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Percutaneous endoscopic gastrostomy feeding effects in patients with neurogenic dysphagia and recurrent pneumonia

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Abstract

Background: Percutaneous endoscopic gastrostomy (PEG) feeding provides enteral nutrition to patients with neurological dysphagia. However, the conditions in which PEG should be applied to prevent pneumonia remain unclear. We aimed to evaluate the effect of PEG for patients with neurological dysphagia in preventing pneumonia.

Methods: We undertook a retrospective data review of 232 patients with neurological dysphagia who had undergone PEG from January 2008 to December 2018 at Inha University Hospital, in Incheon, Korea. We excluded patients who had not been followed up 6 months pre- and post-PEG feeding. In total, our study comprised 42 patients. We compared pneumonia episodes and incidence pre- and post-PEG.

Results: During the median post-PEG follow-up period, the 6-month pneumonia incidence among patients who had undergone PEG had decreased [median 0.3 (interquartile range (IQR) 0.0–0.7) *versus* 0.1 (IQR 0.1–0.3) episodes, $p = 0.04$]. In a multiple mixed model, PEG did not decrease the incidence of pneumonia ($p = 0.76$). However, the association between PEG and the incidence of pneumonia differed significantly depending on the presence or absence of recurrent pneumonia ($p < 0.001$).

Conclusions: PEG could effectively reduce the incidence of pneumonia in patients with neurogenic dysphagia, especially in those who had experienced recurrent pneumonia.

The reviews of this paper are available via the supplemental material section.

Keywords: dysphagia, enteral nutrition, gastrointestinal, intubation, nervous system disease, percutaneous endoscopic gastrostomy, pneumonia

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Introduction

Neurological diseases are common in older adult patients, affecting approximately 5–55% of people aged over 55 years.[1,2] They are associated with a high risk of adverse health outcomes, including mortality, disability, falls, institutionalization, and hospitalization. Neurological conditions such as stroke incidents (the most common cause of dysphagia), traumatic brain injury, cerebral palsy, Parkinson's disease, and other degenerative neurological disorders, including amyotrophic lateral sclerosis or advanced dementia, may cause swallowing difficulties and malnutrition.[3,4]

Pneumonia can be a frequent complication in patients with dysphagia due to central nervous system disease, partly because of unawareness of issues concerning swallowing and silent aspiration. Furthermore, impaired physical and cognitive abilities, which frequently accompany specific neurological diseases, may be exacerbating factors.[3,5] Approximately 38% of all deaths associated with a neurological condition are reported to have had a comorbidity related to respiratory diseases.[6] Therefore, in patients with neurological diseases, preventing recurrent pneumonia is very important.

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Enteral feeding can provide nutritional support in patients for whom oral intake is unsafe and contraindicated.[7,8] Nasogastric tube (NGT) or gastrostomy tube feeding provide two options for enteral tube feeding. Percutaneous endoscopic gastrostomy (PEG), first introduced in 1980, involves an endoscopy to insert a feeding tube into the stomach.[9] Nutritional support through PEG has been shown to result in increased nutritional indicators, weight gain, and lower treatment failure compared with NGT feeding.[10–13] However, it remains unclear whether PEG has effectively altered the incidence of pneumonia or decreased mortality.[5,14] It is also still not well known which condition of patients can be prevented from pneumonia when PEG is applied.

Therefore, we aimed to determine whether PEG can prevent pneumonia development in patients with neurogenic dysphagia through long-term follow-up observation pre- and post-PEG, considering covariates likely to affect the development and incidence of pneumonia.

Materials and methods

Study population and data collection

This study was reviewed and approved by the Ethics Committee of Inha University Hospital (approval no. INHAUH 2019-11-042). A retrospective analysis of patient data was undertaken involving 232 consecutive patients who had developed pneumonia after having undergone PEG, from January 2008 to December 2018, at Inha University Hospital in Incheon, Korea. All patients had been diagnosed with a neurological disease, such as a stroke incident, cerebral hemorrhage, amyotrophic lateral sclerosis, Parkinson's disease, and dementia, at least 6 months pre-PEG. We included patients able to be followed up for 6 months pre- and post-PEG. For each patient, we only considered the 2-year pneumonia incidence pre-PEG. The requirement for informed consent was waived, as the analysis used anonymous clinical patient data, which had previously been gathered with written patient consent.

