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Body weight and serum albumin change after prosthodontic treatment among institutionalized elderly in a long-term care geriatric hospital

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Abstract – *Objectives:* An important purpose of denture treatment is the improvement of nutritional intake. This is especially important for the dependent elderly who have a high risk of protein-energy malnutrition. To evaluate the impact of denture treatment on such a population, we compared body weight as an indicator of nutritional status before and 6 months after prosthodontic treatment. *Methods:* This study was conducted in a long-term care geriatric hospital in Hiroshima, Japan from October 2004 to September 2006. One hundred and four patients received complete or partial denture treatment in both jaws. Nineteen patients were lost to the study because of the development of severe physical conditions or death. Among the remaining 85 patients, 66 used their new prostheses and 19 did not. Body weight and serum albumin levels were examined at prosthesis insertion and 6 months after treatment. *Results:* Six months after prosthodontic treatment body weight changes were significantly different between users and non-users regardless of denture type and, in addition, serum albumin level were significantly increased among individuals using partial denture in either or both jaws ($P < 0.05$). *Conclusion:* It can be concluded that prosthodontic treatment may improve the nutritional status of institutionalized elderly.

Key words: body weight; denture; nutrition institutionalized elderly

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Intake of nutrients through daily meals is a foundation of life. Low nutrition decreases the immunologic defenses, reduces physical functions and can be a direct or indirect cause of morbidity and mortality among the elderly (1, 2). It has been reported that 1–15% of outpatients and 15–60% of the institutionalized elderly suffer from protein-energy malnutrition (PEM) and much attention has been given to nutritional therapy in long-term care facilities (3). PEM can be the result of social factors such as low income, as well as limited physical functioning, degenerative diseases or inadequate food intake and unbalanced diet (4).

Several studies have reported that oral conditions such as reduced tooth number and limited occlusal area are related to inadequate and unbalanced food intake (5–8) and that elderly individuals with fewer than 20 remaining teeth have significantly lower body mass index (BMI) than those with 20 or more remaining teeth (9). It has also been reported that over a 1 year period, weight loss among the edentulous elderly is significantly greater than among elderly with 20 or more residual teeth (10). These studies suggest that tooth loss may be associated with weight loss. However, it has not been demonstrated whether or not reconstruction of occlusion

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through prosthodontic treatment results in increased body weight in the elderly.

In this study, comparisons of body weight and serum albumin level before and after prosthodontic treatment in a sample of institutionalized elderly were performed to investigate the possibility that occlusal reconstruction contributes to nutritional improvement in such individuals.

Methods

Subjects were selected from permanent residents in a geriatric medical care facility for the elderly in Hiroshima who received prosthodontic treatment between October 2004 and September 2006. Because of Japan's national insurance system, fees for this type of hospital are cheap and similar for all patients. The following inclusion criteria were used for this study: Subjects had been hospitalized for more than 6 months with stable systemic conditions. In addition, subjects spent the daytime hours on a bed or in a wheelchair. Patients with uncontrolled diabetes or severe renal failure were eliminated from the study. Subjects were able to feed themselves without assistance, although special food preparation such as mincing or chopping was available according to each patient's needs or preferences.

At the start of the study, all subjects had no premolar and molar occlusion. Subjects were classified into three groups:

A: Persons who were edentulous in both jaws.
B: Persons who were edentulous in the maxilla and partially dentate in the mandible.
C: Persons who were partially dentate in both jaws.

All received new complete or partial dentures in upper and lower jaws as needed to restore molar occlusion. Although detailed information about previous experience with dentures was not gathered, all subjects reported dissatisfaction with existing dental prostheses and used their dentures only occasionally. Cognitive function was evaluated by the mini-mental status (MMS) test, following the approach of Taji et al. (11). All subjects and their families gave informed consent to the prosthodontic therapy.

Body mass index (BMI) before prosthesis treatment was calculated as (body weight)/(body height)^2 and subjects were categorized as underweight (BMI < 18.5), normal (BMI 18.5–25.0), or overweight (BMI > 25.0). Body weight as well as serum albumin level was measured before and 6 months after prosthodontic treatment. These variables were widely used as significant markers of adequate nutrition (12, 13). Six months after prosthesis insertion, subjects were interviewed as to whether or not they used the new prosthesis during meal time and were divided into prosthesis user and non-user groups. Patients who could not be followed up 6 months after prosthesis delivery were excluded from the study.

Baseline characteristics such as BMI and MMS were compared among the three occlusal groups using ANOVA and *post-hoc* testing using SPSS 15.0J for Windows (SPSS Inc.). The differences between prosthesis users and non-users in body weight and serum albumin level before and after treatment were compared using Student's *t*-test. In addition, changes in body weight for all prosthesis users before and after the treatment were analysed with ANOVA and *post-hoc* test, and the impact of this change compared among BMI groups.

Results

One hundred and four patients received prosthodontic treatment. Nineteen patients were lost to the study due to the development of severe physical conditions or death. The remaining 85 subjects included 27 group A subjects who received both upper and lower complete dentures, 29 group B subjects who received a complete denture on one jaw and a partial denture on the other, and 29 group C subjects who received both upper and lower partial dentures.

Baseline characteristics as shown Table 1 were not different between prosthetic users and non-users in each group, although group C subjects were significantly younger than groups A and B subjects ($P < 0.05$). Nutritional status such as body weight and serum albumin level were almost same between users and non-users among the three occlusal groups. In addition, mental function examined by MMS as well as physical function was not different among these groups.

Tables 2 and 3 showed changes in body weight and serum albumin level 6 months after prosthodontic treatment. Regardless of inserted denture type, the body weight of prosthesis users increased significantly compared with non-users. In addition, serum albumin levels for those who used partial dentures in either or both jaws (groups B and C) increased significantly compared with non-users as did measures taken before and after treatment ($P < 0.01$).

Table 1. Baseline characteristics of the three occlusal groups

		Users	Non-users	Total
Group A	Male/female	9/13	2/3	11/16
	Mean age	87.3 ± 6.0	84.4 ± 7.3	86.7 ± 6.2
	Body weight	44.4 ± 7.2	46.1 ± 7.7	44.7 ± 7.2
	Serum albumin level	3.5 ± 0.3	3.8 ± 0.5	3.5 ± 0.4
	BMI (kg/m^2)	20.5 ± 2.7	20.4 ± 4.1	20.5 ± 3.0
	MMS	12.4 ± 7.1	9.0 ± 12.7	12.1 ± 7.4
Group B	Male/female	6/16	2/5	8/21
	Mean age	86.9 ± 3.9	86.4 ± 5.7	86.8 ± 4.3
	Body weight	44.9 ± 8.3	49.9 ± 5.7	46.1 ± 8.0
	Serum albumin level	3.5 ± 0.4	3.8 ± 0.4	3.6 ± 04
	BMI (kg/m^2)	19.7 ± 3.5	21.0 ± 2.7	20.1 ± 3.3
	MMS	13.7 ± 6.6	9.0 ± 3.5	12.6 ± 6.3
Group C	Male/female	4/18	1/6	5/24
	Mean age	82.5 ± 8.0	81.1 ± 11.2	82.1 ± 8.7*
	Body weight	45.9 ± 8.8	46.1 ± 7.5	46.0 ± 8.4
	Serum albumin level	3.7 ± 0.4	4.0 ± 0.2	3.8 ± 04
	BMI (kg/m^2)	20.4 ± 4.3	20.7 ± 3.0	20.5 ± 4.0
	MMS	12.8 ± 6.4	13.1 ± 4.0	12.9 ± 5.9
		(mean ± SD)		

Group A: Persons who were edentulous in both jaws. Group B: Persons who were edentulous in the maxilla and partially dentate in the mandible. Group C: Persons who were partially dentate in both jaws.
*Although ANOVA and *post hoc* tests revealed that the mean age of group C was significantly younger than Groups A and B ($P < 0.05$), other baseline characteristics were not different among the three groups.

