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Original Article

Dysphagia associated with acute-phase brainstem cerebrovascular disorder

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ABSTRACT

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Objective: To elucidate the details of dysphagia associated with acute-phase brainstem cerebrovascular disorders.

Methods: A total of 207 patients with brainstem cerebrovascular disorder that had developed within the past 3 days were examined at the Department of Rehabilitation Medicine. The median duration of hospital stay was 20 days. The most common lesion site was the pons in 168 patients and the lateral medulla in 25. A total of 167 patients had no history of cerebrovascular disorder in any part of the brain other than the brainstem (CVD−), and 40 patients had such a history (CVD+). A retrospective survey of these patients was conducted to identify the dysphagia severity scale (DSS) scores, eating status scale (ESS) scores, food texture, seating positions during meals, onset of pneumonia during follow-up, and functional independence measure (FIM).

Results: A total of 51% of CVD− patients and 64% of CVD+ patients had dysphagia, and DSS, ESS, food texture, and FIM scores at discharge all showed improvement at a significance level of 5%. No significant differences in DSS, ESS, and pneumonia incidence were observed between the CVD− and CVD+ patients.

Conclusions: The results of this study indicated that dysphagia can be improved even in patients with both CVD+ and CVD− acute-phase brainstem cerebrovascular disorders.

Key words: brainstem, cerebrovascular disorder, dysphagia, acute-phase

Introduction

While dysphagia frequently occurs in acute-phase cerebrovascular disorders, the rate decreases with disease progression. A study on 357 patients with supratentorial cerebrovascular disorders reported that 29% of patients experienced dysphagia within 48 h, 16% within 1 week, and 2% after 1 month [1]. In their study of the brainstem, Meng et al. [2] reported that of 36 patients who were hospitalized for brainstem cerebrovascular disorders, 39% could obtain nutrition through oral intake alone, and this increased to 88% at 4 months post-onset. When categorized on the basis of the lesion site, data showed the following rates of dysphagia: 10% of 40 patients with midbrain infarction [3], 46% of 25 patients with pons infarction [4], 24% of 49 patients with pons infarction [5], 65% of 130 patients with lateral medulla infarction [6], and 57% with lateral medulla infarction and 29% with medial infarction of 214 patients with medulla infarction [7]. Flowers et al. [8] reported that the rate of dysphagia following the onset of brainstem cerebrovascular disorder was 6% for the midbrain, 43% for the pons, 43% for the medial medulla, and 57% for the lateral medulla. Central pattern generators (CPG) and the nucleus ambiguus located in the medulla are closely involved in the swallowing function; therefore, a high percentage of patients in whom the affected area includes the nucleus ambiguus will experience dysphagia [9].

However, although most reports mention whether patients had dysphagia, the diagnostic criteria and severity level remain unclear. In addition, we

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conducted a thorough search of the available literature and found no reports that included details regarding food texture and the ways of dealing with dysphagia, particularly in patients with acute-phase brainstem cerebrovascular disorders. Thus, the objective of the present study was to elucidate the details of dysphagia in patients with these disorders.

Methods

This study was approved by the local Institutional Review Board. Subjects included patients who were admitted to Fujita Health University Hospital between June 2010 and May 2017 for brainstem cerebrovascular disorders and who were examined by the Department of Rehabilitation Medicine within 3 days of onset. Exclusion criteria were acute-phase cerebrovascular disorders located in other than the brainstem at the time of onset and a history of previous brainstem cerebrovascular disorders. A total of 207 patients (137 males and 70 females) met the criteria. The age was 71±12 years (mean ± SD). Investigation of primary disease indicated that 63 patients had branch atheromatous disease (BAD), 61 had lacunar infarction, 31 had hypertensive cerebral hemorrhage, 22 had atherothrombotic brain infarction, 9 had dissecting cerebral aneurysm, 4 had cardiogenic cerebral embolism, 1 had cerebral infarction following endovascular repair of cerebral aneurysm, 3 had cerebral hemorrhage due to cavernous hemangioma, and 13 had an unknown mechanism of pathogenesis. BAD was defined as infarct in contact with the basilar part of the pons, without a major artery with a high degree of stenosis or occlusion, or clear embolic source. Investigation of the affected sites revealed the following: 4 cases in the midbrain, 168 in the pons, 25 in the lateral medulla, 6 in the medial medulla, 2 in the semilateral medulla, and 2 extending from the pons to the midbrain.

