Preliminary Report

Xerostomia, Hyposalivation, and Oral Microbiota in Type 2 Diabetic Patients: A Preliminary Study

Siribang-on Piboonniyom Khovidhunkit DDS, DMSc*, Tongchat Suwantuntula DDS*, Soisiri Thaweboon DDS, PhD**, Somsak Mitrirattanakul DDS, PhD***, Umawadee Chomkhakhai DDS, MSc****, Weerapan Khovidhunkit MD, PhD*****

** Department of Hospital Dentistry, Faculty of Dentistry, Mahidol University, Bangkok, Thailand*
*** Department of Microbiology, Faculty of Dentistry, Mahidol University, Bangkok, Thailand*
**** Occlusion Unit, Faculty of Dentistry, Mahidol University, Bangkok, Thailand*
***** Anandamahidol Hospital, Lopburi, Thailand*
****** Department of Medicine, Faculty of Medicine, Chulalongkorn University and King Chulalongkorn Memorial Hospital, Bangkok, Thailand*

Background and Objective: *Mouth dryness is one of the major problems that can lead to several oral diseases such as dental caries, periodontitis and oral infection. Mouth dryness has also been associated with type 2 diabetes mellitus (DM). The objective of the present study was to investigate the prevalence of xerostomia (feeling of mouth dryness), hyposalivation (the reduction of saliva), and oral microbiota in Thai patients with type 2 DM.*

Material and method*: One hundred and fifty-four ambulatory patients with type 2 DM and 50 non-diabetic control subjects were interviewed for symptoms of xerostomia. The medical records of these subjects were reviewed for pertinent medical history and laboratory investigations regarding their diabetic control. Oral examination and measurement of hyposalivation using a modified Schirmer test (MST) were performed. The presence of oral microbial flora was investigated using a modified dip-slide test.*

Results: *The prevalence of xerostomia was 62% in patients with type 2 DM compared with 36% in the non-diabetic control group ($p = 0.001$). The prevalence of hyposalivation (defined as MST values $\leq$ 25 mm at 3 min) was 46% in the patient group, whereas only 28% of the control group had hyposalivation ($p = 0.03$). Patients with hyposalivation had significantly higher numbers of mutans streptococci,* Lactobacillus *spp., and* Candida *spp. in the saliva compared with those without hyposalivation.*

Conclusion: *These results suggested that xerostomia and hyposalivation were prevalent in patients with type 2 DM and were associated with higher numbers of oral pathogens in the saliva.*

Keywords: *Xerostomia, Hyposalivation, Type 2 diabetes mellitus, Modified Schirmer test, Mutans streptococci, Streptococcus mutans, Lactobacilli, Lactobacillus, Candida*

J Med Assoc Thai 2009; 92 (9): 1220-8
Full text. e-Journal: *http://www.mat.or.th/journal*

Saliva plays an important role in maintaining homeostasis of the oral cavity[1,2]. The protective mechanisms of saliva involve lubrication and debridement of the oral cavity. Saliva facilitates initial digestion, swallowing, and speech. In addition, saliva buffers acids generated by oral bacteria and contains various antibacterial substances such as lysozyme, lactoferrin, lactoperoxidase, and secretory IgA. A reduction in saliva production may cause burning sensation of the mouth, changes in taste perception, difficulties in swallowing and speech, and increase the risk of caries and oral infection[1,2].

Xerostomia and hyposalivation are two different words that should not be used interchangably[3]. Xerostomia is a conventional term used to denote the *subjective* complaint of mouth dryness,

Correspondence to: Khovidhunkit SP, Department of Hospital Dentistry, Faculty of Dentistry, Mahidol University, 6 Yothi Street, Ratchathewi, Bangkok 10400, Thailand. Phone: 0-2644-8644-6 ext. 6531, Fax: 0-2203-6530, E-mail: dtspb@mahidol.ac.th

whereas hyposalivation is an *objective* reduction in salivary secretion. In normal healthy subjects, there is a wide range of salivary flow. In patients with hyposalivation, however, both the unstimulated and stimulated salivary flow rates are significantly reduced. Although most patients with xerostomia has hyposalivation, others may not. On the other hand, patients who had documented hyposalivation may not complain of xerostomia[4]. Changes in oral microbiota have also been associated with hyposalivation. An increase in the number of some oral microbial flora have been observed in patients with hyposalivation, and may be associated with an increased incidence of dental caries, periodontitis, and candidiasis[4,5].

