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Association between simple evaluation of eating and swallowing function and mortality among patients with advanced dementia in nursing homes: 1-year prospective cohort study

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ABSTRACT

Background: A simple and predictable method of evaluating eating and swallowing has not been yet established; thus, it is difficult to implement advance care planning according to deterioration in this function. This study aimed to clarify the association between a simple evaluation of eating and swallowing function and 1-year mortality in advanced dementia patients in nursing homes in Japan.

Methods: The study included 325 residents with advanced dementia. In a baseline survey, we examined medical history, physical function, and eating and swallowing function. We recorded mortality for 1 year from baseline. Kaplan-Meier survival analysis and Cox proportional regression were performed to investigate the association between the simple evaluation of eating and swallowing function and mortality.

Results: Statistical analysis included data from 312 of the 325 residents who had completed the baseline survey (7 individuals with non-oral ingestion and 6 who were alive but did not reside in the nursing home 1 year later were excluded). The participants' mean age was 85.2 years, and 79.5 % of participants were female. At the 1-year follow-up, 70 patients had died. According to Cox proportional regression analysis, age, male gender, history of cerebrovascular disorder, poor results of palpation of masseter muscle tension, and modified water swallowing test were significantly associated with 1-year mortality.

Conclusion: The results of palpation of masseter muscle tension and modified water swallowing test were associated with 1-year mortality. These routine observations can predict mortality, and may thus provide evidence of the opportunity to implement advance care planning.

1. Introduction

In recent years, to reflect the care desired by patients, advance care planning is implemented when devising end-of-life care plans by involving the patient, family, medical workers, and caregivers in the discussion (Sampson, 2010). It has been reported that maintaining the quality of life (QOL) of the patient and improving the family's satisfaction can be achieved by implementing advance care planning in accordance with changes in life situation and function (Martin, Hayes, Gregorevic, & Lim, 2016). Thus, advance care planning is essential to achieve better end-of-life care.

Patients with advanced dementia, who generally have more severe nursing care needs, have difficulty in evaluating pain; the progression of the disease is also diverse. Therefore, it is important to implement advance care planning appropriately and to formulate a care plan in line with the values of the patient (Murphy et al., 2016; Sampson, 2010). Distressing symptoms occurring in many advanced dementia patients include eating and swallowing disorder (Mitchell, Kiely, &

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Hamel, 2004, 2009). For example, compared to Alzheimer's disease, dementia with Lewy bodies has more problems such as difficulty in swallowing foods and liquids, and taking a long time to swallow. In addition, vascular dementia has been reported to show impairment of bolus formation and chewing function (Shinagawa et al., 2009; Suh, Kim, & Na, 2009). Providing appropriate end-of-life care requires routinely evaluating and responding to the person's changing eating and swallowing functions. Moreover, by reviewing the patient's care plan based on such evaluations, it is possible to consider appropriate care and support in cooperation with experts. Although a diagnosis by experts is desirable to identify an eating and swallowing disorder, this is often difficult to perform frequently in elderly people who require high-level care at home or in nursing homes. Therefore, it is important for caregivers who have little knowledge of eating and swallowing function (e.g., caregivers, nurses, and sometimes relatives) to observe and evaluate its function routinely and to detect signs of deterioration early. However, there are no reports that have previously examined the association between simple evaluation of eating and swallowing function and mortality.

In this study, we focused on the simple evaluation of lips, tongue, mastication, and swallowing involved in eating and swallowing function as an assessment, which can be carried out by the caregiver at the care site. It was hypothesized that the simple evaluation of eating and swallowing function would predict mortality; specifically, we investigated the association between such evaluation of eating and swallowing function and 1-year mortality in residents with advanced dementia in nursing homes in Japan.

2. Methods

2.1. Study design

This was a 1-year prospective cohort study.

2.2. Subjects

We explained the contents of this research project to the staff members at five nursing homes run by the same corporation in central Japan. Explanations about the study survey were provided to 144 residents in two facilities in June 2016 and 260 residents in three other facilities in December 2016, including their families. All residents were aged 65 years and over. The purpose of this study was explained to all 325 subjects and guardians of the subjects; if a subject could not complete the consent form, the guardian agreed to participate in the study in writing. Afterward, the baseline survey data was collected from the subjects. Mortality data were collected by sending a questionnaire to each facility 1 year after the baseline survey. According to the baseline survey results, patients with non-oral ingestion or who were alive but did not reside in the nursing home 1 year later were set as the exclusion criteria. This study was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) and was approved following review by the Ethics Committee of Japan's National Center for Geriatrics and Gerontology (Approval No. 605).

