Surgical Endoscopy (2019) 33:750–756
https://doi.org/10.1007/s00464-018-6339-1

Complications of percutaneous endoscopic and radiologic gastrostomy tube insertion: a KASID (Korean Association for the Study of Intestinal Diseases) study

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Received: 3 January 2018 / Accepted: 6 July 2018 / Published online: 21 August 2018

Abstract

Background Gastrostomy tube insertion is beneficial to selected patients, and percutaneous endoscopic gastrostomy (PEG) and percutaneous radiological gastrostomy (PRG) are two of the frequently used methods in gastrostomy. This study aimed to investigate the indications and complications of both PEG and PRG.

Methods This was a retrospective multicenter cohort study. Patients who underwent initial PEG or PRG tube insertion for nutritional purpose between January 2010 and December 2015 at five university hospitals were included in the study. We analyzed the indications and all complications related to gastrostomy, which were divided into the major (systemic or life-threatening) and minor (local and non-life-threatening) categories.

Results A total of 418 patients who underwent PEG ($n=324$) and PRG ($n=94$) were reviewed. The indications for gastrostomy tube insertion were different and included mainly neurological disease ($n=240$, 74.1%) such as cerebrovascular accident in the PEG group ($n=119$, 36.7%) and mainly surgical disease ($n=28$, 29.8%) such as head and neck cancer ($n=16$, 17.0%) in the PRG group ($p=0.05$). There were no differences in the minor (16.4% vs. 19.1%, $p=0.52$) and major (12.3% vs. 14.9%, $p=0.51$) complication rates between the PEG and PRG groups. The risk factors for complications were age [yearly increments; odds ratio (OR) 1.03, 95% confidence interval (CI) 1.01–1.06], tube diameter (1-Fr increments; OR 1.26, 95% CI 1.01–1.58), insertion time (1-min increments; OR 1.07, 95% CI 1.01–1.13), and neurological disease as the gastrostomy indication (vs. surgical disease; OR 4.61 95% CI 1.47–14.42).

Conclusions In our study, both PEG and PRG provided a safe route for nutrition delivery despite their different indications. Our data suggest that PEG might be the procedure of choice for patients with medical or neurological disease and PRG for patients with surgical disease in whom PEG is technically difficult or contraindicated.

Keywords Percutaneous endoscopic gastrostomy · Percutaneous radiological gastrostomy · Nutrition

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Percutaneous gastrostomy is the most common method of providing enteral feeding to patients who cannot receive adequate nutrition orally [1]. The purposes of placement of gastrostomy tubes also include primary feeding, supplemental feeding, and gastric decompression [2]. The importance of feeding patients through the enteral route has been shown to have substantial immunological and nutritional benefits compared with parenteral feeding [3]. Gastrostomy tube insertion is beneficial to selected patients, and percutaneous endoscopic gastrostomy (PEG) and percutaneous radiological gastrostomy (PRG) are two of the frequently used methods for gastrostomy [2].

To date, several studies have compared the safety of PEG and PRG. Studies related to PEG and PRG divide complications into the minor (local and non-life-threatening) and major (systemic and life-threatening) categories. However, owing to the non-uniform definition of complications, the rates of major and minor complications are difficult to compare among studies. In addition, previous studies that reported about complications have been limited to individual patient populations or a small number of patients. Recognizing and understanding the indications and potential complications of percutaneous gastrostomy are important for appropriate patient selection when deciding between PEG and PRG. Thus, we aimed to compare the indications, complications, and outcomes of PEG and PRG in a diverse patient population.

Materials and methods

Study design and data collection

A retrospective analysis was performed using the electronic medical reports of all patients who underwent initial PEG or PRG tube insertion between January 2010 and December 2015 at five university hospitals in Korea. Patients who underwent gastrostomy and had a follow-up of < 30 days were excluded. This study was approved by the institutional review boards at Kangbuk Samsung Hospital and the participating medical centers.

