

Effectiveness of Water Jelly Ingestion for Both Rehabilitation and Prevention of Aspiration Pneumonia in Elderly Patients With Moderate to Severe Dysphagia

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Background and Aims: We evaluated the effectiveness of water jelly ingestion for both rehabilitation and the prevention of aspiration pneumonia in a retrospective analysis of elderly patients with moderate to severe dysphagia.

Patients and Methods: Study 1: consecutive patients with borderline ingestion in an endoscopic swallowing evaluation were enrolled (n = 36, 18 men and 18 women: mean age 82 ± 9 y) and categorized into a group with water jelly (50 to 100 mL) ingestion training 3×/day or an untrained control group. Their food intake levels were then compared using a Food Intake Level Scale. Study 2: consecutive patients who were hospitalized because of aspiration pneumonia were enrolled (n = 64, 35 men and 29 women: mean age 81 ± 9 y) and categorized into a group with cyclic ingestion of water jelly immediately after each meal or a control group. The incidence of aspiration pneumonia that was newly developed during hospitalization was compared between the groups.

Results: In study 1, 36 patients with a Hyodo-Komagane score of 8 were enrolled. Three of the 12 (25%) patients who underwent water jelly ingestion training were able to eat a pureed diet (level 5, 2 patients; level 6, 1 patient) while none of the 24 patients (0%) who did not undergo this training were able to eat any form of diet (levels 5 and 6, no patients) ($P = 0.011$). In study 2, 64 patients were enrolled. No newly developed aspiration pneumonia was observed in the 34 patients (0%) who received cyclic water jelly ingestion, whereas 17% (5/30) of patients not receiving water jelly after meals newly developed aspiration pneumonia during hospitalization ($P = 0.031$).

Conclusions: Water jelly ingestion was effective for both rehabilitation and the prevention of aspiration pneumonia in elderly patients with moderate to severe dysphagia.

Key Words: water jelly, cyclic ingestion, dysphagia, aspiration pneumonia

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The authors declare that they have nothing to disclose.

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The swallowing function of humans deteriorates with age, and dysphagia is estimated to affect ~8% of the world's population (~590 million people).¹ Japan has the highest percentage of elderly people in the world,² and thus the issue of how best to manage dysphagia in daily medical practice is thus quite important. The management of dysphagia includes both rehabilitative approaches and compensatory strategies. Although the benefits of various methods have been reported, no standard strategies or approaches have been established.^{3,4}

In the United States, most gastroenterologists do not perform endoscopic oropharyngeal swallowing examination and/or manage oropharyngeal dysphagia. In Japan, on the other hand, gastroenterologists have been performing endoscopic examination of swallowing using a transnasal endoscope since 2014. The prevalence of this examination in Japan is partly because of the Japanese insurance system requiring endoscopic examination of swallowing in order to determine whether percutaneous endoscopic gastroscopy is indicated. As the aging of societies continues, swallowing examinations are expected to be increasingly relevant to clinical gastroenterologists in other countries as well.

The strategy known as “cyclic ingestion” attempts to clear oral and pharyngeal residues through the alternating ingestion of foods with differing values of hardness, cohesiveness, and adhesiveness. In Japan, cyclic ingestion consisting of water jelly immediately after a meal is commonly used in elderly patients with moderate to severe dysphagia, as a way to clear pharyngeal residues. Although cyclic ingestion is considered one of the compensatory strategies for dysphagia,⁵ there are currently no structured methods for cyclic ingestion, and few studies have examined its effectiveness. We previously demonstrated that both pureed diets containing a gelling agent and cyclic jelly ingestion reduced the risk of aspiration pneumonia in elderly patients with moderate to severe dysphagia, with no adverse events.⁶ On the basis of these previous findings, in the present study we speculated that cyclic jelly ingestion alone could be a rehabilitative approach for the very elderly and for dementia patients who are less likely to continue rehabilitation for dysphagia. We thus conducted the present experiments to evaluate the effectiveness of water jelly ingestion as a rehabilitative approach and as a compensatory method for the prevention of aspiration pneumonia in elderly patients with moderate to severe dysphagia.

PATIENTS AND METHODS

Study Design and Setting

The study was comprised of retrospective analyses of clinical outcomes from a single center (Showa Inan General Hospital in Komagane, Japan). The Institutional Review Board of the hospital approved the retrospective chart review study protocol (No. 2019-08) on January 15, 2020. All of the patients or their guardians had given written

informed consent for the original procedures. The study was conducted in accord with the Declaration of Helsinki. All authors had access to the study data and reviewed and approved the final manuscript.

