Smoking and Vertical Bone Defects in a Saudi Arabian Population

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Purpose: To investigate the relationship between water pipe and cigarette smoking and the prevalence and severity of vertical periodontal bone defects.

Material and Methods: A study sample of 355 individuals in the age range 17 to 60 years was recruited from Jeddah, Saudi Arabia. Full sets of intra-oral radiographs for each individual were assessed with regard to the presence or absence of vertical bone defects. A vertical defect was defined as an angular resorption of the interdental marginal bone of 2 mm or more at either the mesial or distal aspect of the root.

Results: The overall prevalence of vertical defects was 39%, with a specific prevalence of 47% in water pipe smokers, 54% in cigarette smokers, and 23% in non-smokers. The prevalence was significantly elevated in both types of smokers compared with non-smokers ($p < 0.001$). Expressed as the proportion of sites with vertical defects per person, the severity was 2.6% for water pipe smokers, 2.8% for cigarette smokers, and 1.3% for non-smokers. The association between smoking and severity of vertical defects was statistically significant ($p < 0.001$). The severity of vertical defects was significantly greater in heavy exposure compared to light exposure smokers in water pipe as well as cigarette smokers ($p < 0.001$). The relative risk associated with water pipe and cigarette smoking was 2.9-fold and 6.6-fold increased, respectively, compared to non-smoking.

Conclusion: The present observations suggest that prevalence and severity of vertical periodontal bone defects are increased in tobacco smokers. The association of vertical bone loss with water pipe smoking is comparable to the association with cigarette smoking.

Key words: angular bone loss, cigarette smoking, periodontal disease, Saudi Arabia, tobacco smoking, vertical bone defect, water pipe smoking

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The most common pattern of bone resorption in periodontal disease is the horizontal bone loss. The bone is reduced in height and the bone margin is horizontal or slightly angulated. As the severity of the disease increases, the bone destructive pattern becomes vertically angulated and crater-like resorption occurs (Carranza, 2002). According to the radiographic appearance this pattern of the bone destruction is referred to as a vertical or angular bone defect. The vertical bone defect is characterised by an asymmetrical destruction around the tooth with the base of the defect located apically to the alveolar crest (Pepelassi et al, 2000). Vertical bone loss has been associated with periodontal bone loss and tooth loss and, therefore, the early detection of this phenomenon is considered clinically important (Papapanou and Wennström, 1991). The presence of vertical defects is considered a sign of severe or progressive periodontal disease (Carranza, 2002).

The detrimental effect of cigarette smoking on periodontal health is well documented and smokers exhibit higher occurrence and severity of periodontal

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disease than non-smokers (Bergström and Floderus-Myrhed, 1983; Feldman et al, 1983; Ismail et al, 1983; Preber and Bergström, 1986; Haber and Kent, 1992; Bergström et al, 2000a;b; Jansson and Lavstedt, 2002; Bergström, 2003; 2004; Khader et al, 2003). Cigarette smoking has emerged as a predominating risk factor associated with periodontal bone loss (Bergström and Floderus-Myrhed, 1983; Feldman et al, 1983; Preber and Bergström, 1986; Haber and Kent, 1992; Norderyd and Hugoson, 1998; Persson et al, 1998; Bergström et al, 2000a;b; Jansson and Lavstedt, 2002; Bergström, 2003; 2004). In addition, vertical defects have been observed in a higher frequency in smokers compared to non-smokers (Persson et al, 1998; Baljoon et al, 2004; 2005). Besides cigarette smoking, other forms of tobacco smoking such as cigar and pipe smoking also have a negative impact on periodontal bone (Feldman et al, 1983; Krall et al, 1999).

Water pipe smoking known under different names such as oriental pipe, Argila, Hookah, Sheesha and Goza, is widely practised in Saudi Arabia and in other Middle East countries. This traditional type of smoking is traced back to ancient India. Briefly, in water pipe smoking with each puff mainstream smoke is drawn through the burning tobacco and passes into water via a stem, then enters the rubber tube and is finally delivered to the smoker via a mouth piece. The tobacco used for water pipe smoking contains 2-4% nicotine and is mixed with commercially supplied cooked fruits and sugar syrup of different flavors (Kiter et al, 2000). Even though there are no epidemiological studies regarding the prevalence of water pipe smoking in Saudi Arabia, its popularity seems to be increasing and public toleration to this habit becoming wider. A key question for health professionals is whether or not water pipe smoking negatively affects the periodontal health in a manner similar to that of cigarette and other forms of tobacco smoking.

