ASSESSMENT OF ORAL HEALTH IN PERITONEAL DIALYSIS PATIENTS WITH AND WITHOUT DIABETES MELLITUS

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The incidence of chronic renal failure continues to rise worldwide, and although the oral and dental changes in individuals with this condition have been examined, investigations with diabetic peritoneal dialysis (PD) patients are limited. We therefore examined salivary pH, dry mouth, taste change, and mucosal ulceration in diabetic and nondiabetic uremic patients receiving PD. A total of 49 patients undergoing PD therapy were allocated to either the diabetic or the nondiabetic group. Salivary pH, dry mouth, taste change, and mucosal ulceration were determined for both groups. Salivary flow rate and pH were both lower in the diabetic group. Buffer capacity, dry mouth, taste change, and mucosal ulceration were all increased in that group. These findings were associated with level of glycosylated hemoglobin A1c. Our observations indicate that, compared with nondiabetic PD patients, patients with diabetes exhibit more severe oral uremic symptoms, including dry mouth, burning mouth syndrome, taste change, and mucosal ulcerations. The oral health in these patients should be followed.

Perit Dial Int 2012; 32(1):81-85 www.PDIConnect.com
epub ahead of print: 31 May 2011 doi:10.3747/pdi.2010.00113

KEY WORDS: Diabetes mellitus; oral health; saliva.

A broad range of oral symptoms have been reported in end-stage renal disease (ESRD) patients, including gingivitis, dry mouth, ammonia-like odor resulting from a high urea content, mucosal lesions, tooth mobility, malocclusion, and an increased risk of dental erosion because of frequent regurgitation (1–4). In severe renal failure, uremic stomatitis may be present. Enamel hypoplasia has been documented in patients with ESRD whose disease began at an early age (5).

When patients with ESRD also have diabetes mellitus (DM), the oral manifestations of both conditions may be present. It is well established that DM is correlated with a number of oral conditions such as periodontal diseases, dental caries, stomatitis, glossitis, alterations in salivary secretions, taste change, burning mouth syndrome (BMS), oral mucosal lesions, and bacterial, viral, and fungal infections (6,7). Although the oral and dental changes of the general disease condition have been examined, investigations focused on diabetic peritoneal dialysis (PD) patients are limited. The present study therefore examined salivary flow rate (SFR), buffer capacity (BC) and pH, dry mouth, taste change, BMS, and mucosal ulceration in diabetic and nondiabetic uremic patients receiving PD.

METHODS

A total of 49 patients undergoing PD therapy were recruited from the PD unit, Faculty of Medicine, Ataturk University, Erzurum. Before enrollment, each patient consented to a predefined protocol, and all procedures followed the tenets of the Declaration of Helsinki. The study protocol was approved by the local ethics committee of Ataturk University.

All patients were using the twin-bag system, but various kinds of PD fluid were being used. The patients were classified into diabetic (type 1 and type 2) and nondiabetic groups. Patients with a diabetes history of less than 6 months were excluded from the study. Patients who were smokers were also excluded. To classify the degree of metabolic control in the diabetic patients, their levels of glycosylated hemoglobin A1c (HbA1c) were collected, based on medical records from the preceding 3 months. Patients with HbA1c values of 6.0% or lower were considered to have good metabolic control, and those with HbA1c values higher than 6.0% were considered to have poor control.

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Received 3 January 2011; accepted 12 January 2011

Unstimulated whole saliva (UWS) was collected by the spitting method, with small modifications, as previously described (8). All subjects were instructed to refrain from eating, drinking, and tooth-brushing for 1 hour before the 3 saliva collection periods. Each saliva collection period was 5 minutes long.

The pH of the UWS was measured immediately after collection. Salivary pH was determined electrometrically (pH/ion meter DP-880: Dong-Woo Medical, Seoul, Korea). Salivary BC was measured using the Ericsson method (9).