2.3. Procedure

All nurses, caregivers, and registered dietitians at the facilities were trained on the evaluation of survey items and unified evaluation criteria. Subsequently, the nurses and registered dietitians who were in charge of the patients filled out a questionnaire, including basic information, medical history, physical function, dementia severity, nutritional status, and food form. As for the measurement of skeletal muscle mass index (SMI) and evaluation of eating and swallowing function, these assessments were completed by dentists and dental hygienists who conducted a 2 -h course in advance so that there was no measurement error. Attending caregivers collaborated in the assessments to check whether the participants' conditions were any different from the usual circumstances.

2.4. Questionnaire

Participants' basic information was collected via interview with the nurse in charge of the institution: age, gender, height, weight, and medical history, with items for diseases previously reported as common in older people living in nursing homes (e.g. respiratory disease, aspiration pneumonia, cerebrovascular disorder, circulatory disorder, neoplastic disease, depression, diabetes mellitus) (Goldberg & Botero, 2008; Mitchell et al., 2004). Physical function was evaluated using the Barthel Index (BI) (Mahoney & Barthel, 1965; Nakazawa, Nakamura, Kitamura, & Yoshizawa, 2012). The Clinical Dementia Rating (CDR) was used to determine dementia severity (Morris, 1993), and was evaluated by physicians. Nutritional status was assessed using the Mini Nutritional Assessment–Short Form (MNA-SF) (Rubenstein, Harker, Salva, Guigoz, & Vellas, 2001). Body mass index (BMI) was calculated from height and weight. Food form was classified as normal diet, chopped diet, munched diet, or soft diet.

2.5. Assessments

2.5.1. Skeletal muscle mass index (SMI)

The SMI was calculated using InbodyS10® (Bio Space, Korea) (Gibson, Holmes, Desautels, Edmonds, & Nuudi, 2008).

2.5.2. Simple evaluation of eating and swallowing function

The evaluation considered in this study was chosen based on the criteria that the assessments are able to be evaluated by caregivers and are less invasive, can be done without the use of specialized equipment, and are feasible in the observation of daily activities.

I. Palpation of masseter muscle tension

Palpation of masseter muscle tension (PMMT), which has been reported to be associated with masticatory performance (Gaszynska, Godala, Szatko, & Gaszynski, 2014; Ohara et al., 2013), was performed. Four fingers (excepting the thumb) were placed on the patient's face above the masseter muscle, and he/she was asked to bite forcefully with the molars. Cases where the tension of the masseter muscle was strong were evaluated as "good," and cases where it was weak or not present, or where occlusion was impossible, were evaluated as "poor." If the occlusion instructions were not followed, the evaluation was performed by having the participant imitate the evaluator. In addition, for patients wearing a denture, the examination was conducted with the dentures being worn.

II. Evaluation of articulation

We instructed participants to pronounce the monosyllables /pa/, /ta/, and /ka/, or words containing them, and evaluated whether the syllables could be pronounced clearly. If participants could not follow verbal instructions, the monosyllables were written down, and participants were asked to pronounce them. Cases in which the pronunciation was clearly articulated were evaluated as "good," otherwise they were evaluated as "poor." When it was difficult for participants to follow the instructions, the assessment was conducted by observing daily conversations.

III. Tongue motility

Tongue motility was evaluated referring to the method of Sato et al. (2014). If the verbal instructions could not be followed, the operator stuck out the tongue and participants' imitation of this was evaluated.

IV. Rinsing ability

Rinsing ability was evaluated referring to the method of Sato et al. (2014).

V. Gargling ability

Gargling ability was evaluated referring to the method of Sato et al. (2014). Participants at risk of aspiration were evaluated as "poor"

without performing the test.

