Shimane J. Med. Sci., Vol.36 pp.41-48, 2019

The Relationship Between Oral Health-Related Quality of Life and Gastrointestinal Symptom-Related Quality of Life: A Cross-Sectional Study

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（Received August 30, 2019; Accepted October 1, 2019）

Decreased masticatory function may cause gastrointestinal symptoms, leading to appetite loss. This study aimed to elucidate the relationship between oral health status and gastrointestinal symptoms. Two hundred and fifty-six Japanese subjects completed a questionnaire including the General Oral Health Assessment Index and Izumo scale, as well as provided data regarding gender, age, body mass index, daily brushing frequency, denture use, presence of family dentist, dental visits in the past year, alcohol consumption, smoking status, and hours of sleep. Significant differences were found in terms of gender, age, brushing frequency per day, hours of sleep, and the Izumo scale（reflux, pain, fullness, constipation, diarrhea）. No significant differences in the other variables were found between the two groups. Multivariate analysis showed a significant correlation of the General Oral Health Assessment Index score with diarrhea.
Overall, poor oral health-related quality of life may increase the likelihood of experiencing diarrhea.

Key words: gastrointestinal symptoms, general oral health assessment index, Izumo scale, oral health-related quality of life

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BACKGROUND

In 2016, the Japanese Society of Gerodontology（JSG）, as the official representative of researchers and clinicians interested in geriatric dentistry in Japan, made several recommendations on the concept of “oral frailty, oral hypofunction, and oral dysfunction.” Oral frailty was defined as the preliminary phase of oral hypofunction（decreased articulation, slight choking/spillage while eating, and increase in unchewable foods）[1]. Oral hypofunction comprises seven items（poor oral hygiene, oral dryness, reduced occlusal force, decreased tongue-lip motor function, decreased tongue pressure, decreased masticatory function, and deterioration of swallowing function）. Oral dysfunction was defined as the next phase of oral hypofunction（eating/swallowing disorder and mastication disorder）. The JSG also described the criteria for making a diagnosis of oral hypofunction [1].

Recently, it has been revealed that a decrease in oral function is related to physical frailty. In a previous study, the three masticatory functions（maximum occlusal force, mixing ability, and self-reported chewing ability）were associated with pre-frailty or frailty [2, 3]. In addition, Tanaka *et al*. reported that oral frailty was one of the risk factors for physical frailty and mortality in community-dwelling elderly people [4]. Thus, oral function is considered to be related to sarcopenia, locomotive syndrome, and malnutrition [5, 6]. In particular, many researchers have reported a relationship between oral function and malnutrition. Van *et al*. systematically reviewed the association between malnutrition and

oral health status, indicating an independent association between the two [6, 7]. These previous studies of the malnutrition pathway have presumed that decreased masticatory function causes decreased dietary diversity and appetite loss [8, 9]. However, we disagree with this argument, and there is evidence to support our own argument. In this regard, Altenhoevel *et al*. reported that masticatory function impairment may lead to a higher incidence of digestive complaints [10]. Correspondingly, Mercier *et al*. reported that patients with masticatory disturbances, who were suffering from mandibular ridge atrophy, complained of digestive symptoms (abdominal pain, constipation, diarrhea, and stool transit abnormalities) and that these symptoms improved after jaw reconstruction [11].

Thus, we hypothesized that poor oral health status or decreased masticatory function may not directly cause decreased dietary diversity, but rather may be the indirect cause of it. In other words, decreased masticatory function may be the cause of gastrointestinal symptoms, which, in turn, cause appetite loss. Accordingly, the purpose of this study was to elucidate the relationship between oral health status and abdominal symptoms.

METHODS

The data for this cross-sectional study were obtained from Shimane University's mass oral cancer screening conducted on September 22, 2018. This ongoing mass oral cancer screening began in Izumo City, Shimane, Japan in 2013.

All of those who participated in the oral cancer screening were included in this study. Exclusions were made only on the basis of missing data.

This study was conducted with the approval of the Medical Ethics Committee of Shimane University (No. 3325).

Variables

A standardized questionnaire using the General Oral Health Assessment Index (GOHAI) and Izumo scale was administered to all participants. In addition, we obtained background data comprising gender (man/woman), age (years), body mass index as defined by the criteria using the weight/height2 formula, brushing frequency per day, use of dentures (yes/no), presence of family dentist (yes/no), dental visits in the past year (yes/no), alcohol consumption (never/social drinker/every day), smoking status (never/ever in lifetime), and hours of sleep.

