Tobacco Smoking and Gingival Health in a Saudi Arabian Population

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Purpose: While cigarette smoking is recognized as being detrimental to periodontal health, the effect of water pipe smoking on gingival health is not known. The present study was conducted to determine whether water pipe smoking has an influence on gingival health.

Material and Methods: A cross-sectional study was carried out in 244 individuals aged 25–70 years. The levels of plaque and gingivitis were recorded on four sites of all present teeth, using the plaque index (PI) and gingival index (GI). Information about oral hygiene practices, dental care and smoking habits was obtained at the time of the clinical examination in accordance with a predetermined questionnaire.

Results: The means of plaque index and gingival index values were 1.2 and 0.9, respectively. Similarly, the mean percentages of surfaces with plaque and gingival bleeding sites were 66.7% and 30.4%, respectively. There was an overall significant association between smoking and plaque index and gingival index ($F = 22.9$ and $F = 10.8$, respectively, $p < 0.001$). Oral hygiene was inferior in water pipe smokers, cigarette smokers, and mixed smokers when compared to non-smokers. The correlation between plaque % and gingival bleeding % in cigarette smokers was significantly weaker than in non-smokers. It was also weaker in water pipe smokers, but the difference was not statistically significant.

Conclusion: The gingival bleeding response to plaque was significantly suppressed in cigarette smokers. There was a tendency towards suppression also in water pipe smokers.

Key words: cigarettes, gingival bleeding, Saudi Arabia, tobacco smoking, water pipe

Oral Health Prev Dent 2004; 2: 351–357. Submitted for publication: 17.02.04; accepted for publication: 10.06.04.

A substantial body of evidence has demonstrated the detrimental effect of cigarette smoking on periodontal health. Clinical and epidemiological observations indicate that the prevalence and severity of periodontal disease as well as its progression rate are increased in smokers (Bergstrom and Eliasson, 1987; Haber and Kent, 1992; Horning et al, 1992; Bergstrom et al, 2000; Kerdvongbundit and Wikesjo, 2002; Khader et al, 2003). Although cigarette smoking is the habit most widely studied, other tobacco smoking habits such as cigar and pipe smoking seem to be equally harmful and appear to have a similar adverse effect on periodontal health (Feldman et al, 1987; Krall et al, 1999; Albandar et al, 2000). One habit of tobacco smoking that has not been investigated regarding its possible effects on periodontal health is water filtered tobacco smoking (known as hubble-bubble, nargila, argila, hookah, or sheesha). This smoking habit has old traditions and is widely encountered in the countries of South Asia, the Middle East and North Africa. The tobacco used is moist and flavored with cooked fruits, and is placed under burning charcoal to keep the tobacco burning. Among reported health effects of water pipe smoking are increased blood carboxyhemoglobin levels (Zahran et al, 1985) and impaired pulmonary function (Kiter et al, 2000).

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Table 1 Study group, distribution by age and gender

Age Group	Age	Male		Female		Total	
	Mean (SD)	N	(%)	N	(%)	N	(%)
25 – 40 yr	28.8 (2.9)	74	(69)	38	(31)	107	(100)
35 – 44 yr	38.9 (2.7)	55	(68)	25	(32)	80	(100)
45 – 70 yr	51.3 (4.8)	33	(58)	24	(42)	57	(100)
Total	37.4 (9.5)	162	(66)	82	(34)	244	(100)

Gingival bleeding has been reported as the earliest clinical sign of gingival inflammation (Newbrun, 1984). In cigarette smokers, this sign of gingival inflammation is often altered: a lower exudation rate and bleeding responsiveness have been reported, indicating that smoking exerts a suppressor influence on the gingival inflammatory response (Bergstrom and Floderus-Myrhed, 1983; Preber and Bergstrom, 1985; Bergstrom and Preber, 1986; Bergstrom, 1990; Danielsen et al, 1990; Lie et al, 1998; Bergstrom and Bostrom, 2001; Dietrich et al, 2004). However, other studies found no significant differences between cigarette smokers and non-smokers where gingival health is concerned (Haber et al. 1993; Axelsson et al. 1998; Payne et al. 2000). Whether water pipe smoking, like cigarette smoking, would influence the gingival health, to our knowledge is not yet known. Therefore, the aim of the present investigation was to explore the effect of water pipe smoking on gingival health. The study was carried out in a Saudi Arabian population.

