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## Case Report

# Unusual computed tomography findings of gas in the superior mesenteric artery system with no signs of porto-mesenteric venous gas in a case of acute mesenteric ischemia<sup>☆</sup>

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## ABSTRACT

Acute Mesenteric Ischemia (AMI) is a rare life-threatening entity caused by sudden interruption of the blood supply to a segment of the bowel due to impairment of mesenteric arterial blood flow or venous drainage. Clinical presentation varies according to the time course of vascular occlusion. Contrast-enhanced Computed Tomography (CT) of the abdomen represents the main diagnostic test for AMI diagnosis, enabling fast and excellent evaluation of the intestine, mesenteric vasculature, and other ancillary characteristics of AMI. Typical CT findings of AMI include paralytic ileus, decreased or absent bowel wall contrast-enhancement, pneumatosis intestinalis, and porto-mesenteric venous gas. We hereby report a case of an 89-year-old man presenting with AMI due to Superior Mesenteric Artery (SMA) thrombotic occlusion following endovascular stenting superficial femoral arteries. Typical findings were observed on abdominal CT imaging, yet associated with the presence of gas exclusively in the SMA district, without any involvement of the porto-mesenteric venous system. Different imaging features and pitfalls can help radiologists to accurately diagnose AMI, especially when irreversible bowel damage is about to occur. Therefore, radiologists and emergency physicians should be aware of the unusual association between

Abbreviations: AMI, Acute Mesenteric Ischemia; CT, Computed Tomography; CTA, Computed Tomography Angiography; DIC, Disseminated Intra-Vascular Coagulation; ED, Emergency Department; MAE, Mesenteric Arterial Embolism; MAT, Mesenteric Arterial Thrombosis; MVT, Mesenteric Venous Thrombosis; NOMI, Non-Occlusive Mesenteric Ischemia; PAOD, Peripheral Arterial Occlusive Disease; SMA, Superior Mesenteric Artery.

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gas in the SMA arterial district and AMI, even in the absence of porto-mesenteric venous system involvement, in order to urge prompt surgical consultation when observed.

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Acute Mesenteric Ischemia (AMI) is a rare entity, defined as the sudden interruption of the blood supply to a segment of the bowel, leading to cellular damage, intestinal necrosis, and eventually patient death if left untreated [1].

AMI is induced by a disruption of the mesenteric arterial blood flow as well as a blockage of the mesenteric venous drainage. In general, Mesenteric Arterial Thrombosis (MAT), Mesenteric Arterial Embolism (MAE), Mesenteric Venous Thrombosis (MVT), and Non-Occlusive Mesenteric Ischemia (NOMI) constitute the main causes of AMI [1–5].

Clinical presentation is characterized by non-specific signs and symptoms, which vary according to the time course of the vascular occlusion. The overall incidence is low, ranging from 0.09% to 0.2%, yet mortality may be as high as 90%, varying from 80% to 100% if intervention is delayed beyond 24 hours from clinical onset. In order to reduce the high mortality rate, prompt diagnosis and effective intervention are thus necessary [1–5].

Imaging investigations are very valuable in the diagnosis of AMI given that neither clinical findings nor laboratory tests are specific. Although catheter angiography was considered the gold standard for the diagnosis of intestinal ischemia [5], it has since been replaced by Computed Tomography (CT). Due to its availability and its ability to diagnose alternative causes of acute abdominal pain, CT represents the first-line imaging modality for the evaluation of suspected AMI. [6].

CT imaging findings differ based on the etiology and time course. Bowel wall thickness may appear to be increased, or may be thinned in the case of arterial occlusion. Nonetheless, most severe acute cases usually present with several characteristics that result from trans-mural bowel infarction, including pneumatosis intestinalis, porto-mesenteric venous gas, and pneumoperitoneum [5]. While porto-mesenteric venous gas is typically seen in AMI cases with irreversible infarction, descriptions of imaging findings concerning the presence of gas in the Superior Mesenteric Artery (SMA) and its branches, without any involvement of the porto-mesenteric venous system, are absent in the literature. We hereby report an unusual case of AMI caused by MAT that demonstrated typical findings on abdominal CT imaging, yet associated with the presence of gas exclusively in the SMA system, emphasizing the implied diagnostic challenge for emergency radiologists and physicians.

