Impact of oral ingestion on oral health condition in dysphagic inpatients

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Abstract

Objective: The present preliminary study examined how oral feeding improves oral health status in dysphagic inpatients.

Background: Research suggests that the oral health condition of dysphagic patients is affected by not only oral health care but also oral intake because oral feeding is expected to facilitate salivary secretion and orofacial motor action.

Materials and methods: Twenty-one dysphagic patients participated in the present study. Clinical data including feeding status, oral health condition, and ingestion-related motor function were collected every week until the patients were discharged from the hospital. All recorded scores were compared between the first and last examination. The correlations among the items were investigated.

Results: Feeding status, including intake level and dietary form, was significantly improved. Oral hygiene and tongue coating were also significantly improved, while ingestion-related function was less changed. Oral hygiene, tongue coating, and tongue moisture were significantly improved with improvement in feeding status. A few parameters of the oral health condition were significantly correlated with those of ingestion-related function.

Conclusion: Oral resumption may be important to maintain or improve oral health in dysphagic patients, although oral intake does not improve or affect the whole ingestion function in the short term.

Keywords

dysphagia, oral hygiene, tongue coating, oral intake

Introduction

Japan has the highest proportion of older people in the world. The ratio of people of 65 years and older in the total population was >26% in 2015 **(1)**. Additionally, the working-age population is shrinking so quickly that by 2050 it will be smaller than it was in 1950 **(2)**. In this super-aging society, pneumonia has replaced brain stroke as the third leading cause of death **(3)**. This is strongly related to the fact that Japan is aging; 90% of people who died of pneumonia were over 65 years. Teremoto et al. **(4)** reported that most of the patients hospitalized for pneumonia were older and that the ratio of aspiration pneumonia to total cases of pneumonia increased with age. Aspiration pneumonia is a common but sometimes serious disease that frequently occurs in older patients. Patients who develop aspiration pneumonia, particularly older patients, subsequently experience dysphagia **(5-7)**, and aspiration pneumonia may be a risk factor for problems with oral intake.

Dysphagia rehabilitation is considered to improve ingestion function and hence oral intake **(8-10)**. Dysphagia rehabilitation includes swallowing compensation strategies, appropriate dietary modification, swallowing advice, and direct swallowing exercises. The exercises are designed to facilitate oropharyngeal motor strength, range of motion, and coordination. These approaches have been found to decrease aspiration and enable safe oral intake **(11)**. In fact, clinical reports have stated that dysphagia rehabilitation improves the capability for oral intake in patients with head and neck cancer **(9)** and stroke **(8, 10)**.

Oral health care is also important to prevent aspiration pneumonia in dysphagic patients. Numerous studies have shown that oral care may be useful in preventing pneumonia in institutionalized older patients irrespective of their dentate or edentate status **(12-16)**. Furthermore, studies have suggested that oral care with functional feeding training is also effective in preventing pneumonia in older people who are fully dependent on tube feeding. Ueda et al. **(17)** reported that the frequency of pneumonia in the group who received functional training for dysphagia in addition to oral care decreased year by year, although cognitive function was not improved. It is suggested that oral health condition is affected by not only oral health care but also oral intake. We hypothesized that oral feeding is important in terms of oral hygiene, not nutrition, because mechanical or chemical stimulation using food facilitates salivary secretion and/or ingestion-related motor action, and hence cleans the oral and pharyngeal cavity. The present preliminary study examined how oral feeding improves oral health status in dysphagic patients.

Methods

Patients

Twenty-one inpatients (11 males, 10 females; mean age ± standard deviation, 73.9 ± 10.6 years; age range, 59–91 years) at Niigata University Medical and Dental Hospital who were referred to the Unit of Dysphagia Rehabilitation between April 2014 and February 2015 participated in the present study. The participants' primary diseases included disuse syndrome or sarcopenia (n = 11), cerebrovascular disease (n = 4), pneumonia (n = 2), postoperative status after treatment of a brain tumor (n = 1), dehydration (n = 1), cardiovascular disease (n = 1), and infection of unknown etiology (n = 1). The mean length of hospitalization was 9.0 ± 4.2 weeks (range, 3–21 weeks), and the mean fasting period was 3.7 ± 3.1 weeks (range, 1–13 weeks). All participants gave their written informed consent. The study was reviewed and approved by the Ethics Committee of Niigata University Faculty of Dentistry (25-R28-11-21).