Systemic diseases, medications, and therapeutic radiation are common causes of salivary gland dysfunction. Both xerostomia and hyposalivation have been associated with diabetes mellitus (DM). Subjects with type 1 DM reported symptoms of dry mouth more frequently than control subjects did (24% vs. 18%, respectively)[6]. Salivary flow rates were impaired in subjects with type 1 DM, especially in those with neuropathy[6]. In type 2 diabetic patients, unstimulated and stimulated salivary flow rates were also significantly reduced[7]. Furthermore, 30% of diabetic patients had high oral yeast counts ($\geq$ 1,000 cfu/mL) compared with 17% of the healthy subjects[7].

Although xerostomia and salivary flow have been studied in patients with type 2 DM, the number of subjects in those studies was small and methods to measure the salivary flow, such as gravimetric and volumetric measurements, are impractical in clinical practice[7-15]. In the present study, therefore, the authors investigated the prevalence of xerostomia and hyposalivation in a large number of ambulatory patients with type 2 DM using a modified Schirmer test and examined the association between xerostomia, hyposalivation, and oral microflora, namely mutans streptococci, *Lactobacilli* spp. and *Candida* spp. in these patients using a modified dip-slide test.

Material and Method

Patient selection

Ambulatory patients with type 2 DM who received ongoing care at the Endocrinology Clinic of the King Chulalongkorn Memorial Hospital were consecutively invited to participate in the present study from November 2005-January 2006. The inclusion criteria were ambulatory patients, age 20 years or older, who had a diagnosis of type 2 DM and were willing to participate in the present study. Patients who refused oral examination, did not provide informed consent, or did not have sufficienct clinical data were excluded form the present study. One hundred and sixty-two patients gave written informed consent and were enrolled in the study. Patients were interviewed and examined, and pertinent clinical data were obtained. Following the review of medical records, 8 patients were excluded because of insufficient clinical data, leaving a total of 154 subjects. Fifty non-diabetic subjects were also recruited as controls for MST values. The inclusion criteria for the control group were any person who did not have type 2 DM, could give informed consent, and were willing to participate in the present study. The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Chulalongkorn University.

Assessment of xerostomia and Oral examination

Three questions, modified from Fox et al[16], were used to assess the patient's feeling of mouth dryness as follows:

1) Do you feel that your mouth is dry?

2) Do you have any difficulty eating dry food?

3) Do you feel that your tongue sticks to the palate when you wake up in the morning?

The patient was examined by one dentist (TS) and findings from an intra-oral examination were recorded. The oral mucosa was assessed and categorized into moist, partially dry, or severely dry based on the visible saliva in the oral cavity. Oral lesions, if present, were recorded in the oral soft tissue diagram. Oral hygiene status including the number of decayed, missing, and filled teeth and the degree of calculus deposition were also recorded.

Modified Schirmer test procedure

An unstimulated salivary flow was measured using a modified Schirmer test (MST), which was developed from the Schirmer tear test routinely used by ophthalmologists to measure the tear film wetness. A commercially available 5 x 35 mm ColorBar™ Schirmer tear test strip (Eagle Vision, TN, USA) has a blue color bar that travels with the fluid front and has a millimeter scale (2-35 mm) delineating the amount of fluid flow. All the tests were performed from 8 am to 12 noon according to Fontana et al[17]. Briefly, all subjects were asked not to eat or drink 2 hours prior to the MST. After a period of 3-5 minutes rest, the patient was asked to swallow all the saliva in the mouth prior to the test, and not to swallow anymore during the test. In addition, the patient was asked to rest the tongue on the hard

palate so that the test strip would not touch the tongue during the test. The MST strip was held vertically with a cotton plier and the rounded end of the strip was positioned at the floor of mouth. When the round end of the strip contacted moisture, the blue dye traveled up the strip and its distance was read at 1, 2 and 3 minutes and recorded immediately. In this study, hyposalivation was diagnosed if the color moved $\leq$ 25 mm at 3 min[17]. Alternatively, analyses were also performed using a more stringent criterion of hyposalivation, defined as an MST value $\leq$ 15 mm according to data from Chen et al[18].

Modified dip-slide test

Stimulated whole saliva was obtained by having the subject chew a piece of paraffin for 5 minutes and collected for microbiological assessment using a modified dip-slide test as previously described[19]. This method has been shown to correlate well with the conventional agar plate counts[19]. Six patients had very little amount of stimulated saliva, and one refused the collection; therefore, only 147 saliva samples were collected for the analysis. An aliquot of 100 ml undiluted saliva was poured over the surface of a 3-compartment dip-slide containing Mitis-Salivarius Bacitracin agar, Rogosa SL agar and Sabouraud dextrose agar for the growth of mutans streptococci, *Lactobacilli* spp., and *Candida* spp., respectively. The excess saliva was removed by blotting the edge of the dip-slide on absorbent paper. The slide was placed into a plastic tube and incubated at 37°C for 48-72 hours in a 5% CO_2 incubator. The number of colonies of mutans streptococci, *Lactobacilli* spp., and *Candida* spp. was counted under a stereomicroscope. The presence of mutans streptococci and *Lactobacilli* spp. was also checked by gram staining. There were five levels of the score ranging from 0-4 according to the density of the colonies which were scored and recorded by comparison with a chart provided with the test[19].

