Oral symptoms and oral hygiene behaviors among patients with type 2 diabetes at a hospital in Japan: A Cross-Sectional Study

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ABSTRACT

Objectives: Effective daily oral hygiene behavior will prevent periodontal disease. This study aimed to examine the oral symptoms, oral hygiene behaviors, and factors contributing to oral hygiene behaviors among patients with type 2 diabetes in a hospital in Japan.

Methods: A cross-sectional survey was conducted with 198 patients with type 2 diabetes. Oral symptoms were assessed using a dichotomous scale based on clinical guidelines. Oral hygiene behaviors were assessed based on the frequency of daily tooth brushing and the use of interdental cleaning aids. Chi-square tests and logistic regression analyses were also performed.

Results: Overall, 71.2% of the participants had oral symptoms. Of the participants, 80.3% performed twice daily tooth brushing and 61.1% did not perform interdental cleaning on a daily basis. Logistic regression analysis revealed that tooth brushing behavior was negatively associated with male patients (odds ratio [OR] = 0.45, 95% confidence interval [CI]: 0.25–0.80), difficulty with mastication (OR = 0.63, CI: 0.43–0.92), and tooth loss (OR = 0.68, CI: 0.46–1.00) and positively associated with periodontal disease (OR = 1.73, CI: 1.10–2.72). There were no significant variables related to the use of interdental cleaning aids.

Conclusions: Patients need to learn about the necessity for regular oral hygiene behaviors and the appropriate way. In particular, support for male patients, those who have difficulty with mastication, those who have experienced natural tooth loss, and those who have not been diagnosed with periodontal disease are needed.

Keywords: periodontal disease, dental hygiene process of care, tooth loss, interdental brush, interdental devices

1. INTRODUCTION

Diabetes mellitus is a group of metabolic disorders with high mortality and morbidity associated with complications such as neuropathy, retinopathy, nephropathy, cardiovascular disease, and stroke.[1] Diabetes has a rapidly increasing prevalence worldwide.[2] In 2019, 19.7% of males and 10.8% of females in Japan were strongly suspected of having diabetes. The prevalence of diabetes also increases markedly with age, with 1 in 6 adults aged ≥20 years affected by diabetes, approximately 95% of them affected by type 2 diabetes.[3,4] Long-term complications of diabetes mellitus have a profound impact on quality of life and mortality in patients.[1] Thus, it is important to prevent these complications. Moreover, periodontal disease has been recognized as one of the serious complications of diabetes mellitus.[5] Periodontal disease is an infection that can cause tooth loss from damaged gum tissue and bone decay.[5] Japan has one of the highest rates of tooth loss caused due to periodontal diseases.[6] In 2014, more than 3 million Japanese people were diagnosed with periodontal disease, and the number of patients has continued to increase.[7,8]

There is some evidence of a reciprocal adverse relationship between diabetes and periodontal disease.[9] A longitudinal study has shown that patients with type 2 diabetes have a 2.6 times higher incidence of periodontal disease than those without diabetes.[10]

Other studies have suggested that periodontal disease can cause chronic inflammation that increases insulin resistance[11] and tooth loss. It also reducing chewing ability that leads to poor nutrition and thereby potentially worsening blood glucose control.[12] Moreover, periodontal diseases have adverse effects on other diabetic complications such as cardiovascular disease and nephropathy.[13] Regarding the effects of periodontal treatment on glycemic control, Grossi et al. (1997) reported that periodontal treatment improves glycated hemoglobin in patients with diabetes.[14] Simpson et al. (2010) showed that glycated hemoglobin decreases by 0.40% after 3–4 months of periodontal treatment.[15] The risk of developing periodontal disease can be reduced by careful and effective daily tooth brushing. Twice daily brushing is more effective than once daily to control plaque formation and interdental brush is also an important component of it.[16, 17] Hence, the World Health Organization and the International Diabetes Federation recommend periodontal treatment such as oral self-care for patients with diabetes.[2,18]