Table 2. Body weight changes in dental prosthesis users and non-users among the three groups

Body weight change (kg)	Users	Non-users	*P*-value (Students' *t*-test)
Group A	1.6 ± 2.5	−1.7 ± 0.7	0.008*
Group B	0.6 ± 2.8	−2.3 ± 2.2	0.019*
Group C	1.3 ± 1.2	−0.8 ± 0.7	0.000*
Total	1.2 ± 2.3	−1.6 ± 1.5	0.000*
	(mean ± SD)		

Group A: Persons who were edentulous in both jaws. Group B: Persons who were edentulous in the maxilla and partially dentate in the mandible. Group C: Persons who were partially dentate in both jaws.
*Body weight change after 6 month denture insertion was significantly different between prosthesis users and non-users in all occlusal groups ($P < 0.01$).

Table 3. Serum albumin level changes in dental prosthesis users and non-users among the three groups

Serum albumin level change (g/dl)	Users	Non-users	*P*-value (Students' *t*-test)
Group A	0.2 ± 0.3	−0.1 ± 0.3	0.228
Group B	0.1 ± 0.3	−0.5 ± 0.5	0.005*
Group C	0.1 ± 0.3	−0.4 ± 0.3	0.005*
Total	0.1 ± 0.3	−0.3 ± 0.4	0.000*
	(mean ± SD)		

Group A: Persons who were edentulous in both jaws. Group B: Persons who were edentulous in the maxilla and partially dentate in the mandible. Group C: Persons who were partially dentate in both jaws.
*Serum albumin level change after 6 month denture insertion was significantly different between prosthesis users and non-users in groups B and C groups ($P < 0.01$).

Within subject analysis, the paired *t*-test showed that body weight for all prosthesis users in the three occlusal groups significantly increased following treatment ($P < 0.01$). Among those members of the three BMI groups (underweight, normal, and overweight) who used their new prosthesis, body weight after denture insertion increased significantly in the underweight group ($P < 0.05$) (Table 4).

Discussion

The results of this study suggest that recovery of oral function as a result of prosthodontic treatment may be effective in improving nutrition among the dependent elderly.

Modifying daily meals to include high calorie foods has been utilized to improve nutrition in older people in need of care (14). Although the subjects in this study, selected from patients in one institution, received the same meals before treatment, almost half of the subjects required special food preparation such as mincing or chopping. During the study period, the caloric value of diets did not change and only a few individuals needed alteration of food form because of difficulty eating. Previous reports suggest that changes in daily meal intake before and after denture treatment are

Table 4. Body weight change and serum albumin level change in prosthesis users among the three BMI groups

	Underweight (BMI < 18.5)	Normal (18.5 to 25.0)	Overweight (BMI < 25.0)
Subjects (m/f)	24 (7/17)	34 (11/23)	8 (1/7)
Mean age	86.6 ± 6.8	85.9 ± 5.6	82.6 ± 7.1
Body weight change	2.1 ± 2.3*	0.9 ± 2.2	−0.9 ± 1.3
Serum albumin level change	0.2 ± 0.4	0.04 ± 0.3	0.1 ± 0.3
	(mean ± SD)		

*The body weight of the underweight group significantly increased after prosthodontic treatment compared with the normal and overweight groups ($P < 0.05$).

rare (15). Therefore, it has been proposed that food instruction is necessary among denture wearers to encourage increase in consumption of vitamins and minerals (16). In this study, such special instruction was not performed. This suggests that the significant body weight increase among prosthesis users reflected improvement in mastication as a result of the new prostheses.

Masticatory efficiency and masticatory ability are both linked to the number of teeth. A minimum of 20 teeth with 9–10 pairs of contacting units is associated with adequate efficiency and ability (17). Therefore, masticatory function in Group C subjects who kept contacting units in anterior teeth were likely to result in reduction because they had only 5.4 maxillary teeth and 6.2 mandibular teeth on average. Furthermore, changes in diet and exercise patterns are most effective in the prevention of nutrition-related conditions when they are instituted early in life, but positive effects can occur at any age (18). It may indicate that masticatory function of Group A and B subjects as well as Group C improve with the insertion of new prostheses.

It has been reported that thorough mastication has the potential to improve absorption of nutrients and prevent rapid increase of blood glucose levels (19). Another study has reported that masticatory movement itself enhances peristaltic movement in the small intestine (20). Improvement in the absorption of nutrients in the intestinal tract can be expected to promote increase in body weight. Because malabsorption leads to malnutrition, resulting in lean body weight, the finding that body weight in the underweight group (BMI < 18.5) was significantly increased after treatment may support this hypothesis. Although evaluation of masticatory ability was not performed before or after treatment in this study, previous studies have documented reduced masticatory ability with the use of inadequate dentures in comparison with use of adequate dentures (21). All prosthesis users in this study were satisfied with the newly fabricated appliances. Though not a measurable result, this also suggests that masticatory ability improved after treatment. Ikebe et al. reported that it is a decrease in such oral functions as occlusal force and masticatory efficiency rather than the number of residual teeth that affects BMI in healthy older people (22). Moreover, Kikutani et al. found that exercise therapy of the lips and tongue helps to improve nutrition in those elderly in need of care because of severe disability (23). These results suggest that levels of improvement in oral function as a result of prosthodontic treatment should be further evaluated and that more objective functional evaluations should be performed in addition to documenting subjective reports of feelings of satisfaction.

Currently, attempts to improve nutrition by nutritional support teams have begun in many hospitals. Within the limited conditions of this study, the results suggest that the dental profession should be involved in the programs of nutritional support teams, playing a role in the evaluation and improvement of oral function through prosthodontic treatment.

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Gerodontology

Original article

The degree of tongue-coating reflects lingual motor function in the elderly

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The degree of tongue-coating reflects lingual motor function in the elderly

Objectives: The aim of this study was to examine the relation between the degree of tongue-coating and oral function.

