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Portal Venous Gas in Adults: Clinical Significance, Management, and Outcomes of 25 Consecutive Patients

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Background: Portal venous gas (PVG) is a rare finding and has a grave prognosis. The most common and critical underlying pathology of PVG is bowel necrosis. However, bowel necrosis is sometimes difficult to accurately diagnose. We retrospectively analyzed data from patients that contributed to the decision to perform emergency surgery and bowel resection.

Methods: Between 2009 and 2019, 25 consecutive adult patients with PVG were identified retrospectively and divided into the Operation and Non-operation groups. The Operation group was further subdivided into the Bowel resection and Non-resection groups. Clinical, laboratory, and radiographic variables were analyzed.

Results: Conservative management was successful for 32% (8/25) of patients (Non-operation group: mortality 0%); 68% (17/25) were treated surgically (Operation group: mortality 35.3%). In the Operation group, 52.9% (9/17) underwent bowel resection (Bowel resection group: mortality 55.6%); however, bowel resection was unnecessary in 47.1% (8/17) of cases (Non-resection group: mortality 12.5%). Univariate analysis revealed significant differences between the Operation and Non-operation groups in GCS, APACHE II, abdominal distention, CRP, lactate, and CT findings of bowel dilatation, pneumatosis intestinalis, and attenuation of contrast effects of the bowel wall. However, with the exception of GCS, there was no significant difference between the Bowel resection and Non-resection groups.

Conclusions: Analysis of clinical, laboratory, and radiographic variables can inform decisions on conservative management. However, 47.1% of the present patients who underwent surgery for suspected bowel necrosis did not require bowel resection, suggesting that this approach alone may not be sufficient to avoid non-therapeutic laparotomy. A new approach should be developed to improve this situation. (J Nippon Med Sch 2021; 88: 88–96)

Key words: portal venous gas, pneumatosis intestinalis, mesenteric ischemia, bowel necrosis

Introduction

Portal venous gas (PVG) is a rare finding associated with a grave prognosis[1–3]. In 1978, Liebman et al. reported that the mortality rate of patients with PVG was 75%[3]. However, recent improvements in imaging modalities, including CT and ultrasonography, allow detection of even small amounts of PVG, resulting in an increased number of reported cases and a decreased rate of overall mortality[1,2,4,5].

PVG is associated with various pathological conditions, and clinical significance ranges from benign findings to bowel necrosis[1,2,4–8]. The most common underlying pathology of PVG includes bowel necrosis[1–7]. Bowel necrosis is the most critical condition associated with PVG and requires emergency laparotomy[1–7]. Although decision-making regarding clinical management of PVG is based on a combination of factors, including clinical symptoms, physical examination, laboratory data, and CT[2,6,9], bowel necrosis is sometimes difficult to accurately diagnose, which can affect decisions regarding the performance of

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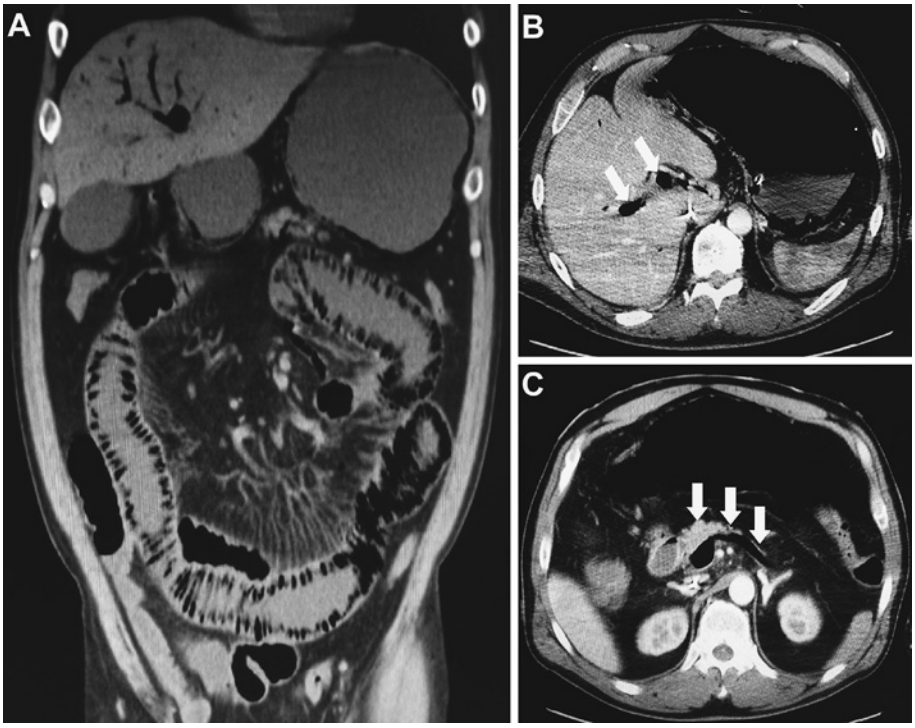