Statistical analysis

Means and standard deviations were calculated and either the Student's t-test or Chi-squared test was used to analyze differences between groups where appropriate. Analysis of variance was used and post hoc tests were performed when applicable. The SPSS for Windows program was used for statistical analysis (SPSS Inc., Chicago, IL, USA). All p-values given are based on two-tailed test of significance and a p-value less than 0.05 was considered statistically significant.

Results

Patient characteristics

One hundred and fifty-four ambulatory patients with type 2 DM were included in the present study as shown in Table 1. The most common co-morbid diseases were hypertension and dyslipidemia. One hundred and two patients (66%) had DM, hypertension and dyslipidemia, 22 patients (14%) had DM and hypertension, 14 patients (9%) had DM and dyslipidemia, and only 16 patients (10%) had DM alone. The most commonly used medication for DM was metformin and the most commonly used medication for hypertension was an angiotensin converting enzyme (ACE) inhibitor.

Prevalence of xerostomia and hyposalivation

The prevalence of xerostomia was 62% since ninety-five diabetic patients reported at least one symptom of xerostomia, whereas 59 patients (38%) reported no symptoms at all. In the control group, 36% (18 subjects) reported at least one symptom of xerostomia ($p = 0.001$, Table 1). Seventy-three diabetic patients (47%) felt that they had dry mouth compared with 16 (32%) control subjects. Thirty-nine patients (25%) felt that they had difficulties eating dry food and needed to drink water after they had dry food compared with 6 control subjects (12%). Thirty-seven patients (24%) reported a sensation of the tongue stuck to the palate when they woke up in the morning compared with 5 control subjects (10%). Forty-eight percent of diabetic patients reported more than one symptom.

When visible saliva in the oral cavity was investigated, 55 patients (36%) had moist oral mucosa, whereas 87 (56%) and 12 (8%) patients presented with partially dry and severely dry oral mucosa, respectively.

The mean $\pm$ standard deviation of the MST values for all 154 patients at 1, 2 and 3 min were 12.3 ± 5.9, 19.0 ± 7.5 and 24.6 ± 8.5 mm, respectively. Detailed data of the MST values at 1, 2 and 3 minute(s) are presented in Table 1. To compare the MST values with non-diabetic subjects, 50 subjects without a history of DM were recruited as controls (Table 1). The mean $\pm$ standard deviation of the MST values at 1, 2 and 3 minute (s) in this control group were 19.5 ± 8.6, 25.5 ± 8.9 and 28.5 ± 8.6 mm, respectively, which were significantly higher than those of the diabetic group ($p \leq 0.005$ at each time point) (Table 1). Because only the mean $\pm$ SD values cannot give enough details regarding the distribution of the MST values which would represent the severity of hyposalivation in each

group, Table 2 reports the distribution of the MST values in the patients and control subjects. Using the cut-off MST value of $\leq$ 25 mm at 3 min, the prevalence of hyposalivation in patients with type 2 DM was 46% compared with 28% in the control group (p = 0.03) (Table 2). Using a more stringent criterion for the diagnosis of severe hyposalivation (MST value $\leq$ 15 mm at 3 min), the percentage of subjects with severe hyposalivation was also significantly higher in the diabetic group compared with the control group (20% vs. 8%, respectively, p = 0.048) (Table 2).

According to the symptoms of xerostomia, the MST values in subjects with type 2 DM who reported 0, 1, 2, and 3 symptoms were 26.9 $\pm$ 6.3, 22.3 $\pm$ 9.9, 24.5 $\pm$ 8.8, and 21.9 $\pm$ 9.6 mm, respectively (p = 0.03). However, the percentage of patients who had hyposalivation was not significantly different among those who reported 0, 1, 2, and 3 symptoms of xerostomia (34%, 55%, 47%, and 63%, respectively, p = 0.11).