In our hospital, all patients with cerebrovascular disorders are referred to the Department of Rehabilitation Medicine, and all patients receive swallowing exercise under the guidance of a speech–language–hearing therapist; exceptions would be if a physician determines that the patient is ineligible for oral intake because of poor overall condition or if the patient has no problem with their swallowing function. Swallowing exercises were determined according to the condition of each patient and comprised indirect exercises, such as cervical relaxation, cervical range of motion training, breathing training, thermal stimulation, Shaker exercise, Mendelsohn maneuver, supraglottic swallow, and balloon dilation, as well as direct exercises, such as diet modification, multiple swallowing, and think swallow [10–13].

Determinations of dysphagia severity, the possibility of oral intake, and food texture were made by physiatrists, the physicians in charge, the speech–language–hearing therapist, and ward nurses. The following data were collected at the initial examination at the Department of Rehabilitation Medicine and at discharge for both patients with no history of cerebrovascular disorders in sites other than the brainstem (CVD−) and those with such a history (CVD+): Information on Dysphagia Severity Scale (DSS) score, Eating Status Scale (ESS) score [14], food texture, seating position during meals, and Functional Independence Measure (FIM) both at initial examination in the Department of Rehabilitation Medicine and at discharge. Pneumonia onset during follow-up, and Glasgow coma scale (GCS) at admission. These were obtained from medical records at our hospital and retrospectively investigated. DSS was assessed using videofluoroscopic examination of swallowing (VF), videoendoscopic evaluation of swallowing (VE), and available screening tests. The staple food textures utilized were regular rice, soft rice, rice porridge, jellied porridge, and none (five steps). Side dish textures were regular vegetables, softened vegetables, dysphagia diet, dysphagia diet soups (thickened), puree with lumps, puree, and none (seven steps). Liquids were determined according to the National Dysphagia Task Force criteria and assessed on a four-step scale: no thickening required, nectar-thick, honey-thick, and liquids prohibited [15]. Dysphagia diet foods utilized at our hospital had degrees of solidness that could be coordinated with chewing with the gums. The soups provided with the dysphagia diet were thickened dysphagia diet soups with the consistency of nectar.

Statistical analysis was conducted using SPSS version 23 software. Data at the initial examination in the Department of Rehabilitation Medicine and those at discharge were compared using the Wilcoxon signed-rank test. Comparisons between CVD− and CVD+ and GCS data were conducted using the Mann-Whitney U test, and 2×2 cross table data were analyzed using the chi-squared or Fisher's exact test. $p<0.05$ was considered statistically significant.

Results

The median period between onset and initial examination at the Department of Rehabilitation Medicine was 2 days, and the median duration of hospital stay was 20 days. Investigation of post-discharge destinations for all 207 patients indicated that 118 (57%) went home, 57 (28%) went to a convalescence hospital, 13 (6%) were transferred to another hospital, 11 (5%) died during their hospital stay, 6 (3%) were institutionalized, and 2 (1%) were transferred to another department at our hospital. A total of 41 (20%) patients underwent VF and/or VE assessment of swallowing function during hospitalization. Of these 41 patients, 15 (7%) underwent both VF and VE, 8 (4%) underwent VF

only, and 18 (9%) underwent VE only. Intervention by a speech–language–hearing therapist was implemented for 116 (56%) patients during hospitalization. A total of 167 patients were CVD− and 40 were CVD+.