Data collection

According to the participants' clinical conditions, the dentist and dental hygienist in charge provided oral health care and functional therapy such as thermal tactile stimulation inside of the oral cavity, muscle stretches, and relaxation exercises every weekday. Clinical data including feeding status, oral health condition, and ingestion-related motor function were collected by well-trained dentists or dental hygienists once a week **(Table 1)** until the patients were discharged from the hospital.

Evaluation of feeding status included assessment of the intake level and dietary form. The intake level was classified as oral intake only (1), more frequent oral intake than non-oral feeding (2), more frequent non-oral feeding than oral intake (3) and non-oral feeding only (4). Dietary form was classified as normal (1), soft (2), paste (3), jelly (4), and non-oral intake (5) .

The oral health condition was classified by evaluating oral hygiene, amount of tongue coating, salivary flow rate, tongue and buccal moisture, and amount of oral bacteria. Using the oral assessment guide introduced by Eilers et al. **(18-20)**, oral hygiene was evaluated by observing the following aspects: a) color changes including pallor, erythema, white patches, discolored lesions, and ulcers; b) moisture changes reflecting salivary impairment, including increased or decreased amounts and changes in quality or tenacity of secretions; c) cleanness issues including debris, coating, bad odor, and tooth discoloration; d) changes in mucosal integrity including cracks, fissures, ulcers, blisters, and lesions that are isolated, clustered, patchy, confluent, or generalized; and e) edema of the lips or tongue. Finally, the oral hygiene status was assigned a score of 1 to 3: 1, good; 2, normal; and 3, poor. The amount of tongue coating was assigned a score of 1 to 4: 1, none (no tongue coating); 2, slight (a thin tongue coating covered less than two-thirds of the whole tongue surface); 3, moderate (a thin tongue coating covered more than two-thirds of the whole tongue surface or a thick tongue coating was partly observed); and 4, heavy (a thick tongue coating covered more than two-thirds of the whole tongue surface) **(Fig. 1)**. The unstimulated salivary flow rate was measured as follows. Each participant was first asked to swallow the saliva present in the mouth. Next, a cotton roll was gently put and left on the oral floor for 30 s. Before and after leaving the cotton roll in the mouth, the weight was measured and the difference in the weight was calculated; this weight represented the amount of unstimulated saliva (g) for 30 s. Oral Moisture Checker MUCUS® (Life Co. Ltd., Saitama, Japan) was used to measure intraoral moisture. The measurement sites were the center of the lingual mucosa (10 mm posterior to the tip of the tongue) and the right buccal mucosa (10 mm posterior to the corner of the lip). The sensor was manually applied to the measurement site at a pressure of about 200 g, as practiced beforehand with a manometer. To eliminate outliers, the oral mucosal wetness was measured continuously three consecutive times, and the median was used as a representative value. Finally, following a previous method **(21)**, we measured the amount of oral bacteria using saliva. The central dorsal surface of the tongue was reciprocally scratched three times with a cotton swab to obtain a specimen. Bacteria were enumerated using a bacterial counter (Panasonic Healthcare Co., Ltd., Tokyo, Japan) to measure the number of oral bacteria; and counts were classified into seven levels: 1 (<10^5 colony-forming units [CFU]/mL), 2 (≥10^5 to <10^6 CFU/mL), 3 (≥10^6 to <$10^{6.5}$ CFU/mL), 4 (≥$10^{6.5}$ to <10^7 CFU/mL), 5 (≥10^7 to <$10^{7.5}$ CFU/mL), 6 (≥$10^{7.5}$ to <10^8 CFU/mL), and 7 (≥10^8 CFU/mL).

Ingestion-related motor function, including orofacial and neck movements, phonation, status of hoarseness, and velopharyngeal closure, was assigned a score of 1 to 4: 1, good; 2, slightly poor; 3, moderately poor; and 4, very poor or not applicable. Orofacial and neck movements were evaluated on the basis of strength and excursion. "Not applicable" indicated that the participant could not perform the task because of problems with cognitive function. In addition, the maximum phonation time was measured and a repetitive saliva swallowing test (RSST) and modified water swallowing test (MWST) were performed. In the RSST, the participants were instructed to engage in repetitive swallowing behavior as quickly as possible for 30 s, and the number of swallows was counted **(22)**. In the MWST, 3 mL of water was poured into the mouth, the participant was instructed to swallow, and their swallowing function was evaluated as follows: 1, the participant cannot swallow; 2, the participant can swallow but feels difficulty in respiration without coughing after swallowing; 3, the participant can swallow but coughs after swallowing; 4, the participant can swallow; and 5, the participant can swallow and additionally swallows voluntarily twice within 30 s. If the participant's score was ≥4, the test was repeated twice, and the lowest score was used as the test result. A score of 4 or 5 was defined as good swallowing function, and a score of ≤3 was defined as poor swallowing function **(23)**.