Definition of diseases

Pneumonia episodes were recorded when patients visited the emergency room or outpatient clinics, at admission or during hospitalization. To differentiate between relapse and recurrence rates, recurrence was considered only when there had been infections separated by at least a 1-month asymptomatic interval, or complete radiographic clearing of the acute infiltrate.[15] The incidence of pneumonia pre-PEG was defined as the number of pneumonia episodes divided by the follow-up period within 2 years. The incidence of pneumonia post-PEG was defined as the number of pneumonia episodes divided by the period post-PEG to the last follow up. For patients who could not be examined during the follow-up period, clinical information was obtained through telephone contact.

Cerebrovascular accidents (CVAs) were divided into acute and chronic phases, based on a 6-month history following symptom onset.[16]

Indices for comorbidity, nutrition, activities of daily living, and dysphagia

Each patient's comorbidities were measured using an age-adjusted Charlson Comorbidity Index (CCI).[17,18] The controlling nutritional status (CONUT) score (calculated using serum albumin and total cholesterol concentration levels, and the total peripheral lymphocyte count) were used to evaluate the patients' nutritional status.[19] The physical functional status was measured using a simplified and modified version of the Katz Index of five activities of daily living (ADLs), namely, bathing, dressing, moving from a bed to a chair, using a toilet, and eating.[20] Dysphagia severity was assessed in a videofluoroscopic swallowing study, using the Dysphagia Outcome and Severity Scale (DOSS).[21] Patients unable to perform the swallowing study were recorded as DOSS level 1. Laboratory data comprised the CONUT score, and elements in the ADL (Katz) score and in the DOSS score (measured using the videofluoroscopic swallowing study) were evaluated using values that had been recorded pre-PEG and within 6–12 months post-PEG.

The PEG procedure

Three experienced endoscopists evaluated the suitability for gastrostomy and performed the PEG using a readily available PEG kit.[22] Most PEG tubes were placed with a pull-through technique.