GOHAI

The GOHAI, a Japanese version of an oral health status evaluation tool, was developed by Naito *et al*. and includes 12 items; each question has five response categories: (1 = always, 2 = often, 3 = sometimes, 4 = seldom, and 5 = never). The GOHAI is intended to evaluate three aspects of oral health-related quality of life (QOL): physical functioning, pain and discomfort, and psychosocial functioning. The GOHAI total score ranges from 12 to 60, with higher scores indicating a better self-reported oral health-related QOL. Using the national standard value of GOHAI as reported by Naito and colleagues [12], the sample was dichotomized into two groups (high or low GOHAI score).

Izumo scale

The Izumo scale, developed and validated by Furuta *et al*. [13], is a self-administered questionnaire designed to assess the effects of abdominal symptoms on QOL. It includes 15 items in five domains: heartburn (questions 1-3), gastralgia (questions 4-6), postprandial fullness (questions 7-9), constipation (questions 10-12), and diarrhea (questions 13-15) [14]. Each question is rated on a six-point Likert scale ranging from 0 to 5, with higher values indicating more severe symptoms. This scale has been shown to have good internal consistency and reproducibility, as well as good correlations with the visual analog scale of abdominal symptoms and the Gastrointestinal Symptom Rating Scale, and is thus widely utilized in Japan [15, 16].

Statistical analysis

The participant characteristics were summarized by descriptive statistics. Normality was evaluated by the Kolmogorov-Smirnov test. The GOHAI score was dichotomized into two groups (high or low score) using the national standard value [12]. Background factors in the two groups were analyzed using Fisher's exact test or the Mann-Whitney U test, as ap-

propriate. Next, the correlations between each variable and occurrence of abdominal symptoms were tested by multivariate logistic regression analysis (forced entry method). Statistical analysis was performed using SPSS (version 25; SPSS Japan Inc., Tokyo Japan). We calculated two-tailed P-values in all of the analyses. The alpha level of significance was set at 0.05.

RESULTS

Participant characteristics

The number of oral cancer screening participants totaled 360. Of this group, 268 participants obtained the informed consent were enrolled in this study. Another twelve respondents were then excluded because of missing data. Finally, 256 participants were registered as the study population (Fig. 1). The variables are summarized in Table 1.

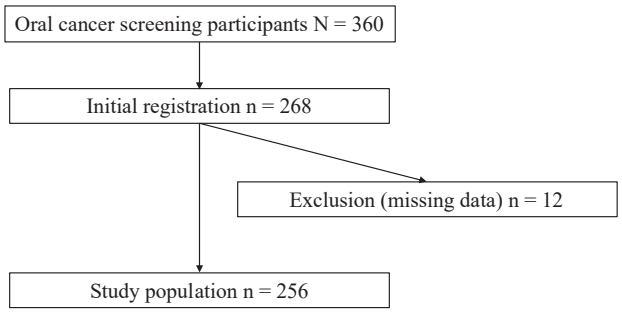

Fig. 1. Study flow diagram for the registration of participants

Univariate analysis

The variables in the high- and low-score groups are summarized in Table 2. Significant differences were found in terms of gender, age, brushing frequency per day, hours of sleep, and the Izumo scale (reflux, pain, fullness, constipation, and diarrhea). No significant differences in the other variables were found between the two groups.

Multivariate analysis

Multivariate analysis showed a significant correlation of the GOHAI score (high or low groups) with diarrhea (odds ratio 0.871, 95% confidence interval 0.769-0.986; Table 3).

DISCUSSION

The Izumo scale is a questionnaire used to comprehensively assess the QOL of patients with gastrointestinal symptoms such as functional gastrointestinal disorders (FGIDs). FGIDs are defined by symptoms originating in the thoracoabdominal region, whose cause cannot be identified by endoscopic or other examinations [13]. FGIDs comprise nonerosive reflux disease (NERD), functional dyspepsia (FD), and irritable bowel syndrome (IBS) [17]. A previous study reported that patients with NERD had more severely impaired daily activity and lower QOL scores than patients with erosive esophagitis [18]. In up to 80% of patients with dyspepsia who consult a physician in a hospital, the condition is classified as FD. Although not associated with increased mortality, FD is a burden at both the community and national levels because it can cause physical, mental, and social distress that can affect a patient's QOL [19]. In addition, investigators have reported that QOL scores (SF-36) in patients with IBS are significantly lower than scores in a general American population sample, a healthy European control population, and healthy American university students [17]. Thus, FGIDs impair QOL and activities of daily living.

The demographic data showed a similar distribution in the study population in terms of the prevalence of FGIDs. A previous study of the prevalence of gastroesophageal reflux disease (GERD), FD, and IBS, as well as their overlap rates, health-related QOL for each disease, and each overlap compared with healthy controls in the general Japanese population showed that out of 2680 eligible subjects, 207 (7.7%) were diagnosed with GERD, 269 (10.0%) with FD, and 381 (14.2%) with IBS [20]. The sample size of our study is one-tenth that of the previous study. Thus, we estimated that there were about 85 patients with FGIDs in our study and judged that the sample size was adequate.