The aim of the present study was to investigate the relationship between water pipe smoking and periodontal bone loss in terms of vertical bone defects in a Saudi Arabian population.

MATERIAL AND METHODS

Study population

Residents of Jeddah, Saudi Arabia, were invited to participate in the study by means of announcements in newspapers. 355 individuals in the age range 17 to 60 years volunteered for participation. To be included the participants were required to exhibit a minimum of 20 teeth, to be in good general health and not to be pregnant. The study population and the selection criteria have been described in detail elsewhere (Natto et al, 2004). The proportion of males was 71%. Each participant was informed verbally and in writing 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 Center, Jeddah, Saudi Arabia, in accordance with the Helsinki Declaration of 1975 and as revised in 1983.

The clinical and radiographic examinations were carried out at King Faisal Specialty Hospital and Research Center. The clinical examiner interviewed each individual as to his/her smoking habits according to a standardized questionnaire. According to their smoking habits, participants were classified into water pipe smokers (33%), cigarette smokers (20%), smokers of both water pipe and cigarettes (labeled mixed smokers 19%), and non-smokers (28%). Former smokers were excluded ($n = 4$). Men predominated in all smoking groups ($p < 0.001$). The mean (95% CI) age was 36.9 (36.8; 37.9) years. The distribution of the study population according to age and smoking is presented in Table 1. The age of mixed smokers was significantly lower than that of water pipe smokers, cigarette smokers, and non-smokers ($p < 0.05$).

The life-time smoking exposure as formed by the product of daily consumption (cigarettes per day or water pipe runs per day) and duration (years of smoking) was expressed in terms of cigarette-years and run-years, respectively. A run is the completion of the water pipe smoking until the tobacco is burnt. The mean (95% CI) life-time exposure for cigarette smokers and water pipe smokers was 230.4 (193.4; 267.5) cigarette-years and 56.8 (48.0; 65.6) run-years, respectively. The mean (95% CI) life-time exposure for mixed smokers was 174.0 (141.0; 206.9) cigarette-years and 23.8 (17.9; 29.5) run-years.

Radiographic assessment

The radiographic examination was based on a full set of intraoral radiographs including 16 periapical

Table 1 The study population by age and smoking

Age (years)	Smokers						Non-smokers		Total	
	Water pipe		Cigarette		Mixed					
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
17–30	27	(23)	22	(31)	31	(46)	36	(36)	116	(33)
31–40	39	(33)	28	(39)	26	(39)	30	(30)	123	(35)
41–50	38	(32)	19	(26)	8	(12)	18	(18)	83	(23)
51–60	13	(11)	3	(4)	2	(3)	15	(15)	33	(9)
Total	117	(100)	72	(100)	67	(100)	99	(100)	355	(100)
Mean	39.1		36.6		32.9		37.1		36.9	
95% CI	37.2; 41.0		34.7; 38.5		31.0; 34.7		34.9; 39.3		35.8; 37.9	

and four bitewing projections for each individual. The examinations were performed according to a standardized paralleling technique. The X-ray machines used operating at 65-70 kVp, were equipped with a rectangular tube giving at least 0.20 m target-to-skin distance. The assessments were performed using a view table and a magnifier (Mattsson viewer 2x, SDI AB, Upplands Väsby, Sweden) in a dim room (Baljoon et al, 2003). A vertical bone defect was defined as a one-sided bone resorption of the interdental marginal bone ≥2 mm that had a typical angulation towards either the mesial or distal aspect of the root. In addition the lamina dura of the affected tooth showed widening (Goaz and White, 1994, Carranza, 2002). All teeth except third molars were assessed as to the presence or absence of a vertical defect. However, if a first or second molar was missing the third molar of the same quadrant if normally erupted was included. Altogether, 18744 sites were examined. Out of these, 300 sites (1.6%) were unreadable. All radiographs were independently assessed by two observers (SN and MB) at the Department of Oral Radiology, Institute of Odontology, Karolinska Institutet. The prevalence of vertical bone loss was estimated from the number of individuals exhibiting one or more vertical defects. The term severity of vertical bone loss was used to describe the frequency of sites with a vertical defect in relation to the frequency of sites measured in the individual, and expressed as proportion per person. Radiographic assessments were performed masked with reference to other characteristics of the individual including smoking status.