Data analysis

All recorded scores were compared between the first and last examination using a paired t-test or the Wilcoxon signed rank test. The correlations between the items of the oral health condition and between those of ingestion-related function were investigated by regression analysis. To examine the relationship between feeding status (such as the intake level or dietary form) and the oral health condition, the mean values of each item of the oral health condition at each feeding status level were compared using one-way repeated-measures analysis of variance with Tukey's honestly significant difference post-hoc test. Finally, the correlations between the items of the oral health condition and ingestion-related function were investigated using regression analysis. Tests for statistical differences and comparisons were performed using statistical software

(SigmaPlot 12; Systat Software Inc., San Jose, CA, USA). Statistical significance was set at $P < 0.05$. All values are expressed as mean ± standard deviation.

Results

General findings

The mean intervention period was 5.5 ± 2.6 weeks (range, 3–14 weeks). We first compared all parameters between first and last examinations **(Table 2)**. The feeding status, including the intake level and dietary form, was significantly improved. Among the parameters of the oral health condition, the mean scores for oral hygiene ($P < 0.001$) and tongue coating ($P < 0.001$) were significantly improved after the clinical intervention, while the other scores did not change over time. With respect to ingestion-related function, the mean scores of only RSST and MWST were significantly increased.

Relationships among the items of the oral health condition

The relationships among the items of the oral health condition, such as oral hygiene, tongue coating, tongue and buccal moisture, salivary flow rate, and amount of oral bacteria were investigated in all cases **(Table 3)**. There was a significant positive correlation between oral hygiene and other parameters such as tongue coating, buccal moisture, and salivary flow rate, while there was no significant correlation between oral hygiene and the amount of oral bacteria.

Relationships among the items of ingestion-related function

The relationships among the items of ingestion-related function, such as orofacial movements, neck movements, phonation, hoarseness, velopharyngeal closure, maximum phonation time, RSST result, and MWST result, were investigated in all cases **(Table 4)**. The items that were positively correlated with many other parameters were orofacial movements, velopharyngeal closure, maximum phonation time, and MWST result.

Relationship between feeding status and oral health condition

Because we found that both the intake level and dietary form improved during the clinical intervention, the temporal relationship between the feeding status and oral health condition and between the feeding status and ingestion-related function was assessed to determine how the feeding status was related with those parameters. With respect to the oral health condition, oral hygiene, tongue coating, and tongue moisture were significantly improved with an improving feeding status **(Figs. 2 and 3)**. Conversely, ingestion-related function was not significantly related to the feeding status (data not shown).

Relationship between oral health condition and ingestion-related function

As mentioned above, oral hygiene, tongue coating, and tongue moisture improved during clinical intervention. Finally, we investigated how these parameters were related to ingestion-related function **(Table 5)**. A few parameters were significantly correlated with each other: oral hygiene and maximum phonation time, tongue coating and orofacial movements, tongue coating and RSST result, and tongue moisture and orofacial movements. These findings suggest that ingestion-related function is less directly related to the oral health condition.

Discussion

In the present study, we showed that oral health condition parameters such as oral hygiene, tongue coating, and tongue moisture improved as the feeding status improved during our clinical intervention in dysphagic patients, while ingestion-related motor function did not significantly change. It has been reported that the oral health condition may be related not only to the intraoral moisture and salivary flow rate **(24, 25)** but also to the nutritional status in older people **(26-29)**. In fact, our data indicate that oral hygiene is significantly correlated with other oral health condition parameters: tongue coating, tongue moisture, buccal moisture, and salivary flow rate. In contrast, motor function (excluding the RSST and MWST results) was not significantly improved and was not closely related to oral hygiene, tongue coating, or tongue moisture.

