「嚥下調整食学会分類2013」について

以下は今年９月19日に日本摂食・嚥下リハビリテーション学会のホームページ上にアップされた嚥下調整食の新たな「ものさし」である。**表１**の食事の早見表を図式化したものが図のスキーマである。基本的に嚥下食ピラミッドを踏襲したものであるが、コード０を「ゼリーから始めるもの」と「とろみから始めるもの」の２つに区分している。これは、すべての症例がゼリーからスタートするわけではなく、ペースト状から食べ始める場合もあることに配慮したものである。また、コード２を2-1と2-2の２段階に設定している。これは、とろみから経口摂取を始める場合、次の段階としてペースト食に移行するが、不均質なペースト食はハードルが高いため、まず均質なペースト食を摂取し、その次に不均質なペースト食をとってもらえるように配慮したものである。とろみについては**表２**に示したように、「薄いとろみ」「中間のとろみ」「濃いとろみ」の３段階を設定している。

この分類は食事の形態調整において施設間で連携を図るための共通言語であり、これらの図表のコードナンバーを使って転院先との連携に活かしていくように策定されている。

※「嚥下調整食学会分類2013」についての詳しい内容は、日本摂食・嚥下リハビリテーション学会ホームページにアップされている「嚥下調整食学会分類2013」の本文をご参照ください。また、本誌53ページからの栢下淳先生の誌上講演もぜひご覧ください。

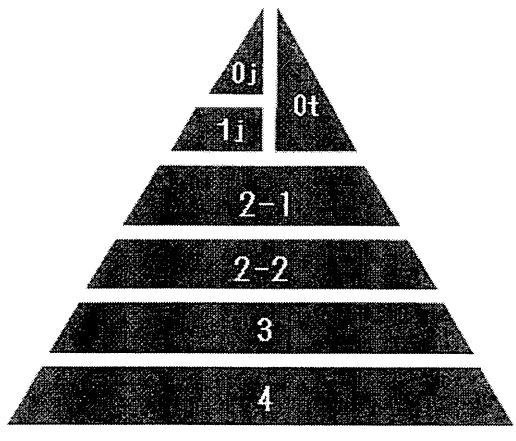
表１　学会分類2013(食事)早見表

コード【0-4の5項】		名称	形態	目的・特色	主食の例	必要な咀嚼能力【1-10段階】	他の分類との対応【1-7段階】
0	j	嚥下訓練食品j	均質で、付着性・凝集性・硬さに配慮したゼリー・離水が少なく、スライス状にすくうことが可能なもの	重度の症例に対する評価・訓練用 少量をすくってそのまま丸のみ可能 残留した場合にも吸引が容易 たんぱく質含有量が少ない		若干の送り込み能力	嚥下食ピラミッドL0 えん下困難者用食品許可基準１
	t	嚥下訓練食品t	均質で、付着性・凝集性・硬さに配慮したとろみ水 （原則的には、中間のとろみあるいは濃いとろみ水のどちらかが適している）	重度の症例に対する評価・訓練用 少量ずつ飲むことを想定 ゼリー丸呑みで誤嚥したり ゼリーが口中で溶けてしまう場合 たんぱく質含有量が少ない		若干の送り込み能力	嚥下食ピラミッドL2の一部 （とろみ水）
1	j	嚥下調整食1j	均質で、付着性、凝集性、硬さ、離水に配慮したゼリー・プリン・ムース状のもの	口腔外で既に適切な食塊状となっている （少量をすくってそのまま丸のみ可能） 送り込む際に多少意識して口蓋に舌を押しつける必要がある 0jに比し表面のざらつきあり	おもゆゼリー、ミキサー粥のゼリー　など	若干の食塊保持と送り込み能力	嚥下食ピラミッドL1・L2 えん下困難者用食品許可基準Ⅱ UDF区分4（ゼリー状） *UDF：ユニバーサルデザインフード
2	1	嚥下調整食2	ヒューレ・ペースト・ミキサー食など、均質でなめらかで、べたつかず、まとまりやすいもの スプーンですくって食べることが可能なもの	口腔内の簡単な操作で食塊状となるもの （咽頭では残留、誤嚥をしにくいように配慮したもの）	粒がなく、付着性の低いペースト状のおもゆや粥	下顎と舌の運動による食塊形成能力および食塊保持能力	嚥下食ピラミッドL3 えん下困難者用食品許可基準Ⅱ・Ⅲ UDF区分4
	2		ヒューレ・ペースト・ミキサー食などで、べたつかず、まとまりやすいもので不均質なものも含むスプーンですくって食べることが可能なもの		やや不均質（粒が多い）でもやわらかく、離水もなく付着性も低い粥類	下顎と舌の運動による食塊形成能力および食塊保持能力	
3	嚥下調整食3		形はあるが、押しつぶしが容易、食塊形成や移送が容易、咽頭でばらけず嚥下しやすいように配慮されたもの 多量の離水がない	舌と口蓋間で押しつぶしが可能なもの（押しつぶしや送り込みの口腔操作を要しあるいはそれらの機能を賦活し、かつ誤嚥のリスク軽減に配慮がなされているもの）	離水に配慮した粥　など	舌と口蓋間の押しつぶし能力以上	嚥下食ピラミッドL4 歯科者ソフト食 UDF区分3
4	嚥下調整食4		硬さ・ばらけやすさ・粘りつきやすさなどのないもの 箸やスプーンで切れるやわらかさ	誤嚥と窒息のリスクを配慮して素材と調理方法を選んだもの 歯がなくても対応可能だが、上下の歯槽提間で押しつぶすあるいはすりつぶすことが必要で舌と口蓋間で押しつぶすことは困難	軟飯・全粥　など	上下の歯槽提間の押しつぶし能力以上	嚥下食ピラミッドL4 高齢者ソフト食 UDF区分1・2

表２　学会分類2013(とろみ)早見表

	段階1 薄いとろみ 【Ⅲ-3病】	段階2 中間のとろみ 【Ⅲ-2病】	段階3 濃いとろみ 【Ⅲ-4病】
英語表記	Mildly thick	Moderately thick	Extremely thick
性状の説明 （飲んだとき）	「drink」するという表現が適切なとろみの程度 口に入れると口腔内に広がる液体の種類・味や温度によっては、とろみがついていることがあまり気にならない場合もある 飲み込む際に大きな力を要しない ストローで容易に吸うことができる	明らかにとろみがあることを感じがありかつ、「drink」するという表現が適切なとろみの程度 口腔内での動態はゆっくりですぐには広がらない 舌の上でまとめやすい ストローで吸うのは抵抗がある	明らかにとろみがついていて、まとまりが良い 送り込むのに力が必要 スプーンで「eat」するという表現が適切なとろみの程度 ストローで吸うことは困難
性状の説明 （見たとき）	スプーンを傾けるとすっと流れおちる フォークの歯の間から素早く流れ落ちる カップを傾け，流れ出た後には，うっすらと跡が残る程度の付着	スプーンを傾けるととろとろと流れる フォークの歯の間からゆっくりと流れ落ちる カップを傾け，流れ出た後には，全体にコーティングしたように付着	スプーンを傾けても，形状がある程度保たれ，流れにくい フォークの歯の間から流れでない カップを傾けても流れ出ない （ゆっくりと塊となって落ちる）
粘度(mPa･s) 【Ⅲ-5病】	50 - 150	150 - 300	300 - 500
LST値(mm) 【Ⅲ-5病】	36 - 43	32 - 36	30 - 32

図　学会分類2013のスキーマ



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COMMUNITY DENTISTRY AND ORAL EPIDEMIOLOGY

Interrelationship of oral health status, swallowing function, nutritional status, and cognitive ability with activities of daily living in Japanese elderly people receiving home care services due to physical disabilities