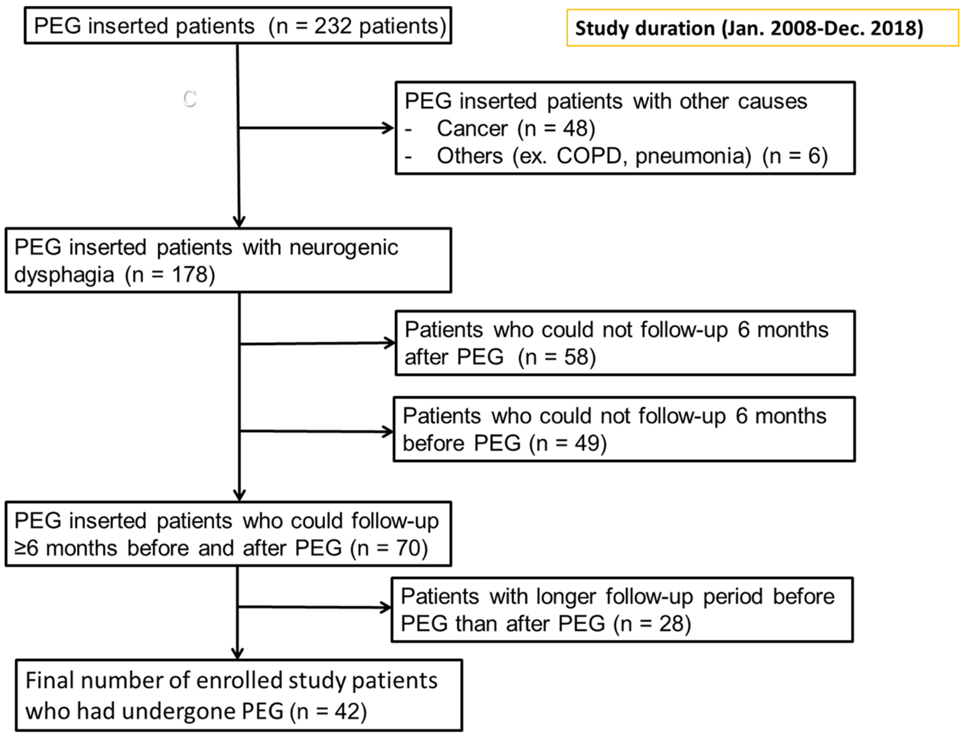

Figure 1. The patient selection process for patients who had undergone percutaneous endoscopic gastrostomy.
PEG, percutaneous endoscopic gastrostomy.

Statistical analysis

We used the Wilcoxon signed rank test for statistical analysis to compare pneumonia episodes and incidence pre- and post-PEG. The distribution of 6-month pneumonia incidence was shown to be positively skewed; therefore, a log-transformed value was used to approximate a normal distribution. A multiple mixed model with a random subject effect was used to analyze the association of covariates that could affect pneumonia incidence.

Multiple linear regression was used to determine the factors associated with post-PEG pneumonia incidence. Statistical significance was set at $p < 0.05$. Statistical analysis was performed using SPSS software version 19.0 (IBM Corp., Armonk, NY, USA) and an R statistics package (R Foundation, Vienna, Austria; https://www.r-project.org).

Results

PEG was performed in 232 patients with neurodysphagia. Of these, 54 patients who had undergone PEG due to other causes, such as cancer, were excluded. We excluded 58 and 49 patients who could not be followed up 6 months pre- and post-PEG, respectively. To check the occurrence of pneumonia for a specific period post-PEG, 28 patients whose pre-PEG follow-up period was longer than their post-PEG period were also excluded. Finally, 42 patients who had undergone PEG were included in our study (Figure 1).

The median patient age was 66 years [interquartile range (IQR), 58.0–75.0 years; Table 1]. More than 80% (81.0%, 34/42) of the patients had experienced a CVA. The median CCI score was 5 (IQR, 4–7). The median symptom duration pre-PEG was 585 (IQR, 243–1059) days, which equates to a symptom duration of approximately 1.5 years. More than two thirds (30/42, 71.4%) of the patients had dysphagia due to a CVA, and 27 (64.3%) patients who had experienced a CVA had undergone PEG 6 months following symptom onset.

Although some nutritional index scores were shown to have improved, no statistically significant difference was found in nutritional

Table 1. Baseline clinical characteristics of patients who had undergone percutaneous endoscopic gastrostomy.

Variable (n = 42)	n (%)	p value
Median age, years (IQR)	66.0 (58.0–75.0)	
Sex		
Male	(52.4)	
Female	20 (47.6)	
Comorbidity		
Diabetes	11 (26.2)	
Liver disease	3 (7.2)	
Malignancy	4 (9.5)	
Chronic kidney disease	0 (8.3)	
Congestive heart failure or AMI	1 (2.4)	
COPD	1 (2.4)	
Cerebrovascular accident	34 (81.0)	
Neurological disease		
Amyotrophic lateral sclerosis	5 (11.9)	
Brain tumor	1 (2.4)	
Ischemic stroke	13 (31.0)	
Hemorrhagic stroke	20 (47.6)	
Parkinsonism	4 (25.0)	
Dementia	5 (10.4)	
Hemiplegia	38 (90.5)	
CCI, median IQR	5.0 (4.0–7.0)	
Symptom duration pre-PEG, median IQR, days	584 (243–1059)	
Cause of dysphagia		
Cerebrovascular accident	30 (71.4)	
Acute phase (⩽6 months)	3 (7.1)	
Chronic phase (>6 months)	27 (64.3)	
Others	12 (28.4)	
Nutrition and ADL		0.33
Albumin, median IQR, mg/dL		
Pre-PEG	3.6 (3.1–4.0)	
Post-PEG	3.6 (3.3–3.9)	
Total cholesterol, median IQR, mg/dl		0.70
Pre-PEG	148 (117–174)	
Post-PEG	157 (126–167)	

(Continued)

Table 1. (Continued)

