ORIGINAL ARTICLE

Type 2 Diabetes Mellitus in Patients with Periodontitis at a Tertiary Care Hospital: A Cross-Sectional Study

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Abstract

Introduction: Periodontitis is a chronic inflammatory disease affecting the tissues surrounding the teeth. Bacteria or bacterial products may enter the general circulation through the ulcerated periodontal pocket, and cytokines produced locally will also have systemic effects, altering the body's internal environment and causing insulin resistance. The aim of this study was to determine glycemic parameters among patients diagnosed with chronic periodontitis.

Methods: This descriptive, cross-sectional study was conducted among 350 patients diagnosed with chronic periodontitis at a tertiary-level hospital from February 2025 to August 2025. Ethical approval was obtained from the Institutional Review Committee (Ref 030/2024). The patients were recruited by convenience sampling, written informed consent was obtained and they were sent for glycemic parameters. Data were entered in Statistical Package for the Social Sciences version 21 and Microsoft Excel 2019. Chi-square test was utilized to compare categorical data.

Results: Among 350 participants with periodontitis, the majority, 219 (62.60%) had normal glycemic levels. However, a substantial proportion showed dysglycemia in which 87 (24.90%) were classified as having pre-diabetes and 44 (12.60%) had diabetes mellitus. The chi-square test suggested that, with progression of periodontitis, poor glycemic control was observed, and periodontitis staging showed significant associations with glycemic status ($p < 0.001$).

Conclusions: Glycemic parameters were higher in patients with periodontitis. The study showed a significant correlation between the severity of periodontitis and poor glycemic control.

Keywords: *diabetes mellitus; fasting blood sugar; gingivitis; periodontitis.*

Introduction

Periodontitis is a multifactorial chronic inflammatory disease affecting the supporting tissues surrounding the teeth. It can be characterized by gingival inflammation, loss of periodontal attachment, alveolar bone resorption, and ultimately, tooth loss.[1] Periodontitis is considered the sixth most frequent diabetic complication.[2-4]

Diabetes mellitus (DM) is a significant form of

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diabetes which results from defects in insulin secretion and/or action.[4] In many reviews and studies, Type 2 DM and periodontitis have a bidirectional relationship.[5] Periodontitis may determine a chronic over expression of pro-inflammatory mediators (e.g., TNF-α, IL-1ß, and IL-6) which can release acute phase reactants (e.g., c-reactive protein) by the liver, lower the insulin production in the pancreas leading indirectly to insulin resistance and hyperglycemia.[6] In recent years the prevalence of DM is rising worldwide and according to the WHO the estimated increase in number of diabetic patients will be around 366 million by 2030.[4] The WHO Global oral health status report (2022) shows that oral diseases pose a significant health burden globally, affecting 3.5 billion people and severe periodontal diseases are estimated to affect more than 1 billion case worldwide.[7]

A study among 417 adult patients showed that 47.50% suffered from periodontitis among which localized and generalized periodontitis were 28.30% and 18% respectively.[8] A longitudinal trial of two-year showed a six-fold increased risk of worsening glycemic control in DM patients who had severe Periodontitis compared with DM patients with no Periodontitis.[9] In a prospective 5 years study of 2,973 non-diabetic individuals, the impact of periodontitis on changes in HbA1c was assessed.[10] Patients with most advanced periodontitis at baseline showed an approximately five-fold more absolute increase in HbA1c over the 5 years of the study when compared to patients with no periodontitis at baseline (change in HbA1c 0.106 ± 0.03% vs 0.023 ± 0.02%).

Screening for glycemic parameters during routine dental visits in patients with periodontal disease may aid in the early diagnosis of pathological or pre-pathological cases.[11] Patients with Periodontitis may be a selected pool of subjects for assessing diabetes and prediabetes, which often remain undiagnosed for a long period. This study aimed to determine glycemic parameters in patients with chronic periodontitis.

Methods

An observational, cross-sectional study was done among patients visiting Nepal Armed Police Force Hospital from February 2025 to August 2025. Ethical approval was granted from the Institutional Review Committee (IRC) of Nepal APF Hospital (Ref 030/2024). Informed consent was obtained from patients recruited by convenience sampling.