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Abstract – *Objectives:* Malnutrition and cognitive impairment lead to declines in activities of daily living (ADL). Nutritional status and cognitive ability have been shown to correlate with oral health status and swallowing function. However, the complex relationship among the factors that affect decline in ADL is not understood. We examined direct and indirect relationships among oral health status, swallowing function, nutritional status, cognitive ability, and ADL in Japanese elderly people living at home and receiving home care services because of physical disabilities. *Methods:* Participants were 286 subjects aged 60 years and older (mean age, 84.5 ± 7.9 years) living at home and receiving home care services. Oral health status (the number of teeth and wearing dentures) was assessed, and swallowing function was examined using cervical auscultation. Additionally, ADL, cognitive ability, and nutritional status were assessed using the Barthel Index, the Clinical Dementia Rating Scale, and the Mini Nutritional Assessment-Short Form, respectively. Path analysis was used to test pathways from these factors to ADL. *Results:* The mean number of teeth present in the participants was 8.6 ± 9.9 (edentates, 40.6%). Dysphagia, malnutrition, and severe cognitive impairment were found in 31.1%, 14.0%, and 21.3% of the participants, respectively. Path analysis indicated that poor oral health status and cognitive impairment had a direct effect on denture wearing, and the consequent dysphagia, in addition to cognitive impairment, was positively associated with malnutrition. Malnutrition as well as dysphagia and cognitive impairment directly limited ADL. *Conclusions:* A lower number of teeth are positively related to swallowing dysfunction, whereas denture wearing

Key words: activities of daily living; cognitive ability; elderly people with physical disabilities; nutritional status; oral health status

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contributes to recovery of swallowing function. Dysphagia, cognitive impairment, and malnutrition directly and indirectly decreased ADL in elderly people living at home and receiving home nursing care. The findings suggest that preventing tooth loss and encouraging denture wearing when teeth are lost may indirectly contribute to maintaining or improving ADL, mediated by recovery of swallowing function and nutritional status.

In almost every country, the proportion of older people is increasing relative to younger age groups (1). Especially in Japan, the population is aging rapidly because of dramatic reductions in early mortality and declines in fertility. Indeed, the population aged 65 years old and older in Japan accounts for 23% of the total population in 2011 (2), and this percentage is the highest in the world. As the number of elderly people increases, so does the number of those requiring long-term nursing care, such as those who are bedridden and suffering from dementia (3).

Since 2000, nursing services supporting the daily lives of elderly individuals who require long-term care because of physical disability have been provided through the social insurance system enacted in Long-term Care Insurance Act in Japan (4). In this system, applicants for services are classified into five grades according to the severity of their physical disability, and the amount of nursing care service provided is determined by grade (5). The number of elderly receiving long-term care based on this act was about 4 million in 2010 according to a report by Japanese Ministry of Health, Labour and Welfare (6). Another report showed that 29% of elderly Japanese requiring long-term care deteriorated as measured by the grade of care service needed, and 23% of them died within 2 years (7). For elderly people receiving nursing care, further deterioration in their ability to conduct activities of daily living (ADL) such as bathing, dressing, and walking is an important concern.

Previous studies have suggested that malnutrition and cognitive impairment can lead to deterioration in ADL (8, 9), and malnutrition has been associated with cognitive impairment in elderly people (8). Moreover, nutrition and cognitive function have also been shown to correlate with oral health status (10, 11) and swallowing function (12, 13). However, these studies focused on direct relationships between bivariates. We need to also take into account that decline in ADL is affected by complex direct and indirect interactions among multiple factors. That is, it is not enough to analyze an association incorporating multiple factors as independent variables to show comprehensively how these risk factors affect deterioration in ADL.

Furthermore, most studies about the effects of oral condition on malnutrition and decline in ADL have been limited to elderly people in nursing homes and hospitals (11–13); few studies have examined these associations in elderly people living at home. In Japan, about 3 million people received home care services, and about 1 million people received facility services, such as at a nursing home, via long-term care insurance in 2010 (5, 14). In the United States, because of social trends toward reduced nursing home use, the number of disabled elderly people needing home care support has increased (15). Considering the growing number of aged people and the inevitable subsequent increase in the number who will require long-term nursing care in most developed countries, an increase in the number of elderly people requiring home care is expected to be a major issue in modern societies worldwide. Therefore, it is useful to investigate the many factors leading to a decline in ADL among elderly people living at home.

In the present study, we examined the direct and indirect effects of oral health status, including number of teeth and denture wearing, swallowing function, nutritional status, and cognitive ability, on ADL in Japanese elderly people living at home and receiving home care services because of physical disabilities. We hypothesized the following: (i) cognitive impairment leads to eating difficulties (e.g., difficulty chewing food, difficulty swallowing food), and these difficulties impair nutritional status (16); (ii) oral health status affects eating difficulties (17); (iii) cognitive impairment affects oral health status (18), or, conversely, oral health status affects cognitive impairment (19); (iv) cognitive impairment and malnutrition lead to a decline in ADL (9) (Fig. 1). The conceptual model was proposed, based on empirical evidence.

Materials and methods

Study setting and study population

This cross-sectional study was undertaken in two midsized municipalities in Fukuoka prefecture (western Japan) between November 2010 and

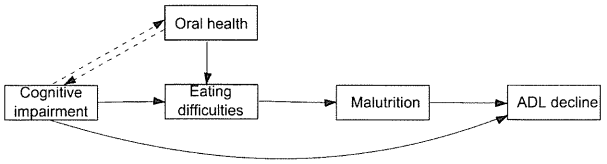

Fig. 1. The conceptual model. Dotted lines indicate paths explored the direction in this study.

February 2011. The study population comprised 337 participants aged 60 years or older who were living at home and using an in-home long-term care support center that coordinates home care services such as home nursing care, visiting rehabilitation, visiting bathing service, day service, and day care (rehabilitation) by service providers. Of these, 51 participants with missing data were excluded. Finally, 286 participants (75 men, 211 women) were included.

The study was approved by Kyushu University Institutional Review Board for Clinical Research. We obtained participants' or their family members' consent, as required for approval by the review board.

Assessment of oral health status and swallowing function

Oral health status and swallowing function were assessed by qualified dental hygienists. Oral health status was assessed by recording the number of teeth and denture wearing.

Swallowing function was examined by cervical auscultation, a non-invasive method of listening with a stethoscope to the sounds of swallowing 3 ml of water during the pharyngeal phase, following the method of Zenner et al. (20) with minor modifications. When breath sounds after swallowing material were clear, we evaluated swallowing function as normal. When stridor, coughing, or throat clearing was heard after swallowing material or when swallowing was repeated, we evaluated this as impaired swallowing function (i.e., dysphagia).

Measurement of ADL, cognitive ability, and nutritional status

Participant's ADL, cognitive ability, and nutritional status were recorded by a nurse or a care worker at the in-home long-term care support center. ADL was assessed using the Barthel Index, which covers all aspects of self-care independence in daily living activities such as transfer, walking stairs, toilet use, dressing, feeding, and bathing (21). A total score of 100 points indicates complete self-sufficiency, whereas a score of zero indicates that the person is completely dependent (21).

Cognitive ability was assessed using the Clinical Dementia Rating (CDR). CDR status was assigned according to the presence or absence of dementia and, if present, its severity (none, questionable or very mild, mild, moderate, or severe cognitive impairment), as described previously (22).

Nutritional status was evaluated using the Mini Nutritional Assessment-Short Form (MNA-SF) (23). The MNA-SF has the option of using calf circumference when body mass index is not available because of a bedridden and immobile state. Nutritional status was defined in three classifications by the MNA-SF: 0–7 points = malnourished; 8–11 points = at risk of malnutrition, and 12–14 points = well nourished.

Comorbid conditions

We assessed comorbidity with the Charlson comorbidity index (24, 25), which provides a weighted score for a participant's comorbidities taking into account how many of 19 predefined comorbid conditions an individual has, because elderly people generally live with multiple diseases, and the presence of comorbidities has a negative effect on both physical and cognitive function (26).