Error of measurement

The interexaminer reliability with respect to vertical bone defects measurements was estimated from 100 randomly selected individuals (representing 5200 sites) using Cohen's kappa statistic (κ) according to the formula

$$\kappa = \frac{Ao - Ac}{1 - Ac},$$

where Ao is the proportion of agreements that was actually observed and Ac the proportion of agreements that could be expected by chance (Cohen, 1960). The interexaminer reliability was $\kappa = 0.93$ indicating 'perfect agreement' (Landis and Koch, 1977). It is concluded that the error related to interexaminer variability of assessments did not substantially influence the outcome.

Clinical recordings

Clinical measurements based on four sites (buccal, mesial, distal, lingual) of all available teeth were performed in 262 individuals (70%) including 80 water pipe, 50 cigarette, 54 mixed and 78 non-smokers. The inflammatory condition of the gingiva and supragingival dental plaque were evaluated according to the gingival index method of Löe and Silness (1963) and the plaque index system of Silness and Löe (1964), respectively. The overall mean (95% CI) plaque index and gingival index was 1.2 (1.1; 1.3) and 0.9 (0.8; 0.9), respectively.

Details of the oral hygiene and gingival health conditions are further described elsewhere (Natto et al, 2004). The depth of the sulci or pockets was probed using a Hilming probe. Sites with a probing depth of 4 mm or more were measured to the nearest 1 mm whereas sites with a probing depth below 4 mm were set to 2 mm. The mean probing depth of all available sites represented the individual. The mean (95% CI) number of remaining teeth was 26.2 (25.6; 26.8) for water pipe smoker, 26.5 (25.8; 27.2) for cigarette smokers, 26.7 (26.3; 27.2) for mixed smokers, and 26.4 (25.8; 27.0) for non-smokers. There were no statistically significant differences between smoking groups ($p > 0.05$).

Statistics

The proportion of vertical defects per person was used as the dependent variable and presented as means and 95% confidence intervals (95% CI). This variable was non-normally distributed and, therefore, primarily tested with Kruskal-Wallis ANOVA. Additional statistical analyses were performed by means of 1- or 2-factor ANOVA, including *post hoc* multiple comparisons testing according to Scheffe. Ordinal data were tested with the Chi-square distribution. Life-time exposure regarding cigarette smoking was stratified into (1) no exposure (n = 99), (2) light exposure < 170 cig-years (mean 102.5 cig-years, n = 37), and (3) heavy exposure ≥ 170 cig-years (mean 330.5 cig-years, n = 35); life-time exposure regarding water pipe smoking was stratified into (1) no exposure (n = 99), (2) light exposure < 40 run-years (mean 31.2 run-years, n = 65), and (3) heavy exposure ≥ 40 run-years (mean 87.7 run-years, n = 52). Multiple linear regression analysis was run with the proportion of vertical defects as the dependent variable. Smoking was transformed into a dummy variable including water pipe smokers, cigarette smokers, and mixed smokers versus non-smokers. Logistic regression was used to estimate the relative risk expressed as odds ratio and 95% confidence interval (OR and 95% CI). The number of vertical defects was used as the dependent variable dichotomized (> 0 = 1, else = 0). In the logistic regression analyses, age was stratified according to (1) 17–30 years (n = 116), (2) 31–40 years (n = 123), and (3) 41–60 years (n = 116); gingival index into (1) low (0 – 0.58, n = 86), (2) medium (0.59 – 1.11, n = 89), and (3) high (1.12 – 3.0, n = 87); plaque index into (1) low (0 – 0.69, n = 83), (2) medium (0.70 – 1.30, n = 86), and (3) high (1.31 – 3.0, n = 93); mean probing depth into (1) shallow (< 2.64 mm, n = 84), (2) medium (2.64 – 3.00 mm, n = 90), and (3) deep (> 3.00 mm, n = 88). The data were analyzed using the STATISTICA (6.0) program. Statistical significance was accepted at $p < 0.05$.

