ORIGINAL ARTICLE

Periodontal Disease in Type 2 Diabetes Mellitus

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ABSTRACT

Objective: To determine the periodontal status in well controlled and poorly controlled type 2 diabetic patients compared with normal healthy individuals.

Study Design: Cross-sectional comparative study.

Place and Duration of Study: Diabetes Management Centre, Services Hospital, Lahore, from November 2009 to January 2010.

Methodology: Forty well controlled and forty poorly controlled type 2 diabetic subjects having good oral hygiene (scored according to simplified oral hygiene index) were compared with a control group of forty normal healthy individuals. Probing depth (PD), gingival recession (GR), and attachment loss (AL) were recorded to obtain the periodontal status of each tooth, using a Michigan probe "0" with Williams marking. Glycemic control was evaluated by glycated Hb value. Using ANOVA and independent sample t-test, mean probing depth and attachment loss in each tooth type (incisors, canines, premolars and molars) were compared.

Results: Mean age of diabetic subjects was 58.86 ± 6.21 years and that of control group was 56.92 ± 6.91 years; 60% were females. Probing depth was greater in patients with poorly controlled diabetes compared to well controlled diabetic patients and non-diabetic controls (4.21 mm vs. 3.72 mm and 2.93 mm respectively, $p < 0.001$). Attachment loss also increased in poorly controlled diabetes ($p < 0.001$) compared to the control group and well controlled diabetes, however, the difference was not statistically significant when comparing well controlled to the control group ($p > 0.05$). Number of sites and mean percentage of sites with attachment loss of ≥ 4 and ≥ 6 mm was also significantly higher in poorly controlled diabetes compared to the control group ($p < 0.05$ and $p < 0.001$ respectively).

Conclusion: Periodontal status as estimated by probing depth and degree of attachment loss deteriorates significantly with poor glycemic control in diabetes.

Key words: *Type 2 diabetes mellitus. Gingivitis. Probing depth. Attachment loss. Glycemic control. Oral hygiene.*

INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by hyperglycemia due to defective secretion or activity of insulin.[1] Chronic hyperglycemia results in production of advanced glycation end substances (AGEs) in the tissues, which have protean effects on the periodontal microenvironment.[2] The primary reparative cells in the periodontium, the fibroblasts, are not able to repair the damaged collagen because of binding with AGEs in high glucose environment, thus leading to delayed wound healing.[3] In the periodontium, AGEs cause bone resorption and break down of collagen fibers which leads to weakening of periodontal support and tooth mobility.[4]

Host-microbial interaction in periodontal tissues results in release of matrix metalloproteinases (MMPs), tumour necrosis factor (TNF) also results in build-up of oxidative stress. Diabetes is in itself a pro-inflammatory condition, with elevated levels of inflammatory cytokines and reactive oxygen species (ROS) and thus exacerbates the inflammation which is characteristic of periodontitis.[5] Smoking is yet another factor which can affect the severity of periodontitis and bone loss concomitantly.[6,7] About 6-10% of middle aged diabetic patients have been shown to have moderate form of periodontal disease in Pakistan.[8]

Gingivitis causes bleeding on probing, whereas periodontal attachment loss, which is considered to be the hallmark character of periodontitis, may or may not be accompanied by pathological pocket formation and gingival recession. A recent study in which probing depth and attachment loss was measured separately for each tooth has revealed the pattern of periodontal disease progression in a general population of young healthy adults.[9] To the best of our knowledge, a similar detailed assessment of attachment loss and probing depth in each tooth type is still deficient in type-2 diabetic patients in the Pakistani population. Although prior studies conducted in other population groups have revealed a significant impact of glycemic control on the severity of periodontitis in diabetics, these have overlooked confounding factors such as smoking habit and poor oral hygiene status, while determining the severity of effect of poorly controlled diabetes on periodontium.[10]

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The present study aimed to address this deficiency by excluding these confounding factors, with the aim of assessing the severity of periodontal disease in each tooth, in both well-controlled and poorly controlled diabetic patients, as well as in a control group of normal healthy volunteers.

