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Smokeless tobacco (snuff) use and periodontal bone loss

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Abstract

Objective: The aim of the present cross-sectional study was to investigate a possible association between the use of Swedish moist snuff and periodontal bone loss.

Material and Methods: The study was carried out on 84 apparently healthy men in the age range 26–54 years, 25 current snuff users, 21 former snuff users, and 38 never-users. The periodontal bone height was evaluated from bitewing radiographs measuring the distance from the cement–enamel junction (CEJ) to the periodontal bone crest (PBC) at pre-molars and molars in each quadrant of the dentition.

Results: The mean (95% confidence interval (95% CI)) CEJ − PBC distance was 1.00 (0.87–1.13), 1.12 (0.97–1.26), and 1.06 (0.95–1.16) mm for current users, former users, and never-users, respectively. The association between snuff use and bone height level controlling for age was not statistically significant (ANOVA $F = 0.3$, $p > 0.05$). There was, further, no statistically significant difference between light and heavy exposure users controlling for age (ANOVA $F = 1.0$, $p > 0.05$).

Conclusion: Our observations suggest that the use of Swedish moist snuff is not associated with periodontal bone loss.

Key words: nicotine; periodontal bone; periodontal disease; periodontitis; smokeless tobacco; snuff; tobacco

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Tobacco smoking has a major impact on many tissues and organs of the body, including the periodontal tissues. A number of studies of various designs performed in many countries over the last decades unanimously demonstrate that the periodontal health of smokers is greatly inferior to that of non-smokers (Bergström & Flodérus-Myrhed 1983, Haber & Kent 1992, Grossi et al. 1995, Norderyd et al. 1999, Bergström 2003, 2004a, b, Hyman & Reid 2003). Not only cigarette smoking but also cigar, pipe, and water pipe smoking entail an increased risk for periodontal illness (Krall et al. 1999, Albandar et al. 2000, Baljoon et al. 2005, Natto et al. 2005a, b). Whereas the untoward effect of smoking on periodontal health is abundantly documented, little is known about the possible effects of non-smoked tobacco products.

The use of smokeless tobacco is widespread, from Sudan and India to Scandinavia and USA (Idris et al. 1998, Nichter et al. 2004). Although available in many different forms, smokeless tobacco is mainly used as chewing tobacco (loose leaf, plug, or twist) and snuff (moist or dry). The different forms vary in composition and can be hard to compare (Idris et al. 1998). This paper will focus on smokeless tobacco in the form of Swedish moist snuff (henceforth called moist snuff).

Although cigarette smoking is the most common form of tobacco habit in Sweden, the use of moist snuff is steadily increasing, the currently estimated prevalence being 20% for men and 3% for women. This can be compared with a smoking prevalence of 17% and 18% for men and women, respectively. Thus, among men in Sweden snuff use is as common as cigarette smoking. In addition, snuff use is on the rise, whereas smoking rates are declining. Like other smokeless tobacco products, snuff is rapidly delivering high doses of nicotine, which leads to dependence (Holm et al. 1992, Fant et al. 1999). The nicotine is readily absorbed via the mucosal membrane by passive diffusion (Beckett & Triggs 1967, Nair et al. 1997). If swallowed, it may also be absorbed from the gastro-intestinal tract (Benowitz et al. 1989). The uptake of nicotine from snuff is dependent on the amount of nicotine, the pH, and the buffering capacity (Ciolino et al. 2001). The nicotine content of Swedish moist snuff is approximately 10 mg/g, and one box of 50 g equals an estimated 35–75 cigarettes (Holm et al. 1992, Henningfield et al. 1995, Idris et al. 1998). The intra-oral usage in the average Swedish snuff user is 13 h/day (Andersson et al. 1994), corresponding to an average daily consumption of 14–21 g.

There is some documentation that the use of moist snuff is associated with elevated risks for hypertension, increased heart rate, type II diabetes, and pancreatic cancer (Bolinder et al. 1992, 1997, Persson et al. 2000, Bofetta et al. 2005). Its possible association with myocardial infarction is controversial (Huhtasaari et al. 1992, 1999, Bolinder

et al. 1994, Hergens et al. 2005), whereas no association with oral cancer or head/neck cancer has been observed (Lewin et al. 1998, Schildt et al. 1998, Bofetta et al. 2005).