There was a good agreement between the findings on oral mucosa moistness and the MST

Table 1. Baseline characteristics, MST values, and prevalence of hyposalivation and xerostomia in the diabetic group and the control group

	Diabetic (n = 154)	Non-diabetic (n = 50)
Age - yr (range)	63 $\pm$ 10 (35-86)	65 $\pm$ 10 (43-85)
Female sex - no. (%)	117 (76%)	38 (76%)
Duration of diabetes - yr (range)	10 (1-31)	NA
Hemoglobin A1c - % (range)	7.8 $\pm$ 1.7 (5.5-18.0)	NA
Hypertension - no. (%)	124 (81%)	16 (32%)
Dyslipidemia - no. (%)	116 (75%)	8 (16%)
Current smoker - no. (%)	10 (6%)	ND
Former smoker - no. (%)	18 (12%)	ND
Betel nut chewing - no. (%)	9 (6%)	ND
Diabetic medications - no. (%)		NA
Sulfonylurea	87 (56%)	
Metformin	111 (72%)	
Thiazolidinedione	12 (8%)	
Alpha-glucosidase inhibitor	19 (12%)	
Glinide	2 (1%)	
Insulin	55 (36%)	
Lipid-lowering medications - no. (%)		ND
Statin	100 (65%)	
Fibrate	16 (10%)	
Antihypertensive medication - no. (%)		ND
Angiotensin converting enzyme inhibitor	69 (45%)	
Angiotensin receptor blocker	21 (14%)	
Beta blocker	39 (25%)	
Alpha blocker	10 (6%)	
Diuretic	54 (35%)	
Aspirin - no. (%)	57 (37%)	ND
MST		
1 minute: mean $\pm$ SD (mm)	12.3 $\pm$ 5.9	19.5 $\pm$ 8.6**
2 minutes: mean $\pm$ SD (mm)	19.0 $\pm$ 7.5	25.5 $\pm$ 8.9**
3 minutes: mean $\pm$ SD (mm)	24.6 $\pm$ 8.5	28.5 $\pm$ 8.6**
Prevalence of xerostomia	62%	36%***
Prevalence of hyposalivation	46%	28%*
No. of subjects who answered yes in Q1	47%	32%
No. of subjects who answered yes in Q2	25%	12%
No. of subjects who answered yes in Q3	24%	10%

NA: not applicable, ND: no data, SD: standard deviation, ***: p = 0.001, **: p < 0.005, *: p = 0.03

Table 2. Stratified MST values at 3 min in the diabetic group and the control group

MST value (mm)	Number of patients with type 2 DM (%)	Number of control subjects (%)
5-10	16 (10%)	4 (8%)
11-15	15 (10%)	0 (0%)
16-20	15 (10%)	5 (10%)
21-25	24 (16%)	5 (10%)
26-30	48 (31%)	7 (14%)
31-35	36 (23%)	29 (58%)
Total number	154 (100%)	50 (100%)

values in the presented patients with type 2 DM. The mean value of MST at 3 min in patients with moist oral mucosa was 29.6 $\pm$ 5.0 mm, whereas the values in those with partially dry and severely dry oral mucosa were 23.3 $\pm$ 8.1 mm and 10.8 $\pm$ 5.9 mm, respectively ($p < 0.001$). The percentage of patients who had hyposalivation (MST $\leq$ 25 mm at 3 min) was 16%, 56% and 100% in those who had moist mucosa, partially dry mucosa, and severely dry mucosa from intra-oral examination, respectively ($p = 0.04$).

Factors associated with hyposalivation

In diabetic patients with hyposalivation (MST $\leq$ 25 mm at 3 min), age and gender distribution were not significantly different from those of the control subjects or from diabetic patients who had normal salivary flow (Table 3). Duration of diabetes and level of diabetes control were also not significantly different between those who had and did not have hyposalivation (Table 3). In addition, there was no correlation between the duration of diabetes or the level of diabetes control and the MST value at 3 min. Similar results were obtained when a more stringent criterion of hyposalivation (MST $\leq$ 15 mm at 3 min) was used for analysis (data not shown). The mean MST values of the diabetic patients without hyposalivation were not significantly different from those of the control group.

The presence of hypertension or dyslipidemia or both in the present type 2 diabetic patients did not affect the MST value at 3 min. When the authors excluded all subjects with hypertension, the MST values in those patients with type 2 DM were still significantly lower than those of the control subjects (24.7 $\pm$ 8.4 vs. 30.1 $\pm$ 8.4 mm, $p = 0.01$). The authors found that there was a trend towards lower MST values as the total number of medications increased. The MST values at 3 min were 25.8 $\pm$ 6.4, 24.8 $\pm$ 9.2, 25.5 8.3, and 20.1 $\pm$ 8.2 mm in patients who took 0-2, 3-4, 5-6, and $\geq$ 7 medications, respectively ($p = 0.07$). Similarly, the percentage of patients who had hyposalivation was 50%, 43%, 36%, and 76% in patients who took 0-2, 3-4, 5-6, and $\geq$ 7 medications, respectively ($p = 0.01$).

