

## Oral Health Consequences of Use of Smokeless Tobacco in North India: A Cross-Sectional Survey

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### ABSTRACT

**Objective:** To evaluate the effects of commonly used smokeless tobacco forms on oral health at habitual placement sites of smokeless tobacco compared to non-placement sites among the North Indian population. **Material and Methods:** This cross-sectional study was conducted among 542 individuals using smokeless tobacco recruited from the outpatient wing of the Dental College. Subjects completed a questionnaire and received an oral examination. Periodontal pocket depth, gingival index, plaque index, gingival recession, and oral mucosal changes were assessed. Kendal's Tau test, paired t-test, and chi-square test were carried out to compare different variables among placement and non-placement sites. **Results:** Most of the subjects were male, reporting an average of 11.26 years of SLT use. Clinical inflammation of gingiva was significantly greater ( $p=0.01$ ) at placement-sites ( $1.64 \pm 0.53$ ) of SLT in comparison to non-placement-sites ( $1.40 \pm 0.41$ ). The difference in the GR and PPD at placement and non-placement-sites was also statistically significant with  $p=0.002$  and  $p=0.001$ , respectively. Clinically, the majority of subjects had mucosal changes at the placement sites, and a statistically significant association ( $p=0.034$ ) was observed between the duration of the use of smokeless tobacco and the mucosal changes. **Conclusion:** Smokeless tobacco use predisposes to increased risk of periodontal diseases and oral mucosal changes at the placement sites in an individual due to the local irritant effect.

**Keywords:** Periodontitis; Tobacco, Smokeless; Mouth Mucosa; Oral Health.

## Introduction

The global tobacco epidemic has resulted in various adverse health effects and is the leading cause of death worldwide. It is considered the most significant public health threat globally, accounting for more than 7 million deaths annually [1]. Over the ages, tobacco use has increased in India. Of the estimated 28.6% tobacco use in India, 21.4% is used in the form of smokeless tobacco (SLT) products such as pan (a blend of lime, bits of areca nut, and spices enclosed in betel leaf), gutka/pan masala (blend of pulverized lime and areca nut) and mishri (used as toothpaste for scouring gums) [2].

Tobacco use is linked with impaired immune system and wound healing, which may play an important role in periodontal tissue destruction [3]. SLT use has been reported to be associated with numerous oral manifestations localized at the SLT placement site in the oral cavity, which can be considered the Placement-site. These manifestations include mucosal lesions as leukoplakia, oral cancer, gingival-periodontal effects, gingival recession, gingival inflammation, gingival blood flow changes, and interproximal periodontal attachment loss and dental caries [4-6].

The localized nature of SLT induced alterations implies that chemical or mechanical irritation from the tobacco quid is responsible for clinical alterations, although bacterial or host factors may influence these lesions' development [7].

The deleterious effects of smoking on oral health have been extensively studied, reported, and gained scientific evidence compared to SLT [8,9]. Limited studies have been carried out in the North Indian population regarding the effect of smokeless tobacco products on the periodontium and oral health [10,11]. Therefore, this study was carried out to evaluate the effects of commonly used smokeless tobacco forms on the periodontium and oral health at habitual placement-sites of SLT and compare it to non-placement-sites SLT in the same individuals among North Indian population. The study results will help provide recommendations for future planning of tobacco cessation activities, preventive, and treatment programs.

## Material and Methods

### Study Design and Sample

This cross-sectional study was conducted among the individuals in the age range of 18–60 years, using smokeless tobacco, from the outpatient wing of the Dental College, Aligarh Muslim University.

### Ethical Consideration

Ethical clearance was obtained from the Institutional Ethical Review Board (Protocol No. 359/FM dated 27/5/17). Informed consent was obtained from the patients before the start of the study. Participation in the study was voluntary and confidentiality of data was maintained.

### Inclusion and Exclusion Criteria

Patients aged 18-60 years, using smokeless tobacco, and having at least 10 teeth were included in the study. Patients with tobacco smoking habits, complete edentulous status, systemic diseases, under medication, and patients who underwent surgery in the past 6 months, pregnant and lactating females were excluded from the study.

