Periodontal Health and its Relationship with Salivary Factors among Different Age Groups in a Saudi Population

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Purpose: This study aimed to describe the periodontal condition of children, adolescents and young Saudi adults and to investigate its relationship with salivary variables and oral hygiene status.

Materials and Methods: A sample of 114 children, 99 adolescents and 99 young adults were randomly selected from patients attending dental clinics at the school of dentistry. Clinical examination of oral health status included using WHO Community Periodontal Index and Green and Vermillion oral hygiene index. In addition, salivary flow rate, pH, buffering capacity and microbial flora were measured.

Results: A healthy periodontal condition was found in 6.7% of the sample. Calculus was the most frequently encountered periodontal disease. Children had better periodontal condition than adolescents and adults. Males had higher plaque and gingival scores than females. The salivary flow rate and pH were significantly higher in individuals with good periodontal condition. The salivary level of fluoride and buffering capacity was not related to the periodontal condition. Yeast was the only microorganism related to periodontal condition. The relationship between poor periodontal condition and high plaque score was highly significant.

Conclusions: Periodontal disease increased with age and was strongly related to salivary flow rate, pH value and yeast level, as well as plaque accumulation. Preventive efforts must be increased in order to achieve the WHO goal for the year 2010 of no more than one sextant showing bleeding or calculus at the age of 15.

Key words: community periodontal index, microbial flora, oral hygiene, saliva

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At the global level, marked changes in oral disease patterns have been observed in recent decades. In several industrialised countries, the adult population maintains a functional dentition and a significant reduction in rates of edentulism has been noted (Walker and Cooper, 2000; Albandar, 2005). For developing countries and especially in the Middle East, the trend for periodontal health prevalence is not particularly clear.

Gingival and periodontal diseases are common in adults aged 50 years or older (Schurch and Lang, 2004; Holm-Pedersen et al, 2006). Multiple factors such as poor oral hygiene, other dental diseases, systemic conditions, medications, socioeconomic disadvantages, inadequate access to care, behavioural problems and decreased motor function may be responsible for poor periodontal conditions (Ship and Crow, 1994; Krustrup and Petersen, 2006).

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Saliva plays an important role in the maintenance of oral function. It lubricates the oral mucosa, aiding in phonation, deglutition and mechanical cleansing of the oral tissues by removing food particles. Biochemical properties of saliva include buffering, dental remineralisation, initial digestion of starch, and antimicrobial actions. Systemic diseases that impair glandular function (such as Sjögren's syndrome), medications, chemotherapy for cancer and therapeutic radiation to the head and neck may reduce total saliva output. Resulting complications include new recurrent caries, fungal infections, xerostomia, dysphagia and difficulty in retaining dentures. Since xerostomia is a fairly common complaint in older people (Pajukoski et al, 2001; Nagler and Hershkovich, 2005), clinicians and researchers have suggested that decreased salivary flow in the elderly may also be related to periodontal disease.

Information regarding the relationship of salivary dysfunction to periodontal health is conflicting. The effect of high or low salivary flow on gingival and periodontal conditions in both healthy unmedicated people and community-dwelling elderly people has been assessed, and significant relationships were reported (Ship and Crow, 1994; Hirotomi et al, 2006). However, some studies suggest that there is no consistent relationship between major salivary gland flow rates and gingival and periodontal conditions in healthy people (Crow and Ship, 1995; Pattanaporn and Navia, 1998) or between periodontal condition and the number of bacteria present in the saliva (Dini, 2001; Rowshani et al, 2004). In contrast, in a study of the oral health in adolescents from a French town, gingival index was found to be strongly related to mutans streptococci count in saliva (Weissenbach et al, 1995). In a comparison of the microbial flora of periodontally healthy patients and chronic periodontitis patients, the strains from the former group showed a lower antimicrobial activity against *Streptococcus mutans* (SM) (Koll-Klais et al, 2005).

Oral disease is influenced by a number of aetiological factors. It is important to investigate the web of relationships, including the age, ethnic and socio cultural conditions of different populations. Studies on periodontal status and its relationship to salivary variables are still rare in Saudi Arabia. The aims of this study were to assess periodontal health among a group of generally healthy Saudi individuals stratified according to age, and to determine the relationships between periodontal condition and different salivary variables, such as flow rate, pH, buffering capacity and microbial flora.

MATERIALS AND METHODS

Study sample

Using the random number table, 312 outpatients attending screening clinics at the school of dentistry, King Abdulaziz University, were selected according to their serial number. The age of participants ranged from 6 to 40 years. The sample was then stratified according to age into three groups. The age and sex distribution of the participants are shown in Table I. Study subjects received a questionnaire requesting information on medication and general medical status. Subjects who had been regular users of any medication for systemic disorders (such as corticosteroids, antidepressants and antihypertensives) within the previous 3 months were excluded from the study.