VI. Modified water swallowing test

Swallowing function was evaluated using the modified water swallowing test (MWST) (Tohara, Saitoh, Mays, Kuhlemeier, & Palmer, 2003), combined with cervical auscultation (Zenner, Losinski, & Mills, 1995). According to the conventional method, 3 ml of cold water was poured into the floor of the mouth with a 5-ml syringe and the participants were instructed to swallow. To evaluate the state of aspiration more strictly, the MWST was performed on all subjects using cervical auscultation. We then evaluated changes in swallowing and breath sounds before and after swallowing with a stethoscope. These sounds were classified as abnormal if a wheezing or coughing reflex appeared, or a bubbling or wet sound occurred in the pharyngeal swallowing sound (Zenner et al., 1995). If participants could not complete the MWST, respiratory sounds were assessed by cervical auscultation to confirm saliva retention. Based on the method of Sakai et al. (2016), participants who could not complete the test, or who had MWST scores of 3 or less and abnormal cervical auscultation, were classified as "poor," while those with scores of 4 or more were considered "good."

2.6. Statistical analysis

Spearman's correlation coefficient was used to determine multiple collinearity between variables. Univariate analysis was performed by using χ^2 tests for categorical variables and Mann-Whitney *U* tests for continuous variables. To investigate the effect of eating and swallowing function deterioration on mortality, the results of PMMT, evaluation of articulation, tongue motility, rinsing ability, gargling ability, and MWST were divided into "good" and "poor" groups. The cumulative survival rate between the two groups was determined by the Kaplan-Meier method. After that, in order to examine the differences between the two groups, an analysis was performed using the log-rank test.

To examine factors related to mortality with Cox proportional regression analysis, the objective variable was set as the period from the observation start date to event occurrence (death), and variables with $p < .10$ as the result of the initial χ^2 tests and Mann-Whitney *U* tests were considered covariates in the multivariate analysis. Since multiple collinearity was observed between food form and eating and swallowing function evaluation, food form was excluded from the independent factors. In the multivariate analysis, MNA-SF was selected from BMI and MNA-SF as a nutrition indicator. IBM SPSS Statistics 23 (IBM Corp., Armonk, NY, USA) was used for all statistical analyses, and the level of significance was set at .05.

3. Results

The patient flow diagram for this study is shown in Fig. 1. After the baseline survey was completed for 325 residents, 7 with non-oral ingestion were excluded. According to the collection of mortality data for 1 year after the baseline survey, 312 individuals (64 men and 248 women, mean age 85.2 ± 7.6 years) were included in the analysis (6 individuals who were discharged alive and were not living in the nursing home after 1 year were excluded). Those who died during the observation period constituted the death group and those who survived were the survival group. At the 1-year follow-up, there were 242 individuals (77.6 %) in the survival group and 70 individuals (22.4 %) in the death group. The mean duration of observations in the death group was 145.7 ± 86.1 days (Table1).

Participant characteristics at baseline are shown in Table 1. The univariate analysis revealed significant differences in age, history of cerebrovascular disease, BI, BMI, MNA-SF, and SMI between the death and survival groups. In terms of food form, there were significantly more patients with a normal diet in the survival group and more with a munched diet in the death group. In addition, CDR was severe in about half of the death group as compared to less than 40 % in the survival group; PMMT, evaluation of articulation, tongue mobility, rinsing ability, gargling ability, and MWST were significantly poorer in the death group.

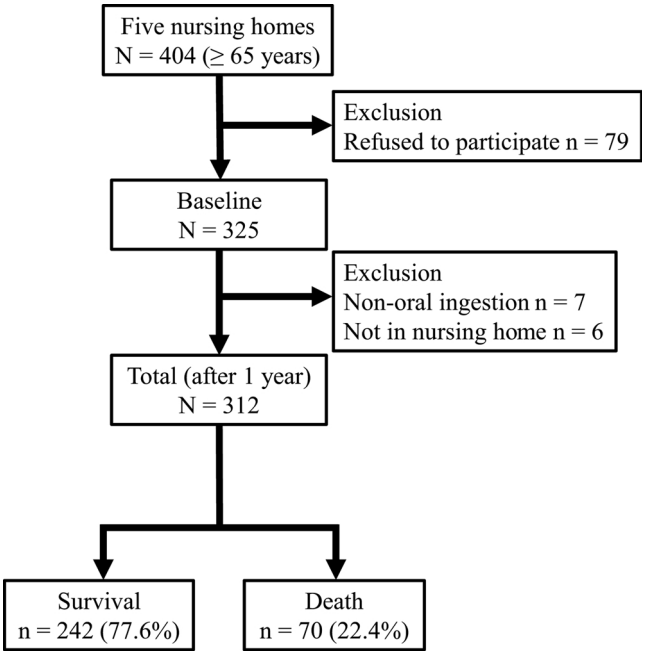

Fig. 1. Study flow chart.

