Prevalence of Periodontitis and its Association with Glycemic Control Among Patients with Type 2 Diabetes Mellitus Seen at St. Luke’s Medical Center

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Abstract

Background: Studies have shown that diabetes increases the prevalence and severity of periodontitis. Furthermore, among patients with Type 2 Diabetes Mellitus (DM), poorer glycemic control was found to be associated with poorer periodontal health.

Objective: To determine the prevalence of periodontitis and its association with glycemic control among Filipino patients with Type 2 DM.

Design: Cross-sectional study

Materials and Methods: Diagnosed Type 2 DM patients 35 years and above were recruited from the out-patient clinics of St. Luke’s Medical Center from June-October 2009. Periodontitis was evidenced by the presence of ≥3mm probing depth and ≥3mm periodontal attachment loss at the same site. Periodontitis severity was classified based on probing depth and furcation involvement. Glycemic control was assessed by laboratory assay for HbA1c grouped into <7% and ≥7%. Association between glycemic control and periodontitis and severity of periodontitis were determined using Pearson chi square test for independence. A multiple logistic regression analysis was performed to determine the association of glycemic control with the presence of periodontitis, controlling for the effects of selected indicators. Level of significance was set at α=0.05.

Results: A total of 192 subjects were analyzed. Prevalence of periodontitis among the Type 2 DM population studied was 68.23%. In this study, we found out that for those whose length of time since last dental check-up was >1 year, the odds of having periodontitis is 3.8 times higher (95% CI 1.45-9.76, p-value 0.007) among subjects with HbA1c ≥7% compared to those with HbA1c <7%.

Conclusion: Our findings suggest that periodontitis is prevalent among the Filipino Type 2 DM population studied. In this study, it is the interaction of both HbA1c ≥7% and length of time since last dental check-up >1 year that resulted in a statistically significant association with periodontitis.

Keywords: Periodontitis, Glycemic control, Type 2 Diabetes Mellitus

Introduction

Diabetes mellitus (DM) is a common and growing global health problem. The prevalence of diabetes for all age-groups worldwide was estimated to be 2.8% in 2000 and 4.4% in 2030. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. Among countries with the highest numbers of estimated cases of diabetes, it is projected that the Philippines will rank 9th by the year 2030 with an estimated 7.8 million cases of people with diabetes. Thus, with the increasing prevalence of DM, it follows that any other disease that may be associated with it would increase as well.

Studies have shown that diabetes increases the prevalence and severity of periodontitis and has even been cited as the sixth complication of diabetes mellitus. Periodontitis is defined as a chronic inflammatory disease of the supporting tissues of the teeth caused by specific microorganisms or groups of specific microorganisms, resulting in progressive destruction of the periodontal ligament and alveolar bone with pocket formation, recession, or both, leading to tooth loss. In a review article by Measley, he cited a number of established mechanisms by which diabetes can influence the periodontium which include the following: alteration in the host immunoinflammatory response, altered wound healing, accumulation of advanced glycation end products (AGE’s), and elevated proinflammatory cytokines.

Furthermore, there are also studies to support that among patients with Type 2 DM, poorer glycemic control was found to be a significant factor associated with poorer periodontal health.

Despite current knowledge on the relationship of these two diseases, information on the prevalence and extent of periodontitis and its association with glycemic control among
Type 2 DM patients in the Philippines is lacking. This study has the following general and specific objectives:

**Objectives**

**General:**
To determine the prevalence of periodontitis and its association with glycemic control among Filipino patients with Type 2 DM

**Specific:**
1. To determine the prevalence of mild, moderate and advanced periodontitis among Filipino patients with Type 2 DM
2. To determine the association of glycemic control with periodontitis among Filipino patients with Type 2 DM
3. To determine the association of glycemic control with severity of periodontitis among Filipino patients with Type 2 DM
4. To determine the association of glycemic control with periodontitis controlling for the effect of selected indicators