Fig. 1 CT scan of a patient with portal venous gas. a: A coronal CT scan showed portal venous gas (PVG) in the liver and pneumatosis intestinalis (PI) throughout the stomach and small intestine. b: An axial CT scan showed PVG in the right and left portal vein (white arrows). c: Air is present in the extrahepatic portal vein and splenic vein (white arrows). This patient underwent emergency laparotomy; however, bowel resection was not needed. He was discharged from our hospital.

emergency surgery and bowel resection[4–6,9]. This study retrospectively analyzed clinical, laboratory, and radiographic variables contributing to a decision to perform emergency surgery in patients with PVG and assessed the validity of this approach for the clinical management of PVG.

Materials and Methods

This study was approved by the Institutional Review Board of Nippon Medical School Hospital (30-01-1063). The study sample included all patients admitted to the Department of Emergency and Critical Care Medicine of Nippon Medical School during the period from July 2009 through June 2019 with PVG identified on CT scans (**Fig. 1**). Patients were identified based on comments on CT findings by staff radiologists, which were included in electronic medical records. Patients younger than 18 years and those who underwent cardiopulmonary resuscitation were excluded. Patients' medical records were reviewed to obtain information on demographics, medical history, comorbidities, underlying diseases, early symptoms, vital signs, CT findings, arterial blood gas analysis data, laboratory data, management, length of hospital stay, and mortality. Arterial blood gas analysis data and all laboratory data were values measured at the time of PVG diagnosis based on CT findings before the decision to perform emergent surgery (≤2 hours before and after performing CT). The severity of illness and the expected risk of hospital mortality were evaluated by calculating the Acute Physiology and Chronic Health Evaluation (APACHE) II score[10].

All patients received PVG diagnoses based on CT findings. Decisions regarding clinical management of PVG were made by the attending surgeon and were based on a combination of factors, including clinical symptoms, physical examination, laboratory data, underlying disease, and CT findings. Surgical intervention was performed for patients with clinical signs and/or laboratory data suggesting intra-abdominal pathologies that were consistent with radiographic abnormalities, such as bowel obstruction, perforation, and peritonitis. When a combination of clinical, laboratory, and radiographic variables suggested bowel necrosis, surgical exploration was performed without a conclusive diagnosis because of the high mortality rate[1–6]. We performed bowel resection only in patients with transmural bowel necrosis when this op-

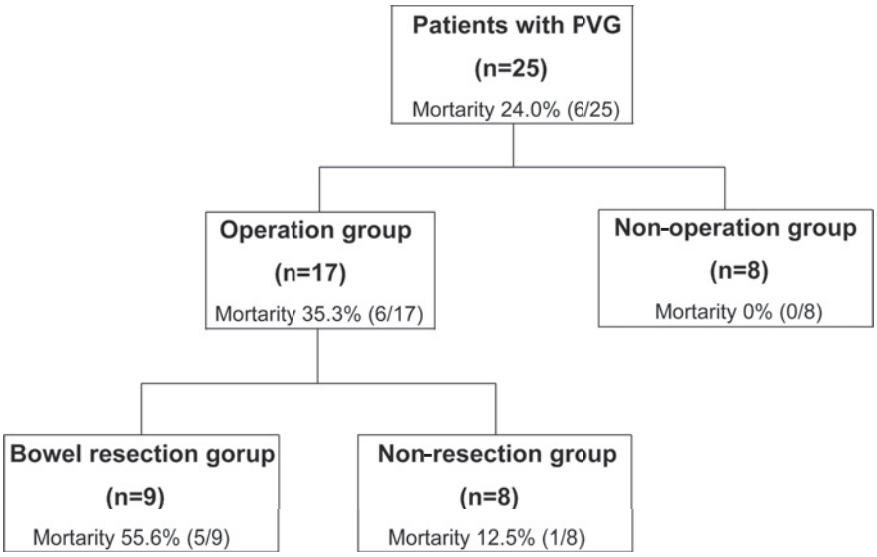

Fig. 2 Allocation of patients with portal venous gas, and the mortality rates of each group.
Patients were divided into 2 groups based on whether an emergency operation was performed (Operation group, n=17; Non-operation group, n=8). The Operation group was further subdivided into 2 groups based on whether bowel resection was performed (Bowel resection group, n=9; Non-resection group, n=8)

erative finding was observed during exploration.