Data including sex; age at the time of procedure; medication related to bleeding tendency (such as aspirin, clopidogrel, warfarin, or a new oral anticoagulant); laboratory findings before gastrostomy including hemoglobin, platelet, international normalization ratio (INR), and albumin; and the interval between admission and gastrostomy were collected. The indications for gastric tube feeding were categorized into four main groups: medical disease, neurological disease, surgical disease, and others. Medical disease included hepatic failure, renal failure, and respiratory failure. Neurological disease included cerebrovascular accident, motor neuron disease, acquired brain injury, dementia, Parkinson's disease, multiple systemic atrophy, and others. Surgical disease included head and neck cancer and gastrointestinal tract cancer.

For procedure-related factors, antibiotic prophylaxis, gastrostomy location [intensive care unit (ICU), endoscopic unit, or radiological unit], gastrostomy tube type (pigtail catheter, balloon catheter, and bumper catheter), tube diameter [in French (Fr.)], and procedure duration were collected.

PEG or PRG procedure

Among the gastrostomy types, the choice of the technique was based on service availability, technical issues, and physician's preference. At the five hospitals, PEG tubes were inserted using the pull-type or introducer-type technique by an experienced endoscopist with the assistance of another endoscopist. All PRG tubes were inserted under fluoroscopic guidance using a modified Seldinger technique by two experienced radiologists.

In both procedures, the patients were routinely sedated with intravenous midazolam (and/or propofol) with continuous monitoring of blood pressure, heart rate, and oxygen saturation. In addition, 5–10 mL of 1% lidocaine was used for local anesthesia. The procedures were performed in the ICU, or in an endoscopic or radiological unit. All patients were placed in the supine position during PRG or PEG. Most of the patients who were taking medications related to bleeding tendency (such as aspirin, warfarin, clopidogrel, or a new oral anticoagulant) needed to stop the medications for 3–5 days before the procedure, and low molecular weight heparin was used instead of anticoagulants until 8 h before the procedure.

Outcomes

For the outcome measurements, we analyzed all complications related to gastrostomy. Complications were divided into major (systemic or life-threatening) and minor (local and non-life-threatening) categories. Major complications included aspiration pneumonia, peritonitis, and massive hemorrhage, and minor complications included pneumoperitoneum, peritoneal leakage, wound infection, tube dislodgement, tube blockage, diarrhea, abdominal pain, PEG site ulcer, and ileus. Complications were further divided into those that occurred during gastrostomy (gastric hemorrhage, abdominal wall hemorrhage, intraperitoneal hemorrhage, and pneumoperitoneum) or after gastrostomy (peritoneal leakage, tube dislodgement, abscess, wound infection, clogged tube, diarrhea, abdominal pain, and others). We analyzed the treatment methods for complications, hospital days after gastrostomy tube insertion, and death until last follow-up.

Statistical analysis

Univariate comparisons of the characteristics of PEG and PRG patients were conducted using Chi-square test and Student's *t* test for categorical and continuous variables, respectively. A multivariate logistic regression analysis was used to determine which, if any, of the patient-related variables (sex, age, obesity, aspirin or anticoagulant use, antibiotic use) and procedure-related variables (gastrostomy indication, admission-to-gastrostomy interval, tube diameter, procedure duration) are related with complications. The type of gastrostomy (PEG or PRG) was included as an explanatory variable in this model. Correlations between potential predictors and outcomes of interest were estimated using odds ratios (ORs) with 95% confidence intervals (CIs). A p value of <0.05 was considered statistically significant. All statistical analyses were performed using the Statistical Package for Social Sciences version 18.0 software for Windows (SPSS Inc., Chicago, IL, USA).

Results

Patient demographics, clinical characteristics, and biochemical results

A total of 452 patients were identified to be eligible during the study period, and 34 patients with a follow-up of < 1 month were excluded. Finally, 418 patients were included in the study, of whom 324 underwent PEG and 94 underwent PRG. Among 94 patients who underwent PRG, 14 (14.9%) patients attempted PEG first then went on to getting PRG.

