Hepatic portal venous gas – three non-fatal cases and review of the literature

Kevin McElvanna, Alastair Campbell, Tom Diamond

Accepted 26 January 2012

ABSTRACT

Background: Hepatic portal venous gas is a rare imaging finding most commonly associated with intestinal ischaemia and high mortality. Increased use of advanced imaging techniques has resulted in increased reporting and recognition of hepatic portal venous gas. Advanced imaging can also recognise the many associated pathologies which have variable management strategies and prognoses.

Methods: We report 3 non-fatal cases and review the pathogenesis, aetiology, diagnosis, management and prognosis of hepatic portal venous gas.

Conclusion: Once considered an indication for urgent surgery, hepatic portal venous gas is a rare imaging finding. More recently, HPVG has been recognised to be associated with various benign causes many of which may be treated non-operatively. However, intestinal ischaemia remains the most common cause and the most important to exclude. CT is the diagnostic modality of choice. The underlying cause determines the treatment strategy and outcome.

BACKGROUND

Hepatic portal venous gas (HPVG) is a rare imaging finding first described in 1955 in neonatal necrotising enterocolitis. A subsequent review of adult cases concluded that this was an ominous finding – usually indicating intestinal ischaemia, necessitating urgent laparotomy and mortality of 75%.

In more recent decades, in particular with the advent of computed tomography (CT), HPVG has been increasingly recognised. It has been associated with various abdominal pathologies and a lower overall mortality than previously reported. We report 3 non-fatal cases and review the pathogenesis, aetiology, diagnosis, management and prognosis of HPVG.

METHOD

The clinical notes and imaging of 3 non-fatal cases of HPVG recently diagnosed in our hospital were reviewed. PubMed, PubMed Central and BioMed Central databases were searched using the terms ‘hepatic portal venous gas’ and ‘portal venous gas’. A literature review of articles in the English language regarding HPVG in adults was conducted. References cited in articles were also reviewed and 45 relevant articles were selected.

CASE 1: HPVG WITH ACUTE PANCREATITIS AND GASTROINTESTINAL DILATATION

A 76-year-old man was admitted with upper abdominal pain radiating through to the back and vomiting. He had a history of alcohol excess, liver cirrhosis and ischaemic heart disease. Physical examination revealed tachycardia and right hypochondrial tenderness. Laboratory data showed deranged liver function and hyperamylasaemia of 984 U/l (25-125 U/l). A diagnosis of acute pancreatitis was made and abdominal ultrasonography was performed to exclude gallstones. This showed gallbladder sludge, a distended stomach and gas bubbling through the hepatic portal veins (Figure 1). CT demonstrated gross fluid distension of the oesophagus, stomach, duodenum and proximal jejunal loops. Gas was seen within the mesenteric and hepatic portal veins (Figure 2). No biliary or pancreatic abnormality was identified.
Hepatic portal venous gas – 3 non-fatal cases and review of the literature

The patient was treated with nasogastric decompression, intravenous fluids and analgesia. A gastrografin meal and follow-through at 6 days showed a normal calibre stomach and small bowel. His symptoms resolved and he was discharged after 9 days.

CASE 2: HPVG WITH ABDOMINAL HAEATOMA AND GASTRIC DILATATION

A 44-year-old female underwent an elective Roux-en-Y hepaticojejunostomy for a benign biliary stricture. Four days post-operatively she developed right-sided abdominal pain and vomiting. On examination she was found to be pale, tachycardic and hypotensive. Laboratory investigations revealed: haemoglobin of 7.2 g/dl (11.5-16.5 g/dl), leukocytosis of 35.2x10⁹/l (4.0-10.0 x10⁹/l) and elevated C-reactive protein of 459mg/l (1-10mg/l). Two units of packed red cells were transfused and intravenous antibiotics were commenced.

Abdominal CT showed a large right-sided intra-peritoneal haematoma. The stomach was markedly distended and gas was seen within the wall of the stomach and oesophagus. Gas was identified peripherally within both lobes of the liver (Figure 3).

Naso-gastric decompression and urgent laparotomy were performed. The haematoma was evacuated, haemostasis achieved and a further drain inserted. The stomach did not appear ischaemic. The naso-gastric tube was removed 2 days later and a further CT at 4 days showed resolution of the gastric distension, pneumatosis and HPVG. The patient was discharged 6 days later.

