Prognostic outcomes after direct percutaneous endoscopic jejunostomy in elderly patients: comparison with percutaneous endoscopic gastrostomy

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Background and Aims: Direct percutaneous endoscopic jejunostomy (DPEJ) is an alternative method of enteral feeding to percutaneous endoscopic gastrostomy (PEG). Although long-term outcomes of PEG have been reported, little is known regarding the outcomes of DPEJ.

Methods: A retrospective cohort study was conducted including 115 and 651 consecutive attempts of DPEJ and PEG, respectively, in a total of 766 elderly patients between April 2004 and March 2019. Patients' clinical background, procedural and long-term outcomes, survival analysis, and cause of death were analyzed.

Results: Successful placement rates were 93.9% and 97.1% for DPEJ and PEG, respectively. There was no significant difference in procedure-related adverse events (AEs) between the DPEJ and PEG groups. Rates of pneumonia, vomiting, and upper GI bleeding were significantly lower, whereas those of fistula enlargement and ileus were significantly higher in the DPEJ group as long-term AEs. The median survival periods were 694 and 734 days for DPEJ and PEG, respectively, with no significant differences between the 2 groups. Multivariate analysis revealed that age 80 years old or older, C-reactive protein level of 1.0 mg/dL or higher, and the presence of diabetes were independent risk factors for mortality after DPEJ. Respiratory tract infection was the primary cause of death in both groups.

Conclusions: DPEJ is considered a safe and feasible method of access for enteral feeding as well as PEG. Although the survival period after DPEJ may be expected to be as long as that with PEG, DPEJ-specific AEs should be kept in mind on long-term feeding. (Gastrointest Endosc 2021;94:48-56.)

INTRODUCTION

Since the introduction of percutaneous endoscopic gastrostomy (PEG) in 1980, PEG has been the standard method for enteral access for long-term enteral nutrition, because it is a simple and rapid technique compared with surgical gastrostomy.[1,2] However, some patients referred for PEG cannot undergo PEG because of dislocation of the stomach from the abdominal wall or previous resection of the esophagus or stomach. Direct percutaneous endoscopic jejunostomy (DPEJ), described by Shike et al,[3] is an alternative method of enteral feeding for such patients. DPEJ is also applicable for patients whose GI and digestive functions are impaired

Abbreviations: AE, adverse event; CCI, Charlson comorbidity index; CRP, C-reactive protein; DPEJ, direct percutaneous endoscopic jejunostomy; PEG, percutaneous endoscopic gastrostomy; PEG-J, percutaneous endoscopic gastrostomy with a jejunal extension tube.

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due to gastroparesis, gastroesophageal reflux, or pancreatitis.[4-6] Although PEG with a jejunal extension tube (PEG-J) is an applicable method for jejunal feeding in patients who have already undergone PEG, frequent re-intervention is required to resolve clogging, migration, or dysfunction of the tube.[7] Therefore, DPEJ is considered suitable for long-term jejunal feeding rather than PEG-J.

With the development of enteroscopic techniques, DPEJ has become feasible in many institutions. The success rate of single- or double-balloon-assisted DPEJ was recently reported to be more than 90%, higher than the past.[8,9] Although several researchers reported techniques for placement and short-term outcomes of DPEJ, little is known about long-term outcomes and factors predicting mortality. In the present study, we report the short- and long-term outcomes after DPEJ, including survival analysis, prognostic factors, and cause of death, comparing with those after PEG.

METHODS

Patients and study design

We conducted a retrospective cohort analysis of patients who underwent DPEJ or PEG between April 2004 and March 2019 at our medical center. Patients who underwent DPEJ or PEG only for decompression (not for enteral feeding) were excluded from the analysis. Our study included 115 consecutive patients receiving DPEJ in 3 hospitals of Gifu Seino Medical Center and 651 consecutive patients who underwent PEG at Nishimino Kosei Hospital. Most of the patients were followed up by a physician at Nishimino Kosei Hospital every 6 months for replacement of the jejunostomy or gastrostomy tubes. This study was approved by the institutional review board of Gifu Seino Medical Center.

Outcomes

The primary outcomes of the study were comparison of the survival periods after DPEJ and PEG placement, including analysis of the prognostic factors and cause of death. The secondary outcomes were comparison of results at placement and adverse events (AEs) after placement between the DPEJ and PEG groups.