Ueda et al. **(17)** evaluated the effects of functional training on the outbreak frequency of pneumonia in older dysphagic tube-fed patients. The authors showed that the frequency of pneumonia in the training group in which the jelly food was provided every week significantly decreased year by year, suggesting that functional training using foods might be effective in preventing pneumonia. Considering their results, swallowing itself might help to clean the oral and pharyngeal cavity where the oral flora exists. Furthermore, oral feeding may have effects on maintaining the motivation of patients or on improving the cleansing action of the oral cavity and pharynx by promoting secretion of stimulated saliva. Taken together, these findings indicate that oral intake resumption may be important to maintain or improve oral health. Thus, although oral intake did not improve or affect the whole function in the short term, it clearly showed a positive effect on the improvement in the oral health condition.

In the present study, ingestion-related function such as orofacial movements and other parameters was not significantly improved during the clinical intervention. In dysphagic patients, the key points of treatment are to prevent aspiration pneumonia and consider how the oral food intake is safely maintained depending on the patients' condition. Maintenance of oral hygiene and feeding status are important elements in this respect **(30)**. Although improving the oral health condition is expected to be associated with the maintenance or improvement of a patient's general well-being as well as the maintenance or recovery of oral or feeding statusfunctions **(31, 32)**, how the function is improved with the improvement of oral health condition remains unknown.

Indirect therapy was provided to improve motor function in the present study. Indirect therapy refers to an exercise regimen performed without a food bolus and includes stimulation of the oropharyngeal structures and the adoption of behavioral techniques such as the swallow maneuver. Haruta et al. **(24)** examined how an oral function promotion program for independent older people was effective in improving the oral health condition and ingestion-related function. The authors implemented the function promotion program, which included facial muscle and tongue exercises and salivary gland massage, for 3 months and found that not only oral health condition parameters such as the tongue coating, tongue moisture, and salivary flow rate, but also motor function was significantly improved. In the present study, although we expected functional training to be effective in improving ingestion-related motor function, we found that only the RSST and MWST results were improved. The mean intervention period in the present study was 5.5 weeks. Robbins et al. **(33)** showed positive changes in lingual strength after progressive resistance exercises for the tongue in dysphagic patients; the participants performed an 8-week lingual exercise and eventually increased their isometric tongue force and swallowing pressure. Shaker et al. **(34)** evaluated the effect of a novel rehabilitative exercise on restoration of deglutition in patients with deglutitive failure caused by abnormal upper esophageal sphincter opening. The authors showed that following 6 weeks of necessary exercise, all patients exhibited a significant improvement in their function: anteroposterior upper esophageal sphincter opening, laryngeal anterior excursion, and functional outcome assessment of swallowing. Thus, the intervention period in the present study might have been shorter than that in the abovementioned reports, significantly affecting the ingestion-related motor function.

Finally, the amount of oral bacteria did not change over time. This may have been caused by the fact that the food contained carbohydrates, which are important constituents for the grown of some bacterial species **(35)**. We expected that chewing led to salivary secretion, which is considered to be involved in the self-cleaning function of the oral and pharyngeal cavity. In the present study, however, only two participants recovered their dietary form to normal. This may be why the salivary flow rate and amount of oral bacteria did not significantly change throughout the study.

Limitations

There are several potential limitations in our study. Only 21 participants were recruited, and they had several different background diseases. The intervention period varied widely depending on the treatment course of the primary disease. In addition, because we did not evaluate the participants' nutritional status, we could not determine how the nutritional level affected the oral health condition. Future evaluation of dysphagic conditions and the effects of the intervention period or nutritional level will be required.

Conclusion

We can suggest that oral feeding may be important not only to maintain the nutritional level but also to improve oral health condition parameters such as oral hygiene.

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Disclosure

The authors declare that they have no conflicts of interest.

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Figure captions

Fig. 1. Examples of tongue coating. All samples were scored 1 to 4. (A) 1, none; (B) 2, slight; (C) 3, moderate; and (D) 4, heavy.

Fig. 2. Relationship between intake level and oral health condition. There was a significant difference in the mean values of oral hygiene and tongue coating among intake levels. The numbers of samples of non-oral feeding only, more frequent non-oral feeding than oral intake, more frequent oral intake than non-oral feeding, and oral intake only were 21, 13, 12, and 11 for oral hygiene; 21, 14, 12, and 12 for tongue coating; 21, 14, 11, and 11 for salivary flow rate; 15, 9, 10, and 11 for tongue moisture; 21, 13, 11, and 11 for buccal moisture; and 21, 14, 11, and 11 for amount of oral bacteria, respectively. ***$P < 0.001$, **$P < 0.01$, *$P < 0.05$.