A validated xerostomia inventory consisting of 11 items, each with a 5-point Likert-type scale (1 = never to 5 = very often), was used to quantify the level of xerostomia. Examples of the xerostomia items include "My mouth feels dry," "My lips feel dry," and "I sip liquids to aid in swallowing food." The item scores are summed to yield an individual xerostomia score ranging from 11 (no dry mouth) to 55 (extremely dry mouth) (8,10).

The patients were examined for oral symptoms, including mucosal petechiae or ecchymosis, and ulceration. Findings were recorded as the presence or absence of each of those symptoms. The presence of BMS was operationally defined by the responses to these questions: "Do you now have, or in the last month have you had, any persistent uncomfortable sensations in your mouth or tongue? If yes, would you describe the feeling as tingling, burning, sore, numb, or other?"

A two-part assessment of oral health—a DMFT (decayed, missing, filled teeth) index for the incidence of dental

caries, and a Community Periodontal Index (CPI) for an appraisal of the need for periodontal treatment—was performed using a World Health Organization (WHO) probe and a mouth mirror. For the DMFT caries index, the examiner recorded the teeth as decayed, missing, or filled according to WHO criteria. The CPI index is currently recommended by the WHO, and it consists of dividing the oral cavity into sextants, with index teeth in each sextant. The index teeth are 17/16 for the 1st sextant, 11 for the 2nd, 26/27 for the 3rd, 36/37 for the 4th, 31 for the 5th, and 47/46 for the 6th (11,12). The index teeth are then scored as follows: code 0 = healthy periodontium without pathologic changes; code 1 = bleeding on gentle probing; code 2 = calculus deposition; code 3 = probing depth of 4–5 mm; code 4 = probing depth 6 mm or deeper; code X = 3 or more teeth missing.

After data collection, statistical analyses to identify group differences were performed using the SPSS statistical software application (version 13.0 for Windows: SPSS, Chicago, IL, USA). The between-group associations were analyzed using the chi-square and Fisher exact tests, with 95% confidence limits. Age, sex, and dialysis duration were compared using the Student t-test for unpaired samples, with homogenous variances. A value of $p < 0.05$ was considered statistically significant.

RESULTS

Table 1 shows the data on the oral symptoms of study patients. Of the 49 patients on PD who participated in the

TABLE 1
Demographics and Laboratory Findings for the Peritoneal Dialysis (PD) Study Population

Variable	With Diabetes	Without Diabetes	<i>p</i> Value
Patients (<i>n</i>)	22	27	
Age (years)	44.6	40.4	NS
Sex, female/male (%)	59/41	56/44	NS
PD duration (years)	3.5±0.39	3.0±0.45	NS
Saliva flow rate (mL/min)	0.23±0.03	0.32±0.06	0.01
Salivary pH	7.87±0.57	8.43±0.32	0.01
Buffer capacity	7.27±1.06	6.68±1.28	0.01
Dry mouth [<i>n</i> (%)]	13 (59.1)	3 (11.1)	0.001
Taste change [<i>n</i> (%)]	12 (54.5)	2 (7.4)	0.001
Mucosal ulceration [<i>n</i> (%)]	12 (54.5)	2 (7.4)	0.001
Burning mouth syndrome [<i>n</i> (%)]	9 (40.9)	3 (11.1)	0.01
Decayed, missing, filled teeth (<i>n</i>)	26.01	22.41	0.05
Community periodontal index	3.38±0.71	3.07±0.41	0.055 (NS)
Blood urea nitrogen (mg/dL)	112±33.7	115±30.9	NS
Serum creatinine (mg/dL)	7.8±2.7	8.4±2.9	NS
HbA1c (%)	7.4±1.2	—	

NS = nonsignificant.

study [21 men, 28 women; mean age: 42.3 years (range: 25 – 55 years); mean PD duration: 3.2 years (range: 0.5 – 7 years)], 22 were classified as diabetic and 27 as nondiabetic. The mean duration of DM in the diabetic group was 13.2 years (range: 4 – 17 years). Both groups of patients were similar in age, sex, and PD duration.