## Case Report

An 89-year-old man presented to the Emergency Department (ED) with vague lower abdominal pain and severe lower extremity pain. On physical examination, right foot elevational pallor was observed, and palpation of peripheral arterial pulses revealed absent dorsalis pedis pulse bilaterally. The

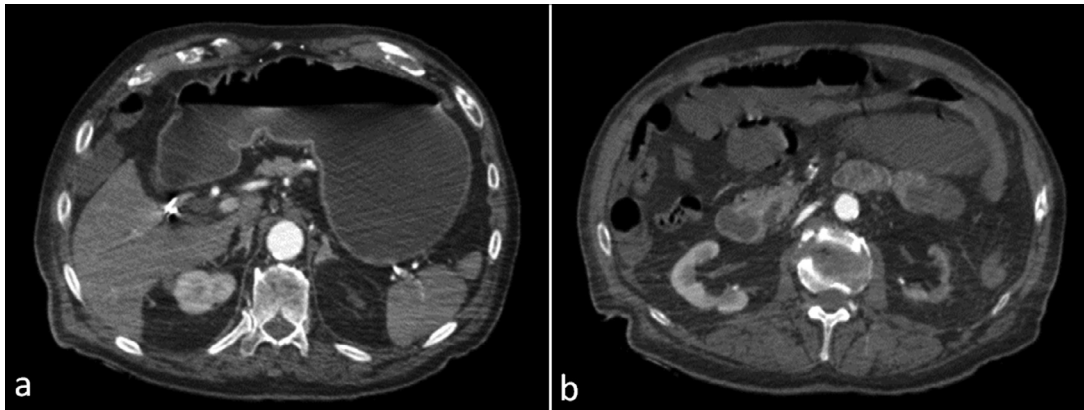
results of laboratory tests were unremarkable. Clinical suspicion was therefore heightened for Peripheral Arterial Occlusive Disease (PAOD), and Computed Tomography Angiography (CTA) of the lower extremities demonstrated diffuse atherosclerotic disease, with bilateral superficial femoral arterial occlusion. The patient underwent endovascular therapy with stenting of both superficial femoral arteries. Hypovolemic shock occurred during the procedure, immediately treated by means of fluid resuscitation, without any further complications. A few hours after the procedure, the patient developed sudden onset of abdominal pain with associated vomiting, and blood samples for laboratory tests revealed leukocytosis (22,000 cells/ $\mu$ l), elevated troponin (165 ng/mL), and lactic acidosis (pH: 7.10; lactate concentration: 8.7 mmol/L). Consequently, a contrast-enhanced CT scan of the abdomen and pelvis was performed to investigate further.

Contrast-enhanced abdominal CT imaging findings during arterial phase showed distension of the stomach and small bowel loops associated with air-fluid levels scattered throughout the abdomen, without signs of mechanical obstruction, reflecting paralytic ileus owing to disruption of peristaltic activity (Fig. 1). At the same time, marked thinning of the small bowel wall with lack of contrast-enhancement was also observed, together with the presence of intra-mural gas within the wall of small bowel (pneumatosis intestinalis), all CT imaging features indicative of occlusive AMI with signs of trans-mural infarction of the bowel (Fig. 2). The evaluation of abdominal aorta and visceral arteries revealed thrombotic arterial occlusion of the proximal SMA to be the underlying cause of AMI. Moreover, multiple tubular and branched areas of low attenuation were surprisingly noted within the SMA, immediately downstream of the thrombotic occlusion, and along its terminal branches, findings consistent with gas in the SMA system (Fig. 3). More unexpectedly, despite the presence of typical CT findings indicating irreversible bowel ischemia caused by MAT, there was no evidence of porto-mesenteric venous gas, neither in the mesenteric venous system nor within the main portal vein and its intra-hepatic branches, whereas gas was detected exclusively in the mesenteric arterial system supplied by SMA (Fig. 4).