Fig. 3. Relationship between dietary form and oral health condition. There were significant differences in the mean values of oral hygiene, tongue coating, and tongue moisture among intake levels. The numbers of samples of non-oral feeding (none), jelly, paste, soft food, and normal diet were 21, 4, 17, 17, and 2 for oral hygiene; 21, 4, 17, 17, and 2 for tongue coating; 21, 6, 18, 16, and 0 for salivary flow rate; 15, 3, 13, 15, and 2

for tongue moisture; 21, 4, 16, 16, and 2 for buccal moisture; and 21, 3, 17, 17, and 2 for amount of oral bacteria, respectively. $^{**}P < 0.01$, $^{*}P < 0.05$.

Table 1. Collected data

Categoly	Evaluated item
Feeding status	Nutrition
	Dietary form
Oral health condition	Oral hygiene
	Coated tongue
	Salivary flow
	Tongue mositure
	Cheek moisture
	Oral bacteria
Ingesition related function	Orofacial movement
	Neck movement
	Phonation
	Hoarseness
	Velopharyngeal closure
	maximum phonation time
	Voluntary swallowing (RSST)
	3-ml water swallowing (MWST)

Table 2. Comparion of all parameters between first and last examinations

Collected items		First	Last	P
Feeding status	Intake level	4.00 ± 0.00	1.71 ± 0.90	P <0.001
	Dietary form	5.00 ± 0.00	2.19 ± 0.81	P <0.001
Oral health condition	Oral hygiene	2.67 ± 0.48	2.00 ± 0.45	P <0.001
	Tongue coating	2.95 ± 0.74	1.81 ± 0.60	P <0.001
	Tongue mositure	23.47 ± 10.81	30.02 ± 2.40	P = 0.108
	Cheek moisture	27.78 ± 6.34	30.27 ± 4.54	P = 0.106
	Salivary flow rate (g)	0.06 ± 0.07	0.14 ± 0.28	P = 0.325
	Bacteria	3.38 ± 1.56	3.62 ± 1.47	P = 0.424
Ingestion function	Orofacial movements	2.14 ± 0.85	1.71 ± 0.78	P = 0.064
	Neck movements	1.52 ± 0.51	1.38 ± 0.50	P = 0.313
	Hoarseness	1.37 ± 0.68	1.32 ± 0.67	P = 0.750
	Velopharyngeal closure	1.11 ± 0.32	1.00 ± 0.00	P = 0.500
	Phonation	1.58 ± 0.51	1.50 ± 0.51	P = 0.813
	Phonation time (s)	3.37 ± 3.85	6.35 ± 6.03	P = 0.135
	RSST (swallows/30 sec)	1.45 ± 1.43	2.15 ± 1.81	P = 0.027
	MWST	3.57 ± 0.87	4.14 ± 0.73	P = 0.030

Table 3. Relationships among the items of the oral health condition

		Oral hygiene	Tongue coating	Tongue mositure	Cheek moisture	Salivary flow	Oral bacteria
Oral hygiene	CC		0.513	-0.215	-0.25	-0.227	-0.062
	P		＜0.001	0.042	0.007	0.013	0.504
	n		118	90	113	118	118
Tongue coating	CC	0.513		0.008	-0.107	-0.083	0.025
	P	＜0.001		0.942	0.256	0.368	0.790
	n	118		90	114	119	119
Tongue mositure	CC	-0.215	0.008		0.145	0.188	0.265
	P	0.042	0.942		0.176	0.076	0.012
	n	90	90		89	90	90
Cheek moisture	CC	-0.25	-0.107	0.145		0.150	0.124
	P	0.007	0.256	0.176		0.112	0.188
	n	113	114	89		114	114
Salivary flow	CC	-0.227	-0.083	0.188	0.150		-0.002
	P	0.013	0.368	0.076	0.112		0.981
	n	118	119	90	114		119
Oral bacteria	CC	-0.062	0.025	0.265	0.124	-0.002	
	P	0.504	0.790	0.012	0.188	0.981	
	n	118	119	90	114	119	