DPEJ and PEG procedures

The exclusion criteria for DPEJ and PEG included (1) uncorrected coagulopathy, (2) uncontrollable cardiac and respiratory failure, (3) severe obstruction of the upper GI tract, (4) large amount of ascites, and (5) inability to obtain consent for the procedures from the patients or their family members. The indication for DPEJ was made for cases in which (1) PEG was considered not possible for anatomic reasons, or (2) direct feeding into the jejunum was considered appropriate due to ongoing problems, including repeated vomiting after nasogastric tube feeding, chronic pancreatitis or cholangitis, and gastric outlet obstruction.

All DPEJ and PEG tube placements were conducted by a single physician (S.N.). Written informed consent was obtained from the patients or their guardians. The tube placement procedures were mainly conducted using the standard pull technique. Materials used for DPEJ and PEG were a PEG button kit (One Step Butto, Boston Scientific Co, Natick, Mass, USA) or a safety PEG kit (Standard PEG system, Ponsky PEG, Bard Access Systems, Inc, Salt Lake City, Utah, USA). A modified introducer technique (IDEAL PEG Kit, Olympus Medical Co, Tokyo, Japan) was used for patients with pharyngeal or esophageal cancer or those who were carriers of methicillin-resistant *Staphylococcus aureus*. PEG was usually conducted using peroral endoscopy with a pull technique or transnasal endoscopy with the modified introducer technique. DPEJ was mostly conducted under the guidance of fluoroscopy. Endoscopic access up to the jejunum was done using an enteroscope (SIF Q240 or SIF Q260, Olympus Medical Co, Tokyo, Japan) for patients with no previous history of surgery, with postesophagectomy, and with Billroth I reconstruction. Small-caliber endoscopy was used through the gastrostomy tract for patients who had already undergone PEG, as described previously.[10] Standard peroral endoscopy was used for access in patients with Billroth II reconstruction or after total gastrectomy. We used fluoroscopy to identify the position of the endoscope and the presence of jejunal air, and we used transillumination and finger indentation to confirm contact between the abdominal wall and the jejunum at the target site to create a stoma. Jejunopexy and gastropexy were routinely conducted using a stomach-wall fixation tool for gastrostoma (Easy Tie, Boston Scientific Japan, Tokyo, Japan) for the formation of a tight fistula and replacement in the early phase of accidental dislodgment. To securely perform DPEJ, 2-point punctures of the T-fastener were made at a 2-cm interval using Easy Tie under fluoroscopic guidance to prevent migration of the jejunal loop from the abdominal wall. A cannula needle was punctured at the center of the 2 T-fasteners toward an open snare, which came out of the endoscope. A loop wire was inserted through the cannula and a 20F tube was placed on the jejunum by the pull-through technique. Prophylactic antibiotics were administered for 3 days after placement. Enteral feeding was started on the day after placement and the feeding amount was increased up to the required energy level within 1 or 2 weeks.

Data collection

At study entry, the patients' demographic data were recorded, including age, sex, comorbid disease, history of pneumonia and foregut operation, nutritional administration route before placement, blood analyses (levels of albumin, cholesterol, total lymphocyte counts, hemoglobin, and C-reactive protein [CRP]), and the main reason for

TABLE 1. Clinical background of patients who underwent DPEJ or PEG procedures

Variables	DPEJ (n = 115)	PEG (n = 651)	*P* value
Age (years), median	82 (75-86)	84 (78-88)	.098
Sex, males/females	59/56	251/400	.011
Charlson comorbidity index, mean ± SD	3.0 ± 1.4	3.0 ± 1.2	.844
Previous foregut operation	54 (47.0)	16 (2.5)	<.001
Reasons for enteral feeding			
Cerebrovascular disease	58 (50.4)	340 (52.2)	.723
Dementia	26 (22.6)	147 (22.6)	.995
Frequent aspiration	16 (13.9)	80 (12.3)	.632
Neuromuscular disease	6 (5.2)	50 (7.7)	.33
Malignant tumor	6 (5.2)	9 (1.4)	.018
Others	3 (2.6)	25 (3.8)	.498
Blood analyses at placement			
Albumin, g/dL	2.9 (2.7-3.3)	3.0 (2.7-3.3)	.709
Total cholesterol, mg/dL	135 (105-163)	146 (119-175)	.006
Total lymphocyte count, /μL	1260 (900-1620)	1250 (950-1680)	.485
Hemoglobin, g/dL	10.7 (9.8-11.8)	11.0 (9.7-12.2)	.269
C-reactive protein, mg/dL	1.14 (0.31-2.93)	0.97 (0.27-2.34)	.032
Reasons for DPEJ			
Previous foregut surgery	53 (46.1)		
Frequent gastroesophageal reflux	37 (32.2)		
Lack of transillumination at PEG	15 (13.0)		
Pancreatitis or cholangitis	6 (5.2)		
Gastric outlet obstruction	4 (3.5)		

