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ORIGINAL

Oral health conditions and swallowing in patients with Parkinson's disease

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ABSTRACT

Objective: The purpose of the present study was to investigate oral health conditions, oral health behavior, and swallowing among patients with Parkinson's disease (PD) in Hokkaido, Japan.

Materials and methods: We investigated 223 PD patients in the Kushiro area of Hokkaido, Japan by mail in 2020. From 112 respondents, we used 71 PD patients from 50 to 79 years old as cases. Four hundred and forty-three persons over 40 years of age underwent dental examinations conducted by Kushiro city from 2018 to 2019. We retrospectively selected 141 persons from 50 to 79 years old as control. Controls were matched to cases for sex and age. We compared oral health conditions and related factors between 71 PD patients and 141 controls. The logistic regression model was used for adjusting for sex and age. We also conducted stratified analysis by sex while adjusting for age using this model.

Results: Compared with the controls, PD patients had more complaints of chewing difficulties, gingival bleeding, annoying teeth alignment, food impaction, swollen gums or mucosa and tooth movement. Among PD patients, 66.2% had problems with swallowing.

Conclusion: We found that PD patients had more complaints about oral health and troubles with swallowing.

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Key words: oral health, Parkinson's disease, health behavior, dysphagia

Introduction

Parkinson's disease (PD) is a progressive, disabling neurodegenerative disorder that is characterized by tremor, bradykinesia, muscle rigidity, postural instability[1]. In addition, there are no established medical treatments to completely cure PD because the etiologies remain largely unknown. These symptoms can lead to problems in maintaining oral health and an inability to swallow which can then negatively affect the patient's quality of life. In the older people with dysphagia, dental disease and/or poor oral hygiene have been shown to have a high incidence of aspiration pneumonia[2, 3], which often leads to death in patients with PD[4, 5]. Therefore, it is important for patients with PD to maintain good oral hygiene.

However, their dental status is ultimately unknown. Persson et al[6] reported that in PD patients, there was a large number of remaining teeth, and the decayed tooth count was lower compared with controls. On the other hand, several studies outside Japan reported that the dental status of the PD patients was poorer than that of the controls[7-11]. Lyra et al.[7] reported that severe tooth loss was prevalent among PD patients. Woo et al.[8] reported that the number of tooth loss was positively related to an increased risk of new-onset PD by cohort study. As far as we know, there were four surveys of the dental status of PD patients in Japan[3, 12-14]. Fukayo et al.[12] reported that the oral health of PD outpatients with mild symptoms was better than the controls. Hanaoka et al.[13] reported patients with PD had fewer remaining teeth, more

caries and a higher incidence of deep periodontal pockets. In our investigations of the oral health conditions of PD patients in the Okhotsk area of Hokkaido Prefecture in 2000 and in the eastern Iburi area of Hokkaido in 2013, patients with PD had more complaints and fewer remaining teeth than the controls[3, 14]. Accordingly, the findings in Japan were not consistent regarding the dental status of PD patients[3, 12-14]. These reasons may be due to the difference in oral health behaviors among the different regions. In Japan, further studies of PD which include the data of oral health behaviors are needed in several different regions.

The symptoms of PD patients such as bradykinesia, muscle rigidity and postural instability make it difficult to perform daily oral hygiene by themselves. PD patients may be a higher-risk group for caries, periodontal disease, and swallowing dysfunction than the general population. The purpose of the present study was to investigate the oral health conditions, oral health behaviors, and swallowing abilities of patients with PD in Hokkaido, Japan.

Methods

Participants

The design of this study is a case-control study analyzing PD patients as cases and members of community residents as control.

In Japan, patients with PD can receive public financial aid from the government if their disease stage according to Hoehn and Yahr, is from Ⅲ to Ⅴ. The eligible study cases that participated in this research were all drawn from the 223 patients with PD who had received public financial aid in the Kushiro area (one city, six towns and one village) in 2020. Kushiro is located in the eastern part of Hokkaido, the northernmost island of Japan. The population of the Kushiro area was 225,807 persons. One hundred and twelve PD patients responded (response rate: 50.2%). We used 71 PD patients from 50 to 79 years old as cases.