In CVD− patients, the lesions were located in the right side in 73, left in 82, and both sides in 12. It was difficult to determine DSS because it was impossible to satisfactorily assess the swallowing function of 14 patients during the initial examination at the Department of Rehabilitation Medicine and 12 patients at discharge. Of the 153 patients who were assessed for DSS both during the initial examination at the Department of Rehabilitation Medicine and at discharge, DSS 7 was the most common score at both time points, and DSS scores showed a significant improvement at discharge ($p < 0.001$). In CVD+ patients, the lesions were located in the right side in 17, left in 16, and both sides in 7. It was not possible to determine the DSS score both at initial examination and at discharge in one patient but it was possible in the other 39. Among these 39 patients, most had a score of DSS 3 at initial examination and DSS 7 at discharge, indicating significant improvement (p= 0.019). DSS scores at initial examination and discharge showed no significant differences between CVD− and CVD+ patients (Fig. 1).

The percentage of patients with a DSS score of ≤5, indicating the presence of dysphagia, was 51% at initial examination and 38% at discharge for CVD− patients and 64% at initial examination and 54% at discharge for CVD+ patients. For patients with lesions located in the pons, 15% of CVD− patients and 20% of CVD+ patients were still undergoing enteral feeding at discharge. No significant differences were found between CVD− and CVD+ patients in terms of the percentage of patients with dysphagia at initial examination and discharge or the percentage of patients undergoing enteral feeding at discharge (chi-squared test) (Table 1).

Among CVD− patients, 148 (89%) were able to orally ingest food during their hospital stay. Investigation of their seating position at the start of meals indicated that 127 were in the seated position and 21 were in a reclining position, with one patient at an angle of elevation of 75°, 13 at 60°, and 7 at 45°. For 15 patients, the angle was determined based on results of a swallowing function assessment (either VF or VE), and in the remaining 6 patients, angle coordination was conducted because they had difficulty in maintaining the seated position. Based on the results of VF or VE, 7 patients performed head rotation during oral food intake; 5 patients performed rotation to the affected side of the head during oral intake, and 2 of these no longer needed to perform head rotation by the time they were discharged. Three patients performed both head rotation and reclining position at the start of meals, and 2 of these 3 patients also performed trunk rotation to the non-affected side. At discharge, 1 patient was able to orally ingest food in a seated position without head rotation, 1 in a seated position with head rotation to the affected side, and 1 at an elevation angle of 45° with head rotation to the affected side. No patients required trunk rotation at discharge. In 2 patients, because the bolus tended to be passed on the affected side from the start of oral intake until discharge, they performed head rotation to the non-affected side in a seated position. At discharge, 140 patients were able to orally ingest food in a seated position. Of these, 51% of patients with lesions in the pons and 62% of those with lesions in the lateral medulla were able to orally

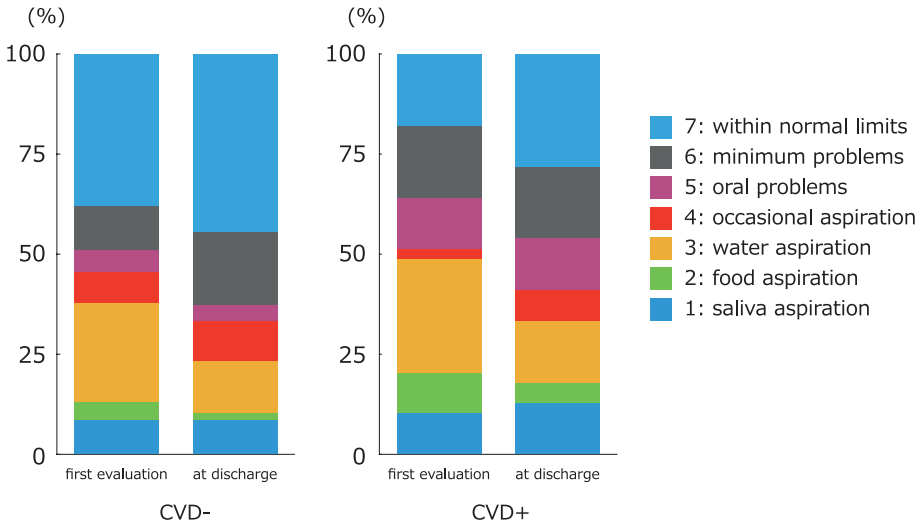

Figure 1. Changes in Dysphagia Severity Scale (DSS).
DSS scores at initial examination and discharge showed no significant differences between CVD− and CVD+ patients (Mann-Whitney U test). DSS scores showed a significant improvement at discharge both in CVD− ($p < 0.001$) and in CVD+ (p = 0.019) patients (Wilcoxon signed-rank test).

