Original Article

Nutritional intervention after an early assessment by a flexible endoscopic evaluation of swallowing is associated with a shorter hospital stay for patients with acute cerebral infarction: A retrospective study

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Background and Objectives: It is important to evaluate the swallowing function of patients with acute cerebral infarction. The effects of nutritional intervention after an early assessment by a flexible endoscopic evaluation of swallowing (FEES) were evaluated. **Methods and Study Design:** This retrospective study included 274 patients who were hospitalized for acute cerebral infarction and underwent a FEES between 2016 and 2018. The effects of early nutritional intervention after an assessment by a FEES within 48 h from admission were evaluated. The patients were divided into a shorter hospital stay group (<30 days) and a longer group (≥30 days). A multivariate analysis was performed to identify the predictive factors for a shorter hospital stay. **Results:** The overall patient characteristics were as follows: 166 men; median age, 81 years old; and median body mass index (BMI), 21.1 kg/m^2. No significant differences in the age, sex, or BMI were found between the shorter and longer hospital stay groups. A FEES within 48 h of admission (odds ratio [OR], 2.040; 95% confidence interval [CI], 1.120–3.700; *p*=0.019), FILS level ≥6 at admission (OR, 2.300; 95% CI, 1.190–4.440; *p*=0.013), and an administered energy dose of ≥18.5 kcal/kg on hospital day 3 (OR, 2.360; 95% CI, 1.180–4.690; *p*=0.015) were independently associated with a hospital stay <30 days. **Conclusions:** Patients with acute cerebral infarction are more likely to have a shorter hospital stay (<30 days) if they undergo a FEES early after admission and receive optimal nutritional intervention.

Key Words: flexible endoscopic evaluation of swallowing, acute cerebral infarction, dysphagia, hospital stay length, nutritional intervention

INTRODUCTION

Stroke is the most common cause of care dependency.[1] Generally, an oral intake is the most desirable route of nutrition administration; however, 27%-55% of patients have dysphagia at the onset of stroke.[2-5] The reported incidence of dysphagia is lowest when using cursory screening techniques (37%-45%), higher when using clin-

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ical testing (51%-55%), and highest using instrumental testing (64%-78%).[6]

Dysphagia makes oral intake difficult and causes malnutrition, dehydration, and aspiration pneumonia.[6] Dysphagia has been associated with an increased length of hospital stay, malnutrition, dehydration, and death[7] and is an independent prognostic factor in patients with stroke.[8] Therefore, swallowing screening tests are recommended for patients to decide whether they can safely start oral intake.[9] It is common to perform the repeated saliva swallowing test, modified water swallowing test, or 3-oz water swallowing test.[10,11] However, video fluorography (VF) and a flexible endoscopic evaluation of swallowing (FEES) are necessary for accurately evaluating the swallowing function.[9,12]

According to the European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines on clinical nutrition in neurology, oral intake and enteral nutrition should be started early during hospitalisation based on the results of swallowing function evaluation.[9] In our hospital, the dysphagia team was established in 2012, and a FEES for patients with stroke has been performed as early as possible following hospital admission since 2016. We have also developed a system that enables timely optimal nutritional intervention.

The present study explored the relationship between the effects of early nutritional intervention after assessment by a FEES and the length of hospital stay in patients with acute cerebral infarction.

METHODS

Patients

A total of 305 patients were admitted due to cerebral infarction and underwent a FEES between April 2016 and April 2018 at our hospital (Figure 1). After excluding patients with mild swallowing disorder with a food intake level scale (FILS) level >7, we retrospectively analysed data from 274 patients. The FILS is an evaluation method that classifies dysphagia into 10 levels; a FILS level of 7 means that easy-to-swallow food is orally ingested in three meals, and no alternative nutrition is given.[13] Because dysphagia of patients with stroke usually resolves within a few weeks,[14] patients were divided into a shorter stay group (<30 days of hospital stay) and a longer stay group (≥30 days of hospital stay). Among the factors compared between the two groups were the (i) age at admission; (ii) body mass index (BMI) at admission; (iii) serum albumin level at admission; (iv) nutrient dose administered on hospital days 3 and 7; (v) FILS at admission; (vi) number of days to initial a FEES from admission; and (vii) cerebral infarction side and site.