From April 2018 to December 2019, 443 persons over 40 years of age underwent dental examination conducted by Kushiro city. Dentists from the dental clinics in Kushiro city examined the teeth and the participants completed the self-administrated questionnaires by themselves on the day of the dental examination. We retrospectively selected 141 persons from 50 to 79 years old as controls. Controls were matched to cases for sex and age. The distribution of the age and sex in the 71 cases with PD and 141 controls are shown in Table1. The mean age of the 71 cases was 70.6 (standard deviation 6.3); there were 34 males (mean age 69.4, standard deviation SD 6.7) and 37 females (mean age 71.7, standard deviation 5.7). The mean age of 141 controls was 65.4 (standard deviation 6.9); there were 66 males (mean age 64.2, standard deviation 7.8) and 75 females (mean age 66.4, standard deviation 5.8). Written informed consent was obtained from all participants. This survey was approved by the Ethical Committee of Sapporo Medical University on August 13, 2020.

Method of survey

During the period spanning from September through October in 2020, we investigated the patients with PD by mail. An original structured questionnaire, which was almost the same as the one used in the dental examination in Kushiro city was employed for survey for PD patients. Common questions in the survey for patients and controls inquired about dental status, oral complaints, and oral health behavior. Question items for all cases and controls included wearing dentures, bad breath, sliminess of the mouth, chewing difficulties, swollen gums or mucosa, having a dental examination regularly, the presence of a family dentist, drinking alcohol habit, and smoking history. Individuals who still had their own teeth were asked about toothache, gingival bleeding, annoying teeth alignment, food impaction, tooth movement, tooth brushing, and whether they were using a fluoride toothpaste, an interdental brush, or a dental floss. Those for individuals with dentures involved denture discomfort, cleaning dentures, and storing their dentures correctly before sleeping. In addition, the presence of their own teeth and troubles with swallowing (spilling one's food from the mouth, choking on food or beverage, coughing during eating or drinking, feeling as if a lump of food is stuck in one's throat, producing sputum during a meal) were surveyed among the PD patients. We obtained data on the presence of their own teeth among controls from the dental examination in Kushiro city.

Analyses

We used the logistic regression model to assess the difference in oral complaints, oral health behaviors, and dental status between the case group and the control group. In the analysis of oral health behavior, age and sex were included in the model as confounding factors, and in the analysis of dental status and oral complaints, history of smoking status was further included in the model. The adjusted odds ratio (OR) and its 95% confidence interval (CI) for oral health in PD patients were estimated. We also conducted stratified analysis by sex using this model. Tests of statistical significance were based on a two-sided p-value, and the α-error was set at 5%.

Regarding some variables that we could not calculate by logistic regression, we used exact logistic regression. Regarding comparison for distribution of the age and sex between cases and controls, we used Fisher's exact test.

The SAS system (ver.9.4; SAS Institute, Cary, NC, USA) was employed for the analysis.

Results

Results from a case-control study

Table 2 shows the results from the logistic regression analyses of oral health in PD patients and controls.

In total participants, regarding dental status and oral complaints, complaints of gingival bleeding, chewing difficulties, annoying teeth alignment, food impaction, swollen gums or mucosa, and tooth movement were significantly associated with PD after adjustment for age, sex and a history of smoking. As for oral health behaviors, not using a fluoride toothpaste, not drinking alcohol and not having a history of smoking were significantly associated with PD after adjustment for age and sex.

In male participants, regarding dental status and oral complaints, complaints of chewing difficulties, food impaction, and tooth movement were significantly associated with PD after adjustment for age and a history of smoking. As for oral health behaviors, not using a fluoride toothpaste, having own family dentists, not drinking alcohol, and not having a history of smoking were significantly associated with PD after adjustment for age.

In female participants, regarding dental status and oral complaints, wearing denture, complaints of gingival bleeding, chewing difficulties, annoying teeth alignment, food impaction, and swollen gums or mucosa were significantly associated with PD after adjustment for age and a history of smoking. As for oral health behaviors, brushing teeth less than once a day, and not having own family dentists were significantly associated with PD after adjustment for age.

Complaints of swallowing among PD patients

Table 3 shows the complaints of swallowing among 71 PD patients. As for swallowing, 47 (66.2%) PD patients answered that they had some problems. By multiple answer, over 25% of PD patients complained of the following: spilling one's food from the mouth (31.0%), choking on food (25.4%), and/or choking on beverage (31.0%).