Statistical analysis

Bivariate associations between oral health status and swallowing function, nutritional status, cognitive ability, ADL, or confounding variables such as age, gender, and comorbid conditions were tested with the chi-square or ANOVA test. Oral health status was categorized as 20 or more teeth with dentures; 20 or more teeth without dentures; 10 to 19 teeth with dentures; 10 to 19 teeth without dentures; 0 to 9 teeth with dentures; or 0 to 9 teeth without dentures. A P value < 0.05 was considered to indicate statistical significance. The SPSS software (ver. 19.0 for Windows; IBM SPSS Japan, Tokyo, Japan) was used for data analyses.

To test the hypothesis, we conducted path analysis using the M-plus statistical package (27). Path analysis can be used instead of several separate regressions to examine mediating effects within a single model (28). Additionally, path analysis allows testing of causal relationships among a set

of observed variables (29). We tested the hypothesized model using path analysis (Fig. 2). The model examined the interactive effects of nine constructs. We hypothesized that cognitive ability and nutrition status directly affect ADL. We also hypothesized that the number of teeth, denture wearing, and cognitive ability precede swallowing function. Additionally, the number of teeth, denture wearing, and swallowing function precede nutrition status. Considering the association between cognitive ability and oral health status, it is possible that cognitive impairment affects oral health status (18) or, conversely, that oral health status affects cognitive impairment (19). We tested alternative path models each with different directionalities among the number of teeth, denture wearing, and cognitive ability. We adjusted for age, gender, and comorbid condition.

Data used in this study included both continuous and dichotomous variables. Thus, the path model was analyzed using weighted least-squares mean and variance adjustment estimation (WLSMV). WLSMV uses a diagonal weight matrix with robust standard errors and mean- and variance-adjusted chi-square test statistics (27). We used a significance level of $P < 0.05$ for the regression coefficients. The degree of correspondence between the hypothesized models and the actual data was assessed with a goodness-of-fit test. Criteria for the goodness-of-fit test include a comparative fit index (CFI), a Tucker-Lewis index (TLI), a root-mean-square error of approximation (RMSEA), and the weighted root-mean-square residual (WRMR). Values of >0.95 for the CFI, >0.95 for the TLI, <0.06 for the RMSEA, and <0.90 for the WRMR are considered to indicate a good fit of the data to the model (27) (30).

Statistical power was considered for this analysis. In path analysis, sample sizes of around 150 to 200 are more desirable (31). With an alpha level of 0.05 and 286 subjects, it is estimated that the statistical power for this study reached 0.95.

Results

The participants were 75 men and 211 women. The age of the study population ranged from 61 to 104, and the mean age ± SD was 84.5 ± 7.9 years (79.1 ± 7.9 years for men and 86.4 ± 6.9 years for women). The mean number of teeth present was 8.6 ± 9.9, and 40.6% of participants were edentulous, while the mean number of teeth present was 14.4 ± 8.9 in 170 dentate subjects. The proportion of participants who did not visit a dental clinic was 75.9%.

Activities of daily living, cognitive ability, and nutritional status according to different categories of oral health status (including number of teeth, denture wearing), and swallowing function are presented in Tables 1 and 2. Subjects having 0 to 19 teeth and no dentures showed lower levels of ADL, cognitive function, and nutritional status than did those who had more than 20 teeth or who wore dentures. Subjects with dysphagia had lower ADL, more severe cognitive impairment, and more malnutrition than those with normal swallowing (Table 3).

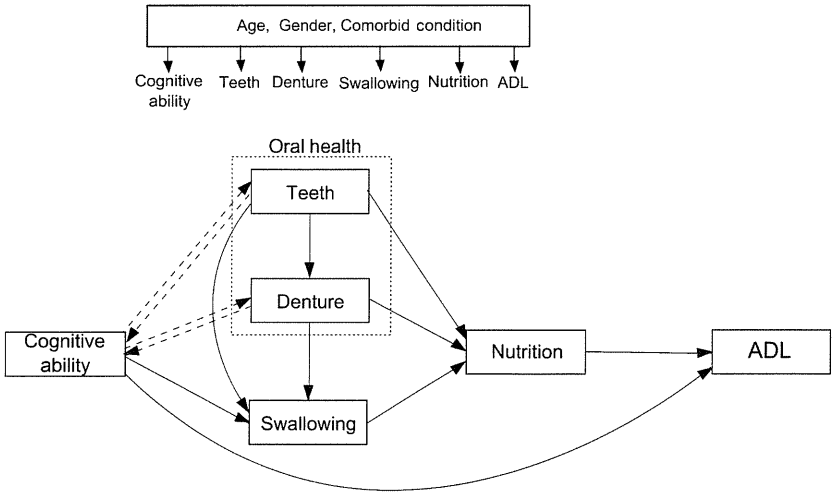

Fig. 2. The hypothesized model. The model consists of nine observed variables including confounding variables such as age, gender and comorbid conditions. Dotted lines indicate paths explored the direction in this study.

Table 1. Functional ability, cognitive function, and nutritional status according to the number of teeth [*n* (%)]

Variable	0–9 teeth (*n* = 179)	11–19 teeth (*n* = 48)	≥ 20 teeth (*n* = 59)	Total	*P* value
Age, mean ± SD	86.4 ± 7.1	82.8 ± 7.2	80.0 ± 8.5	84.5 ± 7.9	<0.001
Female	144 (80.4)	33 (68.8)	34 (57.6)	211 (71.3)	0.002
Dysphagia	57 (31.8)	16 (33.3)	16 (27.1)	89 (31.1)	0.743
Functional ability (Barthel Index), mean ± SD	57.2 ± 26.7	59.8 ± 28.4	62.1 ± 30.2	58.6 ± 27.7	0.467
Nutritional status (MNA-SF), mean ± SD	10.2 ± 2.1	9.7 ± 2.4	10.3 ± 2.6	10.1 ± 2.2	0.361
Nutrition status category					0.311
Normal (12–14)	52 (29.1)	13 (27.1)	23 (39.0)	88 (30.8)	
Risk of malnutrition (8–11)	105 (58.7)	25 (52.1)	28 (47.5)	158 (55.2)	
Malnutrition (0–7)	22 (12.3)	10 (20.8)	8 (13.6)	40 (14.0)	
Cognitive function (CDR)					0.262
None/Questionable	48 (26.8)	11 (22.9)	23 (39.0)	82 (28.6)	
Mild/Moderate	90 (50.3)	25 (52.1)	28 (47.5)	143 (50.0)	
Severe	41 (22.9)	12 (25.0)	8 (13.6)	61 (21.3)	
Comorbid condition (Charlson Comorbidity Index), mean ± SD	1.3 ± 1.1	1.5 ± 1.2	1.7 ± 1.3	1.4 ± 1.2	0.100

SD, standard deviation.

Table 2. Functional ability, cognitive function, and nutritional status according to oral health status [*n* (%)]