Patients

Study 1

An endoscopic swallowing evaluation using the Hyodo-Komagane score⁷ was performed for elderly patients with dysphagia who were hospitalized during the period from January 2015 to December 2018. Only patients with a Hyodo-Komagane score of 8 were consecutively enrolled, because these patients were expected to be able to eat pureed food after their rehabilitation while enteral feeding was used.⁷ A total of 36 patients (18 men and 18 women) with a mean age of 82 ± 9 years were enrolled in study 1.

Study 2

Elderly patients who were hospitalized because of aspiration pneumonia during the period from January 2018 to November 2019 were consecutively enrolled. On the basis of a departmental policy in place since April 2016, all patients who were hospitalized because of aspiration pneumonia were fed pureed rice containing a gelling agent during their hospitalization, starting after they were judged as being able to eat orally. A total of 64 patients (35 men and 29 women) with a mean age of 81 ± 9 years were enrolled in study 2.

Study Protocols

Study 1

The ingestion of water jelly (50 to 100 mL, characteristics described below) 3×/day was attempted by the enrolled patients as a rehabilitative approach, aided by a speech therapist or nurse while enteral feeding was used. No other rehabilitative methods were used.

Study 2

The selection of whether to perform cyclic ingestion with water jelly immediately after each meal depended on whether the patient was hospitalized in the gastroenterology division ward or in an internal medicine ward; this ingestion regimen was performed only for the patients hospitalized in the gastroenterology division ward. When dysphagia patients developed fever or respiratory symptoms, chest x-rays and laboratory blood tests were performed. A new aspiration pneumonia was defined based on a chest x-ray consistent with aspiration pneumonia and the results of blood test and the requirement of treatment in addition to the discontinuation of meals. The frequency of episodes of newly developed aspiration pneumonia during hospitalization was prospectively recorded. For any feature, for example, aspiration pneumonia, the patients could be counted only once (the initial episode).

Endoscopic Swallowing Evaluation

Gastroenterologists experienced in transnasal esophagogastroduodenoscopy performed each endoscopic swallowing evaluation along with a speech therapist. The degree of dysphagia was evaluated using the Hyodo-Komagane score which ranges from 0 to 12 and was scored as mild (0 to 3), moderate (4 to 7), or severe (8 to 12) (Table 1).^{6,7} The patients underwent the endoscopic swallowing evaluation while sitting in a chair or sitting up in bed. Two minutes before the insertion of the endoscope, 0.2 to 0.5 mL of 4% lidocaine was applied to the nasal cavities of the patient as a nasal spray. An Olympus

TABLE 1. Hyodo-Komagane Score

A. Salivary pooling in vallecula and piriform sinuses	
0	No pooling
1	Pooling only in the vallecula
2	Pooling in vallecula and piriform sinuses and no penetration* into the larynx
3	Pooling in vallecula and piriform sinuses and penetration into the larynx
B. The response of glottal closure reflex induced by touching the epiglottis with an endoscope	
0	Marked reflex by 1 touch
1	Slow and/or weak reflex by 1 touch
2	Reflex by 2 or 3 touches
3	No reflex despite 3 touches
C. The location of the bolus at the time of swallow onset assessed by "white-out"† following the swallowing of test jelly	
0	Pharyngeal
1	Vallecula
2	Piriform sinuses
3	No swallowing
D. The extent of pharyngeal clearance after swallowing of test jelly	
0	No residues
1	Pharyngeal residues remain, but are absent after swallowing is attempted 2 or 3 times
2	Pharyngeal residues remain, but do not penetrate into the larynx
3	Pharyngeal residues remain and penetrate into the larynx

Total score (A+B+C+D)=(0 to 12).

*When saliva or test jelly enters the glottis (opening to the trachea) and moves as far as the vestibule above the true vocal folds, this is termed "penetration."

†"White-out" is defined as the period when the videoendoscopic image is obscured owing to pharyngeal closure.

endoscope (model #GIF-XP260N) was used; this endoscope is a forward-viewing upper gastrointestinal videoscope with an ultra-miniature, resolution charged-coupled device with a 120 degrees field of view. The insertion diameter is 5.5 mm, and the videoscope has a tip deflection capability of 210 degrees/120 degrees up/down in a single plane. The lubricated endoscope was passed transnasally, typically on the floor of the nose, to obtain a superior view of the hypopharynx. The endoscope was moved between swallowing and the postswallow position to collect the data as described.^{7,8} Images of the oropharynx and larynx were displayed on a monitor and recorded on the digital video recorder (model #HVO-3300MT; Olympus).