RESULTS

Prevalence

Overall, a total of 377 vertical defects was observed corresponding to 2.0% of the total number of sites available for determination. The distribution of individuals according to number of vertical defects is presented in Fig 1. Among affected individuals 83.4% had a maximum of two defects, while 6.5% exhibited five or more defects.

The overall prevalence of individuals exhibiting one or more vertical defects was 39.2%, 47.0% in water pipe smokers, 54.2% in cigarette smokers, 32.8% in mixed smokers, and 23.2% in non-smokers. The prevalence was significantly related to smoking habit ($\chi^2 = 21.5$, $p < 0.001$). Compared to non-smokers, water pipe smokers as well as cigarette smokers exhibited significantly elevated prevalence rates ($\chi^2 = 13.1$ and $\chi^2 = 17.3$, respectively, $p < 0.001$). The prevalence significantly increased with age from 16.4% in age group 17–30 years to 56.9% in the age group 41–60 years, ($\chi^2 = 41.8$, $p < 0.001$). In all age groups there was a trend towards a greater prevalence in water pipe smokers, cigarette smokers, and mixed smokers than in non-smokers (Fig 2). The trend was statistically significant in the 17–30 year age group ($\chi^2 = 11.4$, $p < 0.001$).

Severity

The overall mean (95% CI) severity expressed as the proportion of vertical defects per person was 2.2% (1.7; 2.6); increasing from 0.8% (0.4; 1.2) in age group 17–30 years to 3.9% (2.9; 4.8) in age group 41–60 years. The increase across age groups was statistically significant (Kruskal-Wallis $H = 44.4$, $p < 0.001$). Furthermore, the severity increased with increasing plaque index level or mean probing depth (Kruskal-Wallis $H = 26.0$ and $H = 19.8$, $p < 0.001$, respectively).

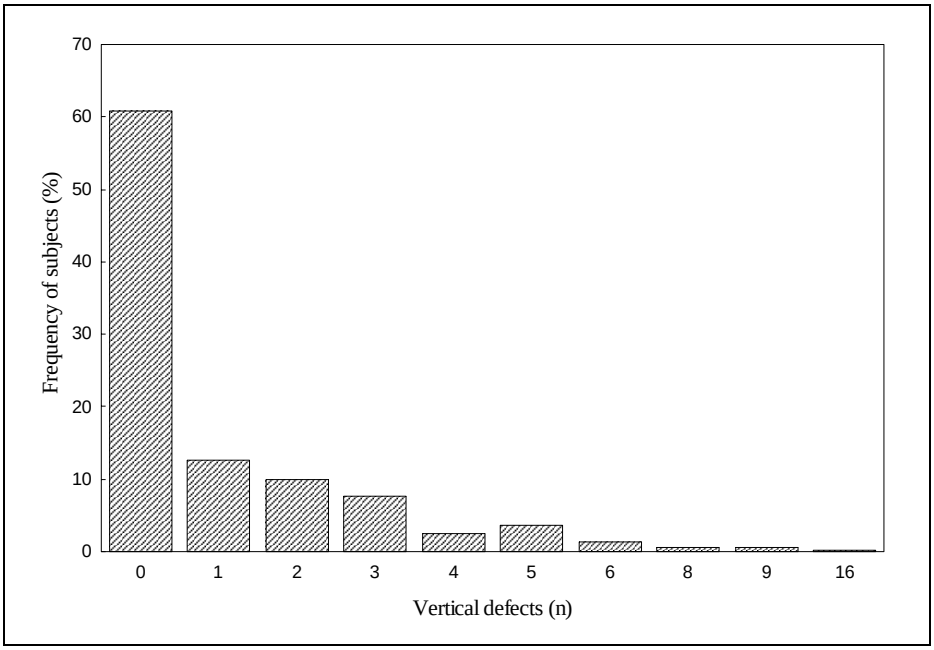

Fig 1 Frequency distribution of individuals according to number of vertical defects.

