Relationship between oral intake level and oral health assessment tool scores in the convalescent ward

Enri Nakayama1,2), Haruka Tohara2,3), Mitsuyasu Sato1), Kimiko Abe1), Masanori Kimura1), Mao Watanabe1), Masato Iida1), and Koichiro Ueda1)

1) Department of Dysphagia Rehabilitation, Nihon University School of Dentistry, Tokyo, Japan
2) Shin-yachiyo Hospital, Yachiyo, Japan
3) Dysphagia Rehabilitation, Department of Gerontology and Gerodontology, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan

Abstract

Purpose: To examine the relationship between oral intake function and oral health status in convalescent inpatients.

Methods: Subjects were 222 patients admitted to a convalescent hospital between 1 January and 30 June 2018. Investigation items were age, sex, causative disease, body mass index, functional oral intake scale (FOIS), functional independence measure, occlusal contact, assistance with oral cleaning, and oral health assessment tool (OHAT) scores. Multiple regression analysis was performed with FOIS as the dependent variable, and investigation items were related to FOIS as independent variables.

Results: Results of multiple regression analysis for all patients suggested that saliva and denture scores were significantly associated with FOIS. However, analysis excluding non-oral feeding patients did not show a significant association between FOIS and OHAT scores.

Conclusion: The results of this study suggest that oral health status is associated with oral intake function. In addition, the oral health status of inpatients may be strongly related to whether or not they are eating orally. Therefore, it is necessary to take good care of oral health in non-oral feeding patients in the convalescent ward.

Keywords: oral care, oral health, oral intake

Introduction

Deterioration of the oral environment not only causes diseases such as pneumonia [1,2], but also raises the risk of contracting diseases [3-5] via invasion of bacteria into the blood. Therefore, maintaining oral health is important for whole-body health management. In general, medical staff and care workers in hospitals and care facilities make daily efforts to clean the oral cavities of patients and residents. However, some people quickly revert to a poor oral hygiene status, while others maintain a high level of oral hygiene. The reason why oral health deteriorates in some patients is not necessarily related to oral cleaning techniques of the staff or the patient, but rather to environmental or personal factors having an adverse effect on oral hygiene status.

In a previous study [6], the oral status of an oral feeding group and a non-oral feeding group in an acute hospital was compared using the oral assessment guide (OAG) [7]. Results showed that the non-oral feeding group had significantly lower voice, swallowing, saliva, and tongue related OAG scores than the feeding group in the unadjusted analysis. However, the relationship between oral intake function and oral health status was not clarified in previous studies. To examine this relationship, the presence of confounding factors must be considered. According to previous reports, malnutrition [8,9], cranial nerve disease [10,11], cognitive function [12,13], activities of daily living (ADL) [14,15], and tooth defect status [16,17] can be confounding factors. Therefore, the purpose of this study was to clarify the relationship between oral intake function and oral health status, taking into account the effects of these confounding factors.

The results of this study may contribute to the creation of oral hygiene management plans and management systems tailored to the patient’s oral intake stage. If a direct correlation between oral intake function and oral health status is found, dental treatment with dysphagia rehabilitation should be considered to maintain general health and promote recovery of oral intake function in a convalescent ward.

