Comparison of Periodontal Inflammatory Parameters and Whole Salivary Cytokine Profile Among Saudi Patients with Different Obesity Levels

Fahim Vohra, MProsRCS1/Zohaib Akram, MDS2
Ishfaq A. Bukhari, PhD3/Saeed A Sheikh, MS3
Asma Riny, MS4/Fawad Javed, PhD5

The aim of the present study was to compare clinical periodontal parameters and salivary interleukin (IL)-1β and IL-6 levels in patients with different obesity levels. A total of 419 individuals with class I, II, and III obesity and nonobese with chronic periodontitis were included. Clinical periodontal parameters were recorded, and whole salivary IL-1β and IL-6 were quantified using enzyme-linked immunosorbent assay. Clinical parameters and salivary cytokine concentrations were analyzed using one-way analysis of variance. For multiple comparisons, Bonferroni post hoc adjustment test was used. Clinical periodontal parameters and salivary IL-1β and IL-6 levels were statistically significant in class II and class III obese as compared to class I obese patients (P < .01) but were comparable between class II and class III obese individuals. These findings should be interpreted with caution due to the inclusion of hyperglycemic patients.


Obesity is increasing at an alarming rate and is defined as superfluous amount of fat accumulation that is associated with severe health risks.1 According to the National Institutes of Health (NIH); National Heart, Lung, and Blood Institute (NHLBI); and North American Association for the Study of Obesity (NAASO), individuals with a body mass index (BMI) of 30 to 34.9 kg/m², 35 to 39.9 kg/m², and ≥ 40 kg/m² are categorized as obese class I, II, and III, respectively.2 Data from the National Nutrition Survey of 2007 revealed an estimated 23.6% women and 14% men suffer from severe obesity (> 40 kg/m²) in Saudi Arabia.3 In the past decade, obesity has been thoroughly investigated as one of the modifying factors for periodontal inflammation and several studies have demonstrated the association between weight gain and worsening of clinical periodontal parameters.4,5 A systemic proinflammatory state is suggested for worse periodontal outcomes in obesity, with altered immune response because of compromised functional state of immune cells in obesity.6,7

Chronic periodontitis (CP) is an inflammatory disease that occurs as a consequence of the host immune response. Periodontal tissue destruction is driven by harmful by-products released by subgingival plaque bacteria that results in an up-
regulated host immune-inflammatory response. This is characterized by dysregulated and increased production of enzymes such as collagenases, endotoxins, and inflammatory cytokines by host cells. These enzymes break down collagen and lead to alveolar bone resorption and eventually tooth loss. Several proinflammatory cytokines are implicated in the pathogenesis of periodontitis, including interleukin (IL)-1β and IL-6 that could be altered by obesity. A number of clinical studies have investigated periodontal inflammatory conditions in patients with and without obesity; however, the severity of periodontal destruction and various salivary proinflammatory cytokines involved in periodontal inflammation in obese individuals with different forms of severity remains uninvestigated. The hyperinflammatory status is increased through raised cytokine levels in cases of severe obesity, such as class III. This may in turn lead to a build-up of constant systemic inflammation that may lead to cardiovascular disease, metabolic disorders, hormonal imbalance, and cancers. Severe obesity could also accelerate the already existing localized periodontal inflammation through systemic hyperinflammation.

Therefore, it is hypothesized that (1) clinical periodontal parameters are worse with increasing severity of obesity, since systemic low-grade inflammatory markers are higher in individuals with severe obesity, and (2) concentrations of salivary IL-1β and IL-6 are higher in individuals with severe obesity. To the best of the authors’ knowledge, the severity of periodontal destruction among different levels of obesity has yet to be investigated. The aim of the present cross-sectional study was to compare clinical periodontal inflammatory conditions and whole salivary IL-1β and IL-6 levels in patients with different severity levels (class I, II, and III) of obesity.