Oral microbiota and hyposalivation

The authors next investigated the presence of mutans streptococci, *Lactobacilli* spp., and *Candida* spp. in the saliva of the present diabetic patients. Six patients with hyposalivation did not have enough saliva and one patient refused the saliva collection; hence, saliva samples from 147 diabetic patients were obtained for microbial analysis. In these 147 patients, 64 patients had hyposalivation, and 83 patients did not have hyposalivation.

Mutans streptococci, *Lactobacilli* spp., and *Candida* spp. were present in 96.6%, 90.4% and 74.8%

Table 3. Data comparison among control subjects and patients with type 2 DM without or with hyposalivation

	Control (n = 50)	Patients (n = 154)	
		No hyposalivation (n = 84)	Hyposalivation (n = 70)
Age (yr)	63 $\pm$ 10	62 $\pm$ 10	65 $\pm$ 12
Female sex (%)	76	76	76
Duration of diabetes (yr)	-	12 $\pm$ 7	11 $\pm$ 8
Hemoglobin A1c (%)	-	7.6 $\pm$ 1.4	7.7 $\pm$ 1.8
FPG (mg/dL)	-	148.9 $\pm$ 47.8	139.4 $\pm$ 41.5
MST (mm at 3 min)	28.5 $\pm$ 8.6	31.0 $\pm$ 2.6	16.9 $\pm$ 6.6*

*: $p \leq 0.005$ (hyposalivation vs. no hyposalivation)

Table 4. Mean scores for microbes in 147 patients with type 2 DM with or without hyposalivation

	S. mutans	*Lactobacilli*	*Candida*
All patients (n = 147)	2.4 ± 1.1	2.5 ± 1.3	1.5 ± 1.4
No hyposalivation (MST > 25 mm at 3 min) (n = 83)	2.1 ± 1.1	2.2 ± 1.2	1.3 ± 1.3
Hyposalivation (MST ≤ 25 mm at 3 min) (n = 64)	2.8 ± 1.0***	2.8 ± 1.3**	1.8 ± 1.5*

*: $p < 0.05$, **: $p = 0.002$, ***: $p < 0.001$ (hyposalivation vs. no hyposalivation)

in the saliva samples of our patients, respectively. The mean scores in all patients were 2.4 ± 1.1, 2.5 ± 1.3, and 1.5 ± 1.4 for mutans streptococci, *Lactobacilli* spp. and *Candida* spp., respectively. In 64 patients who had hyposalivation, the mean scores for mutans streptococci, *Lactobacilli* spp. and *Candida* spp. were significantly higher than those of patients who did not have hyposalivation (Table 4).

Discussion

In the present study, the authors investigated the presence of xerostomia and hyposalivation in ambulatory patients with type 2 DM. The authors found that 62% of our patients reported at least one symptom of xerostomia. When intra-oral examination was performed, 64% of patients had some degree of dry oral mucosa. A modified Schirmer test was performed in each case and 46% were found to have hyposalivation, defined as an MST value ≤ 25 mm at 3 min. Both the duration of diabetes and the degree of diabetes control were not significantly different between those who had and did not have hyposalivation. In addition, there was no correlation between the duration of diabetes or the level of diabetes control and the MST values. Both hypertension and dyslipidemia did not affect the MST values, but the presence of hyposalivation appeared to increase and the MST values decreased as the number of medications was ≥ 7. Mutans streptococci, *Lactobacilli* spp. and *Candida* spp. were common oral flora in these patients, and the number of mutans streptococci, *Lactobacilli* spp. and *Candida* spp. were significantly higher in the saliva of patients with hyposalivation compared with those without hyposalivation.

Saliva plays a pivotal role in maintaining a healthy oral environment. A reduction in saliva output, or hyposalivation, has been associated with changes in oral microflora and various oral pathologies. In normal healthy subjects, there is a wide range of salivary flow, and several methods have been traditionally utilized to measure the salivary flow rate, such as gravimetric and volumetric measurements[20]. These methods, such as drooling or spitting, however, are cumbersome, mainly used in research, and impractical in clinical practice. Therefore, several simple techniques for measuring salivary flow rate have been developed[21,22]. Among these tests, a modified Schirmer test has emerged as an inexpensive, easy-to-perform, and standardized test to be used in the dental office. Fontana et al. evaluated the relationship between the MST and other traditional methods and found that there was an association between the MST and volumetric/gravimetric methods. In addition, a cut-off value of ≤ 25 mm at 3 min provided high sensitivity and specificity[17]. Data from Chen et al. indicated that the MST value of 15 mm at 3 min could distinguish between control subjects and patients who had profound xerostomia and hyposalivation[18]. In another study of 331 patients referred for oral and maxillofacial evaluation, the MST ≥ 28 mm at 3 min was considered normal[23].