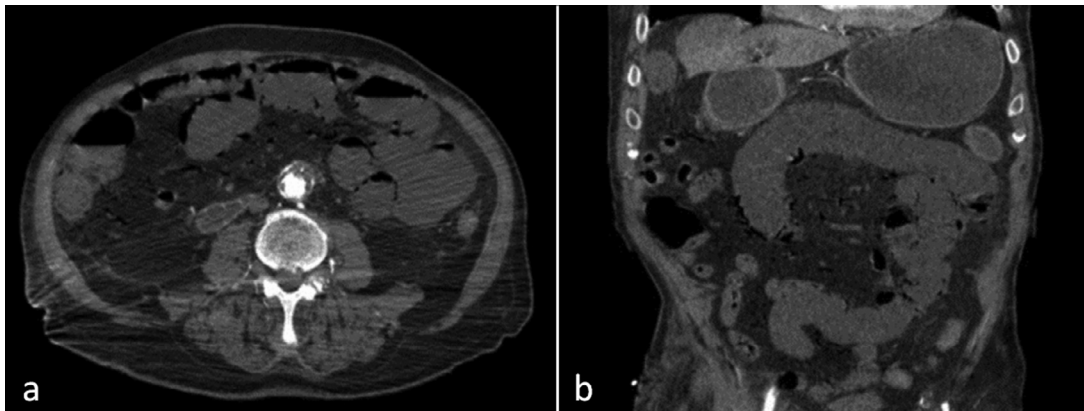
Unfortunately, the patient died on the next day due to complications associated with irreversible bowel infarction.

## Discussion

AMI is a life-threatening emergency caused by a sudden reduction in intestinal perfusion. Despite the low overall incidence, the high mortality rate means that early diagnosis and intervention are of the utmost importance. Acute abdomen is 1 of the most common clinical features upon initial presentation, hence, early AMI recognition is often challenging for



**Fig. 1 – Contrast-enhanced abdominal CT after the onset of abdominal pain with associated vomiting. (A) Axial contrast-enhanced CT scan in arterial phase at the level of epigastrium shows a markedly distended stomach with fluid and air, in absence of mechanical obstruction, suggesting gastroparesis. (B) Axial contrast-enhanced CT image during arterial phase obtained at the level of mesogastric region demonstrates dilated small bowel loops, with associated air-fluid levels, with thinning of the bowel wall, and no evidence of transition, findings confirming a condition of paralytic ileus.**



**Fig. 2 – Contrast-enhanced abdominal CT after the onset of abdominal pain with associated vomiting. (A) Axial contrast-enhanced CT scan in arterial phase at the level of mesogastric region shows small, rounded collections of air within the wall of the bowel, suggestive of intra-mural bowel gas, also known as pneumatosis intestinalis. (B) Coronal reformatted contrast-enhanced CT image of the abdomen in arterial phase depicts the presence of gas lucencies along the wall of the bowel more clearly, confirming the presence of pneumatosis intestinalis.**

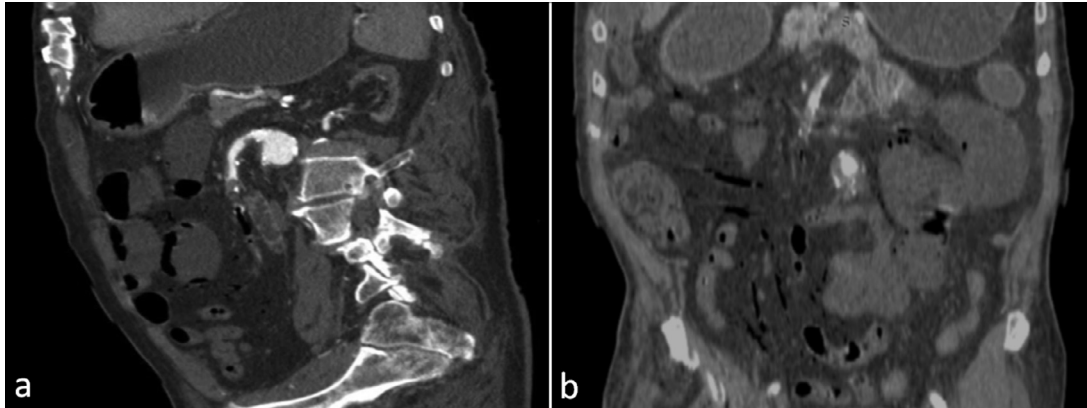
physicians since it may mimic several other acute abdominal diseases, including cholecystitis, and pancreatitis. Diagnosing AMI is further complicated by the vague nature of patient symptoms and the non-specific results obtained from laboratory tests and imaging examinations; therefore, a high index of clinical and radiologic suspicion is required [1–5].