Factors contributing to a shorter hospital stay were evaluated using univariate and multivariate analyses with a logistic regression model.

The assessment of dysphagia

All patients with acute cerebral infarction were screened for dysphagia as early as possible from hospitalisation by speech language therapists or expert nurses. First, the repetitive saliva swallowing test[15] and modified water swallowing test[16,17] were used for primary screening. Next, we conducted a detailed assessment of dysphagia with a FEES. Two dentists performed a FEES at the patient's bedside using the C-MACTM 8403 (KARL STORZ SE & Co. KG, Tuttlingen, Germany),[18] a small-diameter video endoscope for otolaryngology allowing multiple medical staff to view the video images at once. This video endoscope is small (total length of 300 mm and tip diameter of 3.5 mm) and thus highly mobile. Therefore, it can be used at the bedside in patients who cannot be transported to the laboratory room. To reduce pain during the procedure, we used lidocaine jelly when inserting the endoscope into the nasal cavity. Patients were given a drink or test meal orally (see next section for

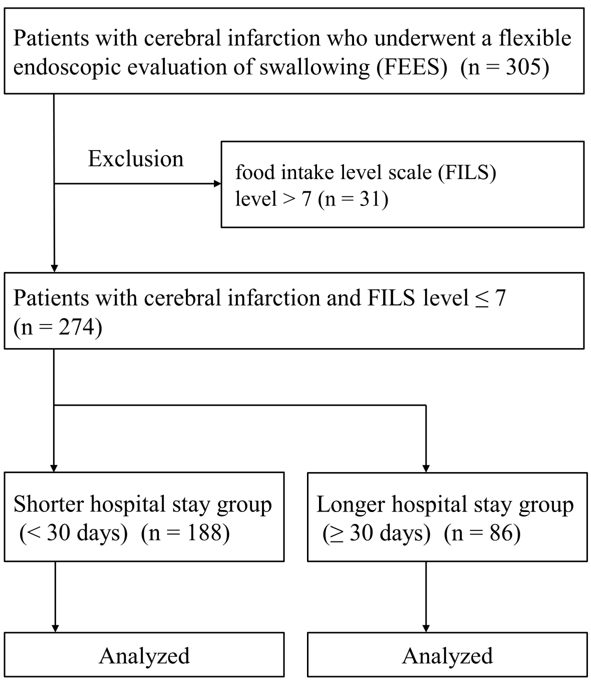

Figure 1. The selection process of the patients with cerebral infarction who underwent a flexible endoscopic evaluation of swallowing (FEES).

details on the test liquids and foods), and the swallowing ability was evaluated by observing the patient's pharynx directly with video endoscopy. To minimize the inter-examiner error, three or more examiners, including a dentist, registered dietitian and nurse, performed the FEES. They evaluated the saliva aspiration, aspiration on swallowing food, effect of adjustment of food texture and body position, and the relevance of the method of nutrition administration. Based on the FEES findings, the nutrition support team, consisting of physicians, dentists, speech language therapists, registered dietitians, nurses, pharmacists, and laboratory technicians, determined the optimal method of nutrition intake and food texture.

We tried to evaluate dysphagia and start nutritional intervention as early as possible after admission. The differences in duration until the initial FEES after admission depended on the staff numbers met with above criteria.

Test liquids and foods used in the assessment of dysphagia

Commercially available plain water, nectar thick water, and water jelly were used as test liquids in the FEES. The viscosity of thickened water was adjusted to 150-300 mPa·s as defined in the Japanese Dysphagia Diet (JDD) 2013 by the Japanese Society of Dysphagia Rehabilitation dysphagia diet committee.[19] To improve visualisation in the pharynx, the test liquids were artificially coloured green using fast green FCF (For Coloring Food), which is a turquoise triarylmethane food dye.