Sample size was calculated using the formula: [12]

$n = (Z^2 \times p \times q) / e^2$

Where, n= minimum required sample size , Z= 1.96 at 95% Confidence Interval (CI)

p= prevalence, q= 1-p, e= margin of error, was set at 5% (0.05)

Inclusion criteria comprised diagnosed cases of periodontitis aged 13 and older who attended the Dental OPD at Nepal APF Hospital.

Exclusion criteria were known cases of diabetes; patients who were previously treated for periodontal disease with intake of antibiotics in the previous 6 months; According to WHO recommendations, patients on medication that may cause rapid glucose rise (e.g., steroids and antipsychotics) or affect HbA1c values (aspirin and antiretrovirals); Medical conditions where HbA1c measurement is not indicated, were excluded.[13]

For every participant, a full-mouth periodontal examination was done and recorded on a Proforma. The clinical examinations were done using a sterilized UNC (University of North Carolina) periodontal probe and a mouth mirror, under artificial illumination in the dental chair. The complete periodontal examination was performed on all teeth, except for the third molars. The periodontal parameters, Plaque index (PI), Gingival index (GI), probing depth (PD), and Clinical Attachment Loss (CAL), were recorded to diagnose periodontitis. The staging and grading of Periodontitis were determined based on "The 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions."[14]

HbA1c was estimated using the Fine care TM FIA Meter III Plus (model: FS-205, Wondfo, Guangzhou, China) and classified according to the American Diabetes Association (ADA) criteria.[13] It is a semiautomatic fluorescence-immune chromatographic closed analysis system. Fasting and Postprandial blood glucose levels were estimated by using Diatron Pictus 500, Hungary.

A single investigator handled all the data. Statistical Package for Social Sciences (SPSS) version 21 and Microsoft Excel 2019 were used. Chi-square test was used to compare categorical data. One-way ANOVA test was used for comparison of mean HbA1c (%) across periodontitis stages and grades. Post-hoc multiple comparison of HbA1c between periodontitis stages and grade (Tukey HSD test) were carried out. Multivariate regression analysis with HbA1c as the dependent variable identified several significant predictor variables (PD, CAL, GI, PI).

Results

The study included 350 patients with periodontitis, with a mean age of 40.35±11.92 years (range: 19-76). Clinical parameters showed substantial disease burden: pocket depth 6.26±1.59 mm (range: 3.0-14.0mm), clinical attachment loss 6.27±2.06mm (range: 2-14mm), plaque index 2.16±0.42, indicating

moderate-to-heavy accumulation, and gingival index 2.16±0.43, suggesting moderate inflammation. Glycemic parameters included fasting blood sugar 98.63±18.77mg/dl (range: 75-200mg/dl) and postprandial blood sugar 122.25±33.53mg/dl (range: 70-320mg/dl). Mean HbA1c was 5.42±0.95% (range: 4-13%).

Glycemic status among the 350 periodontitis patients showed that the majority, 219 (62.60%), had normal glycemic levels. However, a substantial proportion showed dysglycemia: 87 (24.90%) were classified as having pre-diabetes. In comparison, 44 (12.60%) had diabetes mellitus, indicating that more than one-third (37.40%) of periodontitis patients in this study had either pre-diabetes or diabetes.

Table 1: Periodontitis staging and glycemic status

Stages	Glycemic status			
	Diabetes n(%)	Normal n(%)	Prediabetes n(%)	Total n(%)
Generalized stage 2	-	23(92)	2(8)	25 (100)
Generalized stage 3	9(12.20)	23(31.10)	42(56.80)	74 (100)
Generalized stage 4	30(83.30)	1(2.80)	5(13.90)	36 (100)
Localized stage 2	-	54(100)	-	54(100)
Localized stage 3	-	113(88.30)	15(11.70)	128(100)
Localized stage 4	5 (15.20)	5(15.20)	23(69.70)	33(100)
p value				<0.001*

*Statistically significant, chi-square test applied

Periodontitis grading showed a highly significant association with glycemic status (p=0.00). Grade A (n=188, slow progression) had 172 (91.50%) normal, 15 (8%) pre-diabetic, 1 (0.5%) diabetic. Grade B (n=136, moderate progression) showed 71 (52.20%) pre-diabetic, 47 (34.60%) normal, 18 (13.20%) diabetic. Grade C (n=26, rapid progression) revealed 25 (96.20%) diabetic, 1 (3.80%) pre-diabetic, with none normal.