Variable ($n = 42$)	***n* (%)**	***p* value**
Lymphocyte count, median IQR, /mm^2		0.71
Pre-PEG	1456 (1020–1780)	
Post-PEG	1527 (1161–1750)	
CONUT score, median IQR		0.98
Pre-PEG	3 (2–5)	
Post-PEG	3 (3–4)	
ADL score, median IQR		0.82
Pre-PEG	0 (0–0)	
Post-PEG	0 (0–1)	
Feeding		
Oral feeding pre-PEG	3 (7.1)	
NGT pre-PEG (<6 months)	15 (35.8)	
NGT pre-PEG (⩾6 months)	24 (57.1)	
Follow-up days from NGT to PEG, median IQR, days	200 (85–261)	
Dysphagia score (DOSS), median IQR		0.57
Pre-PEG	1 (1–2)	
Post-PEG	1 (1–2)	
Possible oral feeding post-PEG	4 (9.5)	
Outcome		
Recurrent pneumonia pre-PEG	11 (26.2)	
Number with pneumonia, median IQR		0.31
Pre-PEG	1 (0–2)	
Post-PEG	1 (0–1.3)	
Follow-up days, median IQR		<0.001*
Pre-PEG	534 (247–730)	
Post-PEG	973 (759–1265)	
Incidence of pneumonia, median IQR, 6 months		0.04*
Pre-PEG	0.3 (0.0–0.7)	
Post-PEG	0.1 (0.1–0.3)	
Discharge destination		
No discharge to death	2 (4.8)	
Home	13 (31.0)	
Long-term care facility	27 (64.2)	
Death	14 (33.3)	

*Statistically significant ($p < 0.05$).
ADL, activity of daily living; AMI, acute myocardial infarction; CCI, Charlson Comorbidity Index; CONUT, controlling nutritional status; COPD, chronic obstructive pulmonary disease; DOSS, Dysphagia Outcome and Severity Scale; IQR, interquartile range; NGT, nasogastric tube feeding; PEG, percutaneous endoscopic gastrostomy.

indicators in terms of the CONUT score ($p = 0.90$). No significant difference was observed in the laboratory examination findings in relation to albumin levels ($p = 0.33$), total cholesterol levels ($p = 0.70$), and lymphocyte counts ($p = 0.71$) pre- and post-PEG, nor was there a difference in ADL scores or in the DOSS pre- and post-PEG.

Aside from three (7.1%) patients, NGT feeding had been performed prior to PEG. More than 50% (57.1% 24/42) of the patients had been fed *via* NGT feeding for >6 months prior to PEG. The median follow-up NGT feeding duration was 200 (IQR, 85–261) days. Four (4/42, 9.5%) patients were able to undertake oral feeding post-PEG.

Eleven (26.2%) patients had developed pneumonia on more than one occasion pre-PEG. No significant difference was found in the number of pneumonia episodes pre- and post-PEG [median, 1 (IQR 0–2) *versus* 1 (IQR 1–1.3) episodes, $p < 0.31$]. The 6-month pneumonia incidence was significantly different pre- and post-PEG [median, 0.3 (IQR 0.0–0.7) *versus* 0.1 (IQR 0.1–0.3) episodes, $p = 0.04$]. Approximately one third of the patients had been discharged home and approximately two thirds of the patients had been discharged to long-term care facilities. Two (4%) patients had died prior to discharge. Fourteen (33.3%) patients died during the follow-up period. Eight patients died of pneumonia, and six patients found to have had a cardiac arrest had died on arrival to hospital.

