



# Gas in the Portal Vein: An Emergency or Just Hot Air?

N. Zorzetti<sup>1</sup> · A. Lauro<sup>2</sup> · A. Ruffato<sup>1</sup> · V. D'Andrea<sup>2</sup> · L. Ferruzzi<sup>1</sup> · N. Antonacci<sup>1</sup> · R. M. Tranchino<sup>1</sup>

Accepted: 16 June 2021

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2021

## Abstract

We report the case of a 87-year-old woman admitted to our Emergency Department for mild abdominal pain associated with vomiting. An abdominal X-ray showed gas present in the portal venules of the left hepatic lobe, a finding associated with numerous surgical and medical conditions. The patient was successfully managed with conservative treatment. Isolated intrahepatic gas is a rare radiologic finding; emergency surgery should be performed only when there are signs of associated acute intestinal infarction.

**Keywords** Hepatic portal venous gas (HPVG) · Intrahepatic pneumatosis · Emergency surgery · Intestinal ischemia · Superior mesenteric artery embolism

## Abbreviations

WBC	White blood cell
Hgb	Haemoglobin
CRP	C-reactive protein
HPVG	Hepatic portal venous gas
AMI	Acute mesenteric ischemia
ED	Emergency Department

## Case Report and Evolution

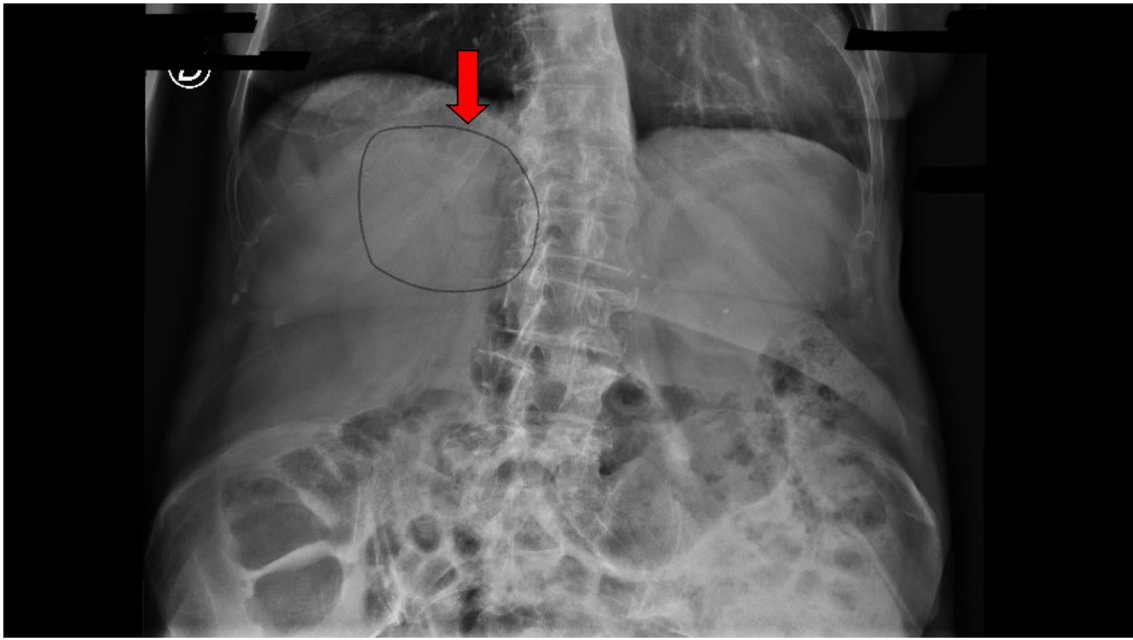
A 87-year-old woman was admitted to the ED in “Ospedale Civile Umberto I” in Lugo (Ravenna) for a single vomiting episode associated with mild abdominal pain, without fever or diarrhea. Despite her age, the patient was autonomous in her daily activities; her primary medical comorbidity was chronic atrial fibrillation treated with oral anticoagulants. On initial presentation, the patient appeared in minimal distress; abdominal examination was unremarkable. Laboratory tests showed normal WBC count and Hgb with mildly increased CRP (34 mg/dL; N.V. ≤ 10 mg/dL). An abdominal X-ray showed gas present in the portal venules of the left hepatic lobe (Fig. 1), confirmed by CT scan (Fig. 2) with