Generally, people are unlikely to be aware of changes occurring in the periodontium, and only visit a dentist in case of pain.[19] People who are able to access preventive care through regular dental checkups have their periodontal health assessed and maintained by dentists. However, patients with diabetes tend to have a poor attitude toward oral health behavior compared with the general population.[20,21] A previous study reported that 17.0%

of patients with diabetes performed tooth brushing twice a day and 61.0% did not use interdental cleaning aids.[22] In Japan, 44.6% of the 5,721 outpatients at medical facilities with a diabetes care specialist performed tooth brushing twice a day and 62.9% of outpatients had not been using interdental cleaning aids.[23] Furthermore, 56.5% of patients with diabetes do not undergo regular dental checkups, which imposes a risk of leaving oral problems unattended.[23] Therefore, educational support and advice from medical professionals at medical facilities are necessary to promote oral self-care in patients with diabetes.[24]

Oral management is ideally performed by dental specialists in hospitals that have a dentistry department or unit. However, hospitals without a dentistry department or unit often rely on nurses.[25] Approximately 70% of the general hospitals in Japan do not have a dentistry department or unit,[26] and oral management for preventing periodontal disease may be insufficient. A study reported that 68.2% of patients with type 2 diabetes did not undergo regular dental checkups during the preceding year at a hospital without a dentistry department or unit.[27] Hence, patient education about daily oral self-care for the prevention of periodontal disease should be performed not only in dentistry but also in general medical care. To the best of our knowledge, the oral symptoms, oral hygiene behavior, and factors contributing to oral hygiene behavior among outpatients with type

2 diabetes have not been well examined in Japan. Therefore, the aim this study is to evaluate the oral symptoms, oral hygiene behaviors and factors contributing to oral hygiene among patients with type 2 diabetes at a general hospital in Japan.

2. STUDY POPULATION AND METHODOLOGY

2.1 Study Design

A cross-sectional survey was conducted at a 325-bed general hospital without a dentistry department in the second medical area of the Kanto region of Japan.

2.2 Study Participants

The details on the inclusion and exclusion criteria are presented in Figure 1. Patients with type 2 diabetes who were aged 20 years or older and had natural teeth were included in the study. Patients who were unwilling to participate or those who were judged by a physician to be unable to complete the questionnaire because of mental or physical illness were excluded. Data from one person who refused to participate in the study following the questionnaire collection and one person who did not provide valid responses were also excluded. A total of 198 participants were included. The participants were recruited between August and October 2017.

2.3 Components of the questionnaire

Participants' background information, frequency of tooth brushing daily, and frequency of use of interdental cleaning aid were assessed using a self-report questionnaire developed for the study. With reference to Shyjälä et al. (1999), Shyjälä et al. (2004) and Cinar et al. (2012), the oral hygiene behavior was defined as the frequency of tooth brushing daily and the frequency of use of interdental cleaning aids.[28,29,30] The content validity of the questionnaire was confirmed through consultation with five medical professionals, namely, a dentist, a diabetologist, an experienced physician who had engaged in diabetes medical practice for more than 10 years, and two nurses who were certified diabetes educators in Japan. We conducted a pilot test with four patients who were eligible for inclusion in the study. The questionnaire comprised the following sections:

2.4 Characteristics of participants

The participants' background information included sex, age, work, education level (<12 years, 12 years, >12 years), body mass index, smoking status, diagnosis of periodontal disease, family history of diabetes, patients' experience of diabetes education,

and oral symptoms. Information regarding work, smoking status, diagnosis of periodontal disease, family history of diabetes, patients' experience of diabetes education, and oral symptoms was assessed using a dichotomous scale (1 = yes, 0 = no).

2.5 Frequency of tooth brushing daily and frequency of use of interdental cleaning aids.

The frequency of tooth brushing daily and the frequency of use of interdental cleaning aids were assessed using an ordinal scale ranging from 1 (not on a daily basis) to 5 (four or more times a day).

2.6 Clinical data

Clinical data, including glycated hemoglobin (HbA1c) level, and diagnosis of comorbidities, such as hypertension and dyslipidemia, were obtained from medical records. The hypertension and the dyslipidemia were assessed using a dichotomous scale (1 = yes, 0 = no).