Materials and Methods

Ethical Guidelines

The study was reviewed and approved by the Research Ethics Committee and performed at a specialist practice in Riyadh, Saudi Arabia. An information sheet was provided to the participants that explained the objectives and methods of the present study, and individuals had the right to withdraw from the study at any stage without penalty.

Recruitment of Study Participants

Between January 2016 and January 2017, a cross-sectional study was performed in which participants were recruited from a specialist practice in Riyadh, Saudi Arabia. All participants were (1) aged > 30 years; (2) obese individuals classified according to the World Health Organization classification of obesity for Asian, which is defined as having body mass index (BMI) ≥ 27.5 kg/m² and nonobese as having a BMI ranging between 18.5 to 22.9 kg/m²; and (3) diagnosis of chronic periodontitis (two or more interproximal sites with clinical attachment loss [CAL] ≥ 4 mm [not on same tooth], or two or more interproximal sites with probing depth (PD) ≥ 5 mm [not on same tooth]). Self-reported tobacco smokers, individuals using smokeless tobacco products, habitual alcohol users, and patients with systemic diseases such as acquired immune deficiency syndrome/HIV, self-reported diabetes mellitus, renal disorders, and cardiovascular disorders were excluded.

Sample Size Calculation

Sample Size Tables for Clinical Studies software was used to calculate the sample size for this study. A sample of 412 individuals (103 participants per group) was determined to have 90% power to detect a clinically relevant odds ratio of 2.0 for presence of chronic periodontitis in obese compared to nonobese individuals, assuming a prevalence of obesity in the general population of 23.6% and using a two-sided significance level of 0.05.

Study Groups

All the study participants were diagnosed with generalized chronic periodontitis. The study participants were divided into four groups on the basis of BMI as follows:

- Group 1: class I obese individuals with BMI 27.5 to 34.9 kg/m²
- Group 2: class II obese individuals with BMI 35 to 39.9 kg/m²
• Group 3: class III obese individuals with BMI ≥ 40 kg/m²
• Group 4: nonobese individuals with BMI 18.5 to 22.9 kg/m²

Interview Questionnaire

A trained interviewer presented the structured written questionnaire to all participants. All patients answered questions regarding sex, age, duration of obesity, and family history of obesity.

Serum Sampling for Lipid Parameters

Lipid parameters were measured in the serum samples, including triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and glucose parameters, including fasting blood glucose (FBGL), insulin, and homeostasis model assessment of insulin resistance (HOMA-IR). HOMA-IR was calculated as follows: \[ \text{HOMA-IR} = \frac{\text{FBGL} \times \text{fasting serum insulin}}{405} \]. A HOMA-IR score > 2.7 estimates insulin resistance.

Marginal Bone Loss

All radiographic examinations were performed by a trained and calibrated investigator (Z.A.) (κ = 0.85). Digital panoramic radiographs were taken using a panoramic tomography machine (Kodak 8000C System, Carestream Dental). The radiographs were viewed on a calibrated computer screen (Samsung SyncMaster digital TV monitor) using a software program (Image Tool 3.0 Program, Department of Dental Diagnostic Science, University of Texas Health Science Center). Marginal bone loss (MBL) was measured the vertical distance from 2 mm below the cementoenamel junction (CEJ) to the most crestal part of marginal bone and was measured on bilateral maxillary and mandibular premolars and molars. Third molars and tooth surfaces on which the CEJ and/or crestal bone were not clearly visible due to dental restorations, interproximal caries lesions, overlapping of teeth, or poor radiographic quality were excluded.

Unstimulated Whole Saliva Sampling

In all groups, unstimulated whole saliva (UWS) was sampled (5 mL) before clinical examination. For collection of UWS samples, patients were comfortably seated on the chair with the head slightly bent forward. Patients were instructed to pool saliva in the mouth for 5 minutes and to expectorate into a falcon tube (Fisher Scientific) under ice for the measurement of unstimulated whole salivary flow rate (UWSFR). UWS samples were stored at –80°C until analysis. All samples were analyzed within 3 months of collection.

