Survival Rate and Shunt Infection Incidence Following Gastrostomy in Adult Patients with an Existing Ventriculoperitoneal Shunt

Fumihiro MAWATARI,[1] Tadashi SHIMIZU,[2] Hisamitsu MIYAAKI,[3]
Tetsuhiko ARIMA,[1] Sachiko FUKUDA,[1] Yoshiko KITA,[1] Aiko FUKAHORI,[1]
Hiroyuki ITO,[4] Kei MATSUKI,[4] Yoshito IKEMATSU,[5] Nobutoshi RYU,[2]
and Kazuhiko NAKAO[3]

[1]Department of Gastroenterology, Juzenkai Hospital, Nagasaki, Nagasaki, Japan
[2]Department of Neurosurgery, Juzenkai Hospital, Nagasaki, Nagasaki, Japan
[3]Department of Gastroenterology and Hepatology, Graduate School of Biomedical Sciences,
Nagasaki University, Nagasaki, Nagasaki, Japan
[4]Department of Pulmonology, Juzenkai Hospital, Nagasaki, Nagasaki, Japan
[5]Department of Surgery, Juzenkai Hospital, Nagasaki, Nagasaki, Japan

Abstract

Ventriculoperitoneal shunts (VPS) and gastrostomies are frequently provided in daily practice. This study investigated the incidence of VPS infection and the survival rate among adult patients who underwent gastrostomy at least 1 month after VPS placement. This single-center retrospective cohort study was conducted among patients with a VPS, who underwent a gastrostomy. This procedure was performed on a standby basis after a period of at least 1 month had elapsed since VPS placement. Subsequent VPS infection and survival rates were assessed over a period of at least 6 months. We reviewed 31 patients who had a VPS at the time of gastrostomy. Gastrostomy was performed endoscopically in 29 cases and via open surgery in 2 cases. The average interval between VPS insertion and gastrostomy was 1135.5 ± 1717.1 days. A single case of VPS infection (3.2%) was diagnosed during the study. This infection rate was not significantly different than that among 230 patients who underwent their first VPS placement (without gastrostomy) at our institution during the same time period (P = .57); there was also no significant difference in the survival rate, compared to 38 age-matched patients (with cerebrovascular disease, but without a VPS) who underwent gastrostomy (P = .73). Gastrostomy performed after an interval of at least 1 month after VPS placement was extremely safe in adult patients, and their prognosis was excellent. Additional studies are required to develop appropriate nutritional interventions for patients with a VPS.

Keywords: gastrostomy, infections, Japan, survival rate, ventriculoperitoneal shunt

Introduction

A ventriculoperitoneal shunt (VPS) is commonly used to treat hydrocephalus caused by traumatic intracranial hemorrhage, strokes (e.g., subarachnoid

hemorrhage), as well as other medical conditions. Many of these patients have severe brain impairments and require artificial nutrition. Gastrostomy is the preferred method for providing artificial nutrition when the patient is considered to need more than 1 month of nutrition.[1] However, the pros and cons of performing a gastrostomy in patients with a VPS are debatable.[2–4]