Systemic diseases, medications, and therapeutic radiation are common causes of hyposalivation. In older persons, medication use is the most common cause of complaints of xerostomia and salivary gland hypofunction. It has been reported that the percentage of patients complaining of oral dryness increases as the daily number of medications increases[24,25]. Similarly, the salivary flow rate declines as the number of medications increases[26,27]. Several medications act as potent inhibitors of saliva production, including antidepressants, antipsychotics, antihypertensives, antihistamines, and decongestants[28]. In the present group of patients, there was a trend towards lower MST values as the total number of daily medications increased.

DM has also been associated with xerostomia and hyposalivation. Both symptoms of dry mouth and impaired salivary flow rate have been reported in patients with type 1 DM, especially in those with neuropathy[6]. In type 2 DM, several studies have been performed to examine the presence of xerostomia and

hyposalivation in these patients, however, most of the studies involved only a small number of subjects, and the methods used to measure salivary flow were impractical in clinical practice. The present study included a large number of ambulatory patients with type 2 DM being followed in the outpatient Endocrine Clinic and used the MST to measure the unstimulated salivary flow. The authors found that the prevalence of xerostomia was 62%, whereas hyposalivation was documented in 46% of patients. Only a few studies have reported the prevalence of xerostomia in type 2 DM, ranging from 43 - 76%[8,9,15]. Carda et al conducted a study in 17 patients with type 2 DM and 16 control subjects and found that the prevalence of xerostomia was 76%[8]. In another study, the prevalence of xerostomia was identified to be 43% in 40 adult diabetic patients. Although 40 healthy non-diabetic control subjects were included in the present study, there was no report on the prevalence of xerostomia in the control group[15]. Sandberg and Wikblad also reported the prevalence of xerostomia to be 54% in 102 randomly sampled type 2 diabetic patients from a health care district in mid-Sweden, however, no control group was included in this study[9]. The difference in the prevalence among these studies is probably due to a small number of patients and the selection bias. Therefore, the authors enrolled a large number of unselected patients in the ambulatory clinic for the study to reflect the prevalence in day-to-day clinical practice, and also included non-diabetic controls for comparison.

Although questionnaire for xerostomia is a good screening tool, several studies have shown that results from the questionnaire do not correlate well with the salivary flow[3,29]. The authors found that 34% of patients who had hyposalivation did not have symptoms of xerostomia. Similarly, 37% of patients who reported all three symptoms of xerostomia did not have hyposalivation. The result from the present study suggests that measurement of salivary flow should be performed in patients who complain of xerostomia to document hypofunction of the salivary gland. An MST, which is practical, standardized, and easy to perform in the clinical setting, is therefore preferred over other methods.

Hyposalivation has been reported to be associated with changes in oral microbial flora. In a group of 20 non-diabetic patients, subjects with hyposalivation were found to have a significant increase in the number of mutans streptococci and *Lactobacilli* spp.[5]. These microbial flora are risk factors for the development of caries. A higher number of diabetic patients also had oral *Candida* spp. compared with control[30], although it was unclear whether it was related to xerostomia or salivary flow rate[10,30]. Again, these studies were performed only in a small number of subjects. In the present study, the authors found that diabetic patients with hyposalivation had significantly increased mean scores of mutans streptococci, *Lactobacilli* spp. and *Candida* spp. in the saliva compared with those without hyposalivation. The presented data suggest that hyposalivation in patients with DM is associated with alterations in oral microbiota. Because both mutans streptococci and *Lactobacilli* spp. are associated with dental caries and patients with diabetes are prone to caries, it is possible that this increase in caries incidence is a result of hyposalivation in these patients. In addition, saliva is known to have antimicrobial activity [31], therefore, a reduction in saliva may predispose the patient to other oral complications, such as gingivitis, periodontitis, and certain mucosal infections.

The result from our present study illustrates a prevalent, but often under-investigated oral health problem in patients with type 2 DM. Immediate implication from the present study for treatment of patients with type 2 DM is to start assessment of xerostomia and hyposalivation in these patients. Whether treatment of xerostomia or hyposalivation in patients with type 2 DM results in alterations in oral microbial flora, quality of life or clinical outcomes requires further investigation.

Acknowledgements

The authors thank Ms Chanutda Radarit and Ms Worakamol Naen-Udorn for excellent clinical and technical assistance. Dr Sook-Bin Woo for her critical review of the manuscript. This work was supported by the Ratchadapiseksompotch Fund, Hormone Research Fund, Anandamahidol Foundation, and the Research Fund of the Endocrinology and Metabolism Unit, Department of Medicine, Faculty of Medicine, Chulalongkorn University.