The sample size was calculated using the following formula:  $Z^2 =$  Standard score corresponding to a given confidence level;  $P =$  Prevalence of disease;  $q = (1 - p)$  or percentage of failure which is  $100 - 1 = 99\%$ ; and  $e =$  Precision limit or proportion of sampling error which is usually 5% confidence limit; where  $Z = 1.96$ ,  $P = 16\% = 0.16$  [12], Absolute level of precision ( $e$ ) which specifies the width of the confidence interval was kept as 5%. According to the above-given formula, the final sample size obtained was 206. The sample size was increased to 542 as larger sample sizes give more reliable results with greater precision and power.

#### Data Collection

The information was recorded on a self-prepared questionnaire, consisting of demographic details, SLT use status, and oral hygiene. A complete intraoral examination was carried out on a dental chair in dental college by a single dentist using diagnostics (mouth mirror, explorer, UNC 15 probe, cotton pliers and Naber's probe) instruments including an assessment of gingival index (GI; Loe and Silness), plaque index (PI; Silness and Loe), periodontal pocket depth (PPD), using University of North Carolina 15 probe (UNC 15 probes, Hu-Friedy Mfg. Co., Inc, USA), gingival recession (GR; P. D. Miller classification). The dentist was fully equipped with personal protective equipment. Clinically, oral mucosal changes in the form of typically wrinkled appearance were also recorded at the placement sites of smokeless tobacco [13].

#### Standardization and Calibration

Standardization and calibration of the dentist were performed regarding the diagnostic criteria through comprehensive written instructions, practice, and through discussing clinical cases.

#### Pilot Study

A pilot study was conducted to pretest the questionnaire on 75 individuals who were not included in the main study and comprised 15% of the study sample. The questionnaire's reliability was assessed using test-retest, and the questionnaire's internal consistency was ascertained by Chronbachs-Alpha ( $\alpha$ ). The mean Kappa value was found to be 0.90. The overall internal reliability of the questionnaire was 0.72, according to Cronbach's alpha. Therefore, no changes were required in the questionnaire.

#### Statistical Analysis

The collected data were analyzed using Statistical Package for Social Sciences (SPSS) 16.0 (version 16 for Windows, IBM Corp., Armonk, NY, USA) and descriptive and analytical tests, including mean, standard deviation, were calculated. Kendal's Tau test, paired t-test, and Chi-square test were carried out to compare different variables between placement and non-placement sites. The p-value  $<0.05$  was considered as statistically significant.

## Results

For the present cross-sectional study, a total of 542 subjects were selected on the basis of the habitual use of different forms of smokeless tobacco (SLT). Most of the participants were male (63.83%) and brushed their teeth daily (84.13%). The demographic information is summarized in Table 1. The participants' mean age was 36.23 years, reporting an average of 11.26 years of SLT use. Among the different types of smokeless tobacco products used, betel leaf with tobacco and gutkha (27.49%) was the most commonly consumed, followed by tobacco with lime (23.25%).

**Table 1. Socio-demographic details of the patients.**

Characteristics	N (%)
<b>Gender</b>	
Male	346 (63.83)
Female	196 (36.26)
<b>Age Distribution (Years)</b>	
≤20	48 (8.86)
21-30	156 (28.78)
31-40	242 (44.65)
41-50	78 (14.39)
>50	18 (3.32)
Mean ± SD	36.23 ± 8.3
<b>Education Level</b>	
Profession or Honours	14 (2.62)
Graduate or Postgraduate	68 (12.54)
Intermediate or Post High School Diploma	83 (15.31)
High School Certificate	61 (11.24)
Middle School Certificate	183 (33.76)
Primary School Certificate	115 (21.21)
Literate	18 (3.32)
<b>Oral Hygiene</b>	
Brush Daily	456 (84.13)
Brush Weekly	64 (11.82)
<Once a Week	15 (2.76)
Never	7 (1.29)
<b>Type of Smokeless Tobacco Used</b>	
Tobacco with Paan (Betel Leaf)	104 (19.19)
Tobacco Dentifrices	52 (9.59)
Tobacco with Betel Nut and Gutkha	111 (20.48)
Paan (Betel Leaf) with Tobacco and Gutkha	149 (27.49)
Tobacco with Lime	126 (23.25)
<b>Duration of Smokeless Tobacco Use (Years)</b>	
≤5	78 (14.39)
6-10	286 (52.77)
11-15	95 (17.53)
16-20	51 (9.41)
>20	32 (5.90)

The periodontal clinical parameters of the study population are presented in Table 2. Clinical inflammation of gingiva as measured by the gingival index was significantly greater ( $p=0.01$ ) at the placement-site ( $1.64 \pm 0.53$ ) of SLT in comparison to non-placement-site ( $1.40 \pm 0.41$ ). Accumulation of plaque was more at the placement-site of smokeless tobacco ( $1.52 \pm 0.39$ ) than non-placement-site ( $1.50 \pm 0.37$ ), but the difference was not statistically significant ( $p=0.51$ ). The difference in the pocket probing depth at placement ( $2.42 \pm 0.63$ ) and non-placement sites ( $3.29 \pm 0.95$ ) was statistically significant ( $p=0.001$ ) with greater pocket probing depth at non-placement site.