To the best of our knowledge, no guidelines have recommended gastrostomy for patients with a VPS. A range of factors must be considered before
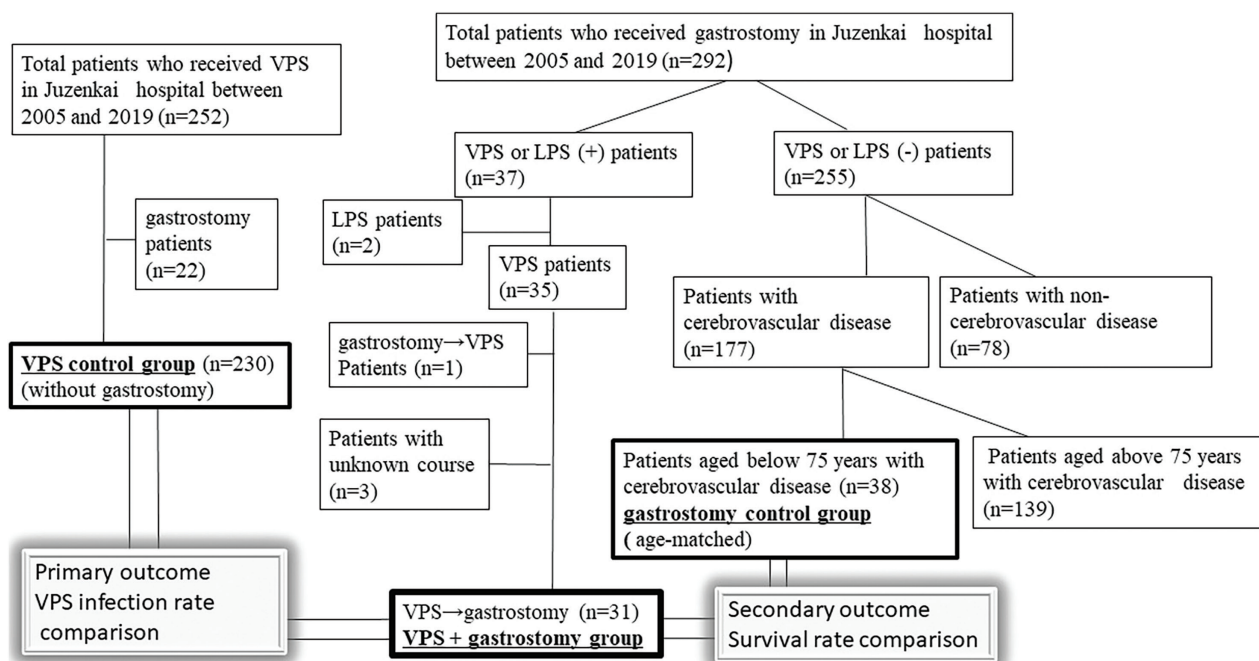
Fig. 1 Strengthening the Reporting of Observational Studies in Epidemiology diagram depicting the patient screening and selection process. LPS: lumbo-peritoneal shunt, VPS: ventriculoperitoneal shunt.

concluding whether concurrent gastrostomy and VPS placement are safe. This study aimed to evaluate the safety and survival of 34 patients with a VPS who subsequently underwent gastrostomy tube placement more than 1 month later.

Materials and Methods

Patients and study design

This single-center study utilized a retrospective cohort design and was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (Fig. 1). Patients who underwent gastrostomy at our hospital between 2005 and 2019, and had a VPS at the time of gastrostomy, were included in the study (VPS + gastrostomy group). Their survival and the presence or absence of shunt infection were assessed. The VPS control group comprised patients (without a gastrostomy) who received a VPS between 2005 and 2019. The infection rate and the number of days from initial shunt construction to infection onset were determined from the hospital's medical records.

As our main objective was to determine whether gastrostomy increases susceptibility to VPS infection, the primary outcome was the difference in shunt infection rate between the VPS control group and VPS + gastrostomy group. In addition, we wanted to determine whether gastrostomy in patients with

a VPS would also affect their survival. Therefore, the secondary outcome was the difference in the survival rate between the VPS + gastrostomy group and gastrostomy control group. The latter group compromised age-matched patients with cerebrovascular disease, but without a VPS.

We made written enquiries at relevant facilities (e.g., hospitals and clinics unaffiliated with our hospital, but located in the same province) where pertinent information (i.e., survival, date and cause of death, presence or absence of shunt infection) for patients in the gastrostomy control group and VPS + gastrostomy group was missing in our hospital's medical records. Our investigation was conducted from May 2020 to December 2020.

