

Predictors of Percutaneous Endoscopic Gastrostomy Tube Placement after Stroke

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ABSTRACT: *Aims:* The goal of this study was to identify important prognostic variables affecting placement of a percutaneous endoscopic gastrostomy (PEG) tube after acute stroke. *Methods:* We retrospectively reviewed our patient database to identify acute ischemic stroke patients who placed PEG or nasogastric tube (NGT) tube, but were free of other confounding conditions affecting swallowing. A total of 340 patients were involved in our study. We assessed the influence of age, National Institutes of Health Stroke Scale (NIHSS) score, infarct volume, stroke subtype based on the TOAST criteria, swallowing disorders, bilateral lesions in cerebrum and length of stay (LOS) in a logistic regression analysis. *Results:* In univariate analysis, age ($p=0.048$), NIHSS score ($p<0.0001$), lesion volume ($p<0.0001$), LOS ($p<0.0001$), stroke location ($p=0.045$), and swallowing disorders ($p<0.0001$) were found to be the primary predictors of placing PEG. The presence of lesions in bilateral cerebral was included in the final model based on clinical considerations. After multivariate adjustment, only NIHSS score (odds ratio [OR], 4.055; 95% confidence interval [CI], 2.398-6.857; $p=0.0001$), lesion volume (OR, 1.69; 95%CI, 1.09-4.39; $p=0.014$), swallowing disorders (OR, 1.151; 95% CI, 1.02-1.294; $p=0.047$), LOS (OR, 0.955; 95% CI, 0.914-0.998; $p=0.0415$) and bilateral lesions (OR, 2.8; 95% CI, 1.666-4.705; $p=0.0001$) remained significant. *Conclusion:* Our data shows that NIHSS score, lesion volume, swallowing disorders, LOS and bilateral lesions in cerebrum can predict the requiring of PEG tube insertion in patients after stroke.

RÉSUMÉ: *Facteurs de prédiction de la mise en place d'un tube de gastrostomie par endoscopie percutanée après un accident vasculaire cérébral.* *Objectifs:* Le but de cette étude était d'identifier les variables importantes du pronostic influençant la mise en place d'un tube de gastrostomie par endoscopie percutanée après un accident vasculaire cérébral aigu. *Méthode :* Nous avons revu rétrospectivement notre base de données pour identifier les patients atteints d'un AVC ischémique aigu, chez qui un tube nasogastrique ou un tube de gastrostomie par endoscopie percutanée avait été mis en place, mais qui ne présentaient pas d'autres problèmes touchant la déglutition. Notre étude porte sur 340 patients. Nous avons étudié au moyen d'une analyse de régression logistique l'influence de l'âge, le score au National Institutes of Health Stroke Scale (NIHSS), le volume de l'infarctus, le sous-type d'AVC selon les critères TOAST, les problèmes de déglutition, les lésions bilatérales au niveau des hémisphères cérébraux et le temps d'hospitalisation (TH). *Résultats :* À l'analyse univariée, l'âge ($p = 0,048$), le score au NIHSS ($p < 0,0001$), le volume de la lésion ($p < 0,0001$), le TH ($p < 0,0001$), l'endroit de l'AVC ($p = 0,045$) et les troubles de la déglutition ($p < 0,0001$) étaient les principaux facteurs de prédiction de la mise en place d'un tube de gastrostomie. La présence de lésions cérébrales bilatérales était incluse dans le modèle final pour des raisons cliniques. Après ajustement multivarié, seuls le score NIHSS (rapport de cotes [RC] 4,055 ; intervalle de confiance [IC] à 95% de 2,398 à 6,857 ; $p = 0,0001$), le volume de la lésion (RC 1,69 ; IC à 95% de 1,09 à 4,39 ; $p = 0,014$), les troubles de la déglutition (RC 1,151 ; IC à 95% de 1,02 à 1,294 ; $p = 0,047$), le TH (RC 0,955 ; IC à 95% de 0,914 à 0,998 ; $p = 0,0415$) et les lésions bilatérales (RC 2,8 ; IC à 95% de 1,666 à 4,705 ; $p = 0,0001$) demeuraient significatifs. *Conclusion :* Nos données démontrent que le score au NIHSS, le volume de la lésion, les troubles de la déglutition, le TH et la présence de lésions bilatérales dans les hémisphères cérébraux peuvent prédire la nécessité de mettre en place un tube de gastrostomie par endoscopie percutanée chez les patients atteints d'un AVC.