References

1. Dodds MW, Johnson DA, Yeh CK. Health benefits of saliva: a review. J Dent 2005; 33: 223-33.
2. Sreebny LM. Saliva in health and disease: an appraisal and update. Int Dent J 2000; 50: 140-61.
3. Nederfors T. Xerostomia and hyposalivation. Adv Dent Res 2000; 14: 48-56.

4. Atkinson JC, Wu AJ. Salivary gland dysfunction: causes, symptoms, treatment. J Am Dent Assoc 1994; 125: 409-16.
5. Almstahl A, Wikstrom M. Microflora in oral ecosystems in subjects with hyposalivation due to medicines or of unknown origin. Oral Health Prev Dent 2005; 3: 67-76.
6. Moore PA, Guggenheimer J, Etzel KR, Weyant RJ, Orchard T. Type 1 diabetes mellitus, xerostomia, and salivary flow rates. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 92: 281-91.
7. Dodds MW, Yeh CK, Johnson DA. Salivary alterations in type 2 (non-insulin-dependent) diabetes mellitus and hypertension. Community Dent Oral Epidemiol 2000; 28: 373-81.
8. Carda C, Mosquera-Lloreda N, Salom L, Gomez de Ferraris ME, Peydro A. Structural and functional salivary disorders in type 2 diabetic patients. Med Oral Patol Oral Cir Bucal 2006; 11: E309-14.
9. Sandberg GE, Wikblad KF. Oral dryness and peripheral neuropathy in subjects with type 2 diabetes. J Diabetes Complications 2003; 17: 192-8.
10. Kadir T, Pisiriciler R, Akyuz S, Yarat A, Emekli N, Ipbuker A. Mycological and cytological examination of oral candidal carriage in diabetic patients and non-diabetic control subjects: thorough analysis of local aetiologic and systemic factors. J Oral Rehabil 2002; 29: 452-7.
11. Chavez EM, Borrell LN, Taylor GW, Ship JA. A longitudinal analysis of salivary flow in control subjects and older adults with type 2 diabetes. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 91: 166-73.
12. Meurman JH, Collin HL, Niskanen L, Toyry J, Alakuijala P, Keinanen S, et al. Saliva in non-insulin-dependent diabetic patients and control subjects: The role of the autonomic nervous system. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998; 86: 69-76.
13. Narhi TO, Meurman JH, Odont D, Ainamo A, Tilvis R. Oral health in the elderly with non-insulin-dependent diabetes mellitus. Spec Care Dentist 1996; 16: 116-22.
14. Ben Aryeh H, Serouya R, Kanter Y, Szargel R, Laufer D. Oral health and salivary composition in diabetic patients. J Diabetes Complications 1993; 7: 57-62.
15. Sreebny LM, Yu A, Green A, Valdini A. Xerostomia in diabetes mellitus. Diabetes Care 1992; 15: 900-4.
16. Fox PC, Busch KA, Baum BJ. Subjective reports of xerostomia and objective measures of salivary gland performance. J Am Dent Assoc 1987; 115: 581-4.
17. Fontana M, Zunt S, Eckert GJ, Zero D. A screening test for unstimulated salivary flow measurement. Oper Dent 2005; 30: 3-8.
18. Chen A, Wai Y, Lee L, Lake S, Woo SB. Using the modified Schirmer test to measure mouth dryness: a preliminary study. J Am Dent Assoc 2005; 136: 164-70.
19. Thaweboon B, Thaweboon S, Sopavanit C, Kasetsuwan R. A modified dip-slide test for microbiological risk in caries assessment. Southeast Asian J Trop Med Public Health 2006; 37: 400-4.
20. Humphrey SP, Williamson RT. A review of saliva: normal composition, flow, and function. J Prosthet Dent 2001; 85: 162-9.
21. Wolff A, Herscovici D, Rosenberg M. A simple technique for the determination of salivary gland hypofunction. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002; 94: 175-8.
22. Ogami K, Sakurai K, Ando T. A method of measuring salivary flow rate in the lower labial mucosal region. J Oral Rehabil 2004; 31: 861-5.
23. Zunt SL, Lee L, Woo SB. Identification of salivary gland hyposalivation in the management of oral mucosal disease [abstract]. Oral Surg Oral Med Oral Pathol 2002; 94: 210.
24. Sreebny LM, Valdini A, Yu A. Xerostomia. Part II: Relationship to nonoral symptoms, drugs, and diseases. Oral Surg Oral Med Oral Pathol 1989; 68: 419-27.
25. Thorselius I, Emilson CG, Osterberg T. Salivary conditions and drug consumption in older age groups of elderly Swedish individuals. Gerodontics 1988; 4: 66-70.
26. Osterberg T, Landahl S, Hedegard B. Salivary flow, saliva, pH and buffering capacity in 70-year-old men and women. Correlation to dental health, dryness in the mouth, disease and drug treatment. J Oral Rehabil 1984; 11: 157-70.
27. Handelman SL, Baric JM, Saunders RH, Espeland MA. Hyposalivatory drug use, whole stimulated salivary flow, and mouth dryness in older, long-term care residents. Spec Care Dentist 1989; 9: 12-8.
28. Scully C. Drug effects on salivary glands: dry mouth. Oral Dis 2003; 9: 165-76.
29. Longman LP, McCracken CF, Higham SM, Field EA. The clinical assessment of oral dryness is a significant predictor of salivary gland