Test Diet

For each attempted ingestion of water jelly for either rehabilitation or cyclic ingestion, 3 mL of gelatin jelly (Isotonic jelly; Nutri Co., Yokkaichi, Japan) was used. Its characteristics were as follows: hardness, 5000 N/m²; cohesiveness, 0.4; adhesiveness, 89 J/m³ (Fig. 1).

Evaluations

Study 1

We used a Food Intake Level Scale (Table 2)⁹ to retrospectively compare the food intake levels between the patients with or without water jelly (50 to 100 mL) ingestion training 3×/day.

Study 2

We retrospectively compared the number of patients with aspiration of any form or amount of diet from the trachea or the development of new aspiration pneumonia



FIGURE 1. The water jelly used for rehabilitation or cyclic ingestion is shown (Isotonic jelly; Nutri Co., Yokkaichi, Japan). Its characteristics were as follows: hardness, 5000 N/m²; cohesiveness, 0.4; adhesiveness, 89 J/m³.

during hospitalization between the groups with and without cyclic ingestion of jelly immediately after each meal.

Statistical Analysis

The data are presented as the mean ± SD. Categorical data were compared by the χ^2 -test or the Fisher exact test where appropriate. Numerical data were analyzed by the Student *t*-test. Nonparametric data were analyzed by

TABLE 2. Food Intake Level Scale

Level 1	No swallowing training is performed except for oral care
Level 2	Swallowing training not using food is performed
Level 3	Swallowing training using a small quantity of food is performed
Level 4	Easy-to-swallow food less than the quantity of a meal (enjoyment level) is ingested orally
Level 5	Easy-to-swallow food is orally ingested in 1 to 2 meals, but alternative nutrition is also given
Level 6	The patient is supported primarily by ingestion of easy-to-swallow food in three meals, but alternative nutrition is also used

Wilcoxon rank sum test. Statistical significance was taken as a 2-sided *P* < 0.05. The statistical analyses were performed using GraphPad Prism ver. 8.4.1 (GraphPad Software, La Jolla, CA).

RESULTS

Study 1

A total of 36 patients (18 men and 18 women; mean age 82 ± 9 y) with a Hyodo-Komagane score of 8 were enrolled among the 287 patients (189 men: mean age 83 ± 7 y) who underwent an endoscopic swallowing evaluation. The most frequent concurrent medical condition was cerebrovascular disease (59%), followed by aspiration pneumonia (29%) and neuromuscular disease (9%) (Table 3). Twelve of the 36 patients continued to undergo water jelly ingestion training after the endoscopic swallowing evaluation; the remaining 24 did not continue to undergo the training. There were no significant differences between the 2 groups with respect to clinical baseline parameters including age, gender, the amount of enteral feeding, the observation period, concurrent medical conditions, or proton pump inhibitor use (Table 4). The mean training duration (range) was 28 ± 9 (24–56) days. Three (25%) of the 12 patients who continued to undergo water jelly ingestion training were able to eat at least 1 pureed diet (level 5, 2 patients; level 6, 1 patient), whereas none of the 24 patients who did not undergo the training were able to eat any form of diet (levels 5 and 6, no patients): 25% (3/12) versus 0% (0/24), *P* = 0.011 (Table 5). Although there was an improvement in caloric intake in 3 patients who had improved food intake, it remains uncertain whether water jelly ingestion training would result in a decrease in rates of future hospitalization for aspiration pneumonia.