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Dysphagia are common after stroke and can cause chest infection and malnutrition.¹ Therefore, patients with swallowing problems may need nutritional support. Enteral feeding offers one way of providing such support.² It may be needed for a short time or for prolonged periods after acute stroke. Short-term feeding is usually given through a nasogastric tube (NGT).³ Percutaneous endoscopic gastrostomy (PEG), a minimally invasive technique that places a feeding tube into the stomach or jejunum, is used for longer periods. It is considered to be relatively simple and safe, while causing minimal discomfort.⁴ Each of these enteral feeding methods, however, has its own associated risks and benefits which must be considered. Nasogastric tube is easy to place, but it carries risks of tube displacement, aspiration pneumonia, and mechanical irritation of

the nasopharynx, and can be uncomfortable for the patient as well.^{3,5} It is necessary to state that aspiration pneumonia is the most prevalent acute complication of dysphagia, affecting up to one-third of patients with acute ischemic stroke. Percutaneous endoscopic gastrostomy is a more desirable method for

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sustaining patient nutrition over longer periods, due to fewer tube failures⁶, lower risk complications, such as damage to the nose and larynx, chronic sinusitis, gastro-oesophageal reflux, and aspirative pneumonia.^{6,7}

Identifying patients who fail to substantially improve swallowing function in early diagnosis would be beneficial for patients and their caregivers. Such patients can be placed on PEG earlier. The risk of aspiration pneumonia, length of stay (LOS), and cost of care can be reduced while nutrient absorption can be increased. However, PEG increases the risk of other complications, such as bowel perforation^{6,8,9}. Up until now, there has been a lack of high quality evidence demonstrating the benefit of PEG in stroke patients.^{10,11}

Some clinical observations have indicated that swallowing dysfunction predictors may include severe stroke as assessed by the National Institutes of Health Stroke Scale (NIHSS),³ different parts of brain regions (most notably the motor cortex, inferior frontal gyrus, insula, anterior insula, and periventricular white matter),^{12,13} age,¹⁴ and stroke lesion volume.¹⁵ However, the impact of these variables has not yet been systematically explored.¹⁶ The aim of our study was to analyze the effect of age, clinical severity (assessed by NIHSS score) and neuro-anatomical correlates (including sites and lesion volume) in predicting PEG placement in patients with swallowing problems. In addition, we attempted to identify a new predictive factor for PEG placement.

MATERIAL AND METHODS

Our study design was approved by Beijing Chaoyang Hospital's Institutional Review Board. In this retrospective and single-center study, patients were identified using Health Interventions codes-10 I63; I64; I65 and I66. Patients between January 2005 and January 2013 at Beijing Chaoyang Hospital were enrolled in the study. Inclusion criteria for patients included the presence of dysphagia, diagnostic accuracy cerebral infarction, as well as PEG or NGT placement during the same hospitalization. Each patient involved in our research underwent swallowing evaluation and a brain magnetic resonance imaging (MRI) scan. The stroke severity was assessed by the NIHSS when patients were admitted to the department of neurology in Beijing Chaoyang Hospital. We gathered information on patient demographics, including age, sex, stroke-associated vascular risk factors, history of transient ischemic attack or stroke, comorbidities (cardiac illnesses, diabetes, chronic hypertension, dyslipidemia), and common hospital complications (aspiration pneumonia, hospital mortality). Aspiration was defined as the entry of material into the airway below the levels of the true vocal cords.¹⁷ We also included the type of stroke (based on TOAST criteria) and the arterial distribution. Patients who had other confounding conditions that might have independently produced swallowing impairment, such as vocal cords dysfunction, prior tracheostomy, oropharyngeal malignancy, brain tumor, Parkinson's disease, advanced dementia, demyelinating diseases, inflammatory myopathies, myasthenia gravis, muscular dystrophies and cerebral hemorrhage, were excluded. Advanced dementia cognitive disorder eligibility criteria included age: 65 and older, dementia (any type, determined from the medical record), and a Global Deterioration Scale score of 7 (ascertained in an interview with a nurse caring

for the resident).¹⁸ In order to maximize the reliability of the estimates and minimize the confounding factors, subjects from the NGT group were also excluded if they subsequently had PEG inserted.

