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Smokeless Tobacco Use and Periodontal Health in a Rural Male Population

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Abstract

Background—Despite the reported effects of smokeless tobacco (ST) on the periodontium and high prevalence of ST use in rural populations and in men, studies on this specific topic are limited. The purpose of this cross-sectional investigation is to evaluate the periodontal health status of male ST users from a rural population.

Methods—Adult male residents of two rural Appalachian Ohio counties and daily ST users, with a unilateral mandibular oral ST keratosis lesion, were recruited. Subjects completed a questionnaire and received oral examination. Teeth present, ST keratosis lesion, plaque and gingival index, probing depth (PD), recession depth (RD), and attachment level were recorded. Statistical analysis compared ST-site mandibular teeth (teeth adjacent to the subject's unilateral ST keratosis lesion) to NST-site teeth (contralateral corresponding teeth).

Results—This study includes 73 ST users. Recession prevalence is much greater in ST-site quadrants (36%) compared to NST-site quadrants (18%; $P < 0.001$). Twice as many teeth had recession on ST-site (approximately 20%) than NST-site (approximately 10%; $P = 0.0001$). Average buccal RD on ST-site teeth did not differ from that on the NST-site teeth ($P = 0.0875$). Although average buccal attachment loss is greater on ST-site teeth ($P = 0.016$), the mean difference is <0.5 mm. When stratified by years of ST use, subjects using ST for 10 to 18 years exhibit the most differences between ST and NST sites, whereas subjects using ST for <10 years show no differences.

Conclusion—The results indicate that greater gingival recession prevalence and extent are associated with ST placement site in rural male ST users.

Keywords

Gingival recession; periodontitis; smokeless tobacco

The effects of tobacco smoking on periodontal health have been extensively documented and reviewed.[1] Smoking tobacco, whether in the form of cigarettes,[2,3] cigar,3›4 pipe,3›4 or hookah (water pipe),5 is strongly associated with periodontal tissue destruction and is considered a risk factor for periodontitis1 and tooth loss.6 In contrast, the potential periodontal health effects

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of smokeless tobacco (ST), which is also available in various forms, such as loose leaf, pouch, or snuff, have received much less attention.[6–8]

The prevalence of male ST users in the United States is recently estimated at 4.5%,[9] but in certain subgroups, such as white men, the prevalence is as high as 10%.[10] The use of ST has been reported to be disproportionately higher among white men between 18 and 44 years of age, those who have ≤12th grade education,[11] and those who reside in rural areas.[12] The Appalachian region in Ohio is characterized as a rural region with a low level of education and low socioeconomic status.[13]

ST use has been associated with several oral manifestations localized at the site of ST placement. These manifestations include mucosal lesions[14–16] and gingival-periodontal effects, such as gingival recession,[15,17–19] gingival inflammation,[20] changes in gingival blood flow,[21] and interproximal periodontal attachment loss.[8] Other studies, however, have reported no association between ST use and interproximal attachment loss.[18,19]

The purpose of this cross-sectional study is to evaluate the periodontal health status of a male population of ST users from rural Appalachia. This study is designed to test the hypothesis that, in this population, the clinical periodontal parameters of sites associated with ST placement (ST-sites) are different than the corresponding parameters of the contralateral sites, where ST is not placed (NST-sites).

MATERIALS AND METHODS

Study Population

This study evaluates a population selected among participants of a larger, longitudinal, community-based ST-intervention study, which is still in progress. The longitudinal study participants from two rural Appalachian counties in Ohio (Ross County and Muskingum County) recruited under the following inclusion criteria: 1) male, 2) aged ≥18 years, 3) current daily ST user without any contraindication for over-the-counter nicotine replacement therapy, and 4) current resident of the county. Participants who were former ST or current users of tobacco product other than ST were excluded from the study. A total of 256 eligible subjects enrolled following recruitment through radio and newspaper advertisements and personal contacts. Enrollment took place between August 2002 and October 2003. All participants of the study were given detailed study information and explanations and all provided signed informed consent. The study protocol, including the cross-sectional component, study instruments (questionnaires and record forms), advertisements, and consent forms were approved by the Ohio State University Institutional Review Board.