Materials and Methods

The study design was a cross-sectional study. Subjects were patients admitted to a convalescent hospital between 1 January and 30 June 2018. At this hospital, nurses routinely perform oral cleaning for patients who cannot clean their mouth by themselves after each meal, even if the patient is not taking food orally. The oral cleaning method performed by nurses consists of wiping the oral mucosa with a sponge brush, and brushing the teeth with a toothbrush and a liquid type toothpaste. Oral status was assessed within about 3 days after hospitalization to establish the need for dental treatment or specialized oral care. Oral assessment, based on the oral health assessment tool (OHAT) scores [18], records of missing teeth, and the need for assistance with oral cleaning or dental treatment, was carried out by a dental hygienist when more than 1 h had passed since the last meal. OHAT assesses the status of the patient’s lips, tongue, gums and tissues, saliva, natural teeth, dentures, oral cleanliness and dental pain. A score (0 = healthy, 1 = oral changes, or 2 = unhealthy) was given in each of the assessment categories, as well as a total score over the eight categories. In this study, OHAT scores were used as the evaluation criterion for oral health status. However, because there are no evaluation items in OHAT for occlusal contact in the molar region, this item was added to the investigation items. The criterion for assessing occlusal contact was the presence of one or more places in the molar region occluding with natural teeth or an existing denture. Other necessary information such as age, sex, causative disease, body mass index (BMI), oral intake level, and ADL of patients at the time of hospitalization were obtained from the patient’s medical records. Oral intake level was classified by the functional oral intake scale (FOIS) [19]. The FOIS ranged from level 1 (nothing by mouth) to level 7 (total oral diet with no restrictions). The patient’s ADL levels were evaluated using the functional independence measure (FIM) [20]. The FIM comprises 18 items, each with a maximum score of 7 and a minimum score of 1.

Statistical analysis

Investigation items were compared using the unpaired t-test (age and BMI), the Mann-Whitney U-test (motor FIM, cognitive FIM, and OHAT items), and the chi-square test (all other variables) between two groups: the oral feeding group (≥FOIS 2) and the non-oral feeding group (= FOIS 1). Correlations between FOIS, OHAT items and each parameter were assessed using Spearman’s rank-correlation coefficients. In the multiple regression analysis, significant factors associated with FOIS in univariate analyses were chosen as independent variables for FOIS. P < 0.05 was considered
statistically significant. SPSS Statistics 23 software (IBM Japan, Tokyo, Japan) was used for statistical analyses. Measurement values did not include missing data.

The number of samples required to confirm the relationship between FOIS and OHAT items and their related items by multiple regression analysis was calculated in advance. When 16 items measured are used as independent variables, effect size is 0.15, α error is 0.05, and power is 0.8, the number of samples required for multiple regression analysis is 204. Since this number corresponds to 6 months of newly admitted patients at the hospital, the survey period was set to 6 months.

Ethical considerations

This study was approved by the Institutional Review Board (Approval no.: EP20D003) and the Ethics Committee of the Shin-yachiyo Hospital (Approval no.: 19-003) and was conducted in accordance with the Declaration of Helsinki. This research was conducted with adequate understanding and written consent from all participants or their families in order to publish anonymized medical information for research.

Results

Subjects were 222 patients (mean age ± SD of 76.0 ± 11.9 years) who were hospitalized during the study period and received oral assessment. The characteristics of the subjects are shown in Table 1. Patients who had been ingesting food orally since admission were referred to as the oral feeding group (n = 194), and those who had not been ingesting food orally were referred to as the non-oral feeding group (n = 28). In the oral feeding group, 2 patients were receiving nutrition through a gastrostomy tube in addition to oral feeding, and the other patients were fully orally fed. In the non-oral feeding group, 26 patients were receiving nasogastric tube feeding and 2 patients were receiving intravenous nutrition. The results of the Kolmogorov-Smirnov test showed that the collected age and BMI data were normally distributed. In the comparison between the oral feeding group and the non-oral feeding group, there were significant differences in the causative disorder, the motor and cognitive FIM, occlusal contact, and oral cleaning assistance. Comparison of OHAT scores revealed that the oral feeding group scored significantly higher than the non-oral feeding group for lips, tongue, gums and tissues, saliva and dentures (Table 2).

Table 2 shows the results of the correlation analysis. Relatively high correlation coefficients were observed between FOIS, motor FIM, and cognitive FIM (FOIS-motor FIM: 0.650, FOIS-cognitive FIM: 0.577, motor FIM-cognitive FIM: 0.639). Although there were some pairs in which other scores showed significant correlations, the correlation coefficients were low, so these correlations were judged to be weak.

