Evaluation of Periodontal Status in Subjects with Hyperlipidemia

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Abstract

Aim: The aim of this study was to evaluate the periodontal status in subjects with hyperlipidemia and to determine whether there is any association between hyperlipidemia and periodontal disease.

Methods and Materials: Sixty female patients were enrolled in the study; group one is hyperlipidemic patients (30 subjects) and group 2 is systemically fit patients within the same age group (control; 30 subjects). In both groups body mass index (BMI) and clinical parameters were measured; plaque index (PI), bleeding on probing (BOP), pocket depth (PPD) as well as clinical attachment level (CAL) and biochemical parameters, including plasma triglyceride, total cholesterol, low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) levels, were evaluated.

Results: The mean values of BMI, PPD, CAL, PI (%), and BOP (%) for the hyperlipidemia group were significantly higher than those for the control group. Total cholesterol and LDL-C levels were significantly and positively associated with CAL. Plasma triglyceride level was significantly associated with PPD and CAL.

Conclusions: The results of our study showed that female patients with hyperlipidemia had higher values of periodontal parameters compared to control individuals. However, in the future studies with larger sample sizes in mixed gender populations are needed to determine the association between hyperlipidemia and periodontal disease.

Clinical Significance: The results of our study showed that female patients with hyperlipidemia might manifest clinically higher values of periodontal parameters compared to nonlipidemic individuals. However, due to the small sample size of this study the exact association between hyperlipidemia and periodontal disease is still uncertain. Care has to be taken with a hyperlipidemia patients and advice can be given to them for periodic periodontal checkup.

Keywords: Hyperlipidemia, periodontitis, body mass index, triglycerides, cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol.

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Introduction

Cardiovascular disease is primarily associated with atherosclerosis, which is one of the primary causes of death worldwide. The importance of cholesterol—in particular, low-density cholesterol (LDL)—is well established in the development of atherosclerosis. Recent studies have suggested a relationship between high lipid susceptibility to periodontitis and general systemic health. “Model 1” has been shown previously. The cycle begins when the serum lipid level is elevated toward the upper limit of the normal physiologic range; then it alters the immune cell function. Lipids may interact directly with the macrophage cell membrane by altering macrophage gene expression for essential polypeptide growth factors and therefore increase the production of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-alpha) and interleukin 1 beta (IL-1β) by polymorphonuclear (PMN) cells. The release of the pro-inflammatory cytokines and interleukin is believed to compromise tissue response and affect wound healing, therefore increasing the susceptibility to periodontitis.

“Model 2” also explains a cyclic relationship that exists between periodontitis and hyperlipidemia: the presence of periodontitis leads to the elevation of serum lipid levels. This can be explained by the fact that periodontal disease is a chronic infectious disease caused predominantly by anaerobic microorganisms. These microorganisms are capable of producing a variety of molecules such as bacterial lipopolysaccharides (LPS), which may affect the immune system and invade the gingival tissues. Systemic exposure to infections can result in the production of high levels of pro-inflammatory cytokines. The release of these cytokines leads to the destruction of periodontal ligaments and alveolar bone; in addition, they alter the fat metabolism and promote hyperlipidemia.

Many researchers have studied model 2, which is the association between periodontal health and hyperlipidemia. However, these studies have primarily been conducted on subjects with periodontitis; however, there are a few clinical studies involving model 1, which has its focus on the periodontal condition of patients with hyperlipidemia.

Fentoglu studied the periodontal status of subjects with hyperlipidemia. The mean values of the clinical parameters plaque index (PI), probing pocket depth (PPD), bleeding on probing (BOP), and clinical attachment level (CAL) were significantly higher in the hyperlipidemia group than the control group. Plasma triglycerides, total cholesterol, and low-density lipoprotein cholesterol (LDL-C) levels were significantly and positively associated with PPD, BOP (%), and CAL. The results of their study showed that patients with mild or moderate hyperlipidemia manifested higher values of periodontal parameters compared to normal lipidemic individuals.

In Saudi Arabia a high prevalence of lipid abnormalities exists in diabetic patients, including a high level of cholesterol and triglycerides. This is important because the initiation of atherosclerotic plaque is ascribed to the focal accumulation of lipids. This explains the importance of plasma lipids in the development of atherosclerosis; other reports have focused on the role of infection as an additional etiological factor in the development of atherosclerotic lesions.

