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Comparison of tube feeding in stroke patients

Nasogastric tube feeding versus oroesophageal tube feeding—A pilot study

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Abstract

Backgrounds: Patients with central nervous system injuries present with dysphagia and may require non-oral feeding methods, like percutaneous endoscopic gastrostomy, nasogastric (NG) tube, or oroesophageal (OE) tube. The prevalence of pneumonia in patients with gastroesophageal reflux (GER) is significantly higher than that in patients without GER. We aimed to determine the most appropriate tube feeding with low risk of GER by comparing the results of 24-hour pH monitoring studies in patients who were administered 2 types of feeding: NG tube and OE tube.

Methods: In this pilot study, 6 stroke patients underwent 24-hour esophageal pH monitoring during NG tube feeding and OE tube feeding, sequentially. Parameters collected included acid exposure time, mean esophageal pH, number of reflux episode, time of bolus reflux for both total 24-hour pH study data and postprandial data, and deMeester composite score.

Results: Total acid reflux time (minutes) decreased more with OE tube feeding than that with NG tube feeding in the total 24-hour pH study. The number of reflux episodes decreased in both total and postprandial data with OE tube feeding versus NG tube feeding ($P < .05$). There were no significant differences in mean esophageal pH and total time of bolus reflux between the 2 groups.

Conclusions: Although we could not definitively conclude that OE tube feeding decreased the severity of GER compared with NG tube feeding, there were significant differences in 4 out of 9 parameters. OE tube can be a substitute for NG tube in patients with dysphagia after stroke leading to GER disease.

Abbreviations: CNS = central nervous system, GER = gastroesophageal reflux, NG = nasogastric, OE = oroesophageal, VFSS = videofluoroscopic swallow study.

Keywords: dysphagia, gastroesophageal reflux, pH monitor, stroke, tube feeding

1. Introduction

Swallowing in healthy individuals is a complex process through which food is delivered from the oral cavity to the esophagus, which involves sequential contraction and relaxation of various muscles related to the anatomical structures through which the bolus passes.[1] Normal swallowing requires regulation by the swallowing center located in both hemispheres and in the brain stem as well as normal sensory and cognitive signaling, and anomalies in this process may cause dysphagia.[2] Central nervous system (CNS) injuries, such as stroke, traumatic brain injury, brain tumor, encephalitis, and cerebral palsy, and degenerative neural disorders, such as Parkinson disease, amyotrophic lateral sclerosis, multiple sclerosis, and Alzheimer disease, induce dysphagia by decreasing the functions of brain areas related to swallowing and the swallowing center. In addition, inflammatory diseases of the oral and pharyngeal muscles, oropharyngeal tumor, and esophageal diverticulum may also cause dysphagia by hindering sequential and harmonious contraction and relaxation.[2]

In particular, dysphagia is a major problem for stroke patients, with an incidence of 30% to 76% in the acute phase; it is caused by oral and pharyngeal disabilities due to abnormal lip closure, loss of oral motor function, and a delay or loss of the normal swallowing reflex.[3,4] Moreover, patients often have reduced motor functions in the extremities and trunk muscles and reduced visceral function, making them more vulnerable to other medical illnesses, such as dehydration, malnutrition, and aspiration pneumonia, which have detrimental outcomes including prolonged hospital stay and increased mortality.[3]

Multiple studies have suggested several alternatives to the normal oral diet in patients with dysphagia. Enteral feeding, such as nasogastric (NG) tube feeding, gastrostomy, and oroesophageal (OE) tube feeding, have several benefits over the parenteral route through the jugular vein, including easier provision of total calories and reduced risk of bloodstream bacterial infection.[5]

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Among the enteral tube feeding methods, the NG tube supply is the most widely used. However, since the NG tube is constantly placed in the swallowing organs, it artificially interferes with the natural physiology of oropharyngeal movements. Furthermore, the NG tube induces significant changes in the duration of food passage through the oral cavity and the larynx and in the duration of upper esophageal sphincter opening[3]; it is also associated with a risk of nasopharyngeal and esophageal inflammation, due to continuous oropharyngeal stimulation and gastroesophageal reflux, and aspiration pneumonia due to continuous opening of the upper and lower esophageal sphincter.