The brain MRI scan was reviewed by a radiologist who was blinded to the clinical data. Lesion volume and location were analyzed on diffusion-weighted imaging (DWI) sequences of brain MRI images obtained between 24 and 72 hours after symptom onset. Lesion volume was obtained from the original medical record and verified by two independent neurologist-observers and two radiologists. We used the ABC/2 formula to evaluate the lesion volume.¹⁹ Observers were blinded to data measured lesions in three perpendicular axes.²⁰ The slice with the largest lesion was first selected by eye. The longest lesion axis on this slice was measured with the ruler on an AGFA R4 Workstation with Impax Select software (v5205.0.0.1). A second line was drawn perpendicular to the first at the widest dimension. These two measurements were called the x (A) and y (B) axes. A third axis, the z (C) axis, was computed by multiplying the number of slices by slice thickness.¹⁹⁻²¹ The scan slice for MRI ranged from 6 to 7 mm for each subject was made by manually tracing the perimeter of the area on each MRI slice showing the infarct.¹⁹ This has been shown to be the most reproducible method of measuring lesion volume.^{19,20} All regions were scored aggregately in each individual patient.

The swallowing evaluation was done at bedside, including the repetitive saliva swallowing test (RSST) and modified water swallowing test (MWST).^{22,23} The tests were performed on the first day and the seventh day of hospitalization. These are excellent screening methods for assessing swallowing functions without using video fluoroscopy (VF), and their results correlate closely with those obtained using VF.^{22,24} The RSST and MWST were not performed in subjects with disturbed consciousness or unstable respiration, hypersecretion of sputum, or in those who were coughing intensely on their own saliva. In addition, the MWST was not performed in subjects who were unable to sit at

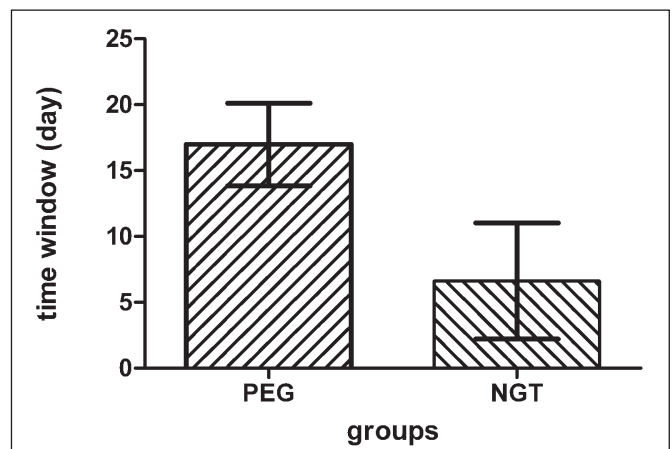


Figure: The mean time for PEG and NGT placement is shown in the Figure. The mean time for PEG placement was 16.98 days, and the mean time of NGT placement was 6.62 days after hospitalization. There was a significant difference between the two groups ($P < 0.0001$).

90° or who had fever or pneumonia. In this study, patients in the acute phase of stroke were classified as having normal swallowing function if RSST within 30 seconds was ≥ 3 and the MWST was ≥ 4 ; swallowing impairment was defined as a RSST within 30 seconds of ≤ 2 or a MWST result of ≤ 3 . The exact time for PEG and NGT placement were decided by two gastroenterologists who were blind to the diagnosis and treatment of the patients.

Statistical Analysis

Variables were analyzed by univariate and then multivariate logistic regression using SPSS software 17.0. For the purpose of statistical analysis, two continuous variables—age and infarct volume—were dichotomized into two groups each (age , < and ≥ 75 years; infarct volume , < and ≥ 100 mm) to improve clinical

interpretability. All remaining variables were entered in the analysis as binary variables (present/absent). Multivariate modeling included any variable found to have a P value <0.05 in univariate analysis; the lesions in bilateral cerebrum were included in the final model based on clinical considerations.

RESULTS

In our study there were 350 potential patients, 10 of them had NGT before PEG placement. These ten subjects were excluded from the study. The final analysis included 340 patients. The times of PEG and NGT placement are shown in the Figure. The mean time for PEG placement was 16.98 days, and the mean time of NGT placement was 6.62 days after hospitalization. There was a significant difference between the two groups (P < 0.0001).