Univariate analysis indicated that there were significant differences in terms of gender, age, brushing frequency per day, hours of sleep, and all subscales of the Izumo scale. FGIDs were impacted by gender, age, society, and the patient's perspective [21]. In addition, a previous study investigated the role

Table 1. Demographic characteristics of participants（N = 256）

Characteristics	N (%) or median (min-max)
Gender	
Men	85 (33.2)
Women	171 (66.8)
Age (years)	67 (17-93)
Body mass index	21.9 (11.7-33.8)
Brushing frequency per day	2.5 (1-5.5)
Use of dentures	
Yes	169 (66)
No	87 (44)
Presence of family dentist	
Yes	20 (7.8)
No	236 (92.2)
Dental visits in the past year	
Yes	197 (77)
No	59 (23)
Alcohol consumption	
Never	124 (48.4)
Social drinker	74 (28.9)
Every day	58 (22.7)
Smoking status	
Never	245 (95.7)
Ever in lifetime	11 (4.3)
Hours of sleep	6 (4-35)
GOHAI total score	52 (23-60)
Izumo scale	
Reflux	2 (0-10)
Pain	1 (0-12)
Fullness	1 (0-15)
Constipation	2 (0-15)
Diarrhea	2 (0-15)

Table 2. Characteristics of participants with high or low GOHAI scores

Characteristics	High score (n = 123)	Low score (n = 133)	*P*-value
	n (%) or median (min-max)		
Gender			
Men	52 (42.3)	33 (24.8)	0.003*
Women	71 (57.7)	100 (75.2)	
Age (years)	69 (34-93)	66 (17-87)	0.032*
Body mass index	21.9 (11.7-31.1)	21.8 (15.1-33.8)	0.207
Brushing frequency per day	2 (1-5.5)	3 (1-5)	0.003*
Use of dentures			
Yes	41 (33.3)	45 (33.8)	1.000
No	82 (66.7)	88 (66.2)	
Presence of family dentist			
Yes	112 (91.1)	125 (94)	0.352
No	11 (8.9)	8 (6)	
Dental visits in the past year			
Yes	91 (74)	106 (79.7)	0.301
No	32 (26)	27 (20.3)	
Alcohol consumption			
Never	62 (50.4)	62 (46.6)	0.443
Social drinker	31 (25.2)	43 (32.3)	
Every day	30 (24.4)	28 (21.1)	
Smoking status			
Never	116 (95.1)	129 (97)	0.528
Ever in lifetime	6 (4.9)	4 (3)	
Hours of sleep	6.5 (4-9)	6 (4-9)	0.042*
Izumo scale			
Reflux	1 (0-9)	2 (0-10)	<0.001*
Pain	0 (0-6)	2 (0-12)	<0.001*
Fullness	0 (0-15)	3 (0-12)	<0.001*
Constipation	1 (0-15)	3 (0-11)	<0.001*
Diarrhea	1 (0-15)	3 (0-15)	<0.001*

GOHAI, General Oral Health Assessment Index; *, significant difference

Table 3. Binomial logistic regression analysis between each variable and high or low GOHAI scores

Explanatory variable	Partial regression coefficient	Wald	OR (95% CI)	*P*-value
Gender	-0.536	3.143	0.585 (0.323-1.058)	0.076
Age	0.021	3.046	1.021(0.997-1.045)	0.081
Brushing frequency per day	-0.245	2.151	0.782(0.564-1.086)	0.142
Hours of sleep	-0.009	0.027	0.991(0.885-1.108)	0.869
Izumo scale				
Reflux	-0.057	0.590	0.944(0.815-1.093)	0.442
Pain	-0.140	2.326	0.869(0.726-1.041)	0.127
Fullness	-0.002	0.000	0.998(0.854-1.167)	0.985
Constipation	-0.095	1.946	0.910(0.797-1.039)	0.163
Diarrhea	-0.138	4.761	0.871(0.769-0.986)	0.029*
Constant	0.562	0.320	1.754	0.572

GOHAI, General Oral Health Assessment Index; OR, odds ratio; CI, confidence interval; *, significant difference

of sleep quality and psychosocial problems as predictors of FGIDs in doctors who work 24-hour on-call shifts. Consequently, poor sleep quality was a predictor of IBS [22]. Therefore, we considered that gender, age, and hours of sleep were confounding factors for the criterion variables. According to significant differences in brushing frequency per day, a high frequency of brushing significantly correlated to a high GOHAI score, a result that supported a previous study [23]. All the subscales of the Izumo scale were significantly different in comparing participants with high and low GOHAI scores. These results support the hypothesis that decreased masticatory function may be the cause of gastrointestinal symptoms. However, overlap of gastrointestinal symptoms, such as FGIDs, was found in 46.9% of the participants [20]. Therefore, multivariate analysis was needed in consideration of the interaction of each subscale of the Izumo scale (reflex, pain, fullness, constipation, and diarrhea).