In OE tube feeding, the patient is instructed to swallow a 14 Fr. Nelaton catheter so that the tip of the catheter is placed in the middle of the esophagus, and food is provided through the tube[6] (Fig. 1). This method is not an option for patients with a hyperactive gag reflex or anatomical abnormalities, and it requires patient cooperation and voluntary participation.[2,5] However, the tube is only placed during feeding, which may prevent bacterial introduction and ulceration in the laryngopharyngeal mucosa, shorten the opening time of the upper esophageal sphincter, and avoid an open passageway from the mouth to the stomach caused by continuous tube placement. Furthermore, it enables the patient to maintain normal physiological and anatomical structures, which is helpful for rehabilitation of swallowing and facilitates the improvement of swallowing functions. Based on these data, OE tube feeding could be an appropriate feeding method for stroke patients who require swallowing rehabilitation but for whom other functions are relatively well preserved.[4]

Although the association between brain injury and gastroesophageal reflux has not been elucidated, studies continue to investigate the presence of gastroesophageal reflux in patients maintained on tube feeding or the association between tube feeding and gastroesophageal reflux.[7] This gastroesophageal reflux is clinically important because it is associated with reflux esophagitis, repeated vomiting, malnutrition, and recurrence of aspiration pneumonia.[8] The 24-hour pH monitoring study is a reliable method of measuring gastroesophageal reflux, as it shows the changes in reflux according to posture, diet, and training by recording gastroesophageal acidity throughout the day, as opposed to temporarily.[9]

None of the previous studies have investigated the incidence of gastroesophageal reflux associated with 2 tube feeding methods —NG and OE tube feeding. This study aimed to identify the most appropriate tube feeding with a low risk of gastroesophageal reflux by comparing the results of 24-hour pH monitoring study in patients who were administered the 2 types of feeding sequentially.

2. Materials and methods

2.1. Participants

Eleven outpatients and inpatients at the Department of Rehabilitative Medicine of the authors' facility from March 2013 to October 2014 were recruited. After excluding 1 patient for not cooperating in the first pH monitoring study, 3 patients who completed the first pH monitoring study but failed the second study, and 1 patient who was lost to follow-up, 6 patients were analyzed.

In this pilot study, the inclusion criteria were patients whose stroke occurred at least 1 week earlier and were judged to have no acute progression of brain lesion, patients who were determined to have dysphagia due to brain injury based on videofluoroscopic swallow study (VFSS), patients aged between 19 and 80 years, patients with partial dependence with a Modified Rankin

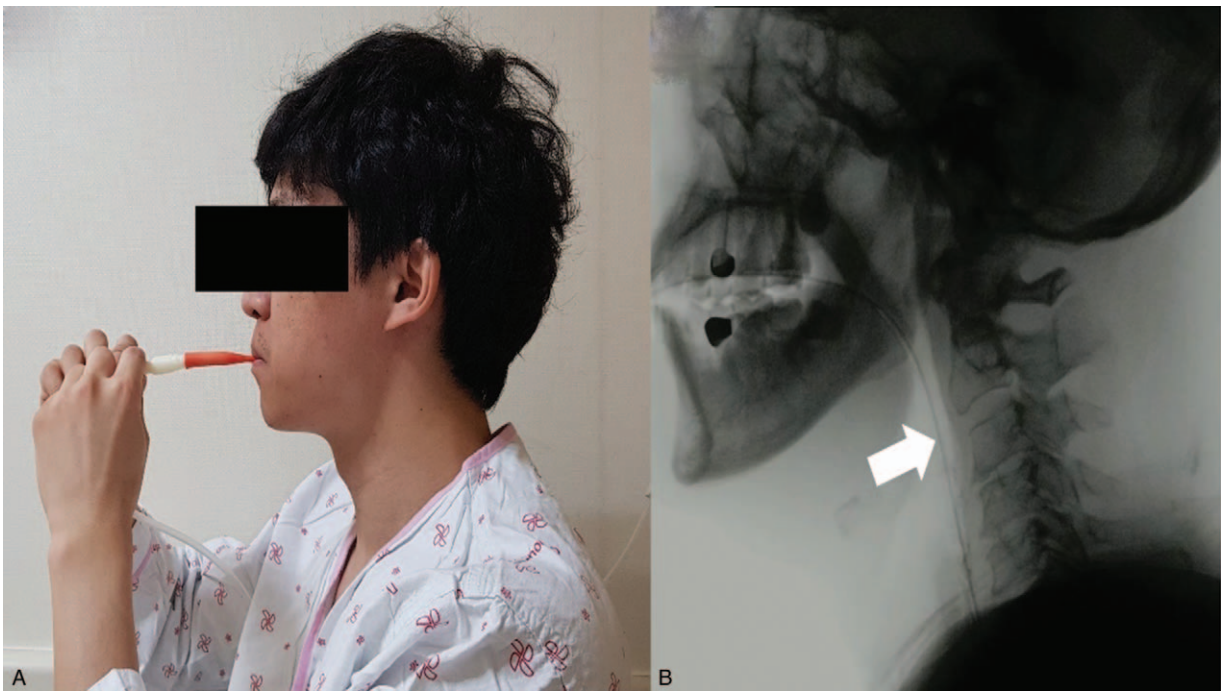

Figure 1. Intermittent oroesophageal tube feeding method. (A) A patient swallowing a tube by himself. (B) The intermittent oropharyngeal tube (white arrow).