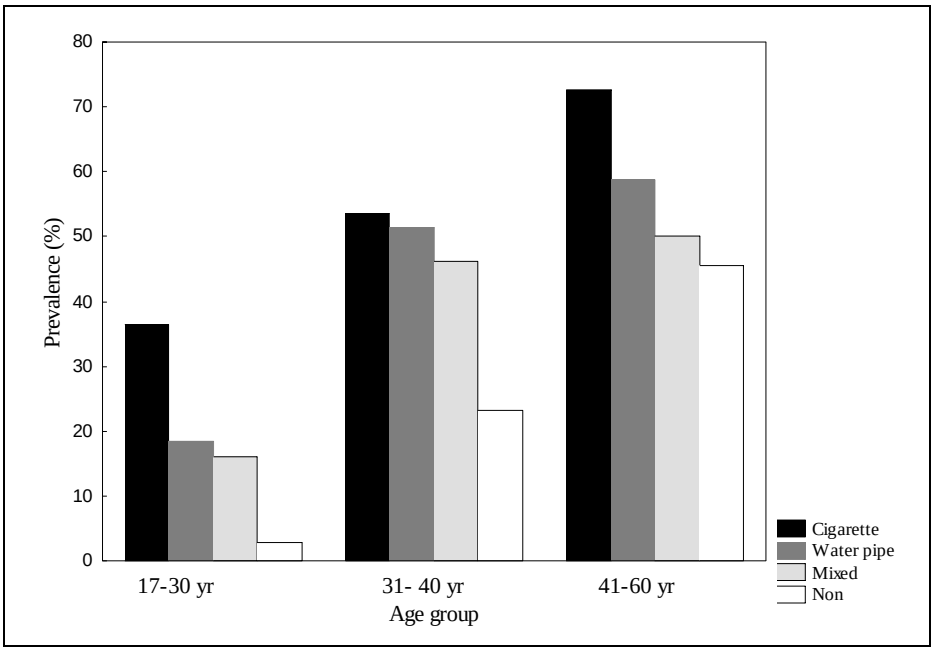

Fig 2 Prevalence of individuals with one or more vertical defects according to age and smoking habit.

The severity was 2.6% (1.9; 3.3) for water pipe smokers, 2.8% (1.7; 3.8) for cigarette smokers, 1.9% (1.1; 2.8) for mixed smokers, and 1.3% (0.6; 2.0) for non-smokers (Fig 3). The association between smoking and the proportion of vertical defects was statistically significant (Kruskal-Wallis $H = 19.4$, $p < 0.001$). The significance was attenuated when controlling for age (ANOVA $F(3,2) = 2.4$, $p = 0.065$, Fig 4), plaque (ANOVA $F(3,2) = 2.3$, $p = 0.081$), or mean probing depth (ANOVA $F(3,2) = 2.2$, $p = 0.086$). Post hoc comparisons testing, however, indicated statistically significant differences between water pipe smokers and non-smokers, and between cigarette smokers and non-smokers ($p = 0.003 – 0.014$).

The association between life-time smoking exposure and severity of vertical defects was statistically significant within water pipe smokers as well as

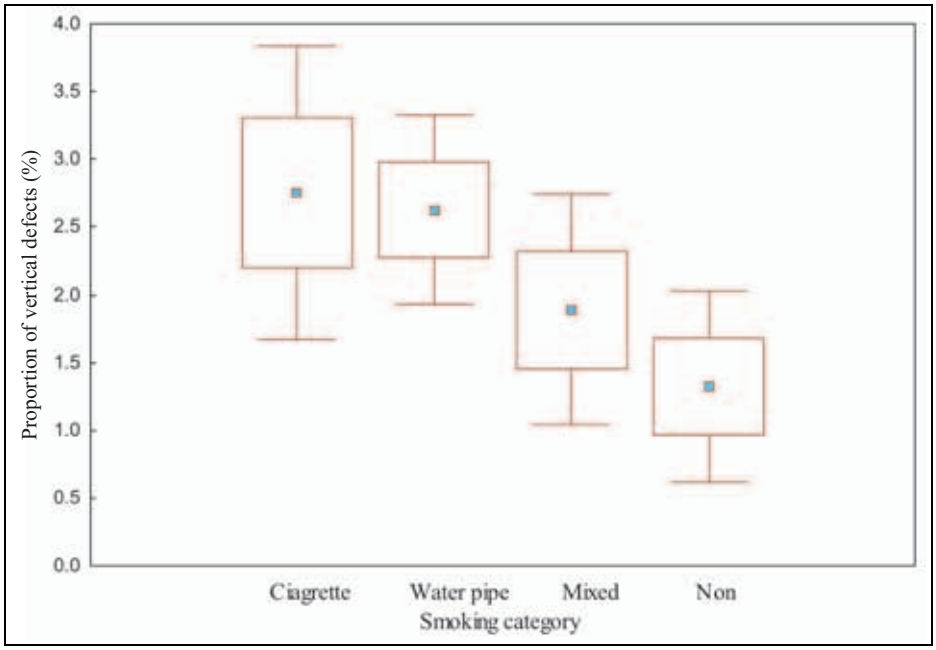

Fig 3 Proportion of vertical bone defects per person. Mean and 95% CI according to smoking.