Table 4. Relationships among the items of ingestion-related function

		Orofacial movements	Neck movements	Phonation	Hoarseness	Velo-pharyngeal closure	Maximum phonation time	RSST	MWST
Orofacial movements	CC		0.267	0.119	-0.068	0.286	-0.289	-0.402	-0.266
	P		0.005	0.234	0.506	0.004	0.004	＜0.001	0.007
	n		107	101	99	99	100	107	103
Neck movements	CC	0.267		-0.057	0.012	-0.152	-0.178	0.013	-0.022
	P	0.005		0.556	0.903	0.121	0.066	0.895	0.820
	n	107		108	106	106	107	113	111
Phonation	CC	0.119	-0.057		0.357	0.199	-0.296	-0.124	-0.193
	P	0.234	0.556		＜0.001	0.041	0.002	0.200	0.048
	n	101	108		106	106	107	108	105
Hoarseness	CC	-0.068	0.012	0.357		0.275	-0.385	0.082	-0.149
	P	0.506	0.903	＜0.001		0.004	＜0.001	0.402	0.134
	n	99	106	106		106	105	106	103
Velo-pharyngeal closure	CC	0.286	-0.152	0.199	0.275		-0.237	-0.272	-0.202
	P	0.004	0.121	0.041	0.004		0.015	0.005	0.041
	n	99	106	106	106		105	106	103
Maximum phonation time	CC	-0.289	-0.178	-0.296	-0.385	-0.237		0.268	0.465
	P	0.004	0.066	0.002	＜0.001	0.015		0.005	＜0.001
	n	100	107	107	105	105		107	104
RSST	CC	-0.402	0.013	-0.124	0.082	-0.272	0.268		0.384
	P	＜0.001	0.895	0.200	0.402	0.005	0.005		＜0.001
	n	107	113	108	106	106	107		109
MWST	CC	-0.266	-0.022	-0.193	-0.149	-0.202	0.465	0.384	
	P	0.007	0.820	0.048	0.134	0.041	＜0.001	＜0.001	
	n	103	111	105	103	103	104	109	

Table 5. Relationship between oral health condition and ingestion-related function

		Orofacial movements	Neck movements	Phonation	Hoarseness	Velo-pharyngeal closure	Maximum phonation time	RSST	MWST
Oral hygiene	CC	-0.027	0.152	0.159	0.098	-0.027	-0.264	0.163	-0.107
	P	0.781	0.106	0.100	0.319	0.785	0.006	0.082	0.263
	n	108	115	108	106	106	107	115	111
Tongue coating	CC	-0.213	0.110	-0.044	0.033	-0.132	0.001	0.250	-0.052
	P	0.027	0.240	0.651	0.735	0.177	0.993	0.007	0.591
	n	108	115	108	106	106	107	115	111
Tongue mositure	CC	-0.287	-0.046	-0.062	-0.020	-0.191	0.198	0.161	0.187
	P	0.008	0.672	0.577	0.859	0.090	0.077	0.133	0.089
	n	83	88	82	80	80	81	88	84