TABLE 3. Baseline Characteristics of the 287 Dysphagia Patients Who Underwent Endoscopic Swallowing Evaluation in Study 1

Variable	N = 287
Gender (male/female)	189/98
Age [mean ± SD (range)] (y)	83 ± 7 (65–103)
Concurrent medical conditions, number of patients (%)	
Cerebrovascular disease	168 (59)
Aspiration pneumonia	84 (29)
Neuromuscular disease	25 (9)
Others	10 (4)
Hyodo-Komagane score, number of patients (%)	
1–7	193 (67)
8	36 (13)
9–12	58 (20)

TABLE 4. Baseline Characteristics of the 36 Dysphagia Patients With a Hyodo-Komagane Score of 8 Enrolled in Study 1

Variable	Water Jelly Training (+) (N = 12)	Water Jelly Training (-) (N = 24)	P
Gender (male/female)	7/5	11/13	0.48
Age [mean \pm SD (range)] (y)	83 \pm 9 (75-92)	82 \pm 8 (67-91)	0.88
Amount of enteral feeding administered (kcal)	900	900	
Observation period (mean \pm SD) (d)	42 \pm 8	38 \pm 9	0.65
Concurrent medical conditions, number of patients			0.56
Chronic kidney disease	1	4	
Chronic liver disease	2	3	
COPD	2	4	
Proton pump inhibitor use	2	5	0.77

COPD indicates chronic obstructive pulmonary disease.

Study 2

A total of 64 patients (35 men and 29 women: mean age 81 \pm 9 y) were enrolled; 34 were in the group with cyclic ingestion of jelly immediately after each meal and 30 were in the group without cyclic ingestion. There were no significant differences between the groups with respect to clinical baseline parameters including age, gender, the amount of pureed diet intake, the period during which the incidence of complications was observed, concurrent medical conditions, or proton pump inhibitor use (Table 6).

The number of patients who aspirated food from the trachea and the number who developed new aspiration pneumonia in the group with cyclic ingestion were both significantly lower than those in the group without cyclic ingestion: 6% (2/34) versus 27% (8/30), $P=0.022$; 0% (0/34) versus 17% (5/30), $P=0.031$ (Table 7). The number needed to treat for cyclic ingestion (+) for the prevention of aspiration pneumonia was only 6 (95% confidence interval: 3-27).

Aspiration pneumonia was treated by the administration of 2 g/day of ceftriaxone sodium for 4 to 7 days

TABLE 5. Clinical Outcomes of the 36 Dysphagia Patients With a Hyodo-Komagane Score of 8 Enrolled in Study 1

Variable	Water Jelly Training (+) (N = 12)	Water Jelly Training (-) (N = 24)	P
Mean training duration [mean \pm SD (range)] (d)	28 \pm 9 (24-56)	0	
Food Intake Level Scale, number of patients (%)			
Level 1	0	6 (25)	
Level 2	0	6 (25)	
Level 3	1 (8)	12 (50)	
Level 4	8 (67)	0	
Level 5	2 (17)	0	
Level 6	1 (8)	0	
Levels 5 and 6	3 (25)	0	0.011

Food Intake Level Scale.¹⁰

TABLE 6. Baseline Characteristics of the 64 Dysphagia Patients Enrolled in Study 2

Group	Cyclic Ingestion (+) (N = 34)	Cyclic Ingestion (-) (N = 30)	P
Gender (male/female)	18/16	17/13	0.77
Age [mean \pm SD (range)] (y)	82 \pm 8 (73-93)	81 \pm 9 (75-92)	0.88
Hyodo-Komagane score, number of patients (%)			
4-5	18 (53)	17 (57)	0.93
6-7	8 (24)	8 (27)	
NA	8 (24)	5 (17)	
Amount of pureed diet (mean \pm SD) (kcal)	1200 \pm 150	1240 \pm 160	0.76
Mean period when the incidence of complications was observed (mean \pm SD) (d)	21 \pm 4	18 \pm 4	0.66
Concurrent medical conditions, number of patients (%)			0.56
Chronic kidney disease	3 (9)	4 (13)	
Chronic liver disease	5 (15)	6 (20)	
COPD	3 (9)	2 (7)	
Proton pump inhibitor use	8 (24)	10 (33)	0.38

COPD indicates chronic obstructive pulmonary disease; NA, not applicable.

after admission, and all patients recovered; additional hospitalizations were subsequently required for 5 patients with aspiration pneumonia.