MATERIAL AND METHODS

Study Population

People in the western part of Saudi Arabia – water pipe smokers, cigarette smokers and non-smokers – were invited to participate in the study by means of announcements in newspapers. Clinical examinations were carried out at King Faisal Specialist Hospital and Research Centre, Jeddah, and King Abdul Aziz University, Faculty of Dentistry, Jeddah, Saudi Arabia. In all 375 individuals appeared for screening and 262 (70%) answered a questionnaire and volunteered for an oral clinical examination. The participants were required to exhibit a minimum of 20 teeth, to be in good general health and not being pregnant. In addition, for the purpose of this study individuals below 25 years of age (n = 18) were excluded. Each participant was informed individually about the purpose of the study and signed an informed consent form. The study was approved by the local ethical committee of King Faisal Specialist Hospital and Research Centre, Jeddah, in accordance with the Helsinki Declaration of 1975 and as revised in 1983. The final study population is presented by age and gender in Table 1.

Interview Questionnaire

Each participant was interviewed at the time of the clinical examination in accordance with a predetermined questionnaire with fixed alternative answers. The questionnaire variables were selected to obtain information about dental care habits, oral hygiene habits, education levels, and smoking habits (Table 2). Oral hygiene habits were shown by three questions concerning the frequency of tooth brushing, and dental care habits were revealed by the participant's stated reason for visiting the dentist. Formal education status was classified on a five-point scale according to highest level the participant achieved in the school system in Saudi Arabia: no formal education, primary school only (6 years), intermediate school (9 years), secondary school (12 years), and university. According to their smoking habits, participants were classified as water pipe smokers, cigarette smokers, smokers of both water pipe and cigarettes (mixed smokers),

and non-smokers. The smoking exposure was expressed in terms of consumption, i.e., the number of cigarettes or water pipe runs consumed per day, and duration, i.e., the number of years of smoking.

Clinical Examinations

The presence of visible dental plaque was recorded according to the criteria of Silness and Löe (1964). The mesial, buccal, distal, and lingual surfaces of all teeth except third molars were given a score and the plaque index (PI) of the subject was the arithmetic mean of the sum of scores. In addition, the relative frequency of surfaces with a plaque score of 1 or more was given as a percentage for each subject (plaque %).

The inflammatory condition of the gingiva was evaluated according to the GI method of Löe and Silness (1963). The mesial, buccal, distal, and lingual sites of all teeth except third molars were scored and the arithmetic mean of the sum of scores formed the GI of the subject. In addition, the relative frequency of gingival sites with score 2 or 3, denoting gingival bleeding on probing, was calculated for each subject and given as a percentage (gingival bleeding %).

The probing depth of periodontal pockets of all teeth in each individual was measured to the nearest mm with a Hillming probe at mesial, distal, buccal, and lingual sites per tooth. The periodontal health condition in terms of the frequency (%) of sites with a probing depth of more than 4 mm, 5 mm, and 6 mm, respectively, and number of retained teeth is presented in Table 3.

Statistics

Data are presented as means and 95% confidence intervals (CI). The distributions of the variables, PI, GI, and gingival bleeding percentage followed normality (Kolmogorov-Smirnov test). Statistical significance was tested with 1-factor and 2-factor ANOVA, including *post hoc* multiple comparisons testing according to the Fisher LSD test. Ordinal data were tested with the Chi-square distribution. As a category variable, PI was stratified into: (1) 0 – 0.75, (2) 0.76 – 1.49, (3) 1.50 – 3.0. Pairwise correlations were carried out by means of Pearson's product moment method. The STATISTICA (6.1) software program was used for the calculations (StatSoft Scandinavia AB, Sweden). Statistical significance was accepted at $p < 0.05$.

Table 2 Education, oral hygiene habits, dental care seeking and smoking habits in the study group

Variable	Category	N (%)
Education level	No education	12 (5%)
	Primary	21 (9%)
	Intermediate	32 (13%)
	Secondary	56 (23%)
	University	123 (50%)
Visits to the dentist	Regular	40 (16%)
	Irregular	179 (74%)
	Never	25 (10%)
Tooth brushing	More than twice daily	36 (14%)
	Twice daily	98 (40%)
	Once daily	87 (36%)
	Never	23 (10%)
Smoking habit	Yes	
	Water pipe	76 (31%)
	Cigarettes	49 (20%)
	Both	49 (20%)
	No	70 (29%)

RESULTS

Interview Questionnaire

The results of the interview concerning oral hygiene, dental care, education and smoking habits are presented in Table 2. The frequency of individuals with no, primary, intermediate, secondary, and university education was 5%, 9%, 13%, 23%, and 50%, respectively. The majority of the individuals (84%) visited a dental clinic in case of emergency only or never, while 16% were regular dental care attenders. Ninety per cent reported that they brushed their teeth daily, and 54% brushed their teeth twice daily or more, while 10% never brushed their teeth.