Patients were classified into 2 groups in relation to whether emergency surgery was performed (Operation group, n=17; Non-operation group, n=8). There were no patients who was not offered operative intervention as a result of futility or refused to give the consent for surgery. The Operation group was further subdivided into 2 groups based on whether or not bowel resection was performed (Bowel resection group, n=9; Non-resection group, n=8) (**Fig. 2**). In the Bowel resection group, a diagnosis of bowel wall necrosis was confirmed by reviewing postoperative histological findings.

Statistical analyses were performed with the SPSS software program (SPSS Inc., Chicago, IL, USA). Continuous variables are expressed as medians and ranges; categorical data are expressed as proportions and percentages. Intergroup differences were evaluated with the Student's *t*-test for continuous variables and the chi-square test for categorical variables. Multivariate analysis was not performed because of the insufficient sample size. A P value of <0.05 was considered to indicate statistical significance.

Results

Study Group

On the basis of information obtained from patients' medical records, the final study sample comprised 25 consecutive patients with PVG diagnosed during the study period (males, n=17; females, n= 8; median age, 75 years; age range, 20-99 years). Seventeen of 25 (68%) patients underwent emergency surgery (Operation group), and 8 of 25 (32%) patients were conservatively managed (Non-operation group) (**Fig. 2**). In the Non-operation group, no patient crossed over to surgery. The demographics and comorbidities of PVG patients in the Operation and Non-operation groups are shown in **Table 1**. There were no statistically significant differences in age, sex, or comorbidities between these groups.

Underlying Disease

The underlying diseases associated with PVG were mesenteric ischemia, n=7 (28.0% [non-occlusive mesenteric ischemia (NOMI), n=5; mesenteric vascular occlusion, n=2]); enterocolitis, n=6 (24.0%); bowel obstruction/dilatation, n=3 (12.0%); trauma, n=2 (8.0%); unidentified disease, n=3 (12.0%); gastric ulcer, n=1; diverticulitis, n=1; appendicitis, n=1; and intoxication, n=1 (**Table 2**).

Management

In the Operation group (n=17), free air was not detected on CT in any patient. All patients underwent emergency laparotomy for treatment of suspected bowel necrosis. In the Bowel resection group (n=9), bowel wall necrosis was confirmed histologically in all patients (NOMI, n=4; superior mesenteric artery [SMA] thrombosis, n=1; enterocolitis, n=1; strangulation ileus, n=1; para-

Table 1 The demographics and comorbidities of PVG patients in the Operation and Non-operation groups

	Operation group (n=17)	Non-operation (n=8)	*p*
Age, median (range), years	75 (51-89)	74.5 (20-99)	.810
Sex, male	13/17 (76.5%)	4/8 (50%)	.359
Comorbidity			
Pulmonary disease	1	0	1.000
Hypertension	6	1	.362
Cardiac vascular disease	7	1	.205
Chronic renal failure	0	1	.320
Liver disease	2	0	1.000
Stroke	5	2	1.000
Diabetes	6	2	1.000
Malignancy	3	2	1.000
Gastric ulcer	1	1	1.000
Abdominal surgery	4	1	1.000
Psychiatry	2	3	.283
Femur fracture	4	1	1.000

PVG: portal venous gas

Table 2 Underlying disease for PVG

	Operation group (n=17)		Non-operation (n=8)	Total (n=25)
	Bowel resection (n=9)	Non-resection (n=8)		
Mesenteric ischemia	5	1	1	7 (28.0%)
NOMI	4	1	0	5 (20.0%)
SMA thrombosis	1	0	0	1 (4.0%)
SMA syndrome	0	0	1	1 (4.0%)
Bowel obstruction/dilatation	2	1	0	3 (12.0%)
Enterocolitis	1	3	2	6 (24.0%)
Appendicitis	1	0	0	1 (4.0%)
Gastric ulcer	0	1	0	1 (4.0%)
Diverticulitis	0	0	1	1 (4.0%)
Trauma	0	1	1	2 (8.0%)
Intoxication	0	0	1	1 (4.0%)
Unidentified	0	1	2	3 (12.0%)