the additional findings of thickening of the terminal ileum and cecum with free abdominal fluid (Fig. 3), without intestinal pneumatosis, clear signs of intestinal ischemia or gas in the biliary system. Since an inflammatory enteritis was suspected, the patient was hospitalized in a medical unit and treated with antibiotics. After a few uneventful days, her symptoms recurred, though laboratory tests remained unremarkable. A second CT scan did not demonstrate gas in the left hepatic lobe (Fig. 4). A diagnosis of transient intestinal ischemia due to embolism of the superior mesenteric artery was suspected; the thickening of the intestinal loops together with the abdominal fluid was still persistent but without gas in the portal venules of the left hepatic lobe. Although we wished to perform an MR angiogram to document the suspected embolus, this investigation was not available in our hospital and referral to another hospital was not possible due to the COVID pandemic. The patient was moved to our surgical unit where conservative management was elected, without emergency surgery, due to the patient's stable condition. After two weeks, a third CT scan showed marked improvement with almost no free abdominal fluid and improved contrast enhancement of the intestinal mucosa, previously impaired due to suspected transient ischemia (Fig. 5). A small bowel follow-through was performed in order to evaluate transit along the intestinal loops, involved by the ischemic episode, which was normal. The patient was discharged from the hospital without any invasive treatment and in good clinical condition.

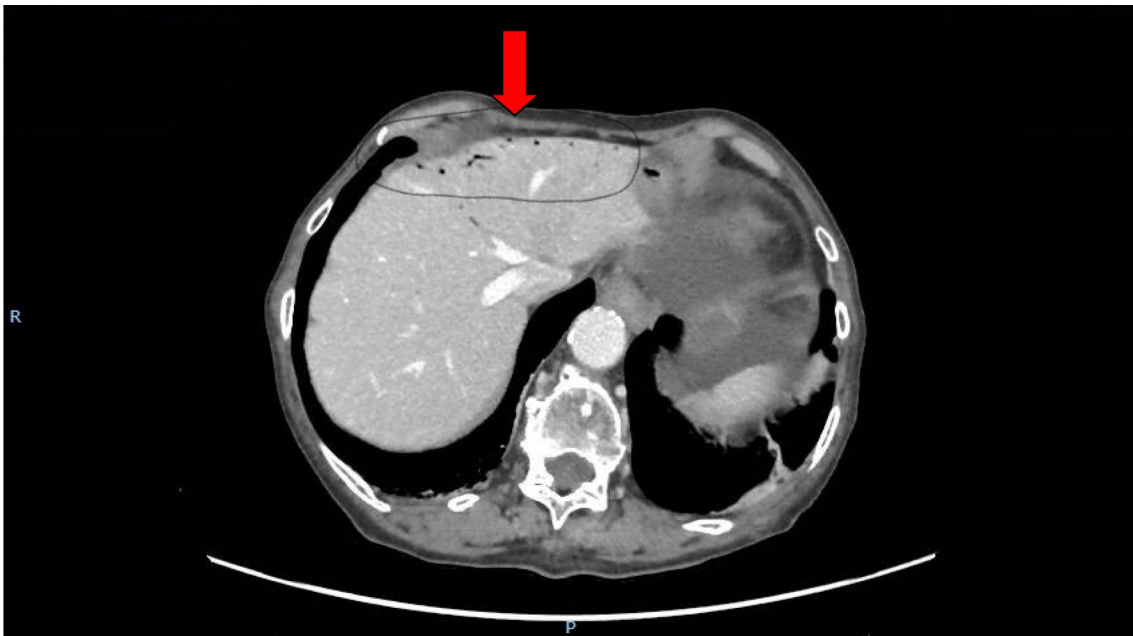
✉ N. Zorzetti  
noemi.zorzetti@gmail.com