From our center, the relationship between diabetic dyslipidemia and periodontal disease was studied. Results showed that most of the diabetic patients had a glycemic control of less than or equal to 9%; the diabetic patients had...
significantly higher PPD, CAL, total cholesterol, LDL, and triglycerides when compared to periodontitis patients. The researchers concluded that dyslipidemia might be considered as a possible link between chronic periodontitis and diabetes mellitus; however, the level of metabolic control and the presence or absence of diabetes in the presence of hyperlipidemia and its effect on the periodontal condition were not assessed.

Little research was done in Saudi Arabia regarding the periodontal status in hyperlipidemic patients without the presence of disease that could by itself affect lipid metabolism, such as impaired glucose tolerance, diabetes mellitus, or other endocrine diseases. Therefore, the aim of this study was to evaluate the periodontal status in subjects with hyperlipidemia and to determine whether there is any association between hyperlipidemia and periodontal disease.

Methods and Materials

From April 2008 to November 2008, we selected and enrolled 60 subjects. Patients were recruited from King Abdulaziz Hospital and Dental College of King Saud University. The dental college ethics committee (NF2137) approved the study and an informed written consent was obtained from each patient. The 60 patients included in the study were divided into two groups of 30, distributed as follows:

- **Group 1**: 30 subjects with hyperlipidemia in otherwise systemically healthy patients.
- **Group 2**: 30 subjects systemically healthy within the same age group (control group).

Inclusion Criteria

1. Female patients with no history of systemic disease that affects lipid metabolism, such as diabetes mellitus, or other endocrine diseases, nephritic syndrome, chronic renal disease, or cardiovascular disease.
2. More than 14 natural teeth.
3. Not pregnant at the time of the study.
4. No periodontal treatment within three months prior to the study.
5. No history of systemic antibiotic administration within the last three months.

All subjects were questioned regarding their age, brushing habits, height, and weight. BMI was calculated as body weight (kg) divided by height (m²).

Periodontal Parameters

The following clinical indices were measured: plaque index (PI), bleeding on probing (BOP), periodontal probing depth (PPD), and clinical attachment level (CAL).

The presence of visible plaque was assessed according to the criteria of the plaque index as described by O’Leary, where the presence of any amount of plaque, as revealed by disclosing solution, was assessed on four surfaces of each tooth on a full-mouth basis (mesial, distal, buccal, and lingual). The values for the plaque index were calculated by dividing the number of surfaces with plaque by the total number of surfaces and then multiplying by 100.

The BOP index was used to indicate the presence or absence of bleeding on probing within 10 seconds. The BOP score was calculated on a full-mouth basis by dividing the number of bleeding surfaces by the total number of surfaces and then multiplying by 100.

The PPD measurements were obtained using a Michigan “0” periodontal probe with William’s markings. PPD was measured at six sites around each tooth (mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual, and distolingual) and from the free gingival margin (GM) to the bottom of the pocket. The probe was maintained parallel to the long axis of the tooth; at the midbuccal and midlingual sites, at the proximal sites, the probe was placed as close to the contact point as possible and slightly angled to determine the apical-most extent of the pocket.

The CAL was assessed at four sites around each tooth: the mesiobuccal, midbuccal, midlingual, and distolingual and was determined by measuring the distance from the cemento-enamel junction (CEJ) to the base of the pocket using a Michigan “0” periodontal probe with William’s marks to the nearest millimeter. When the CEJ was masked by a restoration or a crown, the relative CAL (the distance from the restoration or the crown margin to the bottom of the pocket) was measured. When the gingival margin coincided with the CEJ, the CAL was considered equal to the periodontal probing depth.
Metabolic Parameters

Researchers obtained 10 ml venous blood samples for the measurement of plasma triglyceride, total cholesterol, low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) levels in the hyperlipidemic group and in the control group. The samples were obtained after a 12-hour fasting period from an antecubital vein. Plasma lipids were measured the same day in the Alqanah laboratory using an autoanalyzer (Dimension RXL Clinical Chemistry System, Dade Behring, Deerfield, Illinois, USA).

Hyperlipidemia assessment: To identify subjects with pathologic values, the following cutoff points were used according to American Heart Association Guideline Task Force recommendation:
- Triglycerides: >200 mg/dl; >2.26mmol/l
- Total cholesterol: >200 mg/dl; >5.2mmol/l
- LDL-C: >130 mg/dl; >3.38mmol/l
- HDL-C: <35 mg/dl; <1.43mmol/l

Statistical Analysis

Descriptive statistics, means, and standard deviation of the mean (SD) were calculated.

Prevalence of plaque and bleeding were calculated as percentage of persons affected. The significance of difference was determined using the analysis of variance, ANOVA test, and Tukey’s multiple comparison analysis with a level of significance at a \( p \) value of 0.05. The data were analyzed using SPSS 10 (SPSS Inc., Chicago, Illinois, USA) software system.