Contrast-enhanced CT of the abdomen and pelvis is the recommended diagnostic test for AMI diagnosis. CT is a quick and accurate imaging modality that enables the excellent evaluation of the intestine, mesenteric vasculature, and other ancillary characteristics of AMI [6].

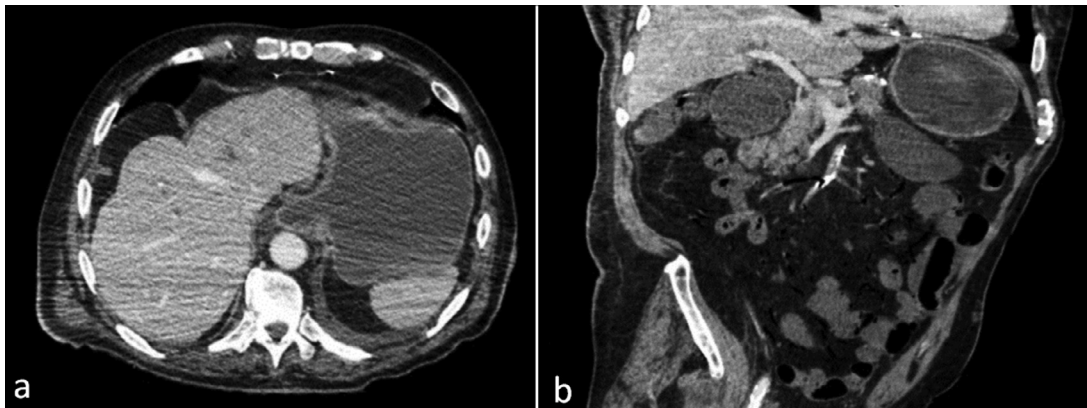
The main subtypes of AMI are represented by arterial occlusion, including MAT and MAE, venous occlusion, and NOMI, with arterial occlusive disease accounting for the majority of cases. In particular, MAT typically occurs in the proximal SMA in the context of diffuse atherosclerotic burden, thereby potentially affecting a long segment of bowel,

and constituting the AMI subtype with the worst prognosis [5].

Bowel imaging findings following acute mesenteric arterial occlusion correspond to the distribution of the occluded artery, and they can be variable and indicative of disease severity. Cross-sectional imaging findings obtained with contrast-enhanced CT typically include paralytic ileus, associated with thinning of the bowel wall, decreased or absent bowel wall contrast-enhancement, and pneumatosis intestinalis, defined as gas within the bowel wall [3–6]. Porto-mesenteric venous gas, whereby gas is observed in the portal vein and mesenteric veins, is another well-known CT feature secondary to irreversible AMI. The exact pathogenic mechanisms that cause gas to develop in the porto-mesenteric venous system are still unclear. Intestinal wall mucosal changes, bowel lumen overdistention, and infection are considered the main factors that may promote the development of porto-mesenteric ve-



**Fig. 3** – Contrast-enhanced abdominal CT after the onset of abdominal pain with associated vomiting. (A) Oblique sagittal reformatted contrast-enhanced CT image of the abdomen during arterial phase revealing a filling defect in the proximal superior mesenteric artery caused by acute thrombotic occlusion. Surprisingly, an intra-vascular tubular area of low attenuation is clearly observed immediately downstream of the thrombotic occlusion, consistent with gas in the superior mesenteric artery. (B) Coronal reformatted contrast-enhanced CT image of the abdomen in arterial phase confirms the thrombotic occlusion of proximal superior mesenteric artery, together with multiple intra-vascular tubular and branched areas of gas lucencies distributed throughout superior mesenteric artery branches. No gas is seen in the porto-mesenteric venous system.