Background: Tongue-coating is a moss-like deposit which forms over the tongue surface, and includes micro-organisms, food residues, and abrasive epithelia. It is considered that motor function of the tongue and lips and saliva secretion decrease in the aged and have some effect on the accumulation of tongue-coating. Although saliva secretion has been reported as a factor amongst these oral functions in contributing to tongue-coating, the correlation with the motor function of oral structures is unknown.

Subjects and methods: The factors that contribute to the accumulation of tongue-coating were examined in 48 subjects of advanced age (mean age 80.8 ± 7.8 years) with no severe levels of periodontal disease. Changes in the degree of tongue-coating were also examined after oral functional training in these subjects. The frequency of oral cleaning, status of oral hygiene, motor function of the tongue, and masticatory performance were examined as potential factors associated with the degree of coating.

Results: The results showed that tongue pressure and the frequency of oral diadochokinesis measured by pronouncing the single syllable 'ka' as an indicator were statistically significantly correlated with the degree of tongue-coating. Several factors in oral function improved with training, and also the degree of tongue-coating decreased in 27 subjects.

Conclusion: These results suggest a correlation between the degree of tongue-coating and a reduction in lingual motor function and, in addition, possible improvement in level of coating by functional training of the tongue.

Keywords: tongue-coating, lingual motor function, masticatory performance, elderly.

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Introduction

The colour of a normal tongue is pink-to-slightly white, and is very often covered with a coating. Tongue-coating is a 'moss-like' deposit which forms over the tongue surface, and includes micro-organisms, food residues, and abrasive epithelia[1].

It is known that tongue-coating accumulates in patients with periodontal disease as leucocytes derived from periodontal pockets are increased in saliva and attach onto the tongue surface[2]. Tongue-coating is seen more frequently in elderly people than in the young, because of dietary changes, decreased brushing efficacy and saliva secretion, and changes in the components of saliva[3]. In addition, tongue-coating causes halitosis[4,5], contributing to an important issue in the oral health of the aged.

Generally, self-cleaning functions are present in the mouth, and the accumulations on the tongue surface might be influenced by this function. However, it is considered that motor function of the tongue and lips and saliva secretion, which are related to oral self-cleaning function, decrease in the aged[6,7] and may have some effect on the accumulation of tongue-coating. Although there is

a report of saliva secretion as a factor contributing to tongue-coating[6], no data correlated with the motor function of oral organs such as the tongue and cheeks have yet been reported. Therefore this study examined the relation between the degree of tongue-coating and lingual motor function relating to mastication, swallowing and articulation.

Materials and methods

Study population

Forty-eight subjects (mean age, 80.8 ± 7.8 years: 13 men with mean age of 76.7 ± 8.5 and 35 women with mean age of 82.6 ± 6.8) were selected from the participants in 'Lectures on Oral Health' held at day-care centres at four locations in Tokyo, Japan. The selection criteria of subjects were that the patients were to be able to live semi-independently but with some help required for walking or going up or down stairs, and not to have periodontal pockets deeper than 4 mm. No subjects had ever used brushes for the tongue. Four subjects were regular smokers at the time of the survey.

On ethical considerations, written consent was obtained from the subjects, to whom the objectives, methods and projected results of the study had been explained orally and in written form. This study was approved by the Ethics Committee of the The Nippon Dental University, School of Life Dentistry at Tokyo.

Transverse survey

A transverse survey on the condition of tongue-coating and associated factors was performed in October 2005, and the results were compiled and summarised in 2007. The survey time was set between 10:00 AM and 12:00 noon, more than 2 h after having breakfast.

Evaluation items

Tongue-coating status. Tongue-coating status was visually evaluated according to the following four grades: Score 0: not visible, Score 1: less than one-third of the tongue dorsum covered, Score 2: less than two-thirds covered, and Score 3: more than two-thirds covered[9].

Lingual motor function. Lingual motor function was evaluated from the power speed and range of motion. The power of the tongue was judged from the maximum tongue pressure generated by the tongue pressing against the palate, measured according to the method of Hayashi *et al.*[10]. Subjects were instructed to press a balloon-like sensor with their tongue onto the front part of the palate as strongly as possible. When subjects had been able to practise several times, the mean value of five measurements was obtained.

The speed and extent of tongue motions were evaluated by oral diadochokinesis[11]. In this test, subjects were instructed to repeat the sound 'ta' or 'ka' for 10 s as fast as possible. The number of syllables pronounced repeatedly per second was recorded.

Masticatory performance. Masticatory performance was measured using the masticatory performance evaluation gum product of LOTTE Co., Ltd (Tokyo, Japan)[12,13]. The colour of this gum changes gradually to red as its saliva-soluble pigment leaks out with chewing. Subjects were asked to 'chew the gum very hard' for 5 min. After chewing, the gum was collected, covered with polyethylene film, and pressed into a thickness of 1.5 mm between two glass plates. After removing the glass plates, masticatory performance was evaluated through the polyethylene film with a chromaticity meter (CR-13, KONICA MINOLTA, Tokyo, Japan).

Hayakawa *et al.*[13] evaluated the colour of the chewed gum using the 'L*', 'a*' and 'b*' colour space, which was developed by the Commission Internationale de l'Eclairage[14] for measuring object colour. In the colour space, 'L*' indicated lightness and 'a*' and 'b*' were chromaticity co-ordinates. The co-ordinate 'a*', representing the degree of red, was measured and found that as the number of chews increased, the value of 'a*' increased. The chewed gum was measured at three random points, and the mean 'a*' value of three measurements was used for analyses. The number of chewing cycles was also recorded.

Condition of oral cavity. The oral condition was evaluated from oral hygiene and dryness. The former was evaluated from the presence of dental plaque on the teeth and dentures. Dental plaque was evaluated using a three-level scale; DPI1: dental plaque on half or more of the teeth surface, DPI2: dental plaque on less than half of the teeth surface, and DPI0: no plaque[15].

Oral dryness was evaluated on the following scale of four grades according to the method of Kakinoki *et al.*[16]: Grade 0: not dry (and does not show Grade 1, 2, or 3 condition), Grade 1: saliva shows viscosity, Grade 2: saliva shows tiny bubbles on the tongue, and Grade 3: dry tongue, without viscosity, little or no saliva present.

Life style. Daily oral hygiene practice was surveyed by recording the frequency of oral cleaning. In addition, smoking status was recorded at the time of the survey.

Interventional study

An interventional study was performed to examine the effect of oral motor function training on tongue-coating in 27 subjects (mean age, 82.4 ± 7.2 years) with more than the median degree of tongue-coating judged by the transverse survey. Consent had also been obtained from these subjects. This aspect of the study was performed between October and December 2005 and the results were also compiled and summarised in 2007.

Oral functional training

Oral motor function training was performed for 20 min once a week for 2 months at the day care centre. The training regimen was: (i) repeatedly touching the left and right sides of the oral cavity alternately (for 10 s, two times), (ii) repeatedly sticking the lips forward and pulling the corners of the lips sideways (for 10 s, three times) and (iii) pressing the tongue on the palate (for 10 s, three times). The regimen of training exercises was supervised by dentists and dental hygienists. Subjects were trained directly by dental hygienists and instructed to practice the regimen by themselves once a day also at home.