Before starting the study, a proposal was approved by the ethical committee, and all the patients signed an informed consent form.

Method

Saliva was collected from each of the subjects for evaluation of flow rate, pH level, buffering capacity, fluoride level and microbiological assay for the proportion of SM, *Lactobacillus* (LB) and yeast counts. All salivary tests were made according to the instructions given by the manufacturer. Two calibrated, qualified and experienced dentists conducted the clinical examination and saliva analysis.

Saliva analysis

Flow rate

Under close supervision, saliva samples were collected from subjects between 9:00 and 12:00 noon, no earlier than 2 hours after meal. Prior to collection of each sample the subject was asked to sit down and relax. Unstimulated saliva was collected first for 5 minutes, after which paraffin-stimulated saliva was collected for 5 minutes. The saliva was collected in a graduated sampling tube fitted with a funnel.

Buffering capacity

Saliva buffering capacity was assessed immediately after the collection using a commercial Dentobuff strip test (CRT Buffer, Vivadent). The buffer effect was determined by comparing visually the colour

Table 1 Distribution of periodontal scores among study sample, according to age (years) and sex

CPI	Group A (6–12 years)						Group B (13–18 years)						Group C (19–40 years)						Overall total	
	Male (N = 46)		Female (N = 68)		Total (N = 114)		Male (N = 44)		Female (N = 55)		Total (N = 99)		Male (N = 43)		Female (N = 56)		Total (N = 99)		(N = 312)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
0	5	10.9	10	14.7	15	13.2	1	2.3	2	3.6	3	3.0	1	2.3	2	3.6	3	3.0	21	6.7
1	18	39.1	37	54.4	55	48.2	12	27.3	17	30.9	29	29.3	1	2.3	4	7.1	5	5.1	89	28.5
2	16	34.8	15	22.1	31	27.2	27	61.4	24	43.6	51	51.5	17	39.5	37	66.1	54	54.5	136	43.5
3	7	15.2	6	8.8	13	11.4	4	9.1	12	21.8	16	16.2	24	55.8	13	23.2	37	37.4	66	21.2
P value			0.02						NS						NS				0.000*	

CPI score 0, no periodontal disease
CPI score 1, gingival bleeding
CPI score 2, calculus
CPI score 3, shallow pockets 4–5mm
*P value of difference between age groups
NS, not significant

changes in the Dentobuff strip, employing the manufacturer's colour chart. The buffering capacity was rated as: 1, low; 2, intermediate; or 3, high.

pH value

The pH of the collected stimulated and unstimulated saliva was measured using a benchtop pH meter immediately after collection (EC 40 pH/ISE meter, model 50265, Hach Company, Loveland, CO, USA).

Fluoride level

Fluoride was determined in the collected samples with the use of a fluoride meter EC40 pH / ISE (Fluoride Electrode Model 50265, Hach).

Microbial compositions

Salivary counts of SM and LB were determined from stimulated and unstimulated saliva using the commercial techniques for Dentocuff-SM and Dentocult-LB (CRT bacteria, Vivadent). The classification of test scores 1 and 2 correspond to $<10^5$ and $\geq 10^5$ colony forming units (CFU)/ml respectively.

To record the presence of yeast, the saliva samples were vortexed (Vortex, Scientific Industries, Springfield, NY, USA) for 1 minute and then 10-fold serially diluted to 10^{-2} in reduced transport fluid (RTF). From the undiluted sample and the dilutions 50 ml aliquots were spread on sabouraud dextrose agar (SAB) plates (Oxiod, Basingstoke, UK) using a sterile glass spreader. The plates were incubated at 30°C for 3 days. Yeast colonies were recorded as present or absent. Fifteen saliva samples were excluded from yeast analysis because there was insufficient collected saliva or contamination of the samples.

Clinical examination

Periodontal status was assessed by the Community Periodontal Index (CPI) using the Community Periodontal Index for treatment need (CPITN) probes (WHO 621) on the six standard index teeth (World Health Organization, 1997). Oral hygiene was assessed using the Green and Vermillion Oral Hygiene Index (OHI) (Green and Vermillion, 1964).