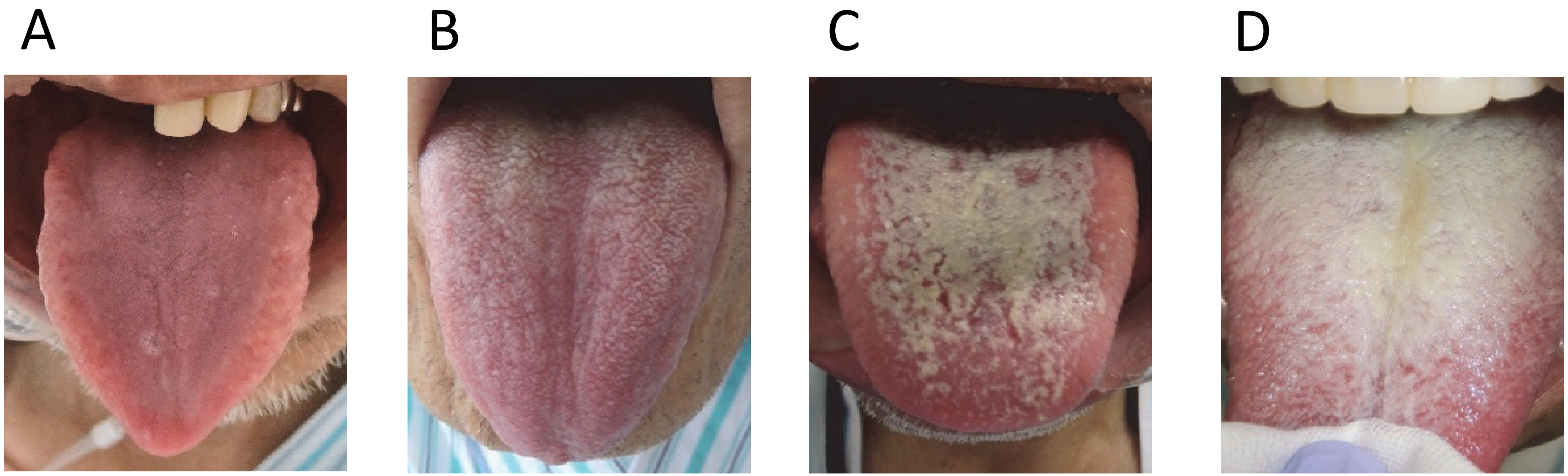

Fig. 1

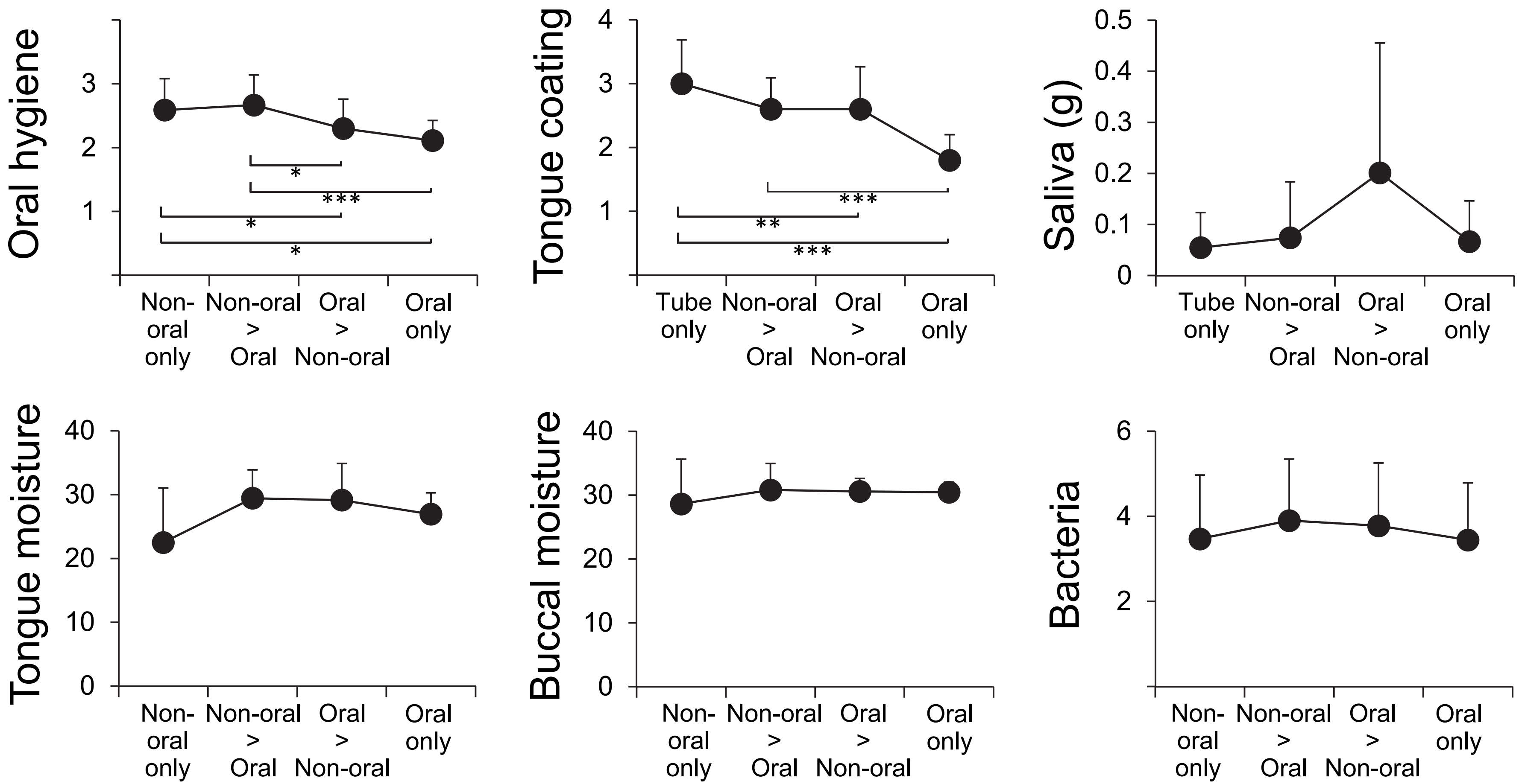
Oral hygiene
Tongue coating
Saliva (g)
Tongue moisture
Buccal moisture
Bacteria
Non-oral only
Non-oral > Oral
Oral > Non-oral
Oral only
Tube only
*
**
***