Measurement of IL-1β and IL-6 in Unstimulated Whole Saliva

In UWS, IL-1β (salivary IL-1β, Salimetrics) and IL-6 (human IL-6, ELISA Kit, Abcam) were assessed in triplicate using enzyme-linked immunosorbent assay. In summary, saliva samples were vortexed and centrifuged at 800 G for 10 minutes in a high-speed refrigerated microcentrifuge (MX 305, TOMY). The supernatant was then pipetted out for analysis. An amount of 50 µL of the respective saliva samples was dispensed, in duplicate, into wells coated with a specific antibody. The plates were then incubated at room temperature for 120 minutes, after which they were manually washed three times with wash
buffer. Biotinylated antibody in the amount of 50 µL was then added to the wells and allowed to incubate for 120 minutes. Conjugate solution (50 µL) was then added, and the plates were incubated at room temperature for another 30 minutes. The wells were washed three times with a wash solution, after which 50 µL of chromogen substrate solution was added. The plates were incubated for 12 minutes at room temperature until the optimal blue color density was achieved. Following this, 50 µL of stop solution was added to terminate color development. Absorbance was determined by reading the plate at 450 nm on a microplate reader (ELISA Microplate Reader, VersaMax). The procedure was repeated with standard IL-1β and IL-6 at different concentrations. The absorbance of different concentration for both cytokines was used to plot the standard curve. The standard curve was then used to determine the concentration of IL-1β and IL-6 in the samples expressed in pg/mL.

### Statistical Analyses

Statistical analyses were carried out using statistical software (SPSS version 20, IBM). Differences were considered significant when \( P \leq .05 \). Data were expressed as means and SDs. Normality of distribution of the variables was tested with Shapiro-Wilk test and confirmed with Q-Q plots. Clinical parameters and salivary cytokine concentrations were assessed using one-way analysis of variance. For multiple comparisons, Bonferroni post hoc adjustment test was used. Stepwise logistic regression analysis was employed to identify explanatory variables for periodontal outcomes, controlling for the effect of possible covariates such as FBGL, TC, LDL, and TG. The direction and strength of association between periodontal outcomes and covariates were assessed by generating odds ratios, the precision of which could be measured by 95% confidence intervals.

### Results

#### Characteristics of the Study Population

In total, 419 individuals were included in the study: 106 class I obese patients (group 1), 102 class II obese patients (group 2), 98 class III obese patients (group 3), and 113 nonobese patients (group 4) as controls. The mean age of obese (class I, II, and III) and nonobese individuals was 40.5 years (33 to 51 years), 39.3 years (32 to 54 years), 41.2 years (31 to 55 years), and 38.2 years (31 to 49 years), respectively. There was no significant difference in age between groups. FBGL in obese class I, II, and III individuals was 96.2 mg/dL, 104.4 mg/dL, and 115.2 mg/dL, respectively, whereas FBGL in nonobese individuals was 84.5 mg/dL. The mean BMI of obese (class I, II, and II) and nonobese individuals was 31.3 kg/m² (30.9 to 33.8 kg/m²), 38.4 kg/m² (36.6 to 38.9 kg/m²), 43.7 kg/m² (40.4 to 47.5 kg/m²) and 21.8 kg/m² (20.9 to 22.7 kg/m²), respectively. Metabolic parameters including TC, LDL, TRG, and HOMA-IR showed statistically significant difference between group 3 and 4 subjects. Among patients in groups 1, 2, and 3, the duration of obesity was 6.0 years (5 to 7 years), 8.9 years (6 to 10.7 years), and 9.1 years (7 to 11.4 years), respectively. In group 1, a family history of obesity was reported by 32.4% of obese individuals; in group 2, a family history of obesity was reported by 34.6%; and in group 3, 38.1% of obese individuals reported a family history of obesity. No family history of obesity was reported by any of the nonobese individuals in group 4. Toothbrushing twice daily was reported by 68%, 33%, 14%, and 71% in obese class I, class II, and class III and nonobese individuals, respectively (Table 1).