DISCUSSION

The results of study 1 demonstrated that the simple strategy of consuming water jelly 3 \times /day enabled some of the elderly patients with borderline oral intake to eat a pureed diet. Study 2 revealed that the use of cyclic ingestion with water jelly immediately after each meal was associated with a reduction in newly developed aspiration pneumonia in elderly patients with moderate to severe dysphagia. Since all of the present patients who were hospitalized because of aspiration pneumonia were fed pureed rice containing a gelling agent during their hospitalization, the results of study 2 were correspondent with those of our previous report, in which pureed diets containing a gelling agent and cyclic water ingestion were suggested to reduce the risk of aspiration pneumonia, possibly by decreasing pharyngeal

TABLE 7. Clinical Outcomes of the 64 Dysphagia Patients Enrolled in Study 2

Variable	Cyclic Ingestion (+) (N = 34)	Cyclic Ingestion (-) (N = 30)	P	NNT (95%CI)
No. patients with diet aspirated from the trachea	2	8	0.022	5 (2-23)
No. patients with newly developed aspiration pneumonia	0	5	0.013	6 (3-27)

CI indicates confidence interval; NNT, number needed to treat.

residues.⁶ Taken together, the 2 studies in the present analysis suggest that water jelly ingestion is a very useful strategy for both rehabilitation and the prevention of aspiration pneumonia in elderly patients with moderate to severe dysphagia.

Cyclic ingestion is one of the compensatory strategies of dysphagia to clear oral and pharyngeal residues.^{4,5} A systematic review demonstrated that hardness, cohesiveness, and adhesiveness of the ingested materials are important factors for physiological behaviors and bolus flow patterns.⁹ Foods with high cohesiveness and low adhesiveness are suitable for cyclic ingestion, because these characteristic features can entrap the pharyngeal residues and flows from the pharynx into the esophagus. Although there is no specific data in regard to the optimal degrees of cohesiveness and adhesiveness for cyclic ingestion, we speculate that the properties of the water jelly used in this study (hardness, 5000 N/m²; cohesiveness, 0.43; adhesiveness, 89 J/m³) may enable it to become a standard item for reducing aspiration pneumonia in the elderly with moderate to severe dysphagia.

We propose that repeated attempts to swallow water jelly that is suitable for cyclic ingestion can be an effective rehabilitative approach for oral intake. In general, it is known that strength-training exercises can ameliorate the effects of muscle weakness that accompany normal aging. Although muscle weakness may also be a result of decreased physical activity accelerated by disuse and acute or chronic illness, muscle weakness is preventable and reversible.³ These facts suggest that the simple repetition of swallowing movements may lead to an improvement of swallowing function. In addition, based on suprahyoid electromyography, the oral processing time for gels is longer than that for water, and the processing time increases with increasing gel hardness.^{10,11} Swallowing water jelly may therefore be more effective and safer than swallowing plain water to improve muscle weakness. In the present cohort, some of the dysphagia patients with borderline oral intake were able to eat a pureed diet following the simple water jelly ingestion training. However, because water jelly ingestion was the only rehabilitation intervention undertaken in our subjects, it is unclear whether similar rates of improvement in food intake and recurrent aspiration pneumonia might also be achieved by other interventions.

Generally, many swallowing exercises require physical strength and stamina in addition to good comprehension and memory, and many patients need to increase their endurance gradually.⁵ Therefore, water jelly ingestion 3×/day may be useful as a simple strategy for oral intake rehabilitation. In addition, water jelly also plays a role in oral care by clearing oral residue. Oral care has the effect of reducing the risk of aspiration pneumonia by reducing the oral flora and lowering the induction threshold of the cough reflex, which is an airway defense reflex, through an elevation of substance P.^{12–15} In light of the use of food to remove oral residues containing proteins, sugars, and lipids, the water jelly described herein may be a suitable item to contribute to a reduction of aspiration pneumonia.

This study has some limitations. In addition to the small sample size, the studies were conducted at a single hospital in Japan, and the analyses were retrospective. It was not possible to completely eliminate the influence of the patients' background and confounding factors, although the patients were consecutively enrolled. In addition, although all patients enrolled in study 1 and 2 underwent esophagogastroduodenoscopy to

differentiate oropharyngeal dysphagia from esophageal or gastric cancer, neither esophageal manometry nor radiography was used in any of the subjects. Therefore, patients with esophageal motility disorder such as diffuse esophageal spasm or achalasia may not have been excluded. Larger, randomized multicenter trials are needed to confirm the effectiveness of water jelly ingestion for both rehabilitation and the prevention of aspiration pneumonia in elderly patients with moderate to severe dysphagia.

In conclusion, water jelly ingestion training is expected to be an effective method for rehabilitation even in dysphagia patients who have difficulty continuing rehabilitation. In addition, cyclic ingestion with water jelly immediately after each meal may reduce the risk of aspiration pneumonia in the elderly with moderate to severe dysphagia.

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