Values are median (interquartile range) or n (%).
DPEJ, Direct percutaneous endoscopic jejunostomy; *PEG*, percutaneous endoscopic gastrostomy; *SD*, standard deviation.

enteral feeding. The Charlson comorbidity index (CCI) was used to assess the severity of the baseline condition. After DPEJ and PEG, the patients' general condition was continuously monitored by the nutrition support team in our hospital. After discharge, the feeding tube was replaced every 6 months at Nishimino Kosei Hospital, and the clinical condition was recorded. Patients with serious AEs were re-admitted mainly to Nishimino Kosei Hospital. AEs were classified as severe or mild; a severe AE was defined as requiring surgical or endoscopic intervention or leading to death. Causes of death were recorded based on the description in the death certificate. Clinical data on patients who were followed up at places other than Nishimino Kosei Hospital were relayed by the affiliated facilities by telephone or e-mail.

Statistics

All data were analyzed using JMP for Windows software (Version 5.1.1; SAS Institute Inc., Cary, NC, USA). Demographic data and the outcomes of the 2 groups were analyzed by the chi-squared test or the Student t test. Overall survival curves were drawn using the Kaplan-Meier method and compared by the log-rank test between the 2 groups. Univariate cox proportional hazard regression was used to identify the variables for survival. Multiple Cox proportional hazards regression analysis was used for significant variables in univariate analysis for the DPEJ group. Analysis of the causes of death was conducted by the chi-squared test. *P* values <.05 were considered statistically significant.

RESULTS

Patients

Overall, 766 patients underwent DPEJ or PEG procedures (Table 1). There were no significant differences in age, sex, or CCI between the DPEJ and PEG groups, although significantly more patients had previous foregut surgery in the DPEJ group. Approximately half of the patients had cerebrovascular diseases as the underlying disease for enteral nutrition in both the DPEJ and PEG groups. Malignant tumors were significantly more frequent in the DPEJ group. Blood analysis showed that levels of total cholesterol were significantly lower and CRP levels were higher in the DPEJ group than in the PEG group. The primary reason for DPEJ was previous

TABLE 2. Procedural and long-term outcomes after DPEJ and PEG

	DPEJ	PEG	*P* value
Patients who received trial for placement	115	651	
Number of successful placements			
Total	108 (93.9)	632 (97.1)	.111
No history of foregut operation (n = 61:635/DPEJ:PEG)	55 (90.2)	622 (98.0)	.004
Previous foregut operation (n=54:16/DPEJ:PEG)	53 (98.2)	10 (62.5)	<.001
Reasons for failure			
Lack of transillumination	5 (4.3)	13 (2.0)	.882
Endoscope insertion failure	0 (0)	3 (0.5)	.155
Presence of gastrointestinal lesions	0 (0)	3 (0.5)	.155
Technical failure	2 (1.7)	0 (0)	.017
Patients who underwent ostomy	108	632	
Duration of procedures, minutes			
Total	23 (18-35)	16 (14-18)	<.001
No history of foregut operation (n=55:622/DPEJ:PEG)	30 (21-40)	16 (14-18)	<.001
Previous foregut operation (n=53:10/DPEJ:PEG)	20 (15-28)	16 (14-18)	.027
Placement related adverse events			
Fistula infection	5 (4.6)	33 (5.1)	.794
Gastrointestinal bleeding	2 (1.9)	17 (2.7)	.596
Colocutaneous fistula	2 (1.9)	2 (0.3)	.094
Pneumonia	1 (0.9)	3 (0.4)	.585
Massive pneumoperitoneum	1 (0.9)	2 (0.3)	.427
CO_2 narcosis	0 (0)	2 (0.3)	.427
Patients who underwent enteral feeding	106	628	
Adverse events after initiation of enteral feeding			
Pneumonia	27 (25.4)	222 (35.4)	.043
Fistula enlargement (peristomal leakage)	23 (21.7)	54 (8.6)	<.001
Dislodgement	8 (7.6)	32 (5.1)	.325
Diarrhea	7 (6.6)	50 (8.0)	.622
Vomiting	6 (5.7)	100 (15.9)	.002
Granuloma	4 (3.8)	35 (5.6)	.425
Fistula disruption	2 (1.9)	12 (1.9)	.987
Buried bumper syndrome	2 (1.9)	2 (0.3)	.092
Ileus	2 (1.9)	0 (0)	.005
Upper GI bleeding	0 (0)	26 (4.1)	.004
Upper GI ulcer	0 (0)	19 (3.0)	.014
Stomal bleeding	0 (0)	4 (0.6)	.263