The characteristics of patients who underwent PEG and PRG tube insertion are described in Table 1. The mean age of patients who underwent PEG and PRG were 66.7 and 66.2 years, respectively ($p=0.75$). The proportion of male patients were higher in the PEG group than in the PRG group, with marginal statistical significance (72.2% vs. 61.7%, $p=0.05$). In the biochemical results, INR was higher in the PRG group than in the PEG group (1.2 vs. 1.1, $p=0.04$).

Table 2 shows the indications for PEG and PRG tube insertion. The main indication for tube insertion in both groups was cerebrovascular accident (36.7 and 35.1%, respectively). More patients in the PEG group tended to undergo gastrostomy for neurological disease than those in the PRG group (74.1% vs. 59.6%), and more patients in the PRG group tended to undergo gastrostomy for surgical disease than those in the PEG group (29.8% vs. 18.5%) ($p=0.055$). The other indications for PEG or PRG tube insertion ($n=26$) were lung cancer with brain metastasis ($n=6$), lung cancer with esophageal invasion ($n=3$), brain tumor ($n=6$), hypoxic brain damage ($n=3$), esophageal stricture ($n=2$), esophagotracheal fistula ($n=1$), cervical spine injury ($n=1$), dermatopolymyositis ($n=1$), nasopharyngeal mucormycosis ($n=1$), lymphoma ($n=1$), and functional dysphagia ($n=1$). One patient underwent PRG for emergent need, as esophagotracheal fistula occurred due to foreign body ingestion.

Comparison of procedure-related factors

Procedure-related factors were compared between the two groups (Table 3). There were no differences in the admission-to-gastrostomy interval and procedure location. PEG and PRG tubes were inserted in the outpatients setting in five and four cases respectively, and one PEG case and three PRG cases were admitted for monitoring or complications directly related to the tube placement. PEG tubes were inserted using the pull-though technique ($n=319$, 89.2%) or with the introducer technique ($n=2$). Among the gastrostomy tube types, pigtail catheters were more frequently used in the PRG group (43.6% vs. 0%), and bumper catheters were more frequently

Table 1 Baseline characteristics of the enrolled patients

	PEG ($n=324$)	PRG ($n=94$)	p
Age (years)	66.7 ± 14.8	66.2 ± 13.3	0.75
Sex (male)	234 (72.2)	58 (61.7)	0.05
Antiplatelet or anticoagulation use	72 (22.3)	16 (17.0)	0.27
Admission-to-gastrostomy interval (days)	11 (0–617)	10 (1–498)	0.60
Biochemical results			
Hemoglobin (mean, g/dL)	11.9 ± 1.9	11.5 ± 2.0	0.16
Platelet (10^3/mm^3)	254.5 ± 98.8	271.5 ± 91.2	0.14
INR	1.1 ± 0.2	1.2 ± 0.3	0.06
Albumin (g/dL)	3.4 ± 0.5	3.5 ± 0.5	0.17

Data were shown as n (%), mean ± SD, or median (range)

PEG percutaneous endoscopic gastrostomy, *PRG* percutaneous radiological gastrostomy, *INR* international normalization ratio

Table 2 Indications for PEG and PRG tube insertion

	PEG ($n=324$)	PRG ($n=94$)
Medical diseases	6 (1.9)	2 (2.1)
Respiratory failure	4 (1.2)	2 (2.1)
Hepatic failure	1 (0.3)	0
Renal failure	1 (0.3)	0
Neurological diseases	240 (74.1)	56 (59.6)
Cerebrovascular accident	119 (36.7)	33 (35.1)
Acquired brain injury	39 (12.0)	5 (5.3)
Parkinson's disease	35 (10.8)	9 (9.6)
Motor neuron disease	15 (4.6)	4 (4.3)
Dementia	20 (6.2)	2 (2.1)
Other neurological disease[a]	12 (3.7)	3 (3.2)
Surgical diseases	60 (18.5)	28 (29.8)
Head and neck cancer	45 (13.9)	16 (17.0)
Esophageal cancer	15 (4.6)	12 (12.8)
Others[b]	18 (5.6)	8 (8.5)

