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Periodontal conditions in male adolescents using smokeless tobacco (moist snuff)

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Abstract

Aim: The aim of this study was to evaluate the potential association of the use of smokeless tobacco (moist snuff) on the periodontal conditions of adolescents.

Material and methods: A subject sample of one hundred and three 19-year-old male individuals (33 snuff users, 70 controls) living in Göteborg, Sweden, were clinically examined with regard to oral hygiene, gingivitis, probing pocket depth (PPD), clinical attachment loss (CAL) and gingival recession. Bitewing radiographs were obtained for assessments of alveolar bone level. Information about tobacco and oral hygiene habits was obtained by a structured questionnaire. Student 's t-test, χ^2-test and logistic regression analysis were used for statistical analysis.

Results: The mean plaque and gingivitis scores in snuff-users were 59% (SD 21.0) and 47% (18.6), respectively, and in controls 64% (22.4) and 50% (18.3), respectively. The average PPD and CAL in snuff-users amounted to 2.3 mm (0.3) and 0.2 mm (0.1), respectively, and in controls 2.4 mm (0.3) and 0.1 mm (0.1) ($p > 0.05$), respectively. The mean bone level was 1.3 mm (0.2) in both groups. The prevalence of subjects showing recession was 42% among snuff-users and 17% among controls ($p = 0.006$). In snuff users, an average of 4% (0.9) of the teeth showed recession, compared with 1% (0.3) in controls ($p < 0.001$). Limiting the analysis to the maxillary anterior tooth region, 33% of the snuff-users and 10% of the controls presented recessions ($p = 0.002$). The use of snuff entailed an OR = 5.1 to have gingival recessions.

Conclusion: In the present population sample of adolescents, the use of smokeless tobacco (moist snuff) was not associated with the presence of periodontal disease except for a significantly high prevalence of gingival recessions.

The impact of cigarette smoking on the prevalence and severity of periodontal disease is well documented in the literature (e.g. Preber & Bergström 1986, Bergström 1989, 2004, Ismail et al. 1990, Bolin et al. 1993, Haber 1994, Borrell & Papapanou 2005, Heitz-Mayfield 2005). A literature search on whether the use of other tobacco products, e.g. smokeless tobacco (snuff), may have adverse effects similar to those of smoking, discloses comparatively few reports describing negative effects on the periodontal tissues. The pre-dominant finding of adverse effects reported is an increased prevalence of gingival recessions among snuff users (Frithiof et al. 1983, Greer & Poulson 1983, Poulson et al. 1984, Offenbacher & Weathers 1985, Hart et al. 1995, Johnson & Slach 2001, Rolandsson et al. 2005).

The use of smokeless tobacco (moist snuff) is an ancient custom in Sweden, practiced since the 18th century (Wickholm 2003). Parallel to the decline in cigarette smoking observed in Sweden during the last decades, a significant increase in the use of smokeless tobacco has been recorded. Moist snuff is the predominant product, used by 99% of the Swedish habitual users of smokeless tobacco products. It is estimated that at present there are about 1 million users of snuff in Sweden, constituting about 22% of all males and 3% of all females (Folkhälsoinstitutet 2004). The use of snuff was previously most common among elderly people, whereas today the highest prevalence is found among teenagers and young adult males (WHO 1988, Wickholm 2003).

Swedish moist snuff is non-fermented, where the ground tobacco, after addition of salt and water, is subjected to a heat treatment process that renders it practically free from microorganisms and lowers the risk of nitrate and nitro-

samines formation. Further, sodium carbonate is added to raise the pH of the snuff to 8–9 in order to facilitate nicotine absorption through the oral mucous membranes. The nicotine content of moist snuff varies between 5 and 11 mg/g for the various brands on the market (Andersson 1991).