Significant factors associated with 6-month pneumonia incidence determined using a multiple mixed model

Covariates including PEG (pre- and post-), sex, recurrent pneumonia pre-PEG, NGT feeding (⩾6 months or not), CCI (⩾5 or <5), symptom duration pre-PEG (⩾1 year or not), cause of dysphagia (CVA or not), CONUT score (⩾2 or >2), ADL score (⩾1 or <1), and dysphagia score (⩾3 or <3) were considered as fixed effects in the model for log-transformed 6-month pneumonia incidence (Figure 2). Of these, recurrent pneumonia and NGT feeding ⩾6 months were found to be significantly associated with the 6-month pneumonia incidence. Recurrent pneumonia × PEG interaction and NGT × PEG interaction were also considered to determine whether PEG affected pneumonia depending on the presence or absence of recurrent pneumonia or a longer NGT feeding duration. In the multiple mixed model (Table 2), recurrent pneumonia pre-PEG ($t_{66} = 6.65$, $p < 0.001$) and NGT ⩾6 months pre-PEG ($t_{37} = 2.47$, $p = 0.02$) were positively correlated with the log-transformed 6-month pneumonia incidence. When controlling for these factors and interactive effects, PEG performance was shown not to differ significantly in terms of pneumonia incidence ($t_{66} = 0.3$, $p = 0.76$). However, the effect of PEG on pneumonia incidence significantly differed depending on the presence or absence of recurrent pneumonia. ($t_{39} = -3.61$, $p < 0.001$). No significant interaction was found between NGT feeding for ⩾6 months and PEG performance ($t_{39} = -1.02$, $p = 0.31$). The least squared mean of the log-transformed 6-month pneumonia incidence after adjusting for other covariates differed significantly, depending on the occurrence of recurrent pneumonia pre-PEG (Figure 3).

Significant factors associated with the post-PEG 6-month pneumonia incidence determined using a multiple linear regression model

The covariates including sex, recurrent pneumonia pre-PEG, NGT feeding (⩾6 months or not), CCI (⩾5 or <5), symptom duration pre-PEG (⩾1 year or not), cause of dysphagia (CVA or not), CONUT score (⩽2 or >2), ADL score (⩾1 or <1), dysphagia score (⩾3 or <3), and discharge destination (home or long-term care facility) were considered in the model for the post-PEG log-transformed 6-month pneumonia incidence (Figure 4). Of these, only NGT feeding ⩾6 months was significantly associated with the post-PEG 6-month incidence of pneumonia.

Discussion

This study investigated the risk of pneumonia development in patients with dysphagia, due to a neurological disorder, who had undergone enteral feeding. A statistically significant difference was found in the 6-month incidence of pneumonia pre- and post-PEG. PEG, recurrent pneumonia pre-PEG, and NGT feeding >6 months were significantly associated with pneumonia development in patients with neuro-dysphagia. NGT feeding ⩾6 months was found to be a significant factor for the post-PEG incidence of pneumonia. The incidence of pneumonia significantly changed for patients post-PEG depending on whether they had experienced recurrent pneumonia pre-PEG,