**Materials and Methods**

**Study Design and Population**
This study was designed as a cross-sectional study. Following approval of the research protocol by the institutional scientific and ethics review board of St. Luke’s Medical Center, Quezon City, Philippines, subjects provided informed consent and were recruited from the out-patient clinics of St. Luke’s Medical Center, conducted from June to October 2009. Diagnosis of Type 2 DM was based on the American Diabetes Association criteria and clinical history as follows: 1) FBS ≥ 126mg/dl on 2 determinations, 2) symptoms of hyperglycemia and RBS ≥ 200mg/dl, 3) 2-hour plasma glucose ≥ 200mg/dl after a 75 grams oral glucose tolerance test (performed as described by the World Health Organization), 4) on oral hypoglycemic agents, 5) for patients ≥ 40 years old and insulin requiring, insulin was not required during the first four years of diagnosis.

Inclusion Criteria were as follows: 1) diagnosed Type 2 DM Filipino male or female ≥ 35 years and above; 2) dentulous persons with ≥ 6 teeth present. We excluded those patients with specific conditions (heart murmurs) that would require antibiotics prior to dental examination; and patients who are ≥ 40 years old and who required insulin treatment within four years after diagnosis.

**Data Collection and Study Variables**

In this study, periodontitis was defined as a disease state in which there is an active destruction of the periodontal supporting tissues as evidenced by the presence of ≥3mm probing depth and ≥3mm periodontal attachment loss at the same site. The individuals were classified according to severity of periodontitis using the following criteria (NHANES III protocol, 1988-1994):

- **Advanced periodontitis:** 1) two or more teeth (or 30% or more of the teeth examined) having ≥5mm probing depth, or 2) four or more teeth (or 60% or more of the teeth examined) having ≥4mm probing depth, or 3) one or more posterior teeth with grade II furcation involvement.
- **Moderate periodontitis:** 1) one or more teeth with ≥5mm probing depth, or 2) two or more teeth (or 30% or more of the teeth examined) having ≥4mm probing depth, or 3) one or more posterior teeth with grade I furcation involvement and accompanied with ≥3mm probing depth.
- **Mild periodontitis:** 1) one or more teeth with ≥3mm probing depth, or 2) one or more posterior teeth with grade I furcation involvement.
- **No periodontitis:** persons with 6 or more teeth present who did not fulfill any of the above criteria.

From each patient, we collected the following additional socio-demographic, dental and medical variables using a standard data collection form: Pertinent socio-demographic variables include age in years (specified as both continuous and categorical with two categories: 35-59, and ≥60), gender, educational attainment (high school graduate or lower and some college education or higher). Self-reported oral-health related variables included oral hygiene habits (grouped into tooth brushing at least twice a day with or without dental flossing and tooth brushing less than twice a day with or without dental flossing) and length of time since last dental check-up (grouped into ≤1 year and ≥1 year). The self-reported medical variables consisted of cigarette smoking status (adopted from the NHANES III classification12 categorized into current smoker- subjects who had smoked ≥100 cigarettes in their lifetime and are currently smoking; former smokers- subjects who had smoked ≥100 cigarettes in their lifetime, not currently smoking; never smokers- subjects who had not smoked ≥100 cigarettes in their lifetime) and duration of diabetes (grouped into ≤10 years and >10 years). Glycemic control was assessed by laboratory assay for HbA1c conducted at St. Luke’s Medical Center grouped into <7% and ≥7%.