In the analysis for all subjects, univariable analysis results showed that age, cranial nerve disease, motor FIM, and cognitive FIM, occlusal contact, requirement for oral cleaning assistance, OHAT scores for lips, tongue, gums and tissues, saliva, and dentures were significantly associated with FOIS. When multiple regression analysis was performed using these as independent variables and FOIS as a dependent variable, there was also a significant effect on the regression equation (F (12, 221) = 23.618, P < 0.001), and the adjusted coefficient of determination was 0.530. The standardized partial regression coefficients of motor FIM, cognitive FIM, occlusal contact, saliva, and denture scores for OHAT were significant. Multicollinearity was not suspected from the tolerance and variance inflation factor values (Table 4).

In the analysis of the oral feeding group (except for the non-oral feeding group), univariable analysis results showed that age, cranial nerve disease, BMI, motor FIM, and cognitive FIM, requirement for oral cleaning assistance, OHAT scores for lips, tongue, gums and tissues, and saliva were significantly associated with FOIS. When multiple regression analysis was performed using these as independent variables and FOIS as a dependent variable, there was also a significant effect on the regression equation (F

Table 1

| Characteristics | All (n = 222) |
|-----------------|--------------|
| Age (mean ± SD) | 76.0 ± 11.9  |
| Sex (n, man / woman) | 108 / 114 |
| Causative disorder | |
| Cranial nerve disease (n) | 110 |
| Orthopedic disease (upper body) (n) | 39 |
| Orthopedic disease (lower body) (n) | 51 |
| Others (n) | 22 |
| BMI (mean ± SD) | 20.9 ± 4.1 |
| Motor FIM (median, IQR) | 43, 27.8-61.5 |
| Cognitive FIM (median, IQR) | 25, 15.0-28.3 |
| FOIS (n, 1 / 2 / 3 / 4 / 5 / 6 / 7) | 28 / 0 / 2 / 5 / 31 / 39 / 117 |
| Occlusal contact (n, presence / absence) | 164 / 58 |
| Oral cleaning assistance (n, with / without) | 117 / 105 |

BMI, body mass index; FIM, functional independence measure; FOIS, functional oral intake scale; OHAT, oral health assessment tool

Table 2

| Oral feeding (n = 194) | Non oral feeding (n = 28) | P |
|-----------------------|--------------------------|---|
| Age (mean ± SD) | 75.5 ± 12.1 | 79.9 ± 1.0 | 0.065 |
| Sex (n, man / woman) | 93 / 101 | 15 / 13 | 0.577 |
| Causative disorder | |
| Cranial nerve disease (n) | 88 | 22 | 0.005 |
| Orthopedic disease (upper body) (n) | 36 | 3 |
| Orthopedic disease (lower body) (n) | 51 | 0 |
| Others (n) | 19 | 3 |
| BMI (mean ± SD) | 21.0 ± 3.9 | 20.3 ± 5.6 | 0.149 |
| Motor FIM (median, IQR) | 49, 13 | 13, 13 | <0.001 |
| Cognitive FIM (median, IQR) | 24, 17 | 9, 5 | <0.001 |
| Occlusal contact (n, presence / absence) | 153 / 41 | 11 / 17 | <0.001 |
| Oral cleaning assistance (n, with / without) | 89 / 105 | 28 / 0 | <0.001 |
| OHAT | |
| Lips (n, 0 / 1 / 2) | 127 / 93 / 2 |
| Tongue (n, 0 / 1 / 2) | 91 / 130 / 1 |
| Gums and tissues (n, 0 / 1 / 2) | 30 / 142 / 50 |
| Saliva (n, 0 / 1 / 2) | 104 / 109 / 9 |
| Natural teeth (n, 0 / 1 / 2) | 78 / 98 / 46 |
| Dentures (n, 0 / 1 / 2) | 118 / 17 / 87 |
| Oral cleanliness (n, 0 / 1 / 2) | 37 / 124 / 61 |
| Dental pain (n, 0 / 1 / 2) | 185 / 24 / 13 |