The present cross-sectional study component was based on the baseline evaluation of a subset of the longitudinal study participants. The additional inclusion criteria for selection of this subset were dentate, with at least one mandibular tooth on both sides of the mouth; and presence of clearly identifiable unilateral mandibular oral ST keratosis. Exclusion criteria were, 1) edentulous or dentate on one side of the mandible, 2) lack of mandibular oral ST keratosis, and 3) presence of bilateral mandibular oral ST keratosis. Of the 256 subjects enrolled in the intervention study, 175 were identified to have teeth associated with ST keratosis; of them, 68 subjects were excluded due to bilateral keratosis. Of the remaining 107 subjects, 34 were excluded because of keratosis on the maxilla; therefore, the final population for the present study consists of 73 subjects.

Study Questionnaire

All participants completed a baseline questionnaire that included the following: 1) demographics (gender, age, education, and income); 2) frequency of tooth-brushing; 3) past

and present tobacco use history; 4) frequency of alcohol consumption; and 5) number of years of ST use.

Clinical Assessments

All participants received an oral examination by the same trained and calibrated examiner (AGW), who assessed the following parameters:

1. ST keratosis: the location, size, and specific teeth adjacent to the ST keratosis were recorded.[14,22]
2. Plaque[23] and gingival[24,25] indices: both were measured on Ramfjord teeth,[26] scoring four surfaces per tooth. When a designated tooth was missing, the closest tooth distal to the missing one was used.
3. Probing depth (PD): calibrated manual periodontal probes (UNC-15) were used to measure to the nearest millimeter the distance from the gingival margin to the bottom of the periodontal sulcus or pocket, at four sites of a tooth (mesio-buccal, mid-buccal, disto-buccal, and mid-lingual).
4. Recession depth (RD): the distance from the cemento-enamel junction to the gingival margin[26] was measured to the nearest millimeter, at four sites per tooth, as for PD. When the gingival margin was coronal to the cemento-enamel junction, the values were recorded as negative.
5. Clinical attachment level: computed from the RD and PD measurements.
6. The total number of teeth present in the mouth: this number was recorded for each subject.

Intra examiner reliability for PD, gingival index, and RD was assessed by randomly selecting7% of the subjects and scheduling a repeat examination within 4 to 21 days of the original examination. The examiner (AGW) was masked to previous measurements. The exact agreement between first and second measurement is as follows: PD 75% (Lin concordance correlation coefficient27 = 0.52); gingival bleeding 61% (κ statistic28 = 0.75); and RD 62% (Lin concordance correlation coefficient27 = 0.9).

Data Analysis

Descriptive statistics (mean ± SD) were calculated for average number of mandibular teeth present, average number of teeth per ST and NST quadrant, average number of teeth corresponding to the area of the ST lesion, and the recorded periodontal clinical parameters. The subject was the unit of analysis, with each subject contributing one ST and one NST mandibular quadrant.

The mandibular teeth adjacent to the subject's unilateral oral ST keratosis lesion were labeled as "ST-site" teeth. The contralateral corresponding mandibular teeth were identified and labeled as "NST-site" teeth. Descriptive statistics for the periodontal parameters were calculated for the ST-site and NST-site teeth, for the tooth as a whole, for only interproximal sites, and for only buccal sites. For the purposes of data analysis, ST-site was designated the site where the ST keratosis was clinically identified, and not the site (left or right) reported by the patient in the questionnaire.

To analyze mean differences between ST- and NST-sites for all periodontal parameters the Wilcoxon signed-rank test was used because the data failed to meet normality (Shapiro-Wilk test). The McNemar test was used to analyze differences between proportions. The level of statistical significance was set at $\alpha = 0.05$.

RESULTS

Of the 256 current ST users enrolled in the longitudinal trial, 73 were eligible for the present cross-sectional study. The demographic information for the 73 selected subjects, as obtained from the questionnaires, is summarized in Table 1. The mean age of the participants was 31.1 years, reporting an average of 12.8 years of ST use. Most of the subjects brushed their teeth daily (approximately 88%) and drank alcohol ≤2 days per week (approximately 86%). Table 1 also presents the demographic data separately for the 62 non-smokers, who were not significantly different from the entire group.

The periodontal clinical parameters of the study population are also presented in Table 1. On average, the subjects had 25 teeth present in the mouth. In the mandible, the average number of teeth was 13 and the periodontal attachment loss averaged <0.5 mm. The site of ST lesion was 45.2% (n = 33) on the left and 54.8% (n = 40) on the right side of the mandible. When the number of teeth corresponding to the ST site was compared between subjects having the ST lesion on the left side and subjects having the ST lesion on the right side, there was no difference ($P = 0.1576$, Wilcoxon).