2.7 Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics 26.0 (Chicago, IL, USA). Descriptive statistics were calculated for all measured variables. To examine the

contributing factors that influenced oral hygiene behavior among patients with type 2 diabetes, we first examined the relationship between oral symptoms and tooth brushing behavior, and the relationship between oral symptoms and the status of use of interdental cleaning aids by using the chi-square test. Second, we examined the contributing factors that influenced tooth brushing behavior using a multiple logistic regression analysis model. Regarding oral symptoms, we used explanatory variables that were significant in the chi-square test. It has been reported that the risk of progression of periodontal disease reduces by careful and effective tooth brushing and daily tooth brushing at least twice a day.[23] Thus, the dependent variables were transformed from continuous to binomial as "0 (Daily tooth brushing; <2 times)" was considered as the minimum score of factors and "1" for the others in this study. The level of significance was set at a p-value of <.05, and all p-values were based on two-sided tests. We excluded patient with missing values from all the analyses.

2.8 Ethics Considerations

The study protocol was approved by the institutional review boards of Hospital A and the University of Tsukuba (no. 1208). Written informed consent was obtained from all participants.

3. RESULTS

The characteristics of the participants are presented in Table 1. More than 70% of participants had oral symptoms. More than 80% of the participants performed tooth brushing twice daily, and 61.1% did not perform interdental cleaning on a daily basis. The participants diagnosed with a periodontal disease by a dentist were more likely to perform tooth brushes twice daily compared with those who were not diagnosed with periodontal disease (87.5% vs. 75.4%; $p = 0.036$). The first group also performed interdental cleaning on a daily basis (47.5% vs. 32.5%; $p = 0.033$). Moreover, the participants who had difficulty with mastication were more likely to brush their teeth twice daily compared with those who did not have difficulty with mastication (82.8% vs. 52.9%; $p = 0.003$). The participants who did not have an oral malodor tended to perform tooth brushes twice daily compared with those who had been informed of their oral malodor by others (82.4% vs. 63.6%; $p = 0.037$). Furthermore, the participants who performed tooth brushing twice daily tended not to experience natural tooth loss compared with those who did not perform tooth brushing twice daily (84.2% vs. 60.6%; $p = 0.002$); however, with respect to the number of times of daily brushing, other oral complications were not statistically significant.

There were no significant variables in the model regarding the use of interdental cleaning aids.

The results of the multiple logistic regression models of tooth brushing behavior among patients with type 2 diabetes are shown in Table 2. Among the participants, males were less likely to perform tooth brushing twice daily (odds ratio [OR] = 0.45; 95% confidence interval [CI], 0.25–0.80); those with periodontal disease were more likely to perform tooth brushing twice daily (OR = 1.73; CI, 1.10–2.72). Meanwhile, the participants who had difficulty with mastication (OR = 0.64; CI, 0.43–0.95) and those who experienced natural tooth loss (OR = 0.64; CI, 0.43–0.95) tended not to perform tooth brushing above twice daily.

4. DISCUSSION

While more than 80% of the participants in this study performed tooth brushing above twice daily, 71.2% of those had some oral symptoms related to periodontal disease. Previous studies reveal that more than twice daily tooth brushing is important to prevent periodontal disease.[23] Moreover, recent study reported that 68.2% of patients with type 2 diabetes did not undergo regular dental checkups during the preceding year at a hospital with a dentistry department or unit.[26] This result suggests that the participants of this study

might have been performing ineffective tooth brushing without receiving guidance from the dentist. Additionally, one previous study reported that the frequency of interdental cleaning was significantly associated with decreased periodontal disease, and the number of teeth present.[31] Patients with a low interdental cleaning frequency were more likely to have severe periodontal disease than those with a high cleaning frequency.[31] Establishing regular oral hygiene behavior may help in the prevention of periodontal disease.[32] Therefore, it is important to educate patients regarding the need for regular oral hygiene behaviors to prevent periodontal disease and the correct methods to perform oral hygiene effectively.

The present results showed that diabetes patients with a diagnosis of periodontal disease were more likely to perform toothbrush and interdental cleaning more frequently than those without a diagnosis of periodontal disease. The present results suggest that a diagnosis of periodontal disease by a dentist might promote daily oral self-care in patients with type 2 diabetes. Hence, assisting patients in learning about the necessity of having regular dental checkups in addition to daily oral self-care to maintain oral health may also be required.