BMI, body mass index; FIM, functional independence measure; FOIS, functional oral intake scale; OHAT, oral health assessment tool
Table 3  Correlation coefficients between FOIS, OHAT items and each parameter

| Variables | FOIS | Age | BMI | motor FIM | cognitive FIM | Lips | Tongue | Gums and tissues | Saliva | Natural teeth | Dentures | Oral cleanliness | Dental pain |
|-----------|------|-----|-----|----------|-------------|------|--------|------------------|--------|--------------|----------|----------------|------------|
| FOIS      | 1.00 |     |     |          |             |      |        |                  |        |              |          |                |            |
| Age       | 0.303** | 1.00 |     |          |             |      |        |                  |        |              |          |                |            |
| BMI       | 0.212* | −0.175* | 1.00 |          |             |      |        |                  |        |              |          |                |            |
| Motor FIM | 0.650* | −0.376* | 0.140* | 1.00      |             |      |        |                  |        |              |          |                |            |
| Cognitive FIM | 0.577* | −0.307* | 0.102 | 0.639* | 1.00      |      |        |                  |        |              |          |                |            |
| OHAT      |      |     |     |          |             |      |        |                  |        |              |          |                |            |
| Lips      | −0.312** | 0.197** | −0.019 | −0.346** | −0.290** | 1.00 |        |                  |        |              |          |                |            |
| Tongue    | −0.362** | 0.251** | −0.055 | −0.389** | −0.356** | 0.421** | 1.00 |        |                  |        |              |          |                |            |
| Gums and tissues | −0.281* | 0.062 | −0.021 | −0.216** | −0.212** | 0.273 | 0.128 | 1.00 |        |                  |        |              |          |                |            |
| Saliva    | −0.386* | 0.256* | −0.046 | −0.317** | −0.305** | 0.361* | 0.198* | 1.00 |        |                  |        |              |          |                |            |
| Natural teeth | −0.026 | −0.026 | 0.030 | −0.027 | −0.053 | 0.007 | 0.025 | 0.330* | 0.018 | 1.00 |        |          |                |            |
| Dentures  | −0.138* | 0.223** | −0.035 | −0.221** | −0.253** | 0.13^4 | 0.131 | 0.246** | 0.116 | 0.292* | 1.00 |        |          |                |            |
| Oral cleanliness | −0.059 | 0.017 | 0.033 | −0.077 | −0.175** | 0.172* | 0.178* | 0.241* | 0.159 | 0.224* | 0.046 | 1.00 |        |                |
| Dental pain | 0.063 | 0.022 | 0.035 | −0.005 | 0.049 | 0.053 | 0.030 | 0.129 | −0.058 | 0.253** | 0.182** | 0.091 | 1.00 |        |

*P < 0.05; **P < 0.01. FOIS, functional oral intake scale; OHAT, oral health assessment tool; BMI, body mass index; FIM, functional independence measure;

Table 4  Multivariate linear regression analysis for FOIS in all subjects (n = 222)