Table: The baseline characteristics of patients and risk factors associated with PEG and NGT placement

Variable	Study cohort	PEG (57)	NGT (283)	P value*
age, years, mean \pm SD	69.00 \pm 17.03	73.2 \pm 8.9	64.7 \pm 8.1	0.048*
Female (%)	178 (52.25%)	35	143	0.069
Male (%)	162 (47.65%)	22	140	0.076
NIHSS score, mean \pm SD	13.32 \pm 9.4	19.01 \pm 6.1	8.03 \pm 8.21	<0.0001*
Stroke volume (cm ³), mean \pm SD	48.02 \pm 12.3	76.2 \pm 13.2	34.8 \pm 11.2	<0.0001*
Length of stay, mean \pm SD	18.25 \pm 9.36	28.1 \pm 10.1	12.9 \pm 5.9	<0.0001*
Stroke subtype based on TOAST criteria, n (%)				0.006
Large vessel atherosclerosis	93(27.4%)	11 (19.3%)	82 (29.0%)	
Cardio embolism	114(33.5%)	41 (71.9%)	73 (25.8%)	
Small vessel occlusion	54(15.9%)	3 (0.5%)	51 (18.0%)	
Stroke of other determined etiology	28(8.2%)	2 (0.4%)	26 (9.2%)	
Stroke of undetermined etiology	48 (14.1%)	0	48 (17.0%)	
Stroke location by arterial distribution, n (%)				0.045*
Middle cerebral artery	221(65.0%)	42(73.7%)	179(63.3%)	
Posterior cerebral artery	11(3.2%)	2(3.5%)	9(3.2%)	
Anterior cerebral artery	24(7.1%)	3(5.3%)	21(7.4%)	
Vertebrobasilar artery	39(11.5)	7(12.3%)	32(11.3%)	
Watershed infarction	16(4.7%)	1(1.8%)	15(5.3%)	
Multifocal circulation	39(11.5%)	2(3.5%)	27(9.5%)	
Hospital complications,				0.054
Hospital mortality	10	1	9	
Pneumonia	103	18	85	0.64
Diabetes	175	29	146	0.67
Chronic hypertension	172	33	139	0.72
Dyslipidemia	211	37	174	0.77

*Statistical significance provided for the PEG group versus NGT group.

The baseline characteristics of patients and risk factors associated with PEG and NGT placement are shown in the Table. Males comprised slightly less than half of the total population, but both groups had similar sex proportions and hospital complications. The mean \pm SD NIHSS score was 13.32 ± 9.4 , indicating a moderately severe stroke burden. The incidence of middle cerebral artery infarction was 33.5% in the included patients. In addition, there was no significant difference between the embolic disease group and the large vessel atherosclerosis group.

The most common hospital complications were hypoproteinemia and pneumonia. More than half of the patients suffered from at least one disease, such as diabetes, chronic hypertension, or dyslipidemia. Some patients even suffered from more than two of these diseases. Little difference was displayed between the two groups ($P=0.048$).

After univariate analysis, age, NIHSS score, infarct volume, LOS, stroke location based on arterial distribution and oropharyngeal dysphagia ($P<0.0001$) were found to be significantly associated with PEG placement. In a previous anatomical analysis, bilateral infarcts were significantly associated with oropharyngeal dysphagia and aspiration.³ Based on this consideration, we specifically assessed bilateral cerebral lesions (cerebral hemisphere and brain stem), whether the infarct was new or old. In the final multivariate model, we analyzed the influence of the aforementioned significant variables on our outcome of interest. The consequences of our study suggest that NIHSS score ($P < 0.0001$), lesion volume ($P=0.014$), deglutition disorders ($P=0.047$), LOH ($P=0.0415$), and lesions in bilateral cerebrum ($P<0.0001$) are significantly associated with PEG placement. Age ($P=0.55$), cardio embolism ($P=0.88$) and middle cerebral artery ($P=0.74$), which appeared to associate with PEG, didn't reach statistical significance.

DISCUSSION

To our knowledge, this was the largest reported multivariate analysis on prognostic factors that affected PEG placement in acute ischemic stroke patients in China. One of the most important observations of our study was the effect of lesions in bilateral cerebrum in oropharyngeal dysphagia patients.