The data on the comparisons between ST-sites and NST-sites are presented in Table 2. The number of teeth corresponding to ST-sites was not different from the number on NST-sites ($P = 0.055$, Wilcoxon). When the whole tooth measurements were analyzed there was greater attachment loss on the ST-sites ($P = 0.003$, Wilcoxon); however, the mean difference was <0.2 mm. There were no differences between ST-site and NST-site teeth regarding interproximal measurements ($P>0.1$, Wilcoxon). When the buccal measurements were examined separately, ST-site teeth had greater attachment loss ($P = 0.016$, Wilcoxon) than NST-site teeth, and the mean difference was 0.36 mm. ST-side quadrants, compared to NST-side quadrants, had twice as many teeth with recession ($P = 0.0001$, Wilcoxon) and were twice as likely to have a tooth with recession ($P<0.001$, McNemar). The average buccal RD for teeth with buccal recession was 1.92 ± 1.1 mm for ST-side teeth and 1.77 ± 1.1 mm for NST-side teeth ($P = 0.0001$, Wilcoxon). More than a third of ST quadrants (36%) had teeth with recession, compared to 18% of the NST quadrants (Table 2). Of the teeth present on ST-sites 20% had recession, whereas on the NST-sites approximately 10% had recession (Table 2).

Table 3 presents the periodontal clinical parameters with subjects stratified by years of ST use. There were no differences in any of the clinical parameters between ST- and NST-sites in subjects (n = 27) that had used ST for <10 years. For subjects using ST for 10 to 18 years (n = 26), the between site differences were as described above for all 73 subjects. In addition, there were statistically significant differences between ST- and NST-sites for whole tooth and buccal RD (P <0.02, Wilcoxon) but the corresponding mean differences were <0.2 and 0.4 mm, respectively. In subjects using ST for 10 to 18 years, more than half of the ST quadrants (54%) had teeth with recession.

Subjects using ST for ≥19 years were the smallest subgroup (n = 20); in this subgroup, the prevalence of quadrants with recession did not differ between ST and NST sides ($P = 0.25$) (Table 3). The number of teeth with recession was significantly different between ST and NST sites in this subgroup ($P = 0.026$, Wilcoxon). Statistically significant differences between ST and NST sites were observed in this subgroup for buccal PD ($P = 0.034$, Wilcoxon) and buccal attachment level ($P = 0.025$); again, the mean differences were small (<0.5 mm).

DISCUSSION

This cross-sectional study is designed to test the hypothesis that, in a male rural population of ST users, the clinical periodontal parameters of sites associated with ST placement are different than the corresponding parameters of the contralateral sites, where ST is not placed. The results

indicate that ST-sites, compared to NST-sites, experience greater recession prevalence and extent. To our knowledge, the present study is the first to analyze the periodontal parameters of rural Appalachian ST users, an underserved population.

The present study dealt with an adult male rural population with an average ST use of 12.8 years. This represents a unique group in terms of ST exposure, compared to the ST literature. In the published studies examining effects of ST use on periodontal tissues, participants were either adolescents with brief ST exposure (average ST use of 2.7 years)[22] or adults with much greater exposure to ST (average ST use of 23.9 years).14 Because a dose-response relationship seems to exist between ST use and severity of injury to the periodontium,29,30 the analysis of the present study population was stratified according to years of ST use. Among adult male rural subjects who used ST for <10 years there were no differences in any periodontal parameters between ST- and NST-sites. However, in subjects using ST for 10 to 18 years the differences between ST- and NST-sites were significant for recession prevalence, extent, and severity. For the subjects with ≥19 years of ST use, only the number of teeth with recession was significantly different between ST- and NST-sites; the lack of significance for other aspects of recession may be caused by the limited number of subjects in this last subgroup. Overall, these results further support the concept of dose-response relationship between ST use and periodontal injury.29,[30]

The plaque index and gingival index results in the present study suggest that, despite the daily toothbrushing reported by most (88%) of the participants, this population had poorer oral hygiene and greater gingival inflammation than other ST-user populations reported in the literature.[18,]20 The lack of site-specific plaque index and gingival index measurements in the present study precludes any comparison to other studies where such local parameters were factored in the analysis of ST-associated injury to the periodontium.18,31

In the present split-mouth analysis of chronic ST users, teeth located at the ST placement site had greater attachment loss. Although this finding is consistent with the results of Fisher et al., [8] who found that current ST users were almost three times more likely to have severe active periodontal disease compared to never users, the magnitude of the attachment differences observed in the present study was small (Table 3). Even in subjects using ST for >10 years (Table 3), the magnitude of the significant attachment differences was <0.5 mm; differences of such magnitude are of questionable clinical significance. It should be noted that other studies reported no association between ST use and interproximal attachment loss.[18,19] Study population and methodologic differences could account for such discrepancies.