Table 1. Lesions and dysphagia.

a. CVD−

Lesion	Number of patients	Presence of dysphagia at initial examination	At the start of meals			At discharge		
			Reclining position	Head rotation	Trunk rotation	Presence of dysphagia	Regular diet	Presence of tube feeding
Midbrain	4	0	0 (0%)	0 (0%)	0 (0%)	1 (25%)	3 (75%)	1 (25%)
Pons	133	66	18 (14%)	1 (1%)	0 (0%)	48 (36%)	68 (51%)	20 (15%)
Lateral medulla	21	9	2 (10%)	5 (24%)	1 (5%)	7 (33%)	13 (62%)	0 (0%)
Medial medulla	5	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	5 (100%)	0 (0%)
Semilateral medulla	2	2	1 (50%)	1 (50%)	1 (50%)	1 (50%)	1 (50%)	0 (0%)
Pons+midbrain	2	1	0 (0%)	0 (0%)	0 (0%)	1 (50%)	1 (50%)	1 (50%)
Total	167	78 (51%*)	21 (13%)	7 (4%)	2 (1%)	58 (38%*)	91 (55%)	22 (13%)

b. CVD+

Lesion	Number of patients	Presence of dysphagia at initial examination	At the start of meals			At discharge		
			Reclining position	Head rotation	Trunk rotation	Presence of dysphagia	Regular diet	Presence of tube feeding
Midbrain	0	–	–	–	–	–	–	–
Pons	35	22	4 (11%)	0 (0%)	0 (0%)	19 (54%)	15 (43%)	7 (20%)
Iateral medulla	4	2	1 (25%)	2 (50%)	1 (25%)	1 (25%)	0 (0%)	0 (0%)
Medial medulla	1	1	0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)	1 (100%)
Semilateral medulla	0	–	–	–	–	–	–	–
Pons+midbrain	0	–	–	–	–	–	–	–
Total	40	25 (64%*)	5 (13%)	2 (5%)	1 (3%)	21 (54%*)	152 (38%)	8 (20%)

*Excluding patients who cannot be evaluated on the Dysphagia Severity Scale (DSS).

ingest regular food (Table 1).

Among CVD+ patients, 34 (85%) were able to orally ingest food during hospitalization. Investigation of their seating positions at the start of meals indicated that 29 were in the seated position and 5 were in a reclining position, with 3 at an elevation angle of 60° and 2 at 45°. Based on the swallowing function assessments on 4 of 5 patients, 1 selected a position other than the seated position when starting oral intake of food because it was difficult for this patient to maintain the seated position. Two patients also performed head rotation to the affected side at the start of oral ingestion, but at discharge both no longer needed to perform head rotation. One of these patients was at an elevation angle of 60° and performed trunk rotation to the non-affected side at the start of meals, but at discharge, this patient no longer required either head or trunk rotation and was able to orally ingest food in a seated position. At discharge, 32 patients were able to orally ingest food in a seated position, and 43% of those with lesions in the pons were able to ingest regular food.

The necessity for coordination of seating position for patients with lesions in the pons and lateral medulla, which were most patients, is shown in Table 2. A significantly smaller number of patients with pons lesions required head rotation ($p < 0.001$) and trunk rotation ($p = 0.016$) (Fisher's exact test).