PVG: portal venous gas, NOMI: non-occlusive mesenteric ischemia, SMA: superior mesenteric artery

lytic ileus, n=1; gangrenous appendicitis, n=1) (**Table 2**). Resection of the necrotic bowel was performed in the small bowel (n=6), ileocecum (n=1), appendix (n=1) and ascending colon (n=2). One patient required resection of the small bowel and ascending colon. In the surgical procedure, end to end anastomosis of the small intestine was performed in 3 cases, an ileostomy was made in 2 cases, and a colostomy was made in 2 cases. In 2 cases of small bowel necrosis and 1 case of ileocecum necrosis, damage control laparotomy was required, and the patients died before anastomosis was achieved, within 3 days postoperatively.

In the Non-resection group (NOMI, n=1; enterocolitis, n=3; inguinal hernia with obstruction, n=1; gastric ulcer, n=1; trauma, n=1; unidentified disease, n=1), despite suspected bowel necrosis, the patients did not develop transmural necrosis, and bowel resection could be avoided after a second look, thus resulting in non-therapeutic laparotomy for 7 patients. In one case of incarceration of inguinal hernia, the ischemic small intestine could be salvaged by manipulative reduction (**Table 2**).

In the Non-operation group, SMA syndrome was decompressed by nasogastric tube drainage only. Patients with enterocolitis, diverticulitis, and trauma, and those with unidentified disease, were given antibiotics. A patient who had accidentally ingested concentrated hydrogen peroxide was observed conservatively (**Table 2**).

Table 3 Early symptoms, physical signs, physical examination and CT findings of the Operation and Non-operation groups

	Operation group (n=17)	Non-operation group (n=8)	*p*
Early symptoms			
Emesis	8/17 (47.1%)	3/8 (37.5%)	1.000
Diarrhea	6/17 (54.5%)	1/8 (12.5%)	.362
Hematemesis/Melaena	6/17 (35.3%)	2/8 (25.0%)	1.000
Physical signs			
Systolic blood pressure (mmHg)	110 (51-146)	123.5 (92-145)	.088
Shock (SBP ≦90 mmHg)	7/17 (41.2%)	0/8 (0%)	.057
Respiratory rate (/min)	25 (12-38)	22 (18-42)	.733
Heart rate (beat/min)	120 (52-155)	94 (54-118)	.050
Body temperature (°C)	37.2 (35.2-39.0)	36.9 (35.0-38.1)	.571
Glasgow Coma Scale	12 (6-15)	14.5 (9-15)	***.040***
APACHE II	19 (9-25)	9.5 (6-19)	***.002***
Physical examination			
Abdominal pain	12/17 (70.6%)	5/8 (62.5%)	1.000
Peritoneal sign	3/17 (17.6%)	2/8 (25.0%)	1.000
Distention	13/17 (76.5%)	2/8 (25.0%)	***.028***
CT findings			
Free air	0/17 (0%)	0/8 (0%)	-
Ascites	4/17 (44.4%)	5/8 (62.5%)	1.000
Dilatation of bowel	11/17 (64.7%)	1/8 (12.5%)	***.030***
Pneumatosis intestinalis	15/17 (88.2%)	3/8 (37.5%)	***.017***
Attenuation of contrast effect of bowel wall	8/14 (47.1%)	0/8 (0%)	***.018***
Bowel wall thickening	5/17 (29.4%)	2/8 (25.0%)	1.000
Intrahepatic PVG	17/17 (100%)	8/8 (100%)	-
Extrahepatic PVG	7/17 (41.2%)	2/8 (25.0%)	.661
PVG in bilateral lobes of liver	15/17 (88.2%)	6/8 (75.0%)	.570
Superior mesenteric venous gas	11/17 (64.7%)	2/8 (25.0%)	.097
Portal vein thrombosis	2/14 (11.8%)	0/8 (0%)	.515

PVG: Portal venous gas
SBP: Systolic blood pressure

Comparison of the Operation and Non-operation Groups

Table 3 shows the results of the comparison of early symptoms, physical signs, physical examination and CT findings in the Operation and Non-operation groups. Analysis of physical signs showed significant differences in the Glasgow Coma Scale (GCS) (p=0.04) and APACHE II score (p=0.002). Physical examination findings showed a significant difference in the rate of abdominal distention (p=0.028). Comparison of laboratory values revealed significant differences in C-reactive protein (CRP) (p=0.04) and lactate (p=0.031) (**Table 4**). Regarding CT findings, bowel dilatation (p=0.03), pneumatosis intestinalis (p=0.017), and attenuation of the contrast effect of the bowel wall (p=0.018) were detected significantly more frequently in the Operation group (**Table 3**).