Localized oral manifestations, such as gingival recessions and mucosal lesions (snuff dipper's lesion) at the site of snuff placement, are common in users of moist snuff (Hirsch et al. 1982, Grady et al. 1990, Kaugars et al. 1991, Larsson et al. 1991, Little et al. 1992). After cessation of use, however, mucosal lesions seem to heal clinically as well as histologically (Andersson & Axell 1989, Andersson et al. 1991, Larsson et al. 1991). To date, few studies only have investigated the potentially harmful effect of moist snuff on the periodontal health condition (Ernster et al. 1990, Robertson et al. 1990, Little et al. 1992). In these studies, which were conducted in young adults with predominantly short-term duration of use, there were no indications of an association between snuff use and chronic destructive periodontal disease. None of the studies investigated the periodontal health condition in terms of bone loss.

In consideration of the strong evidence in favour of smoking as a major risk factor for destructive periodontal disease (Bergström 2004a), the possible risk associated with the use of moist snuff is worthy of attention. The aim of the present study, therefore, was to investigate the possible association between the use of moist snuff and periodontal bone loss in subjects with moderate to long-term duration of use.

Material and Methods

Study population

The participants of the present study were recruited among employees in submarine service of The Swedish Armed Forces. All such personnel undergo regular dental health check-up examinations on an annual basis. In connection with a dental examination, employees were asked for participation in the present study. The study was carried out from November 2002 to December 2003 at the Dental Public Health Clinic of Karlskrona, Karlskrona, Sweden. Ethical approval for the investigation was allowed from the regional ethics committee of Karolinska Institutet, Stockholm (Dnr 02-480).

Table 1. Distribution of study group according to age and snuff use

Age (years)	Snuff user category				
	current (*N*)	former (*N*)	never (*N*)	total (*N*)	mean age (years)
26–36	9	4	13	26	32.1
37–42	12	6	12	30	39.8
43–54	4	11	13	28	48.0
Total	25	21	38	84	40.1
Mean age (years)	38.4	42.8	39.7	40.1	

N, number of participants.

Eighty-four subjects in the age range 26–54 years, with a mean age of 40.1 years, volunteered to participate. Participants were all male. The tobacco habits of the participants were found from self-reports according to a predetermined structured questionnaire. Questionnaires were administered and answered in immediate connection with the clinical and radiographic examinations. When needed, dental personnel were available for assistance. Following responses to the questionnaire, participants were classified as current ($N = 25$), former ($N = 21$), and never-users ($N = 38$) of moist snuff. The distribution of the participants according to age and snuff use is presented in Table 1. The mean (95% confidence interval (95% CI)) current and former consumption of current and former users was 3.2 (2.6–3.8) and 3.1 (2.0–4.1) boxes/week, respectively, and the duration of use was 16.9 (14.1–19.7) and 12.9 (9.6–16.3) years, respectively. The time since giving up the habit among former users was not assessed.

Users were categorized according to duration of snuff use into two exposure groups: light exposure users including participants with a duration of less than 15 years (seven current users with a mean duration of 10.2 years, and 13 former users with a mean duration of 8.7 years), and heavy exposure users including participants with a duration of 15 years or more (14 current users with a mean duration of 20.4 years, and eight former users with a mean duration of 20.3 years). Data of duration were available for 21 current (84%) and all former users. Ten current and eight former snuff users were former smokers. The mean (95% CI) consumption and duration of former smoking was 6.4 (2.9–9.8) cigarettes/day and 8.8 (2.9–14.8) years, respectively, in current users, and 7.2 (2.9–11.4) cigarettes/day and 8.9 (4.3–13.4) years, respectively, in former users. All never-users were never-smokers.