Gastrostomy procedure

Gastrostomy was initially carried out using the pull method[5] (Bard PEG Kit Safety System; Medicon Inc., Osaka, Japan). Starting in mid-2011, dual gastropexy was performed using the Funada-style gastric fixation device[6] (Create Medic Co. Ltd., Yokohama, Japan), and gastrostomy was performed using a modified introducer method[7] (EndoVive Seldinger PEG Kit; Boston Scientific Japan, Tokyo, Japan). Gastrostomy was performed surgically when an endoscopic approach was not feasible. Initially, antibiotics were administered at the discretion of the attending physician; however, the subsequent

introduction of the clinical pathway for gastrostomy in 2009 dictated that 1.5 g of ampicillin–sulbactam be administered to patients twice daily for 2 days (on the day of gastrostomy, and on the following day). Preoperative antibiotics were only administered to 19 of 31 patients who underwent gastrostomy; the majority of the 10 patients who did not receive preoperative antibiotics were treated prior to 2009, and data pertaining to the use of preoperative antibiotics were missing in two patients. Since 2015, carbon dioxide has been used in place of endoscopic air inflation when performing percutaneous endoscopic gastrostomy (PEG).

At our hospital, gastrostomy is not performed in the acute stage.[8] Therefore, gastrostomy is not performed until at least 1 month after the VPS. Currently, we also confirm that there are no signs of infection in the VPS.

VPS infection

The diagnosis of VPS infection was made by the attending neurosurgeon and confirmed via microbiological cerebrospinal fluid analysis, elevated white blood cells in cerebrospinal fluid, or a positive culture obtained from the tip of the shunt catheter. The medical records of patients with a VPS and gastrostomy were reviewed again for cases of suspected shunt infection, based on imaging and clinical history. The number of days to VPS infection was based on the date on which the first signs of infection were observed, and not the date on which infection was confirmed.

Data collection

The following factors were assessed for their potential effects on survival and VPS infection rates after VPS and gastrostomy tube placement: (1) sex; (2) age; (3) gastrostomy method; (4) disease that required VPS; (5) interval between VPS and gastrostomy tube placement (days); (6) position of abdominal VPS catheter; (7) closest distance between shunt catheter and gastrostomy; and (8) blood biomarkers (blood urea nitrogen, alanine aminotransferase, albumin, C-reactive protein, and hemoglobin). (9) The modified Rankin Scale (mRS),[9] a widely used measure of physical disability in stroke care, was examined in three groups of patients. Patients in the VPS plus gastrostomy and gastrostomy control groups were evaluated for mRS at discharge after gastrostomy, and patients in the VPS control group were evaluated for mRS at discharge after VPS.

All data were anonymized before analysis to avoid patient identification. The study protocol was reviewed and approved by the appropriate institutional review board (J2020-04 and 07). Study procedures were conducted in accordance with Ethical Guidelines for Medical and Health Research Involving Human Subjects (Provisional Translation as of March 2015) and its later amendments. Instead of obtaining informed consent from each patient, notices about the design of the study and other information were posted in public spaces in the hospital, as per the guidelines from the Ministry of Health, Labour, and Welfare of Japan.[10]

Statistical analysis

All statistical analyses were performed using BellCurve for Excel (Social Survey Research Information Co., Ltd., Tokyo, Japan). The chi-square test was used to compare the shunt infection rate between the VPS + gastrostomy group and VPS control group. The survival rates of the VPS + gastrostomy group and gastrostomy control group were determined using the Kaplan–Meier method and compared using the log-rank test. P <.05 was considered statistically significant.