Comparison of the Bowel Resection and Non-resection Groups

We also investigated differences between the Bowel resection and Non-resection groups. With the exception of the GCS, there was no significant difference between these groups (**Table 5, 6**).

Outcome

The overall mortality rate for patients with PVG was 24.0% (6/25) (**Fig. 2**). The mortality rates for the Operation and Non-operation groups were 35.3% (6/17) and 0% (0/8), respectively. The mortality rates for the Bowel resection and Non-resection groups were 55.6% (5/9) and 12.5% (1/8). The mortality rate was significantly higher for the Bowel resection group than for the Non-resection and Non-operation groups (55.6% [5/9] vs. 6.25% [1/16], p=0.012).

Discussion

It has been reported that PVG is not a specific disease entity, rather it represents a diagnostic clue in patients with acute abdominal pathologic conditions[1–3]. If treatment of the underlying disease is successful, PVG will

Table 4 Laboratory findings and outcomes of the Operation and Non-operation groups

	n	Operation group (n=17)	Non-operation group (n=8)	*p*
AST (U/L)	25	46 (10-338)	35.5 (11-1,116)	.238
ALT (U/L)	25	42 (6-258)	27.5 (8-179)	.731
T-Bil (mg/dL)	25	1.1 (0.3-4.9)	0.5 (0.2-1.23)	.121
LDH (U/L)	25	309 (85-762)	274 (164-1,665)	.336
CK (U/L)	25	37 (18-7,105)	139.5 (15-123,266)	.163
BUN (mg/dL)	25	38 (13.4-119.2)	27.5 (11.3-56.0)	.100
Cre (mg/dL)	25	1.95 (0.51-5.08)	0.88 (0.59-6.13)	.301
CRP (mg/dL)	25	10.27 (0.38-38.46)	3.35 (0.04-14.08)	***.040***
procalcitonin (ng/mL)	23	4.86 (0.17-100)	0.25 (0.05-19.8)	.156
WBC count (/mm^3)	24	7,900 (2,200-32,400)	10,250 (5,900-20,400)	.881
Platelets (10^4/mm^3)	24	16.3 (0.8-25.9)	19.7 (15-23.2)	.195
INR	25	1.18 (0.92-2.2)	1.18 (0.94-2.58)	.737
D-dimer (μg/mL)	25	14.3 (2.5-92.7)	7.7 (1.3-53.9)	.349
Fibrinogen (mg/dL)	25	448 (149-687)	349 (250-520)	.282
pH	25	7.46 (7.26-7.54)	7.45 (7.34-7.53)	.572
Base deficit	25	–3.7 (–14 to 8.8)	–0.15 (–6.6 to 8.8)	.114
lactate (mmol/L)	25	44 (8.7-93)	22 (15-42)	***.031***
Length of hospital stay (days)	25	18 (2-69)	9.5 (2-28)	.072
Mortality (%)	25	6/17 (35.3%)	0/8 (0%)	.129

WBC: White blood cell, AST: aspartate aminotransferase, ALT: alanine aminotransferase, T-Bil: Total bilirubin, LDH: lactate dehydrogenase, CK: creatine kinase, BUN: blood urea nitrogen, Cre: creatinine, CRP: C-reactive protein, INR: International Normalized Ratio

disappear naturally and prognosis will be improved[11,12]. The most common underlying disease in patients with PVG was shown to be mesenteric ischemia and subsequent bowel necrosis[1–7,9]. In the present study, 28% (7/25) of patients were confirmed to have mesenteric ischemia, which was the main reason for bowel resection (5/9) (**Table 2**). The overall mortality of patients with PVG was 24.0% in the present study; however, the mortality rate was significantly higher in the Bowel resection group than in the Non-resection and Non-operation groups (55.6% vs. 6.25%, p=0.012). Kinoshita et al. previously reported[1] that, the overall mortality in a review of 182 cases with PVG was 39%; however, the mortality was higher in patients with bowel necrosis (75%). On the basis of those results, they recommended exploratory laparotomy[1].