Moreover, participants who had difficulty with mastication tended to brush their teeth more frequently than those who did not have difficulty with mastication. In addition, the

present results showed that the participants who brushed their teeth twice daily tended not to have been pointed to the oral malodor and not to experience natural tooth loss than those who did not brush their teeth twice daily. A recent study reported that people who performed tooth brushing, used interdental cleaning aids, and had regular dental checkups had a lower risk of tooth loss.[33] Moreover, the risk of tooth loss was lower with tooth brushing and interdental cleaning aids than with tooth brushing only.[33] Therefore, the removal of dental plaque through routine oral self-care using a toothbrush and interdental cleaning aid is required to manage periodontal disease.

Oral symptoms such as gingival bleeding, gingival erythema, and edema were not statistically significant with tooth brushing behavior. Asymptomatic features of periodontal disease in the early stages can prevent patients from becoming aware of their periodontal disease and prevent patients from seeking treatment until it becomes serious.[12,19] Accordingly, patients should be educated to be aware of the symptoms caused by periodontal diseases and prevent the diseases through daily oral self-care. Furthermore, educational interventions such as these should be prepared in hospitals for outpatients with diabetes.

There were no significant variables in this study regarding the use of interdental cleaning aids. This result indicates that further studies are required to explore the factors

affecting the use of interdental cleaning aids.

In the present study, male patients were more likely to perform tooth brushing less frequently than female patients. Previous studies report that females were more likely to adopt self-care behavior and tended to maintain a constant lifestyle pattern as they grew older, starting in their 30s.[34] Another study showed that sex differences in oral hygiene behavior aligned with similar trends in health behaviors such as sleep and dietary regularity, and tooth brushing habits were significantly higher in females than in males.[35] This might explain the significant effect of sex in this study's results.

The participants with a diagnosis of periodontal disease were more likely to brush their teeth twice daily. Meanwhile, the participants with difficulty with mastication and those with natural tooth loss tended to brush less than twice daily. Patients with diabetes have more than twice the risk of tooth loss due to periodontal disease than those without diabetes.[20] However, patients with diabetes have little knowledge of oral health, and many patients are unaware of the relationship between diabetes and periodontal disease.[20,21] Thus, patients lack an attitude toward oral health.[11,21] This may be explained by the fact that the participants in this study tended not to perform tooth brushing behavior regardless of having difficulty with mastication and tooth loss. A previous study indicated that patients are unaware of the relationship between periodontal disease and diabetes because

medical providers do not provide information regarding it.[36] Therefore, it is essential to provide accurate knowledge regarding oral self-care in hospitals so that diabetic patients can be aware of these relationships, and they can perform proper oral hygiene behaviors.

Our results suggest that when promoting daily oral self-care, it is important to support the education of patients to understand the need for regular oral hygiene behaviors to prevent periodontal disease and be able to perform it effectively. In particular, the present results showed that support for male patients, those who have difficulty with mastication, those who have experienced natural tooth loss, and those who have not been diagnosed with periodontal disease may be needed to promote tooth brushing behavior in patients with type 2 diabetes.

A recent study reported the effect of patient education on oral management.[37] However, more than 70% of the nurses did not practice adequate oral management at an outpatient department specialized in diabetes care in hospitals.[38] The nurses could increase patients' interest in their oral conditions as part of diabetes management during diabetes consultations. Therefore, enhancing the process of care by nurses may contribute to the facilitation of oral management for patients with diabetes in hospitals, improve nursing quality in oral care, and promote medical–dental collaboration. In other words, the enrichment of education for nurses about oral management as part of diabetes

management is an urgent issue for promoting patient education for oral self-care in patients with diabetes. In the future, educational support for nurses and the creation of a diabetes oral self-care manual for nurses may be important for promoting patient education in hospitals without a dentistry department.