Compared to most rural Appalachians, study participants were more educated and earned a higher income.[32] This fact and the strong association of poorer periodontal conditions with lower socioeconomic status[33–36] suggests that the periodontal health status of the study population may not be representative of the rural Appalachian population at large. A limitation of the study is the lack of detailed information on the participants' brushing habits. Although there are anecdotal reports of participants placing greater attention to brushing the ST-sites, the brushing frequency obtained from the questionnaire does not provide information whether a possible excessive brushing could contribute to the ST-site recession.[18] Subject selection for the present study was based on the clinical diagnosis of unilateral oral ST lesions and no additional information was collected from participants regarding past location or the possible alternating choice of ST placement site. Such unknown habits may have influenced the periodontal status of teeth designated here as NST-sites, a condition that would remain undetectable. This is because studies have shown the ST-induced oral keratosis lesion is reversible with successful ST cessation,[37] whereas any damage to the periodontal tissues, particularly in the form of recession, is likely to be irreversible.

To our knowledge, the present study represents the first report on periodontal health aspects of rural Appalachian ST users, an underserved population at high risk of developing oral and other chronic diseases associated with high tobacco use, low education level, and limited resources for health care. Such concerns are compounded by the limited success observed for tobacco cessation programs[38] and the fact that <30% of all dentists, the health care providers most likely to examine for and identify premalignant oral lesions, practice outside metropolitan areas.[39] The demonstrated effectiveness of dentists and dental hygienists in promoting ST cessation[40] suggests that greater support for oral health care to rural Appalachians and greater emphasis on ST-cessation programs may positively impact the periodontal health status of this population. Studies on ST cessation and periodontal health in this population are in progress.

CONCLUSIONS

The results of the present study are in agreement with other ST-user studies in terms of the strong association between gingival recession and ST placement.[18,31] In the face of methodologic and population differences, the consistency of the results with respect to buccal recession and ST use lends further support to the association between the two conditions.

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Table 1

Study Population Demographics and Periodontal Parameters Stratified by All Participants and Non-Smokers

Demographics % (n)	Total (73)	Non-Smokers (62)
Age (years)		
≤20	12.3 (9)	9.68 (6)
21 to 24	12.3 (9)	11.3 (7)
25 to 29	22.2 (16)	9.4 (12)
≥30	53.4 (39)	59.7 (37)
Education level		
≤High school	57.5 (42)	53.2 (33)
Technical school	9.6 (7)	8.06 (5)
Associate degree	10.9 (8)	12.9 (8)
Some college or higher*	21.9 (16)	25.8 (16)
Oral hygiene		
Brush daily	87.7 (64)	93.5 (58)
Brush weekly	8.2 (6)	6.45 (4)
<Once a week	2.7 (2)	0 (0)
Never	1.4 (1)	1.61 (1)
Drinking (days/week)		
0	47.9 (36)	51.6 (32)
1 to 2	38.3 (28)	35.5 (22)
≥3	12.3 (9)	12.9 (8)
Annual income		
No answer	2.7 (2)	3.2 (2)
0 to $25,000	27.8 (20)	25.8 (16)
≥$25,001†	69.9 (51)	71 (44)
Smokeless tobacco use (average years)	12.9	13.9
Periodontal parameters (mean ± SD)	**Total (73)**	**Non-Smokers (62)**
Plaque index‡	1.18 ± 0.62	1.09 ± 0.61
Gingival index‡	1.05 ± 0.38	1.03 ± 0.38
PD (mm)	1.75 ± 0.32	1.75 ± 0.33
RD (mm)	−1.31 ± 0.74	−1.29 ± 0.77
Attachment level (mm)	0.43 ± 0.63	0.46 ± 0.64
Teeth present (n)	25.2 ± 4.2	26.4 ± 3.9
Teeth present in mandible (n)	13.0 ± 2.7	13.3 ± 1.7

Demographic data based on questionnaire responses, periodontal parameters obtained from clinical examination.

*Includes three with college degree and one with professional degree.

†Includes 22 participants with annual income >$50,000.