It appears from Table 2 that 31% were water pipe smokers, 20% cigarette smokers, 20% smokers of both water pipe and cigarettes (mixed smokers), and 29% non-smokers. Among cigarette smokers 60% consumed more than 15 cigarettes/day and 49% of water pipe smokers consumed 3 or more runs/day. In addition, 53% of cigarette smokers and

Table 3 Study group. Number of sites with different probing depth, and number of retained teeth. Mean (SD) according to age

Age Group	Periodontal probing depth			Teeth (n)
	≥ 4 mm (n)	≥ 5 mm (n)	≥ 6 mm (n)	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
25 – 34 yr	10.4 (10.2)	3.5 (5.4)	0.8 (1.9)	27.4 (1.4)
35 – 44 yr	16.0 (16.4)	6.1 (8.6)	2.1 (4.1)	26.8 (2.3)
45 – 70 yr	17.0 (15.5)	7.2 (10.1)	2.3 (4.8)	25.1 (4.1)
Total	14.5 (14.6)	5.6 (8.4)	1.7 (3.9)	26.4 (2.9)

Table 4 Study group, distribution by age and smoking

Age group	Smokers						Non-smokers		Total	
	Water pipe		Cigarettes		Water pipe and Cigarettes					
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
25 – 34 yr	28	(37)	22	(45)	31	(63)	26	(37)	107	(43)
35 – 44 yr	27	(36)	18	(37)	14	(29)	21	(30)	80	(33)
45 – 70 yr	21	(28)	9	(18)	4	(8)	23	(33)	57	(24)
Total	76	(100)	49	(100)	49	(100)	70	(100)	244	(100)

50% of water pipe smokers had smoked more than 10 years. The distribution of individuals according to smoking habit and age is presented in Table 4. The mean age of water pipe smokers, cigarette smokers, mixed smokers, and non-smokers was 39.4 yr, 36.7 yr, 34.4 yr and 38.1 yr, respectively. There was an overall significant association between smoking habit and age ($F = 4.5$, $p < 0.01$). The age of mixed smokers was significantly lower than that of water pipe smokers and non-smokers ($p < 0.01$). Women were significantly less frequently tobacco smokers than men ($\chi^2 = 16.4$, $p < 0.001$).

The relationship between smoking and dental care habits was statistically significant ($\chi^2 = 15.7$, $p < 0.01$) suggesting that water pipe smokers were more frequent among irregular dental care attenders (occasionally or never) than were cigarette smokers and non-smokers. In addition, mixed smokers were more common among regular dental care attenders than cigarette smokers and non-smokers. There was no significant relationship between smoking and oral hygiene habits or between smoking and educational standard ($p > 0.05$).

Clinical Observations

The mean PI was 1.6 in water pipe smokers, 1.1 in cigarette smokers, 1.3 in mixed smokers, and 0.7 in non-smokers (Table 5). The association between smoking and PI was statistically significant ($F = 22.9$, $p < 0.001$). *Post hoc* testing revealed that all smoking groups exhibited significantly higher plaque levels than non-smokers. Furthermore, the differences between water pipe smokers and cigarette smokers, and between water pipe smokers and mixed smokers were statistically significant ($F = 15.6$, $p < 0.001$ and $F = 5.8$, $p < 0.01$, respectively). The association remained significant when controlling for age or dental care habit, respectively, as independent factors in 2-factor ANOVAs.