Disability Scale score ≤4, patients with the Korean Mini Mental Status Examination score ≥20, patients who could understand and comply with instructions, and patients who provided consent to participate in this study. The exclusion criteria were history of dysphagia prior to brain injury, anatomical abnormalities in the swallowing organ or vocal organs that may affect dysphagia, medications that may affect gastrointestinal tract functions used for a prolonged time prior to brain injury, gastroesophageal reflux disorder prior to brain injury, asymptomatic aspiration on VFSS, and/or patients with inability or difficulty with participation in the trial, determined by the principal investigator. This study adhered to all regulations of the relevant institutions and the government regarding ethical use of human subjects for research throughout the entire study procedure, and this study was approved by the institutional review board at of the authors' facility (GCIRB2013-224).

2.2. Change of tube feeding method and test schedule

Participants who had undergone NG tube feeding for at least 14 days and were determined to require further tube feeding based on VFSS were screened and selected. These participants were administered the first 24-hour pH monitoring study while the NG tube was placed. The test was performed over a 24-hour period, and the tube feeding method was changed to OE tube feeding immediately upon completion of the test. After the change, the patients maintained OE tube feeding for 7 days and then underwent the second 24-hour pH monitoring study. The interval between the first and second 24-hour pH study was equally set to 1 week for each patient, and the amount, time, and type of food provided through the tube were kept equal for all patients. Patients would receive 400 mL of solution, 4 times a day using gravity feeding bag via NG tube or OE tube. The composition of the solution was protein (4 g/100 mL), fats (3.5 g/100 mL), carbohydrates (14 g/100 mL), fiber (1.5 g/100 mL), sodium chloride (90 mg/100 mL), potassium chloride (70 mg/l00 mL), and other minerals; the concentration of the solution was 1 kcal/mL.

The use of digestive medications that may affect study outcomes was prohibited throughout the study period, and swallowing rehabilitation therapy was administered equally, twice per day for 10 sessions per week.

2.3. 24-hour pH monitoring study

Prior to the 24-hour pH monitoring study, esophageal manometry was performed at the Department of Gastroenterology of the authors' facility. The location of the lower esophageal sphincter relative to the stomach was identified on manometry, and the pH electrode was placed 5 cm above the lower esophageal sphincter (Polygram Net; Medtronic Inc., Minneapolis, MN).[10]

The location of the electrode was marked in centimeters for each patient, and the electrode was placed at the same site for both the first and second studies. The placement of the mobile pH monitoring device and electrode was performed by one examiner. The patients and caregivers were informed that the installed pH monitoring device and electrode could record and mark the patient's postural changes (supine, sitting, or upright), diet, and sleep status throughout a 24-hour period. The values obtained after 24 hours were reported using a commercial program (Polygram Net; Medtronic Inc.).[10]

From the pH monitoring results, the total acid reflux time (minutes), mean esophageal pH, reflux episode, and reflux time were used for the analyses, and values obtained throughout 24 hours and those obtained 2 hours postprandial were separately analyzed. The DeMeester composite score was computed using 6 parameters from the 24-hour pH monitoring study: percentage of total time with $pH < 4$, percentage of upright time with $pH < 4$, percentage of supine time with $pH < 4$, number of reflux episodes, number of reflux episodes >5 minutes, and longest reflux episode.[10]

2.4. Statistical analysis

The reliability of the results and differences in the 24-hour pH monitoring study between NG and OE tube feeding among 6 patients were analyzed using the Wilcoxon signed rank test, and $P < .05$ was considered statistically significant. Statistical analyses were performed using SAS version 9.0 (SAS Institute, Cary, NC).

3. Results

3.1. Analysis of total results

Eleven patients who satisfied the inclusion criteria were first enrolled and underwent the first 24-hour pH monitoring study while on NG tube feeding between March 2013 and October 2014. After excluding 1 patient owing to suspected upper gastrointestinal tract bleeding, 3 patients for refusing to undergo or failing to complete the second test due to pain and discomfort caused by the test, and 1 for being lost to follow-up, the results from 6 patients (3 men and 3 women) were included in the final analysis. The duration of NG tube feeding, including the period after the diagnosis of dysphagia based on VFSS, ranged from 21 to 412 days. The types of brain lesions considered to be the cause of dysphagia included subarachnoid hemorrhage and medullary and cerebellar hemorrhage or infarct (Table 1).

3.2. Comparison of pH monitoring results between feeding methods

The results of 24-hour pH monitoring data from patients with NG tube feeding and OE tube feeding are presented as median, minimum, and maximum values (Table 2).