Results

A total of 299 gastrostomy cases were performed between 2005 and 2019 at our hospital in Japan. The medical records of 7 out of 299 cases were missing; among the remaining 292 patients, 37 had a VPS or lumbo-peritoneal shunt (Fig. 1). Two patients with a lumbo-peritoneal shunt were excluded because they were not part of the present study. At our hospital, gastrostomy was not performed during the acute phase of cerebrovascular disease,[8] and it was rarely performed prior to VPS placement. As only one patient received a VPS after gastrostomy (gastrostomy→ VPS), this patient was excluded. Therefore, we reviewed a total of 34 patients. As the medical records for three patients could not be obtained at the transfer site, we included 31 patients (VPS + gastrostomy group) in our analysis. The baseline characteristics of these cases are shown in Table 1. The average age at the time of the VPS and gastrostomy procedures was 65.3 (±14.0) years; 16 patients (51.6%) were men. Gastrostomies were performed via the pull method, modified introducer method, and surgery in 11, 18, and 2 cases, respectively. The average interval between VPS insertion and gastrostomy was 1135.5 ± 1717.1 days, with a median of 205 (range, 55–6484) days. The VPS catheter was positioned in the right abdomen in 14 patients and in the left abdomen in 13 patients. Four patients had two VPSs inserted; one patient had two VPSs inserted in the right abdomen, while three patients had a VPS inserted on each side. The shortest average distance between the shunt catheter

Table 1 Baseline characteristics of 31 patients with a ventriculoperitoneal shunt and gastrostomy

	VPS + Gastrostomy
N	31
Male/female	16/15
Age at gastrostomy + VPS (mean ± SD) (years)	65.3 ± 14.0
Gastrostomy construction method	
Pull method/modified introducer method/surgery	11/18/2
VPS–gastrostomy interval (mean ± SD [median]) (days)	1135.5 ± 1717.1 (205)
Position of abdominal VPS catheter	
1 shunt tube	Right (14), left (13)
2 shunt tubes	Right (1), right and left (3)
Closest distance between shunt catheter and gastrostomy (mm)	59.7 ± 30.8
Average observation period (days)	1326.6 ± 1350.3

VPS: ventriculoperitoneal shunt, SD: standard deviation.

and PEG in the abdominal wall was 59.7 ± 30.8 mm; there were three cases with distances of less than 30 mm. Gastrostomy tubes were removed in two patients after hospital discharge (days 158 and 661 after gastrostomy), as they were able to resume oral intake.

From 2005 to 2019, 252 patients with hydrocephalus received their first VPS at our hospital. In all, 22 of these patients were documented as having undergone a gastrostomy before or after VPS placement; therefore, the VPS control group consisted of 230 patients.

VPS infection

VPS infection rates were compared between the VPS + gastrostomy group (n = 31) and VPS control group (n = 230) (Table 2). At the time of VPS placement, there were 32 cases (13.9%) of idiopathic normal pressure hydrocephalus in the VPS control group; no cases were observed in the VPS + gastrostomy group. There was also a greater tendency for traumatic intracranial hemorrhage in the VP + gastrostomy group than in the VPS control group. While all patients in the VPS + gastrostomy group had mRS 4–5 points, about 40% of patients in the VPS control group had mRS 0–3 points, indicating a trend toward less disability in the control group.

One patient (3.2%) in the VPS + gastrostomy group was diagnosed with shunt infection. No patients in the VPS + gastrostomy group had initially

Table 2 The profile and infection rates of the ventriculoperitoneal shunt control group and VPS + gastrostomy group

	VPS control (n = 230)	VPS + gastrostomy (n = 31)
Male/female	94/136	16/15
Age (mean ± SD) (years)	69.0 ± 13.0	65.3 ± 14.0
Diagnosis		
Subarachnoid hemorrhage	110 (47.8%)	17 (54.8%)
Other cerebrovascular disorders	57 (24.8%)	8 (25.8%)
Traumatic intracranial hemorrhage	25 (10.9%)	5 (16.1%)
Idiopathic normal pressure hydrocephalus	32 (13.9%)	0 (0%)
Brain tumor	4 (1.7%)	0 (0%)
Others	2 (0.9%)	1 (3.2%)
Modified Rankin Scale		
0–2	19 (8.3%)	0 (0%)
3	73 (31.7%)	0 (0%)
4	66 (28.7%)	5 (16.1%)
5	65 (28.3%)	26 (83.9%)
6	7 (3.0%)	0 (0%)
VPS infections: Over the entire study period	13/230 (5.7%)*	1/31 (3.2%)*
At least 1 month after the procedure	3/220 (1.4%)**	1/31 (3.2%)**