Values are n (%) or median (interquartile range).
DPEJ, Direct percutaneous endoscopic jejunostomy; *PEG*, percutaneous endoscopic gastrostomy.

foregut surgery, followed by frequent gastroesophageal reflux and lack of transillumination at PEG.

Procedural outcomes and AEs during feeding

The total number of patients for trial, successful placement, and successful start of enteral feeding for DPEJ were 115, 108, and 106, whereas those for PEG were 651, 632, and 628, respectively (Table 2). The overall success rates for DPEJ and PEG were 93.9% and 97.1%, respectively. However, the success rate was relatively higher in patients with previous foregut surgery than in those without such a history in the DPEJ group (P = .059). The major reason for failure was lack of transillumination in both groups. Technical failures occurred only in the DPEJ group. The procedural duration was significantly longer in the DPEJ group than

in the PEG group. The duration of the DPEJ procedure was significantly shorter in patients with than without previous foregut surgery ($P < .001$), whereas there was no significant difference by surgical history in the PEG group.

We compared short- and long-term AEs in cases of successful placement. The median (interquartile range) follow-up periods in the DPEJ and PEG groups were 645 days (154-1341 days) and 579 days (167-1457 days), respectively. The overall percentage AEs related to the DPEJ and PEG procedures were 10.1% and 9.3%, respectively. There was no significant difference in the frequency of each AE between the 2 groups. The most frequent AE was fistula infection, all of which were mild AEs. Upper GI bleeding was the second major AE in both groups. Endoscopic hemostasis was performed for 2 and 13 cases in the DPEJ and PEG groups, respectively. One case each of DPEJ and PEG failed to achieve endoscopic hemostasis and required surgical hemostasis. The incidence of colocutaneous fistula was relatively higher in the DPEJ group than in the PEG group, and 2 cases of DPEJ and 1 case of PEG underwent ostomy again under the guidance of colonography after removal of the tubes and closure of the fistula. One case of DPEJ and 2 cases of PEG led to severe pneumonia during the placement procedure and resulted in death due to respiratory failure. The overall rates of severe AEs with the DPEJ and PEG procedures were 4.6% and 3.0%, respectively.

AEs during enteral feeding were analyzed after excluding 6 patients in whom enteral feeding could not be started (2 and 4 patients in the DPEJ and PEG groups, respectively). The most frequent AE during feeding was pneumonia in both groups, and the frequency was 25.4% and 35.4% in the DPEJ and PEG groups, respectively. Vomiting (5.7% vs 15.9%), upper GI bleeding (0% vs 4.1%), and ulcer (0% vs 3.0%) were also significantly less frequent in the DPEJ group than in the PEG group. The frequency of fistula enlargement was 21.7% and 8.6% in the DPEJ and PEG groups, respectively, and the frequency of ileus was 1.9% and 0%, respectively. Fistula disruption was caused at the time of replacement or accidental dislodgment of the feeding tube. All of the disruptions were resolved by replacing the feeding tube by endoscopic management. Upper GI bleeding, ulcer, and stomal bleeding were only seen in the PEG group.

Survival analysis

Comparison of the Kaplan-Meier survival curves for the DPEJ and PEG groups is shown in Figure 1. Although the survival rate was not significantly different between the groups by the log-rank test, the survival rate was higher in the PEG group after 2 years of placement. The median survival periods were 694 and 734 days for the DPEJ and PEG groups, respectively. The survival rates for the DPEJ and PEG groups were 96.3% and 93.7% at 30 days, 80.5% and 82.1% at 90 days, 74.1% and 74.2% at 180 days, 65.7% and 62.4% at 1 year, 48.6% and 50.3% at 2 years, and 19.4% and 28.7% at 5 years, respectively.