Table 5 Plaque index, plaque percentage, gingival index and gingival bleeding percentage. Mean and 95% CI according to smoking status

Smoking Status	Plaque index Mean (95% CI)	Plaque % Mean (95% CI)	Gingival index Mean (95% CI)	Gingival bleeding % Mean (95% CI)
Water pipe smoker	1.6 (1.5; 1.8)	84.8 (80.0; 89.6)	1.0 (0.9; 1.2)	36.6 (30.6; 42.5)
Cigarette smoker	1.1 (0.9; 1.3)	69.4 (62.3; 76.6)	0.9 (0.8; 1.0)	29.4 (22.9; 35.9)
Mixed smoker	1.3 (1.1; 1.5)	74.6 (67.4; 81.7)	1.0 (0.8; 1.1)	31.4 (24.2; 38.5)
Non-smoker	0.7 (0.6; 0.8)	39.6 (34.1; 45.0)	0.6 (0.5; 0.7)	23.7 (20.3; 27.2)
Total	1.2 (1.1; 1.3)	66.7 (63.0; 70.4)	0.9 (0.8; 0.9)	30.4 (27.5; 33.3)

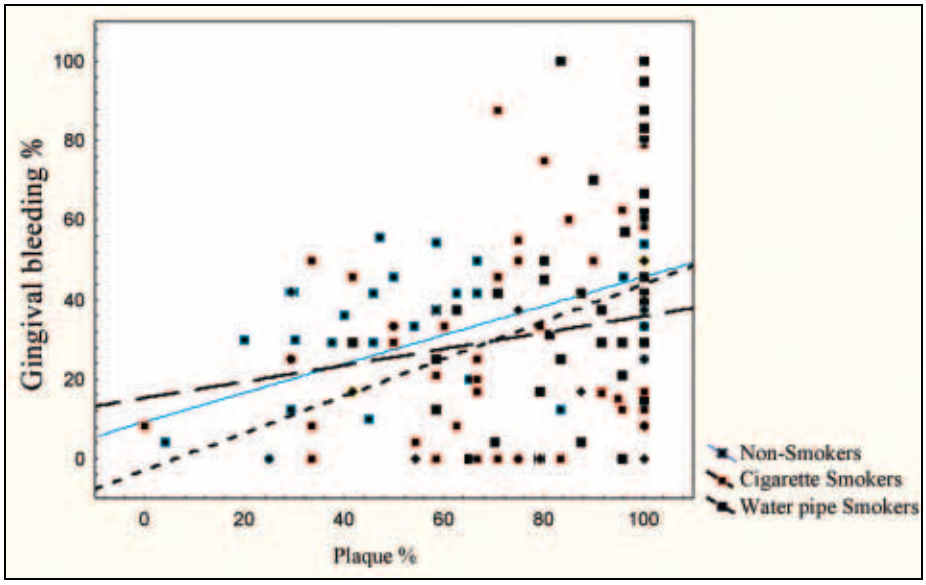

Fig 1 The correlation between plaque % and gingival bleeding % in cigarette smokers ($r = 0.23$, $p > 0.05$), water pipe smokers ($r = 0.37$, $p < 0.001$) and non-smokers ($r = 0.57$, $p < 0.001$).

The mean GI was 1.0 in water pipe smokers, 0.9 in cigarette smokers, 1.0 in mixed smokers, and 0.6 in non-smokers (Table 5). There was an overall significant association between smoking and GI ($F = 10.8$, $p < 0.001$). *Post hoc* testing showed that all smoking groups exhibited significantly higher levels of GI than non-smokers. There were, however, no significant differences between water pipe smokers, cigarette smokers and mixed smokers. The association remained significant when controlling for age and dental care habit, respectively. When controlling for plaque index, however, the significant association between smoking and GI disappeared ($F(3.2) = 0.5$, $p > 0.05$). The same results were obtained when gingival bleeding % was used as measure of gingival health condition. If 20% of gingival bleeding was taken as cut-off for gingival health, 60% of the total population and 72% of water pipe smokers, 59% of cigarette smokers, 59% of mixed smokers, and 46% of non-smokers had a more or less unhealthy gingival condition.

The overall correlation between PI and plaque % was $r = 0.84$ and that between GI and gingival bleeding % was $r = 0.86$. The overall correlations between PI and GI, and between plaque % and gingival bleeding % were $r = 0.63$ and $r = 0.44$, respectively.

The correlation between plaque % and gingival bleeding % in cigarette smokers ($r = 0.23$) was significantly weaker ($p < 0.01$) than that in non-smokers ($r = 0.57$). The correlation between plaque % and gingival bleeding % in water pipe smokers was also lower ($r = 0.37$) than that in non-smokers but the difference was not statistically significant. The correlations between plaque % and gingival bleeding % in cigarette smokers, water pipe smokers and non-smokers are further illustrated in Fig 1.