The Pearson coefficient correlation (\( r \)) was measured to see the strength of association between the lipid profile values and clinical parameters.

Results

This cross-sectional study was carried out in the Department of Preventive Science in Dental College in King Saud University in Saudi Arabia. Sixty subjects participated in our study with an age range of 40 to 55 years old. According to the demographic data analysis, there were no differences in the social status of the hyperlipidemic and control groups (Table 1).

All patients were female nonsmokers; the mean age and daily tooth brushing were similar in the two groups (Table 2).

Table 1. Characteristics of the study population (n=60).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hyperlipidemia group (n=30)</th>
<th>Control group (n=30)</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>25 83.3%</td>
<td>26 86.7%</td>
<td>0.63</td>
</tr>
<tr>
<td>Rural</td>
<td>5 16.7%</td>
<td>4 13.3%</td>
<td>0.19</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>5 16.6%</td>
<td>4 13.3%</td>
<td>0.37</td>
</tr>
<tr>
<td>School</td>
<td>12 40%</td>
<td>13 43.3%</td>
<td>0.56</td>
</tr>
<tr>
<td>Diploma</td>
<td>11 36.7%</td>
<td>12 40%</td>
<td>0.61</td>
</tr>
<tr>
<td>University</td>
<td>2 6.7%</td>
<td>1 3.3%</td>
<td>0.14</td>
</tr>
</tbody>
</table>
To analyze any association between total cholesterol, LDL, triglycerides, and clinical parameters of periodontal disease, Pearson’s correlation coefficient analysis was performed with a two-tailed p value of 0.05 as a threshold for significance. In the hyperlipidemia group (group 1), there was a significant positive correlation between total cholesterol, LDL-C, and CAL. Also there was also a strong positive correlation between triglycerides, PPD, and CAL (Table 5). In the control group (Group 2), plasma triglycerides, total cholesterol, LDL-C levels, and body mass index (BMI) were significantly higher in the hyperlipidemic group (Group 1) (Table 3). The mean values for PPD, CAL, and BOP (%) in the hyperlipidemic group were statistically significantly higher than those for the control group (Table 4). HDL-C was slightly lower in the hyperlipidemic group; however, it was not significantly different from the control group.
Clinical studies that examine the association between blood lipid levels and periodontal disease are controversial. Some report an association between cholesterol and periodontal parameters; others report an association between triglycerides and periodontal parameters. Our study reported an association between total cholesterol, LDL, and triglycerides with clinical parameters; this positive correlation indicates that both variables increase or decrease together. This was in agreement with the results of Lösche et al.

The HDL-C level, although not statistically significant, is slightly less in the hyperlipidemia group than in the control group. Serum HDL concentration usually decreases in subjects with chronic infection. In the present study, the patients did not have a significant decrease in the HDL levels; this could be due to the fact that most of the subjects had mild to moderate hyperlipidemia as expressed by the mean values.

There are very limited data reported for the periodontal status in hyperlipidemia subjects. There are two recent studies regarding this issue. Noack examined the effects of metabolic diseases on periodontal status with a case control design. The group, there was no association between clinical parameters and lipid profile values (Table 6).

### Discussion

The study was conducted to assess the periodontal condition of hyperlipidemic patients, and also to compare it with that of healthy patients of the same age control group. This was done to assess model 1 that had been suggested by recent researchers. Female subjects were selected because only female patients attended the Malaz campus dental clinic in the Dental College at King Saud University. Hyperlipidemia patients were selected from patients who were routinely treated in the nearby King Abdulaziz Hospital.

Our study showed higher values of BOP and higher mean values of PPD and CAL in the hyperlipidemia group than in the control group. It also showed that there is a positive association between total cholesterol, LDL-C, and the value of CAL. An association between triglycerides and both PPD and CAL also was noticed. This suggests that hyperlipidemia may be a potential risk factor for periodontal disease.

<table>
<thead>
<tr>
<th>Periodontal parameters</th>
<th>Triglycerides</th>
<th>Total cholesterol</th>
<th>LDL-C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>p value</td>
<td>r</td>
</tr>
<tr>
<td>PI</td>
<td>0.21</td>
<td>0.53</td>
<td>0.14</td>
</tr>
<tr>
<td>PPD</td>
<td>0.62</td>
<td>0.000*</td>
<td>0.178</td>
</tr>
<tr>
<td>BOP</td>
<td>0.16</td>
<td>0.39</td>
<td>0.21</td>
</tr>
<tr>
<td>CAL</td>
<td>0.40</td>
<td>0.014**</td>
<td>0.31</td>
</tr>
</tbody>
</table>

*Two-tailed p value.
**One-tailed p value.