#### Periodontal Inflammatory Parameters

\( PI (P < .05), BOP (P < .05), PD (4 to 6 \text{ mm}; > 6 \text{ mm}) (P < .05), \) and CAL \( (P < .05) \) were significantly higher in class I, II, and III obese individuals as compared to nonobese individuals. \( PI (P < .01), BOP (P < .01), PD (4 to 6 \text{ mm}; > 6 \text{ mm}) (P < .01), \) and CAL \( (P < .01) \) were significantly higher in class II and class III obese individuals as compared to class I obese individuals. All clinical periodontal parameters were comparable in patients with class II and class III obese individuals (Table 2).

#### Marginal Bone Loss

MBL was significantly higher in patients with class I, II, and III obese
individuals as compared to non-obese individuals ($P < .05$). MBL was significantly higher in class II and III obese patients as compared to class I obese patients ($P < .01$). Similarly, there was no significant difference in MBL among class II and III obese individuals (Table 2).

**Salivary IL-1β and IL-6 Levels**

Salivary IL-1β and IL-6 levels were significantly higher among class I

---

<table>
<thead>
<tr>
<th>Covariates</th>
<th>Group 1: Class I obese (n = 106)</th>
<th>Group 2: Class II obese (n = 102)</th>
<th>Group 3: Class III obese (n = 98)</th>
<th>Group 4: Nonobese (n = 113)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (men/women)</td>
<td>26/22</td>
<td>22/24</td>
<td>24/21</td>
<td>25/23</td>
</tr>
<tr>
<td>Mean age, y (range)</td>
<td>40.5 (33–51)</td>
<td>39.3 (32–54)</td>
<td>41.2 (31–55)</td>
<td>38.2 (31–49)</td>
</tr>
<tr>
<td>FBGL (mg/dL)</td>
<td>96.2 ± 7.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>104.4 ± 8.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>115.2 ± 8.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>84.5 ± 7.4</td>
</tr>
<tr>
<td>Mean BMI, kg/m&lt;sup&gt;2&lt;/sup&gt; (range)</td>
<td>31.3 (30.9–33.8)</td>
<td>38.4 (36.6–38.9)</td>
<td>43.7 (40.4–47.5)</td>
<td>21.8 (20.9–22.7)</td>
</tr>
<tr>
<td>Duration of obesity, y (range)</td>
<td>6.0 (5–7)</td>
<td>8.9&lt;sup&gt;b&lt;/sup&gt; (6–10.7)</td>
<td>9.1&lt;sup&gt;b&lt;/sup&gt; (7–11.4)</td>
<td>–</td>
</tr>
<tr>
<td>TC (mg/dL)</td>
<td>194 ± 39&lt;sup&gt;a&lt;/sup&gt;</td>
<td>198 ± 31&lt;sup&gt;a&lt;/sup&gt;</td>
<td>210 ± 46&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>180 ± 30</td>
</tr>
<tr>
<td>LDL (mg/dL)</td>
<td>106 ± 22</td>
<td>109 ± 24&lt;sup&gt;a&lt;/sup&gt;</td>
<td>115 ± 25&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>102 ± 20</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>42 ± 6</td>
<td>42 ± 7</td>
<td>43 ± 6</td>
<td>41 ± 6</td>
</tr>
<tr>
<td>TG (mg/dL)</td>
<td>157 ± 22</td>
<td>164 ± 23&lt;sup&gt;a&lt;/sup&gt;</td>
<td>179 ± 28&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>142 ± 18</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>3.9 (0.9–7.2)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.2 (1.0–9.8)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.0 (2.3–12.4)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>1.1 (0.62–4.9)</td>
</tr>
<tr>
<td>Family history of obesity (%)</td>
<td>32.4</td>
<td>34.6</td>
<td>38.1</td>
<td>–</td>
</tr>
<tr>
<td>Daily toothbrushing (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once</td>
<td>31</td>
<td>67</td>
<td>84</td>
<td>26</td>
</tr>
<tr>
<td>Twice</td>
<td>68</td>
<td>33</td>
<td>14</td>
<td>71</td>
</tr>
<tr>
<td>Thrice or more</td>
<td>1</td>
<td>–</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

<sup>a</sup>Significantly different from group 4 ($P < .05$).