One-way ANOVA revealed highly significant differences in HbA1c across periodontitis stages (p=0.00). Localized stage II showed the lowest mean HbA1c at 4.96±0.41% (range: 4-5.60%), while generalized stage IV had the highest at 7±1.25% (range: 5.50-13%). Localized stage III: 4.98±0.54%, localized stage IV: 6.04±0.48%, generalized stage II: 5.26±0.42%, and generalized stage III: 5.83±0.53% (Table 2).

Table 2: Comparison of mean HbA1c (%) across periodontitis stages (One-Way ANOVA)

Stages	n	Mean	SD	Minimum	Maximum
Generalized stage II	25	5.26	0.42	4.60	6.30
Generalized stage III	74	5.83	0.53	4.80	7
Generalized stage IV	36	7	1.25	5.50	13
Localized stage II	54	4.96	0.41	4	5.60
Localized stage III	128	4.98	0.54	4	6.40
Localized stage IV	33	6.04	0.48	5	7
Total	350	5.42	0.95	4	13
P value					0.001*

*Statistically significant, ANOVA test applied

Post-hoc Tukey HSD analysis showed that generalized stage IV had significantly higher HbA1c than all other stages (all p-values <0.001), with mean differences of 0.95-2.47%. Localized stages II and III showed considerably lower values versus advanced stages. Generalized stage II versus localized stage III (p=0.314) and generalized stage III versus localized stage IV (p=0.566) were not significant.

Post-hoc Tukey HSD testing confirmed that all pairwise comparisons were statistically significant. Grade B had significantly higher HbA1c than Grade A (mean difference: 0.91%, p=0.001), Grade C was substantially higher than Grade A (mean difference: 2.39%, p<0.001), and Grade C was significantly higher than Grade B (mean difference: 1.47%, p<0.001).

Mean HbA1c levels differed significantly across periodontitis grades (p=0.01). Grade A patients had the lowest mean HbA1c at 4.88±0.56% (range: 4.00-6.60%), Grade B showed intermediate levels at 5.80 ± 0.59% (range: 4.20-6.90%), and Grade C demonstrated the highest at 7.28±1.37% (range: 5.80-13.00%). (Table 3)

Table 3: Comparison of mean HbA1c (%) across periodontitis grades (One-Way ANOVA)

Stages	n	Mean	SD	Minimum	Maximum
Grade A	188	4.88	0.56	4	6.60
Grade B	136	5.80	0.59	4.20	6.90
Grade C	26	7.28	1.37	5.80	13
Total	350	5.42	.95	4	13
P value					0.001*

*Statistically significant, ANOVA test applied

Multivariate linear regression analysis with HbA1c as the dependent variable identified significant predictors. Probing depth (B=0.16, p<0.001) indicated each millimeter increase was associated with a 0.161% HbA1c rise. Plaque index (B = 0.353, p < 0.001) indicated that poorer oral hygiene significantly elevated HbA1c levels. Age showed a positive association (B=0.030, p<0.001), with a 0.030% increase in HbA1c per year. The Gingival Index showed a significant negative association (B = -0.206, p = 0.029), possibly reflecting complex inflammatory dynamics. Clinical attachment loss (B=0.041, p=0.146) and gender (B=-0.065, p=0.429) were not significant.