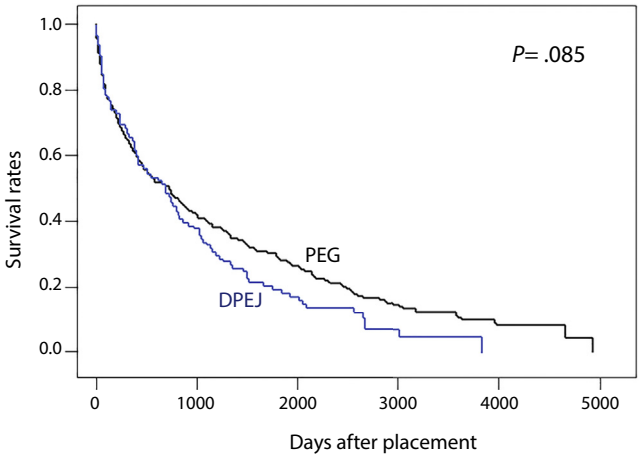

Figure 1. Kaplan-Meier survival curves of patients after undergoing DPEJ or PEG. *DPEJ*, Direct percutaneous endoscopic jejunostomy; *PEG*, percutaneous endoscopic gastrostomy.

The Cox proportional hazard model was used to assess the proposed univariate risk factors (Table 3). Eighty years of age or older, a CRP level of 1.0 mg/dL or higher, and CCI od 4 or more points were common risk factors for mortality in both groups. No history of upper GI surgery and the presence of diabetes were risk factors for mortality only in the DPEJ group. Multivariate analysis was conducted for the significant risk factors by univariate analysis in the DPEJ group (Table 4). Eighty years of age or older, a CRP level of 1.0 mg/dL or higher, and the presence of diabetes were independent risk factors for mortality after DPEJ.

Analysis of the causes of death is shown in Table 5. The primary reason for mortality was respiratory infection in both groups, although the rate was relatively lower in the DPEJ group. The second major cause of death was nonrespiratory infections in the DPEJ group, whereas it was heart failure in the PEG group.

DISCUSSION

To our knowledge, this is the first report to compare the prognosis of consecutive patients between DPEJ and PEG based on the success rate, AEs, and long-term outcomes, including survival analysis. DPEJ is still regarded as a more difficult technique compared with PEG, because the jejunal lumen is narrow and migration from the abdominal wall can occur easily with active peristalsis. The success rate of DPEJ was reported to range from 68% to 86% in large-scale studies conducted decades ago,[11-13] and the rate may decrease depending on an increase in the body mass index.[14] Several techniques have been reported to facilitate

TABLE 3. Univariate analysis of individual risk factors for mortality

Variables	DPEJ (n = 108)		PEG (n = 632)	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age ≥80 years	1.45 (1.17-1.83)	<.001	1.45 (1.30-1.61)	<.001
Female	1.07 (0.87-1.31)	.512	0.91 (0.83-0.99)	.047
Previous history				
Pneumonia	1.15 (0.93-1.42)	.211	1.27 (1.16-1.40)	<.001
Foregut operation	0.79 (0.64-0.97)	.025	1.21 (0.82-1.66)	.311
Parenteral nutrition alone*	1.18 (0.95-1.44)	.127	1.16 (1.06-1.27)	.613
Blood analyses				
Albumin <3 g/dL	1.03 (0.84-1.26)	.814	1.24 (1.14-1.36)	<.001
Total cholesterol <150 mg/dL	0.89 (0.72-1.12)	.309	1.24 (1.13-1.36)	<.001
Total lymphocyte count <1300/μL	1.05 (0.85-1.30)	.676	1.12 (1.03-1.23)	.013
Hemoglobin < 11.0 g/dL	1.10 (0.89- 1.36)	.380	1.22 (1.12-1.34)	<.001
C-reactive protein ≥1.0 mg/dL	1.34 (1.09-1.66)	.006	1.13 (1.03-1.24)	.007
Comorbidity				
Charlson comorbidity index ≥4	1.41 (1.13-1.74)	.003	1.29 (1.17-1.41)	<.001
Hypertension	1.12 (0.92-1.57)	.168	1.02 (0.93-1.13)	.633
Chronic heart diseases	1.10 (0.84-1.41)	.461	1.35 (1.21-1.49)	<.001
Cerebrovascular diseases	0.97 (0.80-1.20)	.796	0.94 (0.86-1.02)	.148
Dementia	1.12 (0.91-1.33)	.292	1.13 (1.03-1.24)	.008
Chronic obstructive pulmonary disease	1.01 (0.74-1.33)	.943	1.34 (1.17-1.51)	<.001
Diabetes	1.80 (1.18-2.56)	.008	0.97 (0.84-1.10)	.635
Malignant tumor	1.35 (0.94-1.84)	.100	1.39 (1.13-1.55)	.003