In the dental examination, we used the same principles of the Third National Health and Nutrition Examination Survey (NHANES III, 1988-1994). Periodontal examination was carried out in 2 randomly selected quadrants, one maxillary and one mandibular. In the 2 quadrants, all fully erupted teeth were assessed excluding third molars. A maximum of 14 teeth per individual were examined. The distance from the cemento-enamel junction (CEJ) to the free gingival margin (FGM) and the distance from the FGM to the bottom of the pocket/sulcus were assessed at the mesio-buccal and mid-buccal surfaces. Measurements were made in millimeters and were rounded to the lowest whole millimeter. The assessment was made by using the periodontal probe PCP 11. The probing depth is defined as
the FGM/sulcus measurement. The CEJ/FGM distance was given a negative sign if the gingival margin is located on the root. Attachment loss is defined as the distance from the CEJ to the bottom of the pocket/sulcus and was calculated as the difference between the CEJ/FGM and FGM/sulcus distance (or the sum of the 2 distances if the FGM was at the root). Assessment of furcation involvement was made on 5 posterior teeth. The assessments were made at the mesial, buccal, and distal furcations of maxillary first and second molars, the mesial and distal furcations of mandibular second premolars and the buccal and lingual furcations of mandibular first and second molars. Explorer #17 was used for maxillary molars and premolars, and Explorer #3 for mandibular molars. Partial furcation involvement (grade I) was scored in sites where the explorer is definitely catching into but did not pass through the furcation. Total furcation involvement (grade II) was used when the explorer could be passed between the roots and through the entire furcation. To minimize inter-observer variability, periodontal examination was performed by only one dentist (one of the authors) who assigned each subject a given classification if he/she fulfilled one or more of the criteria of that classification and was given the most advanced classification. Number of teeth present (half-mouth count) was also included in the data collected.

Data Analysis

Data processing and analysis were performed using STATA 10 software.

Prevalence was presented as the proportion of patients with periodontitis among those with Type 2 DM. The 95% confidence interval was computed using exact binomial method. Demographic and clinical characteristics were described using means and standard deviations for continuous variables and proportions for nominal variables. Associations between glycemic control and periodontitis and severity of periodontitis were determined using chi square tests for independence.

Univariate analysis was done to determine potential factors associated with periodontitis. Level of significance of 0.25 was used as cut-off to select for variables that were checked for interaction and confounding with glycemic control using stratified analysis and inclusion in the multiple logistic regression.

A multiple logistic regression analysis was then performed to determine the association of glycemic control with the presence of periodontitis, controlling for the effect of selected indicators. Level of significance was set at α=0.05.

Results

Two hundred fifty three (253) diagnosed Type 2 DM patients consecutively seen at the out-patient clinics of St. Luke’s Medical Center were screened for this study. Out of these 253 patients, 56 were not enrolled because they have less than 6 teeth present and 5 were excluded because of the presence of heart murmurs. Baseline characteristics of the 192 subjects included in the study are presented in Table I. The mean age of participants was 54±9.2 years SD, with age range of 35-81 years old. Majority of subjects (73.96%) belong to the 35-59 years old age category. There were 120 (62.50%) female and 72 (37.50%) male participants. Ninety-seven subjects (50.52%) attained high school education or lower while 95 (49.48%) had some college education or higher. Frequency of tooth brushing of at least twice/day was noted in most subjects (92.19%). Only 2 subjects (1.04%) performed daily flossing while 178 (92.71%) of the participants do not perform dental flossing at all. Majority of the participants had their last dental check-up more than 1 year prior to enrollment in the study (67.19%). Mean number of teeth present±SD was 9.9±2.3 based on half-mouth count (as per NHANES III protocol). Only 17 (8.85%) were current smokers with the greater percentage of subjects being never smokers.