DISCUSSION

This is the first investigation of the effect of different tobacco smoking habits on the gingival health in a Saudi Arabian population. The study population was obtained by means of announcement in newspapers. The announcement was phrased so as to attract water pipe smokers in particular to participate in the study in order to arrive at a sufficient number of participants with different tobacco habits. This circumstance most likely resulted in an overrepresentation of tobacco smokers in the present study. In the present sample, 70% engaged in at least one form of tobacco smoking. This is a higher proportion than in the general population. The prevalence of cigarette smoking in Saudi Arabia is estimated to be 35% (Siddiqui et al, 2001), while the prevalence of water pipe smoking is estimated to be 17% in elderly Saudi Arabian (Almas et al, 2003). Also with reference to education, the present sample was not representative since the proportion of persons with a comparatively high education level was greater than that of the general population. There were, however, no substantial dissimilarities in education level with respect to tobacco smoking habits.

The vast majority of the participants of the present investigation classified themselves as irregular dental attenders that seek dental care when needed only or never (problem-oriented attenders); only 16% claimed to visit the dentist on a regular basis. This is similar to what has been reported earlier in the Saudi population based on a multicenter questionnaire study (Almas et al, 2000). Although the smoking groups were largely similar in this respect, water pipe smokers were the least and mixed smokers the most regular dental care attenders. This may to some extent be reflected in the observation that water pipe smokers exhibited the highest plaque level.

On the other hand, the vast majority of the participants in the present investigation reported regular daily tooth brushing (87%). Water pipe smokers, cigarette smokers and non-smokers all claimed to have the same oral hygiene practices. Cigarette smokers in the present study conformed to some earlier reports (Mullally and Linden, 1996; Muller et al, 2002) regarding the frequency of daily tooth brushing performance but not to others (Andrews et al, 1998; Al-Wahadni and Linden, 2003).

In spite of the fact that both water pipe smokers and cigarette smokers claimed to practice oral hygiene in as regular a manner as non-smokers, they exhibited significantly higher plaque levels.

The main purpose of the present investigation was to explore whether water pipe smoking, like cigarette smoking, would influence gingival health. For the total study population, the overall GI was 0.9, a value corresponding to the initial stages of clinical inflammation. In terms of gingival bleeding sites the overall mean was 30%, and about 60% of the population exhibited bleeding in excess of 20%. On the average all categories of smokers had inferior gingival health condition when compared to non-smokers.

The inferior gingival health of smokers was due to the fact that their oral hygiene was, on average, inferior. However, when the oral hygiene level was taken into account they did not show increased levels of gingival bleeding. Rather, the correlation between plaque and gingival bleeding was lower in smokers than non-smokers. This held particularly true for cigarette smokers, but there was a trend in the same direction also for water pipe smokers. Thus, it appears that the effect of tobacco smoking on gingival health is marked by a reduced inflammatory response in terms of gingival bleeding in cigarette smokers. This finding is in agreement with those of numerous epidemiological and clinical studies reported previously (Bergstrom and Floderus-Myrhed, 1983; Preber and Bergstrom, 1985; Bergstrom and Preber, 1986; Bergstrom, 1990; Danielsen et al, 1990; Lie et al, 1998; Bergstrom and Bostrom, 2001). The results from the present study, in addition, suggest that water pipe smoking may inflict a suppressive effect on the gingival inflammatory response, which, although weaker than that of cigarette smoking, still may be considered harmful to the gingiva. The effect of water pipe smoking is in contrast to a particular form of smokeless tobacco consumption, the betel chewing tobacco habit, which seems to enhance gingival bleeding (Amarasena et al, 2003). The influence of water pipe smoking on the gingival bleeding merits further investigation.

In conclusion, the results of the present investigation confirm that gingival health is compromised by cigarette smoking as evidenced by a suppressed gingival bleeding response to plaque. In addition, there was a tendency towards suppression also by water pipe smoking, which may indicate an influence on gingival health, although less than that of cigarette smoking that still should be considered of clinical importance.

ACKNOWLEDGMENTS

The authors wish to express their gratitude to Dr Salem Alattas and Dr Safa Janbi, Department of Dentistry, King Faisal Specialist Hospital and Research Centre, Jeddah, Saudi Arabia for their assistance in the data collection.

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