$p=0.055$

Data were shown as *n* (%)

PEG percutaneous endoscopic gastrostomy, *PRG* percutaneous radiological gastrostomy

[a]Other neurological diseases include encephalitis ($n=1$), progressive multifocal leukoencephalopathy ($n=1$), status epilepticus ($n=1$), cranial nerve palsy ($n=1$), multiple systemic atrophy ($n=4$), cerebral palsy ($n=1$), Huntington's disease ($n=1$), myasthenia gravis ($n=1$), and progressive supranuclear palsy ($n=4$)

[b]Other diseases include lung cancer with brain metastasis ($n=6$), lung cancer with esophageal invasion ($n=3$), brain tumor ($n=6$), hypoxic brain damage ($n=3$), esophageal stricture ($n=2$), esophagotracheal fistula ($n=1$), cervical spine injury ($n=1$), dermatopolymyositis ($n=1$), nasopharyngeal mucormycosis ($n=1$), lymphoma ($n=1$), and functional dysphagia ($n=1$)

Table 3 Procedure-related factors

	PEG ($n=324$)	PRG ($n=94$)	*p*
Antibiotic prophylaxis	290 (89.5)	81 (86.2)	0.36
Location of gastrostomy			0.28
ICU	4 (1.2)	0 (0)	
Endoscopic or radiological unit	320 (98.8)	94 (100)	
Tube choice[a]			< 0.001
Pigtail tube	0	70 (95.9)	
Balloon tube	4 (1.2)	0 (0)	
Bumper tube	317 (98.8)	3 (4.1%)	
Tube diameter[a] (Fr.)	21.3 ± 1.7	14.3 ± 1.9	< 0.001
Procedure duration (min)	12.4 ± 6.6	8.1 ± 2.3	< 0.001

Data were shown as *n* (%) or mean ± SD

PEG percutaneous endoscopic gastrostomy, *PRG* percutaneous radiological gastrostomy, *Fr*. French

[a]Data were available in 394 patients

used in the PEG group (97.8% vs. 3.2%) ($p<0.001$). Thus, the mean tube diameter was smaller in the PRG group than in the PEG group (14.3 Fr. vs. 21.3 Fr., $p<0.001$). The procedure duration was shorter in the PRG group than in the PEG group (8.1 min vs. 12.4 min, $p<0.001$).

Comparison of complication rate

The mean follow-up duration after gastrostomy was 335 days in the PEG group and 400 days in the PRG group ($p=0.16$). The complication rates are shown in Table 4. The 88 patients of the PEG group and 28 patients of the PRG group showed one or more complications, and there was no difference in the overall complication rate between the two groups (27.2% vs. 29.8%, $p=0.61$). When complications were classified according to major and minor categories, the major