Table I. Characteristics of participants (N=192) with Type 2 DM ages 35 years old and above seen at St. Luke’s Medical Center (June-October 2009)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Age N (%)</th>
<th>Gender N (%)</th>
<th>Educational attainment N (%)</th>
<th>Oral hygiene habits N (%)</th>
<th>Length of time since last dental check-up N (%)</th>
<th>Number of teeth present (half-mouth count)</th>
<th>Cigarette smoking status N (%)</th>
<th>Duration of Diabetes Mellitus N (%)</th>
<th>Glycemic control N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35-59 years old</td>
<td>Female</td>
<td>High school graduate or lower</td>
<td>Tooth brushing at least 2x/day with or without dental flossing</td>
<td>&lt;1 year</td>
<td>Mean±SD</td>
<td>Current smoker</td>
<td>&lt;10 years</td>
<td>HbA1c&lt;7%</td>
</tr>
<tr>
<td></td>
<td>142 (73.96)</td>
<td>120 (62.50)</td>
<td>97 (50.52)</td>
<td>177 (92.19)</td>
<td>63 (32.81)</td>
<td>129 (67.19)</td>
<td>17 (8.85)</td>
<td>137 (71.35)</td>
<td>79 (41.15)</td>
</tr>
<tr>
<td></td>
<td>&gt;60 years old</td>
<td>Male</td>
<td>Some college education or higher</td>
<td>Tooth brushing less than 2x/day with or without dental flossing</td>
<td>&gt;1 year</td>
<td>Mean±SD</td>
<td>Former smoker</td>
<td>&gt;10 years</td>
<td>HbA1c 7% and above</td>
</tr>
<tr>
<td></td>
<td>50 (26.04)</td>
<td>72 (37.50)</td>
<td>95 (49.48)</td>
<td>15 (7.81)</td>
<td>129 (67.19)</td>
<td>129 (67.19)</td>
<td>31 (16.15)</td>
<td>55 (28.65)</td>
<td>113 (58.85)</td>
</tr>
</tbody>
</table>

N=number; SD= standard deviation
smokers (75.0%). Majority of patients have duration of DM ≤ 10 years (71.35%) and HbA1c of ≥ 7% (58.85%).

In this study, the prevalence of periodontitis among subjects with Type 2 DM 35 years old and above was 68.23% (95% CI 61.1-74.7) while 61 (31.77%) did not have the disease. Mild periodontitis was noted in 84 (43.75%) of the participants, moderate periodontitis was seen in 27 (14.06%), while 20 (10.42%) subjects had advanced periodontitis.

Using Pearson chi square, we found a significant association with glycemic control and periodontitis with p-value of 0.030. The odds of having periodontitis in patients with HbA1c ≥ 7% was 1.97 times greater (95% CI 1.01-3.82) compared to patients with HbA1c of <7%.

Table II shows the association of glycemic control with severity of periodontitis. Using Pearson chi square, results showed a significant association with p-value of 0.05. It can be noted that the occurrence of advanced periodontitis among subjects with HbA1c of ≥ 7% (14.16%) was significantly higher compared to those with HbA1c of <7% (5.06%). Furthermore, there were more subjects without periodontitis among those with HbA1c of <7% (40.51%) compared to those subjects having HbA1c ≥ 7% (25.66%).

Table III shows the association of glycemic control with severity of periodontitis (N=192)

<table>
<thead>
<tr>
<th>Glycemic Control</th>
<th>Severity of Periodontitis N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
</tr>
<tr>
<td>HbA1c &lt;7%</td>
<td>32 (40.51)</td>
</tr>
<tr>
<td>HbA1c ≥7%</td>
<td>29 (25.66)</td>
</tr>
</tbody>
</table>

Identified potential risk factors associated with periodontitis in the univariate analysis were checked for interaction and confounding with glycemic control using stratified analysis. We found a significant interaction between length of time since last dental check-up and glycemic control. This finding was confirmed in the multiple logistic regression analysis (see Table IV). HbA1c ≥ 7% was no longer a significant independent variable associated with periodontitis but it is the interaction of both HbA1c ≥ 7% and length of time since last dental check-up >1 year that resulted to a statistically significant association with the
Table IV. Logistic regression model of the association between glycemic control and periodontitis controlling for the effects of selected indicators among Type 2 DM patients 35 years of age and older seen at St. Luke’s Medical Center (June-October 2009)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Adjusted OR</th>
<th>SE</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HbA1c &gt;7%</td>
<td>0.95</td>
<td>0.42</td>
<td>0.41-2.24</td>
<td>0.913</td>
</tr>
<tr>
<td>Age 35-59 years old</td>
<td>2.19</td>
<td>0.82</td>
<td>1.05-4.57</td>
<td>0.036</td>
</tr>
<tr>
<td>Male Gender</td>
<td>1.56</td>
<td>0.56</td>
<td>0.79-3.17</td>
<td>0.193</td>
</tr>
<tr>
<td>High school or lower</td>
<td>1.59</td>
<td>0.54</td>
<td>0.82-3.09</td>
<td>0.174</td>
</tr>
<tr>
<td>Educational attainment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of Diabetes</td>
<td>1.84</td>
<td>0.72</td>
<td>0.85-3.98</td>
<td>0.123</td>
</tr>
<tr>
<td>Mellitus&lt;10 years old</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction term ( HbA1c of &gt;7% and length of time since last dental)</td>
<td>3.75</td>
<td>1.83</td>
<td>1.45-9.76</td>
<td>0.007</td>
</tr>
</tbody>
</table>