CASE 3: HPVG WITH ACUTE DIVERTICULITIS, INTRA-ABDOMINAL ABSCESS & SEPTIC THROMBOPHLEBITIS

A 67-year-old female presented with lower abdominal pain, vomiting and rigors. She had a past history of superior mesenteric venous thrombosis 9 years previously resulting in mesenteric infarction necessitating ileo-caecal resection followed by anti-coagulation for 6 months. Pulse rate was 128/min, blood pressure 103/59mmHg and temperature 37.8°C. She had left iliac fossa tenderness on examination. Laboratory data revealed a white cell count of 11.7x10⁹/l (4.0-10.0 x10⁹/l) and C-reactive protein of 363 mg/l (1-10 mg/l). CT of the abdomen and pelvis identified sigmoid diverticulitis with an adjacent 3.2cm gas and fluid-filled collection consistent with a diverticular abscess. Inferior mesenteric, splenic and portal venous gas was evident (Figure 4). There was also peripheral intra-hepatic portal venous gas (Figure 5). A filling defect was seen within the inferior mesenteric and extra-hepatic portal veins in keeping with thrombus and a diagnosis of septic thrombophlebitis. Blood cultures were positive for Pseudomonas stutzeri and Streptococcus milleri.

She was treated with therapeutic low-molecular weight heparin and intravenous meropenum and gentamicin. Her symptoms resolved, inflammatory markers improved and she was discharged 2 weeks later on lifelong oral anticoagulation.
PATHOGENESIS

The mechanism of HPVG is not fully understood. Theories include: (i) migration of swallowed gas via mural capillaries into the portal venous circulation due to high gastrointestinal luminal pressure. This is the most likely mechanism in Cases 1 and 2 where marked gastric dilatation appear to have been precipitated by pancreatitis and intra-abdominal bleeding respectively; (ii) disruption of intestinal mucosa with passage of gas into the mesenteric venous system from gas-forming organisms within the bowel lumen; (iii) the presence gas-forming bacteria either from an abscess or porto-mesenteric pyelophlebitis. In Case 3, where there was diverticulitis with an associated abscess, both theories (ii) and (iii) could explain the development of portal venous gas. In many cases these factors appear to contribute in combination. Gas within the portal vein then passes centrifugally via the intra-hepatic portal veins to the hepatic periphery.

AETIOLOGY

Mesenteric thrombosis with intestinal necrosis is still the most common underlying cause and the most important diagnosis to exclude. Recent studies have recognised other common pathologies associated with HPVG (Table 1). Many other causes have been reported and together account for approximately 15% of cases (Table 2).

DIAGNOSIS

HPVG is a rare imaging finding - just 28 cases were identified on review of 33,000 CT scans in 2 centres. It is typically identified on plain x-ray, ultrasonography (US) or CT. The clinical presentation and examination findings are those of the underlying aetiology.

PLAIN RADIOGRAPHY

HPVG was originally described as a plain radiographical sign. It appears as branching radiolucencies extending to the liver periphery. It may be detected in up to 12.5% of cases but requires the presence of large quantities of gas and is often a subtle finding. A left lateral decubitus view increases sensitivity. The presence of HPVG on plain x-ray has been considered a poor prognostic sign, usually associated with intestinal infarction. Features of the underlying cause may also be evident such as marked pneumatosis intestinalis, gastro-intestinal oedema and dilatation or paucity of luminal gas.

US

On ultrasound scanning, HPVG appears as hyper-echoic, dot-like or streak-like foci flowing within the portal veins or liver parenchyma. It is a rapid, low-cost, low-radiation method with comparable sensitivity and accuracy to CT. Sensitivity may be increased if colour Doppler flow imaging is also utilised. US also offers dynamic imaging of the centrifugal flow of portal gas to the hepatic periphery thus differentiating from biliary gas.

CT

With the increased use of abdominal CT scanning, HPVG has been more frequently diagnosed. Small volumes of gas can be detected and the application of ‘lung-window’ settings aids identification. Gas is predominantly seen within the portal veins of the non-dependant left lobe and anterior right lobe. Branching low-attenuation tubular areas are seen within 2cm of the hepatic capsule. HPVG can be distinguished from intra-hepatic pneumobilia which is...
detected centrally within the liver rather than extending to the peripheral parenchyma. It is highly sensitive and considered the gold standard imaging modality as it also offers the advantage of early detection of associated pathology. In particular, dilatation and inflammation of the digestive tract, intra-peritoneal abscess and features of bowel ischaemia, such as pneumatisos intestinalis, may be demonstrated.

### MANAGEMENT AND PROGNOSIS

Early studies concluded that the diagnosis of HPVG was an ominous finding which necessitated urgent laparotomy. This was due to the association with bowel infarction and high mortality of at least 75%. With advanced imaging techniques and the reporting of many non-life-threatening cases, the gold standard imaging modality as it also offers the ability to detect centrally within the liver rather than extending to the peripheral parenchyma. It is highly sensitive and considered the gold standard imaging modality as it also offers the advantage of early detection of associated pathology. In particular, dilatation and inflammation of the digestive tract, intra-peritoneal abscess and features of bowel ischaemia, such as pneumatisos intestinalis, may be demonstrated.