hypofunction. Oral Dis 2000; 6: 366-70.
30. Belazi M, Velegraki A, Fleva A, Gidarakou I, Papanaum L, Baka D, et al. Candidal overgrowth in diabetic patients: potential predisposing factors. Mycoses 2005; 48: 192-6.
31. Tenovuo J. Antimicrobial agents in saliva - protection for the whole body. J Dent Res 2002; 81: 807-9.

อาการปากแห้ง ภาวะการลดลงของการไหลของน้ำลายและระดับเชื้อในช่องปากในผู้ป่วยเบาหวานชนิดที่สอง: การศึกษาเบื้องต้น

สิริบังอร พิบูลนิยม โชวิฑูรกิจ, ทองฉัตร สุวรรณตัณทุลา, สร้อยศิริ ทวีบูรณ์, สมศักดิ์ ไมตรีรัตนกุล, อุมาวดี ชมแขไข, วีรพันธุ์ โชวิฑูรกิจ

วัตถุประสงค์*: ภาวะปากแห้งสามารถนำไปสู่โรคในช่องปากได้หลายโรค เช่น โรคฟันผุ โรคปริทันต์อักเสบ และการติดเชื้อในช่องปาก ภาวะปากแห้งยังมีความสัมพันธ์กับโรคเบาหวานชนิดที่ 2 การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาความชุกของอาการปากแห้ง (ความรู้สึกว่าปากแห้ง) ภาวะการลดลงของการไหลของน้ำลาย (มีการลดลงของน้ำลายจากการวัด) และระดับเชื้อในช่องปากในผู้ป่วยไทยที่เป็นโรคเบาหวานชนิดที่สอง*

วัสดุและวิธีการ*: คณะผู้วิจัยได้ทำการสัมภาษณ์ผู้ป่วยเบาหวานชนิดที่สองจำนวน 154 คนและตัวแทนกลุ่มควบคุมที่ไม่ได้เป็นโรคเบาหวานจำนวน 50 คนถึงความรู้สึกของการมีปากแห้ง ประเมินประวัติและผลทางห้องปฏิบัติการของผู้ป่วยเบาหวานชนิดที่สองจากบันทึกประวัติทางการแพทย์ถึงการควบคุมระดับเบาหวานของผู้ป่วย จากนั้นผู้ป่วยและกลุ่มควบคุมได้รับการตรวจช่องปากและวัดระดับน้ำลายโดยวิธีการหาค่า เอ็มเอสที (MST: Modified Schirmer Test) จากการทดสอบที่ดัดแปลงจากการทดสอบเชอร์เมอร์ และวัดระดับเชื้อในช่องปากด้วยวิธี โมดิฟายด์ ดิบ สไลด์ (modified dip slide test)*

ผลการศึกษา*: ความชุกของอาการปากแห้งในผู้ป่วยเบาหวานชนิดที่สองพบร้อยละ 62 เปรียบเทียบกับร้อยละ 36 ในกลุ่มควบคุมที่ไม่เป็นเบาหวาน (ค่านัยสำคัญทางสถิติเท่ากับ 0.001) ความชุกของภาวะการลดลงของการไหลของน้ำลาย (นิยามจากค่าเอ็มเอสทีน้อยกว่าหรือเท่ากับ 25 มิลลิเมตรที่เวลา 3 นาที) พบร้อยละ 46 ในผู้ป่วยเบาหวานในขณะที่พบร้อยละ 28 ในกลุ่มควบคุม (ค่านัยสำคัญทางสถิติเท่ากับ 0.03) ผู้ป่วยเบาหวานชนิดที่ 2 ที่มีการลดลงของระดับน้ำลายมีจำนวนเชื้อในช่องปากสูงกว่าผู้ป่วยที่มีระดับน้ำลายที่ปกติ*

สรุป*: อาการปากแห้งและภาวะการลดลงของการไหลของน้ำลายพบได้บ่อยในผู้ป่วยเบาหวานชนิดที่สอง และพบความสัมพันธ์ระหว่างการลดลงของการไหลของน้ำลายกับจำนวนเชื้อที่พบในน้ำลายของผู้ป่วย*