The mean SFR and pH were significantly lower in the diabetic group (SFR: 0.23 ± 0.03 mL/min; pH: 7.87 ± 0.57) than in the nondiabetic group (SFR: 0.32 ± 0.06 mL/min; pH: 8.43 ± 0.32 ; Table 1), and BC was significantly higher in the DM group (7.27 ± 1.0628 vs. 6.68 ± 1.28 non-DM, $p < 0.001$). Compared with the nondiabetic group, the diabetic group more frequently reported dry mouth (59.1% vs. 11.1%) and taste change (54.5% vs. 7.4%), and they more frequently had mucosal ulceration (54.5% vs. 7.4%) and BMS (40.9% vs. 11.1%), all $p < 0.01$ (Table 1).

Compared with the nondiabetic group, the diabetic group had statistically significantly more dental caries ($p < 0.05$). The mean DMFT was 26.01 among patients with DM and 22.41 among patients without DM. In assessing the CPI index, both study groups had a low incidence of codes 0 and 1. Code 3 was the most common CPI code in both groups. Although the CPI trended slightly higher in the diabetic group than in the nondiabetic group, the chi-square test of the results did not quite reach significance ($p = 0.055$).

Table 1 also shows selected laboratory parameters for the groups. Levels of serum creatinine and blood urea nitrogen were not significantly different between the groups ($p > 0.05$, Table 1).

Table 2 shows the relations between oral and dental symptoms and HbA1c levels for the diabetic group. In this

group, increased symptoms and salivary changes were clearly associated with increasing levels of HbA1c.

DISCUSSION

Results for UWS from the present study show that pH, BC, and SFR values are lower in diabetic PD patients than in nondiabetic PD patients. Additionally, symptoms such as BMS, dry mouth, taste change, and mucosal ulceration are more severe in diabetic patients. These findings provide new information for an understanding of oral physiology in PD patients with DM.

Patients with DM may also experience increased thirst and urination as a consequence of osmotic diuresis caused by sustained hyperglycemia. Diuresis results in loss of glucose, free water, and electrolytes in urine. Chuang *et al.* (13) examined dental condition and oral symptoms in diabetic and nondiabetic uremic patients undergoing hemodialysis (HD). They reported that, compared with the nondiabetic group, the diabetic group exhibited significantly lower SFR and more severe dry mouth. The diabetic group tended to have lower salivary pH, and patients with poor glycemic control showed higher incidences of caries, mucosal pain, and tongue coating. However, the DMFT and the CPI index were not associated with glycemic control in the diabetic group. Similarly, in the present study, a low SFR and dry mouth occurred more frequently in the diabetic group.

Alterations in SFR and salivary composition in diabetic subjects have been reported previously. Nonetheless, the findings about reduced SFR in diabetic patients remained contradictory (8,10). Decreased salivary secretion in diabetic patients may correlate with autonomic neuropathy

TABLE 2
Relationship Between Oral Findings and Glycosylated Hemoglobin A1c (HbA1c) Levels in Diabetic End-Stage Renal Disease Patients Undergoing Peritoneal Dialysis

Variable	HbA1c level		<i>p</i> Value
	≤6%	>6%	
Patients (<i>n</i>)	8	14	
Saliva flow rate (mL/min)	0.26 ± 0.15	0.21 ± 0.08	0.029
Saliva pH	6.7 ± 3.5	8.4 ± 3.1	0.038
Buffer capacity	7.43 ± 2.1	7.18 ± 2.4	0.022
Dry mouth (<i>n</i>)	3	10	0.005
Taste change (<i>n</i>)	4	8	0.017
Burning mouth syndrome (<i>n</i>)	2	7	0.009
Mucosal ulceration (<i>n</i>)	3	9	0.027
Decayed, missing, filled teeth (<i>n</i>)	22.6 ± 10.1	27.9 ± 8.8	0.042
Community periodontal index	3.0 ± 3.2	3.6 ± 2.6	NS

NS = nonsignificant.