ESS scores indicated that most CVD− patients had ESS scores of 5 and CVD+ patients had ESS scores of 4 at both initial examination and discharge. Both groups showed a significant improvement at discharge ($p < 0.001$). No significant differences in ESS were found between the CVD− and CVD+ groups at initial examination and at discharge (Fig. 2). Investigation of food textures indicated that both the CVD− and CVD+ groups showed a significant improvement at discharge in terms of staple food, side dishes, and liquids. For most CVD− patients, the staple food was regular rice, and for most CVD+ patients, it was rice porridge, but at discharge, it was regular rice for most patients in both groups. The regular vegetables and thin liquids were the most common side dishes at both initial examination and discharge. Although there was a significant difference between the CVD− and CVD+ groups in terms of staple food texture at discharge ($p = 0.021$), there were no differences between the CVD− and CVD+ groups in terms of staple food texture at initial examination or side dishes and liquids at initial examination and discharge (Fig. 3).

Twenty-five (15%) CVD− patients and 3 (8%) CVD+ patients had pneumonia during hospitalization, with no significant difference between the two groups (Fisher's exact test). Most patients with pneumonia

Table 2. Seating position coordination.

		Pons	Lateral medulla	*p* value*
Reclining	Necessary	22	3	0.589
	Not necessary	146	22	
Head rotation	Necessary	1	7	<0.001
	Not necessary	167	18	
Trunk rotation	Necessary	0	2	0.016
	Not necessary	168	23	

*Fisher's exact test.

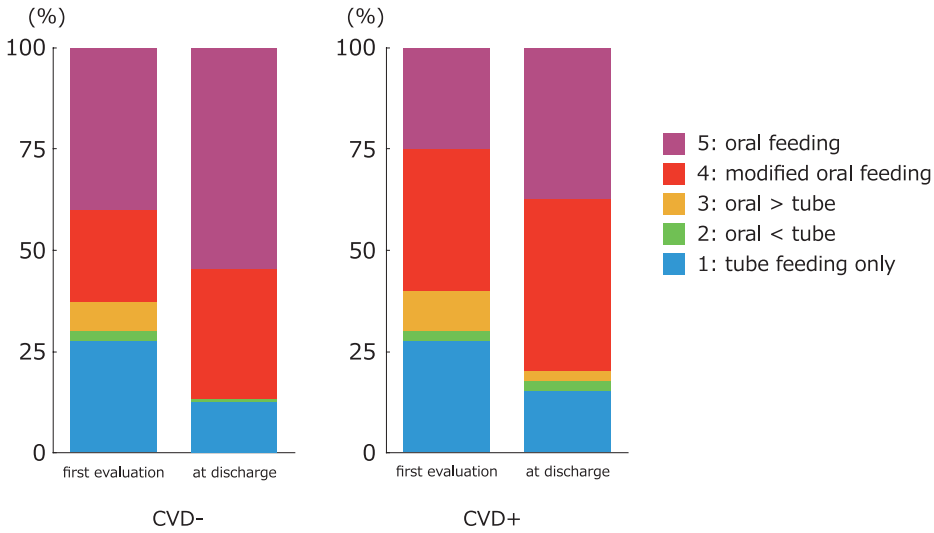

Figure 2. Changes in Eating Status Scale (ESS).
No significant differences in ESS were found between the CVD− and CVD+ groups at initial examination and at discharge (Mann-Whitney *U* test). Both groups showed a significant improvement at discharge ($p < 0.001$) (Wilcoxon signed-rank test).

(12 patients) were diagnosed at admission, and pneumonia during the period of no oral feeding was also noted in 9 patients. Investigation of the lesion sites of patients with pneumonia on admission indicated the pons and the region from the pons to the midbrain. The onset of pneumonia after the start of oral ingestion was seen in 3 CVD− patients. Based on VF findings in one patient, VE findings in another patient, and clinical determination in a third patient, oral intake was permissible. Among CVD+ patients, the one who developed pneumonia after starting oral intake performed direct training based on the results of VE assessment (Table 3). No patients experienced repeated onset of pneumonia during hospitalization. Although GCS at admission for all patients was 14.0 ± 2.6, patients diagnosed with pneumonia at admission had a GCS of 10.1 ± 4.6, which was significantly lower than that of patients without pneumonia who had a GCS of 14.2 ± 2.4 (mean ± SD) ($p < 0.001$).