<sup>b</sup>Significantly different from group 1 ($P < .05$).

TG = triglycerides; TC = total cholesterol; HDL = high-density lipoprotein; LDL = low-density lipoprotein; FBGL = fasting blood glucose level; HOMA-IR = insulin and homeostasis model assessment of insulin resistance; BMI = body mass index.

---

<table>
<thead>
<tr>
<th>Periodontal parameters</th>
<th>Group 1: Class I obese (n = 106)</th>
<th>Group 2: Class II obese (n = 102)</th>
<th>Group 3: Class III obese (n = 98)</th>
<th>Group 4: Nonobese (n = 113)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI, % (range)</td>
<td>51.2 (44.4–58.9)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>56.3 (46.0–63.7)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>58.1 (47.5–61.7)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>38.2 (22.1–48.5)</td>
</tr>
<tr>
<td>BOP, % (range)</td>
<td>54.1 (48.7–60.6)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>60.6 (46.4–66.8)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>69.8 (48.7–75.9)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>37.9 (24.2–41.6)</td>
</tr>
<tr>
<td>PD 4–6 mm, % (range)</td>
<td>40.8 (31.3–41.8)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>58.6 (51.5–65.9)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>61.4 (52.6–73.5)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>36.1 (21.9–39.2)</td>
</tr>
<tr>
<td>PD &gt; 6 mm, % (range)</td>
<td>14.2 (10.9–20.6)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>23.1 (13.0–28.1)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>24.2 (12.9–27.3)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>12.4 (11.4–13.3)</td>
</tr>
<tr>
<td>CAL, % (range)</td>
<td>34.1 (21.6–44.4)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.3 (22.2–57.1)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>56.8 (32.3–67.4)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>24.0 (12.1–35.0)</td>
</tr>
<tr>
<td>MBL, mm (range)</td>
<td>5.9 (2.5–6.6)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.4 (2.2–8.2)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>7.9 (5.5–8.5)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>4.3 (2.2–5.2)</td>
</tr>
<tr>
<td>Average no. of missing teeth, n (range)</td>
<td>5.9 (3.0–7.3)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.0 (2.6–7.5)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>7.3 (2.9–7.7)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>3.1 (2.0–4.8)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Significantly different from group 4 ($P < .05$).

<sup>b</sup>Significantly different from group 1 ($P < .01$).

PI = Plaque Index; BOP = bleeding on probing; PD = probing depth; CAL = clinical attachment loss; MBL = marginal bone loss.
The International Journal of Periodontics & Restorative Dentistry

The severity of periodontal destruction among different levels of obesity. The present study was based on the hypotheses that periodontal inflammatory parameters (PI, BOP, PD, CAL, MBL) and salivary IL-1β and IL-6 concentrations are significantly higher in severely obese (class III) patients as compared to individuals with mild or no obesity. The present result showed that clinical periodontal parameters and whole salivary IL-1β and IL-6 were worse in class II and class III obese patients than in class I obese patients; however, class II and class III obese individuals showed similar periodontal destruction and whole salivary IL-1β and IL-6 levels.

Obesity has been associated with metabolic disturbances and their effects on other chronic diseases, such as osteoarthritis, type 2 diabetes mellitus, and cancers.22 It is speculated that obesity may also act as a contributing factor in periodontal destruction.23,24 It has been proposed that expansion of white adipose tissue leads to generalized chronic inflammation by two different mechanisms: overexpression of proinflammatory cytokines (ie, IL-1, IL-6, tumor necrosis factor-alpha) into the bloodstream and stimulating migration of macrophages to the core of the tissue, thereby increasing the secretion of proinflammatory markers.25,26 Hence, this chronic inflammation increases the susceptibility of obese patients to infectious challenges by down-regulating the immune response.27 These immunologic findings explain the increased susceptibility of patients with obesity to periodontal breakdown. Furthermore, increased periodontal destruction in obesity than in class I obese patients; however, class II and class III obese individuals showed similar periodontal destruction and whole salivary IL-1β and IL-6 levels.