Table 1. Sex and age distribution of 71 Parkinson's disease (PD) patients and 141 controls

	total			Male			Female		
	PD (n=71)	control (n=141)	p-value*	PD (n=34)	control (n=66)	p-value*	PD (n=37)	control (n=75)	p-value*
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
age (year)									
50-59	8 (11.3)	16 (11.3)		6 (17.6)	12 (18.2)		2 (5.4)	4 (5.3)	
60-69	16 (22.5)	33 (23.4)	1.00	7 (20.6)	14 (21.2)	1.00	9 (24.3)	19 (25.3)	1.00
70-79	47 (66.2)	92 (65.2)		21 (61.8)	40 (60.6)		26 (70.3)	52 (69.3)	

*Fisher's exact test

Table 2. Results of logistic regression analysis of oral health conditions in 71 Parkinson's disease patients and 141 controls

	total			adjusted for sex, age, or a history of smoking				by sex adjusted for age, or a history of smoking							
								male				female			
	cases n	controls n	nature of population	cases n(%)	controls n(%)	odds ratio[a] (95%CI)	odds ratio[b] (95%CI)	cases n(%)	controls n(%)	odds ratio[c] (95%CI)	odds ratio[d] (95%CI)	cases n(%)	controls n(%)	odds ratio[c] (95%CI)	odds ratio[d] (95%CI)
Dental status															
No own teeth	71	141	All	5(7.0)	0(0)	5.46 (0.92-Infinity)*	4.84 (0.80-Infinity)*	1(2.9)	0(0)	0.57 (0.03-Infinity)*	0.21 (0.01-Infinity)*	4(10.8)	0(0)	3.67 (0.56-Infinity)*	3.64 (0.56-Infinity)*
Wearing dentures	71	141	All	40(56.3)	44(31.2)	1.76(0.93-3.33)	1.84(0.93-3.64)	16(47.1)	21(31.8)	1.10(0.43-2.78)	0.99(0.34-2.88)	24(64.9)	23(30.7)	2.76(1.12-6.79)	3.02(1.21-7.52)
Oral complaints															
Toothache	66	141	Having own teeth	18(27.3)	24(17.0)	1.68(0.79-3.54)	1.69(0.77-3.74)	11(33.3)	9(13.6)	2.88(0.99-8.42)	3.04(0.95-9.74)	7(21.2)	15(20.0)	1.02(0.34-3.01)	0.98(0.32-2.95)
Gingival bleeding	66	141	Having own teeth	15(22.7)	15(10.6)	4.09(1.57-10.66)	3.56(1.28-9.84)	9(27.3)	12(18.2)	2.43(0.79-7.44)	1.78(0.52-6.12)	6(18.2)	3(4.0)	11.38(1.78-72.95)	12.95(1.79-98.80)
Bad breath	71	141	All	20(28.2)	24(17.0)	1.72(0.82-3.61)	1.74(0.79-3.86)	13(38.2)	12(18.2)	2.35(0.88-6.26)	2.64(0.87-8.02)	7(18.9)	12(16.0)	1.18(0.37-3.78)	1.12(0.35-3.63)
Sliminess of the mouth	71	141	All	20(28.2)	26(18.4)	1.56(0.75-3.21)	1.53(0.71-3.29)	10(29.4)	10(15.2)	2.16(0.75-6.19)	2.18(0.68-7.03)	10(27.0)	16(21.3)	1.09(0.39-3.04)	1.12(0.40-3.17)
Chewing difficulties	71	141	All	28(39.4)	14(9.9)	4.96(2.26-10.90)	5.63(2.42-13.08)	11(32.4)	5(7.6)	4.82(1.42-16.39)	4.63(1.22-17.60)	17(46.0)	9(12.0)	5.02(1.76-14.32)	6.91(2.19-21.85)
Annoying teeth alignment	66	141	Having own teeth	11(16.7)	8(5.7)	3.02(1.07-8.53)	3.07(1.04-9.07)	5(15.2)	5(7.6)	1.78(0.45-7.00)	1.82(0.40-8.28)	6(18.2)	3(4.0)	6.64(1.17-37.60)	5.70(1.04-31.13)
Food impaction	66	141	Having own teeth	49(74.2)	66(46.8)	3.35(1.70-6.58)	3.59(1.75-7.37)	26(78.8)	31(47.0)	4.30(1.58-11.68)	4.87(1.58-15.00)	23(69.7)	35(46.7)	2.72(1.07-6.91)	2.81(1.10-7.22)
