 86% of patients respond well to medical management when SMA syndrome is promptly diagnosed and managed. Because this is a very treatable condition with adverse outcomes if not acted upon, early diagnosis is vital to allow enough time for corrective NG tube insertion. Once the NG tube is inserted properly, decompression can happen before obstruction occurs [10].

Though CT is a more definitive form of diagnosis for SMA syndrome, there are key findings on POCUS that point toward this diagnosis. When assessing for SMA syndrome using POCUS, both the angle of take-off of the SMA from the aorta (referred to as the aortomesenteric angle or AMA) as well as the distance from the SMA to the aorta (aortomesenteric distance or AMD) can be measured. An AMA of less than twenty-five degrees and AMD of less than 8 mm is consistent with SMA syndrome [11]. Other findings include dilation of the first and second part of the duodenum or stomach, abrupt vertical and oblique compression of the mucosal folds (shown in Fig. 1), antiperistaltic flow of barium proximal to the obstruction, relief when the patient is placed in a position that diminishes the drag of the small bowel mesentery or a four to six-hour delay of transit through the gastroduodenal region [12]. SMA syndrome is also detectable when there is a decrease in the angle with automatic decrease to the length to that criteria- based on the Pythagorean theorem [13]. POCUS is readily available in most emergency departments. This may allow for more rapid diagnosis, immediate resuscitation, and supplemental nutrition if there is any index of suspicion. POCUS should be explored for young patients who present with any



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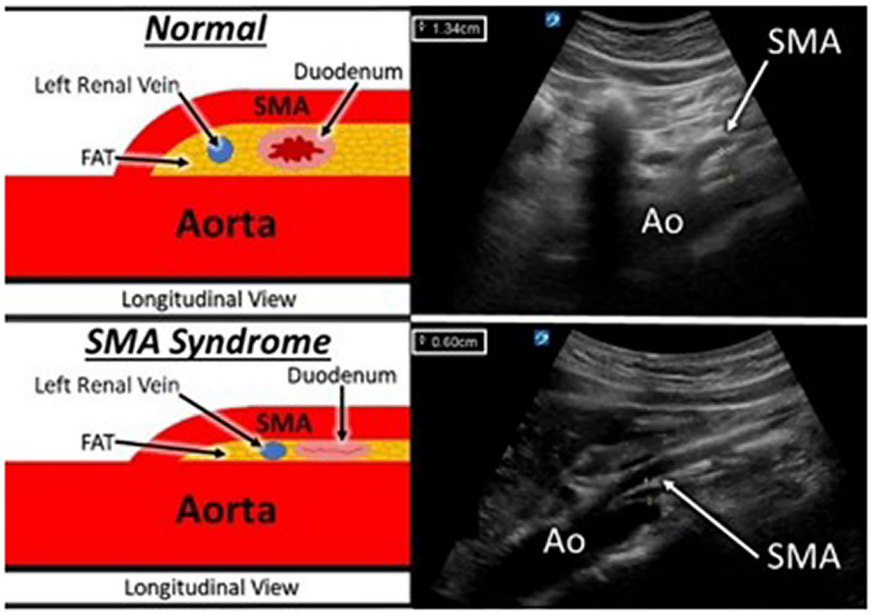


**Fig. 2.** Longitudinal view of the relationship between the abdominal aorta and superior mesenteric artery in normal anatomy and physiology as opposed to superior mesenteric artery syndrome.

vague gastrointestinal symptoms such as postprandial pain, nausea, vomiting, bloating, abdominal pain, tenderness, or discomfort [7]. Patients who are slight in statue and undergo rapid weight loss should be considered at risk. The use of POCUS in this case was performed as response to treatment was atypical for the presumed diagnosis. The physician performed a systematic POCUS approach which yielded results that were inconsistent with simple gastroenteritis. SMA syndrome should be considered in the differential diagnosis of patients who do not respond to treatment and POCUS can provide clues to hasten definitive diagnostic testing and treatment. Though our patient had normal electrolytes, delayed diagnosis can result in the need for significant fluid resuscitation, electrolyte replacement, and proper nutritional supplementation. This was crucial since the patient was unable to take nutrition orally at the time of her presentation. It is important that ED physicians are aware of both the clinical presentation and POCUS findings in SMA syndrome to prevent any further complications or mortality from this condition.

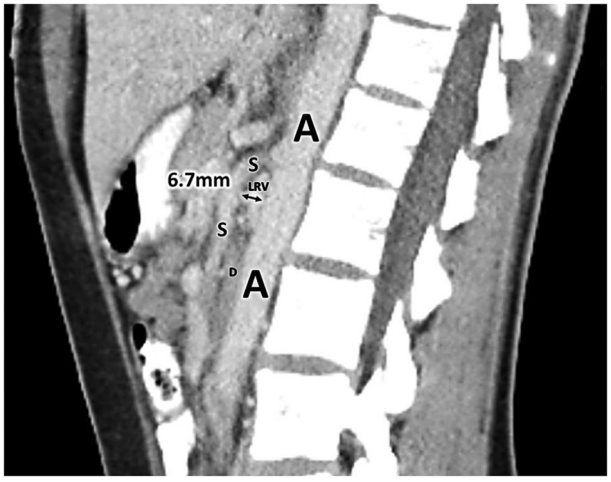


**Fig. 3.** Computed tomography results confirming superior mesenteric artery syndrome. A = Aorta, S = Superior Mesenteric Artery, LRV = left renal vein, D = duodenum. The Aortic/SMA distance ↔ was measured at 6.7 mm.

## 4. Conclusion

This case demonstrates the potential advantage of utilizing POCUS in a systematic fashion for patients with gastrointestinal symptoms to better characterize structural etiologies. While uncommon, ED physicians should consider SMA syndrome in their differential diagnosis of patients who have risk factors and a clinical course that might suggest the disease.

## Author contributions

All authors provided substantial contributions to manuscript content. All authors gave final approval of the version of the article to be published.

## Declaration of Competing Interest

None.

The authors have no outside support information, conflicts or financial interest to disclose. This case report did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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