### REFERENCES

1. Wolfe JN, Evans WA. Gas in the portal veins of the liver of infants: a roentgenographic demonstration with postmortem anatomical correlation. Am J Roentgenol 1957;80(3):486-8.
2. Liebmann PR, Patten MT, Manny J, Benfield JR, Hechtman HB. Hepatic-portal venous gas in adults: etiology, pathophysiology and clinical significance. Ann Surg. 1978;187(3):281-7.
3. Alqahtani S, Coffin CS, Burak K, Chen F, MacGregor J, Beck P. Hepatic portal venous gas: a report of two cases and a review of the epidemiology, pathogenesis, diagnosis and approach to management. Can J Gastroenterol. 2007;21(5):309-13.
4. Nelson AL, Millington TM, Sahani D, Chung RT, Bauer C, Hertl M, et al. Hepatic portal venous gas: the ABCs of management. Arch Surg. 2009;144(6):575-81.
5. Peloponissos N, Halkic N, Pugnale M, Jornod P, Nordback P, Meyer A, Gillet M. Hepatic portal gas in adults: review of the literature and presentation of a consecutive series of 11 cases. Arch Surg. 2003;138(12):1367-70.
6. Kinoshita H, Shinozaki M, Tanimura H, Umemoto Y, Sakaguchi S, Takifaji K, Kawasaki S, Hayashi H, Yamae H. Clinical features and management of hepatic portal venous gas: four case reports and cumulative review of the literature. Arch Surg. 2001;136(12):1410-4.
7. Hussain A, Mahmood H, El-Hasni S. Portal vein gas in emergency surgery. World J Emerg Surg. 2008;3:21.
8. Katz BH, Schwartz SS, Vender RJ. Portal venous gas following a barium enema in a patient with Crohn's colitis. A benign finding. Dis Colon Rectum. 1986;29(1):49-51.
9. Lai CF, Chang WT, Liang PC, Lien WC, Wang HP, Chen WJ. Pneumatisos intestinalis and hepatic portal venous gas after CPR. Am J Emerg Med. 2005;23(2):177-81.
10. Mogmol P, Chosidow D, Marmuse JP. Hepatic portal gas due to gastrointestinal anastomotic leak after laparoscopic gastric bypass. Obes Surg. 2005;15(2):278-81.
11. Morimoto Y, Yamasawa T, Tanaka Y, Hiranaka T, Kim M. Recurrent hepatic portal venous gas in a patient with hemodialysis-dependent chronic renal failure. J Hepatobiliary Pancreat Surg. 2001;8(3):274-8.
12. Iuchi S, Aizhi B, Safar F, Kasai A, Suzuki K, Kihara H, et al. Hepatic portal venous gas associated with nonocclusive mesenteric ischemia in a hemodialysis patient. Clin Nephrol. 2005;63(4):310-2.
13. McCarthy P, Adam A, Jackson J, Benjamin IS, Allison D. Computed tomography demonstration of portal venous gas after hepatic artery embolization. Br J Radiol. 1990;63(752):647-8.
14. Chezmar JL, Nelson RC, Bernardino ME. Portal venous gas after hepatic transplantation: sonographic detection and clinical significance. AJR Am J Roentgenol. 1989;153(6):1203-5.

15. Pua U. Percutaneous liver biopsy: a cause of hepatic portal venous gas. CMAJ. 2010;182(18):E861.

16. Oei T, van Sonnenberg E, Shankar S, Morrison PR, Tuncali K, Silverman SG. Radiofrequency ablation of liver tumors: a new cause of benign portal venous gas. Radiology. 2005;237(2):709-17.

17. Tsuobono T, Sato K, Fukuda M. Hepatic portal venous gas associated with cholangitis following pancreaticoduodenectomy: report of a case. Surg Today. 1994;24(4):375-7.

18. Lee CS, Kuo YC, Wang JD, Wang LM. Hepatic portal venous gas caused by hyperglycaemic shock associated with hepatic portal venous gas. J Hepatol. 2006;45(4):66-7.

19. Wu JM, Wang MY. Hepatic portal venous gas in necrotizing pancreatitis. Dig Surg. 2009;26(2):119-20.

20. Zalinski S, Scatton O, Jacqmin S, Tacher V, Brézault C, Soubrane O. Portal venous gas following chemotherapy for colorectal cancer liver metastasis. Eur J Surg Oncol. 2009;35(5):557-60.

