

# Exploring the use of single-port surgery in the conservative management of hepatic portal vein gas

## A case report

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### Abstract

**Rationale:** Hepatic portal vein gas (HPVG) is known as a sign of a lethal condition resulting from bowel necrosis. Recently, the detection rate of non-life-threatening cases of HPVG has increased due to the technological development of imaging, i.e., computed tomography (CT). However, it is difficult to determine accurately whether surgical treatment is necessary because of its lethal potential.

**Patient concerns:** A 74-year-old woman suddenly complained about lower abdominal pain and vomiting after an operation for cervical spondylosis myelopathy. Her vital signs were slightly unstable and she was perspiring and exhibited pallor. Muscular defense was not clear, though her abdomen was tender and slightly distended.

**Diagnosis:** CT results showed massive HPVG. However, laboratory investigation did not clearly indicate bowel necrosis. Also, a contrast-CT scan was not performed due to her chronic renal dysfunction and asthma.

**Intervention:** Exploration was performed by single-port surgery (SPS) instead of exploratory laparotomy.

**Outcome:** This approach showed no ischemic bowel and so conservative therapies were undertaken with confidence. The HPVG disappeared 2 days later, and she recover completely from the illness.

**Lessons:** HPVG requires immediate and reliable decision for management. However, unnecessary exploratory laparotomy should be avoided. Hence, a novel strategy should be considered in light of innovative surgical procedures. Our experience suggested that SPS was useful as an exploratory tool for the management of HPVG.

**Abbreviations:** ADL = activities of daily living, CT = computed tomography, HPVG = hepatic portal vein gas, ICU = intensive care unit, PV = portal vein, SPS = single-port surgery.

**Keywords:** acute abdomen, hepatic portal vein gas, HPVG, SILS, SPS

## 1. Introduction

Hepatic portal vein gas (HPVG) is one of the most serious conditions and requires prompt definitive treatment focusing on

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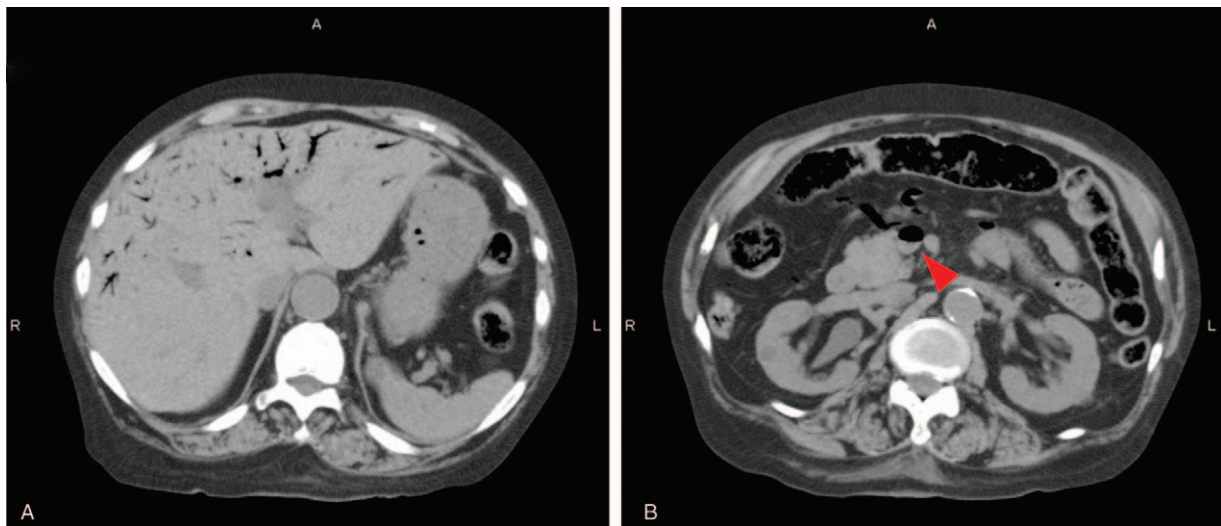
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surgery.<sup>[1]</sup> Recently, the detection rate of non-life-threatening cases of HPVG has increased with simple and precise examination by computed tomography (CT).<sup>[2]</sup> Due to excessive invasiveness, unnecessary exploratory laparotomy should be avoided, especially in the elderly. However, many clinicians are sometimes unable to make a clear decision for the management of HPVG; accordingly, they cannot choose only conservative management without exploratory laparotomy for HPVG due to the possibility of a lethal consequence. Single-port surgery (SPS) as a minimally invasive procedure has been used recently, mainly for cholecystectomy or appendectomy, in many institutions, including ours.<sup>[3]</sup> Herein, we present an instructive case for SPS as an evaluation tool for bowel conditions in HPVG in order to avoid unnecessary laparotomy.