| Variables | Univariable analysis | Multivariable analysis | Collinearity statistics |
|-----------|----------------------|------------------------|------------------------|
|           | β | 95% CI | P  |           | β | 95% CI | P  | Tolerance | VIF |
| Age       | −0.222 | −0.058 - -0.015 | 0.001 | 0.067 | −0.006 - 0.028 | 0.199 | 0.799 | 1.252 |
| Man       | −0.023 | −0.613 - 0.435 | 0.738 | 0.063 | 0.001 - 0.107 | 0.040 | 0.442 | 2.263 |
| Cranial nerve disease | −0.294 | −1.660 - −0.658 | 0.001 | 0.091 | −0.097 - 0.091 | 0.273 | 0.442 | 1.860 |
| Motor FIM | 0.656 | 0.051 - 0.070 | 0.001 | 0.407 | 0.025 - 0.050 | 0.000 | 0.442 | 2.263 |
| Cognitive FIM | 0.565 | 0.102 - 0.151 | 0.001 | 0.152 | 0.003 - 0.064 | 0.030 | 0.442 | 2.264 |
| Occlusal contact (presence) | 0.316 | 0.851 - 1.983 | 0.001 | 0.212 | 0.453 - 1.445 | <0.001 | 0.685 | 1.460 |
| Oral cleaning assistance (with) | −0.476 | −2.343 - −1.420 | 0.001 | −0.095 | −0.840 - 0.086 | 0.110 | 0.602 | 1.660 |
| OHAT      |      |     |     |          |             |      |        |                  |        |              |          |                |            |
| Lips      | −0.308 | −1.669 - −0.699 | 0.001 | 0.011 | −0.067 - 0.045 | 0.035 | 0.722 | 1.384 |
| Tongue    | −0.221 | −1.764 - −0.771 | 0.001 | 0.011 | −0.067 - 0.045 | 0.035 | 0.722 | 1.384 |
| Gums and tissues | −0.287 | −1.378 - −0.532 | 0.001 | 0.011 | −0.067 - 0.045 | 0.035 | 0.722 | 1.384 |
| Saliva    | −0.412 | −1.841 - −1.005 | 0.001 | −0.167 | −0.940 - −0.205 | 0.002 | 0.732 | 1.367 |
| Natural teeth | 0.012 | −0.325 - 0.390 | 0.857 | 0.113 | 0.001 - 0.467 | 0.049 | 0.658 | 1.520 |
| Dentures  | −0.16 | −0.605 - −0.064 | 0.117 | 0.241 | 0.004 - 0.119 | 0.002 | 0.538 | 1.860 |
| Oral cleanliness | −0.04 | −0.519 - 0.280 | 0.555 | 0.267 | 0.012 - 0.048 | 0.001 | 0.520 | 1.924 |
| Dental pain | 0.029 | −0.381 - 0.590 | 0.672 | 0.029 | −0.381 - 0.590 | 0.672 | 0.029 | 1.924 |

FOIS, functional oral intake scale; BMI, body mass index; FIM, functional independence measure; OHAT, oral health assessment tool; β, standardized beta coefficient; CI, confidence interval; VIF, variance inflation factor

(10, 193) = 12.046, P < 0.001, and the adjusted coefficient of determination was 0.364. The standardized partial regression coefficients of cranial nerve disease, BMI, motor FIM, and cognitive FIM were significant. However, the standardized partial regression coefficients of the OHAT scores were not significant. Multicollinearity was not suspected from the tolerance and variance inflation factor values (Table 5).

Discussion

In this study, the relationship between oral intake level and oral health status was investigated. Comparison of the oral feeding and non-oral feeding groups revealed that lips, tongue, gums and tissues, saliva, and denture OHAT scores were significantly higher in the oral feeding group than the non-oral feeding group. Furthermore, multiple regression analysis showed...
that saliva and denture OHAT scores were independently associated with FOIS. However, the multiple regression analysis excluding non-oral feeding group did not show a significant association between FOIS and OHAT scores. Oral assessment is useful for standardizing oral care, which is effective in improving oral hygiene [21]. Oral assessment can also be a guide for referring patients for dental care. OHAT is a useful oral assessment because it can be used by any medical personnel, not just dentists. Additionally, it is suitable for convalescent hospitals because it can evaluate abnormalities in items that affect oral intake, such as dental pain and the condition of the natural teeth and dentures, which are not included in the OAG.

Ohno et al. investigated the relationship between oral feeding and oral health status using OAG [6], targeting patients in acute care hospitals. The majority of the subjects in the study were hospitalized for pneumonia. On the other hand, this study was conducted in a convalescent ward and about half of the subjects were patients with cerebrovascular disease. Despite different environments and different proportions of causative diseases, similarities were found between the results of the previous study and this study. Significant differences were found in the items of tongue and saliva scores. These findings suggest that dry mouth symptoms and associated oral mucosal abnormalities tend to occur in non-oral feeding patients in convalescent hospitals as well as in acute care hospitals.