DPEJ, Direct percutaneous endoscopic jejunostomy; *PEG*, percutaneous endoscopic gastrostomy; *OR*, odds ratio; *CI*, confidence interval.
*Starvation for more than 2 weeks before placement.

TABLE 4. Multivariate analysis of risk factors for mortality after DPEJ

Variables	OR (95% CI)	*P* value
Age ≥80 years	1.30 (1.02-1.68)	.033
Previous foregut operation	0.89 (0.70-1.13)	.333
C-reactive protein ≥1.0 mg/dL	1.29 (1.03-1.63)	.028
Charlson comorbidity index ≥4	1.14 (0.80-1.46)	.295
Diabetes	1.57 (1.03-2.25)	.039

DPEJ, Direct percutaneous endoscopic jejunostomy; *OR*, odds ratio; *CI*, confidence interval.

placement, including the use of ultrasonography, fluoroscopy, or anchoring a needle to the jejunum.[15-17] Our success rate of DPEJ was as high as 93.9%, almost equivalent to that of PEG. This is probably because we routinely conduct DPEJ under the guidance of fluoroscopy and use a T-fastener fixation device. Although it is often difficult to identify the target jejunal site by transillumination and finger indentation, especially for obese patients, fluoroscopy is useful to determine the puncture site while observing the positions of the jejunal loop and the endoscope. Then, a T-fastener anchoring the jejunal wall to the abdominal wall facilitates DPEJ.

Another difficulty with DPEJ is to achieve endoscopic access up to the jejunum. Although push enteroscopy or pediatric colonoscopy was initially used for access to the jejunum, a single- or double-balloon enteroscopy was recently used for DPEJ.[8,9] Song et al[18] reported that double-balloon enteroscopy achieved successful placement of a DPEJ tube in patients with failed placement by push enteroscopy. In the present study, the duration of the DPEJ procedure was shorter and the success rate was higher in patients with a history of GI surgery than patients without such a history, showing a similar tendency to the previous reports.[11,13] When endoscopic access and technical problems are resolved, the remaining common

TABLE 5. Analyses of cause of death in patients who underwent DPEJ or PEG

Cause of death	DPEJ (n = 95)	PEG (n = 484)	*P* value
Respiratory infection	30 (31.6)	204 (42.2)	.052
Nonrespiratory infection	21 (22.1)	58 (12.0)	.013
Heart failure	13 (13.7)	79 (16.3)	.513
Respiratory failure other than respiratory infection	7 (7.3)	34 (7.0)	.905
Malignant tumor	6 (6.3)	25 (5.2)	.656
Multiorgan failure	3 (3.2)	7 (1.5)	.281
Cerebrovascular disease	2 (2.1)	15 (3.1)	.584
GI bleeding	2 (2.1)	6 (1.2)	.533
Renal failure	2 (2.1)	3 (0.6)	.207
Ileus	2 (2.1)	2 (0.4)	.120
Other diseases	1 (1.1)	3 (0.6)	.661
Unknown	6 (6.3)	48 (9.9)	.248

Values are n (%).
DPEJ, Direct percutaneous endoscopic jejunostomy; *PEG*, percutaneous endoscopic gastrostomy.

cause of failure for DPEJ and PEG may be lack of transillumination.

The AEs caused by DPEJ were similar to those of PEG in our study. Previously reported severe AEs of DPEJ included bleeding, bowel or gastric perforation, ileus, volvulus, abscess, sepsis, and aspiration, with frequency ranging from 1.1% to 7.7%.[9,11,13,14,17,19] In these AEs, bowel perforation, ileus, and volvulus are characteristic of DPEJ but not PEG. Although PEG is placed in the epigastrium region in most cases, an appropriate DPEJ site depends on each patient in view of his/her entire abdomen. Therefore, the possibility of accidental punctures involving intervening gut is higher with DPEJ than with PEG, even when fluoroscopy is used. However, the AEs in our study were generally minor events that could be managed conservatively and improved.