There are several reports describing local reactions in the gingival tissues when exposed to snuff or nicotine. Mavropoulos et al. (2001) found an increased blood flow in the gingiva of humans in response to local exposure to snuff, and Petro et al. (2002) reported that smokeless tobacco extract increased IL-2 production and decreased IL-12 production from macrophages. In an experimental study, Alpar et al. (1998) showed that the growth of human oral fibroblasts decreased when exposed to nicotine.

A concern is the increased use of snuff among young individuals, and studies on the impact of moist snuff on periodontal health among young individuals (adolescents and young adults) are few. The purpose of the present study was therefore to evaluate the potential influence of the use of smokeless tobacco (moist snuff) on the periodontal conditions in adolescents.

Material and Methods

The subject sample utilized in the present study originated from an epidemiological study of 19-year-olds living in the community of Göteborg, Sweden (Abrahamsson et al. 2006). The population sample comprised 272 randomly selected individuals, who were clinically and radiographically examined by two calibrated dental hygienists. Information about the scope and aims of the project was given to all subjects and a signed consent was obtained. Approval of the study protocol was obtained from the regional ethical review board at Göteborg University. The sub-sample utilized in the present analysis comprised all non-smoking snuff-users (33 subjects; all males) and all male subjects who stated that they have never smoked or used snuff (70 subjects; controls).

Questionnaire

All individuals completed a structured questionnaire regarding tobacco and oral hygiene habits. In case of the use of snuff, the individuals were asked to report the amount of 50 g boxes used per week. The questions addressed with regard to oral hygiene habits included frequency of tooth brushing and use of inter-dental cleaning aids.

Clinical assessments

The following variables were included in the clinical examination

- Oral hygiene status (plaque score) – presence/absence of visible plaque on four surfaces (mesial, buccal, distal and lingual) of six index teeth (Ramfjord, 1967).
- Gingivitis – presence of bleeding following probing of the sulcus area (Löe 1967) scored at six sites (mesio-buccal, mid-buccal, disto-buccal, disto-lingual, mid-lingual and mesio-lingual) of all teeth.
- Probing pocket depth (PPD) – assessed to the nearest mm at six sites of all teeth with the use of a manual ''UNC'' periodontal probe.
- Clinical attachment loss (CAL) – assessed from the cement–enamel junction (CEJ) to the bottom of the probable pocket at six sites of all teeth.
- Gingival recession – scored as present if the gingival margin was located apical to the CEJ at the buccal aspect of all teeth.

Third molars were not included in the clinical assessments.

Before the start of the study, the two examiners were trained to levels of accuracy and reproducibility for the various clinical parameters to be used. For both inter- and intra-examiner reproducibility, the standard deviation for probing measurements had to reach a level of <0.5 mm, with an agreement within $\pm$ 1 mm of at least 99% of the examined sites for PPD and 95% for PAL.

Radiographic assessments

Four bitewing radiographs (Ectaspeed Plus®, Kodak Eastman, Rochester, NY, USA) of the pre-molar/molar region were taken using a standardized parallel projection technique (Eggen 1969). On the radiographs, the alveolar bone level (ABL) was assessed by measuring the distance in millimetre from the CEJ to the alveolar bone crest, i.e. the point at which the periodontal ligament space was considered to have a normal width (Björn et al. 1969). The measurements were made by using a magnifying lens ($\times$ 8) to the nearest lower 0.5 mm at all mesial/distal tooth surfaces reproduced in the bitewing radiographs. A site was considered ''non-readable'' if the CEJ could not be defined. A single examiner, blinded with respect to the purpose of the study, performed the radiographic assessments.

The intra-examiner reproducibility of alveolar bone level measurements was determined by repeated assessments of 10 randomly selected subjects (a total of 299 sites). Replicate pairs of measurements showed a mean difference of 0.04 mm [standard deviation (SD) 0.11]. 96.4% of the measurements were reproduced within a difference of $\pm$ 0.5 mm. The error of the method corresponded to 6% of the variance for the mean alveolar bone level in the total sample.