In this study, the relationship between oral intake function and oral health status was examined. This has not been clarified in previous studies. Distinguishing between tube feeding and oral intake is not sufficient to assess oral intake function, because oral intake function is significantly different between those who eat a pureed food diet and those who eat a normal diet, even though both involve taking nutrition orally. The most commonly used scale for evaluating oral intake function is FOIS. Therefore, in this study, the relationship between FOIS and oral health status was examined. However, the effects of confounding factors must be considered when confirming this relationship. There are several confounding factors that may be associated with both oral intake function and oral health status [8-17]. Therefore, it was necessary to perform multiple regression analysis to adjust for these effects. The results of the multiple regression analysis for all subjects suggested that saliva and denture OHAT scores were independently associated with FOIS, even when the effects of these confounding factors were taken into account. This result may provide important evidence of the relationship between oral intake function and oral health status.

In the analysis excluding the non-oral feeding group, univariate analysis results showed that some OHAT items were significantly associated with FOIS, but multiple regression analysis results did not show a significant association. This was different from the results of multiple regression analysis for all subjects. These results suggest that significant differences in OHAT scores between the oral feeding group and non-oral feeding group significantly increase the correlation between FOIS and OHAT. Based on these findings, it was considered that the oral health status of inpatients in the convalescent ward may be strongly related to whether or not they are eating orally.

Patients who have difficulty ingesting orally may experience dryness of the oral cavity because they have fewer opportunities to stimulate and move the mouth. Additionally, patients with a nasogastric tube are prone to mouth breathing and oral dryness. Of the 26 patients in this study who were receiving nasogastric tube feeding, 24 had a dry mouth. On the other hand, poorly adapted dentures and reduced salivary flow are factors that inhibit bolus formation [22,23]. Therefore, it is necessary to take good care of oral health for non-oral feeding patients.

A study reported that oral health status was a significant independent factor for motor-FIM on discharge in convalescent rehabilitation wards [24]. Furthermore, recent research has indicated that poor oral health status can potentially cause physical frailty, sarcopenia, and subsequent requirement for long-term care [25]. These findings suggest that oral health status may have an influence on the physical functions of the whole body. The results of this study suggest that patients with low oral intake levels tend to have poor oral health. In such patients, it is important to take sufficient measures to improve oral health in cooperation with dentistry so that poor oral health does not hinder the recovery of swallowing or physical function.

This study has several limitations. First, it was conducted in only one hospital. Therefore, the research results may be influenced by the specificity of the hospital. Second, because this was a cross-sectional study, a causal relationship could not be determined. Therefore, additional studies are needed to examine the causal relationship between oral intake level and oral health status.

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Conflict of interest

None.