Radiographic assessment

Measurements of the periodontal bone height were performed from two bilateral pairs of bitewing radiographs in each individual. The bone height distance from the cement–enamel junction (CEJ) to the periodontal bone crest (PBC) was measured at inter-proximal sites of premolars and molars. CEJ – PBC distance determinations were obtained from mesial sites of first pre-molars through distal sites of first molars in each quadrant of the dentition, thus allowing a maximum of 24 determinations per person. Measurements were made under $\times 7$ magnification with the aid of a viewing box and a magnifying lens equipped with a 0.1 mm graduated scale. All single measurements were read to the nearest 0.1 mm. The arithmetical mean of all CEJ – PBC determinations served as a measure of the periodontal bone height in the individual (case-mean). In addition, each dental quadrant was evaluated separately. A tooth was deemed non-measurable if one or several measurement landmarks could not be identified due to projection overlap or dental artefacts. The same observer (H. K.), unaware of the tobacco use of the individual, made all measurements.

The magnitude of measurement error was determined from 20 randomly selected bitewing radiographs that were re-measured after 6–8 months. The measurement error was expressed as the standard deviation (s) and calculated following the formula

$$s = \sqrt{\sum d^2/2n},$$

where d is the difference between duplicate case-means, and n the number of duplicates ($n = 20$). The measurement error related to a single case-mean was $s = 0.061$. The error related to a single group mean ($n = 28$) was estimated to $s_m = 0.011$. It is concluded that the influence of measurement error on

the comparison of group means is negligible.

Clinical assessment

The periodontal condition was assessed in terms of gingival bleeding and probing pocket depth. The tendency of the marginal gingiva to bleed upon gentle probing and the probing depth of pockets were clinically assessed at four sites per tooth. The oral hygiene condition was evaluated according to the plaque index of Silness & Löe (1964). The periodontal health and oral hygiene estimates were based on all teeth of the dentition. In addition, photo documentation of the mucosal appearance at the site of snuff placement was obtained for current and former users.

Statistics

Data are presented as means and 95% CI or standard error of the mean (SEM) as appropriate. The dependent variable of CEJ – PBC distance was approximately normally distributed and testing of statistical significance was performed by means of 1- and 2-factor ANOVA. Post-hoc testing was performed according to Scheffé. When included in the multivariate analysis, age was stratified into (1) 26–36 years, $n = 26$; (2) 37–42 years, $n = 30$; and (3) 43–54 years, $n = 28$. Statistical significance was accepted at the probability level of $p < 0.05$.

Table 2. Number of bone height determinations per person

Snuff use	Maxillary right		Maxillary left		Mandibular right		Mandibular left		Total	
	mean	SEM	mean	SEM	mean	SEM	mean	SEM	mean	SEM
Current	5.3	0.31	4.8	0.30	4.9	0.29	4.5	0.23	19.5	0.84
Former	5.3	0.34	5.1	0.32	5.3	0.31	5.0	0.24	20.7	0.90
Never	4.3	0.23	4.2	0.22	4.3	0.21	4.5	0.16	17.3	0.62
Total	4.8	0.17	4.6	0.16	4.7	0.15	4.6	0.12	18.8	0.45

Mean and SEM according to snuff use and dental quadrant.
SEM, standard error of the mean.