**Table 2. Comparison of Clinical periodontal parameters between placement and non placement sites of smokeless tobacco.**

Periodontal Parameters	Mean (SD)
<b>Gingival Index Sites</b>	
Placement Site	$1.64 \pm 0.53$
Non-placement Site	$1.40 \pm 0.41$
Mean Difference (95% CI)	$0.24 \pm 0.12$
p-value	0.01*
<b>Plaque Index</b>	
Placement Site	$1.52 \pm 0.39$

Non-placement Site	1.50 ± 0.37
Mean Difference (95% CI)	0.02 ± 0.02
p-value	0.51
Pocket Probing Depth	
Placement Site	2.42 ± 0.63
Non-placement Site	3.29 ± 0.95
Mean Difference (95% CI)	0.87 ± 0.32
p-value	0.001*

\*Statistically Significant (Paired T Test).

More than half of the placement sites of SLT users (65.7%) showed gingival recession compared to non-placement sites of SLT where only 32.3% of sites showed gingival recession (Table 3). There was a statistically significantly higher gingival recession ( $p=0.002$ ) at placement sites of SLT than non-placement sites of SLT among various classes of Miller's classification of gingival recession.

**Table 3. Comparison of gingival recession.**

Site	Normal		Class I		Class II		Class III		p-value
	N	%	N	%	N	%	N	%	
Placement Site	186	34.3	220	40.7	107	19.7	29	5.3	0.002*
Non-Placement Site	367	67.7	123	22.6	30	5.6	22	4.1	

\*Kendall's Tau Test.

Clinically, most subjects had mucosal changes at the placement sites compared to non-placement sites of smokeless tobacco (16.42%), as shown in Table 4. A statistically significant association ( $p=0.034$ ) was observed between the duration of smokeless tobacco and the mucosal changes observed (Table 5).

**Table 4. Comparison of mucosal changes.**

Site (542)	Normal	Mucosal Changes			p-value*
		D-1 N (%)	D-2 N (%)	D-3 N (%)	
Placement	77 (14.21)	224 (41.35)	158 (29.21)	83 (15.23)	0.002
Non-placement	453 (83.57)	89 (16.42)	0 (0.0)	0 (0.0)	

\*Kendall's Tau Test.

**Table 5. Association of duration of smokeless tobacco use and mucosal changes.**

Duration of Tobacco Use	Total N (%)	Normal N (%)	Mucosal Changes			p-value*
			D-1 N (%)	D-2 N (%)	D-3 N (%)	
≤ 5 Years	78 (14.39)	14 (18.23)	28 (35.32)	23 (29.45)	13 (17.00)	0.034
6-10 Years	286 (52.77)	50 (17.43)	81 (28.31)	95 (33.22)	60 (21.04)	
11-15 Years	95 (17.53)	13 (13.21)	26 (27.36)	32 (34.12)	24 (25.26)	
16-20 Years	51 (9.41)	5 (10.34)	11 (21.34)	19 (36.2)	16 (32.21)	
>20 Years	32 (5.90)	3 (10.53)	9 (27.44)	13 (39.7)	7 (22.33)	

\*Chi-Square Test.

## Discussion

There is a greater prevalence of using smokeless tobacco in India than smoking tobacco, not only among males but also females. The type of tobacco use differs between different ages, gender, and social classes [2]. In the Southeast Asia Region, SLT use among adults is higher than smoking, which is different from other regions of the world [12].

This cross-sectional study was designed to determine the effect of smokeless tobacco on the periodontium and oral mucosa at the placement-sites (SLT-sites) compared to non-placement sites (NSLT-

sites). The finding of this study revealed that SLT-sites, compared to NSLT-sites, experienced greater gingival inflammation and gingival recession and a higher prevalence of mucosal alterations but lesser periodontal pocket depth. In the present study, consumption of smokeless tobacco was found to be twice amongst males as compared to females. This result was in line with other studies where tobacco consumption was more common among males [14,15]. The higher prevalence of use of SLT among males has been attributed to the fact that the concentration of economic powers in the hands of males and is due to their proneness to stress situations and the assumption that SLT use helps them to carry out their occupational tasks with more concentration [15].