As test foods, JDD1 to JDD4 foods were used: JDD1, jelly (0j: jelly without protein, 1j: jelly with protein, and 0t: thick liquid), pudding, and mousse; JDD2, foods that can be eaten with a spoon, such as purees, paste, and mixed foods; JDD3, foods that hold a shape without water but are easy to crush, aggregate and move as a bolus, and pass through the pharynx; and JDD4, foods that are soft, loose, or sticky and can be eaten with chopsticks or a spoon.[19]

Data analyses

The Mann-Whitney U-test was used to compare the median of each variable. Categorical data were compared using Fisher's exact test. Continuous data were divided into two groups using each median as a cut-off value in a logistic regression model. To adjust for the confounding factors statistically in order to extract factors affecting hospital stay independently, we used a multivariate logistic regression analysis. Spearman's correlation coefficients were used to determine the association between the length of hospital stay and parameters. A p-value less than 0.05 was considered significant.

All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria).[20] More precisely, it is a modified version of R commander designed to add statistical functions frequently used in biostatistics.

RESULTS

The characteristics of the study patients are shown in Table 1. Among the 274 patients, there were 166 (61%) men and 108 (39%) women, with a median age of 81 (interquartile range [IQR] 73-86) years old and a median BMI of 21.2 (IQR 18.7-24) kg/m^2. The cerebral infarction sites were supratentorial in 209 (76%) patients and infratentorial in 65 (24%). There were 35 (13%) patients with a brain stem infarction and 239 (87%) with a non-brain stem infarction. The median serum albumin level in all patients was 3.9 (IQR 3.5-4.2) g/dL on admission. The

Table 1. The clinical characteristics of patients

Characteristics	Number (%) or median (IQR)
Patients, n (%)	274 (100)
Sex, n (%)	
Male	166 (61)
Female	108 (39)
Age at admission, years	
Side of infarct lesion, n (%)	81 (73, 86)
Left	112 (41)
Right	122 (45)
Bilateral	40 (14)
Site of infarct lesion, n (%)	
Infratentorial	65 (24)
Supratentorial	209 (76)
Brain stem	35 (13)
Non-brain stem	239 (87)
BMI at admission, kg/m^2	21.1 (18.7, 24)
Alb at admission, g/dL	3.9 (3.5, 4.2)
Days from admission to the initial FEES, n	2 (1, 3)
FILS level at admission	6 (3, 7)
FILS level at discharge	7 (3, 8)
Nutritional route at the first FEES, n (%)	
Enteral	163 (59.5)
Intravenous	111 (40.5)
Energy dose on day 3, kcal/kg/day	18.4 (9.6, 26.3)
Energy dose on day 7, kcal/kg/day	24.2 (19.4, 29.5)

Alb: albumin; BMI: body mass index; FILS: food intake level scale; IQR: interquartile range; FEES: Flexible endoscopic evaluation of swallowing.

numbers of days from hospitalisation to the initial FEES was 2 (IQR 1-3). The median FILS level in all patients was 6 (IQR 3-7) at admission and 7 (IQR 3-8) at discharge. The nutritional route at the first FEES was enteral in 163 (59.5%) patients and intravenous in 111 (40.5%). The administered calories on days 3 and 7 after the first FEES were 18.4 (IQR 9.6-26.3) and 24.2 (IQR 19.4-29.5) kcal/kg/day, respectively.