Discussion

This study assessed the glycemic parameters (fasting, postprandial blood sugar, HbA1c) of patients with periodontitis. Among 350 periodontitis patients, the majority, 219 (62.60%), had normal glycemic levels, and more than one-third, 131 (37.40%), had either pre-diabetes or diabetes, highlighting the significant association between periodontal disease and impaired glucose metabolism. Periodontal inflammation can affect the glycemic control by increasing insulin resistance. Inflammatory cytokines can affect insulin signaling pathways, which worsens blood glucose levels and complicates diabetes management.[15]

In this study, generalized stage 2 periodontitis has a normal glycemic status compared to generalized stage 4 periodontitis. Also, the progression of periodontitis staging showed significant associations with glycemic status (p=0.001), which demonstrates that poor glycemic control is associated with periodontitis severity. Our finding is consistent with studies on the Indian Gila River population, where severe periodontal disease patients had poorer glycemic control after 2 years of follow-up when compared to patients without periodontal disease or with mild periodontal disease.[9] Studies have also showed that the extent of periodontal disease and severity are directly associated with poor glycemic control.[8,9]

This study revealed highly significant differences in mean HbA1c levels across periodontitis stages (p=0.00). Localized stage II showed the lowest mean HbA1c at 4.96 ± 0.41% (range: 4.00-5.60%), while generalized stage IV demonstrated the highest at 7.00 ± 1.25% (range: 5.50-13.00%). Our finding is consistent with that of Sanz m et al., where changes in HbA1c were assessed in a prospective 5-year study of 2973 non-diabetic individuals and concluded that participants with the most advanced periodontitis demonstrate approximately a five-fold absolute increase in HbA1c compared to those without Periodontitis (change in HbA1c 0.106±0.03% vs 0.023±0.02%).[10] However, in the present study, periodontally healthy patients were not included.

The multivariate linear regression analysis with HbA1c as the dependent variable identified probing depth as a significant positive predictor (B = 0.161, p < 0.001). This indicates that each millimeter increase in pocket depth was associated with a 0.161% increase in HbA1, which is consistent with the analysis by Wolf et al. This revealed that significantly increased HbA1c levels were observed among periodontitis patients compared to periodontally healthy controls, even after controlling for potential confounding factors (between-group difference,0.21%; p=0.046).[16]

In our study, the Post Hoc Tukey HSD test confirmed that all pairwise comparisons were statistically significant. showing a direct relationship between the rate of periodontal disease progression and glycemic control. A possible reason could be that bacteria or bacterial products, like lipopolysaccharides, may enter into the general circulation through the ulcerated periodontal pocket, and locally produced cytokines can result in persistent low-grade inflammation and insulin resistance.[17]

Plaque index was also a significant positive predictor (B=0.353, p<0.001), suggesting that poorer oral hygiene significantly contributes to elevated HbA1c levels. Since plaque is the main etiology for chronic periodontitis, continued accumulation of plaque favors pocket formation, resulting in a hyper-inflammatory state leading to insulin resistance which might be the possible explanation for this significant finding.[18] Similarly the National Health and Nutrition Examination Survey (NHANES) III found a linear relationship between the periodontal disease destruction and the severity of insulin resistance.[19]

In our study, age showed a significant positive association (B=0.030, p<0.001), with HbA1c increasing by 0.030% for each year of age, which is supported by Wu et al., who found that the number of red blood cells decreased with age, which leads to a prolongation of RBC lifespan and an increase in HbA1c levels.[2]

The significant finding of this study was progressive increase in HbA1c with advancing periodontitis grade

the possible molecular explanation could be that NF-α, IL6, and IL1 are the main periodontal disease inflammatory mediators, which affect metabolism of glucose and lipid, mostly after an acute infectious challenge or trauma.[21-23] Another mechanism of insulin resistance can be inflammatory kinase IKK-β, which through direct serine phosphorylation of IRS-1 and phosphorylation of the NF-Kβ inhibitor increase several inflammatory mediators which inhibits serine phosphorylation of IRS-1 and translocation of the glucose transporter (GLUT 4).[24,25]

Our study suggested that close collaboration between a physician and a dental surgeon could play a pivotal role in the prevention of complications of DM and the maintenance of periodontal health.

The limitations of the study are that periodontally healthy individuals were not included, and glycemic parameters following periodontal therapy were not investigated, which could have shown a bidirectional relationship between periodontitis and glycemic levels.

Conclusions

Glycemic parameters were higher in patients with periodontitis. The study showed a significant correlation between the severity of periodontitis and poor glycemic control. So, they are advised to monitor glycemic parameters to enable the timely diagnosis of DM and prevent diabetic complications. Further studies are recommended to show the bidirectional relationship between Periodontitis and Diabetes Mellitus.

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