Total acid exposure time (minutes) improved with OE tube feeding compared with that with NG tube feeding on the 24-hour study (Fig. 2A), and the number of reflux episodes decreased in all

Table 1

General characteristics and clinical data of participants (N = 6).

	Characteristics value
Age, y	52.5 (40–78)
Sex (% female)	0.5
BMI	22.25 (20.07–28.67)
Body weight, kg	61.5 (52–79)
Onset duration, d*	154 (21–412)
MMSE	27 (21–29)
Lesion location	
Subarachnoid hemorrhage	2
Cerebellum and medulla infarct	3
Cerebellum and medulla hemorrhage	1

Values are given as median (range: minimum–maximum).

BMI = body mass index, calculated as weight in kilograms divided by height in meters squared, MMSE = Mini-Mental State Examination.

* The period from the onset to the first test.

Table 2

A representative 24-hour pH data from subjects with nasogastric tube feeding and oroesophageal tube feeding.

	1st NG tube feeding (N = 6)	2nd OE tube feeding (N = 6)
Total (24-hours)		
Total acid exposure time pH < 4, min	57.65 (10.00–217.90)	12.95 (0.00–48.40)*
Total number of reflux episode	52 (31–76)	30 (0–58)*
Esophageal pH (mean)	6.05 (4.86–6.28)	5.91 (5.73–6.86)
Total time of bolus reflux, min	13.95 (1.90–39.90)	14.90 (0–17.30)
Post prandial data (120 min)		
Acid exposure time pH < 4, min	26.35 (0.00–53.60)	12 (0.00–43.40)
Number of reflux episode	16.5 (7–36)	9.5 (0–27)*
Esophageal pH (mean)	5.09 (4.50–7.66)	5.90 (4.97–7.52)
Time of bolus reflux, min	2.95 (0.40–13.90)	2.10 (0.00–11.30)

Values are given as median (range: minimum–maximum). NG = nasogastric, OE = oroesophageal.
* $P < .05$, *P*-values from a Wilcoxon signed-ranks test.

patients with OE tube feeding on both the 24-hour pH study and postprandial study (Fig. 3). The reductions of these 3 parameters were statistically significant.

The mean esophageal pH decreased with OE tube feeding compared with NG tube feeding on both the 24-hour pH study and the postprandial study (Fig. 4). Total time of bolus reflux also increased with OE tube feeding (Fig. 5).

The median DeMeester composite score showed a lower value for OE tube feeding, which was statistically significant (Table 3). Four patients showed abnormal distal esophageal acid exposure, and the DeMeester score was >14.72 on the first pH study with NG tube feeding.[10] All of these patients showed lower DeMeester scores in the second pH study with OE tube feeding. Two other patients also had lower DeMeester scores in the second pH study compared with that in the first pH study (Fig. 6).

4. Discussion

For patients with dysphagia caused by brain injury, the goal of tube feeding is to provide the required calories and maintain nutritional status. Additionally, tube feeding may prevent the progression of secondary complications, such as aspiration pneumonia or gastroesophageal reflux. Among these, gastroesophageal reflux is associated with aspiration pneumonia and

