Severity of Periodontal Disease in Individuals Chewing Betel Quid With and Without Tobacco

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Abstract: Background: The deleterious effects of chewing betel quid (BQ) with or without tobacco on periodontal health are poorly addressed. The aim of this study was to investigate the severity and extent of periodontal disease among individuals chewing BQ with and without tobacco. Methods: One hundred twenty individuals (70 BQ chewers: 35 with tobacco and 35 without tobacco) and 50 control individuals (non-chewers) were included in this study. Sociodemographic data and information regarding BQ chewing habit were collected using a questionnaire. Plaque index, bleeding on probing and probing pocket depth were measured. Numbers of missing teeth were recorded and marginal bone loss was measured on panoramic radiographs. Statistical analyses were performed using 1-way analysis of variance and Bonferroni post hoc tests. Results: The socioeconomic status of subjects in the control group was significantly higher as compared with those chewing BQ either with or without tobacco. Plaque index, bleeding on probing and probing pocket depth were greater in subjects chewing BQ with tobacco than in those chewing BQ without tobacco and the controls. Subjects chewing BQ with tobacco had fewer teeth than those chewing BQ without tobacco and the controls. Marginal bone loss was higher in subjects chewing BQ with tobacco than in those chewing BQ without tobacco and the controls. Conclusions: The severity of periodontal disease is enhanced in subjects chewing BQ with tobacco as compared with those chewing BQ without tobacco. Subjects with a low socioeconomic status and poor education are significantly more likely than others to develop periodontal disease. Key Indexing Terms: Areca nut; Betel quid; Periodontal disease; Smokeless tobacco. [Am J Med Sci 2013;346(4):273–278.]

A betel quid (BQ) is a mixture of areca nut, slaked lime (aqueous calcium hydroxide paste), catechu, menthol, artificial sweeteners and other condiments (often added according to taste), wrapped in a betel leaf (Piper betle leaf; Figure 1).1,2 It is also often mixed with tobacco. The BQ is placed in the buccal mucosa and chewed gently; it is then held against the buccal mucosa over a long duration while gentle chewing and sucking on the BQ continues intermittently. The contents may either be swallowed or expectorated as desired.

BQ chewing is a popular cultural habit in many countries including Bangladesh, China, India, Pakistan, Sri Lanka, Taiwan and Thailand; however, global export of P betle leaf and other components of BQ has made it available for expatriates of these communities who live in many other countries including Australia, the United Kingdom and the United States.3–4 The BQ is sold in paper pouches that, unlike cigarette packets, lack any statement regarding the hazards associated with habitual BQ usage. The low cost and easy access have made BQ available to individuals of all age-groups particularly in South Asian countries, and it is estimated that there are upward of 200 million people worldwide who habitually chew/suck on BQ with or without tobacco.5

The deleterious effects of chewing tobacco and related products on oral and systemic health have been reported.6–9 Clinical studies6–9 have reported the occurrence and progression of oral mucosal disorders such as oral submucous fibrosis and oral cancer, which have significantly higher levels of incidence in BQ chewers as compared with their respective controls (ie, those who do not use BQ). It has been reported that BQ chewing, either with or without tobacco, is an independent risk factor for oral cancer.1 However, the association between chewing BQ (with and without tobacco) and periodontal inflammation is not understood well. Some in vitro studies10–12 have shown that areca nut (an essential component of BQ) extracts and nicotine suppress the growth of periodontal fibroblasts and gingival keratinocytes. Although clinical studies have investigated the influence of habitual BQ chewing on periodontal health,13,14 the difference in the severity of periodontal disease among individuals chewing BQ with and without tobacco remains unclear. It is therefore hypothesized that individuals chewing BQ with tobacco experience more intense periodontal inflammation as compared with those chewing BQ without tobacco. Hence, the aim of the present retrospective study was to investigate the severity of periodontal disease in individuals chewing BQ with and without tobacco.