Variable	0–9 teeth, no denture (*n* = 26)	0–9 teeth with denture (*n* = 153)	10–19 teeth, no denture (*n* = 18)	10–19 teeth with denture (*n* = 30)	≥ 20 teeth, no denture (*n* = 49)	≥ 20 teeth with denture (*n* = 10)	*P* value
Age, mean ± SD	88.5 ± 6.6	86.1 ± 7.2	81.8 ± 7.5	83.3 ± 7.1	78.4 ± 8.2	87.6 ± 5.4	<0.001
Female	19 (73.1)	125 (81.7)	12 (66.7)	21 (70.0)	26 (53.1)	8 (80.0)	0.005
Dysphagia	15 (57.7)	42 (27.5)	7 (38.9)	9 (30.0)	13 (26.5)	2 (20.0)	0.061
Functional ability (Barthel Index), mean ± SD	38.1 ± 29.6	60.4 ± 24.8	53.9 ± 28.6	63.3 ± 28.2	59.8 ± 30.3	73.5 ± 28.0	0.001
Nutritional status (MNA-SF), mean ± SD	9.2 ± 2.1	10.4 ± 2.0	9.3 ± 2.4	10.0 ± 2.4	10.1 ± 2.8	11.4 ± 1.2	0.041
Nutritional status category							0.313
Normal (12–14)	4 (15.4)	48 (31.4)	4 (22.2)	9 (30.0)	18 (36.7)	5 (50.0)	
Risk of malnutrition (8–11)	16 (61.5)	89 (58.2)	10 (55.6)	15 (50.0)	23 (46.9)	5 (50.0)	
Malnutrition (0–7)	6 (23.1)	16 (10.5)	4 (22.2)	6 (20.0)	8 (16.3)	0 (0.0)	
Cognitive function (CDR)							0.038
None/Questionable	4 (15.4)	44 (28.8)	3 (16.7)	8 (26.7)	17 (34.7)	6 (60.0)	
Mild/Moderate	10 (38.5)	80 (52.3)	9 (50.0)	16 (53.3)	25 (51.0)	3 (30.0)	
Severe	12 (46.2)	29 (19.0)	6 (33.3)	6 (20.0)	7 (14.3)	1 (10.0)	
Comorbid condition (Charlson Comorbidity Index), mean ± SD	1.3 ± 0.9	1.3 ± 1.2	1.1 ± 0.5	1.7 ± 1.4	1.7 ± 1.4	1.6 ± 1.3	0.151

SD, standard deviation.

Path analysis

First, we estimated an initial model with all hypothesized pathways corresponding to the estimated variables directly or indirectly affecting ADL. Then, some insignificant paths were eliminated, and others who showed significant bivariate correlations were added while confirming the model-fit indices. A final model was then estimated with only statistically significant paths retained. The final model was a fairly good fit [χ^2 (14) = 19.805; P = 0.136; CFI = 0.972; TLI = 0.945; WRWR = 0.571; RMSEA = 0.038 (0.001 to 0.074)]. Figure 3 shows parameter estimates for the final path model. The model showed the following

Table 3. Activities of daily living, cognitive ability, and nutrition status with or without dysphagia [*n* (%)]

Variable	Dysphagia (*n* = 89)	Normal (*n* = 197)	*P* value
Age, mean ± SD	84.5 ± 8.6	84.5 ± 7.5	0.991
Female	55 (61.8)	156 (79.2)	0.002
ADL (Barthel Index), mean ± SD	42.8 ± 28.3	65.8 ± 24.3	<0.001
Nutritional status (MNA-SF), mean ± SD	9.3 ± 2.3	10.5 ± 2.1	<0.001
Nutritional status category			<0.001
Normal (12–14)	16 (18.0)	72 (36.5)	
Risk of malnutrition (8–11)	52 (58.4)	106 (53.8)	
Malnutrition (0–7)	21 (23.6)	19 (9.6)	
Cognitive impairment (CDR)			<0.001
None/Questionable	32 (36.0)	60 (30.5)	
Mild/Moderate	35 (39.3)	108 (54.8)	
Severe	22 (24.7)	29 (14.7)	
Comorbid condition (Charlson Comorbidity Index), mean ± SD	1.4 ± 1.1	1.4 ± 1.2	0.976

SD, standard deviation.

significant direct paths: (i) ones from 'Age' and 'Gender' to 'Teeth'; that is, increasing age decreased the number of remaining teeth [β (standardized coefficient) = −0.36] and females had fewer teeth than males (β = −0.14); (ii) one from 'Teeth' to 'Denture'; fewer teeth led to wearing denture (β = −0.79); (iii) one from 'Teeth' and 'Denture' to 'Swallowing'; having many teeth and wearing dentures promoted normal swallowing function (β = 0.78, 0.81, respectively); (iv) one from 'Gender' to 'Swallowing'; female tended to have normal swallowing function (β = 0.22); (v) one from 'Cognitive Ability' to 'Denture' and 'Nutrition'; a high level of cognitive ability led directly to wearing dentures and better nutritional status (β = 0.23 and 0.34, respectively); (vi) one from 'Swallowing' to 'Nutrition'; normal swallowing function promoted normal nutritional status (β = 0.25); (vii) ones from 'Swallowing', 'Cognitive Ability', and 'Nutrition' to 'ADL'; normal swallowing function, a high level of cognitive ability, and normal nutritional status resulted in a higher level of ADL (β = 0.33, 0.26, and 0.35, respectively); (viii) one from 'Comorbid Condition' to 'ADL'; severer comorbid condition caused a lower level of ADL (β = −0.10); and (ix) double-headed arrows among 'Age', 'Gender', 'Comorbid Condition', and 'Cognitive Ability'; age was correlated with cognitive ability, gender, and comorbid conditions. On the other hand, the number of teeth and denture wearing were not directly associated with either nutritional status or ADL.

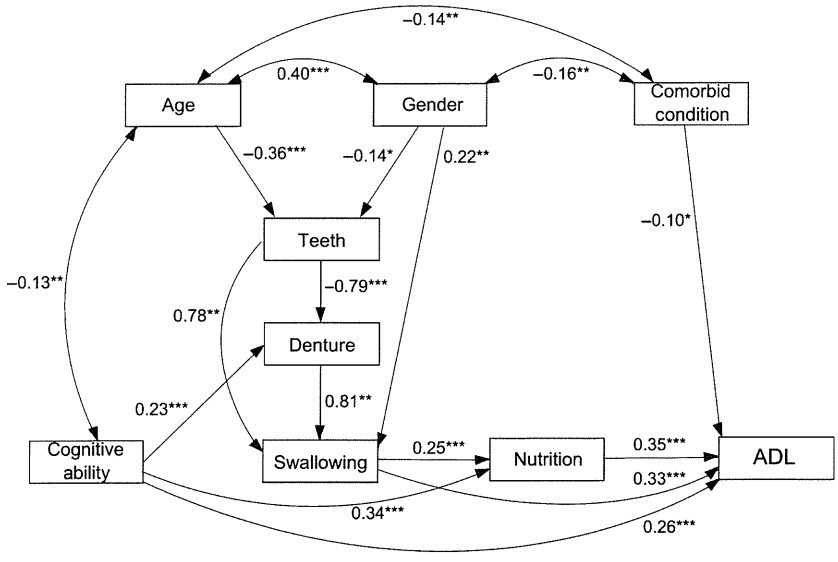

Fig. 3. The final model. Double-headed arrows indicate covariance. All significant values (*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$) indicate standardized coefficients. Continuous variables are 'Age', 'Comorbid Conditions' (Charlson Comorbidity Index), 'Nutrition' (MNA-SF), 'Teeth', and 'ADL' (Barthel Index). Categorical or ordered variables are 'Gender' (1 = male, 2 = female), 'Dentures' (0 = not wearing, 1 = wearing), 'Swallowing' (0 = dysphagia, 1 = normal swallowing function) and 'Cognitive Ability' (1 = severe cognitive impairment, 2 = moderate, 3 = mild, 4 = questionable, 5 = none).

Discussion

This study showed the complex pathway from cognitive ability and oral health status via swallowing function and nutritional status to ADL in aged Japanese people living at home and receiving home care, using path analysis. To the best of the authors' knowledge, this is first study to show the interaction between multiple factors leading to a decline in ADL. Path analysis is an analytical technique that allows the testing of causal models using cross-sectional data. Possible pathways leading to ADL decline, based on our findings and those of previous studies, are as follows. Having fewer teeth leads to wearing dentures, but severe cognitive impairment disrupts denture wearing because of problems in accessing dental care; chewing difficulties resulting from having fewer teeth and no dentures can lead to dysphagia; dysphagia impairs the ability of elderly people to consume adequate amounts of food to meet their nutritional needs, leading to malnutrition (16); cognitive impairment, in turn, causes potential problems related to the inability to eat or to lack of access to food (32), hence leading to malnutrition. Swallowing function, cognitive ability, and nutritional status had direct effects on ADL. This finding agrees with previous studies in elderly people (9, 13). Malnutrition and cognitive impairment are associated with poor muscle strength and reduced physical performance (33), leading to disability, which reduces the ability to perform the basic activities of daily living. Although the effect of oral health status on ADL was indirect in this study, we cannot ignore it because of the moderate association between oral health status and swallowing function. Understanding various factors related to deterioration in ADL among these subjects would contribute to considering a multilateral approach for maintaining ADL in elderly people who are living at home.