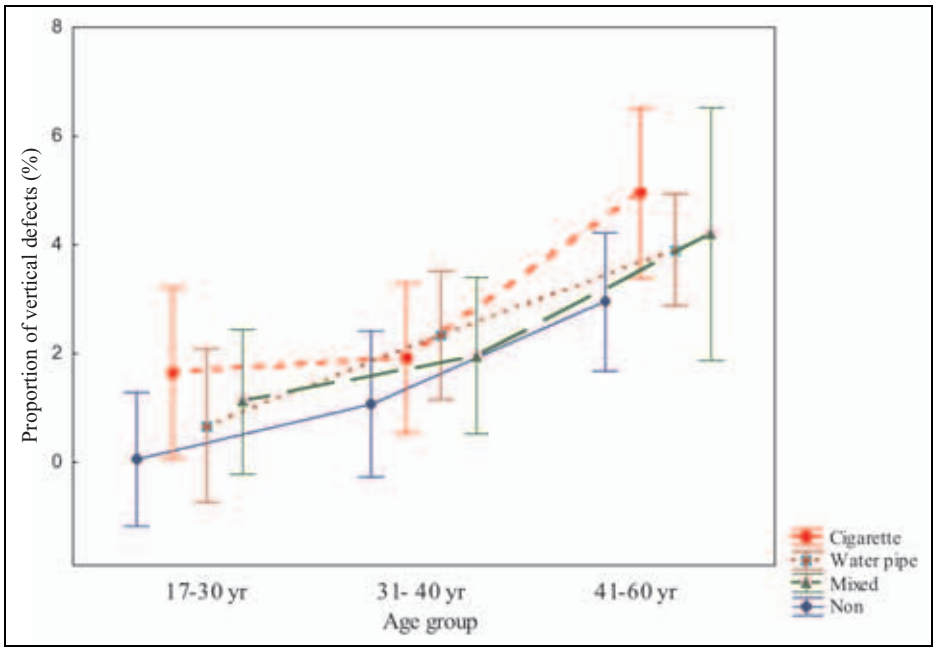

Fig 4 Proportion of vertical bone defects per person. Mean and 95% CI according to age and smoking.

cigarette smokers (Kruskal-Wallis H = 92.6 and H = 50.8, respectively, $p < 0.001$). The association remained significant controlling for age (ANOVA F = 21.8 and F = 11.4, respectively, $p < 0.001$). Post hoc comparisons testing indicated that the differences between light and heavy exposure smokers were statistically significant among water pipe as well as cigarette smokers (Scheffe test $p < 0.001$, Table 2).

Multiple Regression Analyses

By means of multiple linear regression analysis, the proportion of vertical defects as the dependent variable could be predicted from the variables smoking, age, number of teeth, plaque index, gingival index, probing pocket depth, and gender entered in one block. 23% of the total variation in the dependent variable was explained by these

factors (R^2 adj = 0.23, $p < 0.001$). Age ($p = 0.006$), smoking ($p = 0.024$), and number of teeth ($p = 0.000$), were the only statistically significant predictors (Table 3).

Logistic regression analysis was run to estimate the relative risk for the occurrence of vertical defects. Univariate analysis suggested that smoking (yes/no) (OR = 2.9, 95% CI 1.7 – 4.9), age (OR = 2.6, 95% CI 2.0 – 3.5), plaque index (OR = 2.2, 95% CI 1.6 – 3.1), gingival index (OR = 1.3, 95% CI 1.0 – 1.8), number of teeth (OR = 0.9, 95% CI 0.8 – 1.0), and probing depth (OR = 1.8, 95% CI 1.3 – 2.4) were significantly associated with increased risk. The relative risk associated with water pipe and cigarette smoking was also statistically significant (OR = 3.4, 95% CI 1.9 – 6.1 OR = 3.9, 95% CI 2.0 – 5.6, respectively).