## 2. Case report

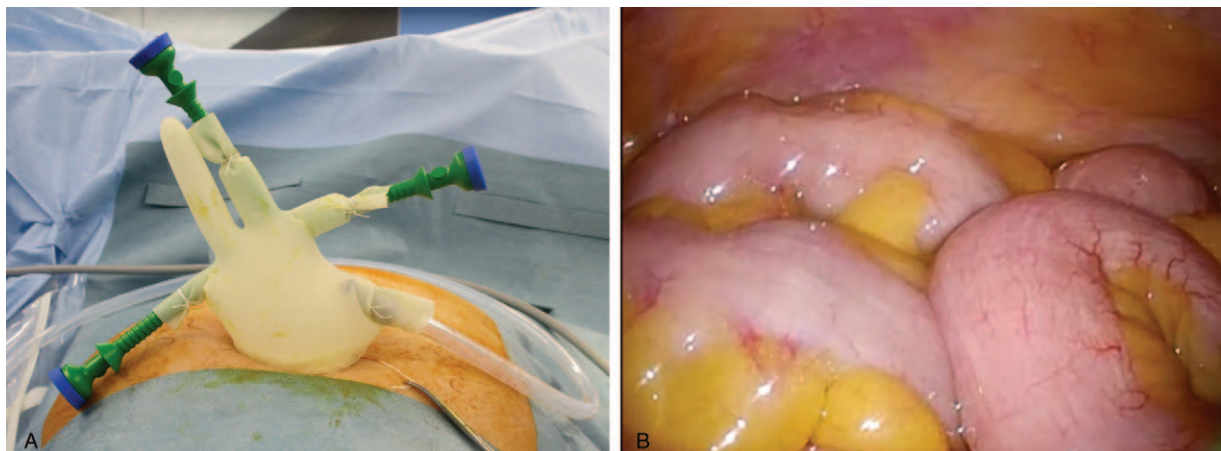
A 74-year-old woman was hospitalized for surgical treatment of cervical spondylosis myelopathy at the Department of Orthopedic Surgery of our hospital. She had a history of chronic asthma due to sarcoidosis. Also, membranous nephropathy due to Sjögren syndrome was diagnosed 20 years earlier; and methylprednisolone (4mg/d) had been prescribed for a long period of time. She had a surgical history of appendectomy. Lower abdominal pain and vomiting suddenly occurred 12 days



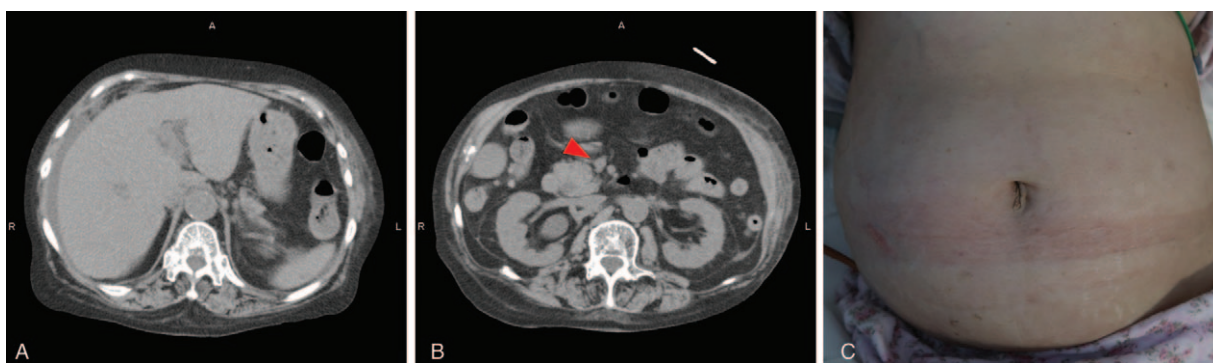
**Figure 1.** A, B, Representative noncontrast abdominal CT images. A, Massive HPVG was observed. B, Massive intravascular gas was observed. The red arrowhead indicates gas in the superior mesenteric vein. CT=computed tomography, HPVG=hepatic portal vein gas.