FIM scores indicated that CVD− patients experienced significant improvement in the motor and cognition subscales ($p < 0.001$). For CVD+ patients, only motor items on the FIM showed a significant improvement at discharge ($p < 0.001$). No significant improvement was seen in cognition item scores. Although there were no significant improvements in the motor item scores at initial examination for either the CVD− or CVD+ groups, the motor score at discharge ($p = 0.005$) and cognition scores at initial examination ($p = 0.040$) and at discharge ($p = 0.004$) were significantly higher for CVD− patients (Table 4).

Table 3. Pneumonia during hospitalization.

	CVD−	CVD+
At admission	11	1
Buring the period of no oral feeding	8	1
Aspiration after vomiting	3	0
After the start of oral ingestion	3	1
Total	25	3

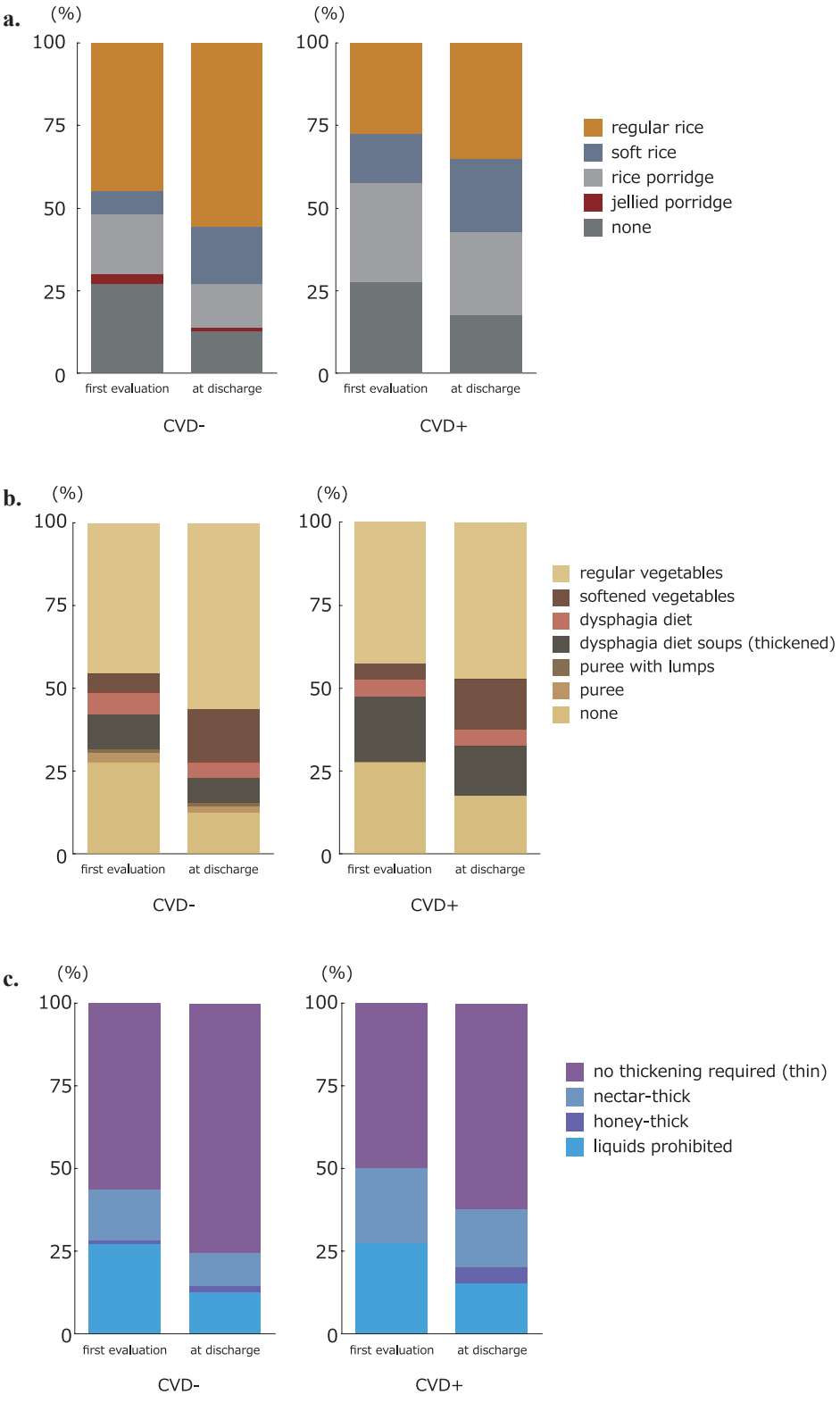

Figure 3. Changes in food textures.
a. staple food. b. side dishes. c. liquids.
Although there were no differences between the CVD− and CVD+ groups in terms of staple food texture, side dishes or liquids at initial examination, there was a significant difference between the groups in staple food texture at discharge ($p = 0.021$) (Mann–Whitney *U* test). There was a significant improvement at discharge in staple food ($p < 0.001$), side dishes ($p < 0.001$), and liquids ($p < 0.001$) in the CVD− group, and in staple food ($p = 0.013$), side dishes ($p = 0.006$), and liquids ($p = 0.033$) in the CVD+ group (Wilcoxon signed-rank test).

Table 4. Changes in Functional Independence Measure (FIM) .

	CVD−		CVD+	
	At initial	At discharge	At initial	At discharge
Motor item	44 (13−91)	79 (13−91)	31 (13−91)	62 (13−91)
Cognitive item	34 (5−35)	35 (5−35)	28 (5−35)	29 (5−35)

Median (minimum−maximum).

Discussion

Pons are usually the most affected location among patients with acute-phase brainstem cerebrovascular disorders [16−18]. Similarly, 81% of the patients in this study showed pons lesions. A total of 51% of CVD− patients and 64% of CVD+ patients at initial examination had dysphagia in the acute stage. No previous studies have compared patients with a history of CVD with those without such history. The results of the present study indicated that while there was a higher percentage of patients with dysphagia who were CVD+, the difference was not statistically significant, and the percentage was similar to that reported in previous studies [4−6, 8]. Although 38% of CVD− patients and 54% of CVD+ patients still had dysphagia at discharge, 87% of CVD− patients and 80% of CVD+ patients were able to orally ingest three daily meals. Investigation of food texture indicated that CVD− patients had