21. Ortega J, Hayes JM, Antonia S. Hepatic portal venous gas in a patient with metastatic non-small cell lung cancer on bevacizumab therapy: a case report and review of the literature. Cancer Chemother Pharmacol. 2009;65(1):187-90.

22. Saksena M, Harisinghani MG, Wittenberg J, Mueller PR. Case report. Hepatic portal venous gas: transient radiographic finding associated with colchicines toxicity. Br J Radiol. 2003;76(911):835-7.

23. Lewin M, Pocard M, Caplin S, Blain A, Tubiana JM, Parc R. Benign portal venous gas following chemotherapy for colorectal cancer liver metastasis: its clinical impact and outcome. Emerg Radiol. 2006;12(4):164-70.

24. Gosink BB. Intrahepatic gas: differential diagnosis. AJR Am J Roentgenol. 1981;137(4):763-7.

25. Schlottke EM, Montizambert B, Pralong P, Berard C, Burgener J, Bloch B. Hepatic portal venous gas in ultrasonographic image: a new cause of benign portal venous gas. Am J Roentgenol. 1997;169(6):1535-8.

26. Oei T, van Sonnenberg E, Shankar S, Morrison PR, Tuncali K, Silverman SG. Radiofrequency ablation of liver tumors: a new cause of benign portal venous gas. Radiology. 2005;237(2):709-17.

27. Nishikawa K, Higuchi M, Kimura S, Shimodate Y, Namiki A. Severe hyperglycaemic shock associated with hepatic portal venous gas. J Anesth. 2008;22(1):74-6.

28. Mao YC, Wang JD, Wang LM. Hepatic portal venous gas caused by emphysematous pyelonephritis. Clin Gastroenterol Hepatol. 2009;7(10):A25.

29. Chang CJ, Shun HC, Chuang CC. Hepatic portal venous gas induced by emphysematous pyelonephritis: a rare case in hemodialytic women. Am J Emerg Med. 2009;27(9):1171.e1-3.

30. Sung JM, Shih TE, Wu AB. Hepatic portal vein gas associated with emphysematous pyelonephritis: a rare association. Nephrology. 2010;15(4):504-5.

31. Butler BD, Fife C, Sutton T, Pogodsky M, Chen P. Hepatic portal venous gas with hyperbaric decompression: ultrasonographic identification. J Ultrasound Med. 1995;14(12):967-70.

32. Chen KW, Shin JS, Chi CH, Cheng L. Seizure: a rare and transient cause of portal venous gas. Am J Gastroenterol. 1997;92(2):351-2.

33. Faberman RS, Mayo-Smith WW. Outcome of 17 patients with portal venous gas detected by CT. AJR Am J Roentgenol. 1997;169(6):1535-8.

34. Schindera ST, Triller J, Vock P, Hoppe H. Detection of hepatic portal venous gas: its clinical impact and outcome. Emerg Radiol. 2006;12(4):164-70.

35. Gossman BB. Intrahepatic gas: differential diagnosis. AJR Am J Roentgenol. 1981;137(4):763-7.

36. Pan HB, Huang JS, Yang TL, Liang HL. Hepatic portal venous gas in ultrasonogram—benign or noxious. Ultrasound Med Biol. 2007;33(8):1179-83.

37. Abboud B, El Hachem J, Yazebeck T, Doumit C. Hepatic portal venous gas: physiopathology, etiology, prognosis and treatment. World J Gastroenterol. 2009;15(29):3585-90.

38. Schulze CG, Blum U, Haag K. Hepatic portal venous gas. Imaging modalities and clinical significance. Acta Radiol. 1995;36(4):377-80.

39. Yarze JC, Markowitz DM. Distinguishing between hepatic portal vein gas and pneumo(aero)bilia. Liver Transpl. 2007;13(10):1476.

40. Sebastià C, Quiroga S, Espin E, Boyé R, Alvarez-Castells A, Armentegol M. Portomesenteric vein gas: pathologic mechanisms, CT findings, and prognosis. Radiographics. 2000;20(5):1213-24.

41. Traverso LW. Is hepatic portal venous gas an indication for exploratory laparotomy? Arch Surg. 1981;116(4):936-8.

42. Celoria G, Coe NP. Does the presence of hepatic portal venous gas mandate an operation? A reassessment. South Med J. 1990;83(5):592-4.

43. Iannitti DA, Gregg SC, Mayo-Smith WW, Tomolonis RJ, Cioffi W, Pricolo VE. Portal venous gas detected by computed tomography: is surgery imperative? Dig Surg. 2003;20(4):306-15.