‡Based on Ramfjord index teeth.[26]

Table 2

Comparison of ST and NST Sides (N = 73)

Parameter	ST (mean ± SD)	NST (mean ± SD)	*P* Value*
Teeth corresponding to ST/NST site (n)	3.36 ± 1.6	3.23 ± 1.6	0.0555
Whole tooth (mm)			
PD	1.80 ± 0.38	1.72 ± 0.50	0.2792
RD	−1.28 ± 0.82	−1.38 ± 0.78	0.0569
Attachment level	0.52 ± 0.76	0.34 ± 0.63	**0.0028**
Interproximal (mm)			
PD	2.20 ± 0.48	2.09 ± 0.58	0.1407
RD	−1.84 ± 0.71	−1.84 ± 0.72	0.9145
Attachment level	0.36 ± 0.74	0.24 ± 0.65	0.0520
Buccal (mm)			
PD	1.31 ± 0.46	1.25 ± 0.46	0.4118
RD	−0.27 ± 1.45	−0.57 ± 1.33	0.0875
Attachment level	1.04 ± 1.39	0.68 ± 1.18	**0.0165**
Teeth with recession (n)	0.68 ± 1.1	0.32 ± 0.8	**0.0001**
Quadrants with recession (n)	26	13	**<0.001**†

ST = site of smokeless tobacco-induced keratosis; NST = corresponding contralateral site, free of smokeless tobacco-induced keratosis.

*Wilcoxon signed-rank test, unless otherwise noted. **Bold** indicates statistical significance.

†McNemar test.

Table 3

Comparison of ST and NST Sides Stratified by Years of ST Use

	0 to 9 Years (n = 27)			10 to 18 Years (n = 26)			≥19 Years (n = 20)		
Parameter	**ST (mean ± SD)**	**NST (mean ± SD)**	***P* Value***	**ST (mean ± SD)**	**NST (mean ± SD)**	***P* Value***	**ST (mean ± SD)**	**NST (mean ± SD)**	***P* Value***
Teeth corresponding to ST/NST site (n)	3.48 ± 1.50†	3.33 ± 1.62†	0.3082	3.50 ± 1.77†	3.42 ± 1.77†	0.3173	3.20 ± 1.15†	3.05 ± 1.19†	0.1574
Whole tooth (mm)									
PD	1.77 ± 0.40	1.68 ± 0.51	0.5145	1.73 ± 0.35	1.72 ± 0.41	0.5842	1.92 ± 0.40	1.79 ± 0.60	0.4434
RD	−1.40 ± 0.94	−1.44 ± 0.74	0.8661	−1.21 ± 0.47	−1.37 ± 0.56	**0.0253**	−1.22 ± 1.00	−1.33 ± 1.08	0.3698
Attachment level	0.37 ± 0.81	0.24 ± 0.60	0.9704	0.53 ± 0.56	0.35 ± 0.40	**0.0005**	0.70 ± 0.89	0.46 ± 0.87	0.1393
Interproximal (mm)									
PD	2.11 ± 0.48	2.00 ± 0.60	0.2579	2.25 ± 0.54	2.14 ± 0.52	0.2025	2.27 ± 0.43	2.13 ± 0.63	0.5242
RD	−1.82 ± 0.82	−1.77 ± 0.78	0.4483	−1.99 ± 0.54	−1.99 ± 0.54	0.7396	−1.71 ± 0.78	−1.76 ± 0.86	0.6405
Attachment level	0.29 ± 0.68	0.24 ± 0.76	0.9735	0.26 ± 0.79	0.15 ± 0.43	0.1660	0.56 ± 0.75	0.37 ± 0.75	0.1923
Buccal (mm)									
PD	1.36 ± 0.45	1.25 ± 0.48	0.3626	1.13 ± 0.21	1.26 ± 0.39	0.1562	1.50 ± 0.65	1.26 ± 0.54	**0.0335**
RD	−0.77 ± 1.40	−0.94 ± 0.77	0.4177	0.04 ± 0.94	−0.42 ± 1.13	**0.0117**	−0.02 ± 1.91	−0.27 ± 1.91	0.4195
Attachment level	0.59 ± 1.32	0.31 ± 0.59	0.4658	1.17 ± 0.90	0.84 ± 0.97	**0.0191**	1.48 ± 1.82	0.99 ± 1.80	**0.0248**
Teeth with recession (n)	0.26 ± 0.71	0.04 ± 0.19	0.0834	0.96 ± 1.15	0.46 ± 0.95	**0.0016**	0.90 ± 1.37	0.50 ± 1.05	**0.0257**
Quadrants with recession (n)†	4	1	0.2500	14	7	**0.0156**	8	5	0.2500

ST = site of smokeless tobacco-induced keratosis; NST = corresponding contralateral site, free of smokeless tobacco-induced keratosis.

*Wilcoxon signed-rank test, unless otherwise noted. **Bold** indicates statistical significance.

†McNemar test.