Multivariate analysis showed that GOHAI scores (high or low groups) were significantly correlated with diarrhea only. Thus, we considered that significant differences (age, gender, brushing frequency per day, hours of sleep, and all subscales of the Izumo scale) in the univariate analysis were confounding factors and that a low GOHAI score was an independent factor related to the prevalence of diarrhea.

Our study has some limitations. First, we used participant data from the oral cancer screening. Thus, our analysis was influenced by selection bias. Second, although we adjusted for the confounding factor of denture use, other confounding factors, namely the number of remaining teeth and medical history of abdominal symptoms, were not adjusted for.

Diarrhea is described as three or more loose or watery stools a day. An infection commonly causes acute diarrhea, and noninfectious etiologies are more common as diarrhea becomes chronic. Abdullah *et al*. defined chronic diarrhea as the passage of loose stools that last for more than four weeks. In general, chronic diarrhea can be categorized into watery, fatty, and inflammatory diarrhea [24]. Overall, chronic diarrhea includes two types, infectious and non-infectious; supportive and pharmacological man-

agement are indicated for both kinds of etiologies. Pharmacological treatment can also be classified into two kinds, including symptomatic and causal treatment, which can be achieved through evidence-based therapy [24]. In our study, the details of the prevalence and character of diarrhea were unknown because our data were based on a patient-reported questionnaire. However, we will discuss possible explanations of why poor oral health-related QOL was significantly related to diarrhea.

Many earlier studies questioned whether the poor masticatory capabilities of partially or totally edentulous people correlated with a higher frequency of gastrointestinal disorders. However, the only criterion in previous studies for defining masticatory efficiency was often the presence of posterior teeth [25-27]. The current findings on how mastication influences the digestive process were obtained from a non-institutionalized elderly population that wears dental prostheses. Poor masticatory performance was associated with significantly lower intakes of dietary fiber and vitamin A [28]. In addition, Laurin *et al*. reported that the functional condition of dental prostheses was a main determinant of food selection, daily fiber intake, and the frequency of gastrointestinal disorders among completely edentulous older people [29]. More recent studies have also shown reduced vitamin and mineral levels in people with partial or complete dentures and reduced fiber intake [25]. There were significant differences in all subscales of the Izumo scale in univariate analysis; however, multivariate analysis indicated an independent association between oral health status and diarrhea only. A strength of our study is that it indicated a specific abdominal symptom (diarrhea). Therefore, we can propose that poor oral health status-related diarrhea may be one of the factors contributing to physical frailty. First, oral frailty (decreased articulation, slight choking/spillage while eating, and increases in the number of unchewable foods) causes decreased diversity of food intake [8, 9]. Second, decreased dietary diversity is associated with significantly lower intakes of dietary fiber and vitamin A [28]. Third, lower intake of dietary fiber and vitamin A causes diarrhea [28]. Fourth, diarrhea causes electrolyte imbalance (dehydration, hypokalemia) and accelerates physical frailty. However, not all of these points have yet been proven. Thus, further studies are needed to prove the correlation between oral health and diarrhea. In the future, randomized controlled trials in which patients with diarrhea receive dental treatment are needed; dental treatment may be a strategy for treating diarrhea.

CONCLUSIONS

A low score on oral health-related quality of life may increase the incidence of diarrhea.

ABBREVIATIONS

FGIDs: Functional gastrointestinal disorders
FD: Functional dyspepsia
GERD: Gastroesophageal reflux disease
GOHAI: General Oral Health Assessment Index
IBS: Irritable bowel syndrome
JSG: Japanese Society of Gerodontology
NERD: Nonerosive reflux disease
QOL: Quality of life

DECLARATIONS

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted with the approval of the Medical Ethics Committee of Shimane University (No. 3325).

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIAL

It is impossible to share research data publicly, because individual privacy could be compromised.

COMPETING INTERESTS

The authors declare that they have no competing interests.

FUNDING

None.

AUTHORS' CONTRIBUTIONS

All ten authors (YM, TK, MK, TK, IK, SO, RO, HT, YN, and KH) were involved in the study design and analysis of the participants' data. All authors read and approved the final manuscript.

ACKNOWLEDMENTS

The authors thank all of the respondents who participated in this study. We express our appreciation to all staff members of the Shimane University Department of Oral and Maxillofacial Surgery for their assistance and support.

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