There have been few reports about the outcomes of conservative management in patients with PVG. Four previous studies of more than 15 cases reported that the mortality rate of conservative management in patients with PVG was 12.5% to 64.7%[11,13,15,16]. Although the reports did not describe the decision-making process in detail and did not include the number of cases that crossed over to surgery, the mortality rate of conservative management seemed to be relatively high. It might have involved patients not being offered an operation because it was considered futile or patients who did not receive an operation because they declined surgery. The present study did not include patients for whom surgery was considered futile and those who declined surgery. Thus, we assessed the validity of the decision for clinical management of PVG made by the attending surgeon by evaluating a combination of factors, including the findings of clinical symptoms, physical examination, laboratory data, underlying disease, and CT, as previously reported[1,2,5,6,9,14,17–19]. These factors were compared between the Operation and Non-operation groups and statistically significant differences were found in GCS[14,18], APACHE II[14,18,19], abdominal distention, CRP levels, lactate levels[6], CT findings of dilatation of bowel[9], pneumatosis intestinalis[6,9,20], and attenuation of the contrast effect of the bowel wall[8] (**Table 3, 4**). As a result, 32% (8/25) of the patients with PVG were successfully managed with a conservative approach (mortality rate 0%). However, on comparing the Bowel resection and Non-bowel resection groups, there was no significant difference in any clinical factor except GCS (**Table 5, 6**). These observations suggest that these variables might be useful for making the decision to perform conservative management; however, it might be difficult to differentiate between transmural and partial bowel wall necrosis.

In the present study, bowel resection was not needed

Table 5 Early symptoms, physical signs, physical examination and CT findings of the Bowel resection and Non-resection groups

	Bowel resection group (n=9)	Non-resection group (n=8)	*p*
Early symptoms			
Emesis	3 (33.3%)	5 (62.5%)	.347
Diarrhea	3 (33.3%)	3 (37.5%)	1.00
Hematemesis/Melaena	3 (33.3%)	3 (37.5%)	1.00
Physical signs			
Systolic blood pressure (mmHg)	96 (51-124)	111.5 (77-146)	.230
Respiratory rate (/min)	25 (18-37)	26 (12-38)	.785
Heart rate (beat/min)	117 (84-155)	126 (52-149)	.922
Body temperature (°C)	37.3 (35.9-39.0)	37.0 (35.2-37.6)	.384
Glasgow Coma Scale	13 (10-15)	10 (6-14)	***.018***
APACHE II	16 (9-25)	19 (11-22)	.941
Physical examination			
Abdominal pain	7 (77.8%)	5 (62.5%)	.620
Peritoneal sign	3 (33.3%)	0 (0%)	.206
Distention	6 (66.7%)	7 (87.5%)	.576
CT findings			
Free air	0 (0%)	0 (0%)	-
Ascites	4 (44.4%)	5 (62.5%)	.637
Dilatation of bowel	4 (44.4%)	7 (87.5%)	.131
Pneumatosis intestinalis	7 (77.8%)	8 (100%)	.471
Attenuation of contrast effect of bowel wall	5 (55.6%)	3 (37.5%)	1.00
Bowel wall thickening	3 (33.3%)	2 (25.0%)	1.00
Intrahepatic PVG	9 (100%)	8 (100%)	-
Extrahepatic PVG	4 (44.4%)	3 (37.5%)	1.00
PVG in bilateral lobes of liver	8 (88.9%)	7 (87.5%)	1.00
Superior mesenteric venous gas	6 (66.7%)	5 (62.5%)	1.00
Portal vein thrombosis	1 (11.1%)	1 (12.5%)	1.00

PVG: Portal venous gas

in 47.1% (8/17) of the patients in the Operation group (**Table 2**). Najafian et al. reported that 4 of 5 patients who underwent an operation resulted in non-therapeutic laparotomy[4]. Exploratory laparotomy is the most reliable method for determining the cause of PVG[1,2,6]; however, unnecessary laparotomy should be avoided. It is suggested that a new approach should be developed to improve this situation. Therefore, if a patient's vital signs are not unstable, diagnostic laparoscopy may be favorable and less invasive[21,22]. In our study, diagnostic laparoscopy was performed in only one patient in the Non-resection group.