MATERIALS AND METHODS

Ethical Approval

The study was approved by the ethics committee of the Engineer Abdullah Bugshan Research Chair for Growth Factors and Bone Regeneration, King Saud University, Riyadh, Saudi Arabia, in accordance with the Helsinki Declaration of 1975 as revised in 1983. Written information was provided to all the participants, which gave the purpose of the study and indicated that participation was completely voluntary. Those willing to participate in the present investigation were presented a consent
Among BQ chewers, the mean numbers of missing teeth were significantly higher as compared with those chewing BQ with tobacco (P < 0.05). The educational status of subjects in the control group was significantly higher as compared to the test group. Monthly income was recorded in Pakistani currency (rupees) and then converted into U.S. dollars. One U.S. dollar corresponded to 84.31 Pakistani rupees.

**Clinical Periodontal Examination and Number of Missing Teeth**

Periodontal examinations were performed by 1 examiner (F.J.) who was blinded as to whether the subject was either in the test group or in the control group. The kappa value for intraexaminer reliability was 0.78. A full-mouth plaque index (PI), bleeding on probing (BOP) and probing pocket depth (PD) (4 to <6 mm and ≥6 mm) were measured at 4 sites (mesial, distal, buccal and lingual/palatal) on all maxillary and mandibular teeth as described previously.\textsuperscript{15,16} PD was measured to the nearest millimeter with a graded probe (Hu-Friedy Manufacturing, Chicago, IL).\textsuperscript{15,16} The numbers of missing teeth were recorded for both arches. Fractured teeth with embedded root remnants were designated as missing.

**Marginal Bone Loss**

Digital panoramic radiographs were taken using a panoramic tomography machine (KODAK 8000C System; Carestream Dental LLC, Atlanta, GA). Radiographs were viewed on a calibrated computer screen (SyncMaster digital TV monitor; Samsung, Seoul, Korea) using a software program (ImageTool 3.0 within the Department of Dental Diagnostic Science, University of Texas Health Science Center, San Antonio, TX). Marginal bone loss (MBL) was measured on bilateral maxillary and mandibular premolars and molars by a single investigator (F.J.). MBL was defined as the vertical distance from 2 mm below the cementoenamel junction to the most apical part of the marginal bone.\textsuperscript{15,16} Tooth surfaces where the cementoenamel junction and/or the bone crest was not clearly visible for technical reasons (such as dental restorations, interproximal caries, overlapping of teeth and/or poor radiographic quality) were excluded.

**Statistical Analyses**

Statistical analyses were performed using the STATISTICA software program (version 10; StatSoft, Tulsa, OK). One-way analysis of variance was used to assess the association between periodontal inflammatory conditions (PI, BOP, PD and MBL), age and BQ chewing (with and without tobacco) in the study population. For multiple comparisons, the Bonferroni post hoc test was used. A study power of 80% was estimated to determine a 50% difference in periodontal inflammatory conditions in individuals chewing BQ with and without tobacco (α = 0.05).

**RESULTS**

**Characteristics of the Study Population**

One hundred twenty individuals (70 BQ chewers and 50 controls) were included in this study. In the test group, 35 individuals were chewing BQ with tobacco and 35 without tobacco. There was no significant difference between the mean age of BQ chewers (with and without tobacco) and the individuals in the control group. The mean monthly income of subjects in the control group was significantly higher as compared with those chewing BQ with tobacco or without (P < 0.01) or without (P < 0.01) tobacco. Among BQ chewers, the mean monthly income was significantly higher in individuals chewing BQ without tobacco as compared with those chewing BQ with tobacco (P < 0.05). The educational status of subjects in the control group was significantly higher as compared

**Study Participants**

In total, 120 individuals (70 habitual BQ chewers and 50 control individuals [non-chewers]) were included. Among the 70 BQ chewers, 35 subjects were chewing BQ with tobacco and 35 without tobacco. These individuals were recruited from a local residential area of Karachi, Pakistan.

**Questionnaire**

A questionnaire printed in simple English and Urdu was distributed to all the study participants (n = 120). Besides age and sex, other information was also obtained including that regarding monthly income, educational status, usage of BQ (yes/no), duration of their BQ chewing habit, reasons for use of BQ, daily frequency of BQ consumption and duration of placement of the quid in the mouth.