Table 4 Complications and prognosis

	PEG ($n=324$)	PRG ($n=94$)	*p*
Follow-up duration (months)	335 (10–2122)	400 (20–2287)	0.16
Overall complications	88 (27.2)	28 (29.8)	0.61
Major complications	40 (12.3)	14 (14.9)	0.51
Gastric hemorrhage	5 (1.5)	3 (3.2)	0.30
Abdominal wall hemorrhage	2 (0.6)	1 (1.1)	0.65
Intraperitoneal hemorrhage	1 (0.3)	0	0.44
Aspiration	33 (10.2)	9 (9.6)	0.86
Minor complications	53 (16.4)	18 (19.1)	0.52
Pneumoperitoneum	4 (1.2)	2 (2.1)	0.52
Tube dislodgement	19 (5.9)	15 (16.0)	0.002
Abscess, wound infection	18 (5.6)	2 (2.1)	0.14
Tube blockage	10 (3.1)	2 (2.1)	0.62
Peritoneal leakage	3 (0.9)	3(3.2)	0.10
Diarrhea	2 (0.6)	2 (2.1)	0.18
Pain	7 (2.2)	0	0.15
Other[a]	3 (0.9)	0	0.44
Complication during gastrostomy	13 (4.0)	6 (6.4)	0.33
Complication after gastrostomy	85 (26.2)	27 (28.7)	0.81
Treatment of complications			0.18
Medical treatment	322 (99.4)	92 (97.9)	
Surgical treatment	2 (90.6)	2 (2.1)	
Hospital stay (days)	11 (0–734)	12 (1–224)	0.26
Death	78 (28.3)	20 (28.6)	0.95

Data were shown as *n* (%) or median (range)

PEG percutaneous endoscopic gastrostomy, *PRG* percutaneous radiological gastrostomy

[a]Other complications associated with gastrostomy use were peritonitis ($n=1$), PEG site ulcer ($n=1$), and ileus ($n=1$)

complication rate was 12.3% in the PEG group and 14.9% in the PRG group ($p=0.60$). The most frequent major complication was aspiration (PEG 10.2% vs. PRG 9.6%, $p=0.86$) followed by gastric hemorrhage (PEG 1.5% vs. PRG 3.2%, $p=0.30$). The most frequent minor complication was tube dislodgement, and it occurred more frequently in the PRG group than in the PEG group (16.0% vs. 5.9%, $p=0.002$).

There was no difference in the complication rate when complications were classified according to the timing of occurrence: during gastrostomy (PEG 4.0% vs. PRG 6.4%, $p=0.33$) or after gastrostomy (26.2% vs. 28.7%, $p=0.81$). In the complications occurring after gastrostomy, median time of insertion to complication was 11, 285, 423, 213, 365, 282, 150, and 4 days in the gastric or abdominal wall hemorrhage, aspiration, tube dislodgement, abscess or wound infection, tube blockage, peritoneal leakage, diarrhea, and pain, respectively. Complications were treated using exploratory laparotomy in two patients in the PRG group (0.6%, for peritoneal hemorrhage and tube dislodgment) and two patients in the PEG group (2.1%, for gastric hemorrhage and peritonitis) ($p=0.18$). Hospital days and mortality showed no difference between the two groups.

Factors associated with complications

As indicated in Table 5, age (OR 1.03, 95% CI 1.01–1.06), tube diameter (Fr.) (OR 1.26, 95% 1.01–1.58), insertion time (OR 1.07, 95% CI 1.01–1.13), and neurological disease as the gastrostomy indication (OR 4.61, 95% CI 1.47–14.42) were associated with the total complications. However, there were no statistically significant factors associated with major complications. Factors associated with minor complications were tube diameter (Fr.) (OR 1.34, 95% 1.04–1.72), insertion time (OR 1.07, 95% CI 1.01–1.14), and neurological disease as the gastrostomy indication (OR 5.94, 95% CI 1.53–22.96). The type of gastrostomy (PEG or PRG) was not associated with major, minor, or total complications.

Discussion

In this large multicenter study, we compared the indications, procedure-related factors, and complications between the PEG and PRG groups. In terms of indications, more subjects in the PEG group underwent gastrostomy for neurological disease and more subjects in the PRG group underwent gastrostomy for surgical disease. In the procedure-related factors, the tube choice, tube diameter, and procedure duration were different between the PEG and PRG groups. However, there was no difference in the major complications between complications that occurred during and after gastrostomy. Tube dislodgement, one of the minor complications, was more common in the PRG group (16% vs. 5.9%, $p=0.002$). The risk factors of the overall and minor complications were neurological disease as the gastrostomy indication, larger tube diameter, and longer procedure duration.