The results of the present study suggested that oral health status, as measured by indicators such as the number of teeth and denture wearing, had a direct effect on swallowing function. A previous study reported that laryngeal penetration, usually because of neuromuscular disorder, occurs with much greater frequency in edentulous elderly people who are not wearing dentures than in those who dentulous (34). In our study, when the effect of denture wearing on swallowing function in edentulous persons was examined, 10 of 15 edentates (66.7%) without dentures showed dysphagia, whereas 29 of 101 edentates (28.7%) wearing dentures did. Tamura et al. described that wearing dentures and keeping the appropriate mandible position and proper occlusion were important for smooth swallowing in elderly individuals (35). Additionally, loss of occlusal support and loss of mandibular stopping by occlusion may disturb the coordination of swallowing function (34).

In this study, we did not find a statistically significant association between oral health status and nutritional status in the path analysis. This finding conflicts with those of previous studies (11, 12). There may be at least two reasons that oral health status was not associated with nutritional status in the present study. First, our path model included some factors related to nutritional status, such as oral health status, swallowing function, cognitive ability, and ADL. However, previous studies (11, 12) that demonstrated an association between oral health status and nutritional status failed to incorporate these factors into their analyses. Probably, because factors other than oral health status more strongly affect nutritional status, the relationship would be less obvious in our study. Second, even when elderly people do not have enough teeth, do not wear dentures, and do not chew satisfactorily, food preparation by a caregiver may make food easy to chew and thereby prevent nutritional deterioration. Nutritional status was related to swallowing function, but not to oral health status, in this study, suggesting that swallowing function may have a greater direct effect than chewing ability on malnutrition. However, there was an association between swallowing function and oral health status in our study, and oral health status may still indirectly influence nutritional status.

Our results suggest that maintaining or improving oral health status and swallowing function indirectly or directly contribute to preventing a decline in ADL in elderly people who require home care. Yoneyama et al. (36) reported that oral care reduced febrile days and the risk of pneumonia in older patients receiving nursing care. These findings indicate that dental interventions, such as provision of dentures, treatment for dental caries or periodontal disease, professional oral care, swallowing training, and oral care training for caregivers, have a beneficial indirect effect on general health in those requiring long-term nursing care. However, our results also showed that 75.9% of participants had not received dental treatment; many elderly people requiring home care have difficulty in gaining access to professional dental care. Further efforts are needed to develop a long-term

care system or community system that provides ready access to dental services.

Our study had some limitations. Using path analysis, our study made causal inferences about the relationships among various factors related to ADL; however, the cross-sectional design means that we cannot rule out reverse causation. Further longitudinal study is needed to examine a temporal relationship. Second, we did not incorporate sociological factors, such as socioeconomic status and education level, into this study. Several studies have reported a relationship between sociological factors and oral health status, ADL, cognitive ability, and nutritional status (9, 37–39). ADLs are associated with psychosocial factors (9). Because sociological factors and psychosocial factors were considered to have more indirect effects on ADL than oral health status, cognitive ability, and nutritional status, we did not gather this information in this survey. Third, we did not assess the prevalence of specific oral diseases such as dental caries and periodontal disease. Finally, we recruited the subjects using an in-home long-term care support center in two midsized municipalities in Japan. Our sample may limit the ability to extrapolate our findings to all Japanese elderly people. Caution is warranted in generalizing our findings to the rest of the Japanese population.

In conclusion, based on the present study, we propose a potential causal pathway by which oral health status directly affects swallowing function, and dysphagia, cognitive impairment, and malnutrition directly or indirectly affect ADL in elderly people living at home and receiving home nursing care. These findings suggest that maintaining the number of teeth from a younger age and wearing dentures when teeth are lost may indirectly reduce malnutrition and subsequent ADL decline in these people.

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ORIGINAL ARTICLE: EPIDEMIOLOGY, CLINICAL PRACTICE AND HEALTH

Effects of the reappearance of primitive reflexes on eating function and prognosis

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Aim: Primitive reflexes can reappear with diseases of the brain, particularly those affecting the frontal lobes. Most studies on primitive reflexes have reported an association between such reflexes and brain damage, and the clinical symptoms of dementia. These reflexes can also be present during eating; however, their effects on eating function are difficult to evaluate. The purpose of the present study was to identify the frequency at which primitive reflexes reappear in elderly people, and to determine the effects that such reflexes have on eating function, nutritional status and prognosis.

Methods: We followed 121 nursing home residents for 6 months. All patients required long-term care and were examined for the presence of a sucking reflex, snout reflex and phasic bite reflex for baseline measures. Demographic characteristics, physical and cognitive function, and nutritional status were obtained from chart reviews, interviews with nurses, and a brief physical examination at baseline and incidence of aspiration pneumonia during the study period.

Results: The sucking reflex was confirmed in 31 patients (25.6%), snout reflex in 15 patients (12.3%) and phasic bite reflex in 28 patients (23.1%). One or more of these reflexes was identified in 38 patients (31.4%). A relationship between the presence of a primitive reflex and nutritional status was shown. An association with the presence of these reflexes and the development of aspiration pneumonia during 6 months was also confirmed.

Conclusions: The appearance of primitive reflexes appears to be associated with the risk of malnutrition and developing aspiration pneumonia. **Geriatr Gerontol Int 2013; ••: ••–••.**

Keywords: dementia, dysphagia, elderly people, nutrition, primitive reflexes.

Introduction

Primitive reflexes are observed during the neonatal and infant periods, but later they recede as a result of cerebral cortex inhibition and brain stem activity.[1] However, they reappear in healthy elderly people and in patients with diseases of the nervous system.[2,3] It is also known that the incidence at which these reflexes reappear increases with age.[4,5] They can also reappear as a result of trauma to the brain.[6] Although any combination of these reflexes is considered to be indicative of damage to cognitive function, it is believed that this relationship is a result of age and is not in itself specific for brain disease.[7] It has been reported that in cases of Alzheimer's disease or cerebrovascular dementia, a relationship can be identified between the appearance of primitive reflexes and the severity of damage to cognitive function.[8] In contrast, no association with a decline in cognitive function has been recognized.[4]

The major primitive reflexes in the oral cavity are the sucking reflex, snout reflex and phasic bite reflex. Most studies on primitive reflexes to date have reported an association between such reflexes and brain damage, and the clinical symptoms of dementia. As these reflexes can also be recognized during eating, their effects on eating function cannot be ignored. Nevertheless, the association between these reflexes and eating function

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or nutritional status is unknown. In the many studies of elderly patients in long-term care, there is a high incidence of malnutrition.[9] Problems associated with malnutrition include reduced immunity and increased susceptibility to infection.[10] Malnutrition is also a risk factor for respiratory tract infections, including aspiration pneumonia[11] and in-hospital infections.[12] Furthermore, it has been found that malnutrition can result from masticatory disorders due to tooth loss,[13,14] but there have been no reports of malnutrition resulting from masticatory disorders due to motor impairment.[15] The purpose of the present study was to determine the incidence of primitive reflexes in older adults living in nursing homes, and to identify the effects of such reflexes on eating function, nutritional status and prognosis.

Methods

The participants were 121 of 127 elderly patients who lived in two nursing homes in Tokyo, Japan, and who required care (mean age 86.1 ± 7.9 years; 33 males [81.6 ± 8.3 years]; 94 females [87.7 ± 7.2 years]). Individuals under nutritional management by feeding tube were excluded.

The criterion for patient selection was that physical symptoms and cognitive impairment must have been stable for the preceding 3 months. During this 3-month period, no patient had acute disorders (e.g. severe infection, heart failure, or stroke requiring special treatment or intensive care).