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with those chewing BQ either with \( P < 0.001 \) or without \( P < 0.01 \) tobacco. There was no significant difference in the duration of the BQ chewing habit and number of quids consumed daily between individuals chewing BQ with tobacco and those chewing BQ without tobacco (hence there were no effects on usage caused by nicotine). Individuals chewing BQ with tobacco were placing the quids in the oral cavity for longer durations as compared with those chewing BQ without tobacco \( P < 0.01 \). These results are shown in Table 1.

### Reasons for Habitual BQ Use

Among subjects chewing BQ with tobacco, 54% of the individuals considered chewing BQ with tobacco to help relieve psychological stress, whereas 46% of the individuals chewed BQ with tobacco to control appetite. In subjects chewing BQ without tobacco, 56% of the individuals reported that they chewed BQ daily to control their appetite, whereas 44% of the subjects considered BQ as a breath freshener (Figure 2).

### Periodontal Inflammatory Conditions, Missing Teeth and MBL With Reference to BQ Chewing With and Without Tobacco

Periodontal inflammatory conditions (PI, BOP and PD \( 4 \) to \( 6 \) mm and \( \geq 6 \) mm) were severe in those who chewed BQ with tobacco as compared with those in the control group \( P < 0.01 \); Table 2). Individuals chewing BQ without tobacco displayed significantly higher PI \( P < 0.01 \), BOP \( P < 0.05 \) and PD \( 4 \) to \( 6 \) mm, \( P < 0.01 \); \( \geq 6 \) mm, \( P < 0.01 \) as compared with those in the control group. Individuals chewing BQ with tobacco showed significantly higher PI \( P < 0.01 \), BOP \( P < 0.01 \) and PD \( 4 \) to \( 6 \) mm, \( P < 0.05 \); \( \geq 6 \) mm, \( P < 0.01 \) as compared with those chewing BQ without tobacco (Table 2).

The number of missing teeth was higher in subjects chewing BQ with tobacco as compared with those chewing BQ without tobacco \( P < 0.05 \) and in comparison with those in the control group (ie, both BQ chewers and BQ plus tobacco chewers; \( P < 0.001 \)). Subjects chewing BQ without tobacco had significantly more missing teeth than those in the control group \( P < 0.05 \); Table 2).

MBL was significantly higher in subjects chewing BQ with tobacco as compared with those chewing BQ without tobacco \( P < 0.01 \) and those in the control group \( P < 0.001 \); Table 2). Subjects chewing BQ without tobacco had significantly more missing teeth than those in the control group \( P < 0.05 \) as shown in Table 2.

### Oral Hygiene Maintenance and Visiting

In subjects chewing BQ without tobacco, 23.2% of the individuals reported that they brush their teeth twice daily as compared with those chewing BQ with tobacco (8.2%; \( P < 0.05 \)) or those in the control group (89.7%; \( P < 0.01 \)). In individuals chewing BQ with tobacco, 8.2% of the individuals reported brushing their teeth twice daily as compared with those in the control group (89.7%; \( P < 0.001 \)).

In the control group, 38.5% of the individuals indicated that they had visited a dentist for a routine checkup within the past 12 months as compared with BQ chewers with and without tobacco where 2.4% \( P < 0.001 \) and 6.6% \( P < 0.001 \) subjects respectively reported that they had visited a dentist in the past 12 months for routine dental checkups.

### DISCUSSION

The results of this study demonstrated that periodontal inflammatory conditions (PI, BOP and PD \( 4 \) to \( 6 \) mm, \( \geq 6 \) mm), number of missing teeth and MBL were significantly higher among subjects chewing BQ with tobacco as compared with those who chew BQ without tobacco, whereas the latter groups have more severe periodontal disease than the control individuals (non-chewers). Areca nut and slaked lime are essential components of a BQ and play an essential role in the initiation and progression of oral inflammatory conditions among BQ chewers. Studies have reported that slaked lime, in the presence of areca nut, is responsible for the formation of reactive oxygen species (ROS) that in turn promote inflammation of periodontal tissues.\(^{17,10}\) It has been suggested that the release of high levels of ROS might cause oxidative damage to the periodontal tissues.\(^{19,28}\) It has also been demonstrated that proliferation of gingival and periodontal fibroblasts is reduced