This study has limitations. First, it was conducted in a single hospital, and the participant selection was highly selective. For example, the proportion of participants who had smoked was higher than that observed in the National Health and Nutrition Survey conducted in Japan in 2016 and the Japan Medical Association Diabetes Database of Clinical Medicine in 2018.[3,39] Further studies should collect data in a more representative manner. Second, the cross-sectional design of the study prevented the examination of causal relations with respect to oral symptoms, contribution factors, and oral hygiene behavior. Prospective studies are required to confirm these findings. Despite these limitations, the present results are novel because there are no studies in Japan that have investigated the relationship between oral symptoms and oral hygiene behaviors.

5. CONCLUSION

Patients need to learn about the necessity for regular oral hygiene behaviors and to be able to perform them appropriately. In particular, support for male patients, those who

have difficulty with mastication, those who have experienced natural tooth loss, and those who have not been diagnosed with periodontal disease are needed.

6. CLINICAL RELEVANCE

6.1 Scientific rationale for the study

There are insufficient data regarding oral symptoms and oral health behavior among outpatients with type 2 diabetes.

6.2 Principal findings

Tooth brushing behavior was negatively associated with male patients, patients who had difficulty with mastication, and those who experienced natural tooth loss, and positively associated with a diagnosis of periodontal disease.

6.3 Practical implications

The smoking status and dyslipidemia of the participants in the present study were not significantly associated with tooth brushing behavior and the results were not as expected. Therefore, further studies are required to collect data regarding these variables.

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Figure 1. The details on the inclusion and exclusion criteria