<sup>1</sup> Department of General Surgery, “Ospedale Civile Umberto I”, Lugo, Ravenna, Italy

<sup>2</sup> Department of Surgical Sciences, Sapienza University, Rome, Italy



**Fig. 1** Abdominal X-ray at admission showing gas in the left hepatic lobe (red arrow) (colour figure online)

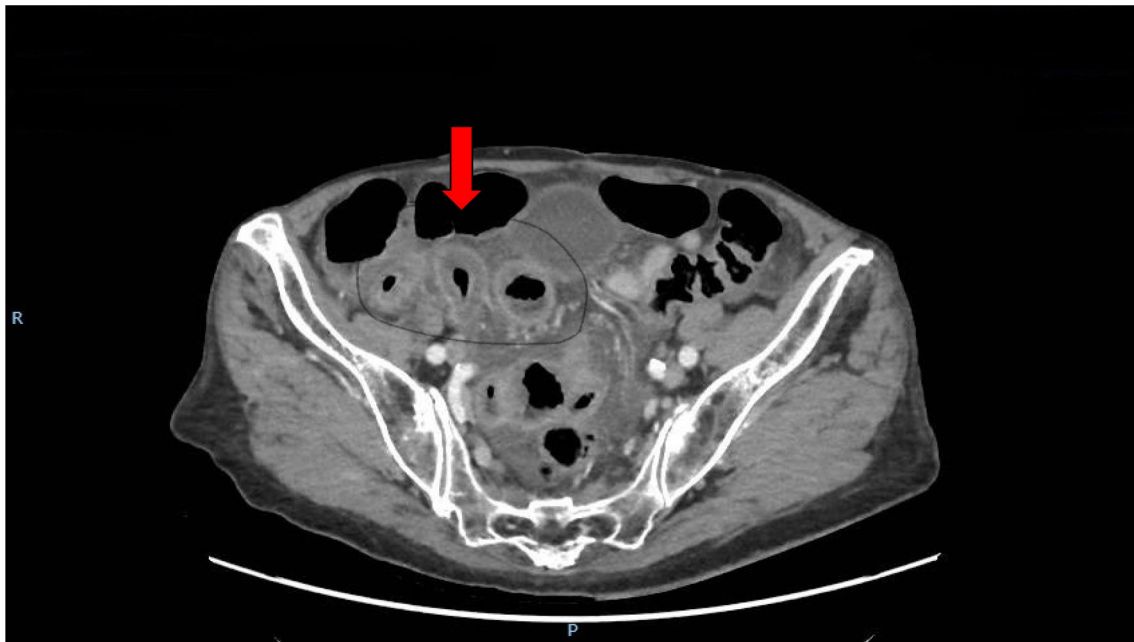


**Fig. 2** Abdominal CT scan at admission confirming gas in the portal venules of the left hepatic lobe (red arrow) (colour figure online)

## Discussion

Hepatic portal venous gas (HPVG), a rare radiological finding where gas enters the portal venous system, was first described by Wolfe and Evans in 1955 in infants with fatal necrotizing enterocolitis [1]. Since then, HPVG has

been reported to occur in a variety of abdominal diseases, such as in benign, malignant, traumatic, iatrogenic, and in other etiologies such as an emphysematous liver abscess [2], gastric emphysema [3–5], or gastritis [6–9]. Other conditions are associated with iatrogenic factors during colonic and gastric endoscopic procedures [10–12] even in children [13], or when a cardiac defibrillator is implanted



**Fig. 3** Abdominal CT scan at admission showing thickening of the terminal ileum and cecum with free abdominal fluid (red arrow) (colour figure online)