(11). Because of the lost protective action of saliva with decreased SFR, diabetic patients may be at increased risk for candidiasis, dental caries, periodontal disease, and bacterial infections (14,15). In addition, in previous studies, decreased SFR and dry mouth in patients with ESRD were reported to be caused by a combination of direct uremic involvement of the salivary glands and of dehydration from the restriction of fluid intake (1,16,17). Bayraktar *et al.* reported that the SFR was significantly lower in PD patients than in healthy controls (18). An earlier report showed that, compared with nondiabetic patients, diabetic patients undergoing HD had a higher incidence of dry mouth and mucosal pain (13). In the present study, the lower salivary flow in diabetic patients can explain the higher level of taste change and BMS, and the higher incidence of oral ulcerations.

The present study focused on an examination of pH and BC in UWS. The increased pH of saliva from patients with ESRD was the result of a higher concentration of ammonia from urea hydrolysis (1,19). The increased salivary phosphate concentration previously reported in these patients could partially contribute to the higher BC (1,18–20). Kho *et al.* (1) reported that the pH and BC of UWS were increased in ESRD patients undergoing HD. However, Chuang *et al.* (14) reported that salivary pH was lower in diabetic than in nondiabetic HD patients. In the present study, pH was significantly lower in the DM than in the non-DM group, and BC values were significantly higher. The lower pH in the DM patients may be associated with a higher prevalence of dry mouth, BMS, taste change, and oral ulceration.

Diabetic patients have a higher rate of caries because of their potential xerostomia, change in oral pH, and microbiology (21). Several studies further claim that a reduction in SFR will increase the risk of caries, particularly in PD patients (18,22,23). In our study, higher rates of DMFT were observed in the DM group than in the non-DM group. The lower pH and SFR may be associated with the higher caries rate in the diabetic group. Caries appears to be stimulated by low pH, BC, and flow rate. Salivary pH tended to be lower in diabetic patients than in nondiabetic patients, and the pH decreased further with increasing HbA1c level.

Diabetes is a risk factor for periodontal disease, and Craig *et al.* (24) reported that chronic renal disease may lead to complications such as bone resorption, DM, and dehydration that are important in periodontal disease. An increase in the extent and severity of periodontal disease in diabetic patients has been reported by various investigators (21,25), although some have not found a significant relationship between DM and PD (11,26). A previous survey (27) reported that periodontitis is an

important source of chronic inflammation and increases levels of C-reactive protein in HD patients. Chuang *et al.* (13) reported that diabetic patients on HD are at increased risk for advanced periodontitis. Kshirsagar *et al.* (28) examined the relationship between periodontitis and cardiovascular disease mortality in outpatients on HD and suggested that treating periodontitis reduces cardiovascular disease mortality in dialysis patients. Bayraktar *et al.* (18) reported that CPI values were significantly higher in PD and HD groups than in a control group, and higher in the HD group than in the PD group, although the latter difference was not statistically significant. They also found a positive correlation between C-reactive protein and CPI values in PD patients. In the present study, we found a borderline significant difference for the CPI assessment between the diabetic and nondiabetic groups. That result may be an effect of the two important limitations of our study: First, we had not known about oral symptoms before the start of dialysis, and second, the number of patients in the study was small.

Diabetes is known to be closely related to oral health, and level of glycemic control is an important determinant in that relationship (29). For that reason, we examined HbA1c levels in the study patients with DM. The results of our study imply a positive correlation between oral symptoms and HbA1c levels in diabetic patients. In agreement with previous studies, we found significant correlations between HbA1c level and oral and dental conditions except for the CPI. Compared with diabetic patients who had good glycemic control, those who had poor glycemic control also had more severe oral symptoms.

CONCLUSIONS

Our study demonstrated that, compared with nondiabetic PD patients, PD patients with DM have more severe oral symptoms, including dry mouth, BMS, taste change, and mucosal ulcerations, and a higher risk of caries. The oral health of these patients should be carefully monitored, and maintenance of ideal oral hygiene could have positive effects in this high-risk group of patients.

DISCLOSURES

The authors have no financial relationship with the organization that sponsored the research.

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