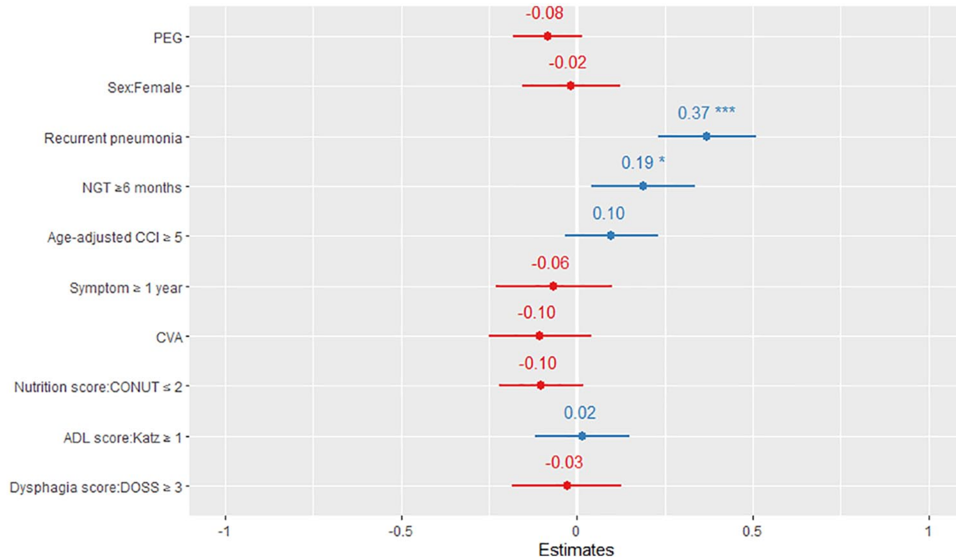

Figure 2. Estimated fixed effects of covariates on log-transformed 6-month pneumonia incidence
*Statistically significant ($p < 0.05$).
***Statistically significant ($p < 0.001$).
ADL, activity of daily living; CCI, Charlson Comorbidity Index; CONUT, controlling nutritional status; CVA, cerebrovascular accident; DOSS, Dysphagia Outcome and Severity Scale; NGT, nasogastric tube feeding; PEG, percutaneous endoscopic gastrostomy.

Table 2. The association between percutaneous endoscopic gastrostomy and recurrent pneumonia and the 6-month incidence of pneumonia.

Variable	Estimate[a]	SE	DF	*t* value	*p* value
(Intercept)	0.05	0.06	66.01	0.95	0.35
Recurrent pneumonia	0.53	0.08	66.01	6.65	<0.001***
NGT ⩾6 months	0.17	0.07	66.01	2.47	0.02*
(Pre- and post-) PEG	0.02	0.06	39.00	0.30	0.76
Recurrent pneumonia × PEG interaction	−0.31	0.09	39.00	−3.61	<0.001***
NGT ⩾6 months × PEG interaction	−0.08	0.08	39.00	−1.02	0.31

*Statistically significant ($p < 0.05$).
***Statistically significant ($p < 0.001$).
[a]Log-transformed value was regressed due to non-normality on residuals.
DF, degrees of freedom; NGT, nasogastric tube feeding; PEG, percutaneous endoscopic gastrostomy; SE, standard error of the estimated effect in the model.

after adjusting for other factors with fixed effects in the mixed regression model. Therefore, in patients with repeated episodes of pneumonia, PEG should be performed to prevent pneumonia.

Like our study, previous studies have identified several risk factors that contribute to the occurrence of pneumonia. Multiple comorbidity has been reported as a definite risk factor affecting the incidence of pneumonia and long-term mortality.[23] The CCI is shown to be a good marker for patients with pneumonia in evaluating the severity and mortality of this condition.[24] CCI has proven to be a significant risk factor for post-stroke or hospital-acquired pneumonia but not significant in this study due to the small number of subjects.[25,26]

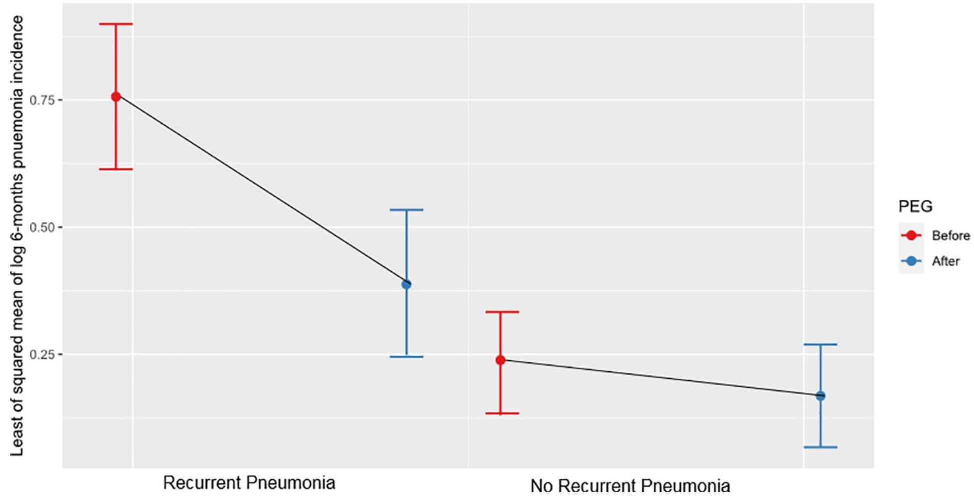

Figure 3. The different effect of PEG on incidences of pneumonia according to the presence or absence of recurrent pneumonia pre-PEG.
PEG, percutaneous endoscopic gastrostomy.