After 2 months, the subjects with tongue-coating were examined to evaluate the effect of training of lingual motor function.

Statistical analysis

The correlations between tongue-coating and each factor were analysed by chi-squared test, Fisher direct probability test, Mann–Whitney *U*-test, and Kruskal–Wallis test. The data of the interventional study were analysed by Wilcoxon test.

Results

Status of tongue-coating

Table 1 shows the status of tongue-coating and each factor. Tongue-coating was absent in nine subjects, and present at a low, moderate, and high degree in 11, 21, and seven subjects respectively.

Lingual motor function

The tongue pressure and the frequency of repeating the syllable 'ka' showed a statistically significant correlation with the degree of tongue-coating (tongue pressure: $p = 0.008$, */ka/*: $p = 0.037$). $p < 0.05$ was considered statistically significant. However, masticatory performance and the frequency of repeating the syllable 'ta' or 'ka' showed no significant differences with the degree of tongue-coating (masticatory performance; $p = 0.859$, */ta/*; $p = 0.061$).

Condition of oral cavity

Oral hygiene and dryness showed no significant difference with the degree of tongue-coating (oral hygiene; $p = 0.191$, oral dryness; $p = 0.741$).

Table 1 Status of tongue-coating and each factor.

Tongue-coating status	*Total*	*Score 0*	*Score 1*	*Score 2*	*Score 3*	*p-value*
Number of subjects	48	9	11	21	7	–
Age (year)	80.8 ± 7.7	80.8 ± 7.7	77.8 ± 8.7	81.0 ± 7.1	84.3 ± 7.5	0.571
Number of natural teeth	9.8 ± 9.9	10.2 ± 11.0	14.6 ± 10.1	6.6 ± 25.0	11.1 ± 10.3	0.159
Number of functional teeth	25.6 ± 5.7	26.9 ± 1.8	23.9 ± 6.5	25.0 ± 7.1	27.9 ± 0.4	0.409
Masticatory performance[a]	18.9 ± 7.4	18.9 ± 5.6	15.3 ± 12.6	20.2 ± 4.9	19.9 ± 5.6	0.859
Tongue pressure (kPa)	31.7 ± 13.4	33.6 ± 13.7	35.0 ± 9.5	35.0 ± 12.2	16.5 ± 11.7	0.008*
Repeating the syllable */ta/* (times/second)	4.5 ± 1.7	5.8 ± 1.2	4.4 ± 1.5	4.2 ± 1.8	4.0 ± 1.8	0.061
Repeating the syllable */ka/* (times/second)	4.2 ± 1.6	5.5 ± 1.0	4.4 ± 1.8	3.8 ± 1.5	3.6 ± 1.8	0.037*
Frequency of oral cleaning (times/day)	1.7 ± 1.0	2.2 ± 1.1	2.1 ± 1.0	1.3 ± 0.9	1.6 ± 0.8	0.188

*$p < 0.05$ was considered statistically significant.
[a]Degree of red in the colour space, developed by Commission Internationale de l'Eclairage.

Life style

The frequency of oral cleaning showed no significant differences with the degree of tongue-coating (frequency of oral cleaning: $p = 0.138$).

Changes after oral functional training

The 27 subjects who participated in the interventional study consisted of nine men with a mean age of 80.2 ± 6.9 and 18 women with a mean age of 83.4 ± 7.3. By training of oral function, masticatory performance, the frequency of repeating the syllable 'ta' and 'ka', the oral hygiene level and the frequency of oral cleaning significantly improved (masticatory performance: $p = 0.0001$, /ta/: $p = 0.0268$, /ka/: $p = 0.037$, oral hygiene level: $p = 0.0004$, frequency of oral cleaning: $p = 0.015$). In addition, a statistically significant difference was observed in the degree of tongue-coating ($p = 0.0001$).

Discussion

Factors that have been reported to contribute to the accumulation of tongue-coating include periodontal disease[9], frequency of oral cleaning[17] and smoking[18]. In addition, it is known that tongue-coating is seen more frequently in elderly people than in young people, probably because of life-style change, reduced brushing efficiency, reduced secretion of saliva, and changes in saliva content[3,8]. In patients with periodontal disease, tongue-coating is formed from adherence of leucocytes, which increase in the saliva[19]. It has also been reported that anatomical changes of the tongue, such as a decrease of fungiform papillae and an increase of filiform papillae, cause an increase in tongue-coating[20].

Concerning the correlation of tongue-coating and oral function, there is a reported correlation with saliva secretion[8]. However, there are little data on the correlation with motor function of oral structures such as the tongue and cheeks. As tongue-coating increases in the aged, who have reduced or impaired oral function, it could be assumed that there might be a correlation between tongue-coating and oral function.

Regarding the selection of subjects, those with periodontal pockets deeper than 4 mm were excluded from the study, in order to reduce the effect of periodontal disease as much as possible. The degree of tongue-coating changes diurnally, as with halitosis[9], and therefore, the time of the survey was set at 2 h after the morning meal.

As tongue brushes have shown efficacy for removing the coating[19], and mouth rinsing is effective in decreasing tongue-coating and halitosis, we examined the daily habit of oral cleaning in each subject to clarify the relationship.

Normally, the oral cavity has various self-cleaning functions such as saliva flow and/or motions of the tongue and lips during mastication or talking, which control the number of micro-organisms adhering to the teeth[21]. These oral motor functions and saliva secretion are known to decrease in the aged[6,7]. The motor function of the tongue can be evaluated from the range, power, speed, and complexity of motion, in addition to muscular endurance. As all the subjects had a wide range of the tongue motion, only tongue pressure and oral diadochokinesis were evaluated as indicators of power and speed of the tongue. Tongue pressure is an important indicator of tongue function, and correlates well with swallowing function[22] and nutritional status[23], which are known to decline with age[10]. Oral diadochokinesis is a method to evaluate clarity, rhythm, and repetition frequency following repeating an indicator sound as rapidly as possible, and is used for evaluation of articulation impairment observed in neuromuscular diseases[11]. Different parts of the oral muscles can be evaluated by selecting indicator sounds with different articulatory points: 'ta' with the articulatory point at the tip of the tongue and 'ka' with the articulatory point at the dorsum of the tongue were used in this study.

A significant (negative) correlation of tongue-coating with tongue pressure and the 'ka' sound was observed. It is reported that tongue-coating tends to accumulate on the dorsum of the tongue[24]. Interestingly, tongue-coating was negatively correlated with the function of the dorsum of the tongue. Although the adhesion site of tongue-coating was not examined in this study, it would be important to examine indicator sounds of oral diadochokinesis and the adhesion site of tongue-coating in the future.