The patients were divided into a shorter hospital stay group (<30 days) and a longer hospital stay group (≥30 days), and their characteristics were compared (Table 2). There was no significant difference in age or sex between the two groups. The ratio of infratentorial and brain stem infarction was significantly higher in the shorter hospital stay group than in the longer hospital stay group (p=0.009 and p=0.006, respectively). The BMI was significantly higher in the shorter hospital stay group (21.5 kg/m^2; IQR 19.3-24.2) than in the longer hospital stay group (19.9 kg/m^2; IQR 17.9-22.9) (p=0.004). The number of days from hospitalisation to the initial FEES was significantly fewer in the shorter hospital stay group (2 days; IQR 1-3) than in the longer hospital stay group (3 days; IQR 1-4.8) (p=0.005). More calories were administered on day 3 in the shorter hospital stay group (20.2 kcal/kg/day; IQR 10.5-27) than in the longer hospital stay group (15.7 kcal/kg/day; IQR 7.6-21.9) (p=0.049). There was no significant difference between the two groups in the dose of calories administered on day 7 (24.5 kcal/kg/day; IQR 19.9-29.7 vs. 23.6 kcal/kg/day; IQR 16.4-28.7) (p=0.395). The serum albumin level was significantly higher in the shorter hospital stay group (3.9 g/dL; IQR 3.5-4.2) than in the longer hospital stay group (3.8 g/dL; IQR 3.5-4) (p=0.022). The FILS level on admission was significantly better in the shorter hospital stay group (7; IQR 3-7) than in the longer hospital stay group (3; IQR 2-7) (p=0.001). The FILS level at discharge was also significantly better in the shorter hospital stay group (7; IQR 5-8) than in the longer hospital stay group (7; IQR 3-8) (p=0.011). There

Table 2. Patient characteristics by length of hospital stay

Characteristics	Shorter hospital stay group (<30 days)	Longer hospital stay group (≥30 days)	*p*-value
Patients, n (%)	188 (69)	86 (31)	-
Sex, n (%)			
Male	110 (59)	56 (65)	0.351
Female	78 (41)	30 (35)	
Age on admission, years			0.115
Median	80.5	81.5	
IQR	72, 86	74, 86	
Side of infarct lesion, n (%)			
Left	76 (40)	36 (42)	0.895
Right	83 (44)	39 (45)	0.896
Bilateral	29 (16)	11 (13)	0.713
Site of infarct lesion, n (%)			
Supratentorial	135 (72)	74 (86)	0.009
Infratentorial	53 (28)	12 (14)	
Brain stem	31 (16)	4 (5)	0.006
Non-brain stem	157 (84)	82 (95)	
BMI at admission, kg/m^2			0.004
Median	21.5	19.9	
IQR	19.3, 24.2	17.9, 22.9	
Alb at admission, g/dL			
Median	3.9	3.8	0.022
IQR	3.5, 4.2	3.5, 4	
Days from admission to the initial FEES, n			
Median	2	3	0.005
IQR	1, 3	1, 4.8	
FILS level at admission			
Median	7	3	0.001
IQR	3, 7	2, 7	
FILS level at discharge			
Median	7	7	0.011
IQR	5, 8	3, 8	
Average	6.4	5.5	
Nutritional route at first FEES, n (%)			
Enteral	118 (63)	54 (63)	0.999
Intravenous	70 (37)	32 (37)	
Energy dose on day 3, kcal/kg/day			
Median	20.2	15.7	0.049
IQR	10.5, 27	7.6, 21.9	
Energy dose on day 7, kcal/kg/day			
Median	24.5	23.6	0.395
IQR	19.9, 29.7	16.4, 28.7	

Alb: albumin; BMI: body mass index; FILS: food intake level scale; IQR: interquartile range; FEES: flexible endoscopic evaluation of swallowing.

were no significant differences between the two groups in the nutritional route at the first FEES (enteral/intravenous: 118 [63%]/70 [37%] vs. 54 [63%]/32 [37%]) (p=0.999).