### Table 3

<table>
<thead>
<tr>
<th>Salivary parameters</th>
<th>Group 1: Class I obese (n = 106)</th>
<th>Group 2: Class II obese (n = 102)</th>
<th>Group 3: Class III obese (n = 98)</th>
<th>Group 4: Nonobese (n = 113)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstimulated whole salivary flow rate (mL/min)</td>
<td>0.38 ± 0.05a</td>
<td>0.35 ± 0.04a</td>
<td>0.31 ± 0.02a</td>
<td>0.57 ± 0.2</td>
</tr>
<tr>
<td>IL-1β (pg/mL)</td>
<td>21.3 ± 4.4a</td>
<td>29.8 ± 3.6ab</td>
<td>31.3 ± 4.9ab</td>
<td>15.8 ± 3.1</td>
</tr>
<tr>
<td>IL-6 (pg/mL)</td>
<td>19.2 ± 3.7a</td>
<td>33.3 ± 4.0ab</td>
<td>30.6 ± 6.7ab</td>
<td>12.5 ± 4.4</td>
</tr>
</tbody>
</table>

aSignificantly different from group 4 (P < .05).

b Significantly different from group 1 (P < .01).

### Table 4

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>FBGL</td>
<td>2.03</td>
<td>0.80–5.20</td>
<td>.043</td>
</tr>
<tr>
<td>TC</td>
<td>2.82</td>
<td>1.39–4.72</td>
<td>.024</td>
</tr>
<tr>
<td>LDL</td>
<td>2.37</td>
<td>1.01–5.12</td>
<td>.034</td>
</tr>
<tr>
<td>TRG</td>
<td>2.97</td>
<td>1.4–6.43</td>
<td>.019</td>
</tr>
<tr>
<td>HOMA-IR</td>
<td>1.96</td>
<td>1.1–4.2</td>
<td>.001</td>
</tr>
</tbody>
</table>

Covariates were simultaneously adjusted for all variables. Bold denotes statistically significant result at P < .05 in direction of increased risk. FBGL = fasting blood glucose level; TC = total cholesterol; LDL = low-density lipoprotein; TRG = triglycerides; HOMA-IR = insulin and homeostasis model assessment of insulin resistance.

(P < .05), class II (P < .05), and class III (P < .05) obese patients as compared to nonobese individuals. IL-1β and IL-6 levels were significantly higher in patients with class II and III obese patients as compared to class I obese patients (P < .01) (Table 3).

**Regression Analysis to Control Metabolic Parameters**

The logistic regression analysis revealed that periodontal outcomes showed statistically significant difference even after adjusting for FBGL, TC, LDL, HDL, and TRG (P < .05) (Table 4).

**Discussion**

To the best of the author’s knowledge, this is the first study to assess the severity of periodontal destruction among different levels of obesity. The present study was based on the hypotheses that periodontal inflammatory parameters (PI, BOP, PD, CAL, MBL) and salivary IL-1β and IL-6 concentrations are significantly higher in severely obese (class III) patients as compared to individuals with mild or no obesity. The present result showed that clinical periodontal parameters and whole salivary IL-1β and IL-6 were worse in class II and class III obese patients than in class I obese patients; however, class II and class III obese individuals showed similar periodontal destruction and whole salivary IL-1β and IL-6 levels.