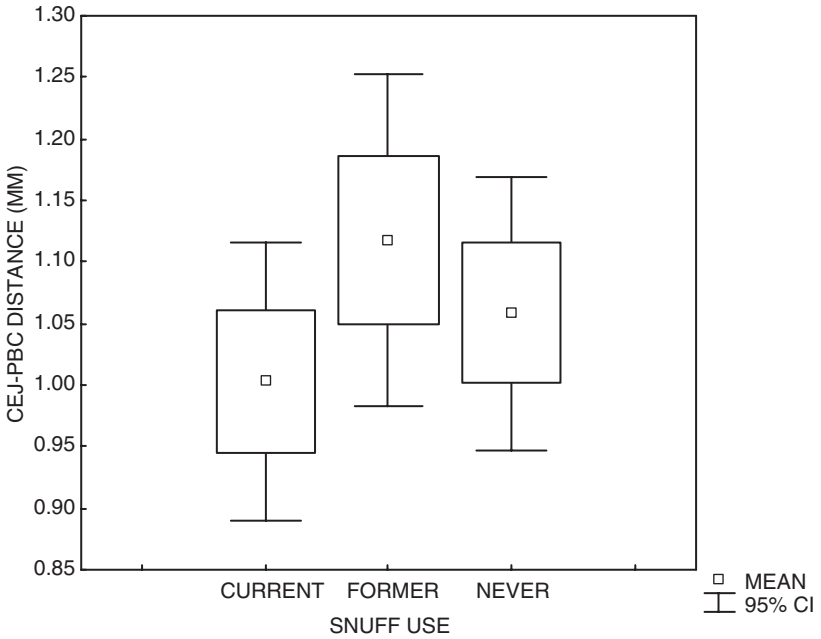

Fig. 1. Cement–enamel junction (CEJ) – periodontal bone crest (PBC) distance (mm). Mean and 95% confidence interval (CI) according to snuff use.

Results

Bone height determinations

The overall median (inter-quartile range) number of retained teeth was 30 (28–31). There were no significant differences between user groups (medians 29, 28, and 28 teeth for current, former, and never-users, respectively, $p > 0.05$).

The mean number of CEJ – PBC distance determinations *per* person by snuff use and dental quadrant is presented in Table 2. The overall mean (95% CI) was 18.7 (17.8–19.6). On average, 78% of available sites were included in the CEJ – PBC distance determinations. There were no significant differences with reference to dental quadrant. The number of determinations significantly decreased with increasing age. In addition, the number of determinations tended to be greater in former users when compared with current users and never-users. This trend was significant within the age group of 43–54 years.

Bone height levels

The mean (95% CI) CEJ – PBC distance was 1.00 (0.87–1.13), 1.12 (0.97–1.26), and 1.06 (0.95–1.16) mm for current users, former users, and never-users, respectively (Fig. 1). Controlling for age, the association between snuff use and bone height was not statistically significant (ANOVA $F = 0.3$, $p > 0.05$). There were no interaction effects between age and snuff use or between former smoking and snuff use. Age was a significant factor ($F = 14.5$, $p < 0.001$). The same held true as the four quadrants of the dentition were analysed separately (Table 3). The results with regard to exposure are demonstrated in Fig. 2. The overall mean (95% CI) CEJ – PBC distance for light and heavy exposure users was 1.06 (0.92–1.15) and 1.04 (0.90–1.12) mm, respectively. The corresponding values for light and heavy current users were 0.89 (0.71–1.07) and 0.97 (0.88–1.06) mm, respectively, and for former light and heavy exposure users 1.12 (0.89–1.35) and 1.11 (0.98–1.25) mm, respectively. There were no statistically significant differences between exposure groups controlling for age. The same held as exposure was expressed in terms of consumption, dichotomized into $\leqslant 3.0$ and > 3.0 boxes/week (data not shown).

Clinical characteristics

Periodontal pockets with a depth exceeding 3 mm were rare. The overall mean (95% CI) probing depth was 1.94 (1.87–1.95) and there were no statistically significant differences between

Table 3. CEJ – PBC distance (mm)

Snuff use	Maxillary right		Maxillary left		Mandibular right		Mandibular left		Total	
	mean	SEM	mean	SEM	mean	SEM	mean	SEM	mean	SEM
Current	1.23	0.08	1.19	0.08	0.97	0.07	0.90	0.08	1.00	0.06
Former	1.31	0.08	1.15	0.08	1.04	0.08	1.00	0.09	1.12	0.07
Never	1.19	0.06	1.13	0.06	0.93	0.05	0.95	0.06	1.06	0.05
Total	1.20	0.04	1.14	0.04	0.94	0.04	0.92	0.04	1.06	0.03

Mean and SEM according to snuff use and dental quadrant.
CEJ, cement–enamel junction; PBC, periodontal bone crest; SEM, standard error of the mean.