The result of our study is in agreement with other reports that periodontitis is a prevalent disease among patients with Type 2 DM. Comparing our study with the findings of Nelson, et al.7 among the Pima Indians of Arizona, a population with the highest occurrence of Type 2 Diabetes in the world where they noted the age- and sex-adjusted prevalence of periodontal disease at first dental examination to be 60% in subjects with HbA1c ≥7% compared to those with HbA1c <7%. This is statistically significant with p-value 0.007. In this study, we found out that age is also a significant independent risk factor for the development of periodontitis among patients with Type 2 DM. The odds of having periodontitis among subjects belonging to the 35-59 years old category was 2.19 times greater than those subjects > 60 years old independent of glycemic control (95% CI 1.05-4.57, p-value 0.036).

Discussion

The result of our study is in agreement with other reports that periodontitis is a prevalent disease among patients with Type 2 DM. Comparing our study with the findings of Nelson, et al.7 among the Pima Indians of Arizona, a population with the highest occurrence of Type 2 Diabetes in the world where they noted the age- and sex-adjusted prevalence of periodontal disease at first dental examination to be 60% in subjects with NIDDM, the prevalence of periodontitis in our study is slightly higher at 68.23%. In their study, however, subjects with little or no evidence of periodontal disease were classified as non-diseased resulting in the lower disease prevalence reported. Furthermore, the great majority of our subjects have mild periodontitis (43.75%). Thus, we have a lower prevalence of more severe periodontitis compared to their study.

In this study, several risk indicators were evaluated in the univariate analysis as potential factors that may influence the association between glycemic control and periodontitis. We set the cut-off for inclusion at a lower level of statistical significance (<0.25) so as not to outright exclude potential indicators that may affect our results. Despite the lower cut-off used, we have noted that cigarette smoking was not significantly associated with periodontitis. This was an unexpected finding. In the study by Tomar, et al.12, they found out that current smokers were about 4 times as likely as persons who never smoked to have periodontitis (95% Cl, 3.20-4.93) after adjusting for age, gender, race/ethnicity, education, and income:poverty ratio. They likewise noted among former smokers that the odds of periodontitis were 1.68 times more likely than persons who had never smoked (95% CI, 1.31-2.17). Furthermore, patients with diabetes who are smokers may be at even greater risk of developing periodontal disease compared with non-smoking patients with diabetes. In the study by Tsai, et al.8, they found out that the Odds ratio (OR) for severe periodontal disease in patients who smoke and had better-controlled diabetes (HbA1c ≤9%) was 2.3, while patient who smoke and had poorly-controlled diabetes (HbA1c>9%) had an OR of 4.6. Our study probably did not show similar findings because the majority of subjects enrolled were never smokers (75%), leading to the possibility that the smoker/former smoker population were underrepresented.

We also found out that oral hygiene habits (based on frequency of tooth brushing with or without dental flossing) were not significantly associated with periodontitis. In the study conducted by Brodeur, et al.13 among Quebec adults aged 35-44 years, they also noted that neither brushing nor flossing frequency was associated with periodontal pockets. This could have been the outcome of both studies because periodontal diseases are chronic diseases and therefore their presence may be the result of past, rather than present, dental hygiene habits.