after surgery for her cervical operation. On examination, she was perspiring and exhibited pallor. Muscular defense was not clear, though her abdomen was tender and slightly distended. Her blood pressure was 68/39 mm Hg, and her heart rate was 100 pulses per minute. The results of the laboratory investigation were as follows: white blood cell count, 14,460/ $\mu$ L (normal, 3300–8600/ $\mu$ L); platelet count, 698,000/ $\mu$ L (normal, 158,000–348,000/ $\mu$ L); C-reactive protein, 5.32 mg/dL (normal, <0.14 mg/dL); lactate dehydrogenase 395 U/L (normal, 124–222); creatine kinase 28 U/L (normal, 41–153); blood urea nitrogen, 32 mg/dL (normal, 8–20 mg/dL); creatinine, 1.13 mg/dL (normal, 0.46–0.79 mg/dL); estimate glomerular filtration rate (eGFR), 36 mL/min/1.73 m<sup>2</sup> (normal, > 90 mL/min/1.73 m<sup>2</sup>); potassium, 6.0 mEq/L (normal, 3.6–4.8 mmol/L). Also, arterial blood gas (ABG) were as follows: pH, 7.407 (normal, 7.35–7.45); PCO<sub>2</sub>, 27.0 Torr (normal, 35–45 Torr); PO<sub>2</sub>, 130.7 Torr (normal, 80–100 Torr); HCO<sub>3</sub><sup>-</sup>, 16.6 mmol/L (normal, 22–26 mmol/L); base excess (BE), -6.8 mmol/L (normal, 0  $\pm$  2 mmol/L); lactic acid, 13.2 mg/dL (normal, 4.5–18.0 mg/dL) under the rate of 3L/min O<sub>2</sub> flow

via face mask. The CT showed massive HPVG involving the mesentery vessels (Fig. 1A, B and Supplementary file 1, <http://links.lww.com/MD/C656>). A contrast-CT examination was ruled out because of her chronic renal dysfunction and asthma. Hence, SPS was performed to evaluate her bowel condition directly. SPS by use of the surgical glove method was performed (Fig. 2A), and the results showed the small intestines and colon were completely intact (Fig. 2B and Supplementary file 2, <http://links.lww.com/MD/C657>). The ascites were collected by irrigation with normal saline. The operation time was 39 minutes. Only conservative management including broad-spectrum antibiotics therapy at the intensive care unit (ICU) followed the SPS-examination. Both ascites and blood cultures were negative. She was discharged from the ICU with uneventful recovery, and the HPVG disappeared on the 2nd day after the SPS procedure (Fig. 3A, B and Supplementary file 3, <http://links.lww.com/MD/C658>). The management for her cervical spondylosis myelopathy was continued by the Department of Orthopedic Surgery without abdominal pain (Fig. 3C).



**Figure 2.** A, Photograph of our SPS method (setup of the surgical glove port). This photograph is the case of cholecystectomy (52-yr-old man) by SPS. The same procedure was used in this present case. B, Intraoperative image highlights. All parts of the small bowel and colon were vital. SPS=single-port surgery.