Cox proportional regression analysis was performed to investigate the association between the simple evaluation of eating and swallowing function and mortality. Adjusting for age, gender, medical history, BI, CDR, MNA-SF, and SMI, we set PMMT, evaluation of articulation, tongue motility, rinsing ability, gargling ability, and MWST as independent variables. Cox proportional regression analysis showed that age (hazard ratio [HR] = 1.04, 95 % confidence interval [CI] = 1.01–1.08; p-value [p] = .017), male gender (HR = 3.01, 95 % CI = 1.53–5.93; p = .001), history of cerebrovascular disease (HR = 1.73, 95 % CI = 1.05–2.86; p = .032), PMMT (HR = 1.91, 95 % CI = 1.05–3.46; p = .034), and MWST (HR = 1.81, 95 % CI = 1.01–3.24; p = .048) were significantly associated with 1-year mortality (Table 2).

Fig. 2 shows the Kaplan-Meier survival curves for PMMT and MWST with significant differences in the Cox proportional regression analysis. Log-rank tests showed significant differences in survival time between the "good" and "poor" groups, regarding both PMMT and MWST.

4. Discussion

In this study, by focusing on the simple evaluation of eating and swallowing function, we examined the association between such function and 1-year mortality among patients with advanced dementia in nursing homes. It was revealed that PMMT and MWST were independently associated with mortality, in addition to age, gender, and history of cerebrovascular disease, which had previously been found to be associated with mortality (Goldberg & Botero, 2008; Nakazawa et al., 2012).

Participants in this study were elderly residents of nursing homes run by the same corporation, with a unified care method across facilities; thus, the effect of the difference in care methods was assumed to be small. The mortality rate during the 1-year follow-up period in this study was 22.4 %. In previous research at nursing homes, the 1-year mortality rate was 17.5 % (Lilamand et al., 2015) and 19.4 % (Barents et al., 2008), which is very similar to this study. This rate seems to be a general characteristic of nursing homes.

PMMT has been reported to be associated with maximum bite force (i.e., chewing ability), masseter muscle thickness (Ohara et al., 2013),

Table 1
Baseline characteristics comparison between survival and death groups.

	All (n = 312)			Survival (n = 242)			Death (n = 70)			
Continuous variables	Mean ± SD			Mean ± SD			Mean ± SD			P- value
Age (years)	85.2	±	7.6	84.7	±	7.8	86.9	±	6.9	.034[a]
Observation period (days)	315.8	±	100.2	365	±	0	145.7	±	86.1	< .001[a]
BI (score)	35.1	±	26.3	38.4	±	26.7	23.9	±	21.6	< .001[a]
BMI (kg/m^2)	20.6	±	3.8	20.9	±	3.9	19.4	±	3.2	.001[a]
MNA-SF (score)	8.8	±	2.5	9.1	±	2.4	7.8	±	2.5	< .001[a]
SMI (kg/m^2)	4.9	±	1.4	5.0	±	1.4	4.5	±	1.5	.002[a]
Categorical variables	n (%)			n (%)			n (%)			P- value
Gender										
Female	248	(	79.5)	197	(	81.4)	51	(	72.9)	.119[b]
Male	64	(	20.5)	45	(	18.6)	19	(	27.1)	
Medical history (Yes)										
Respiratory disease	24	(	7.7)	17	(	7.0)	7	(	10.0)	.411[b]
Aspiration pneumonia	16	(	5.1)	11	(	4.5)	5	(	7.1)	.367[b]
Cerebrovascular disorder	111	(	35.6)	79	(	32.6)	32	(	45.7)	.044[b]
Circulatory disorder	134	(	42.9)	105	(	43.4)	29	(	41.4)	.770[b]
Neoplastic disease	37	(	11.9)	33	(	13.6)	4	(	5.7)	.071[b]
Depression	18	(	5.8)	15	(	6.2)	3	(	4.3)	.772[b]
Diabetes Mellitus	53	(	17.0)	41	(	16.9)	12	(	17.1)	.969[b]
CDR										
0.5	27	(	8.7)	26	(	10.7)	1	(	1.4)	.033[b]
1	50	(	16.0)	42	(	17.4)	8	(	)	
2	108	(	34.6)	82	(	33.9)	26	(	37.1)	
3	127	(	40.7)	92	(	38.0)	35	(	50.0)	
Food form										
Normal diet	56	(	17.9)	54	(	22.3)	2	(	2.7)	< .001[b]
Chopped diet	93	(	29.8)	77	(	31.8)	16	(	22.9)	.149[b]
Munched diet	105	(	33.7)	69	(	28.5)	36	(	51.4)	< .001[b]
Soft diet	61	(	19.6)	42	(	17.4)	16	(	22.9)	.297[b]
PMMT										
Good	148	(	47.4)	125	(	51.7)	23	(	32.9)	.006[b]
Poor	164	(	52.6)	117	(	48.3)	47	(	67.1)	
Evaluation of articulation										
Good	191	(	61.2)	159	(	65.7)	32	(	45.7)	.003[b]
Poor	121	(	38.8)	83	(	34.3)	38	(	54.3)	
Tongue motility										
Good	220	(	70.5)	178	(	73.6)	42	(	60.0)	.029[b]
Poor	92	(	29.5)	64	(	26.4)	28	(	40.0)	
Rinsing ability										
Good	120	(	38.5)	105	(	43.4)	15	(	21.4)	< .001[b]
Poor	192	(	61.5)	137	(	56.6)	55	(	78.6)	
Gargling ability										
Good	48	(	15.4)	45	(	18.6)	3	(	4.3)	.003[b]
Poor	264	(	84.6)	197	(	81.4)	67	(	95.7)	
MWST										
Good	261	(	83.7)	212	(	87.6)	49	(	70.0)	< .001[b]
Poor	51	(	16.3)	30	(	12.4)	21	(	30.0)	