Data analysis

Outcome variables were gingival recession, gingivitis, PPD, CAL and ABL, while plaque score was judged as a descriptive variable.

The highest value with respect to PPD, CAL and gingivitis at the buccal and lingual aspect of each approximal site was selected to represent the proximal tooth site. Mean values and SD were calculated for all teeth and the maxillary anterior tooth region (incisors, canines and the first pre-molars), respectively, using the subject as the statistical unit.

For statistical analyses of potential differences between snuff-users and controls, the Student t-test and χ^2-test were used. A p-value of <0.05 was considered statistically significant. Multivariate logistic regression analysis was performed to identify factors associated with the presence of gingival recession, expressed as odds ratios (OR) and 95% confidence intervals (95% CI).

Results
Assessments by means of the questionnaire

The mean number of boxes of snuff used per week was 2.6 (SD 1.5); 33% of the snuff-users consumed >2 boxes per week (Table 1). Seventy-three percent of the snuff-users and 83% of the controls stated that they were brushing their teeth twice daily, while the remaining subjects brushed less frequently. Inter-dental cleaning aids were irregularly used by 46% and 40% of the snuff-users and controls, respectively, whereas $>50\%$ of the subjects in both

Table 1. Distribution (%) of snuff-users according to the number of boxes of snuff used per week

Boxes per week	No. of subjects (%)
1	7 (21.2)
2	15 (45.5)
3	4 (12.1)
4	2 (6.1)
5	4 (12.1)
$\geqslant 6$	1 (3.0)

Table 2. Clinical characteristics of snuff-users compared with controls

	Snuff-users ($n = 33$)	Controls ($n = 70$)
No. of teeth	28 (1.1)	27 (2.5)
Plaque (%)	59 (21.0)	64 (22.4)
Gingivitis full mouth (%)	47 (18.6)	50 (18.3)
Gingivitis maxillary anterior tooth region (%)	33 (19.8)	36 (21.7)
PPD (mm)	2.3 (0.3)	2.4 (0.3)
CAL (mm)	0.2 (0.1)	0.1 (0.1)
ABL (mm)	1.3 (0.2)	1.3 (0.2)

PPD, probing pocket depth; CAL, clinical attachment loss; AB, lalveolar bone level. Mean values (SD).

groups claimed to never make use of such cleaning aids.

Clinical and radiographic assessments

The results of the clinical and radiographic assessments are given in Table 2 and Figs 1–4. No difference in the mean number of teeth was found between snuff-users and controls (27.6 *versus* 27.1).

Oral hygiene status and gingivitis

Snuff-users and controls showed a mean plaque score of 59% and 64%, respectively (Table 2). A high number of sites with gingivitis was found in both groups (snuff-users 47%, controls 50%). The data analysis with respect to the maxillary anterior tooth region revealed that on average 33% and 36% of the sites in snuff-users and controls, respectively, were scored inflamed. No differences between the two groups were found regarding the proportion of sites showing plaque or gingivitis, neither for the full mouth scorings nor for the subgroup of maxillary anterior tooth region.