Swollen gums or mucosa	71	141	All	20(28.2)	14(9.9)	3.20(1.40-7.32)	2.97(1.23-7.16)	10(29.4)	6(9.1)	3.35(1.04-10.77)	2.43(0.68-8.65)	10(27.0)	8(10.7)	3.22(0.96-10.79)	3.97(1.08-14.62)
Tooth movement	66	141	Having own teeth	12(18.2)	6(4.3)	2.98(1.01-8.79)	5.58(1.60-19.46)	8(24.2)	3(4.6)	4.14(0.97-17.78)	9.63(1.77-52.54)	4(12.1)	3(4.0)	2.10(0.37-11.77)	3.10(0.45-21.44)
Denture discomfort	40	44	Using dentures	13(32.5)	8(18.2)	2.04(0.67-6.19)	1.81(0.57-5.81)	4(25.0)	3(14.3)	2.21(0.33-14.83)	2.00(0.25-15.98)	9(37.5)	5(21.7)	1.97(0.50-7.77)	1.63(0.41-6.53)
Oral health behavior															
Brushing teeth less than once a day	66	141	Having own teeth	13(19.7)	17(12.1)	1.66(0.71-3.90)		5(15.2)	14(21.2)	0.61(0.19-1.94)		8(24.2)	3(4.0)	9.21(1.81-46.94)	
Cleaning denture less than once a day	40	44	Using dentures	15(37.5)	13(29.6)	1.79(0.64-4.96)		8(50.0)	9(42.9)	1.56(0.39-6.24)		7(29.2)	4(17.4)	2.11(0.46-9.63)	
Not removing dentures and putting them in a cup of water when sleeping	40	44	Using dentures	13(32.5)	8(18.2)	1.71(0.58-5.05)		2(12.5)	3(14.3)	0.65(0.09-4.76)		11(45.8)	5(21.7)	2.63(0.70-9.93)	
Not using a fluoride toothpaste	66	141	Having own teeth	11(16.7)	2(1.4)	12.56(2.54-62.22)		7(5.9)	0(0)	19.67 (3.56-Infinity)*		4(12.1)	2(2.7)	4.48(0.70-28.69)	
Not using an interdental brush or a dental floss	66	141	Having own teeth	37(56.1)	61(43.3)	1.59(0.85-2.99)		19(57.6)	37(56.1)	1.04(0.43-2.52)		18(54.6)	24(32.0)	2.37(0.96-5.84)	
Not having a dental examination regularly	71	141	All	36(50.7)	70(49.7)	1.41(0.76-2.63)		18(52.9)	37(56.1)	1.37(0.56-3.38)		18(48.7)	33(44.0)	1.37(0.57-3.29)	
Not having own family dentists	71	141	All	18(25.4)	46(32.6)	0.88(0.44-1.77)		6(17.7)	32(48.5)	0.28(0.10-0.80)		12(32.4)	14(18.7)	2.98(1.05-8.49)	
Drinking alcohol	71	141	All	9(12.7)	62(44.0)	0.18(0.07-0.41)		7(20.6)	40(60.6)	0.17(0.06-0.46)		2(5.4)	22(29.3)	0.23(0.05-1.09)	
Having a history of smoking	71	141	All	9(12.7)	58(41.1)	0.12(0.05-0.33)		9(26.5)	46(69.7)	0.15(0.06-0.39)		0(0)	12(16.0)	0.24(0.00-1.35)*	

CI: confidence interval
[a]: Adjustment for sex and age
[b]: Adjustment for sex, age and a history of smoking
[c]: Adjustment for age
[d]: Adjustment for age and a history of smoking
*: exact logistic regression analysis

Table 3. Troubles of swallowing among 71 Parkinson's disease patients

	n(%)*	n(%)**
No problem		24(33.8%)
Swallowing problems		47(66.2%)
Details of swallowing problems (multiple answers);		
Spilling one's food from the mouth	22(31.0%)	
Choking on food	18(25.4%)	
Choking on beverage	22(31.0%)	
Coughing during eating or drinking	15(21.1%)	
Feeling as if a lump of food is stuck in one's throat	11(15.5%)	
Producing sputum during a meal	12(16.9%)	
Total		71(100%)