Using a logistic regression model, we identified the factors contributing to a shorter hospital stay (<30 days). The univariate logistic regression analysis revealed that among the 11 variables listed in Table 3, the following were associated with a shorter hospital stay: infratentorial infarct lesion (odds ratio [OR], 2.421; 95% confidence interval [CI], 1.217–4.816; p=0.012), brain stem infarct lesion (OR, 4.048; 95% CI, 1.382–11.860; p=0.011), BMI ≥21.1 kg/m^2 (OR, 1.683; 95% CI, 1.005–2.819; p=0.048), serum albumin level on admission ≥3.9 g/dL (OR, 1.853; 95% CI, 1.103–3.114; p=0.020), a FEES within 48 h of admission (OR, 2.781; 95% CI, 1.641–4.713; p<0.001), FILS level ≥6 on admission (OR, 2.760; 95% CI, 1.751–5.033; p<0.001); and administered nutrient energy dose of ≥18.5 kcal/kg/day on hospital day 3 (OR, 2.653; 95% CI, 1.558-4.519; p<0.001). As shown in Table 3, multivariate logistic regression analysis revealed the factors that were independently associated with a shorter hospital stay were: a FEES within 48 h of admission (OR, 2.040; 95% CI, 1.120-3.700; p=0.019), FILS level ≥6 on admission (OR, 2.300; 95% CI, 1.190-4.440; p=0.013), and administered nutrient energy dose of ≥18.5 kcal/kg/day on hospital day 3 (OR, 2.360; 95% CI, 1.180-4.690; p=0.015).

Figure 2 showed the association of the length of hospital stay and parameters analysed by Spearman's correlation coefficient. The BMI (Spearman's correlation coefficient=-0.188, p=0.002), serum albumin level at admission (-0.151, p=0.013), FILS level at admission (-0.324, p<0.001), and energy dose on day 3 (-0.176, p=0.004) were negatively correlated with the length of hospital stay.

DISCUSSION

We showed in this study that patients with acute cerebral infarction were more likely to have a shorter hospital stay (<30 days) if they underwent a FEES early after admission and received optimal nutritional intervention than otherwise. Early nutritional intervention after assessment by a FEES within 48 h was useful for shortening the hospital stay, and the energy dose on day 3 was significantly correlated with the hospital stay. In our hospital, a FEES is performed at the bedside early after the onset of cerebral infarction to evaluate the swallowing function accurately. Based on the information obtained from a FEES,

Table 3. Univariate and multivariate analyses of factors contributing to a shorter hospital stay

	Univariate analysis			Multivariate analysis		
Variables	Odds ratio	95% CI	p-value	Odds ratio	95% CI	p-value
Sex						
Male	0.755	0.445-1.283	0.300	0.703	0.380-1.300	0.263
Female	1			1		
Age, years old						
<81	1.100	0.659-1.830	0.721	0.800	0.445-1.440	0.457
≥81	1			1		
Side of infarct lesion						
Unilateral	1.260	0.616-2.600	0.522	1.150	0.504-2.640	0.735
Bilateral	1			1		
Site of infarct lesion						
Infratentorial	2.421	1.217-4.816	0.012	1.740	0.669-4.520	0.257
Supratentorial	1			1		
Brain stem	4.048	1.382-11.860	0.011	2.140	0.526-8.690	0.288
Non-brain stem	1			1		
BMI, kg/m^2						
≥21.1	1.683	1.005-2.819	0.048	1.720	0.914-3.250	0.093
<21.1	1			1		
Alb on admission, g/dL						
≥3.9	1.853	1.103-3.114	0.020	1.440	0.790-2.620	0.235
<3.9	1			1		
Timing of the FEES						
Within 48 h of admission	2.781	1.641-4.713	<0.001	2.040	1.120-3.700	0.019
More than 48 h from admission	1			1		
FILS level on admission						
≥6	2.760	1.751-5.033	<0.001	2.300	1.190-4.440	0.013
<6	1			1		
Nutritional route at the initial FEES						
Enteral	1.001	0.591-1.697	0.997	1.540	0.806-2.960	0.190
Intravenous	1			1		
Energy dose on day 3, kcal/kg/day						
≥18.5	2.653	1.558-4.519	<0.001	2.360	1.180-4.690	0.015
<18.5	1			1		
Energy dose on day 7, kcal/kg/day						
≥24	1.243	0.745-2.071	0.405	0.922	0.467-1.820	0.815
<24	1			1		

Alb: albumin; BMI: body mass index; CI: confidence interval; FILS; food intake level scale; FEES; flexible endoscopic evaluation of swallowing.

the optimal nutrition route is selected, and adequate nutrition therapy is provided.