References

1. Scannapieco FA, Stewart EM, Mylotte JM (1992) Colonization of dental plaque by respiratory pathogens in medical intensive care patients. Critical Care Med 20, 1957-1960.
2. Yoneyama T, Yoshida M, Ohbue T, Mukaityama H, Okamoto H, Hoshiba K et al. (2002) Oral care reduces pneumonia in older patients in nursing homes. J Am Geriatr Soc 50, 430-433.
3. De Stefano F, Anda RF, Kahn HS, Williamson DF, Russell CM (1993) Dental disease and risk of coronary heart disease and mortality. BMJ 306, 688-691.
4. Mattila KJ (1993) Dental infections as a risk factor for acute myocardial infarction. Eur Heart J 14, 51-55.
5. Gras AJ, Buggle F, Ziegler C, Schwarz W, Meuser J, Tasman AJ et al. (1997) Association between acute cerebrovascular ischemia and chronic and recurrent infection. Stroke, 28, 1724-1729.
6. Ohno T, Heshiki Y, Kogure M, Sumi Y, Miura H (2017) Comparison of oral assessment results between non-oral and oral feeding patients: a preliminary study. J Gerontol Nurs 43, 23-28.
7. Jørgensen A, Berger AM, Petersen MC (1988) Development, testing, and application of the oral assessment guide. Oncology Nursing Forum 15, 325-330.
8. Van Lancker A, Verhaeghe S, Van Hecke A, Vanderkerken K, Geoonsens J, Beeckman D (2012) The association between malnutrition and oral health status in elderly in long-term care facilities: a systematic review. Int J Nurs Stud, 49, 1568-1581.
9. Takeuchi K, Aida J, Ik, K, Furuta M, Yamashita Y, Osaka K (2014) Nutritional status and dysphagia risk among community-dwelling frail older adults. J Nut Health Aging 18, 352-357.
10. Joshuura K (2002) The relationship between oral conditions and ischemic stroke and peripheral vascular disease. J Am Dent Assoc 133, 238-308.
11. Cohon DL, Rolfe C, Beaven J, Blackett B, Fairfield CA, Hamdy S et al. (2016) Post-stroke dysphagia: a review and design considerations for future trials. Int J Stroke 11, 399-411.
12. Alagiairishkam K, Bhanji RA, Kurian M (2013) Evaluation and management of oropharyngeal dysphagia in different types of dementia: a systematic review. Arch Gerontol Geriatr 56, 1-9.
13. Wu B, Fillenbaum GG, Plassman BL, Go L (2016) Association between oral health and cognitive status: a systematic review. J Am Geriatr Soc 64, 739-751.
14. Hunter RN, Clarkson IE, Fraser HW, MacWalker RS (2006) A preliminary investigation into tooth care, dental attendance and oral health related quality of life in adult stroke survivors in Tayside, Scotland. Gerodontology 23, 140-148.
15. Nakayama E, Tohara H, Hino T, Suiter M, Hiraba H, Abe K et al. (2014) The effects of ADL on recovery of swallowing function in stroke patients after acute phase. J Oral Rehabil 41, 904-911.
16. Hildebrandt GH, Dominguez BL, Schock MA, Loeche WJ (1997) Functional Units, chewing, swallowing, and food avoidance among the elderly. J Prosthet Dent 77, 585-595.
17. Tachibana M, Yoshida A, Ansu T, Takata Y, Akifusa S, Fukushima M et al. (2006) Prevalence of periodontopathic bacteria on the tongue dorsum of elderly people. Gerodontology 23, 123-126.
18. Chalmers JM, King PL, Spencer AJ, Wright FA, Carter KD (2005) The oral health assessment tool —validity and reliability. Aust Dent J 50, 191-199.
19. Cray MA, Mann GD, Groher ME (2005) Initial psychometric assessment of a functional oral intake scale for dysphagia in stroke patients. Arch Phys Med Rehabil 86, 1516-1520.
20. Hamilton BB, Laughlin JA, Fiedler RC, Granger CV (1994) Interater reliability of the 7-level functional independence measure (FIM). Scand J Rehabil Med 26, 115-119.
21. Ames NJ, Salima P, Yates JM, McCullah L, Collin SL, Soeken K et al. (2011) Effects of systematic oral care in critically ill patients: a multicenter study. Am J Crit Care 20, e103-114.
22. Walls AW, Steele JG (2004) The relationship between oral health and nutrition in older people. Mech Ageing Dev 125, 853-857.
23. Quandt SA, Savoca MR, Leng X, Chen H, Bell RA, Gilbert GH et al. (2011) Dry mouth and dietary quality in older adults in North Carolina. J Am Geriatr Soc 59, 439-445.
24. Shirasahi A, Yoshimura V, Wakabayashi T, Tsuchi Y (2017) Poor oral status is associated with rehabilitation outcome in older people. Geriatr Gerontol Int 17, 598-604.
25. Tanaka T, Takahashi K, Hirano K, Kikutani T, Watanabe Y, Ohara Y et al. (2018) Oral frailty as a risk factor for physical frailty and mortality in community-dwelling elderly. J Gerontol A Biol Sci Med Sci 73, 1661-1667.