Our result that the younger age category (35-59 years old) was a significant independent factor associated with periodontitis is similar to the findings by Abdellatif, et al.14 where they analyzed data from the first National Health and Nutrition Examination Survey (NHANES I), conducted from 1971-1974, to determine whether the incidence of periodontits increases with age in a representative sample of the U.S. population. In their study, they found out that the prevalence of periodontitis increases with age up through age group 55-59 then it showed a slight reduction in the older age group which could be explained by the greater loss of affected teeth. Both our studies clearly showed that periodontal destruction does not progress with increasing age in a linear fashion.

Finally, in this study, we found out that glycemic control with HbA1c ≥7% was no longer an independent variable associated with periodontitis but a significant interaction was noted with length of time since last dental check-up of >1 year. This is in contrast to the study by Tsai, et al.8, where they investigated the association between glycemic control of Type 2 DM and severe periodontal disease in the U.S. population ages 45 years and older. In their study, they found out that individuals with poorly controlled DM (defined as HbA1c >9%) had a significantly higher prevalence of severe periodontitis (defined as at least two sites with 6mm or more attachment loss and at least one site with probing pocket depth of 5mm or more in one of these sites than those without diabetes (OR 2.9: 95% CI, 1.40-6.03), after controlling for age, education, smoking status, and calculus.
In their study, however, they mentioned that other variables with statistically significant bivariate association with severe periodontitis included length of time since last dental check-up but the result was not shown in their published report and for some reasons known only to the authors, length of time since last dental check-up was not included in their final multiple logistic regression model and thus in their study, the association of length of time since last dental check-up with glycemic control and severe periodontitis was not clear.

Our findings that the occurrence of periodontitis was due to the combined effect of higher HbA1c level and longer duration since last dental check-up clearly reflect both poor compliance to DM management and poor behavior with regards to dental check-up by the Type 2 DM population studied which may be attributed to lack of awareness about their periodontal problem.

There are potential limitations to consider in interpreting the result of our study. A great number of our Type 2 DM patients (22% of the subjects screened) were not enrolled in the study because they have less than 6 teeth present. We can only speculate that these individuals might have lost their teeth due to advanced periodontitis. Furthermore, in the conduct of the dental examination, we have adopted the same protocol used in the NHANES III since this is an established protocol such that the examination was carried out using half-mouth count assessment with the assumption that the half-mouth count assessment be extrapolated to the full mouth and that the measurement of probing depth and attachment loss were conducted only on 2 sites (mesio-buccal and mid buccal surfaces) rather than all around the tooth. Taking into consideration the above mentioned limitations, there is the possibility that our reported prevalence and severity of periodontitis may be an underestimate of the actual prevalence in the population studied. Another limitation is that we used a low cut-off value for glycemic control (HbA1c <7% and ≥7%). Thus, the result of this study may not be reflective of the true prevalence of severe periodontitis among subjects with poorer glycemic control. Furthermore, we only evaluated selected socio-demographic, dental and medical risk indicators in the univariate analysis for inclusion in the final multiple logistic regression model. Many factors have been mentioned in the literature as potential risk factors for periodontitis which were not evaluated in our study such as psychosocial stress (physical and mental), osteoporosis, human immunodeficiency virus (HIV) infection, presence of calculus and presence of diabetes complications such as retinopathy and nephropathy.16

Conclusion and Recommendations

Our findings suggest that periodontitis is prevalent among the Filipino Type 2 DM population we have studied with the majority of subjects having mild periodontitis. Although we initially found a significant association between the presence and severity of periodontitis and higher HbA1c level (≥7%) using Pearson chi square, this association was weakened significantly by the interaction between HbA1c ≥7% and length of time since last dental check-up of >1 year in the multiple logistic regression analysis. This, however, does not necessarily indicate a non-association between glycemic control and periodontitis. Based on our findings, we recommend that further evaluation of this interaction be conducted in future studies. We likewise recommend that prospective longitudinal studies be undertaken to evaluate the effect of long term glycemic control on periodontal health of diabetic patients. Lastly, we highly advocate regular dental check-up as part of management of our Type 2 DM patients.

References