### TABLE 1. Characteristics of the study population

<table>
<thead>
<tr>
<th>Betel quid chewers (n = 70)</th>
<th></th>
<th>Control individuals (n = 50)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With tobacco</td>
<td>Without tobacco</td>
</tr>
<tr>
<td></td>
<td>(n = 35)</td>
<td>(n = 35)</td>
</tr>
<tr>
<td>Age (yr; mean/range)</td>
<td>45/36–52</td>
<td>46.1/34–52</td>
</tr>
<tr>
<td>Sex (male:female)</td>
<td>24:11</td>
<td>25:10</td>
</tr>
<tr>
<td>Monthly income (US $; mean/range)</td>
<td>64.8/42.8–112</td>
<td>122.1/88.5–154.6</td>
</tr>
<tr>
<td>Educational status (%; graduate level)</td>
<td>*</td>
<td>12.2</td>
</tr>
<tr>
<td>Duration of betel quid chewing habit (yr; mean/range)</td>
<td>13.3/5–20</td>
<td>14.8/6–20</td>
</tr>
<tr>
<td>Duration of placement of betel quid in the oral cavity (min; mean/range)</td>
<td>119.4/40–120</td>
<td>20/10–30</td>
</tr>
<tr>
<td>No. betel quids chewed daily (mean/range)</td>
<td>6.1/3–8</td>
<td>5/3–8</td>
</tr>
</tbody>
</table>

<sup>a</sup> \( P < 0.05 \)

<sup>b</sup> \( P < 0.01 \)

<sup>c</sup> \( P < 0.001 \)

<sup>d</sup> \( P < 0.001 \)
in the presence of elevated levels of ROS caused by slaked lime and also arecoline and extracts derived from the areca nut.\textsuperscript{19,20} These findings could explain why subjects who chew BQ without tobacco have increased parameters of periodontal inflammation as compared with the controls, even though they are not using tobacco. It is noteworthy that it was also shown in this investigation that individuals who chewed BQ with tobacco displayed yet more intense periodontal inflammation and MBL as compared with those chewing BQ without tobacco. These clinical results are consistent with data reported in an experimental study that showed that extracts from smokeless tobacco are a major source of ROS and exhibit the potential to induce oxidative tissue damage and apoptosis.\textsuperscript{21} It is also important to note that individuals chewing BQ with or without tobacco expose their tissues to various aryl hydrocarbons such as benzo-a-pyrene and dimethylbenzanthracene, both being upregulators of inflammation, and this too could explain why there is increased disease in individuals who chew BQ. Importantly, those who chew BQ alone are exposed to aryl hydrocarbons, although it is also known that the addition of tobacco would expose these individuals to even higher levels of aryl hydrocarbons. Notably, these aryl hydrocarbons are carcinogenic and bind to aryl hydrocarbon receptors (AhR).\textsuperscript{22} Consequently, the production of inflammatory mediators such as interleukin-1 is upregulated (there is an aryl hydrocarbon response element in the promoter region for interleukin-1). Also, these AhR ligands stimulate upregulation of cytochrome 1-b-1, an enzyme complex that metabolizes the aforementioned hydrocarbons into even more carcinogenic compounds, and upregulation of DNA adduct formation.\textsuperscript{23} The relative differences in exposure to AhR ligands in BQ alone versus BQ plus tobacco could explain the increased risks for more severe periodontitis observed in this investigation when comparing the level of periodontal disease in the former with that in the latter. It is also likely that increased exposure to the AhR ligands in individuals who chew BQ with or without tobacco increases the risks for oral cancer—particularly in those who chew BQ with tobacco. These possibilities could be important because they might point to the development and use of an AhR antagonist, resveratrol, that blocks activation of AhR and to reverse the effects of the aryl hydrocarbons.\textsuperscript{24}

Another factor that might have influenced periodontal inflammation in individuals chewing BQ with or without tobacco is the duration of placement of the BQ in the oral cavity. The present results demonstrated that individuals chewing BQ with tobacco were placing the quid in the oral cavity for significantly longer durations as compared with those chewing BQ without tobacco. It is tempting to speculate that BQ (that contains areca nut and slaked lime as ROS resources) when chewed with tobacco and retained in the oral cavity for