Furthermore, we examined the effect of lingual motor function training on tongue-coating in the subjects. After the training, significant changes were observed in masticatory performance and the repeating frequency of the sounds 'ta' and 'ka', along with a significant decrease in tongue-coating. An effect of training of oral function has been observed in the aged[25]. The decrease in tongue-coating appeared to be the result of improvement of function, even though the subjects were more than 80 years old. Meanwhile, as the frequency of oral cleaning increased significantly, oral cleaning may

also have contributed to the decrease of tongue-coating. It is known that motivation is essential for efficient training of oral function[28]. In this study, the importance of improving oral self-cleaning function as well as improving their masticatory function to ensure the effect of oral motor function training was explained to the subjects. Based on this motivation, the subjects started to pay attention to oral health including tongue-coating, and showed an increased interest and this awareness may have contributed to the increase in frequency of oral cleaning following functional training. However, it was uncertain which was the main cause of the decrease in tongue-coating, the improvement of oral motor function including tongue movement, or the increase in the frequency of oral cleaning. In other words, the degree of tongue motor function seems to have been influenced not only by the frequency of oral cleaning but also by the improvement of lingual motor function. Consequently, it was suggested that the lingual motor function, as well as the frequency of oral cleaning, have greatly contributed to the results of this study.

Conclusion

The present study showed an important finding that lingual motor function correlates with a decrease in tongue-coating, and can be improved by oral function training. These results should contribute to maintaining oral health in people of advanced age.

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ORIGINAL ARTICLE

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Oral motor function and masticatory performance in the community-dwelling elderly

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Abstract This study was performed to ascertain the relationships between oral motor functions, such as those of the tongue and lips, and age in the community-dwelling elderly, as well as to investigate the effects of these factors on masticatory performance. The subjects were 268 healthy elderly Japanese living in Kyoto. They were divided into four age groups and further classified into the following two groups by the presence or absence of posterior occlusal support: Eichner A or B1–B3 (group A), and Eichner B4 or C (group B). They were wearing removable or fixed dentures if they had missing teeth. Oral function evaluation items included (1) masticatory performance and (2) oral motor skills. Significant differences were noted among the age groups in tongue pressure within group A ($P < 0.01$) and group B ($P < 0.05$), and in the number of repetitions of the syllables /ta/ and /ka/ in group B (/ta/: $P < 0.05$, /ka/; $P < 0.01$). The number of natural teeth ($\beta = 0.463$, $P < 0.001$) in group A and tongue pressure ($\beta = 0.436$, $P < 0.001$) in group B were the only predictors of masticatory performance when the data were analyzed by multiple regression analysis. The tongue may compensate for the missing teeth in masticatory performance of those elderly who have lost their natural teeth. The results of this study highlight the importance of tongue function in masticatory performance.

Key words Mastication · Occlusal support · Oral motor function · Community-dwelling elderly · Aging

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Introduction

It is well known that a decrease of masticatory performance affects nutrient intake.[1,2] Furthermore, masticatory performance, which is closely related to quality of life,[3] is essential to the maintenance of the activities of daily living in the elderly. In some reports, the number of teeth, the state of occlusal support, and denture stability have been shown to be factors associated with masticatory performance.[4–6] 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[7] and to influence masticatory performance. However, there are only a few reports on the relationships between changes in tongue and lip function and masticatory performance with age.[8] This study was performed to ascertain the relationships between motor functions of the tongue and lips and age in the community-dwelling elderly, as well as to investigate the effects of these factors on masticatory performance.

Subjects and methods

The subjects were 268 healthy elderly Japanese (86 men, 182 women) 65 to 88 years of age living in Kyoto who participated in a health seminar sponsored by Kyoto Prefectural University of Medicine.

The age groups consisted of 77 subjects 65–69 years old (22 men and 55 women), 86 subjects 70–74 years old (30 men and 56 women), 66 who were 75–79 years old (21 men and 45 women), and 39 who were 80 years or older (13 men and 26 women). All were able to walk without assistance from a caregiver or family member and had no physical or mental dysfunction, nor any speech impairment that interfered with daily activities. Moreover, the subjects had no clinical symptoms such as caries, periodontal disease, periodontitis, or temporomandibular disorders that could influence masticatory performance, and they were wearing

Table 1. Groups of subjects based on occlusal status

	Total no. of subjects (male/female)	Mean age (range) (years)	Average number of natural teeth
Group A	190 (60/130)	72.0 (67.4–76.6)	25.1 ± 4.8
Group B	78 (26/52)	76.3 (70.5–82.1)	7.6 ± 6.7

Group A, naturally adequate dentition; Group B: denture wearers

removable or fixed dentures if they had missing teeth. Subjects with pain from dentures or who were wearing poorly fitting dentures at the time of the survey were excluded from the study.

The subjects were further classified into two groups by the presence or absence of posterior occlusal support by natural teeth (Table 1): group A, subjects who still had occlusal support in the premolar and molar regions, corresponding to Eichner A or B1–B3; and group B, subjects who had no occlusal support in the premolar or molar regions, corresponding to Eichner B4 or C.

The number of natural teeth was counted, and the averages are shown in Table 1. Oral function evaluation items included (1) masticatory performance and (2) oral motor skills.

Determination of masticatory performance

Masticatory performance was measured by using a color-changeable chewing gum (Lotte, Tokyo Japan) designed for judging masticatory ability.[9] The subjects were instructed to chew the gum very hard for 3 min. The gum was collected immediately after the 3 min of chewing and pressed to a thickness of 1.5 mm by covering it with a polyethylene film and then placing it between two glass plates. Then, the glass plates were removed and color measurements of the gum with the polyethylene film were performed with a colorimeter (CR-13, Konika Minolta, Tokyo, Japan). The measurements were performed at three random points on the gum, and the average a^* value was analyzed. The chewing rate was also measured.

Oral motor skills

Tongue movement was evaluated as the maximum pressure generated by the tongue pressed to the palate, by using the method of Hayashi et al.[10] The subjects were instructed to push a balloon-like sensor as hard as possible against the anterior palate using their tongues. After this maneuver had been repeated several times, until their manner of chewing had stabilized, the measurement was performed five times and the average value was calculated. The subjects were instructed to pronounce a monosyllable repeatedly for 10 s as fast as possible to test oral diadochokinesis.[11] The evaluator recorded the number of repeated syllables and calculated the number of syllables produced per second. The monosyllables used for the evaluation were /pa/, /ta/, and /ka/.

Prior to this study, we explained the objectives, method, and expected outcomes to the subjects orally and in writing and obtained their consent. This study was approved by the Ethics Committee of the Nippon Dental University, School of Life Dentistry at Tokyo.

Statistical analysis

Relationships among the age groups and the results of each oral function evaluation were analyzed by analysis of variance and Tukey's method. An unpaired t test was used to analyze the statistically significant differences in subjects between groups A and B. Furthermore, Pearson's correlation coefficient was calculated to study the relationships between the oral function evaluation items and a^*. Multiple regression analysis using the stepwise method was performed, setting the items for which significant relationships were observed as independent variables. $P < 0.05$ was considered statistically significant.