Table 2 Relationships between periodontal condition and salivary variables in resting and stimulated saliva

Periodontal condition		Buffer			Salivary variables Mean flow rate (ml/min)	Mean pH	Mean fluoride (ppm)
		1	2	3			
Resting saliva							
Least disease (N = 110)	**n**	37	63	10	0.606	7.07	0.155
	%	33.6	57.3	9.1			
Most disease (N = 202)	**n**	58	117	27	0.728	7.18	0.158
	%	28.7	57.9	13.4			
***P* value**			NS		NS	NS	NS
Stimulated saliva							
Least disease	**n**	1	29	80	1.629	7.34	0.149
(N = 110)	**%**	0.9	26.4	72.7			
Most disease (N = 202)	**n**	6	42	154	1.352	7.49	0.149
	%	3	20.8	76.2			
***P* value**			NS		0.002	0.01	NS

NS, not significant

Statistical analysis

Data were recorded using a database program and analysed using the statistical software program SPSS, version 10. Kappa values for inter- and intra-observer reliability of the two examiners were 0.94 and 0.89 respectively. The chi-square test of independence was used to evaluate the distribution of periodontal disease according to age and sex. The relationships between periodontal condition and microbial data were assessed using the chi-square test.

Analysis of variance (ANOVA) was used to test the significance of the difference of the mean values of oral hygiene index among different age groups, while student *t* test was used to test the sex difference and relationship between OHI and periodontal condition for the most and the least periodontal disease level groups. A *P* value of < 0.05 was used to determine statistical significance.

RESULTS

The age and sex distribution of the CPI scores are shown in Table 1. Score zero was recorded in 13.2% of children, whereas the proportion decreased to 3% in both adolescents and adults. Scores 2 and 3 were the highest recorded scores in adults, followed by adolescents, with the least scores of 2 and 3 in children. The differences between age groups were highly significant (*P* = 0.000). The sex difference was statistically significant in the children group, where scores 0 and 1 were recorded in higher proportions in females than in males. In adolescents and adults, sex differences were not significant.

For a clearer and more meaningful statistical comparison of salivary parameters, the CPI classes of scores were dichotomised. The subjects were classified into two groups: individuals who had CPI scores 2 and 3 were considered as the group with higher periodontal disease level. Groups with scores zero and 1

Table 3 Relationships between periodontal condition and microorganisms in resting and stimulated saliva

Periodontal condition		SM		LB		Yeast	
		Low 105	High 105	Low < 105	High 105	Present	Absent
Resting saliva							
Least disease (N = 110)	**n**	49	61	45	65	38	58
	%	32.5	37.9	36.6	34.4	32.2	32.4
Most disease (N = 202)	**n**	102	100	78	124	80	121
	%	67.5	62.1	124	65.6	67.8	67.6
***P* value**		NS		NS		NS	
Stimulated saliva							
Least disease (N = 110)	**n**	49	61	42	68	55	41
	%	31.4	39.1	35	35.6	37.4	27.3
Most disease (N = 202)	**n**	107	95	78	124	92	109
	%	68.6	60.9	65	64.6	62.6	72.7
***P* value**		NS		NS		0.02	

NS, not significant

were considered as the group with lower periodontal disease level. Table 2 shows the correlation between periodontal condition and different salivary variables in resting and stimulated saliva. No statistical differences were evident among groups concerning flow rate, buffering capacity, pH or fluoride level of resting saliva.

On the other hand, a statistically significant relationship was found between periodontal condition and salivary variables in stimulated saliva. Among the individuals with the least periodontal disease, the flow rate was significantly higher and the pH value was lower than for those with higher levels of periodontal disease. This trend was not evident when buffering capacity and fluoride levels of saliva were considered.

Table 3 presents the values of SM, LB and yeast in resting and stimulating saliva for each group. Analysis showed that none of the resting saliva levels of the microorganisms investigated significantly influenced the periodontal status. The levels of microorganisms in stimulated saliva revealed a significant relationship between yeast and periodontal disease. There were significantly more yeast colonies in subjects with more periodontal disease compared with those with less periodontal disease. No significant relationships were found between periodontal status and SM or LB salivary levels.

Table 4 shows the distribution of OHI scores according to age, sex and periodontal condition. OHI was not correlated to age but it was significantly higher in males than in females, as well as in those with more periodontal disease compared with individuals with lower levels of periodontal disease.

DISCUSSION

This study aimed to record periodontal condition of Saudi individuals of different age groups. The CPITN was used because it has proved to be a simple and

Table 4 Distribution of oral hygiene scores according to age, sex and periodontal condition

Variables		Oral hygiene condition	
Age (years)		Mean ± SD	*P* value
6–12		1.248 ± 0.653	
13–18		1.322 ± 0.703	
19–40		1.189 ± 0.726	
Total		1.254 ± 0.692	NS
Sex	Males	1.420 ± 0.735	0.03
	Females	1.129 ± 0.632	
Periodontal condition	Most disease	1.356 ± 0.732	0.000
	Least disease	1.064 ± 0.651	

NS, not significant

effective method for measuring and monitoring the severity of periodontal disease at the community level (Dini, 2001; Almas et al, 2005; Senna et al, 2005).