In the present study, the prevalence of tobacco use was lower among the younger youth aged <20 years compared to older ones aged 31-40 years and above; this finding was consistent with other study conducted in Rwandan youth aged 15-34 years. It may be because of insufficient income and lesser exposure to tobacco advertising. This finding provides us an opportunity to act and stop the youths from becoming tobacco users. Therefore, various tobacco cessation initiatives like behavioral interventions would be vital to help these young people refrain from using tobacco [16].

In the current study, the majority of patients were having an education level till middle school certificate and were found to have an increased level of periodontitis. Various studies have reported stressors like poor family relations and low school satisfaction, poor grades in school and peer group pressure amongst adolescents and young adults as the reason behind this finding [17]. This was in agreement with the other study and a review where it was revealed that low educational attainment was associated with an increased risk of periodontitis [18,19].

The clinical finding on the gingival index was significantly higher at placement sites ( $1.64 \pm 0.53$ ) of SLT compared to non-placement sites of SLT ( $1.40 \pm 0.41$ ). SLT products contain a high concentration of volatile N-nitrosamines, tobacco-specific N-nitrosamines, N-nitrosamino and the pH ranged from 5.3 to 8.9 [20]. This suggests that smokeless tobacco's irritational properties, either chemical or mechanical, may contribute to the increased inflammation at the site of placement. These results were in line with several studies [4,21] but in contrast with several other studies where no association was found between smokeless tobacco use and gingival inflammation, which might be due to vasoconstriction caused by nicotine [22,23].

Plaque levels were insignificantly higher at placement-site ( $1.52 \pm 0.39$ ) compared to non-placement-sites ( $1.50 \pm 0.37$ ). These findings were consistent with studies conducted by Montén et al. [22] and Singh et al. [17]. However, Wolfe et al. [21] and Robertson et al. [22] found less frequent plaque and calculus formation at the site of smokeless tobacco use.

Pocket probing depth was found to be lower at placement sites ( $2.42 \pm 0.63$ ) compared to non-placement sites ( $3.29 \pm 0.95$ ) of SLT. It was probably due to an increased degree of gingival recession. A similar result was observed in another study [24].

In the present study, among different types of SLT users, 65.7% had a gingival recession, which suggests a strong association between SLT use and GR. This finding is in line with other studies carried out by Offenbacher et al. [25] and Anderson et al. [26]. It was reported in different studies that the consumption of tobacco in any form leads to poor periodontal status and severe active disease than adults who had never used tobacco [27,28].

There was a statistically significant association between sites of placement of smokeless tobacco and oral lesions. Mucosal changes were prevalent at the placement-sites in comparison to non-placement-sites. The

oral tissues of SLT users were exposed to high nicotine and other tobacco byproducts concentration that negatively affected the local cell population. Several authors have reflected similar results [5,29,30].







In the present study, gingival inflammation, gingival recession, and mucosal alterations were found to be higher at the placement-sites of SLT in comparison to non-placement-sites of SLT, which showed that SLT has potential localized action and deleterious effect on oral health. Thus, the oral health of the general population in the region of North India required immediate attention. The present study results can act as a motivation for the users of tobacco to quit the habit of taking smokeless tobacco.

One of our study's limitations was the cross-sectional nature, which prevents us from making any temporal association between oral health effects and smokeless tobacco use. Secondly, there was more heterogeneity in the type of smokeless tobacco products used and the study patients' oral hygiene practices, which could have affected our results. Therefore, longitudinal studies with a larger sample size need to be carried out to ascertain these results.

## Conclusion

Smokeless tobacco use predisposes to an increased risk of periodontal diseases and oral mucosal changes in an individual. In addition, there is convincing proof to support the significant benefits of tobacco use cessation concerning various oral health outcomes. Therefore, all healthcare providers should assess the patients' tobacco usage habits and actively employ tobacco prevention, cessation, and treatment programs in a variety of populations across all ages.

## Authors' Contributions

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All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.			

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None.

## Conflict of Interest

The authors declare no conflicts of interest.

## Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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