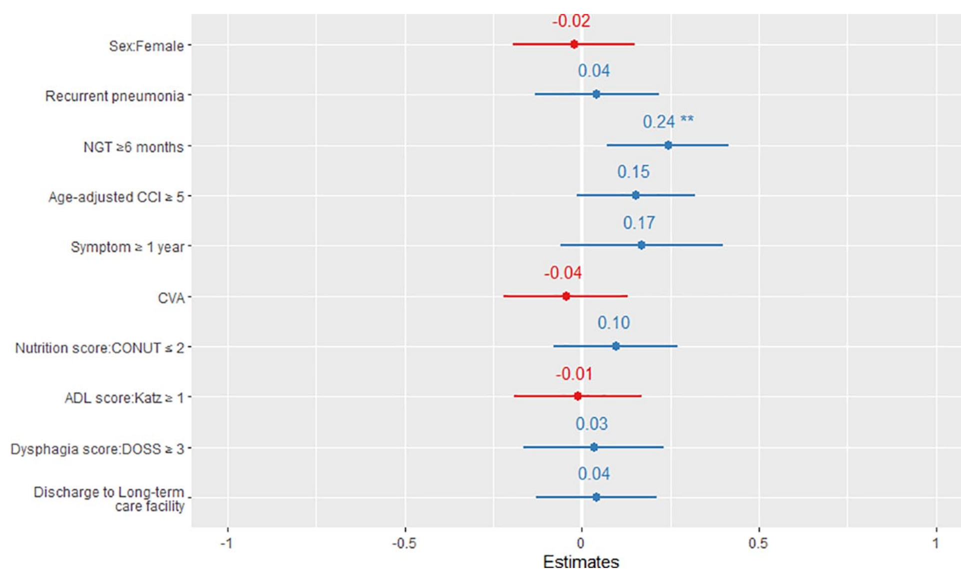

Figure 4. Estimated effects of covariates on log-transformed 6-month pneumonia incidence post-PEG.
*Statistically significant ($p < 0.05$).
ADL, activity of daily living; CCI, Charlson Comorbidity Index; CONUT, controlling nutritional status; CVA, cerebrovascular accident; DOSS, Dysphagia Outcome and Severity Scale; NGT, nasogastric tube feeding; PEG, percutaneous endoscopic gastrostomy.

Dysphagia has been reported in patients with stroke (8.1–80%), with Parkinson's disease (11–81%), and with traumatic brain injury (27–30%), as well as in older adult patients with community-acquired pneumonia (91.7%).[27] Therefore, the occurrence of dysphagia is more important than the precise neurological disease category, and early diagnosis of dysphagia has been shown to be helpful in preventing pneumonia.[28] However, in patients who have experienced a CVA, the swallowing function can recover through rehabilitation; therefore, this could explain the lower incidence of pneumonia in these patients over time compared with patients diagnosed with other diseases.[29,30] A longer NGT feeding time has been shown a risk factor for aspiration pneumonia.[31] Longer NGT feeding results in reflux of gastric contents through the oropharynx, and the materials can be easily aspirated into the lower airways. The following mechanisms have been reported to be responsible for aspiration in patients who undergo NGT feeding: (a) a loss of anatomical integrity of the upper and lower esophageal sphincters; (b) an increase in frequency of transient lower esophageal sphincter relaxations; and (c) a desensitization of the pharyngoglottal adduction reflex.[32]