Results

Relationships among oral motor function, occlusal support, and age

Relationship between masticatory performance and age. The average a^* value, an indicator of masticatory performance, was greater in group A than in group B (16.0 and 12.6, respectively, $P < 0.001$). No significant differences were noted among the age groups in either group A or group B (Table 2).

Relationship between chewing rate and age. The average chewing rate in 3 min was higher (203.7) in group A than in group B (170.3) ($P < 0.001$). No significant differences were noted among the age groups within either group A or group B (Table 2).

Relationship between tongue pressure and age. The average tongue pressure value was similar in groups A and B (34.9 and 34.2 kPa, respectively). Significant differences among the age groups were noted within both group A ($P < 0.01$) and group B ($P < 0.05$) (Table 2).

Relationship between oral diadochokinesis and age. The average number of repetitions of the syllables /pa/, /ta/ and /ka/ per second was higher in group A than in group B ($P < 0.001$). No significant differences among the age

Table 2. Relationship among oral function, occlusal support, and age

Age (years)	Number of subjects		a*		Chewing rate (times/3 min)		Tongue pressure (kPa)		/pa/ (repetitions/s)		/ta/ (repetitions/s)		/ka/ (repetitions/s)	
	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
Total	190	78	16.0 (3.0)	12.6 (4.4)	203.7 (44.2)	170.3 (33.7)	34.9 (8.9)	34.2 (11.0)	6.5 (0.7)	6.2 (0.8)	6.5 (0.7)	6.2 (0.9)	6.3 (0.8)	5.9 (0.9)
<70	65	12	16.3 (2.7)	12.5 (3.0)	206.2 (44.1)	174.8 (20.2)	37.2 (9.5)	38.0 (10.4)	6.4 (0.7)	6.2 (0.6)	6.5 (0.7)	6.4 (0.6)	6.3 (0.9)	6.3 (0.5)
70–74	67	19	16.1 (3.0)	12.3 (5.0)	206.3 (42.8)	166.6 (33.5)	34.5 (8.0)	36.7 (8.9)	6.5 (0.8)	6.4 (0.6)	6.5 (0.8)	6.4 (0.6)	6.4 (0.7)	6.3 (0.5)
75–79	45	21	15.4 (3.3)	14.0 (3.9)	196.9 (38.4)	179.2 (38.1)	34.4 (8.6)	37.5 (10.3)	6.4 (0.6)	6.4 (0.7)	6.5 (0.8)	6.4 (0.8)	6.1 (0.7)	5.9 (0.8)
≥80	13	26	16.5 (3.6)	11.9 (4.7)	201.2 (68.5)	163.7 (35.1)	27.0 (7.4)	28.0 (11.2)	6.5 (0.6)	5.9 (1.0)	6.5 (0.6)	5.6 (1.2)	6.3 (0.5)	5.4 (1.2)
P value*			0.428	0.445	0.675	0.396	0.002	0.016	0.981	0.347	0.947	0.016	0.466	0.004

Values are mean (SD)

* Analysis of variance. Tukey's test results: tongue pressure, group A: <70 vs. ≥80 ($P < 0.001$), 70–74 vs. ≥80 ($P < 0.05$), 75–79 vs. ≥80 ($P < 0.05$); group B: <70 vs. ≥80 ($P < 0.05$), 70–74 vs. ≥80 ($P < 0.05$), 75–79 vs. ≥80 ($P < 0.05$); /ta/, group B: 70–74 vs. ≥80 ($P < 0.05$), 75–79 vs. ≥80 ($P < 0.05$); /ka/, group B: <70 vs. ≥80 ($P < 0.05$), 70–74 vs. ≥80 ($P < 0.01$) ( )

groups were noted in either group for syllable /pa/, but for syllables /ta/ and /ka/, significant differences were noted among the age groups in group B (Table 2).

Predictors of masticatory performance by multiple regression

In group A, masticatory performance was significantly correlated with chewing rate ($P < 0.01$) and with the number of natural teeth ($P < 0.0001$). In group B, masticatory performance was significantly correlated with the number of repetitions of the syllable /ta/ ($P < 0.05$), the chewing rate ($P < 0.05$), and tongue pressure ($P < 0.0001$). The number of natural teeth ($\beta = 0.463$, $P < 0.001$) was the only predictor in group A of masticatory performance, and tongue pressure ($\beta = 0.436$, $P < 0.001$) was the only predictor in group B, according to the multiple regression analysis of masticatory performance using the stepwise method.

Discussion

Subjects and methods

In this study, in all subjects any missing teeth had been restored. We did not evaluate the quality of dentures of each subject at the time of study. However, we considered none of the subjects to be wearing dentures of markedly inferior quality because all of them were satisfied with their dentures. Therefore, we inferred that there was no effect of quality of dentures on our study results.

There are two methods for measuring masticatory ability: a direct testing method that uses a test food, and an indirect testing method that uses other factors related to mastication such as jaw movement, muscle activity, occlusal contact status, and occlusal force. The test food used in the direct testing method is usually chewing gum,[12] gumdrops, peanuts,[13] or ATP granules. The size of the crushed food, sugar flowing from the crushed food, and the amounts of gelatin, glucose, starch, and pigment are measured and evaluated using the colorimetric method and weight. Other studies have also reported on a testing method using food, including a sieve analysis[14] and an artificial test food analysis for mastication.[15,16] In this study, we used a newly developed color-changeable chewing gum, employing it as a test food in the direct testing method to evaluate masticatory ability. The original yellow-green color of the gum turns to red with chewing because citric acid in the gum is eluted and mixed with saliva in response to chewing, which increases the pH of the gum.[5] The red color level is expressed as the a* value. There are two masticatory performance measurement methods: one based on chewing a sample a certain number of times and another based on chewing a sample for a certain number of minutes. Our subjects were elderly and we feared that they might have movement disorders, so we avoided placing an excessive burden on them during the study. Therefore, we adopted the latter method, evaluating

masticatory performance based on their chewing a sample for a certain number of minutes, in order to obtain values reflecting the subject's usual masticatory performance. The time was set at 3 min, and the subjects were instructed to "chew the gum as usual" so that their form of mastication was not restricted. According to a report on healthy dentulous subjects by Hirano et al.,[9] who developed this method of measuring masticatory performance, elution of citric acid is complete when the food has been chewed 160 times or the color change to red is complete. The results of our study indicated that the average chewing rate in 3 min was approximately 200, which fulfilled their criterion of the food having been chewed 160 times. Accordingly, we consider our study to have sufficiently evaluated masticatory performance.

The motor functions of the tongue and lips were evaluated by tongue pressure and oral diadochokinesis. We previously reported the relationship between tongue pressure and swallowing function in the elderly using a simple tongue pressure measuring system.[17] From those results, we assumed tongue pressure to possibly be an important indicator of oral motor skill. Oral diadochokinesis is used to diagnose dysarthria associated with neuromuscular diseases.[18] With this method, subjects are asked to repeatedly pronounce an indicator sound as fast as they can for a given number of minutes in order to evaluate the clarity and rhythm of the sound. Furthermore, different sites can be evaluated by choosing indicator sounds that have different points of articulation. In this study, we selected /pa/, which has a point of articulation on the lips, /ta/, which has a point of articulation at the tip of the tongue, and /ka/ which has a point of articulation on the dorsum of the tongue, as indicator sounds.