PPD=probing pocket depth; CAL=clinical attachment level; PI=plaque index; BOP=bleeding on probing.
The lipid level could be due to diabetes mellitus by itself, as it has been shown that Saudi diabetic patients had a higher prevalence of lipid abnormalities including a high level of cholesterol and triglycerides.\textsuperscript{10,11}

Body mass index values were 29.3 ± 5.7 and 24.1 ± 4.3 in the hyperlipidemic and control patients, respectively. According to the guidelines of the World Health Organization,\textsuperscript{20} the hyperlipidemia group is considered in the overweight range (25 to 29.9 kg/m\textsuperscript{2}) while the control group is within the normal range (18.5 to 24.9 kg/m\textsuperscript{2}). It has been reported that obesity is associated with increased prevalence of periodontitis and could be considered as an independent risk indicator for periodontitis.\textsuperscript{21,22}

Hyperlipidemia can cause an increase in the monocyte differentiation process, which results in a change of macrophage subsets and cytokine release at the wound site, impairing the wound-healing processes. Serum lipids modulating the host immune response to chronic localized infection, such as endotoxins, lead to increased susceptibility to periodontitis. Recent evidence suggests that periodontal disease and delayed wound healing may be manifestations of the same general systemic defect involving impairment of cellular and molecular signals of wounding via an alteration in the macrophage phenotype. Elevation of serum low-density lipoproteins and triglycerides leads to formation of advanced glycation end products that may alter the macrophage phenotype.\textsuperscript{3}

The result of the present study suggested a possible relationship between plasma lipid levels and periodontal disease. There was an association between lipid values and periodontal parameters. Patients with hyperlipidemia (group 1) had higher values of BMI, BOP, PPD, and CAL compared to the control group. However, the study has some limitation before interpreting our results. First, because this study had a case-control design, it is difficult to make causal inferences based on its findings. Second, there were a limited number of patients that participated in the study and all the patients were of one gender. Therefore, further longitudinal studies of larger mixed gender populations are necessary to be able to establish the true relationship between hyperlipidemia and periodontitis.

Fentoglu\textsuperscript{9} examined the periodontal status in hyperlipidemia patients. The results showed that the mean values of PI, PPD, CAL, and BOP (%) for the hyperlipidemia group were significantly higher than those for the control group; triglycerides, total cholesterol, and LDL-C were significantly and positively associated with PI, PPD, BOP, and CAL. Only patients with mild to moderate hyperlipidemia were included. Patient selection followed in the Fentoglu study was similar to that in our study; therefore, they both share the same limitation, such as being a case control design, and it is therefore difficult to make causal inferences based on their findings. There will always be socioeconomic status, diet, and cultural habits that might differentiate between the patients in both studies.

Our result is in agreement with Al-Otibi\textsuperscript{12} regarding patients with dyslipidemia having higher mean periodontal parameters than the control group; however, this study assessed hyperlipidemia in chronic periodontitis patients with diabetes mellitus. Therefore, the increase in subjects had impaired glucose tolerance but not yet diabetes, hyperlipidemia, or normal metabolic status. Although the study included only 17 hyperlipidemia patients, they exhibited increased probing depth (PD) (73.4\%) as compared with the control group. All patients had significantly higher values across all the periodontal parameters that were tested (PI, PPD, CAL, and BOP) with significant correlation between PD and lipid levels.
Conclusions

The aim of this study was to evaluate the periodontal status in subjects with hyperlipidemia. The results of our study showed that patients with hyperlipidemia (group 1) had higher values of BMI, BOP, PPD, and CAL compared to control subjects (group 2). There was an association between lipid values and periodontal parameters. There was a significant positive correlation between total cholesterol, LDL-C, and CAL. Also there was a positive correlation between triglycerides, PPD, and CAL.

Because of the small number of patients and single gender, it is not possible to generalize the findings and, therefore, a larger sample sized trial is required to study high lipid susceptibility to periodontitis, which may suggest that hyperlipidemia is a causative factor of periodontal diseases.

Clinical Significance

The results of our study showed that female patients with hyperlipidemia might manifest clinically higher values of periodontal parameters compared to nonlipidemic individuals. However, due to the small sample size of this study the exact association between hyperlipidemia and periodontal disease is still uncertain. Care has to be taken with a hyperlipidemia patients and advice can be given to them for periodic periodontal checkup.

References


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