In our study, PEG was found to be significantly negatively correlated with the incidence of pneumonia; however, in our multivariable analysis that considered this association, our findings indicated that PEG did not reduce the risk of pneumonia. Contrasting findings have been reported in several studies in terms of the extent to which PEG could prevent pneumonia.[5,14,33] In addition, longer NGT feeding times have not been significantly associated with PEG. Therefore, it remains unclear whether a change from NGT feeding to PEG is effective in preventing pneumonia. Previous studies have also reported contrasting findings concerning whether PEG reduces the incidence of pneumonia, compared with NGT feeding. Large prospective studies have shown no differences in pneumonia, mortality, and hospitalization rates, between patients who received PEG and those who received NGT feeding.[34,35] However, a recent cohort study indicated that patients with direct enteral tube feeding had higher odds of pneumonia in a 2-year period compared with those with temporary NGT feeding only.[36] Therefore, there is insufficient evidence to recommend simply switching from NGT feeding to PEG to prevent pneumonia in patients with neuro-dysphagia. In the analysis of post-PEG pneumonia, longer NGT feeding was found to be a significant factor. This may mean that the patients who had undergone a long period of NGT feeding already had a high aspiration risk. Long-term NGT placement could lead to sensory disorders, such as sensory deficits or desensitization in the laryngopharyngeal structures.[37] As a result, secretion accumulation in the pyriform sinus or a leak into the laryngeal vestibule could result in aspiration in these patients.[38]

Therefore, it is important when selecting patients for PEG to be aware that certain conditions respond more favorably in terms of preventing pneumonia. Our multivariable analysis indicated that PEG reduced the incidence of pneumonia in patients with recurrent pneumonia. Additionally, a past history of pneumonia or hospitalization has been identified as a risk factor for further pneumonia.[23,39,40] Patients with repeated episodes of pneumonia have several aspiration risk factors, such as orientation disturbance, poor performance, neurological disease, sleep medication, gastroesophageal disease, or malnutrition,[41,42] and PEG may mitigate some of these risk factors. Previous studies have reported a reduced incidence of gastroesophageal reflux in patients with PEG feeding.[43,44] In patients with repeated pneumonia, PEG feeding has been found to result in decreased gastric acid reflux compared with NGT feeding.[45] Malnutrition or incomplete functional status has been identified as a risk factor for pneumonia development in older adults.[42,46] It has previously been reported that PEG improves nutritional status in patients with amyotrophic lateral sclerosis.[47] Recent studies have reported that PEG contributed to improved survival rates in patients with amyotrophic lateral sclerosis, and that this was considered to be associated with a decrease in the incidence of pneumonia.[48,49] PEG feeding can improve a patient's nutritional status, quality of life, or functional status, as it has been shown to prevent advanced pneumonia.[50–52] Our study findings did not show any significant results due to the small study size; however, our patients' nutrition laboratory examination results showed some improvement 6 months post-PEG. The reason no improvement in the ADL score was observed is likely because most of the patients who had undergone PEG were sufficiently uncomfortable to not undertake self-feeding. However, many patients were able to visit outpatients using wheelchairs post-PEG (data not shown).

The strength of our study was the comparison of pre- and post-intervention outcomes regarding pneumonia episodes in the same patients after long-term follow-up examination. We also investigated whether there was a change in the incidence of pneumonia in patients with the presence or absence of recurrent pneumonia and a long NGT feeding time. Additionally, the incidence of pneumonia was examined for at least 6 months pre- and post-PEG. To demonstrate the effect of PEG, we adjusted risk factors to evaluate the incidence of pneumonia. To our knowledge, few studies have examined risk factors affecting the incidence of pneumonia. Considering risk factors, we were able to identify optimal patient conditions in which to perform a PEG procedure to prevent advanced or recurrent pneumonia.

Our study had some limitations. First, a limited number of patients were included. Second, pneumonia episodes had been counted and recorded during visits to the emergency room or the outpatient clinics, at admission, or through clinical confirmation during hospitalization. Therefore, it was not possible to estimate the exact number of pneumonia episodes that may have occurred external to our hospital setting. However, most patients had been consistently followed up at our hospital. Even when they had been referred to long-term care facilities, they were finally admitted to our hospital. Third, we examined patients with a mixture of several heterogeneous neurological diseases. However, most of them were in an advanced state of neurogenic dysphagia.

In conclusion, PEG could effectively reduce the incidence of pneumonia in patients with neurogenic dysphagia in optimal conditions, such as experiencing recurrent pneumonia pre-PEG. PEG feeding could improve nutritional status and gastroesophageal reflux in relation to neurological disability that resulted in the prevention of further pneumonia. Nevertheless, future largescale and multi-center studies are required to confirm our study findings.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Supplemental material

The reviews of this paper are available via the supplemental material section.

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