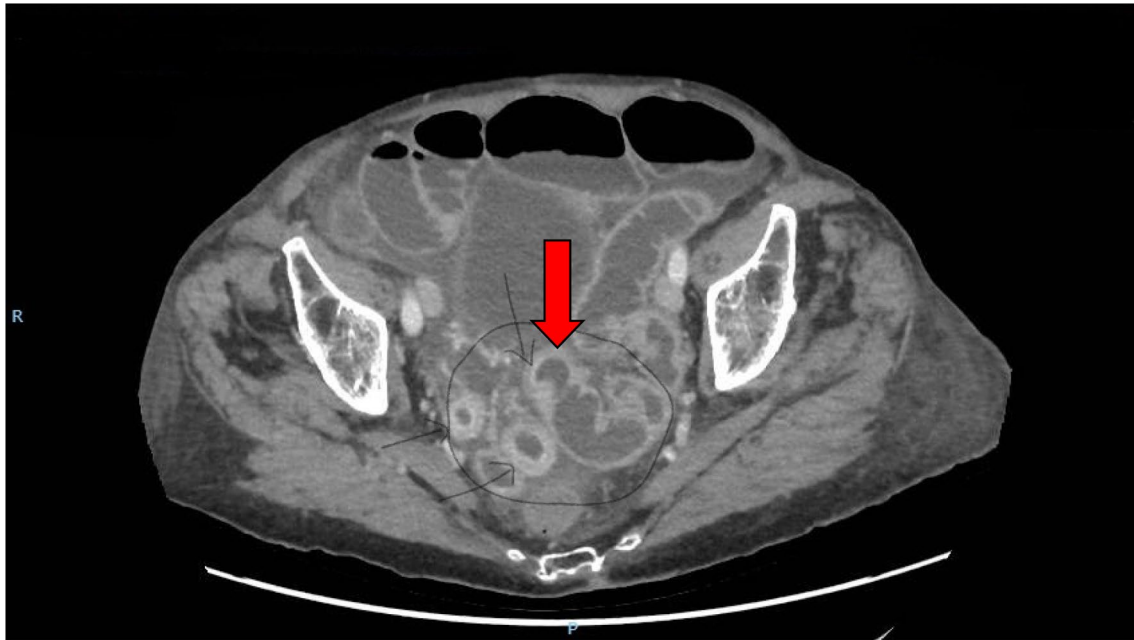


**Fig. 4** Follow-up abdominal CT scan showing no residual gas in the portal venules (red arrow) (colour figure online)

[14]. Infrequently, HPVG can be due to noninvasive positive pressure ventilation (NIPPV) [15]; it can appear after an allogeneic hematopoietic stem cell transplantation [16, 17], or can be a consequence of another rare clinical condition such as pneumatosis cystoides intestinalis [18–21].

More frequently encountered clinical conditions associated with HVPG include biliary-enteric fistula with gallstone

ileus [22], previous cholecystectomy, previous endoscopic retrograde cholangio-pancreato-graphy (ERCP), Bouveret’s syndrome [23–25], and translocation of gas-forming enteric microorganisms into the portal vein due to postoperative paralytic ileus or infections [26, 27]. Another potentially lethal cause is bowel ischemia accompanied by intestinal infarction with extensive necrosis of the intestinal loops