![FIGURE 2. Reasons for betel quid chewing reported by individuals chewing betel quid with (black bars; n = 35) and without (gray bars; n = 35) tobacco.](Image)
prolonged periods may promote the production of ROS and compromise the integrity of both the oral mucosa and the periodontal tissues to a greater extent when compared with BQ chewed without tobacco supplements. As to why BQ with tobacco was retained in the mouth for longer than plain BQ, it should be recognized that tobacco contains high levels of nicotine, a chemical with strong addictive potential.\textsuperscript{2,12} Therefore, it is possible that those individuals who chew BQ with tobacco leave the BQ in the mouth for longer periods of time as a consequence of addiction. Unfortunately, this also evidently leads to higher levels of disease.

In their study on humans, Mavropoulos et al\textsuperscript{22} reported that habitual use of smokeless tobacco increases the gingival blood flow. The present study supports these results because BOP was significantly higher among individuals chewing BQ with tobacco as compared with those chewing BQ without tobacco. According to the results reported in this investigation, there was no significant difference in the duration of the chewing habit (i.e., how long the individuals had the habit as opposed to the duration of the BQ in the mouth) and number of quids consumed daily between subjects chewing BQ with tobacco and those chewing BQ without tobacco. This suggests that the ingredients of the BQ (such as tobacco, slaked lime and areca nut) could influence the severity of the periodontal inflammation in these subjects. Interestingly, and somewhat in contrast to the speculation noted previously regarding the length of time a BQ is held in the oral cavity, it also seems that the contribution of the number of quids consumed daily might be a secondary risk factor. Similarly, these findings could suggest that duration of placement of the quid in the oral cavity is rather secondary given that the 2 factors are parallel to one another.

An underprivileged socioeconomic status (SES), poor education and aging are significant factors that may influence the lifestyle, behavior and oral health status of an individual.\textsuperscript{15,16,26–28} In the present study, there was no significant difference between the mean age of BQ chewers (with and without tobacco) and the subjects in the control group. However, it is important to note that SES, educational status and daily oral hygiene maintenance practices were superior among subjects in the control group than in those chewing BQ either with or without tobacco. Simultaneously, SES, educational status and daily oral hygiene maintenance practices were more often reported by subjects chewing BQ without tobacco as compared with those chewing BQ with tobacco. This reflects that reduced SES and poor education may have compelled individuals chewing BQ with tobacco to neglect their oral hygiene and focus mainly on finding ways to survive. A deprived SES and poor education may also be associated with reduced frequencies of dental checkups.

The observational nature of this study might limit the ability to determine precisely the periodontal health status before when the subjects began chewing BQ (with or without tobacco), exclusively BQ. Habitual tobacco smoking and alcohol consumption are independent risk factors for periodontal inflammation\textsuperscript{15,16,25–30}, therefore, it may be argued that tobacco smoking and alcohol use in addition to BQ chewing (either with or without tobacco) may further aggravate periodontal inflammation as compared with only BQ chewing. Further studies are warranted in this regard. In the present investigation, all individuals self-reported as being healthy; however, impaired glycemic levels have been reported in habitual areca nut and BQ chewers\textsuperscript{11,32}, however, this was not assessed in the present investigation. Given this effect of BQ on glycemic control, it should be recognized that some of the effects observed regarding periodontitis in BQ chewers could have been related, at least indirectly to disorders of glucose metabolism—a significant risk factor for periodontal inflammation.\textsuperscript{15,16} Further studies are needed to assess the association among BQ chewing, serum glucose levels and periodontal inflammation.

CONCLUSIONS

The severity of periodontal disease is enhanced in subjects who chew BQ with tobacco as compared with those who chew BQ without tobacco. Subjects with reduced SES and poor education are at significantly greater risk for the development of periodontal diseases than those without these risk factors.

ACKNOWLEDGMENT

This study is registered (Registration No. NF 2376) at the College of Dentistry Research Chair, King Saud University, Riyadh, Saudi Arabia.

REFERENCES