*: n(%) for details of swallowing problem (multiple answers)
**: n(%) for no problem and swallowing problems

Discussion

The oral health conditions of 71 PD patients

In the present study, PD patients had more oral complaints compared to the controls. We found that many PD patients had symptoms such as periodontal disease. This showed a similar finding to our investigation[14] in the eastern Iburi area of Hokkaido in 2013. Some previous studies[10, 11, 13, 15] reported PD patients had more instances of periodontal disease compared to the controls. This may be explained by the following reasons. First, PD patients have demonstrated diminished manual dexterity, which limits their ability to carry out the effective removal of plaque[4]. Second, Rozas, et al.[16] showed that anti-parkinsonian medications may also influence the composition of the oral microbiota, shifting beta-diversity towards health. Fleury et al.[17] reported that both saliva and subgingival dental plaque microbiota differed between patients and controls. Third, PD patients may be suffering from xerostomia[1, 4, 18, 19] or nausea[19, 20] caused by the administration of antiparkinsonian medications such as anticholinergics and levodopa. Saliva acts to neutralize and dilute acids formed by dental plaque from ingested carbohydrates. Patients with xerostomia are more likely to develop periodontal disease and nausea causes a decrease in oral hygiene.

In this study, those who complained of chewing difficulties were more commonly among the PD patients than the controls. This showed a similar finding to our investigations[3, 14] in the Okhotsk area of Hokkaido in 2000 and in the eastern Iburi area of Hokkaido in 2013. Bakke et al.[21] reported that mastication and orofacial functions are impaired in moderate and advanced PD (Hoehn & Yahr stages Ⅱ-Ⅳ). This may be explained by the following reasons. First, PD patients may be suffering from mastication disorders with oral dyskinesia or xerostomia as a side-effect from using levodopa[1, 3, 22, 23]. Second, tremors and rigidity of the orofacial musculature may create difficulties in chewing. Thirdly, PD patients have a slowness in their chewing due to bradykinesia[1].

In the present study, there were no differences between the PD patients and the controls about having no own teeth. This showed a different finding to our investigations[3, 14] in the Okhotsk area of Hokkaido in 2000 and in the eastern Iburi area of Hokkaido in 2013. However, more female PD patients in this study wore dentures than female controls. Many PD patients may have more missing teeth than the controls. Many PD patients in the present study may be more likely to be suffering from periodontal disease according to their complaints. Aida et al.[24] reported that most of the permanent teeth were extracted due to caries and periodontal disease in Japan.

In this study, we found that more PD patients suffer from swollen gums or mucosa than controls. This showed a similar finding to our investigation[14] in the eastern Iburi area of Hokkaido in 2013. Xerostomia caused by the use of antiparkinsonian medications is a possible cause. Saliva involves mucin, which functions as a lubricating action and also protects the mucosal epithelia of the oral cavity. Kennedy et al.[25] reported that PD patients showed a significant increase in mucositis compard with the control groups.

Swallowing condition

Forty-seven (male: 25 patients, female: 22 patients) of the 71 (66.2%) PD patients had a self-perceived swallowing problem. This showed a higher proportion compared to results of our investigations[3, 14] in the Okhotsk area of Hokkaido in 2000 (53.8%) and in the eastern Iburi area of Hokkaido in 2013 (55.6%). Clifford et al.[26] reported that 48% of PD patients had dysphagia. Melo, Monteiro[27] reported that a recent systematic review showed that PD patients are three times more likely than normal controls to develop oropharyngeal dysphagia. However, we may have underestimated the proportion of PD patients with dysphagia in the present study because of the following reasons. First, swallowing dysfunction occurs from the onset of the earliest stages of Parkinson's disease, even in asymptomatic cases[28, 29]. Second, Nilsson et al.[28] found dysphagia in more than 90% of PD patients who were in the same stages as our study subjects (Hoehn and Yahr stages Ⅲ and Ⅳ). The reasons for why many PD patients have dysphagia may be the dementia most PD patients display[1, 30] ,various motor disorders such as hypokinesia, and akinesia[31], a side effect of using levodopa[1, 4, 18, 32] or poor denture control[26], xerostomia[1, 4, 18, 19] caused by the administration of antiparkinsonian medications such as anticholinergics and levodopa.