In addition, the association between primitive reflexes and nutritional status was examined in 110 participants (mean age 86.2 ± 7.6 years; 30 males [82.4 ± 7.6 years]; 80 females [87.7 ± 7.2 years]) whose serum albumin could be measured. Under the approval of the Ethics Committee in the School of Life Dentistry, Nippon Dental University, the present study was carried out after obtaining informed consent from the participants or their families. The Clinical Dementia Rating (CDR)[16] was used for evaluating cognitive functions, and the Barthel Index[17] was used for evaluating activities of daily living (ADL). The basic survey was conducted in May 2009 and the subjects were then observed over the course of the next 6 months.

The protocol for this study was approved by the Ethics Committee of the Nippon Dental University School of Life Dentistry at Tokyo (#09–11).

Primitive reflex evaluation methods

The presence of primitive reflex was evaluated at the beginning of the present study.

Using the methods of Paulson,[18] participants were examined in the mornings in a quiet room of the nursing home for the presence or absence of a sucking reflex, snout reflex or phasic bite reflex.

Primitive reflexes were evaluated as follows by the same dentist:

Sucking. Incomplete sucking, with only weak contraction of the orbicularis oris muscle, or full sucking, with sucking movements of the tongue and pharynx, after the tip of the patient's index finger is firmly placed between his closed lips.

Snout. Weak puckering or protrusion of the lips, with elevation of the lower lip, after the examiner taps lightly on the midline of the subject's upper lip with his index finger.

Phasic bite. Vertical movement of the lower jaw, as in mastication, after the examiner presses downward with one finger on the molar region of the lower jaw.

Physical and oral examinations

ADL and cognitive functions

In the results of evaluation using the Barthel Index,[17] ADL was considered stable at 45 points or more, but as having declined at 40 points or less. In the present study, based on the results of evaluation by CDR, cognitive function was considered normal at code 1 or lower, and decreased at code 2 or higher.

Nutrition indicators

Nutritional status was evaluated at baseline.

Bodyweight and height were measured and body mass index (BMI) was calculated. In addition, blood samples were taken for the measurement of serum albumin. Values less than 3.5 mg/dL were considered to indicate malnutrition. The texture of the food served at each of the nursing homes was also recorded. Participants who could not ingest an adequate amount of calories as a result of dysphagia were supplemented with high-calorie foods; the participants supplemented with ≥200 kcal per day were assigned to a dietary supplementation group.

Swallowing function

Participants were asked to swallow 3 cc of water and underwent auscultation of the cervical area after swallowing. If choking was produced in conjunction with swallowing or if a wet or gargling sound was detected by auscultation, the participant was considered to have dysphagia.

Other

Medical information at the nursing facilities was examined in order to determine whether the participants had

a history of aspiration pneumonia over the past 12 months. Aspiration pneumonia was diagnosed by a medical doctor.

Statistical analysis

For comparison of two groups, unpaired *t*-tests were used. To examine the independence of each group, χ^2-tests were used. The presence or absence of malnutrition and the development of aspiration pneumonia during 6 months were evaluated as dependent variables. Associated factors were screened by means of logistic regression analysis. For the selection of variables, the stepwise method was applied. All statistical analyses were carried out using the Japanese version of SPSS for Windows (version 16; IBM Japan, Tokyo, Japan), and *P*-values less than 0.05 were considered to be significant. Numerical values in this text are expressed as mean ± standard deviation.

Results

The mean ages of the participants were 87.7 ± 7.2 years for females and 81.6 ± 8.3 years for males, which was a significant difference ($P < 0.001$). The mean Barthel Index was 29.6 ± 27.2; 41.9 ± 28.9 for males and 27.2 ± 25.5 for females, which was significantly different ($P < 0.05$). No sex-based differences in CDR were noted.

Present rate of primitive reflexes

The sucking reflex was noted in 31 (25.6%) participants (mean age 87.7 ± 8.3 years), the snout reflex was found in 15 (12.4%) participants (mean age 86.8 ± 9.3 years) and the phasic bite reflex was found in 28 (23.1%) participants (mean age 86.8 ± 7.6 years). All three reflexes were observed in 11 (9.0%) participants (mean age 89.6 ± 6.8 years). The sucking reflex plus the snout reflex were present in three (2.5%) participants (mean age 81.0 ± 13.8 years), the sucking reflex plus the phasic bite reflex were found in 10 (8.3%) participants (mean age 85.9 ± 9.2 years), the snout reflex plus the phasic bite reflex were found in one (73.0 years) participant, the sucking reflex alone was noted in seven (5.8%) participants (mean age 90.0 ± 5.9 years) and the phasic bite reflex alone was noted in six (5.0%) participants (mean age 85.7 ± 2.1 years); the snout reflex alone was not observed in any participants. One or more of these reflexes were found in 38 (31.4%) participants (mean age 86.9 years).

Relationship between primitive reflexes and characteristics

The presence of primitive reflexes was observed in a large number of participants who had a decline in cognitive function and/or a reduction in ADL. It was also recognized that a significant number of participants often ate foods in which the food texture was modified. In those who showed the sucking reflex, insertion of dentures in either the upper or lower jaw was very difficult. No relationship between age and the appearance of primitive reflexes was noted (Table 1).

Primitive reflexes and nutritional status

A relationship was found between the presence of primitive reflexes and current bodyweight (sucking reflex $P = 0.042$; snout reflex $P = 0.028$). In addition, a relationship was observed between the appearance of the phasic bite reflex at 6 months or 12 months and the rate of change in bodyweight (6 months $P = 0.009$; 12 months $P = 0.042$). The presence of the sucking reflex and phasic bite reflex was also related to serum albumin levels (sucking reflex $P = 0.015$, phasic bite reflex $P = 0.0001$). Participants who had any of the primitive reflexes showed a relationship between bodyweight and serum albumin levels (bodyweight $P = 0.022$, serum albumin level $P = 0.0001$; Table 2).

A serum albumin level of less than 3.5 mg/dL was considered to show malnutrition, and the relationship with each evaluation parameter was investigated.

The following results were obtained: presence/absence of assistance in eating ($P = 0.003$), sucking reflex ($P = 0.005$), snout reflex ($P = 0.02$), phasic bite reflex ($P = 0.001$), participants with some type of primitive reflex ($P = 0.003$) and age (76 participants with adequate nutrition, aged 85.1 ± 7.8 years; and 34 participants with malnutrition, aged 88.7 ± 6.7 years; $P = 0.025$). Malnutrition, viewed in terms of serum albumin levels, was taken as the response variable. Significant parameters (assistance in eating, some type of primitive reflex and age) were taken as explanatory variables, and in the logistic regression analysis, age and appearance of some type of primitive reflex were selected as significantly independent explanatory variables (age: exp = 1.070, 1.007–1.137, $P = 0.029$; some type of primitive reflex: exp = 3.886, 1.582–9.545, $P = 0.003$; Table 3).

Relationship between primitive reflexes and developing aspiration pneumonia

In the course of the study, 22 participants with a mean age of 86.9 ± 8.8 years (9 males: mean age 83.6 ± 6.6 years; 13 females: mean age 89.1 ± 9.6 years) developed aspiration pneumonia. The relationship between each evaluation parameter and the onset of aspiration pneumonia was investigated. Relationships were identified between aspiration pneumonia onset and ADL ($P = 0.026$), sucking reflex ($P = 0.022$), phasic bite reflex ($P = 0.009$), and some type of primitive reflex ($P = 0.011$; Table 4).