SD, standard deviation; BI, Barthel index; CDR, clinical dementia rating; BMI, body mass index; MNA-SF, Mini Nutritional Assessment-Short Form; SMI, skeletal muscle mass index; PMMT, palpation of masseter muscle tension; MWST, modified water swallowing test.
A dummy variable was created with a score of 0 (survival group) if the subject was alive 1 year after the baseline survey, and a score of 1 (death group) if the subject died within 1 year after the baseline survey.
Medical history - According to the questionnaire, this was set as “yes” if the subjects had a disease and “no” if they did not. Only “yes” responses were listed in the table.
[a] Mann-Whitney *U* test for continuous variables.
[b] χ^2 test for categorical variables; (%) = yes/total number; p-value = comparison between survival and death groups.

activities of daily living, and nutritional status (Gaszynska et al., 2014). However, there is no report assessing the association between PMMT and mortality. Factors that affect PMMT may include orofacial apraxia due to severe dementia (Daniels, 2000), loss of occlusal support (Yamaguchi et al., 2018), and deterioration of food form. In this study, there were more participants with advanced dementia and taking a munched diet in the death group. Deterioration of eating and swallowing function may affect food form. It is conceivable that reduced food form leads to masseter muscle inactivity, thus reducing masseter muscle mass (Osterlund, Thornell, & Eriksson, 2011; Yamaguchi et al., 2018). It is also speculated that a deterioration in the form of food prevents adequate nutrition and leads to poor nutrition. Thus, poorer results in PMMT are associated with mortality.

BMI and calf circumference (Lilamand et al., 2015; Tsai, Lai, & Chang, 2012) are indicators reported to be associated with mortality, but previous studies did not evaluate functional aspects. Assessing BMI involves the effort and risk of moving the patient to a measuring device, and calf circumference measurement can be affected by lower leg edema at the time of examination. Since PMMT can also assess the performance of the muscle, this result can be reflected in the care content, such as food form and assistance methods. In addition, PMMT can be evaluated at the care site because it can be performed by

Table 2
Association between simple evaluation of eating and swallowing function and mortality.