Oral health behavior of PD patients

In this study, more female PD patients brushed their teeth less than once a day than female controls. This showed a similar finding to our investigation[3] in the Okhotsk area of Hokkaido in 2000. Müller et al.[9] reported that PD patients had lower frequencies of daily tooth-brushing than the controls. On the other hand, in our 2013 investigation[14] in the eastern Iburi area of Hokkaido, more PD patients brushed their teeth more than twice a day than controls. Fukayo et al.[10] reported that the frequency of tooth-brushing was higher among PD patients. For PD patients, tooth brushing may be particularly difficult because the disease often precludes repetitive movements[1]. In addition, Goodarzi et al.[33] reported that PD patients had a state of depression such as apathy and anhedonia, or reduction of cognitive function. Therefore, lower motivation or lower awareness of dressing oneself may affect lack of tooth brushing.

In this study, fewer PD patients used a fluoride toothpaste than the controls. However, in our 2013 investigation[14] in the eastern Iburi area of Hokkaido, more PD patients used a fluoride toothpaste than the controls. One of the reasons for this discrepancy may be due to the different years in which the survey was conducted because the percentage of the use of fluoride toothpaste has been on the increase nationwide in Japan according to Japan national dental survey[34]. Hence, the proportion of fluoridated toothpaste use in the control group in this study was 98.6%, while in our previous study in 2013, the proportion was 40.4%. In addition, as PD patients of this study less frequently brushed their teeth compared to the controls, PD patients who used a fluoride toothpaste may be fewer than the controls.

There are some limitations to our study. First, we did not check the duration of the disorder. There is the possibility of a survival bias, because we used not only incident cases, but also prevalent cases. Cereda et al.[30] reported that swallowing disturbances were significantly associated with a longer disease duration. Second, the controls were not randomly selected from the general population. The participants in this study were those who were interested a dental examinations conducted by the municipality, possibly causing a response bias. Third, we cannot address the temporal anteroposterior relationship of whether the oral environment deteriorated after the onset of PD because this was a cross-sectional study. Therefore, a cohort study of the risk of tooth loss in PD patients is needed in the future.

In conclusion, we found that PD patients had more complaints about oral health (e.g., gingival

bleeding, chewing difficulties, food impaction, swollen gums or mucosa, and/or tooth movement). In addition, 66.2% of PD patients had problems with swallowing. Moving forward, it would be important that the public health center continuously conducts dental checkups and offer professional oral care through home visits for PD patients. More than ever, it is necessary that clinical dentists understand the oral health conditions and swallowing problems of PD patients.

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パーキンソン病患者の口腔保健状況と嚥下の状況

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目的：本研究の目的は，釧路地域の住民を対象に，歯周疾患検診受診対照群と比較したパーキンソン病（PD）患者の口腔内状況，口腔保健行動及び嚥下状況を明らかにすることである．

方法：2020年に釧路地域のPD患者223人に郵送で質問調査を行い，回答が得られた112人中，50歳以上79歳以下の71人をケースとした．コントールは，2018～2019年に釧路市で実施した歯周疾患検診の40歳以上の受診者443人中，ケースと性・年齢をマッチさせた141人である．71人のPD患者と141人のコントロールとの間で，口腔内状況とその関連要因を比較した．統計解析としては，PDの有無を従属変数とした多重ロジスティック回帰分析を用いて，性・年齢で調整した各口腔内状況や口腔保健行動項目のオッズ比を算出した．また，同様に男女別に年齢で調整後のオッズ比を算出した．

結果：コントロールと比較して，PD患者は，咬むこと，歯肉出血，歯並びの悪さ，食片圧入，粘膜腫脹および歯の動揺に問題を抱えていることが明らかとなった．またPD患者の66.2%が嚥下に問題を抱えていることも明らかとなった．

結論：本研究により，PD患者は一般住民対照と比較して，口腔内や嚥下により多くの問題を抱えていることが明らかとなった．保健所による定期的な歯科健診の継続や，PD患者の訪問を通じて専門的な口腔ケアを提供することが重要であると考えられた．