**Fig. 5** Follow-up abdominal CT scan showing improved contrast enhancement of the intestinal mucosa

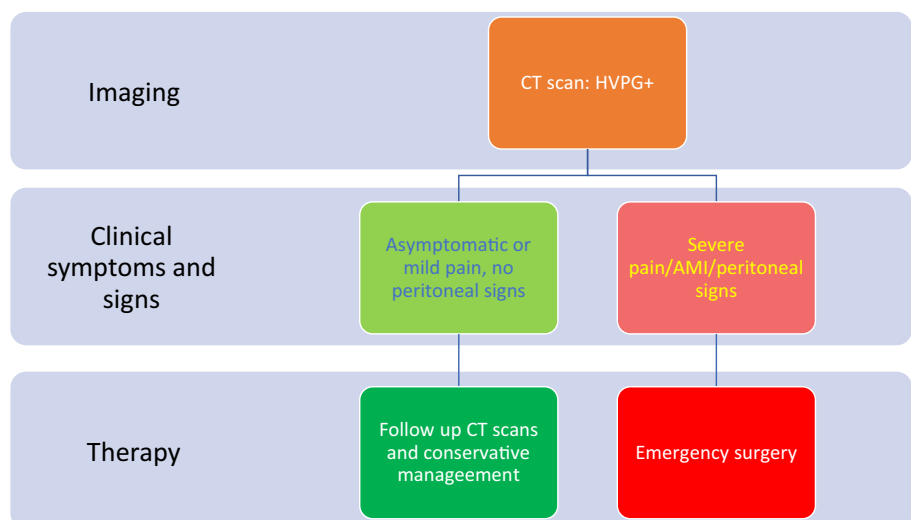
[28, 29]. In this case, HPVG is strictly related to “pneumatosis intestinalis” usually as a consequence of mesenteric infarction[30], though several cases have been described as a consequence of acute appendicitis, colon cancer, and prior trauma [31–34].

HPVG is primarily diagnosed by conventional radiography, ultrasonography, and abdominal CT scan, with the latter representing the gold standard. CT scan not only has the highest sensitivity but can also detect associated underlying diseases [35, 36], in contrast to abdominal ultrasound which is limited by operator experience and luminal gas. The more widespread use of CT scan is associated with a proliferation

of case reports of HPVG, often as incidental finding associated with benign etiologies, a likely explanation for its decreasing reported mortality rate [37]. In the international literature [38], published evidence-based algorithms provide guidance regarding the management of patients with HPVG (Fig. 6). As initial diagnostic testing usually performed in ED, abdominal X-ray can effectively diagnose HPVG though CT scanning is essential in order to confirm the diagnosis and identify associated factors [39, 40].

Acute mesenteric ischemia (AMI) is a life-threatening emergency with associated high mortality rates. Since rapid diagnosis of AMI is the most important predictor of

**Fig. 6** Simplified algorithm to guide the clinician in the management of patients with HPVG (AMI: acute mesenteric ischemia)



outcome, prompt diagnosis and intervention are essential in order to reduce mortality in patients with AMI [41, 42]. The finding of HPVVG alone is not an indication for emergency surgery since surgical intervention is recommended only when intestinal infarction due to superior mesenteric arterial thrombosis is present. Specifically, clinical symptoms typical of acute mesenteric ischemia such as the sudden onset of severe abdominal pain associated with radiologic signs of bowel infarction are robust indications for emergency surgery.

CT findings such as pneumoperitoneum, pneumatosis, HVPG, and bowel wall thickening can provide valuable information, essential for guiding management [43]. In the authors' experience, although CT findings could be related to a transient intestinal ischemia, conservative treatment was preferred due to the absence of peritoneal signs or clinical symptoms. Subsequent CT scanning confirmed transient intestinal ischemia due to a likely embolic cause, since HVPG was absent from the left hepatic lobe. Conservative therapy with close clinical observation was successful in this case and is recommended when evidence of acute intestinal infarction and clinical decompensation are lacking.

## Key Message

- The most common cause of HVPG is intestinal ischemia or necrosis.
- Abdominal CT scan is an effective method to diagnose and follow-up HPVVG.
- In case of HVPG, surgery should be performed early when there are clinical signs of intestinal ischemia, necrosis, or perforation, otherwise exploratory laparotomy should be avoided in favor of conservative management including close observation and serial CT scans.

**Acknowledgments** We wish to thank M. Pasquali, MD for her invaluable support in the radiological reports and discussion.