Nutritional management in the acute phase of patients with cerebral infarction often begins with peripheral parenteral nutrition. Up until a few years ago, enteral nutrition from a nasogastric tube was generally started one to two weeks after admission in our hospital, after the condition stabilised as brain oedema improved. The FOOD Trial 2, which analysed 5,033 cases in 18 countries, reported that patients who started enteral feeding within 1 week from admission had a 5.8% lower mortality rate after 6 months than those who had delayed enteral feeding by peripheral parenteral nutrition.[21] The ESPEN guidelines also recommend enteral nutrition administration in the nutritional management of patients with stroke.[9] Therefore, in our hospital, we are currently using the intestinal tract for nutritional management in early hospitalisation as much as possible for patients with acute cerebral infarction. In this study, the patients with FILS ≥6 were judged to be able to take three meals orally, based on the result of a FEES performed at the onset of cerebral infarction. When the patients were considered to have severe dysphagia and difficulty swallowing, the nutrition support team proposed nasogastric tube feeding to patients whose intestine was functional.

However, aspiration pneumonia is a problematic complication among patients with cerebral infarction and dysphagia. Prevalence of pneumonia in patients with dysphagia after stroke was reported to range from 7% to 33%.[6] Aspiration without a cough (silent aspiration) further increases the incidence of pneumonia to 54% in post-stroke patients.[22] As a result, the optimal screening and assessment of dysphagia should be performed. To ensure appropriate assessments are performed, information obtained from a FEES is useful.

In general, patients with stroke are old and often malnourished.[23] In this study, the median age of all patients was 81 years old. Furthermore, the median BMI was as low as 21.1 kg/m^2. The BMI was negatively correlated with the length of hospital stay in this study. Because malnutrition causes a low BMI, active nutritional intervention from the early onset of cerebral infarction is necessary. The serum albumin level on admission and energy dose on day 3 were also negatively correlated with the length of hospital stay. As a result, the nutrition state and optimal nutritional intervention were important for shortening the hospital stay. To determine the optimal dose energy in the acute phase of cerebral infarction, it is desirable to use indirect calorimetry. However, in actual clinical practice, the energy expenditure is often calculated using the Harris-Benedict equation, as it is easier to use than indirect calorimetry. The energy requirement of patients with stroke is 20 to 30 kcal/kg/day according to the ESPEN guidelines.[9] We currently use this energy dose to manage nutrition in patients with cerebral infarction.

This study is associated with several limitations, including its retrospective design. Because the severity of stroke affects the length of hospital stay, the stroke severity should be analysed. However, it is difficult to estimate this value objectively. We therefore analysed the