PPD, CAL and ABL

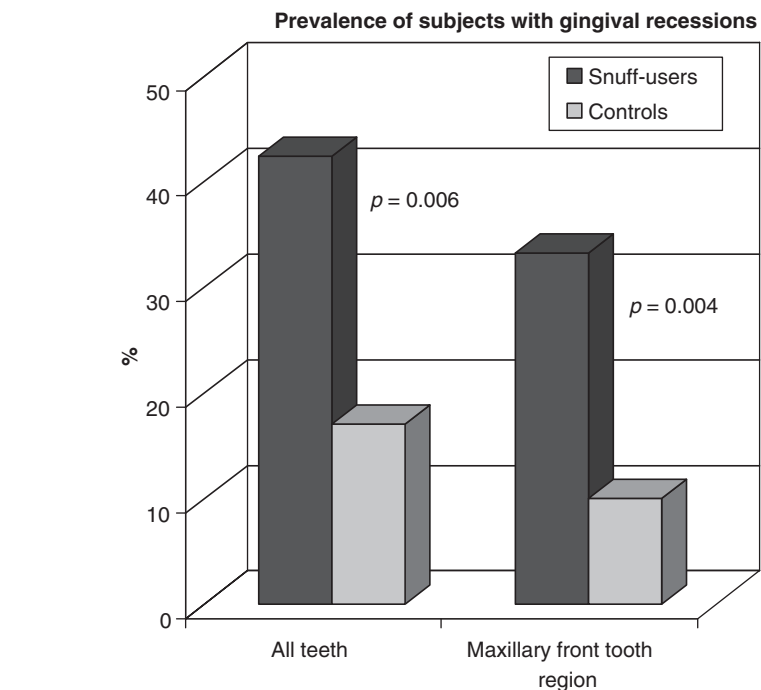The mean PPD was 2.3 mm in snuff-users and 2.4 mm in controls (Table 2),

Fig. 1. Percentages of subjects with recession among snuff-users and controls; all teeth and maxillary anterior tooth region.
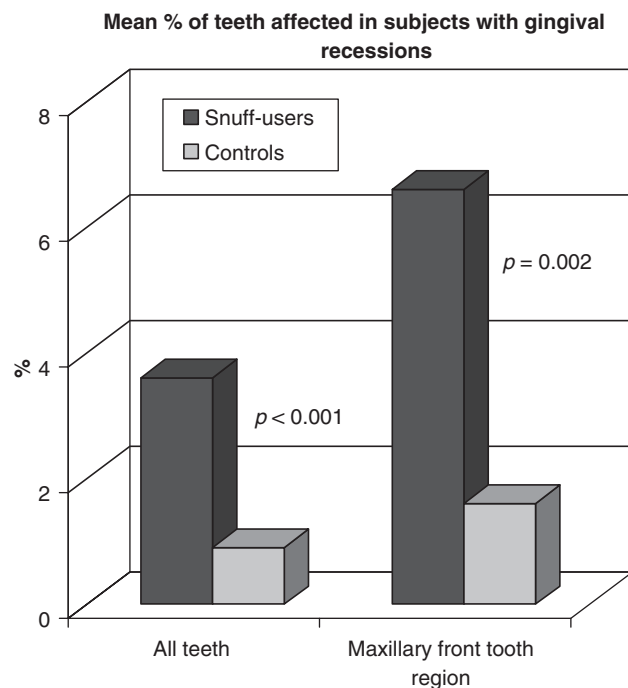

Fig. 2. Mean per cent of teeth affected in snuff-users and controls with recessions; all teeth and maxillary front tooth region.

whereas the mean CAL amounted to 0.2 and 0.1 mm in snuff-users and controls, respectively ($p > 0.05$). In both groups, the mean ABL was 1.3 mm.

Gingival recession

The prevalence of subjects with gingival recession was 42% among snuff-users and 17% among controls ($p = 0.006$;
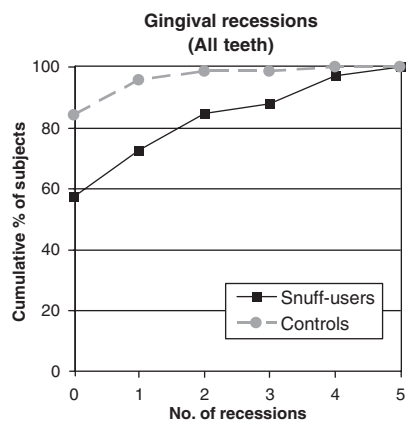
**Gingival recessions
(All teeth)**

Fig. 3. Cumulative per cent distribution of subjects with respect to number of buccal tooth surfaces with gingival recession in snuff-users and controls.