## Declarations

**Conflict of interest** All authors declare that they have no conflict of interest.

## References

1. Wolfe JN, Evans WA. Gas in the portal veins of the liver in infants; a roentgenographic demonstration with postmortem anatomical correlation. *Am J Roentgenol Radium Ther Nucl Med.* 1955;74:486–488.
2. Deng-Wei C, Keh-Cherng W. Emphysematous liver abscess with hepatic portal venous gas. *Intern Emerg Med.* 2019;14:1335–1336.
3. Masaya I, Yuki O, Hiromitsu K et al. Conservative management of gastric emphysema and hepatic portal venous gas: a case report. *Nihon Shokakibyō Gakkai Zasshi.* 2018;115:655–661 (**Article in Japanese**).
4. Tang CM, Yarandi SS, Laxton WH et al. Conservative management of gastric emphysema with hepatoportal venous gas. *BMJ Case Rep.* 2015;2015:bcr2015211669.
5. Tadashi F, Takafumi U, Isao M et al. Non-surgical treatment of gastric emphysema with intra-abdominal free gas and hepatic portal venous gas: Lessons from a rare case. *SAGE Open Med Case Rep.* 2020;8:2050313X20945946.
6. Fredy N, Kyle R, Imad N. Emphysematous gastritis with hepatic portal venous gas: a shift towards conservative management. *BMJ Case Rep.* 2017;2017:bcr2017219651.
7. Ng A, Spanger M, Lubel JS. Education and imaging. Hepatobiliary and pancreatic: emphysematous gastritis with hepatic portal venous gas. *J Gastroenterol Hepatol* 2012;27:1130.
8. Takeshi Y, Nobuaki Y, Yuki N et al. A case of phlegmonous gastritis with hepatic portal venous gas caused by *Aeromonas hydrophila* successfully treated with medication. *Clin J Gastroenterol* 2020;13:281–286.
9. Shipman PJ, Drury P. Emphysematous gastritis: case report and literature review. *Australas Radiol.* 2001;45:64–66.
10. Capolupo GT, Mascianà G, Carannante F, Caricato M. Hepatic portal venous gas after colonoscopy: a case report and review. *Int J Surg Case Rep* 2018;51:54–57.
11. Sho S, Yoji T, Ryu I et al. Hepatic portal venous gas following colonic endoscopic submucosal dissection. *Intern Med* 2019;58:755–756.
12. Toyoaki S, Tsuyoshi N, Masaharu T et al. Asymptomatic hepatic portal venous gas with gastric emphysema as a chronic complication of gastrostomy tube placement: a case report. *J Med Case Rep* 2016;10:234.
13. Sherin D, Denease F, Michelle T et al. Case of hepatic portal venous gas in an infant with hypertrophic pyloric stenosis. *BMJ Case Rep* 2018;2018:bcr2018224794.
14. Dong-Guang N, Chen L, Hong-Chun F. Hepatic portal venous gas associated with transcatheter cardiac defibrillator implantation: a case report. *Int J Surg Case Rep* 2018;44:57–61.
15. Harith A, Mina D, Joseph B et al. Gastric Emphysema and Hepatic Portal Vein Gas as Complications of Noninvasive Positive Pressure Ventilation. *Cureus* 2020;12:e9086.
16. Singavi AK, Shah NN. Graft-versus-host disease-associated hepatic portal venous gas. *Br J Haematol* 2018;181:9.
17. Junichiro Y, Riko H, Gen T et al. Hepatic portal venous gas associated with severe graft-versus-host disease of the gastrointestinal tract. *Intern Med* 2012;51:2417–2421.
18. Telegrafo M, Ianora AA, Angelelli G et al. Reversible pneumatosis cystoides intestinalis after liver transplantation. *G Chir* 2017;38:239–242.
19. Makoto I, Kazuto O, Tetsuzo T et al. Case of portal venous gas and pneumatosis cystoides intestinalis occurring during chemotherapy for a castration-resistant prostate cancer. *Hinyokika Kyo* 2014;60:575–578 (**Article in Japanese**).
20. Kenta T, Hideyuki A, Ayuko Y et al. Improvements in pneumatosis cystoides intestinalis and hepatic portal venous gas with conservative therapy in a patient on maintenance dialysis. *Intern Med* 2016;55:1735–1738.
21. Fangmei L, Di G, Liangru Z. Pneumatosis cystoides intestinalis: a case report and literature review. *BMC Gastroenterol* 2019;19:176.
22. Alemi F, Seiser N, Ayloo S. Gallstone disease: cholecystitis, mirizzi syndrome, bouveret syndrome, gallstone ileus. *Surg Clin North Am* 2019;99:231–244.
23. Haddad FG, Mansour W, Deeb L. Bouveret's syndrome: literature review. *Cureus* 2018;10:e2299.