Obesity has been associated with metabolic disturbances and their effects on other chronic diseases, such as osteoarthritis, type 2 diabetes mellitus, and cancers. It is speculated that obesity may also act as a contributing factor in periodontal destruction. It has been proposed that expansion of white adipose tissue leads to generalized chronic inflammation by two different mechanisms: overexpression of proinflammatory cytokines (ie, IL-1, IL-6, tumor necrosis factor-alpha) into the bloodstream and stimulating migration of macrophages to the core of the tissue, thereby increasing the secretion of proinflammatory markers. Hence, this chronic inflammation increases the susceptibility of obese patients to infectious challenges by down-regulating the immune response. These immunologic findings explain the increased susceptibility of patients with obesity to periodontal breakdown. Furthermore, increased periodontal destruction in obesity...
may be described by the increased prevalence of certain periopathogenic bacteria. 28,29 A recent study by Maciel et al 29 concluded that obese patients with chronic periodontitis harbored higher levels of periodontopathogenic bacteria. Although the cause of this association is still unknown, it is speculated that obesity-associated immune changes in periodontal tissues alter the pocket environment and/or host defenses, affecting subgingival microbial colonization. Further studies assessing the microbiologic and immune-inflammatory aspect of periodontal sites in obese patients are recommended to confirm this hypothesis.

It has been reported that chronic hyperglycemia is associated with excessive formation of accumulated glycation end products (AGEs) in the tissues. 30 AGEs are coupled with impaired fibroblastic growth and increased production of proinflammatory cytokines (including IL-1β and IL-6). 31 Moreover, results by Manouchehr-Pour et al 32 showed that chronic hyperglycemia impairs the chemotactic and phagocytic function of neutrophils (which prevent destruction of bacteria in periodontal pockets), thereby increasing periodontal destruction. In the present study, obese patients in group 2 (class II) and 3 (class III) were hyperglycemic. It is speculated that the oxidative stress induced as a result of hyperglycemia worsened chronic periodontitis in these patients, further compromising clinical (PI, BOP, PD ≥ 4 mm, and clinical attachment loss), radiographic (MBL), and salivary markers (IL-1β and IL-6) of periodontal inflammation.

The present results demonstrated significantly higher salivary IL-1β and IL-6 levels in patients with class II and III obesity compared with class I obese patients. Interestingly, no significant difference was found in salivary IL-1β and IL-6 levels between class II and class III patients. Various explanations may be posed in this regard. Firstly, severity of periodontal disease in patients with obesity may be associated with the duration of the obesity. In the present study, duration of obesity among patients in class II (8.9 years) and III (9.1 years) obese individuals was similar and was higher than class I (6 years) obese individuals. It is therefore speculated that duration of obesity among participants of the present study could have influenced the previously existing periodontal inflammatory state in these patients. In addition, patients with chronic periodontitis with a longer history of obesity may be more susceptible to tissue destruction. Further studies are warranted to test this hypothesis.

In the present study, BMI was the sole parameter for obesity assessment, however, it is not the only indicator of obesity. Waist-to-hip ratio may also be considered. In addition, blinding was impossible to implement in the study, as obesity is an apparent characteristic. The examiner could certainly deduce the patient group, which was a possible source of bias. Saliva might not be sensitive enough to detect cytokine levels of localized inflammatory conditions, and perhaps for a better sensitivity gingival crevicular fluid would be a more appropriate choice. With these limitations, patients with severe obesity should be considered at high risk for periodontal disease. It is recommended that periodontists assess obese patients for periodontal disease in dental clinics and provide frequent oral hygiene screening and maintenance procedures in patients with increasing severity of obesity (high risk).

Conclusions

Within the limits of this cross-sectional study, the authors concluded that clinical periodontal inflammatory parameters and whole salivary cytokine levels worsen with increasing severity of obesity. However, these findings should be interpreted with caution due to the inclusion of some hyperglycemic patients.

Acknowledgments

The authors extend their appreciation to the Deanship of Scientific Research at King Saud University for funding this work through research group no. RGP-1438-024. The authors declare that they have no conflicts of interest and all authors have read and approved the final draft.

References