satisfactory results only for staple food at discharge. However, regardless of whether the patients had a history of cerebrovascular disorders in sites other than the brainstem, if their swallowing function was at the same level at the initial assessment, then they were able to regain nearly the same degree of swallowing function. One study reported that 11 out of 30 (37%) CVD− patients who were admitted to hospital on average 23 days following pons infarction were able to eat normal meals by discharge [16]. In the present study, 51% of CVD− patients with pons lesions and 62% with lateral medullar lesions regained the ability to eat normal meals by discharge. At our hospital, if a physiatrist requires a VF and/or VE assessment of swallowing function, then the assessment and training for deglutition is provided under the supervision of a speech–language–hearing therapist. In addition, speech–language–hearing therapists or nurses can request that such testing be conducted by a physiatrist [19]. The fact that such a system is in place may account for the favorable outcomes achieved. Moreover, 20% of all patients undergo swallowing function assessments using VF and/or VE during their hospitalization, indicating that appropriate assessments are being conducted on several patients with acute-phase brainstem cardiovascular disorders, even if a detailed examination using VF or VE is not specifically conducted.

Seating position coordination is a technique that is commonly used in cases of dysphagia. The reclining position is commonly used when there is poor bolus transport from the oral cavity to the pharynx because this position makes it less likely that the patient will aspirate the food bolus. Also, to ensure that the patient passes the food bolus on the non-affected side in cases in which paralysis of the pharyngeal region has led to bilateral differences in swallowing function, head rotation to the affected side results in a narrowing of the piriform sinus on the affected side, which in turn makes it more likely for the food bolus to be transported on the non-affected side [13]. However, when the reclining position and head rotation are used in combination, head rotation alone often fails to ensure that the food bolus will pass along the non-affected side. In such patients, trunk rotation toward the non-affected side is also performed to ensure that the food bolus passes along the non-paralyzed side [13, 20]. Because the effectiveness of this varies from patient to patient, we utilize the reclining position, head rotation, and trunk rotation when the results of VE and VF assessments suggest that these techniques will be effective.