There have been very few reports about laparoscopic approaches in patients with PVG[6,7,21–23]. Recently, Koizumi et al[7]. reported that, according to an analysis of 1,590 patients with PVG whose data were obtained from a Japanese National Inpatient Database, the total number of patients with PVG undergoing surgery for ischemic bowel was 271, and 4.8% (13/271) of those patients received bowel resection via a laparoscopic approach. However, the number of cases that received laparoscopic exploration was not mentioned. While a laparoscopic approach for exploration may be favorable and less invasive than exploratory laparotomy for patients without unstable vital sings, the evidence-based guideline of the European Association for Endoscopic Surgery on laparoscopy for abdominal emergencies states that laparoscopy does not offer significant advantages in cases of acute mesenteric ischemia[24]. The risks and concerns should be considered, including laparoscopy-related complications (e.g., a further reduction in portal blood flow and intestinal perfusion due to the increase in intra-abdominal pressure during pneumoperitoneum[25]), the timing of second-look laparoscopy, and cost-effectiveness. Further studies will be needed to clarify the risks and benefits of this approach.

Conclusions

PVG is not always an ominous sign. Despite the high

Table 6 Laboratory findings and outcomes of the Bowel resection and Non-resection groups

	n	Bowel resection group (n=9)	Non-resection group (n=8)	*p*
AST (U/L)	17	100 (21-338)	36 (10-235)	.206
ALT (U/L)	17	53 (12-258)	28 (6-145)	.412
T-Bil (mg/dL)	17	1.2 (0.32-4.9)	1.1 (0.3-1.9)	.173
LDH (U/L)	17	400 (204-613)	245 (85-762)	.172
CK (U/L)	17	37 (18-7,105)	40 (27-2,306)	.271
BUN (mg/dL)	17	38 (13.4-119)	48.1 (26.2-72.4)	.761
Cre (mg/dL)	17	2.76 (0.51-4.9)	1.47 (0.64-5.08)	.334
CRP (mg/dL)	17	10.2 (0.38-38.5)	13.5 (6.09-25.9)	.481
procalcitonin (ng/mL)	15	4.86 (0.28-100)	6.66 (0.17-16.7)	.198
WBC count (/mm^3)	16	11,100 (6,000-32,400)	7,900 (2,200-21,300)	.320
Platelets (10^4/mm^3)	16	15.7 (0.8-18.5)	18.2 (11.2-25.9)	.072
INR	17	1.20 (0.92-1.83)	1.15 (1.05-2.2)	.936
D-dimer (μg/mL)	17	14.1 (2.5-36)	25.3 (2.8-92.7)	.137
Fibrinogen (mg/dL)	17	348 (149-687)	466 (71-661)	.654
pH	17	7.4 (7.26-7.50)	7.47 (7.32-7.54)	.140
Base deficit	17	–7.8 (–12 to 8.8)	–1.60 (–14 to 3.9)	.558
lactate (mmol/L)	17	63 (8.7-93)	31 (14-66)	.077
Length of hospital stay (days)	17	16 (2-69)	22.5 (7-62)	.511
Mortality (%)	17	5/9 (55.6%)	1/8 (12.5%)	.131

WBC: White blood cell, AST: aspartate aminotransferase, ALT: alanine aminotransferase, T-Bil: Total bilirubin, LDH: lactate dehydrogenase, CK: creatine kinase, BUN: blood urea nitrogen, Cre: creatinine, CRP: C-reactive protein, INR: International Normalized Ratio

mortality rate of PVG associated with bowel necrosis, there are some cases of PVG in which conservative management is successful. It is important to carefully consider the possibility of conservative management of patients with PVG, based on a combination of factors, including the clinical symptoms, physical examination findings, laboratory data, underlying disease, and CT findings. This approach appears to be useful for making decisions in relation to conservative management of patients with PVG.

However, in the present study, 47.1% of patients who underwent emergency laparotomy for suspected bowel necrosis did not develop transmural bowel necrosis, and bowel resection could be avoided after a second look procedure, resulting in non-therapeutic laparotomy. It was thus suggested that this approach alone would not be sufficient to accurately predict transmural bowel necrosis requiring resection in patients with PVG, and that a new approach should be developed in order to improve this situation.

Diagnostic laparoscopy may be a favorable and minimally invasive approach; however, there have been very few reports about laparoscopic approaches in patients with PVG. Further studies will be needed in order to clarify the risks and benefits of this approach.

Conflict of Interest: The authors declare no conflict of interest.

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