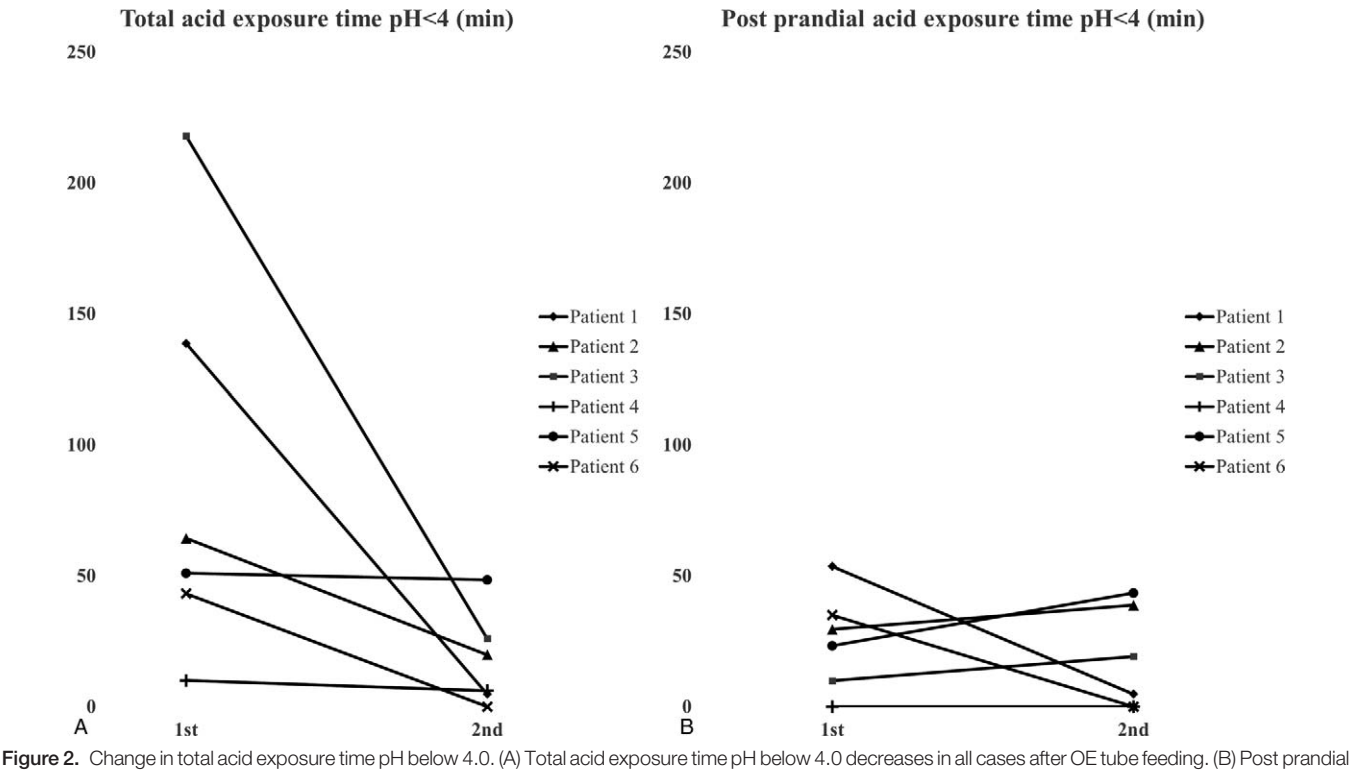

Figure 2. Change in total acid exposure time pH below 4.0. (A) Total acid exposure time pH below 4.0 decreases in all cases after OE tube feeding. (B) Post prandial data of acid exposure time pH below 4.0 decreases in 3 of 6 cases after OE tube feeding. 1st: NG tube feeding, 2nd: OE tube feeding. NG = nasogastric, OE = oroesophageal.