Pneumonia was the primary AE during feeding via the DPEJ tube, as well as the PEG tube. Some reasons for the high frequency of pneumonia in this study are (1) the observation period was long, (2) most of the patients were elderly and bed-ridden, and (3) pneumonia was sometimes caused by aspiration of saliva or nasal secretions, not only by gastroesophageal reflux. It is difficult to differentiate the cause of pneumonia as either retrograde or antegrade aspiration. The frequency of pneumonia was reported to be 25% on long-term observation in a previous report.[20] The frequency of pneumonia was lower in the DPEJ group than in the PEG group in our study, which might be associated with the fact that the frequency of vomiting was significantly lower in the DPEJ group than in the PEG group. Jejunal feeding was reported to suppress the incidence of pneumonia compared with gastric feeding.[5]

Fistula enlargement and peristomal leakage are prominent AEs with DPEJ. Our data show that more than 20% of the patients displayed peristomal leakage and 4.7% of the patients (5 patients) had their feeding through the stoma temporarily suspended. Strong et al[21] reported that 16.9% of DPEJ patients had uncontrollable peritube leakage as an AE when tube feeding was conducted over 30 days. The intestinal contents, including pancreatic juice and bile, might cause peristomal irritation and severe dermatitis. Although there were no upper GI AEs (bleeding and/or ulcer) in the DPEJ group, ileus was only seen in the DPEJ group. Attention must be given to the possibility of intestinal problems in patients who undergo DPEJ.

Only limited data are available on survival analysis after DPEJ. The 1-year survival rate was reported to be around 50%.[19,22] We demonstrate that the mortality after DPEJ was 34.3% at 1 year and 51.4% at 2 years, and the survival curve for DPEJ patients was similar to that of PEG patients in our study with similar demographic data. However, the survival curve of the DPEJ group dropped more than that of the PEG group after 2 years of placement. Long-term management of enteral feeding might be more difficult with DPEJ than PEG.

Factors predicting mortality after PEG are known. Advanced age, male, hypo-albuminemia, increased CRP levels, presence of heart failure, and high CCI score are risk factors for mortality.[23-26] Our analysis of the PEG group revealed a similar tendency. Advanced age, high CCI score, and increased CRP levels are common risk factors in both DPEJ and PEG groups. A history of upper GI surgery and the presence of diabetes were specific risk factors in the DPEJ group. Direct administration of food into the jejunum causes rapid absorption of glucose,

leading to prominent hyperglycemia, hyperinsulinemia, and reactive hypoglycemia.[27] Glycemic control is more difficult in patients with diabetes than in those without diabetes after DPEJ. A recent study revealed that extended glycemic fluctuation is a risk factor for macrovascular and microvascular events and mortality.[28] Slow or continuous infusion or use of low carbohydrate formulas are required for the prevention of glycemic fluctuation in jejunal feeding.[29,30]

Regarding analysis of the causes of death after PEG, Johnston et al[31] reported that the most frequent cause was respiratory disease, followed by central nervous system and cardiovascular diseases among their patients who died within 30 days after PEG. Suzuki et al[32] reported that 59% of Japanese geriatric patients died due to pneumonia on a long-term analysis after PEG. Although the present study also revealed that the primary cause of death was respiratory infection in both DPEJ and PEG groups, the frequency tended to be lower in the DPEJ group. On the other hand, death by nonrespiratory infection was significantly more frequent in the DPEJ group, indicating a possible association with poor glycemic control.

Our study includes some limitations. First, it was conducted in a small number of institutions (mainly one hospital). Multi-institutional studies with a greater number of patients are necessary to verify our findings. Second, this was a retrospective cohort study. A prospective study is considered more favorable. Third, the present study included elderly Japanese patients. The expected results may vary if younger generations or different races are included. Fourth, the nutritional outcomes could not be followed up in our data.

In summary, this is the first study to compare the short- and long-term outcomes DPEJ and PEG, including novel findings related to the effects of DPEJ. The further accumulation of various types of patients is necessary to verify our conclusion.

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