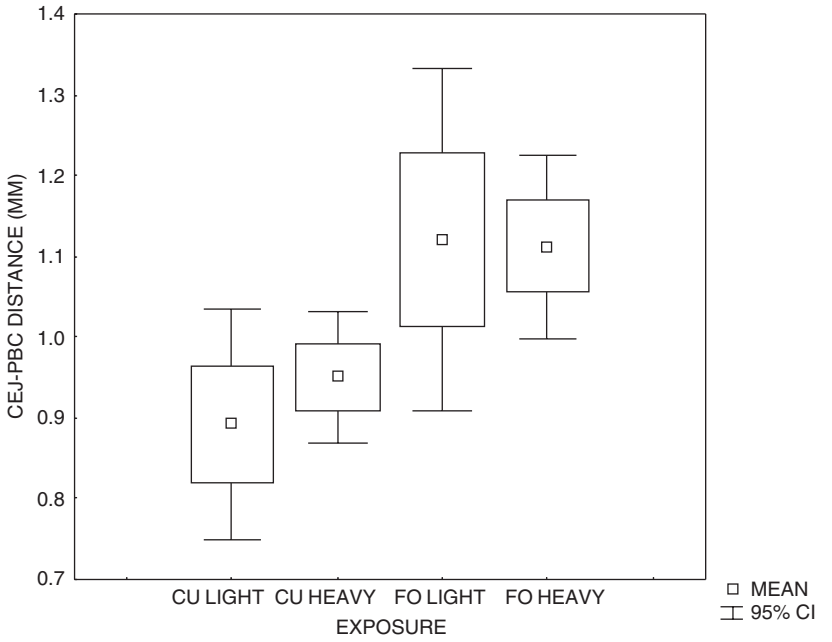

Fig. 2. Cement–enamel junction (CEJ) – periodontal bone crest (PBC) distance (mm). Mean and 95% confidence interval (CI) according to exposure to snuff in current (cu) and former (fo) light (<15 years) and heavy ($\geqslant 15$ years) users.

user groups ($p > 0.05$). The overall mean (95% CI) percentage of sites exhibiting gingival bleeding on probing was 22.0% (18.3–26.6), and the overall mean (95% CI) plaque index was 0.67 (0.52–0.84). There were no statistically significant differences between user groups for either estimate ($p > 0.05$).

The photo documentation revealed a typical mucosal lesion appearance of varying degree in most current users, whereas such an appearance usually was absent in former users. A detailed description of the photographic findings will be reported in a separate communication.

Discussion

The present cross-sectional study seems to be the first one to explore a possible relationship between smokeless tobacco in the form of Swedish moist snuff and the condition of the periodontal bone. The observations suggest that there is no association between the use of moist snuff and loss of periodontal bone height. The observations are in agreement with earlier reports that periodontal pocketing and attachment levels in users of snuff and/or chewing tobacco were no different from those of non-users (Ernster et al. 1990, Robertson et al. 1990). The present observations extend the validity of those reported earlier in the sense that they are found from adults of a wider age range than that of the previous studies, which focused on young adults mainly below 30 years of age. Moreover, the exposure in terms of duration of use was considerably greater than previously reported: on average, almost 17 years as compared with 5 years (Ernster et al. 1990).

Recently, a large-scale American study reported that smokeless tobacco users were at a slightly increased risk for inter-proximal attachment loss (Fisher et al. 2005). The contradictory results compared with the present ones may have several explanations. The American study concerns all types of smokeless tobacco and does not distinguish between snuff and, e.g., chewing tobacco. In addition, different varieties of snuff such as American and Swedish snuff may not be readily comparable due to differences in composition (Henningfield et al. 1995, Idris et al. 1998). Further, methodological dissimilarities exist. In the Fisher et al. study, assessment of the attachment level included tooth sites adjacent to snuff placement where local tissue recessions frequently occur. Interestingly, the results of Fisher et al. lost significance when analyses were restricted to never-smokers, suggesting that unadjusted smoking may be responsible for the association.

By tradition, Swedish snuff is invariably placed in the maxillary anterior region. As demonstrated from the separate analyses of the four quadrants of the dentition, the outcome was the same throughout all quadrants irrespective of snuff placement. Such a consistent outcome suggests that a local effect at a short distance from snuff placement is minimal, if any.