Healthy gingiva was found in only 6.7% of individuals. Our results showed a higher percentage of periodontal disease compared with Jordanian adults, where a healthy gingiva was reported in 41% of the 20- to 29-year-old population (El-Qaderi and Quteish Ta'ani, 2004). Healthy gingiva showed the highest percentage (13.2%) in the 7 to 12 year age group. This percentage decreased to 3% in the oldest age group. This finding is in agreement with many studies that have reported the prevalence of periodontal disease to be higher in adults than in children (Dini, 1994; Khamrco, 1999; Califano, 2006).

Calculus was the most frequently encountered periodontal condition when the total sample was considered as a whole, as well as in the adolescent and adult groups. This highlights the importance of reinforcing oral hygiene instruction among these age groups. As for children, the most prevalent periodontal condition was bleeding on probing. The reviewed literature revealed few studies using the CPITN to assess the periodontal condition in children. Two studies carried out on schoolchildren, using CPITN, reported bleeding as the most frequently observed condition (Guile et al, 1990; Dini, 2001). However, children from Asia and Central America were reported to have calculus as the most prevalent condition (Pilot et al, 1987; Vignarajah, 1990; Corbet, 2006). Shallow pockets were present in 21.2% of the study sample. None of the studied individuals had deep pockets. The findings suggest that periodontal disease in the study population ranged from low to moderate, and that it increases with age. The treatment needed for periodontal disease of this population is improving oral hygiene and scaling as recommended by WHO in the CPITN methodology. Therefore, the results show the importance of primary prevention programmes, which should be given first priority when planning health care.

Females showed less periodontal disease than males probably because they tend to practise better oral hygiene. The gender differences concur with the findings of other studies (Mack et al, 2004; Holm-Pedersen et al, 2006).

There is debate regarding the amount of saliva necessary to maintain oral haemostasis. Since there is a large variation in salivary output in healthy individuals, it is difficult to determine a cut-off amount for normal salivary flow rate (Ship et al, 1991). In addition, because the flow rate depends on the collection method, the normal range might differ from one study to another. For those reasons, in the present study comparison of the mean flow rate was carried out between

individuals with the highest and lowest periodontal disease levels.

The results of the present study demonstrate a relationship between periodontal condition and stimulated salivary flow rate. Subjects with the lowest levels of gingival and periodontal disease had a higher stimulated flow rate than those with high levels of disease. The parameter of resting saliva was not significantly related to periodontal disease. When evaluating flow rate in various conditions, it is important to measure both resting and stimulated rates. Some studies reported resting parotid and submandibular salivary flow rates to be approximating zero even in healthy individuals (Ship et al, 1991; Wu and Ship, 1993), while stimulated flow rates demonstrate the response of the gland to physiological challenges (Heft and Baum, 1984).

The pH was significantly related to periodontal condition. This finding could have arisen because the high pH is associated with super-saturation of saliva with basic calcium phosphate salts. These salts probably enhance calculus accumulation.

The initiation and progression of periodontal disease are the result of the colonisation and multiplication of microorganisms in subgingival sites, stimulation of the host immune system, and the release of host immune factors causing tissue damage (Haffajee and Socransky, 2005).

The present study showed that calculus and clinically detectable gingival pockets were significantly related to the presence of yeast. It was suggested that when yeast gains access to underlying periodontal tissues, damage results from the metabolites produced by the yeast (Haffajee and Socransky, 2005). de Repentigny et al (2000) reported that yeasts have greater adherence to human buccal epithelial cells, mucin, and the oral bacterium *Fusobacterium nucleatum.* In addition, yeasts have significantly higher proteinase activity, which has been shown to degrade mucins, the major constituents of mucus (de Repentigny et al, 2000). With interactions among microorganisms shown to be an important step in infectious disease processes in the oral cavity, the ability of yeast to adhere to *F. nucleatum* may aid in colonisation of deep sulci of periodontal pockets (George and Falkler, 1992).

The lack of a significant difference in the number of SM and LB organisms corresponds with data from previous studies, which found that salivary levels of SM and LB had positive relationships with caries but not with periodontal disease (Timmerman et al, 1998; Brambilla et al, 1999; Rowshani et al, 2004). In contrast, Beighton et al (1996), upon examining 12-year-old English schoolchildren, reported that salivary levels of SM, LB and yeast were significantly correlated with gingival index scores.

Plaque index scores were higher among males than females. Males seem to be less compliant with toothbrushing and oral hygiene in general compared with females.

The present study demonstrated a high correlation between plaque status and periodontal condition, highlighting the importance of plaque control programmes to improve oral health condition. Schools should be encouraged to implement oral health care programmes. Teachers should be trained to screen children and to supervise oral hygiene practices during the school day, especially following lunch break. They should also advise those with oral health problems to seek treatment.

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