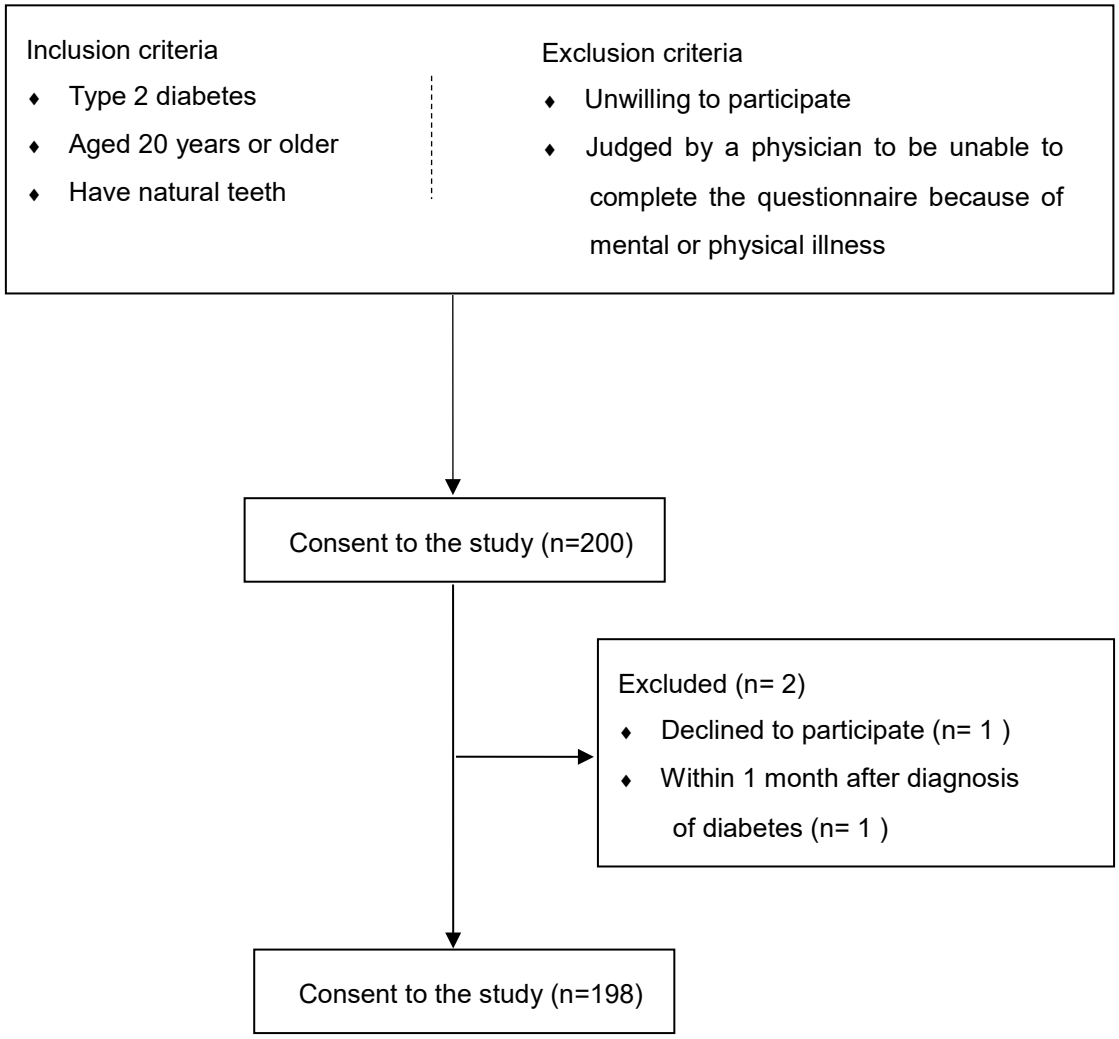

Table 1. Characteristics of participants

Male	112(56.6%)
Age (yrs.)	66.1 ± 10.1
Work	93 (47.0%)
Education level	
<12 years	51 (25.8%)
12 years	100 (50.5%)
>12 years	47 (23.7%)
Body mass index (kg/m^2)	24.3 ±4.0
Smoke	99 (50.0%)
HbA1c (%)	7.3 ±1.0
Hypertension	86 (43.4%)
Dislipidemia	87 (43.9%)
Periodontal disease	80 (40.4%)
Family history of diabetes	105 (53.0%)
Diabetes education	163 (82.3%)
Oral symptoms	141 (71.2%)
Gingival breeding	27 (13.6%)
Gingival erythema and edema	21 (10.6%)
Tooth mobility	31 (15.7%)
Difficulty with mastication	17 (8.6%)
Oral malodor	22 (11.1%)
Sharp pain when eating hot or cool food	32 (16.2%)
Food impaction	87 (43.9%)
Tooth loss naturally	33 (16.7%)
Tooth brushing (times/day)	
Not on a daily basis	1 (0.5%)
Once a day	38 (19.2%)
Twice a day	97 (49.0%)
Three times a day	51 (25.8%)
Four or more times a day	11 (5.5%)
Interdental cleaning (times/day)	
Not on a daily basis	121 (61.1%)
Once a day	30 (15.2%)

Twice a day	26 (13.1%)
Three times a day	17 (8.6%)
Four or more times a day	3 (1.5%)
No answer	1 (0.5%)

N = 198. n (%) or mean ± standard deviation.

Table 2. Multiple logistic regression models of the tooth brushing behavior among patients with type 2 diabetes

		OR	95% CI
Sex	Female/Male	**0.45**	**[0.25–0.80]**
Age		0.99	[0.59–1.68]
Work	Yes/No	0.75	[0.44–1.29]
Education level†	1, 2, 3	1.13	[0.75–1.69]
Body mass index		0.73	[0.44–1.21]
Smoke	Yes/No	1.05	[0.65–1.70]
HbA1c (%)		1.15	[0.73–1.82]
Hypertension	Yes/No	1.21	[0.78–1.89]
Dyslipidemia	Yes/No	1.26	[0.83–1.91]
Family history of diabetes	Yes/No	0.96	[0.62–1.48]
Diabetes education	Yes/No	1.24	[0.83–1.84]
Periodontal disease	Yes/No	**1.73**	**[1.10–2.72]**
Difficulty with mastication	Yes/No	**0.63**	**[0.43–0.92]**
Oral malodor	Yes/No	0.79	[0.53–1.17]
Tooth loss naturally	Yes/No	**0.68**	**[0.46–1.00]**
Nagelkerke R-square		0.30	
Hosmer-Lemeshow goodness of fit		$\chi^2(8) = 8.10$, p = 0.42	

PD: periodontal disease. OR: odds ratio. CI: confidence interval.

† 1: <12 years, 2: 12 years, 3: >12 years.

Dependent variables were transformed from continuous to binomial as "0 (daily tooth brushing; <2 times)" was considered minimum score of factors and "1" for the others