We have previously shown by means of the same radiographic method that the bone height level of chronic cigarette smokers is significantly reduced compared with never-smokers (Bergström 2004b). Our present observations suggestive of absence of a reaction of the periodontal bone to moist snuff are in distinct contrast to the evident reaction to smoke observed in smokers, thus favouring the assumption that the harmful effect of smoking is caused by toxic products in the inhaled smoke via internal routes rather than being a result of local damage to the periodontal tissues. In terms of nicotine yield, the average exposure to current users (21 g/day) corresponds to an exposure of 15–30 cigarettes/day (Holm et al. 1992). The nicotine exposure to the current snuff users of the present study was at least of the same magnitude as that to cigarette smokers in the previous study (Bergström 2004b). The present observations, therefore, additionally suggest that the harmful effect of smoking to the periodontal tissues primarily is

associated with toxic tobacco smoke products other than nicotine.

Bitewing radiographs of pre-molar and molar regions of the dentition were used for the assessment of the periodontal bone height. The reason for such an approach was two-fold. Notably, the intention of the study was to explore any influence on the periodontal condition in general from local oral snuff use. In addition, partial examination secures a high information-to-radiation ratio. There is good agreement between partial and full-mouth radiographic examinations (Eliasson & Bergström 1991, Merchant et al. 2004). We cannot exclude that snuff may exert a local effect at the area of exposure as it is well known to be frequently associated with a typical lesion of the oral mucosa and with gingival recessions.

A limitation of the present study is the comparably small number of participants. It might be argued that the statistical power was insufficient to detect minor differences if there were any. As discussed above, we have been able to show by means of the same radiographic method in a same-sized sample of a corresponding age range that the bone height level is significantly reduced in cigarette smokers compared with non-smokers (Bergström 2004b). We, therefore, conclude that with the radiographic method used, trends most likely would have been identified in the present sample had a true association existed.

A problem encountered in studies on the use of smokeless tobacco is the confounding or modifying effect of smoking. This might be particularly true when studying snuff use in Sweden where a considerable portion of snuff users are former smokers of cigarettes (''replacement users'') (Gilljam & Galanti 2003). In the present study, surprisingly, results were not markedly modified when smoking was entered into the analysis. This is thought mainly to be due to the fact that former smokers were occasional smokers (average 6.7 cigarettes/day) of rather short duration (8.8 years) in the past, and, further, that few of them had started as smokers and later shifted to snuff use (''replacement use'').

In summary, the observations of the present study indicate that there seems to be no association between the use of smokeless tobacco in the form of moist snuff and periodontal bone loss. In accordance with current evidence that use of moist snuff in comparison with cigarette smoking confers a low risk for oral and head/neck cancers (Lewin et al. 1998, Schildt et al. 1998), as well as for myocardial infarction (Huhtasaari et al. 1992, 1999, Hergens et al. 2005), the present observations indicate a low risk, if any, also for periodontal disease. For a complete understanding of a possible effect, however, longitudinal studies are advocated.

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Clinical Relevance

Scientific rationale: Tobacco smoking has been documented to exert devastating effects on periodontal health. The smoking of cigarettes, cigars, pipe, or water pipe is associated with an increased risk for periodontal illness. Less documentation is available regarding the possible harm associated with the use of snuff. In some countries, e.g., Sweden where snuff has old traditions, snuff use is gaining increasing popularity and is currently on par with cigarette smoking. Many a smoker has shifted tobacco habits from smoked to smokeless tobacco. A relevant question, therefore, is whether or not also snuff use entails an increased risk for periodontal illness.

Principal finding: The use of smokeless tobacco in the form of Swedish moist snuff was not associated with loss of periodontal bone height. There were, additionally, no other clinical signs of periodontal morbidity such as increased probing depth or gingival inflammation associated with regular snuff use.

Practical implication: Although snuff may cause mucosal lesions at the site of snuff placement, snuff users seem not to be at increased risk for destructive periodontal disease. This should be considered in clinical dentistry when smoking cessation counselling and harm reduction strategies are being planned.