Results

The results revealed that masticatory performance did not deteriorate with age, but that the presence or absence of occlusal support influenced masticatory performance. The ability to repeat the syllable /pa/ was not influenced by age. We previously reported, in our study on labial function as indicated by the vertical labial-closing pressure, that the pressure was higher in healthy elderly subjects compared to the healthy adult and less likely to decline in the healthy elderly.[18] The vertical labial-closing pressure indicates the amount of lip movement, while the number of repeated syllables indicates the speed of movement and the oral movement skill, which cannot be directly compared. However, the results of this study, that there were no differences due to age in the number of repetitions of the syllable /pa/, may support our previous report showing no decrease in labial function in the elderly.

An influence of age on tongue pressure was noted in both groups, which indicated that tongue pressure decreased with age regardless of the presence or absence of occlusal support, which is consistent with the findings of Hayashi et al.[19]

An influence of age on the number of repetitions of the syllables /ta/ and /ka/ was noted in group B alone, in which the subjects had occlusal support restored by dentures in place of natural teeth. Many studies have reported that muscle strength or physical function is weakened by aging.[19,20] Our further investigation revealed that tongue motor function is well maintained up to the age of 80, but a significant difference was noted between the age group younger than 80 years old and that 80 years or older, suggesting this function is more likely to be affected by age in elderly people 80 years old or older.

Regarding the average number of repetitions of the syllables /ta/ and /ka/, only in subjects in group B were the results influenced by age. This suggests that removable dentures, which restore number of missing teeth, might influence pronunciation, since the tongue needs to be in contact with the teeth as well as with the palate in order to pronounce /ta/ and /ka/.

Multiple regression analysis results showed a strong correlation with masticatory performance of the number of teeth in subjects of group A, and tongue pressure in subjects of group B, perhaps reflecting the relative decrease in the role of teeth in masticatory performance. Furthermore, the tongue may compensate for missing teeth in the masticatory performance of the elderly who have lost natural teeth and whose remaining teeth do not function adequately. Masticatory performance has been studied in various groups, including dentate subjects and denture wearers,[21] as well as in subjects with implant-retained overdentures,[22] and masticatory performance is reportedly reduced significantly when dentures replace natural teeth. A few studies have focused on the relationships between masticatory performance and salivation[23] or oral sensation.[24] Furthermore, mastication is controlled by the suprabulbar structures and consists of coordinated movements of masticatory organs such as the tongue, lips, cheeks, and mandible. These motor functions are known to deteriorate with age[7,25,26] and in relation to neuromuscular diseases associated with movement disorders.[27,28]

The results of this study highlight the importance of tongue function in masticatory performance. Therefore, masticatory disorders might occur more frequently as a result of oral motor dysfunction in the elderly.

Our results indicate that motor functional training for improvement of tongue function[29] as well as an appropriate prosthesis may be useful for restoring masticatory performance in the elderly in whom these functions have deteriorated.

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―― 原　　著 ――

肺炎発症に関する口腔リスク項目の検討
―口腔ケア・マネジメントの確立に向けて―

Selection of Essential Assessment Items for Oral Care Management

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抄録：口腔ケア・マネジメントを確立していくうえで，肺炎リスクを疑うべき口腔の問題を明確にしておくことは必須の課題である。そこで今回，全国19カ所の介護施設入所者172名（男性46名，女性126名，平均年齢84.0歳）を対象に肺炎リスク群を選定し，それらの口腔にかかわる問題点を検討した。その結果，スクリーニングにより選別された肺炎リスク群は56名（男性18名，女性38名，平均年齢84.0歳）であり，これらの者では，要介護度が有意に高く，開口保持，咽頭運動が困難やできない者が有意に多いことが示された（$p<0.05$）。以上のことは，口腔機能の低下した者で肺炎リスクが高まることを示唆しており，歯科医療者との連携による口腔機能の評価が効果的で効率的な口腔ケア提供体制の確立には重要であることを示している。

キーワード：要介護高齢者，口腔ケア，スクリーニング，アセスメント

緒　　言

高齢者の病態および疾患の特徴としては，個人差が大きい，症状が非定型的であるといったものがあり，歯科疾患についても同様のことがいえる[1]。とりわけ，要介護高齢者では自ら症状を訴えたり歯科医院を受診したりすることが困難となることも多いため，介護者の協力がないもとでは歯科疾患が潜在化する恐れがある[2]。

さらに，2005年7月に厚生労働省医政局より医療機関以外の高齢者介護の現場などにおいて，原則として医行為ではないと考えられるものが通知された。ここでは，重度の歯周病などがない場合の日常的な口腔内の刷掃・清拭において，歯ブラシや綿棒または巻き綿子などを用いて，歯，口腔粘膜，舌に付着している汚れを取り除き清潔にすることも挙げられている。このことは，高齢者介護や障害者介護の現場に定着してきた口腔ケアを考えるうえでは，きわめて妥当な通知といえるものの，一方で，歯科医学的管理が必要な要介護高齢者をより潜在化させる恐れもある。

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重度の歯周病などがあるかどうかを歯科専門職以外の者が評価することは困難であり，歯科疾患を潜在化させてしまわないためには，歯科専門職と施設職員が緊密に連携していく必要がある[3]。この歯科との連携のキーワードとしては，最近注目が集まってきている摂食嚥下機能や誤嚥性肺炎予防といったものがあるが[4]，どのような口腔の問題が肺炎のリスクを高めるかといったことについて，歯科専門職として把握しなければならない具体的な評価項目については，これまでほとんど検討されていない。

そこで本研究では，簡易なスクリーニングにより選択された肺炎リスクの高い要介護高齢者の口腔関連領域の問題についてアセスメントシートを用いて評価することで，肺炎のリスクとなりえる口腔機能について検討を行った。

対象者および方法

対象者は，全国19カ所の介護施設入所者のうち，従前に歯科医師もしくは歯科衛生士による専門的口腔ケアを受けたことのない172名（男性46名，女性126名，平均年齢84.0歳）とした。なお，口腔ケアの提供は本人もしくは家族などからの希望があり，今回の調査に同意した者のみとした。

本研究は日本歯科大学生命歯学部倫理委員会の承認を得た。

これらの対象者に対して，各施設に常勤もしくは非常勤として勤務している歯科衛生士によって，図1に示すスクリーニングシートを用いて評価を行った。このうち今回は，歯科衛生士が看護師などへの聞き取り調査を行ったスクリーニングシートの口腔機能の項目の中から，誤嚥性肺炎の既往に「繰り返す発熱あり」「あり」，食事中や食後のむせに「あり」，食事中や食後の痰のからみに「いつもからむ」，口腔乾燥が「著明」，頸部聴診にて「むせ・呼吸切迫あり」のいずれかを回答した者を肺炎リスク群として選択した。