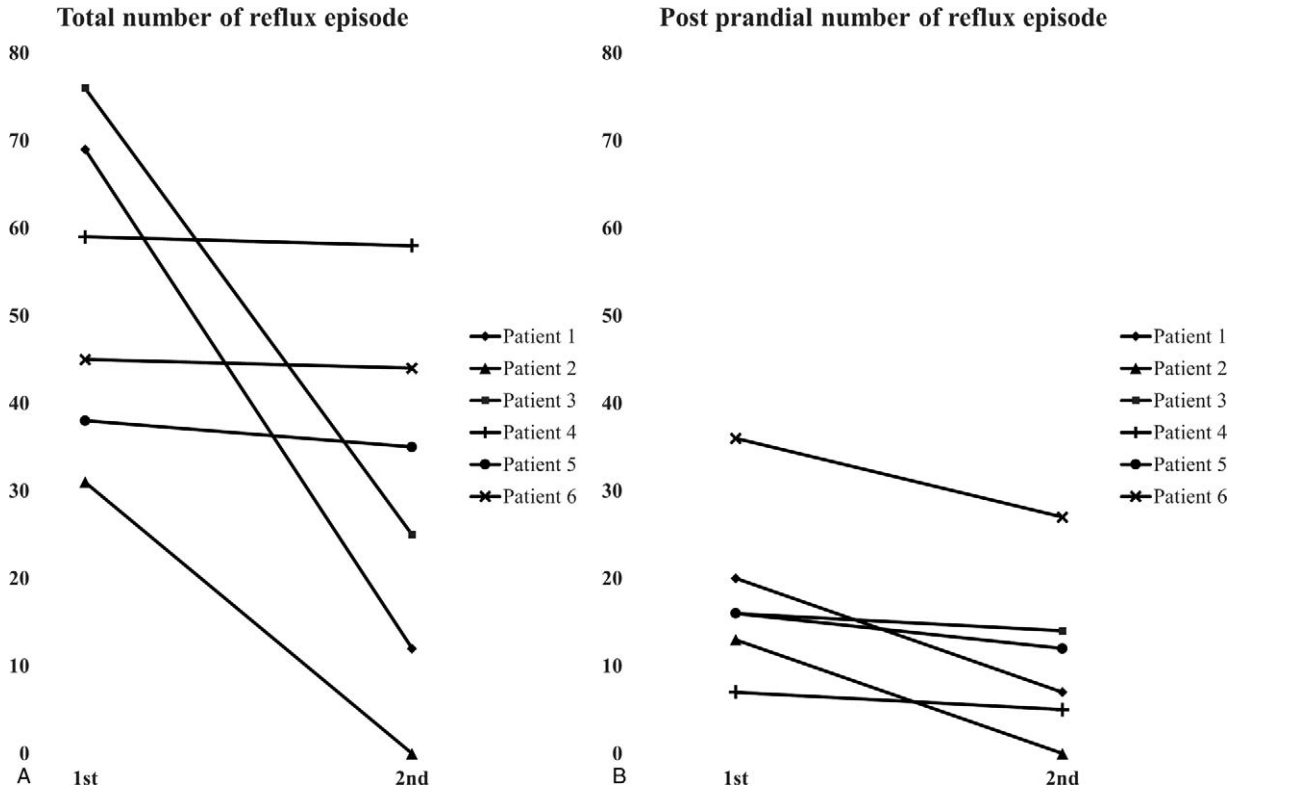

Figure 3. Change in total number of reflux episode. (A) Total number of reflux episodes decreases in all cases after OE tube feeding. (B) Post prandial data of number of reflux episode decreases in all cases. 1st: NG tube feeding, 2nd: OE tube feeding. NG = nasogastric, OE = oroesophageal.

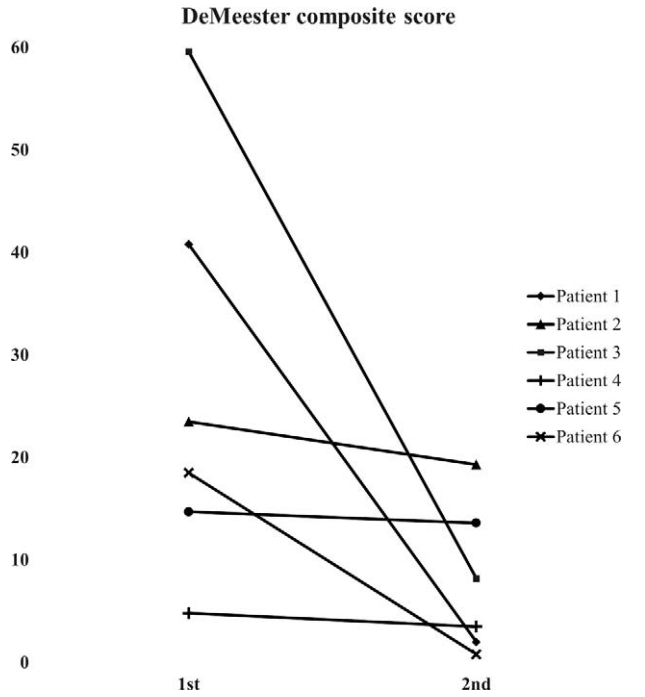

Figure 4. Change in DeMeester composite score. DeMeester composite score decreases in all cases after OE tube feeding. 1st: NG tube feeding, 2nd: OE tube feeding. NG = nasogastric, OE = oroesophageal.

may directly contribute to morbidity and mortality in patients undergoing tube feeding. Although drug therapy and postural adjustments are suggested as treatments of gastroesophageal reflux for patients with dysphagia, it is also important to confirm and apply a tube feeding method with a relatively reduced risk in order to prevent pneumonia from developing or worsening.[11]

In this study, there were significant changes in the total acid reflux time (minutes), total number of reflux episodes, number of reflux episodes after meals, and DeMeester composite score, all of which seemed to suggest that OE tube feeding was more effective in alleviating gastroesophageal reflux compared with NG tube feeding. Other parameters, including median value of mean esophageal pH and time of bolus reflux in the post prandial data, were also decreased in the OE tube feeding compared with NG tube feeding, but these differences were not statistically significant.

The mean esophageal pH in the 24-hour pH monitoring study did not show a statistically significant difference and did not show improvement with OE tube feeding compared with NG tube feeding (Fig. 5A). This may be because although the number of reflux episodes with $pH < 4$ was significantly reduced, the number of reflux episodes with $pH > 4$ increased with OE tube feeding. The total time of bolus reflux also increased when the OE tube was used (Fig. 6A). This could suggest that the number of reflux episodes decreased, but the food itself lingered in the esophagus for a longer period of time after reflux. This could be attributable to the fact that, in contrast to the NG tube providing food directly to the stomach, the OE tube is shorter and thus food is delivered to the mid esophagus.