24. Philipose J, Khan HM, Ahmed M et al. Bouveret's syndrome. *Cureus* 2019;11:e4414.
25. Caldwell KM, Lee SJ, Leggett PL et al. Bouveret syndrome: current management strategies. *Clin Exp Gastroenterol* 2018;11:69–75.
26. Tahara S, Sakai Y, Katsuno H et al. Pneumatosis intestinalis and hepatic portal venous gas associated with gas-forming bacterial translocation due to postoperative paralytic ileus: A case report. *Medicine Baltimore* 2019;98:e14079.
27. Aslam F, Apostolopoulos A, Zeeshan S. Pneumatosis intestinalis with extensive intrahepatic portal venous gas secondary to intra-abdominal sepsis: a rare occurrence. *BMJ Case Rep* 2017;2017:bcr2017222865.
28. Bernstein BS, Callan RG, Bernstein DE et al. Hepatic portal venous gas: acute deterioration in an elderly patient. *J Surg Case Rep* 2017;2017:rjx245.
29. Ito M, Horiguchi A, Miyakawa S. Pneumatosis intestinalis and hepatic portal venous gas. *J Hepatobiliary Pancreat Surg* 2008;15:334–337.
30. Ohtsubo K, Okai T, Yamaguchi Y et al. Pneumatosis intestinalis and hepatic portal venous gas caused by mesenteric ischemia in an aged person. *J Gastroenterol* 2001;36:338–340.
31. Kouzu K, Kajiwaru Y, Aosasa S et al. Hepatic portal venous gas related to appendicitis. *J Surg Case Rep* 2018;2018:rjy333.
32. Chen H, Wu Q, Fang H et al. Intestinal necrosis cannot be neglected in a patient with hepatic portal vein gas combined with appendicitis: a rare case report and literature review. *BMC Surg* 2019;19:17.
33. Li Z, Su Y, Wang X et al. Hepatic portal venous gas associated with colon cancer: a case report and literature review. *Medicine (Baltimore)* 2017;96:e9352.
34. Sen I, Samarasam I, Chandran S et al. Gastric intramural and portal venous gas following blunt abdominal injury. *Arch Trauma Res* 2013;2:95–96.
35. Schindera ST, Triller J, Vock P et al. Detection of hepatic portal venous gas: its clinical impact and outcome. *Emerg Radiol* 2006;12:164–170.
36. Chan SC, Wan YL, Cheung YC et al. Computed tomography findings in fatal cases of enormous hepatic portal venous gas. *World J Gastroenterol* 2005;11:2953–2955.
37. Ginesu GC, Barmina M, Cossu ML et al. Conservative approach to hepatic portal venous gas: a case report. *Int J Surg Case Rep* 2017;30:183–185.
38. Nelson AL, Millington TM, Sahani D et al. Hepatic portal venous gas: the ABCs of management. *Arch Surg* 2009;144:575–581 (**discussion 581**).
39. Iannitti DA, Gregg SC, Mayo-Smith WW et al. Portal venous gas detected by computed tomography: is surgery imperative? *Dig Surg* 2003;20:306–315.
40. Sen-Kuang H, Chii-Hwa C, Chorng-Kuang H et al. Hepatic portal venous gas: clinical significance of computed tomography findings. *Am J Emerg Med* 2004;22:214–218.
41. Kühn F, Schiergens TS, Klar E. Acute mesenteric ischemia. *Visc Med* 2020;36:256–262.
42. Navas-Campo R, Moreno-Caballero L, Ezponda Casajús A. Acute mesenteric ischemia: a review of the main imaging techniques and signs. *Radiologia* 2020;62:336–348.
43. Franca E, Shaydakov ME, Kosove J. *Mesenteric Artery Thrombosis*. StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.