There was no significant difference between the two groups with respect to infections.
*P = .57, **P = .44
VPS: ventriculoperitoneal shunt, SD: standard deviation.

been diagnosed with VPS infection or undergone shunt replacement. We reviewed the medical records of these 31 cases again. One patient (3.2%) in the VPS + gastrostomy group died after being diagnosed with pneumonia; this was considered a case of shunt infection, based on a persistent hyperinflammatory reaction noted in the medical records, and a worsening ventricular enlargement on head computed tomography. In the VPS control group (n = 230), VPS infection was documented in 13 patients (5.7%). There was no significant difference in the infection rate between the VPS + gastrostomy group and VPS control group (P = .57).

Table 3 Demographic variables and blood biomarker levels at baseline, prior to gastrostomy

	Gastrostomy group (n = 38)	VPS + gastrostomy group (n = 31)
Male/female	27/11	16/15
Age (mean ± SD) (years)	65.2 ± 8.8	65.3 ± 14.0
Modified Rankin Scale		
0–3	0 (0%)	0 (0%)
4	4 (10.5%)	5 (16.1%)
5	34 (89.5%)	26 (83.9%)
6	0 (0%)	0 (0%)
Gastrostomy construction methods		
Pull method	11 (28.9%)	11 (35.5%)
Modified introducer method	27 (71.1%)	18 (58.1%)
Surgery	0 (0%)	2 (6.5%)
ALT (UI/l)	24.9 ± 16.4	30.4 ± 31.4
Blood urea nitrogen (mg/dl)	14.0 ± 4.9	14.7 ± 5.9
C-reactive protein (mg/dl)	1.4 ± 1.9	1.1 ± 1.9
Hemoglobin (g/dl)	12.0 ± 1.9	11.8 ± 1.6
Albumin (g/dl)	3.4 ± 0.6	3.4 ± 0.5

ALT: alanine aminotransferase, VPS: ventriculoperitoneal shunt, SD: standard deviation.

Cause of death and survival rate

Patient demographics and blood biomarker levels in the gastrostomy control group and VPS + gastrostomy group are shown in Table 3. The ages in the two groups were matched. There were more men in the gastrostomy control group (27 of 38) than in the VPS + gastrostomy group.

The mRS was the same for both patients in the VPS + gastrostomy and gastrostomy control groups, all at scale 4–5.

In terms of the gastrostomy method, there were two surgical cases in the VPS + gastrostomy group and none in the gastrostomy control group. There was no difference in biomarkers between the two groups, prior to gastrostomy. In all, 18 cases of mortality were documented among the 31 patients in the VPS + gastrostomy group during the course of the study. Pneumonia was the most common cause of mortality, accounting for 11 deaths (61.1%), followed by heart failure (2 deaths

[11.1%]) and cerebrovascular disease (2 deaths [11.1%]). The 1-year survival rate in the VPS + gastrostomy group was 77.2%, and the median survival time was 910 days. Kaplan–Meier curves were generated to compare survival rates between the VPS + gastrostomy group and gastrostomy control group; no significant difference was found (P = .73) (Fig. 2).

Discussion

Key findings

This study is the largest to date among those evaluating gastrostomy and VPS outcomes in Asia. Furthermore, the mean observation period (1326.6 ± 1350.3 days) after concurrent gastrostomy and VPS placement was particularly long. The survival time and presence or absence of infection in the 31 patients who underwent VPS and gastrostomy were obtained by surveying medical records at our hospital, as well as other unaffiliated clinics, hospitals, and facilities. Thus, the results of this study provide an accurate estimation of long-term prognosis in this patient group. Gastrostomies were performed after a sufficient time interval from VPS placement. While VPS infection was suspected in 1 of 31 patients in the VPS + gastrostomy group, this infection rate was not significantly different from the overall infection rate associated with VPS procedures in our department (VPS control group, P = .57). Furthermore, a comparison of survival rates between the VPS + gastrostomy group and gastrostomy control group (consisting of age-matched patients with cerebrovascular disease, who had undergone gastrostomy) did not yield a significant difference (P = .73).