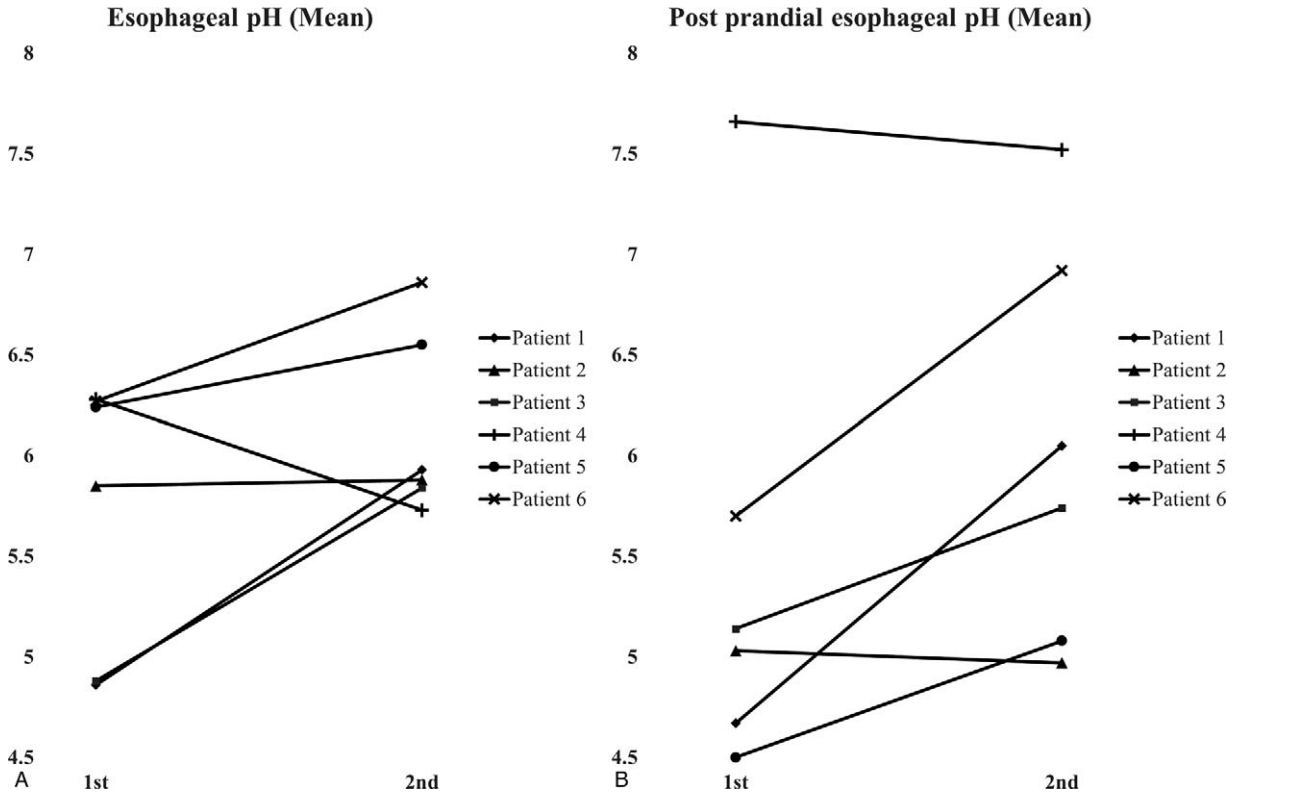

Figure 5. Change in mean value of esophageal pH. (A) Mean value of esophageal pH was decreased in 5 cases of 6 cases after OE tube feeding. (B) Post prandial data mean value of esophageal pH was decreased in 4 cases of 6 cases after OE tube feeding. 1st: NG tube feeding, 2nd: OE tube feeding. NG = nasogastric, OE = oroesophageal.

This study has some limitations. First, this study was initiated without assumptions about the sample size as a pilot study and was therefore analyzed using a nonparametric method. Hence, it would be difficult to obtain statistically significant values and trends with only 6 participants. Furthermore, because of the small sample size, the power calculated can be low. Thus, subsequent studies should analyze a larger number of cases. Second, patients' underlying diagnoses were not diverse. To limit the effects of several variables in participant recruitment, we attempted to limit the site of stroke; however, even with the same lesion, it was difficult to eliminate the differences in severity and specific site involved. Therefore, further studies with varying lesions among stroke patients who require tube feeding, would be beneficial rather than limiting patients according to stroke site. Furthermore, 3 participants with medullary and cerebellar lesions participated in this study within 50 days of onset; thus, there is a possibility that the natural recovery of neurologic symptoms observed in the subacute phase of stroke may have affected the study outcomes. The association between gastroesophageal reflux and aspiration in patients requiring long-term tube feeding could be more accurately examined by analyzing the data from stroke patients diagnosed with dysphagia and in need of long-term tube feeding. Future study warrants the need to investigate whether the gastroesophageal reflux changes induced by pharyngeal and esophageal motility, upper esophageal opening, and lower esophageal function depend on the site of the lesion and duration of onset. Finally, there were variables related to feeding that may have affected the outcomes. Although we set an equal amount, time, and type of food provided through the tube for all patients, patients' postprandial postures and activities were not controlled. To overcome these limitations, subsequent tube feeding studies should include a standard protocol for postfeeding postures and activities.