**Figure 3.** A, B, Representative noncontrast abdominal CT images at day 2 after SPS. A, HPVG has completely disappeared. B, Also, intravascular gas was gone. The red arrowhead indicates the superior mesenteric vein. C, Postoperative photograph of the patient's abdomen. This picture was taken at postoperative day 17. No surgical scar was apparent, and the patient had not complained about any postoperative abdominal pain. CT = computed tomography, HPVG = hepatic portal vein gas.

### 3. Discussion

HPVG was first reported in 1955 by Wolf and Evens as an ominous radiologic sign of neonates in a person who had died due to bowel necrosis.<sup>[4]</sup> A strong relationship between HPVG and mortality due to severe bowel ischemia has subsequently been reported.<sup>[5,6]</sup> Urgent laparotomy should be required in the case of HPVG resulting from an ischemic bowel.<sup>[7]</sup> On the other hand, the detection rate of HPVG has increased in non-life-threatening cases such as gastric dilatation, diverticulitis, ileitis, hemodialysis, endoscopic therapy, and inflammatory bowel disease including examination with barium-enema examination or colonoscopy according to the recent technological development of imaging.<sup>[6,8–12]</sup> Pathophysiological mechanisms of HPVG can be divided broadly into 3 types. The first is damage of the mucosa due to ischemic product gas flowing into the portal vein (PV) system. The second is the increase of intraluminal pressure due to bowel obstruction or trauma causing gas flow into the PV through the infiltration of gas to the intestinal tract wall. The third is the presence of gas-producing bacteremia.<sup>[1,8]</sup> In our consideration, long-term oral administration of steroids for membranous nephropathy is one of the risks of the degeneration of gastrointestinal mucosa. Also, this patient had neck surgery several weeks before, and her activities of daily living (ADL) were poor. It was speculated that HPVG was caused an elevation of degenerated intraluminal pressure by constipation or enteritis. However, this conclusion was reached after surgery. Hence, we had to promptly assess bowel viability in consideration of her vital signs and compromised host. As in the present case, the most difficult part of conservative treatment for HPVG is the accurate decision for such treatment. Contrast-CT is commonly used for the evaluation of bowel necrosis. However, clinicians hesitate to use it when a patient has a history of asthma, contrast media allergy or nephropathy; and sometimes it does not clearly show bowel necrosis. Exploratory laparotomy is the most reliable method for determining the cause of HPVG, but unnecessary and excessive invasiveness should be avoided. These points illustrate the clinical dilemma for the management of HPVG. To solve this matter, several algorithms have been proposed.<sup>[13–15]</sup> Among them, Wayne et al created a vascular disease score based on a patient's history, physical examination, laboratory, and radiology-findings, which differentiated between the ischemic and benign status. Their algorithm suggested that for possibility

(not strong) of mesenteric ischemia, minimally invasive strategies with endoscopy or laparoscopy may be used to assess bowel viability.<sup>[13]</sup> Hence, we need to consider a more reliable and less invasive strategy to assess the bowel viability in HPVG without unnecessary exploratory laparotomy.

Laparoscopic surgery has been adopted in many cases as a minimally invasive surgery. However, SPS is a minimally invasive approach resulting in less postoperative pain than multiport laparoscopic surgery.<sup>[3]</sup> Being a natural orifice, the umbilicus is used as an insertion point. Due to cost and field-of-motion considerations, the glove method is used at our institution (Fig. 2A).<sup>[16]</sup> SPS is sometimes indicated as an effective diagnostic tool in emergencies where judgment of management is difficult.<sup>[17,18]</sup> Also, SPS can be converted promptly to laparotomy if needed. Of course, it is necessary to become familiar with SPS techniques as used in such common surgeries as appendectomy and cholecystectomy. Many lessons can be learned from the use of SPS in the treatment of common diseases. Once the surgeon becomes familiar with the basic principles of SPS, it can be applied as a treatment or diagnostic tool in various situations that call for optimizing the use of technology, performing appropriate disease management, and minimizing surgical invasiveness. Our experience suggested that SPS is useful as a novel exploratory tool for the management of HPVG.

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