One case of shunt infection was that of a 78-year-old patient with subarachnoid hemorrhage who had one VP shunt inserted on the left side. Five months after insertion, PEG was performed using the modified introducer method; the shortest distance between the PEG tube and the VP shunt was 3.2 cm. Since there was only one case of shunt infection, it is difficult to discuss the cause of the outbreak.

Interpretation/generalizability

In a review of 10 studies,[11–16] Oterdoom *et al.* reported an infection rate of 9.4% among 192 patients who had undergone both VPS and gastrostomy; this was much higher than the rate documented in the present study.[17] The shunt infection rate after VPS placement (without subsequent gastrostomy) has been estimated to range from 5 to 8%,[18–20] with the majority of infections occurring within 1 month.[21,22] Indeed, shunt infections rarely occur more than
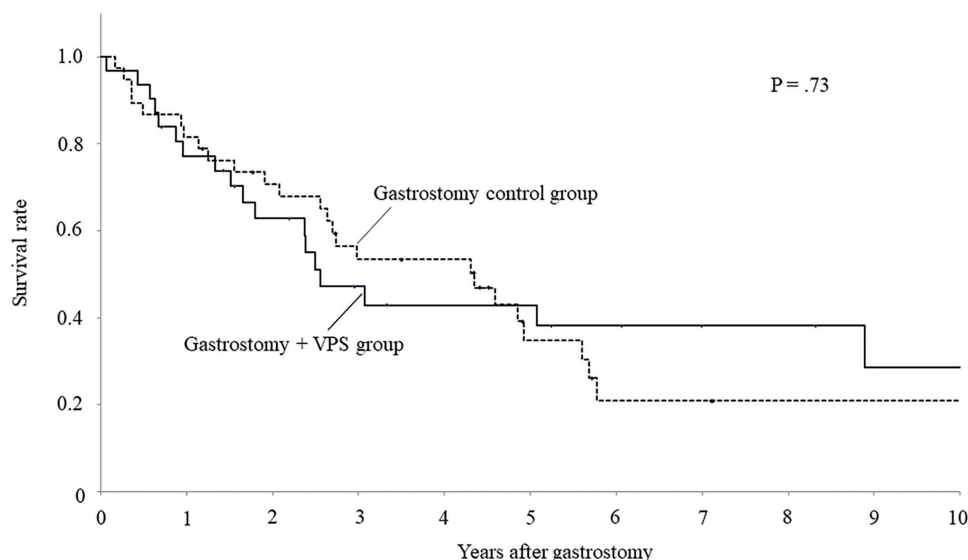
Fig. 2 Kaplan–Meier survival analysis comparing patient subgroups. Solid line, Gastrostomy + VPS group; dotted line, Gastrostomy control group. VPS: ventriculoperitoneal shunt.

1 month after shunt creation. In our investigation of VP shunt infection in patients who underwent their first VPS operation at our hospital (VPS control group), 10 out of 13 infections developed within 1 month (Supplementary Figure 1, available Online). The overall infection rate after VPS placement in our department was 5.6%, and the infection rate after more than 1 month was only 1.4%. VPS infection rates more than 1 month after shunt insertion were not significantly different between the VPS + gastrostomy and VPS control groups (Table 2). Previous studies comparing shunt infection rates among patients with a VPS, with and without gastrostomy, have been limited by the effects of the patient's condition and disease severity[13,15–17]; this has affected the ability of these studies to accurately assess the safety of concurrent gastrostomy and VPS placement. However, in the present study, the influence of the patient's condition and disease severity was reduced as much as possible by providing a sufficient interval between gastrostomy and VPS placement. In fact, 2 of the 31 patients in this study had a history of VPS replacement prior to gastrostomy. Placing a time interval between the two procedures is important: if the interval is too short, the addition of an invasive gastrostomy procedure while the VPS is still immature may further increase the risk of infection. To ensure patient safety, we believe that gastrostomy should only be performed after the VPS is sufficiently mature, as was the practice in our hospital. Nevertheless, the optimum time interval between these two procedures is not yet clear.