Previous studies comparing the indications for PEG and PRG were limited by biased patient selection, as studies on PRG have been done on patients who previously failed PEG tube placement [4–6], or enrolled only patients with a diagnosis of a specific disease such as amyotrophic lateral sclerosis [7–9] or head and neck cancer [10–12]. We analyzed diverse patient data from five university hospitals, and more subjects in the PEG group underwent gastrostomy for neurological disease (74.1% vs. 59.6%) and more subjects in the PRG group underwent gastrostomy for surgical

Table 5 Multivariate analysis of risk factors for complications

	Total complications, OR (95% CI)	Major complications, OR (95% CI)	Minor complications, OR (95% CI)
Male sex (vs. female sex)	0.47 (0.19–1.19)	0.14 (0.01–1.37)	0.57 (0.20–1.61)
Age (yearly increments)	1.03 (1.01–1.06)	1.04 (0.98–1.11)	1.03 (0.99–1.06)
Obesity (vs. ≤25 kg/m^2)	0.29 (0.04–2.34)	0	0.47 (0.05–3.98)
Aspirin or anticoagulant use (yes vs. no)	0.38 (0.12–1.15)	0.35 (0.03–3.21)	0.30 (0.07–1.15)
Antibiotics use (yes vs. no)	1.02 (0.32–3.19)	0. 55 (0.06–5.04)	1.20 (0.34–4.28)
Gastrostomy indication			
Neurological (vs. surgical)	4.61 (1.47–14.42)	4.16 (0.43–39.64)	5.94 (1.53–22.96)
Others (vs. surgical)	0.74 (0.07–7.31)	0	0
Admission-to-gastrostomy interval (1-day increments)	0.99 (0.99–1.00)	0.99 (0.99–1.00)	0.99 (0.99–1.00)
Tube diameter (1-Fr. increments)	1.26 (1.01–1.58)	0.86 (0.48–1.55)	1.34 (1.04–1.72)
Procedure duration (1-min increments)	1.07 (1.01–1.13)	1.03 (0.91–1.16)	1.07 (1.01–1.14)
PEG (vs. PRG)	3.13 (0.46–21.34)	1.31(0.02–77.80)	1.98 (0.13–28.2)

OR odds ratio, *CI* confidence interval, *PEG* percutaneous endoscopic gastrostomy, *PRG* percutaneous radiological gastrostomy

disease (29.8% vs. 18.5%). These results correspond with those of other large-volume studies showing that physicians preferred PEG for patients with neurological diseases [13] and PRG for patients with surgical diseases such as esophageal or head and neck cancer [2, 13]. The reason lies in the difference in technique between PRG and PEG. For example, passing an endoscope is often difficult in patients with esophageal or head and neck cancer, and PRG minimizes contact with the primary tumor.

In the procedure-related factors, the proportion of antibiotic prophylaxis was high in both groups (89.5% in the PEG group and 86.2% in the PRG group), and there was no difference between the two groups. Most other studies described a higher wound infection rate in PEG, possibly owing to the exposure of the tubes to the oral flora before placement through the abdominal wall [14]. Thus, administration of antibiotics has been proven effective in reducing infections during PEG and should be considered for routine use in PEG [15–17]. However, the skin flora may be more important in the causation of wound infection in PRG, and a previous study has attributed early infections to the prevalence of malignancy [18]. Thus, antibiotics might be considered for PRG, especially in high-risk patients such as those with malignant disease. In our study, complications such as abscess and wound infection were not different between the two groups, and this might be due to the high rate of antibiotic prophylaxis in both groups.

The most different procedure-related factors were tube choice and tube diameter. As most PRG cases (95.9%) used small-bore pigtail tubes and most PEG cases (98.8%) used large-bore bumper tubes, the mean tube diameter was smaller in the PRG group than in the PEG group (14.3 Fr. vs. 21.3 Fr.). Although pigtail catheter was secured to the abdominal wall by the fixation disc or by sutures in the PRG cases, tube dislodgement was more common in the PRG group (16% vs. 5.9%). This result is consistent with a previous study [10] that reported that compared with PEG tube dislodgement (5%), a 21% rate of PRG tube dislodgement was expected owing to the smaller diameter and weaker internal fixation mechanism of the PRG tube.