Multivariate analysis including the significant factors indicated that smoking and age were significantly associated with increased risk (Table 4). The relative risk associated with smoking was 3.6-fold increased compared to non-smoking in this model (OR = 3.6, 95% CI 1.6 – 7.8, $p < 0.001$, n = 262). The risk run by water pipe smokers was 2.9-fold elevated (OR = 2.9, 95% CI 1.2 – 7.0, $p = 0.06$, n = 262) and the risk of cigarette smokers 6.6-fold elevated compared to non-smokers (OR = 6.6, 95% CI 2.6 – 17.1, $p < 0.001$, n = 262).

In the total sample (n = 355), the relative risk of light and heavy water pipe smokers was 0.6-fold (OR = 0.6, 95% CI 0.3 – 1.4, $p > 0.05$) and 43.3-fold (OR = 43.3, 95% CI 12.1 – 71.6, $p < 0.001$) elevated, respectively, compared to non-smokers, after adjustment for age. The relative risk of light and heavy cigarette smokers was 1.3-fold (OR = 1.3, 95% CI 0.5 – 3.4, $p > 0.05$) and 18.3-fold (OR = 18.3, 95% CI 6.2 – 53.9, $p < 0.001$) elevated, respectively, compared to non-smokers after adjustment for age.

DISCUSSION

The present study investigated the association between water pipe smoking and periodontal bone loss as reflected by the presence and frequency of vertical defects. The observations indicted an association with water pipe smoking. The present observations, the first ones to suggest an influence of water pipe smoking on periodontal vertical bone loss, are in general agreement with earlier cross-sectional (Bergström and Eliasson, 1987; Norderyd and Hugoson, 1998; Persson et al, 1998; Bergström et al, 2000b; Baljoon et al, 2004) and longitudinal (Norderyd et al, 1999; Bergström et al,

Table 2 Two-factor ANOVA with the proportion of vertical bone defects as the dependent variable and life-time smoking exposure as independent variable together with age as co-factor. *Post hoc* tests between exposure groups in water pipe and cigarette smokers. Means and 95% confidence intervals (CI)

Exposure	Water pipe smoker			Cigarette smoker		
	Mean	95% CI		Mean	95% CI	
No	2.6	1.2; 4.1		2.6	1.2; 4.1	
Light	0.6	0.2; 0.9	*	1.3	0.4; 2.2	*
Heavy	11.3	9.1; 13.5	*	9.9	5.9; 13.9	*

* $p < 0.001$

Table 3 Multiple regression analysis with the proportion of vertical bone defects as dependent variable. (R^2 (adj) = 0.23, F (7, 238) = 9.9)

Variable	Parameter	Standard error	t	P
Age	0.152	0.054	2.78	0.006
Gingival Index	0.892	1.038	0.85	0.391
Plaque Index	1.126	0.826	1.36	0.174
Smoking	2.871	1.270	2.26	0.024
Gender	0.351	1.092	0.32	0.747
Number of teeth	–0.686	0.189	–3.62	0.000
Probing depth	0.469	0.452	1.04	0.300

Table 4 Multivariate logistic regression analysis with vertical defects (absence/presence) as dependent variable and smoking, age, plaque index, gingival index, number of teeth, and probing depth as independent factors. Odds ratio (OR) and 95% confidence intervals (CI)

Variable	OR	95% CI	P
Smoking			
No	1.0		0.001
Yes	3.6	1.6; 7.8	
Age			
17–30 yr	1.0		
31–40 yr	2.7	1.8; 4.1	0.000
41–60 yr	7.1	3.1; 16.5	
Plaque index			
Low	1.0		
Medium	1.5	1.0; 2.3	0.043
High	2.3	1.0; 5.2	
Gingival index			
Low	1.0		
Medium	1.1	0.6; 1.4	0.830
High	1.2	0.4; 2.1	
Number of teeth	0.96	0.9; 1.1	0.573
Probing depth			
Low	1.0		
Medium	1.3	0.9; 1.8	0.229
High	1.6	0.7; 3.3	

2000a; 2004; Payne et al, 2000; Jansson and Lavstedt, 2002; Baljoon et al, 2005) studies on cigarette smoking and periodontal bone loss. In the present study the estimated risk for the occurrence of vertical defects was about three-fold elevated in water pipe smokers compared to non-smokers, suggesting that the impact of water pipe smoking on the periodontal bone was within the range of what was reported earlier regarding the effect of cigarette smoking on periodontal bone loss (Norderyd and Hugoson, 1998; Norderyd et al, 1999; Bergström, 2003; Baljoon et al, 2004; 2005).