This study aimed to identify the optimal tube feeding method with a low risk of gastroesophageal reflux by comparing the results of 24-hour pH monitoring study in patients who were administered NG and OE tube feeding sequentially. This study could not definitively conclude that OE tube feeding decreases the severity of gastroesophageal reflux compared with NG tube feeding. However, there were significant differences in 4 out of 9 parameters; thus, additional studies should address the limitations of this study and further investigate OE tube feeding to determine the best tube feeding method for the prevention of gastroesophageal reflux and aspiration pneumonia.

Table 3

Assessment of 24-hour esophageal acid exposure.

	1st NG tube feeding (N = 6)	2nd OE tube feeding (N = 6)
DeMeester composite score*	21.00 (4.80–59.6)	5.85 (0.08–19.30)**

NG = nasogastric, OE = oroesophageal.

* DeMeester score, calculated from 6 parameters, normal <14.72 (percent total time pH < 4, percent upright time pH < 4, percent supine time pH < 4, number of reflux episodes, number of reflux episodes >5 minutes, longest reflux episode).

** $P < .05$.

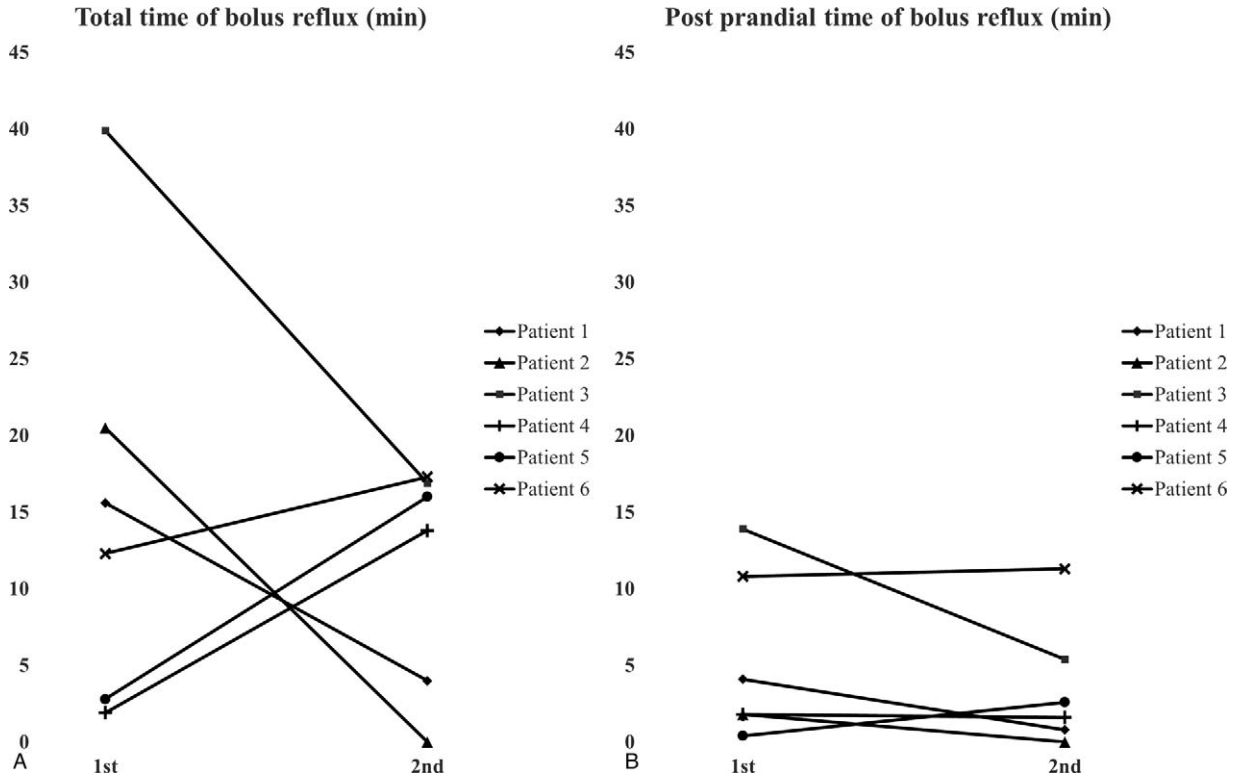

Figure 6. Change in total time of bolus reflux. (A) Total time of reflux episode was decreased in 3 cases of 6 cases after OE tube feeding. (B) Post prandial data of time of bolus reflux was decreased in 4 cases of 6 cases after OE tube feeding. 1st: NG tube feeding, 2nd: OE tube feeding. NG = nasogastric, OE = oroesophageal.

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Visualization: Jin Young Lee.
Writing – original draft: Jung Wook Park.
Writing – review & editing: Tae Hee Kim, Ki Deok Park.

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