Table 1 Relationship between primitive reflexes and basic information

	Suck reflex			Snout reflex			Phasic bite reflex			One or more		
	–	+	*P*-value	–	+	*P*-value	–	+	*P*-value	–	+	*P*-value
Sex (male/female)	27/63	5/26	0.16	30/76	2/13	0.35	27/66	5/23	0.3	27/56	5/33	0.03
Age, years (mean ± SD)	85.8 ± 7.7	87.7 ± 8.3	0.25	86.2 ± 7.7	86.8 ± 9.3	0.78	86.1 ± 7.9	86.8 ± 7.6	0.7	85.9 ± 7.9	86.9 ± 7.9	0.51
BI (<45/≥40)	59/31	29/2	0.00	74/32	14/1	0.00	62/31	26/2	0.0	52/31	36/2	0.00
CDR (<1/≥2)	30/60	1/30	0.07	30/76	1/14	0.11	30/63	1/27	0.0	30/53	1/37	0.00
Food (solid/modified)	17/73	1/30	0.04	18/88	0/15	0.12	18/75	0/28	0.0	17/66	1/37	0.01
Swallowing disorder (yes/no)	68/22	20/11	0.25	80/26	8/7	0.12	70/23	18/10	0.3	64/19	24/14	0.13
History of aspiration pneumonia (yes/no)	83/7	27/4	0.47	97/9	13/2	0.63	87/6	23/5	0.1	77/6	33/5	0.32
Use of upper dentures, yes/no ($n = 104$)	28/51	19/6	0.00	40/52	7/5	0.37	32/48	15/9	0.1	26/46	21/11	0.01
Use of lower dentures, yes/no ($n = 100$)	25/48	22/5	0.00	39/48	8/5	0.37	32/44	15/9	0.1	23/43	24/10	0.00

BI, Barthel Index; CDR, Clinical Dementia Rating.

Table 2 Relationship between primitive reflexes and nutritional status

	Suck reflex			Snout reflex			Phasic bite reflex			One or more		
	–	+	*P*-value	–	+	*P*-value	–	+	*P*-value	–	+	*P*-value
Bodyweight	45.67 ± 8.39	42.27 ± 6.38	0.04	45.40 ± 8.15	40.54 ± 5.8529	0.03	45.45 ± 8.34	42.61 ± 6.60	0.1	45.93 ± 8.57	42.33 ± 6.15	0.02
BMI	20.43 ± 3.02	19.58 ± 2.54	0.16	20.43 ± 2.89	18.66 ± 2.78	0.03	20.45 ± 3.09	19.40 ± 2.14	0.1	20.52 ± 3.08	19.55 ± 2.45	0.09
Weight change rate during 6 months (%)	1.53 ± 5.37	−0.54 ± 6.4	0.10	1.19 ± 5.74	−0.55 ± 5.52	0.30	1.76 ± 5.55	−1.69 ± 5.57	0.0	1.68 ± 5.49	−0.58 ± 5.98	0.06
Weight change rate during 12 months (%)	0.90 ± 7.30	−1.40 ± 9.22	0.21	0.51 ± 7.93	−1.35 ± 7.94	0.44	1.22 ± 7.82	−2.65 ± 7.65	0.0	1.1 ± 7.54	−1.42 ± 8.47	0.15
Serum albumin (g/dL)	3.73 ± 0.32	3.56 ± 0.26	0.02	3.705 ± 0.32	3.53 ± 0.23	0.08	3.75 ± 0.30	3.49 ± 0.26	0.0	3.756 ± 0.31	3.52 ± 0.27	0.00
Dietary supplements (yes/no)	75/15	17/14	0.00	82/24	10/5	0.35	75/18	17/11	0.0	68/15	24/14	0.04
Development of aspiration pneumonia, +/– ($n = 121$)	78/12	21/10	0.02	88/16	11/4	0.03	81/12	18/10	0.0	73/10	26/12	0.01

BMI, body mass index.

Table 3 Relationship between nutritional status and basic information

	Well nourished	Malnourished†	*P*-value
Sex (male/female)	23/53	7/27	0.21
Age (years)	85.1 ± 7.8	88.7 ± 6.7	0.03
BI (<45/≥40)	23/53	6/28	0.12
CDR (<1/≥2)	22/54	5/29	0.08
Feeding assistance (dependent/independent)	48/28	11/23	0.00
Food (solid/modified)	12/64	5/29	0.57
Sucking reflex (presence/absence)	64/12	20/14	0.01
Phasic bite reflex (presence/absence)	64/12	21/13	0.01
Snout reflex (presence/absence)	72/4	27/7	0.02
One or more of these reflexes (presence/absence)	60/16	17/17	0.00
Use of upper dentures (yes/no)	37/39	15/19	0.41
Use of lower dentures (yes/no)	39/37	16/18	0.42
Swallowing disorder (yes/no)	56/20	25/9	0.58
History of aspiration pneumonia (yes/no)	66/10	25/9	0.08

†Malnourished: a serum albumin level of less than 3.5 mg/dL. BI, Barthel Index; CDR, Clinical Dementia Rating.

Table 4 Relationship between primitive reflexes and developing aspiration pneumonia

	Development of aspiration pneumonia		
	No	Yes	*P*-value
Sex (male/female)	23/76	9/13	0.08
BI (<45/≥40)	31/68	2/20	0.03
CDR (<1/≥2)	26/73	5/17	0.48
Feeding assistance (dependent/independent)	57/14/28	7/4/11	0.08
Food (solid/modified)	15/84	3/19	0.58
Sucking reflex (presence/absence)	78/21	12/10	0.02
Snout reflex (presence/absence)	88/11	18/4	0.28
Phasic bite reflex (presence/absence)	81/18	12/10	0.01
One or more of these reflexes (presence/absence)	73/26	10/12	0.01
History of aspiration pneumonia (yes/no)	86/13	14/8	0.02
Use of upper dentures (yes/no)	48/51	13/9	0.25
Use of lower dentures (yes/no)	50/49	13/9	0.31
Swallowing disorder (yes/no)	72/27	16/6	0.61
Malnourished (yes/no)	25/66	9/10	0.08

BI, Barthel Index; CDR, Clinical Dementia Rating.

When onset of aspiration pneumonia was taken as the response variable, significant parameters were taken as explanatory variables, and logistic regression analysis was carried out. The appearance of a bite reflex was selected as a significantly independent explanatory variable (bite reflex: exp = 4.679, 1.39–15.74, $P = 0.013$; Table 5).

Discussion

Primitive reflexes appear during the developmental process of neonatal infants. Primitive reflexes are not observed clinically as the child becomes older, because they are inhibited at a higher level, namely the cerebral cortex and pyramidal tract. The disappearance of

Table 5 Results of logistic regression analysis for onset of aspiration pneumonia

	Coefficient	SE	Wald	*P*-value	Relative risk	95% CI Lower	Upper
History of aspiration pneumonia	1.31	0.67	3.79	0.05	3.71	0.99	13.81
BI	−1.99	1.12	3.19	0.07	0.14	0.015	1.21
Gender	−1.49	0.66	5.17	0.02	0.23	0.06	0.81
Bite reflex	1.54	0.62	6.21	0.013	4.68	1.39	15.74

BI, Barthel Index; CI, confidence interval; SE, standard error.

primitive reflexes is an important sign that shows that the infant is developing normal neurological functions.[19–21] However, primitive reflexes can reappear when a pathological condition is present in the central nervous system.[22]

Such cases are often seen in elderly people with dementia,[4] and the relationship between whether these reflexes appear with age or changes in cognitive function,[4,5] and the relationship between whether these reflexes appear with cerebral disorders are under investigation. However, the relationship between these reflexes and nutritional status and prognosis remains unclear.

The results of the present research showed that elderly people in nursing homes show high rates of primitive reflexes.

Among participants with the sucking reflex, 45.1% also showed the snout reflex, and among those with the phasic bite reflex, 67.7% also had the sucking reflex.

Because the sucking reflex is a superficial reflex and the snout reflex is a deep reflex, they should be differentiated, but they appear together in some people.[18] In the present study, these reflexes often appeared in the same person.