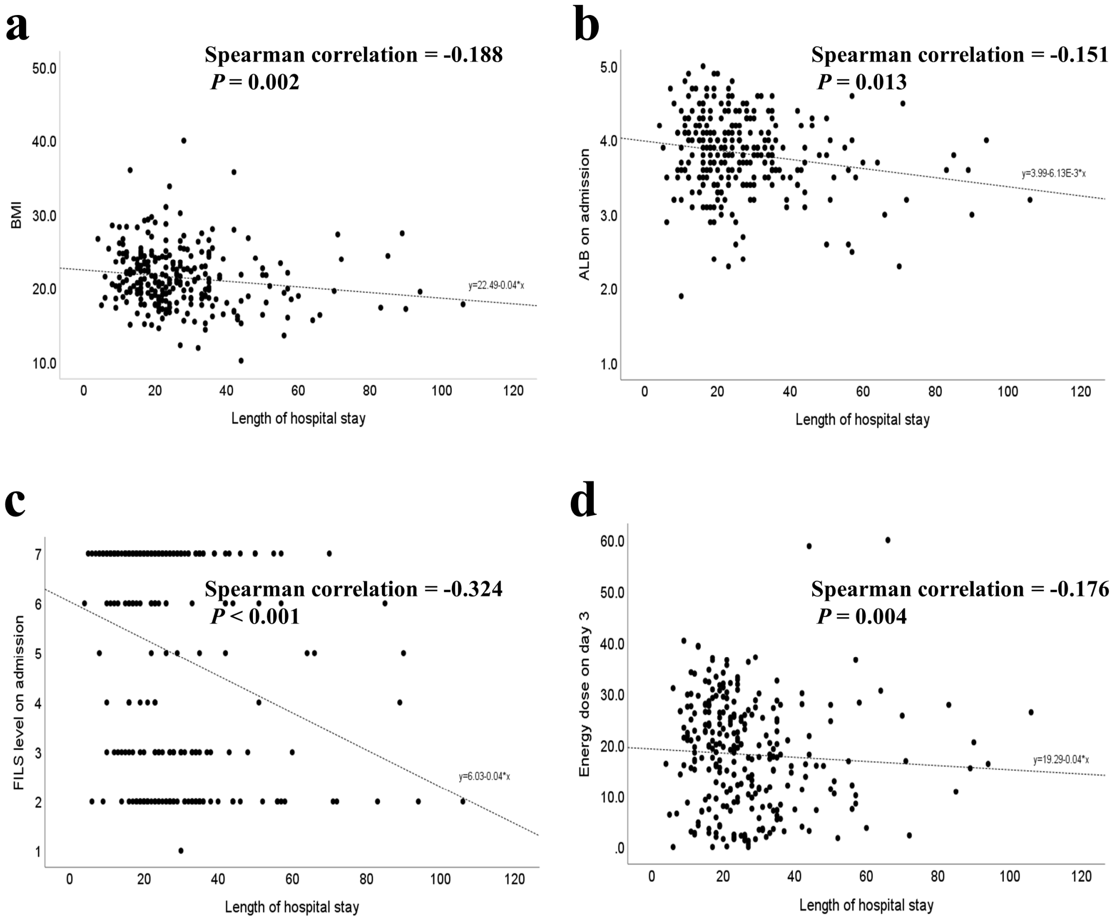

Figure 2. The associations between the length of hospital stay and parameters. (a) Body mass index, (b) serum albumin level at admission, (c) food intake level scale (FILS) level at admission, (d) energy dose on day 3.

side and site of infarction lesions and the FILS as an index of the stroke severity. Because the timing of the FEES was identified as a significant factor by a multivariate analysis, we consider that the results of this study are of consequence. The lack of information on grip strength and muscle mass was also a limitation, as we were unable to study the association of sarcopenia with dysphagia. Yoshimura et al recently reported that sarcopenia is associated with dysphagia recovery.[24] In the future, it will be necessary to investigate the relationship between the length of hospital stay and sarcopenia in a prospective cohort study.

In conclusion, we showed that the early assessment of the swallowing function in the acute phase of cerebral infarction is useful in clinical practice. An early FEES in patients with acute cerebral infarction and optimal nutrition management based on information from the FEES may allow for switching from parenteral nutrition to oral intake and enteral nutrition at an early stage as well as shortening the length of the hospital stay.

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AUTHOR DISCLOSURES

The authors declare no conflict of interest.

Written informed consent from patients was waived because clinical information obtained in routine clinical practice was used. We have provided patients with the opportunity to opt out on the web (official website of our hospital). The study protocol conformed to the ethical guidelines of the Declaration of Helsinki and was approved by the Institutional Review Board of National Hospital Organization Takasaki General Medical Center.

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