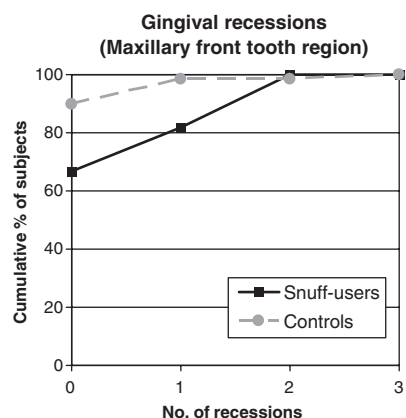**Gingival recessions
(Maxillary front tooth region)**

Fig. 4. Cumulative per cent distribution of subjects with respect to number of buccal tooth surfaces with gingival recession in the maxillary anterior tooth region in snuff-users and controls.

Fig. 1). Among those presenting with gingival recession, on average 4% of the teeth in snuff-users and 1% of the teeth in controls showed recession ($p < 0.001$; Fig. 2). In the maxillary anterior tooth region, 33% of the snuff-users and 10% of the controls exhibited recessions ($p = 0.004$; Fig. 1), with on average 7% of the teeth affected in snuff-users and 2% in controls ($p = 0.002$; Fig. 2).

The cumulative % distribution of snuff-users and controls with respect to number of buccal surfaces with gingival recession is presented in Figs 3 (all teeth) and 4 (maxillary anterior tooth region).

Multivariate logistic regression analysis

The use of snuff showed an OR = 3.7 for identifying a subject with gingival

Table 3. Multivariate logistic regression analysis with $\geqslant 1$ tooth with gingival recession (all teeth) as the dependent variable

Independent variable	Coefficient	SE	OR	95% CI
Snuff user	1.314	0.498	3.721	1.401 – 9.886
Plaque	0.001	0.015	1.001	0.973 – 1.030
Gingivitis full mouth	− 0.029	0.018	0.971	0.937 – 1.007
Toothbrushing	0.514	0.668	1.673	0.452 – 6.197

The model; $p = 0.012$.

Table 4. Multivariate logistic regression analysis with $\geqslant 1$ tooth with gingival recession (maxillary anterior tooth region) as the dependent variable

Independent variable	Coefficient	SE	OR	95% CI
Snuff user	1.629	0.569	5.099	1.672 – 15.549
Plaque	− 0.005	0.015	0.995	0.967 – 1.024
Gingivitis maxillary anterior tooth region	− 0.016	0.017	0.984	0.952 – 1.018
Toothbrushing	1.098	0.854	2.999	0.562 – 16.008

The model; $p = 0.017$.

recession (Table 3). The presence of was 12% of the variance in the prevalence of subjects with gingival recession was explained by including the use of snuff, plaque, gingivitis and toothbrushing habits.

The corresponding logistic regression model formulated with regard to the presence of gingival recession in the maxillary anterior tooth region revealed an OR of 5.1 for the use of snuff ($R^2 = 0.11$; Table 4).

Discussion

The results of the present study of 19-year-old individuals revealed that the use of smokeless tobacco (moist snuff) was associated with a significantly higher risk for the development of gingival recessions, but not in other signs and symptoms of periodontal disease. Hence, the odds of finding a subject with a gingival recession were 3.7 fold greater for snuff-users when compared with controls, and for the predominate location of the placement of snuff among Swedish users, the maxillary anterior tooth region, the odds were 5.1 fold greater. This finding is in agreement with results of other studies investigating the impact of smokeless tobacco on periodontal conditions (Offenbacher & Weathers 1985, Weintraub & Burt 1987, Robertson et al. 1990, Johnson & Slach 2001). Offenbacher & Weathers (1985) reported the odds of having gingival recession to be nine times higher in users of smokeless tobacco as compared with non-users. The latter study was performed in a school population consisting of 565 males with a mean age of 13.8 years.