次いで，過去の報告[5,6]を参考に表1のような口腔関連領域のアセスメント項目を作成し，スクリーニングシートと同様，歯科衛生士による評価を行った。得られたアセスメント項目への回答を要介護度については，要介護度1から要介護度3までの者と要介護度4，5の2群に，それ以外の項目は選択肢

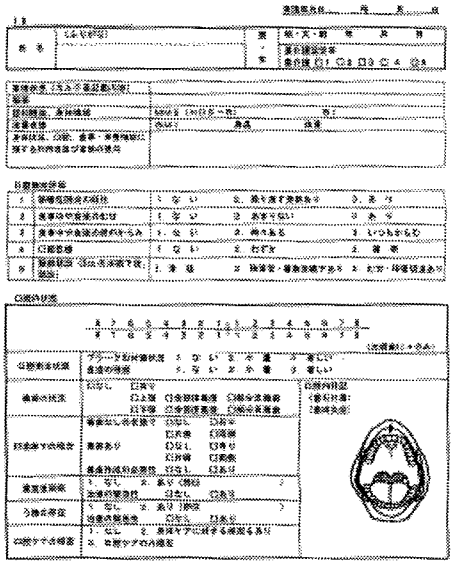

図1　用いたスクリーニングシート

の中から1と回答した者とそれ以外の者の2群にそれぞれ分割した。

統計学的分析はSPSS 15J for Windowsを用いて，肺炎リスク群と対照群の性別，年齢および残存歯数をχ^2検定ならびにMann-WhitneyのU検定を用いて比較した。次いで，両群間で有意差のあるアセスメント項目の選択をχ^2検定により行った。さらに，危険率0.1%未満において肺炎リスク群と有意な関係を示した項目を用いてロジスティック回帰分析を行い，肺炎発症のリスクとなりうる要因の選択を行った。

結　　果

表2にスクリーニングシートの中の口腔機能評価に対する回答結果を示す。これらの回答結果には重複もあることから，選択された肺炎リスク群は56名（男性18名，女性38名，平均年齢84.0歳）となった。一方，選択されなかった対照群は116名（男性28名，女性88名，平均年齢84.1歳）であり，両群間の性別，平均年齢に有意な差はなかった。また，残存歯数もリスク群で10.7±9.4本，対照群で

表1　アセスメントに用いた項目とその対象者数

		対象者数（名）
要介護認定	要介護度　1	23
	要介護度　2	25
	要介護度　3	38
	要介護度　4	44
	要介護度　5	42
気管チューブ	1．留置なし	170
	2．留置あり	2
経管栄養	1．なし	151
	2．あり（胃瘻，経鼻，その他）	21
口腔ケアの自発性	1．なし	76
	2．時々ある	33
	3．いつもある	50
座位保持	1．可能	120
	2．困難	35
	3．不可能	13
頸部可動性	1．十分	121
	2．不十分（前屈，左・右回旋）	33
	3．不可　（前屈，左・右回旋）	10
開口保持	1．可能	137
	2．困難	23
	3．不可能	8
口腔内での水分保持	1．可能	104
	2．困難	19
	3．不可能（むせ，飲んでしまう）	31
含嗽	1．可能	97
	2．困難	21
	3．不可能（むせ，飲んでしまう）	37
咀嚼運動	1．咀嚼運動できる（下顎の回転のあるもぐもぐ様の運動可能）	116
	2．下顎および舌の上下運動可能	18
	3．下顎の上下運動のみ	10
	4．ほとんど下顎の動きなく嚥下	13

11.9±8.6本と差はなかった。

各アセスメント項目への回答結果を表1に示す。各項目で評価できていなかった者を除いて肺炎リスク群と対照群ごとのアセスメント項目の関係を表3に示す。気管チューブ以外のすべての評価した項目で危険率0.1%未満の強い有意な関係が認められた。そこで，気管チューブを除く各項目と肺炎リスク群との関係をロジスティック回帰分析により検討した結果，要介護度，開口保持，咀嚼運動が肺炎リスク群の判定に有意となる診査項目であることが示

表2　スクリーニング項目への回答結果

口腔機能評価		対象者数（名）
誤嚥性肺炎の既往	1．ない	139
	2．繰り返す発熱あり	12
	3．あり	21
食事中や食後のむせ	1．ない	131
	2．あまりない	18
	3．あり	23
食事中や食後の痰のからみ	1．ない	140
	2．時々ある	28
	3．いつもからむ	4
口腔乾燥	1．ない	132
	2．わずか	40
	3．著明	0
頸部聴診（3ccの水嚥下後，聴診）	1．清聴	122
	2．残留音・複数回嚥下あり	39
	3．むせ・呼吸切迫あり	11

誤嚥性肺炎の既往に「繰り返す発熱あり」「あり」と回答した者，食事中や食後のむせに「あり」，食事中や食後の痰のからみに「いつもからむ」，口腔乾燥が「著明」，頸部聴診にて「むせ・呼吸切迫あり」と回答した者を肺炎リスク群とした。

された（$p<0.05$）（表4）。

考　　察

本研究の結果，肺炎リスクの高い要介護高齢者の特徴として，要介護度が高いことに合わせて，開口保持や咀嚼運動ができないといった口腔機能の低下があげられることが示された。

大類ら[7]，誤嚥性肺炎の発生メカニズムとして，脳血管障害や進行性の神経・筋疾患がある者で嚥下反射や咳反射が低下して不顕性誤嚥が生じることの背景に，ADLの低下にともなう身体抵抗性の低下があることを示している。本研究の要介護度が高い者で肺炎リスクが高かったことは，まさしくこのことを示唆している。

一方で，開口保持や咀嚼運動といった口腔機能が肺炎リスクと有意に関係していたことは，開口を保持できるだけの筋力や咀嚼運動を可能とする筋の協調性が保たれていることが，肺炎予防につながることを示唆しているものと考える。実際，不適切な食形態が誤嚥や誤飲の原因となっていることが報告されていたり[8]，咀嚼運動の主体をなす舌運動の低下と食事時のむせといった嚥下障害の症状と関係していることが示されているなど[9]，安全な摂食には，口腔機能に応じた食事形態の提供が，不可欠である。

さらに，舌運動の低下しているもので舌苔が付着しやすいといった報告[10]からもわかるように，口腔機能の低下が口腔の自浄能を低下させ，口腔細菌の増加を導いている可能性もある。実際，歯周病菌が誤嚥性肺炎の有力な起炎菌であるといわれているにもかかわらず[11]，現在歯数と誤嚥性肺炎の発症との間には有意な関係は認められておらず[12,13]，残存歯数やその植立状態といった形態学的な問題に加えて，自浄能の低下による食物残渣の増加といった口腔環境を劣悪にする因子として口腔機能をとらえておく必要があるものと思われる。

しかしながら，これまでのところ，このような口腔機能の評価方法は確立されておらず，昨年度の診療報酬改定において導入された後期高齢者在宅療養口腔機能管理料や，本年4月より介護保険に導入予