Fig. 2

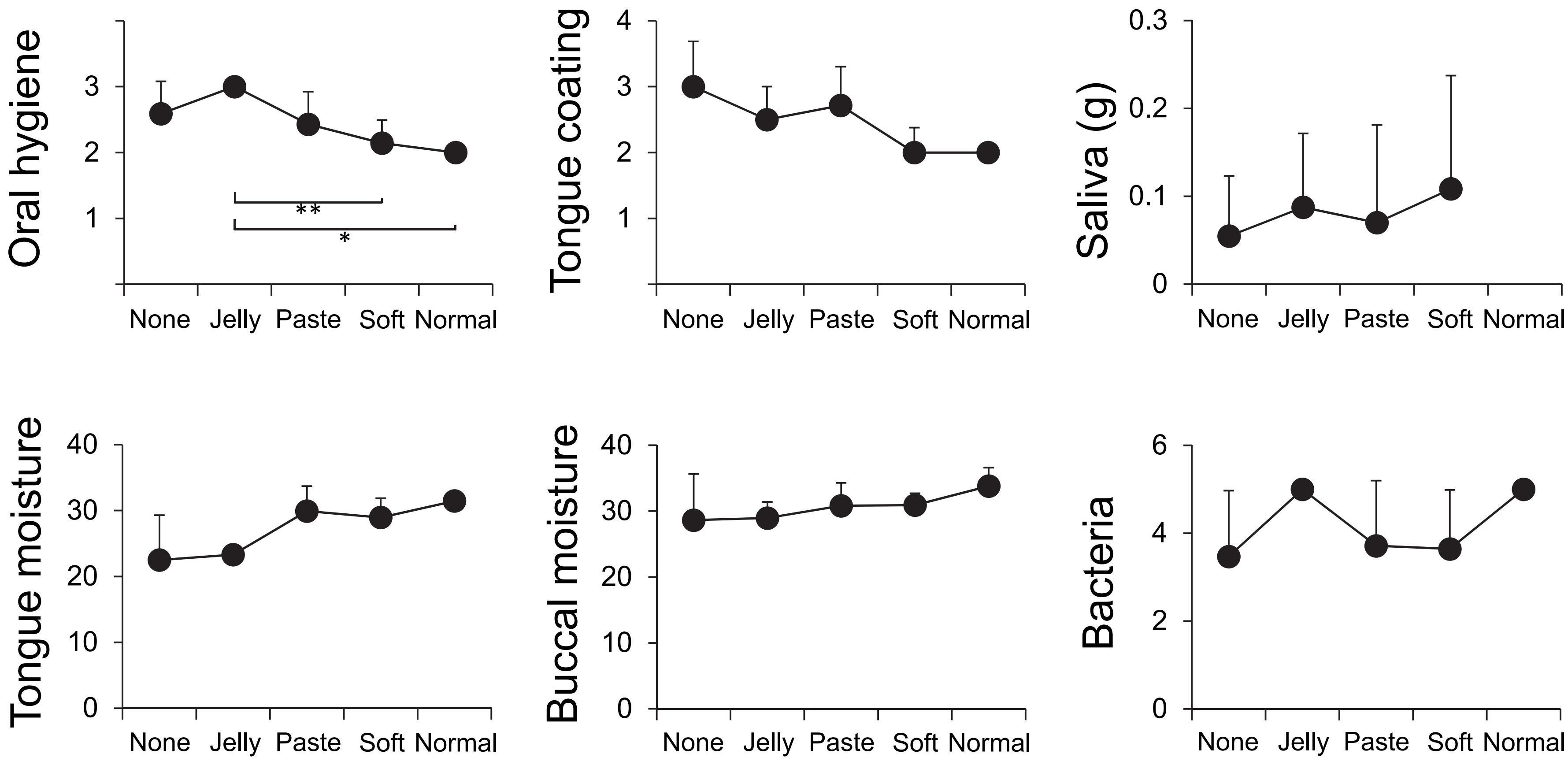
Oral hygiene
3
2
1
**
*
None
Jelly
Paste
Soft
Normal
Tongue coating
4
3
2
1
Saliva (g)
0.3
0.2
0.1
0
Tongue moisture
40
30
20
10
0
Buccal moisture
Bacteria
6
4
2

Fig. 3