The authors also found that in young individuals with healthy gingival conditions, the use of smokeless tobacco was not associated with an increased prevalence of gingival recession. Hence, Offenbacher & Weathers (1985) suggested that gingivitis was a necessary co-factor for an increased risk of recessions in users of smokeless tobacco. This is in contrast to the results of the current study in which the multivariate analysis did not reveal poor oral hygiene and high scores of gingivitis as significant factors for identification of subjects with gingival recessions. A reason for this difference could be that the prevalence of gingivitis was high in the present subject sample. Such an interpretation may partly be supported by findings recently reported from a study on young snuff-using ice-hockey players (Rolandsson et al. 2005), indicating a comparatively low prevalence of gingivitis (12%) and a markedly lower prevalence of recessions (17%). On the other hand, the lack of correlation between gingivitis and the prevalence of gingival recessions found in the current study may indicate mechanical and/or chemical trauma to the gingiva as causative factors for the development of recessions. Several authors have reported that the underlying alveolar bone at buccal sites, prone to the development of recession, may be thin and exhibit alveolar dehiscences (Gorman 1967, Hall 1977, Lost 1984). Robertson et al. (1990) and Weintraub & Burt (1987) stated that smokeless tobacco was likely to cause chemical injury to thin areas of gingiva chronically exposed to the quid, with a resulting loss of marginal gingiva in sites with alveolar dehiscences.

In a study by Poulson et al. (1984), 56 out of 445 investigated subjects (mean age 16.7 years) were found to be snuff-users and they presented a prevalence of gingival recession of 27%. The higher overall prevalence of gingival recession found in the current study (42% in snuff-users compared with 17% in control subjects) may partly be due to a higher age (19 years) and that only male subjects were included. However, in the study by Offenbacher & Weathers (1985), the mean age of the male subject sample studied was lower (13.8 years) and the prevalence of gingival recession was 60% in the 75 snuff-users compared with 14% in 490 non-users. Hence, age *per se* may not be an explanatory factor, but rather the duration of the habit and the amount and type of snuff used (Poulson et al. 1984, Axell 1993). Axell (1993) found gingival recessions to be more frequent among users of loose snuff when compared with users of portion-bag-packed snuff. It was further stated that the amount and duration of daily use seem to have a greater impact on the risk for development of recessions than the number of years with the habit and/or age of the subject. However, such associations could not be verified in the present study, in which the mean number of boxes used per week was 2.6, with 33% of the subjects consuming >2 boxes per week.

In the present study, approximately 80% of the subjects were brushing their teeth twice daily, which corroborates data from a study performed in 16- and 18-year-old adolescents from northern Sweden, in which toothbrushing ⩾2 times daily was reported by 84.3% of the 16-year-olds and by 83.7% of the 18-year-olds (Källestål & Uhlin 1992). Mechanical trauma inflicted on a thin gingiva during toothbrushing is considered a major causative factor for the development of recessions. However, there was no difference in toothbrushing habits between users and non-users of snuff in the current study. Hence, the difference in prevalence of recessions in the maxillary anterior tooth region is most likely attributed to snuff habits, which is supported by results from several other studies (Poulson et al. 1984, Weintraub & Burt 1987, Taybos 2003).

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Clinical relevance

Rationale: Smoking is recognized as a true risk factor for periodontal disease. Whether smokeless tobacco (moist snuff) may be a risk factor for periodontal disease needs to be evaluated.

Principal findings: In the current study of 19-year-old male individuals living in Göteborg, Sweden, the use of smokeless tobacco was associated with a significantly higher prevalence of gingival recessions, but no differences in other parameters characterizing periodontal disease was found in users of moist snuff compared to controls.

Practical implications: As the effects of smokeless tobacco are already present in young individuals with comparatively short exposure time, attention should be paid to prevention programmes focusing on the behavioural aspects of young individuals to reduce potential future attachment loss.