Secondary outcomes

Of the 292 gastrostomy procedures performed at our hospital, 35 (12.0%) required a VPS. Of the 252 patients who underwent VPS placement, 22 (8.7%) also required a gastrostomy. Thus, given the high number of patients needing both procedures, the safety of VPS and gastrostomy co-location was considered a pertinent issue.

In the VPS + gastrostomy group, 18 of the 31 patients (58.1%) underwent gastrostomy using the modified introducer technique, demonstrating for the first time the safety of this technique in patients with an existing VPS. The VPS catheter in the abdominal wall was positioned to the left side in 16 of 31 (45%) cases (including the ones that were attached to both sides). While the closest distance between the VPS catheter and the gastrostomy site was less than 3 cm in three cases, no infections were observed. The gastrostomy site should be kept as far away from the VPS as possible. Nevertheless, the results of this study suggest that the proximity of the VPS to the gastrostomy site in the abdominal wall is not a contraindication. However, it must be emphasized that it is necessary to maintain a sufficient distance between the gastrostomy site and the shunt catheter in the abdominal cavity.

Some limitations must be acknowledged in the present study. First, a retrospective observational study design was used, and the sample size was small. Second, gastrostomy was performed electively, and a sufficient interval was provided after VPS insertion. These factors may have accounted for the

very low rate of VPS infection. However, the only case of VPS infection documented at our hospital occurred soon after gastrostomy and was strongly suspected to have been related to this procedure. It should be noted that while VPS infections are rare, they may occur when gastrostomy and VPS placement are combined; therefore, such cases warrant vigilant neurosurgical follow-up in the initial months after gastrostomy.

Conclusion

The results of this study indicated that gastrostomy tube placement at least 1 month after VPS insertion is safe and has a good prognosis. Nevertheless, these results require further corroboration by future prospective multicenter research studies with larger sample sizes. Confirmation of the safety and advantages of combining VPS and gastrostomy would greatly inform the development of clinical practice guidelines and contribute to the provision of optimal patient care.

Acknowledgments

Conflicts of Interest Disclosure

All authors have no conflict of interest.

References

1) ASPEN Board of Directors and the Clinical Guidelines Task Force: Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. *JPEN J Parenter Enter Nutr* 26: 1SA–138SA, 2002

2) Itkin M, DeLegge MH, Fang JC, et al.: Multidisciplinary practical guidelines for gastrointestinal access for enteral nutrition and decompression from the Society of Interventional Radiology and American Gastroenterological Association (AGA) Institute, with endorsement by Canadian Interventional Radiological Association (CIRA) and Cardiovascular and Interventional Radiological Society of Europe (CIRSE). *Gastroenterology* 141: 742–765, 2011

3) Le Sidaner A, Bouteloup C, Cano N, et al.: Consensus en Endoscope Digestive (CED) Gastrostomie et Jéjunostomie Percutanées Endoscopiques, Paris, Société Française d'Endoscopie Digestive, 2007 (French)

4) Löser C, Aschl G, Hébuterne X, et al.: ESPEN guidelines on artificial enteral nutrition–percutaneous endoscopic gastrostomy (PEG). *Clin Nutr* 24: 848–861, 2005

5) Gauderer MW, Ponsky JL, Izant RJ: Gastrostomy without laparotomy: a percutaneous endoscopic technique. *J Pediatr Surg* 15: 872–875, 1980

6) Funada M: Percutaneous endoscopic gastrostomy: a new gastropexy method. *Gastroenterol Endosc* 33: 2681, 1991 (Japanese)

7) Inoue N, Nagaike K, Ishihara S, Nakamura M, Kuroshima T, Yoshiwara W: A new PEG technique direct method and fistula infection. *Home Health Care Endosc Ther Qual Life* 9: 79–83, 2005 (Japanese)