**Fig. 4** – Contrast-enhanced abdominal CT after the onset of abdominal pain with associated vomiting. (A) Axial contrast-enhanced CT scan obtained during portal-venous phase at the level of the liver demonstrates the absence of signs consistent with porto-mesenteric venous gas: indeed, no tubular areas of decreased attenuation indicative of gas are seen in the intra-hepatic portal veins. (B) Oblique coronal reformatted contrast-enhanced CT image of the abdomen during portal-venous phase clearly confirms the normal appearance of the main portal vein, porto-mesenteric confluence, and part of the superior mesenteric vein. No CT findings suspicious of porto-mesenteric venous gas are observed, whereas gas is clearly depicted in superior mesenteric artery branches.

nous gas. In many circumstances, 2 or all 3 of these conditions coexist [7].

In our case, typical CT findings suggestive of irreversible bowel ischemia following acute thrombotic occlusion of the SMA were present, including paralytic ileus, marked thinning of the small bowel wall, absent bowel wall contrast-enhancement, and pneumatosis intestinalis. However, gas was surprisingly detected in the mesenteric arterial system supplied by SMA, with no evidence of porto-mesenteric venous involvement. Indeed, branching pattern of intra-vascular gas lucencies were seen to be distributed exclusively in the SMA, downstream of the thrombotic occlusion, and along its

branches, while there was no sign of gas in the mesenteric venous system or within the main portal vein and its intra-hepatic branches. To the best of our knowledge, the presence of gas exclusively in the SMA mesenteric arterial district as a consequence of AMI, without the involvement of the porto-mesenteric venous system, has thus far not been reported. Gas in the SMA has been described as a complication of sepsis with Disseminated Intra-Vascular Coagulation (DIC) [8], as a form of gas embolism as a major complication of acute aortic dissection, and following the replacement of the ascending aorta for aortic dissection [9, 10], although always in association with porto-mesenteric venous gas.

In our scenario, the patient suffered from hypovolemic shock during the endovascular procedure, which was treated successfully with fluid resuscitation. The vasoconstriction during the hypovolemic shock together with the imminent vasodilatation induced by fluid resuscitation may have caused substantial abnormalities in blood flow, leading to an acute occlusion of the SMA at the level of a pre-existing atherosclerotic plaque, simultaneously creating a sort of vacuum effect in the mesenteric arterial system, with the establishment of a suction mechanism of gas from the bowel wall directly into the SMA arterial district.

In summary, we described an unusual case of AMI, characterized by typical CT imaging features, with the unexpected presence of gas exclusively in the SMA system.

AMI can be challenging to diagnose, and early recognition requires a high degree of clinical and radiologic suspicion. Nevertheless, a prompt diagnosis can reduce the mortality rate and favor less invasive treatment. Awareness of the various imaging features, and pitfalls can help radiologists accurately diagnose AMI, especially when irreversible bowel damage is imminent. In particular, patients affected by AMI with irreversible intestinal necrosis will require massive bowel resection surgery, whereas minimally invasive endovascular revascularization is the treatment of choice when the ischemia is reversible, leading to an improved post-operative outcome.

Therefore, radiologists and emergency physicians should be aware of the unusual association between the findings of gas in the SMA arterial district and AMI, even in the absence of porto-mesenteric venous system involvement, in order to urge prompt surgical consultation if observed.

## Patient Consent

Considering the study involving human subjects, we hereby confirm that the patients and/or subjects have given their Informed Consent and that there will be no problem publishing the statement below.

Written, informed consent was obtained from all patients and/or next of kin for being included in the study for publication of their case.

## Supplementary Files

**Video 1.** Video in the axial plane of contrast-enhanced CT scan obtained during arterial phase through the abdomen and pelvis clearly depicts CT findings consistent with irreversible bowel ischemia due to acute mesenteric ischemia caused by superior mesenteric artery thrombotic occlusion, including paralytic ileus, associated with marked thinning of the small bowel wall, with lack of contrast-enhancement, and pneumatosis intestinalis. Multiple tubular and branched areas of

low attenuation are surprisingly noted within the SMA, immediately downstream of the thrombotic occlusion, and along its terminal branches, findings consistent with gas in the SMA system. More unexpectedly, despite the presence of typical CT findings indicating irreversible bowel ischemia, there is no evidence of porto-mesenteric venous gas, neither in the mesenteric venous system nor within the main portal vein and its intra-hepatic branches, whereas gas is detected exclusively in the mesenteric arterial system supplied by SMA.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.radcr.2022.04.037](https://doi.org/10.1016/j.radcr.2022.04.037).

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