Heavy smoking exposure was associated with a greater severity of vertical defects than light smoking exposure suggesting a dose-response relationship. In fact heavy smoking was associated with a greatly elevated risk in both water pipe and cigarette smokers. The findings of a dose-response relation agree with earlier evidence (Haber and Kent, 1992; Haber et al, 1993; Grossi et al, 1995; Norderyd and Hugoson, 1998; Bergström et al, 2000a;b; Hugoson and Laurell, 2000; Calcina et al, 2002; Bergström, 2003; 2004; Baljoon et al, 2004; Baljoon et al, 2005). In determining risk, it is important to evaluate the relation between the degree of exposure and the risk factor for the disease prevalence. The ability to demonstrate a relationship strengthens the probability of risk factor status and the biological plausibility (Rothman, 2002).

The influence on the severity of vertical defects by other factors such as age, gender, gingival index, plaque index, probing depth and number of retained teeth was studied by means of multivariate regression analyses. The influence of smoking, however, was independent of plaque level, gingival condition, gender and mean probing depth as was evident from the multivariate analyses performed. Age was associated with the prevalence and severity of vertical defects, which was evident in the oldest age group (41–60 years). This finding, in accordance with earlier findings, may not be unexpected due to the cumulative effect of periodontal bone destruction over time (Nielsen et al, 1980; Wouters et al, 1989; Papapanou et al, 1988; Hugoson and Laurell, 2000; Baljoon et al, 2003; 2004). Beside age, the proportion of vertical defects was positively correlated with the number of missing teeth suggesting that the number of retained teeth is an important factor for the estimation of vertical bone defects. We have reported recently that tooth loss may influence the estimation of vertical defects since individuals who lost teeth developed fewer new defects than individuals who did not lose any teeth. Loss of teeth may reduce the probability of attracting new vertical defects and at the same time increases the probability of losing existing defects, thus resulting in an underestimation of defects (Baljoon et al, 2005).

The present findings of a significant association between water pipe smoking and periodontal bone loss as diagnosed by an increased number of vertical defects are in general agreement with the results of previous studies with emphasis on cigarette smoking and periodontal bone loss (Bergström and Eliasson, 1987; Persson et al, 1998; Norderyd et al, 1999; Bergström et al, 2000a;b; 2004; Jansson and Lavstedt, 2002; Baljoon et al, 2004; 2005). The impact of other forms of tobacco smoking such as cigar and pipe on the periodontal

bone has been studied (Feldman et al, 1983; Krall et al, 1999). According to the study by Krall et al (1999) cigar and pipe smokers were at similar risk of experiencing bone loss as cigarette smokers. The present observations add to the information of these investigations suggesting that water pipe smoking is another form of tobacco consumption that is detrimental to periodontal bone.

Participation in the present study was limited to individuals who responded to newspaper announcements designed to attract individuals with various smoking habits. This resulted in a higher smoking prevalence than in the Saudi population at large (35%) as estimated from a questionnaire study (Siddiqui et al, 2001). A second limitation of the present study is the assignment of individuals to different smoking groups, on the basis of self-reporting alone which might have resulted in some underreporting. An alternative approach to self-reports that will accurately estimate tobacco exposure is to assess tobacco metabolites such as cotinine, carbon monoxide, and thiocyanate (Dolcini et al, 2003). On the other hand, the self-reported smoking habit during the interview questionnaire is a valid method that is used in research for recording smoking history (Petitti et al, 1981) and similar smoking prevalence has been estimated when self-reports have been compared to salivary cotinine measures (Dolcini et al, 2003).

In summary, the present radiographic study in a Saudi Arabian population showed that the prevalence and severity of vertical periodontal bone loss are greater in water pipe and cigarette smokers than in non-smokers. The association of vertical bone loss with water pipe smoking is comparable to the association with cigarette smoking. The findings support the hypothesis that water pipe smoking exerts a negative impact on the periodontal bone.

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