The main results of our study showed that after controlling and correcting for possible confounding effects, the NIHSS score, lesion volume, infarcts in bilateral cerebrum and LOH were significantly associated with PEG tube insertion. The presence of infarcts in bilateral cerebrum (hemispheres or brain stem) in stroke patients was 2.8 times higher in those with PEG tube insertion compared to those with NGT insertion. The results indicated that oropharyngeal swallowing functions were under bilateral brain control. Furthermore, this result confirmed the crucial role of the uninjured hemisphere or brain stem in mediating swallowing function by way of compensatory reorganization of its swallowing cortex.^{24,25}

Ischemic stroke volume has been shown to be an important predictor of stroke recovery. A recent study found stroke volume assessed by DWI sequences was a significant variable in predicting outcome.²⁶ We also investigated the influence of lesion volume on the decision for or against PEG placement. Our results indicated that lesion volume had a significant impact on the decision for PEG insertion.

In hemispheric stroke patients with swallowing irregularities, Daniels *et al*²⁷ found no significant association between severity of dysphagia and size of the stroke lesion using semiquantitative analysis with head computed tomogram (CT) scans, while Kumar *et al*¹⁴ detected that there was a relationship between dysphagia and hemispheric lesion volume. However, both of these studies calculated the volume of hemispheric lesion only.^{14,28,29} In our study, we measured volume of lesions in both cerebral hemispheres and brainstems. In addition, our study employed more quantitative methods and measured ischemic lesion volumes on DWI sequences of brain MRI images, which was a more reliable method of detecting cerebral ischemia. We further oriented the affect of lesion volume in order to obtain more applicable effects in multivariate analysis. After controlling for potential confounding effects, lesion volume showed a significant correlation with PEG placement in stroke patients. Previous studies of global measures for functional recovery have found that NIHSS score is an important predictor of recovery following stroke after adjusting for other variables.^{3,30} Our results are consistent with previous study results.

Our study had some limitations. First, our results indicated that the lesion volume had significant impact on the swallowing function. However, the results did not take into account how different infarct sites or how involvement of multiple such sites affected the chance of PEG placement. The use of more sophisticated and newer imaging techniques, such as voxel-based symptom lesion mapping and diffusion tractography, might help answer these questions in the future. Second, although our study suggests that the lesion volume has significant impact on swallowing function, our sample size was not sufficiently large enough to involve all these variables in our analysis. In addition, we did not collect the data about patients who had swallowing impairment without PEG placement. There were two reasons for this. First, this was a retrospective study, and it was difficult to collect patients who had swallowing impairment without PEG placement. Second, the goal of this study was to identify important prognostic variables affecting placement of a PEG tube after acute stroke. Thus, patients who had swallowing impairment but did not receive a PEG tube were not included in our study. We had attempted to minimize the impact of these influences by using a systematic method for identifying consecutive ischemic stroke patients with severe dysphagia using ICD-10. Nevertheless, we were unable to capture all such patients systematically by using our approach. This might have inadvertently introduced a selection bias. Finally, in order to illustrate OR in clinical data, our study dichotomized ischemic lesion volume. The categories chosen ($<100 \text{ mm}^3$ and $\geq 100 \text{ mm}^3$) were based on the distribution of infarct volumes to ensure adequate numbers of patients in each group. Dichotomizing the continuous variable might also have compromised our statistical power and resulted in a more backward-looking estimate of effect on swallowing disorders. An appropriate solution to this conundrum might be to classify patients into more subcategories (eg, 15 mm^3 categories). However, we were restricted by our sample capacity. Despite these limitations, our analysis improves the understanding of the influence of clinical and radiological variables in predicting PEG placement in the early stage following stroke. Clinicians should

not wait for pneumonia to occur to make a decision regarding PEG placement.

In clinical practice, there is usually a delay of PEG tube insertion after ischemic stroke, which will prolong the length of stay. Identifying the variables discussed in this paper is an important step because building predictive models can capture individual information and assist physicians in making an educated decision. It is worthwhile for medical doctors to select patients who are suitable for PEG tube insertion at an early stage. We hope that our finding will facilitate larger, prospective studies that are better powered to detect the respective influences of these predictive factors.

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