Although we have been unable to find any previous report on the elevation angle used during oral intake of food in dysphagia associated with brainstem cerebrovascular disorders, the reclining position was used at the start of oral intake of meals with 21 CVD− patients and 5 CVD+ patients when it was determined that it would be effective in the present study. In addition, head rotation was effective in 7 CVD− patients and 2 CVD+ patients. The food bolus is normally likely to pass along the non-affected side, but in cases of medullar lesion, it is likely to pass either on the affected side or on the non-affected side of the pharyngeal region during the symptomatic phase [21, 22]. In the present study, 2 CVD− patients were instructed to perform head rotation toward the non-affected side to ensure that the food bolus would pass along the affected side. Moreover, a significantly smaller number of patients with pons lesions compared with lateral medullar lesions required head rotation or trunk rotation to ensure that the food bolus would pass along only one side of the pharyngeal region. Dysphagia associated with brainstem cerebrovascular disorders is thought to have two mechanisms: one is pseudobulbar paralysis, in which the corticobulbar

tract is damaged, and the other is bulbar paralysis, in which the swallowing center is damaged. In patients with pontine lesions, dysphagia is caused by damage to the corticobulbar tract, which may account for the fact that few patients with bilateral differences in paralysis of the pharyngeal region require head rotation.

In the present study, 28 (14%) patients had pneumonia during hospitalization, which is similar to that reported by Meng et al. (11%) [2]. Patients with pneumonia at admission had lesions either in the pons or in the region extending from the pons to the midbrain. Damage to the pons and midbrain causes damage to the ascending reticular activating system, which in turn leads to disturbance of consciousness and micro-aspiration, both of which influence the onset of pneumonia. Because patients with pneumonia at admission had significantly lower scores for attitude level, it can be surmised that disturbance of consciousness had some effect on pneumonia discovered at admission. Toda et al. [19] reported that 23% of patients with acute-phase cerebrovascular disorders who developed pneumonia during hospitalization contracted the disease during the period when the oral intake of food was suspended. We also found that 32% of CVD− patients and 33% of CVD+ patients experienced pneumonia during the period when the oral intake of food was suspended, which indicated that it is extremely important to take measures to prevent pneumonia during this period. Specific prevention measures for pneumonia would include proactive oral care and the prevention of backflow in the enteral feeding tube.

It is only natural that CVD− patients would display a satisfactory level of activities of daily living. Based on the results of the present study, it is possible for CVD+ patients to achieve the same level of improvement in swallowing function as the CVD− patients. Thus, we believe that the approach taken for dysphagia associated with brainstem cerebrovascular disorders is important.

One limitation of this study is that it is a retrospective study. Another is the fact that because there is no control group, the extent to which interventions, such as rehabilitation and seating position coordination, are effective for dysphagia remains unclear. We believe that there is a need for a prospective study of this issue and investigations with control groups. Nevertheless, the present study is particularly useful because it is the first to describe, in detail, the food textures and management of dysphagia in patients with acute-phase brainstem cerebrovascular disorders.

In conclusion, our investigation of patients with acute-phase brainstem cerebrovascular disorders indicated that dysphagia was present in 51% of CVD− patients and 64% of CVD+ patients and that significant improvement was achieved at discharge. At the start of oral intake, reclining was used for seating position coordination in conjunction with head rotation and/or trunk rotation. Head rotation and trunk rotation were used in more patients with lateral medullar lesions than with pontine lesions. The onset of pneumonia during hospitalization was found in 14% of patients, and the results indicated that it might be possible to achieve the same degree of improvement in swallowing function in CVD+ patients as in CVD− patients.

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