8) Mawatari F, Miyaaki H, Arima T, et al.: Procedure-related complications and survival after gastrostomy: results from a Japanese cohort. *Ann Nutr Metab* 76: 413–421, 2020

9) van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J: Interobserver agreement for the assessment of handicap in stroke patients. *Stroke* 19: 604–607, 1988

10) Ministry of Health, Labour and Welfare: Ethical guidelines for medical and health research involving human subjects. https://www.mhlw.go.jp/file/06-Seisaku-jouhou-12600000-Seisakutoukatsukan/0000168764.pdf (Accessed on 2021 Mar 21) (Japanese)

11) Graham SM, Flowers JL, Scott TR, Lin F, Rigamonti D: Safety of percutaneous endoscopic gastrostomy in patients with a ventriculoperitoneal shunt. *Neurosurgery* 32: 932–934, 1993

12) Schulman AS, Sawyer RG: The safety of percutaneous endoscopic gastrostomy tube placement in patients with existing ventriculoperitoneal shunts. *JPEN J Parenter Enter Nutr* 29: 442–444, 2005

13) Nabika S, Oki S, Sumida M, Isobe N, Kanou Y, Watanabe Y: Analysis of risk factors for infection in coplacement of percutaneous endoscopic gastrostomy and ventriculoperitoneal shunt. *Neurol Med Chir (Tokyo)* 46: 226–229; discussion 229-230, 2006

14) Roeder BE, Said A, Reichelderfer M, Gopal DV: Placement of gastrostomy tubes in patients with ventriculoperitoneal shunts does not result in increased incidence of shunt infection or decreased survival. *Dig Dis Sci* 52: 518–522, 2007

15) Cairns A, Geraghty J, Al-Rifai A, Babbs C: Percutaneous endoscopic gastrostomy and ventriculoperitoneal shunts: a dangerous combination? *Dig Endosc* 21: 228–231, 2009

16) Taylor AL, Carroll TA, Jakubowski J, O'Reilly G: Percutaneous endoscopic gastrostomy in patients with ventriculoperitoneal shunts. *Br J Surg* 88: 724–727, 2001

17) Oterdoom LH, Marinus Oterdoom DL, Ket JCF, van Dijk JMC, Scholten P: Systematic review of ventricular peritoneal shunt and percutaneous endoscopic gastrostomy: a safe combination. *J Neurol Surg* 127: 899–904, 2017

18) Korinek AM, Fulla-Oller L, Boch AL, Golmard JL, Hadiji B, Puybasset L: Morbidity of ventricular cerebrospinal fluid shunt surgery in adults: an 8-year study. *Neurosurgery* 68: 985–994; discussion 994–995, 2011

19) Pople IK: Hydrocephalus and shunts: what the neurologist should know. *J Neurol Neurosurg Psychiatry* 73 Suppl 1: i17–22, 2002

20) Borgbjerg BM, Gjerris F, Albeck MJ, Børgesen SE: Risk of infection after cerebrospinal fluid shunt: an analysis of 884 first-time shunts. *Acta Neurochir (Wien)* 136: 1–7, 1995

21) Conen A, Walti LN, Merlo A, Fluckiger U, Battegay M, Trampuz A: Characteristics and treatment outcome of cerebrospinal fluid shunt-associated infections in adults: a retrospective analysis over an 11-year period. *Clin Infect Dis* 47: 73–82, 2008

22) Sacar S, Turgut H, Toprak S, et al.: A retrospective study of central nervous system shunt infections diagnosed in a university hospital during a 4-year period. *BMC Infect Dis* 6: 43, 2006

Corresponding author: Fumihiro Mawatari, MD
Department of Gastroenterology, Juzenkai Hospital, 20-5 Fuchimachi, Nagasaki, Nagasaki 852-8012, Japan
e-mail: fumihiro.mwtr@gmail.com