	HR	95% CI			P-value
Age	1.04	1.01	–	1.08	.017
Gender (Male = 1)	3.01	1.53	–	5.93	.001
Medical history (Yes = 1)					
Cerebrovascular disorder	1.73	1.05	–	2.86	.032
Neoplastic disease	0.41	0.15	–	1.13	.084
BI	0.99	0.97	–	1.00	.088
CDR					
0.5	Reference				
1	5.82	0.70	–	48.46	.104
2	4.86	0.62	–	37.74	.131
3	2.77	0.33	–	23.21	.348
MNA-SF	0.94	0.83	–	1.06	.323
SMI	0.82	0.67	–	1.01	.059
PMMT (poor = 1)	1.91	1.05	–	3.46	.034
Evaluation of articulation (poor = 1)	1.19	0.59	–	2.42	.623
Tongue motility (poor = 1)	0.63	0.27	–	1.43	.264
Rinsing ability (poor = 1)	1.18	0.57	–	2.46	.649
Gargling ability (poor = 1)	1.92	0.52	–	7.07	.329
MWST (poor = 1)	1.81	1.01	–	3.24	.048

HR, hazard ratio; CI, confidence interval; BI, Barthel Index; CDR, Clinical Dementia Rating; MNA-SF, Mini Nutritional Assessment–Short Form; SMI, Skeletal Muscle Mass Index; PMMT, palpation of masseter muscle tension; MWST, modified water swallowing test.

caregivers at the bedside without using specialized equipment.

Since MWST can detect dysphagia with high sensitivity and specificity with a small amount of water (Tohara et al., 2003), it is useful as a screening evaluation for dysphagia in nursing home residents. To the best of our knowledge, no previous studies have investigated the association between MWST and mortality. Dysphagia in advanced dementia not only leads to dehydration, decreased nutritional status, and decreased immune function, but it also causes serious conditions affecting life prognosis such as choking, aspiration, infections, and electrolyte abnormalities (Arcand, 2015; Gavazzi & Krause, 2002; Masot et al., 2018). The results of this study agree with these reports.

The swallowing center is a reflex mechanism located around the central pattern generator at the respiratory center in the medulla (Sugiyama, Shiba, Mukudai, Umezaki, & Hisa, 2014); neuron activities are performed periodically with respiration, even when not swallowing (Grelot, Barillot, & Bianchi, 1989). Since the swallowing function has a large effect on maintaining life, it may be the reason why evaluation of articulation, tongue mobility, rinsing ability, and gargling ability were not associated with mortality in the multivariate analysis. However, this needs to be further investigated in the future.

There was no association between CDR and mortality in this study. The reason may be that 70 % or more of participants had advanced dementia (CDR 2) or higher. In addition, in this study, multivariate analysis showed no association of BI, MNA-SF, and SMI with mortality. The mean BI was 35.1 ± 26.3, MNA-SF 8.8 ± 2.5, and SMI 4.9 ± 1.4, which were lower than in previous studies (Henwood, Hassan, Swinton, Senior, & Keogh, 2017; Lilamand et al., 2015; Nakazawa et al., 2012). This may have been influenced by the fact that most of the participants had severe caregiving status.

In this study, a history of cerebrovascular disease was associated with mortality. In a past study, an association between history of cerebrovascular disease and mortality was also reported (Goldberg & Botero, 2008), supporting our results.

There are two similar studies with patients with advanced dementia, which assessed 6-month and 120-day mortality (Mitchell et al., 2004, 2009). In the former study, approximately 47 % of pneumonia and 40 % of dysphagia cases were observed as concomitant symptoms of death for 6 months (Mitchell et al., 2009); in the latter study, dysphagia was observed in half of the cases (Mitchell et al., 2004). Considering these accompanying symptoms, creating a comfortable oral environment and supporting the person's desired diet so as not to cause pain is considered to lead to better QOL (Arcand, 2015). However, the evaluation of dysphagia in these studies was conducted by physicians, which is often difficult to do for all nursing home residents. Conversely, PMMT and MWST can be evaluated routinely by the caregiver, and can lead to a review of the care plan by identifying changes in real time. Therefore, it may be possible to shorten the time during which the end-of-life care provided and the care that the person desires are different from each other.

In the end-of-life care of patients with advanced dementia, it is important for the team, including the family, to discuss care in line with the values of the person's life. It is considered that this will lead to better end-of-life care based on the prediction of concrete prognosis when deciding on a care plan. This study revealed that PMMT and MWST can in fact predict prognosis. The results of these evaluations will be evidence of the opportunity for the implementation of advance care planning and professional evaluations. These are routine observations that can also be conducted by caregivers and families, and may offer the opportunity to review care plans.