Except for tube dislodgement, other complications including major and minor complications were not different between the PRG and PEG groups in our study. Owing to the non-uniform definition of complications, the rates of major and minor complications are difficult to compare among studies. However, most studies that defined minor complications as tube dislodgement, leakage, and wound infection reported a higher rate of minor complications in the PRG group [2, 7, 12]. Other studies reported no difference in the major [8, 9] and minor [8–10, 19] complications, like our study. In a previous study that analyzed complications according to occurrence during or after gastrostomy, the intraprocedural complication rate was higher in the PRG group [2]. Another study reported that the rate of postprocedural complications (only included aspiration) was higher in the PEG group, and there was no difference in the postprocedural complications (other than aspiration) between the two groups [9]. In our study, the rates of complications that occurred during and after gastrostomy were not different between the two groups, regardless of inclusion of aspiration as a post-gastrostomy complication.

The risk factors for overall and minor complications were neurological disease as the gastrostomy indication, larger tube diameter, and longer procedure duration. None of these factors were identified as risk factors of major complications, and the gastrostomy type (PEG or PRG) was not associated with the overall, major, or minor complications. Although we did not investigate comorbidities, patients who underwent gastrostomy for neurological disease might have had a longer disease duration and more severe comorbidities than cancer patients. Although a larger tube would decrease the risk of tube dislodgement or leakage, it might increase the risk of abdominal pain or hemorrhage.

The strength of our study is that it is a large multicenter study that included patients who underwent gastrostomy for various indications and had a long follow-up in real clinical practice. As indications and procedure-related factors might differ among hospitals, a multicenter study is important in investigating indications, procedure-related factors, and complications. The results of our study could be applicable to other university hospitals in Korea. However, our study also had several limitations. Excluding the main disease as the gastrostomy indication, comorbidities could not be investigated, as they were complex and difficult to classify. In addition, there was difference in the procedure-related factors including indications and tube type between the two groups. In the outcomes, tube dislodgement rate was different between the two groups. Thus, we performed multivariate logistic regression analysis to determine which methods for gastrostomy (PEG or PRG) are related with complications after controlling for confounding factors including procedure-related variables (including indication, tube type). For the gastrostomy indications, as the study was performed in university hospitals, the indications might be different from those in nursing or geriatric hospitals, where gastrostomy is frequently performed. For the hospital stay, although there was no difference of hospital stay between the two groups, it might be related with both underlying disease complications and gastrostomy complications. As overall complication rate of PEG and PRG were 27.2 and 29.8%, respectively, about 30% of patients' hospital stay might be influenced by both underlying disease complications and gastrostomy complications, and 70% of total patients' hospital stay might be influenced by only underlying disease complications. However, as this was a retrospective study, when gastrostomy-related complications were resolved

during admission, it was difficult to investigate by reviewing electronic medical reports.

In conclusion, both PEG and PRG provided a safe route for nutrition delivery despite their different indications. There was no difference in the major and overall complications between the PEG and PRG groups. Tube dislodgement, one of the minor complications, was more common in the PRG group. The risk factors for the overall and minor complications were neurological disease as the gastrostomy indication, larger tube diameter, and longer procedure duration. Our data suggest that PEG might be the procedure of choice for patients with non-surgical disease, such as medical or neurological disease and PRG for those with surgical disease in whom PEG is technically difficult or contraindicated.

Compliance with ethical standards

Disclosure Soo-Kyung Park, Ji Yeon Kim, Seong-Joon Koh, Yoo Jin Lee, Hyun Joo Jang, and Soo Jung Park have no conflicts of interest or financial ties to disclose.

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