Mastication is controlled by suprabulbar structures, and consists of coordinated movements of masticatory organs, such as the tongue, lips, cheeks and mandible. Motor functions of these organs are known to deteriorate with age,[23,24] and to influence masticatory performance.[15]

Humans chew and swallow their food based on its texture, and masticatory patterns differ depending on the food.[25] The basic masticatory pattern is controlled by a central pattern generator in the brainstem, supplemented by centers in the motor cortex and the basal ganglia, and modified by peripheral information from the masticatory system. Degenerative disease, and infarction lesions and hemorrhaging in these areas of the central nervous system might, thus, have profound effects on mastication. Mandibular movement observed in the phasic bite reflex is a simple up and down movement with no lateral displacement. As the simple up and down mandibular movement observed during eating occurs as a result of disorders in the cerebral cortex and basal ganglia at a higher level than the brainstem used for reference in masticatory coordination, it appears that movement controlled by the central pattern generator in the brainstem has priority. This means that this movement is clearly different from masticatory movement.

When the movement pattern cannot be changed in accordance with differences in the food texture, foods that do not require mastication, such as pureed or mashed foods, must be eaten. However, the movement observed when eating is occasionally different from mastication movement, and involves information different from decisions based on food texture.

Malnutrition is known to occur at a high frequency in the elderly that require care,[9] and is a major problem that affects survival prognosis. Therefore, we investigated whether the appearance of primitive reflexes is related to malnutrition.

When primitive reflexes were observed, it was assumed that the individuals could not carry out basic masticatory movement, that they could not eat food with proper timing, food processing in the oral cavity was not sufficient and oral propulsion was not carried out. Disorders in the preparatory stage and problems in the oral stage in swallowing such foods could also affect nutritional status.

Foods with a texture that requires modification to allow consumption without swallowing are often connected with poor nutrition per unit volume, and can become a cause of malnutrition. The results of this research are important, because they show that the appearance of primitive reflexes that affect motor function in the oral cavity can be used as an indicator of nutritional status.

Elderly people with dementia show reduced eating function,[26] and have numerous problems with low bodyweight.[27,28] It has been reported that marked bodyweight reduction in patients with severe dementia is often associated with death as a result of aspiration pneumonia, and that many deaths as a result aspiration pneumonia occur in patients with dysphagia or abnormal behaviors, such as not chewing their food or not swallowing properly. We showed that the presence of problems in the stage before dysphagia has an effect on survival prognosis,[28,29] and found that many patients

with severe dementia often contract fatal diseases associated with eating function disorders and noted that palliative care is necessary. In such studies to date, dysphagia observed in patients with severe dementia affects the nutritional status, and is also involved in survival prognosis. However, although many of the subjects of studies carried out to date have primitive reflexes, no surveys or studies on the appearance of primitive reflexes were included in any of the previous reports. The appearance of a sucking reflex or the phasic bite reflex suggests that voluntary propulsion of food from the oral cavity to the pharynx is disturbed, and discrepancies between swallowing motion and timing occur. It is possible that the risk of accidental swallowing is increased. It has been suggested that the increased risk of accidental swallowing, together with malnutrition, affects the onset of aspiration pneumonia, which is closely connected with the survival prognosis of elderly patients.

Based on the results of the present study, it is clear that primitive reflexes appear in many patients with reduced cognitive function, and that these reflexes are related to the onset of aspiration pneumonia. Based on careful consideration, it is necessary to provide elderly people who have primitive reflexes with assistance in eating.

When eating difficulties are observed, it is necessary to take measures to prevent malnutrition, such as providing food supplements.

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A Problem-Based Learning Tutorial for Dental Students Regarding Elderly Residents in a Nursing Home in Japan

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Abstract: This educational trial was an eight-day problem-based learning (PBL) course for fourth-year predoctoral students at Okayama University's dental school who interviewed elderly residents living in a nursing home. The purpose of this PBL course was to introduce geriatric dentistry to the students by allowing them, independently, to discover the clinical problems of elderly patients as well as the solutions. The sixty-five students were divided into nine small groups and received patient information (age, gender, degree of care needed, medical history, food type, medications, and oral condition) in datasheets before visiting the nursing home. Each group of students directly interviewed one patient and the caregivers and identified the patient's medical, psychological, and social problems. After the interview, the students participated in a PBL tutorial to delineate a management approach for the patient's problems. To measure the efficacy of this program, the students completed a questionnaire before and after the course regarding their level of understanding of and attitudes toward geriatric dentistry, clinical research, and self-study. The results showed that students' perceptions of their knowledge about and attitudes toward oral health care for the elderly significantly increased after the PBL course, which suggests that such tutorials should be an option for dental curricula.

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Currently, the worldwide increase in life expectancy has caused a rise in the number of senior citizens,[1] which, in Japan, exceeds 20 percent of the total population.[2] As the number of seniors increases, specialized services have been developed and adopted to improve seniors' quality of life. In dentistry, several dental treatments, including prosthetic rehabilitation, have been largely reported to improve the oral health-related quality of life of elderly patients.[3,4]

It is important that dental students understand the daily life needs of elderly patients as well as approaches for managing them. Such an understanding of their needs should include not only their physical but also their social and psychological functioning. A particular group of individuals, however, who present more dramatic physical or mental impairments (e.g., Alzheimer's disease and cerebrovascular diseases) usually search for higher levels of personal care and support at long-term nursing homes. Additionally, these frail elderly or bedridden patients frequently have some difficulty eating or swallowing due to prosthodontics problems or oropharyngeal dysphagia (e.g., choking, coughing, and aspiration of food or saliva), which eventually may lead to malnutrition and immune system compromise, dehydration, or even aspiration pneumonia. Under these circumstances, predoctoral dental students rarely will have the opportunity to treat such frail elderly or bedridden patients in the usual dental curriculum because of these patients' inability or great difficulty in receiving treatment at dental schools.

Currently, it is becoming more common in Japan for general dentists to visit disabled elderly patients in their own homes or at nursing care facilities in order to deliver dental treatments, which are partially covered by Japanese national insurance. Henceforth, due to the growing demand of such services, there is also a need to increase the numbers of dental schools offering geriatric training courses at nursing care facilities in order to enable early student contact with this patient population and to expand students' future perspectives; at the same time, this would produce better prepared professionals and eventually enable the provision of better health services to communities. According to reports published in 2003 and 2005, there are only a few dental schools providing clinical training courses on geriatric dentistry in health care facilities outside schools in the United States and Europe.[5,6] Similarly, in Japan, only ten out of twenty-nine dental schools have geriatric clinical training programs; among these, only six include geriatric clinical training at long-term nursing care facilities.[7,8]

In this context, Okayama University's dental school started a problem-based learning (PBL) course in 1996,[9-11] and in 2009 it started a visiting program to elderly nursing care facilities. Our previous study reported that student knowledge about evidence-based medicine (EBM) increased after the tutorial course.[12] In another study focused on dental students who visited elderly patients in nursing homes, Tohara et al. reported that internships in the nursing home helped students understand elderly patients,[13] but those students had already received some clinical experience and did not probe for the patients' problems in that study, i.e., that study did not involve a PBL program.

Although PBL has been widely adopted by many medical and dental schools, its efficacy is still debated. A systematic review of PBL in academic health education reported that, at the level of randomized controlled trials and comparative studies, no clear difference was observed between PBL and conventional teaching. Paradoxically, only comparative studies of single PBL interventions in a curriculum yielded results that were consistently in favor of PBL.[14] Particularly in the dental field, PBL track students have been found to score significantly higher than the traditional track students.[15-19] In another study, PBL improved the educational effect of self-study and clinical inference ability in comparison to lecture-based learning.[20] Although other studies reported that there was no difference in performance between the PBL and the traditional lecture students on examinations,[21,22] a four-year measurement of mock patient examinations and follow-up clinic patient examinations found that using the PBL methodology resulted in student performance of nonsurgical periodontics skills at a level equal to or greater than that of a conventional approach.[22]

In our current PBL course, the students interviewed elderly patients at a nursing care facility with the aim not only of prosthodontic treatment or EBM but also of treating other aspects related to patients' medical conditions or welfare (e.g., dementia, eating, and quality of life). This article reports the results from this course.

Materials and Methods

This PBL course focused on fourth-year dental students at Okayama UIniversity who had no previ-