There are several limitations to this study. First, participants had different baseline survey times. However, this could also reduce the influence of the seasons in the results. Second, blood biochemistry tests (e.g., brain natriuretic peptide) (Barents et al., 2008), which have been reported to be associated with mortality, were not performed. However,

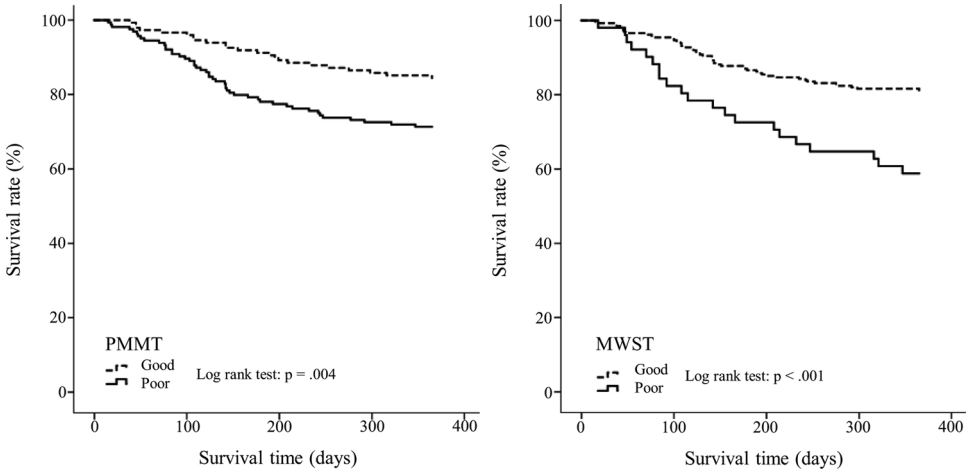

Fig. 2. Kaplan-Meier survival curves for simple evaluation of eating and swallowing function. PMMT - palpation of masseter muscle tension; MWST - modified water swallowing test.

we believe that it was not appropriate to perform invasive evaluations, such as blood tests, frequently performed in advanced dementia patients. Third, the cause of death was not known. In this study, the cause of death of 3 individuals with pneumonia and 2 with aspiration pneumonia was known; however, the cause of death of the remaining 65 participants was not always known. Although the relationship between dysphagia and aspiration pneumonia is clear, it is also believed that dehydration and decreased nutritional status can lead to impaired immune function and electrolyte abnormalities (Arcand, 2015; Gavazzi & Krause, 2002; Masot et al., 2018). As a result, there are many natural deaths in nursing homes; therefore, it is difficult to determine the cause of death (Gruszecki, Edwards, Powers, & Davis, 2004), and this issue needs to be examined in the future. Fourth, because PMMT is affected by the loss of occlusal support (Yamaguchi et al., 2018), we investigated the status of teeth and the condition of wearing dentures. However, no significant differences between the death and survival groups were found in the univariate analysis and these items were thus excluded from the multivariate analysis. It is therefore necessary to reexamine how to evaluate the occlusal condition. Fifth, 7 individuals with non-oral ingestion were excluded from this analysis. In a previous study, 14 % of subjects with a feeding tube had pneumonia (Lin, Hsieh, & Wu, 2008). In comparison, the prevalence of pneumonia in subjects with oral ingestion was 5.1 % in this study; the prevalence of pneumonia in subjects with a feeding tube was higher. In other words, individuals with non-oral ingestion were excluded from this study, because it was thought that pneumonia might have a strong influence on the incidence of death. Future research should examine the predictive indicators for this type of patient. Sixth, to evaluate eating and swallowing function at the care site properly, it will be necessary to standardize the evaluation criteria and provide further verification. Seventh, in this study, the evaluation of those who could not follow instructions was noted as “poor.” There were only a few who were unable to follow the instructions, with PMMT at 4 subjects (1.3 %) and MWST at 26 subjects (8.3 %). Therefore, the influence on the analysis result was considered to be small. If an expert on eating and swallowing function performed the evaluation, subjects with severe apraxia or alexia could follow the instructions and thus be evaluated appropriately. However, the purpose of this study was to investigate the methods that can be used in nursing homes, even for caregivers with little knowledge of eating and swallowing function. Thus, the results of this study were judged to have followed that purpose.

5. Conclusions

As one of the prognostic factors, among the simple evaluation of eating and swallowing function in nursing home residents with advanced dementia, poor results in PMMT and MWST were associated with 1-year mortality. PMMT and MWST are routine evaluations that can predict prognosis, and may thus provide evidence of the opportunity for the implementation of advance care planning.

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Declaration of Competing Interest

The authors declare no conflicts of interest associated with this manuscript.

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