METHODOLOGY

The study was conducted at Diabetes Management Centre, Services Hospital, Lahore, from November 2009 to January 2010 following a verbal and written explanation of the study to the patients who gave written informed consent for participation in the study. The study was conducted in accordance with the ethical guidelines set out in the Declaration of Helsinki and all clinical procedures were approved by the Institutional Review Board, Services Hospital, Lahore.

The study population consisted of type 2 diabetic patients and healthy, non-diabetic volunteers. Patients with a glycated haemoglobin (HbA_1C) level < 7 were considered to have well controlled diabetes and while those with HbA_1C level > 7 were considered to have poorly controlled diabetes. A control group of healthy age and gender matched, non-diabetic individuals, was also included for comparison. An equal number of patients, (n = 40) were selected in all the categories, making up the total number of patients to 120. The inclusion criteria were as follows: type 2 diabetic subjects with a diabetes duration greater than 5 years, and age and gender matched non-diabetic controls, with good oral hygiene status (OHI-S score less than 1.7), maximum of three missing teeth in each arch excluding third molars. Exclusion criteria were pregnancy, smoking (current smokers or with history of smoking in the past 2 years), eating *betel nut* and *quid*, intake of medicines causing gingival enlargement (calcium channel blockers, phenytoin and cyclosporine). Patients having retained roots and periodontal abscess were also excluded.

Clinical examination of all the patients was done by a single trained examiner. In the present study, clinical examination of all the teeth excluding third molars was done and value of each recorded parameter of every tooth was obtained, which was then divided by the number of teeth examined to get the mean value for that individual. Severity of gingivitis was evaluated by periodontal probe (Michigan probe 0 with William's marking) using gingival index (GI) as described by Loe and Silness.[11] Gingival index score was rated as mild (0.1-1.0), moderate (1.1-2.0) or severe (2.1-3.0).[12] Pocket depth (PD) was measured at six sites per tooth (all proximal, buccal and lingual). Gingival recession (GR) was recorded from free gingival margin to (CEJ) at mid-buccal and mid-lingual sites only. Negative value was recorded when gingival margin was present ≥ 1 mm coronal to CEJ. Periodontal attachment loss (AL) was assessed by adding the mean gingival recession (mm) and the probing depth (mm). Present study employed the recording of gingival recession and attachment loss at 2 sites (mid-buccal and mid-lingual) per tooth which was similar to the methodology adopted by Rocha *et al*.[13] All the measurements were rounded to the smaller whole number. Oral hygiene was recorded using simplified oral hygiene index (OHI-S) (proposed by Greene and Wermillion) for the purpose of inclusion or exclusion from the study, wherein a value less than 1.7 represents good oral hygiene.[14]

Glycemic control in diabetic subjects was assessed by HbA_1C (Roche-diagnostic, Basel, Switzerland). Blood samples were processed in the laboratory of Services Hospital, Lahore for HbA_1C evaluation. In order to remove bias, the clinician evaluating the periodontal status was kept unaware of both the fasting blood glucose (FBG) as well as the HbA_1C value while taking the measurements. Similarly, the laboratory investigator was also not provided any information regarding the periodontal status. HbA_1C values were divided into well controlled (< 7.0%) and poorly controlled (> 7.0%). FBG test was done for normal healthy volunteers. Control group was considered having FBG value < 120.

Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 17. For each tooth type, mean probing depth (PD) and attachment loss (AL) were compared in the control group, well controlled and poorly controlled diabetic groups using ANOVA. Independent sample t-test was also used to compare the control group and well-controlled diabetes; control group and poorly controlled diabetes; and well-controlled and poorly controlled diabetes. Prevalence of attachment loss was calculated as an absolute value as well as a percentage, whereas the extent of attachment loss of ≥ 4 and ≥ 6 mm was compared in each group using ANOVA and independent sample t-test. Severity of gingivitis and glycemic level was analyzed by chi-square to evaluate significance. A p-value < 0.05 was considered statistically significant for all analysis.

RESULTS

A total of 120 patients were included in the study according to the inclusion and exclusion criteria. The mean age in control group, well controlled and poorly controlled group were 56.92 ± 6.91, 58.22 ± 6.68, 59.50 ± 5.74 respectively (p = 0.21). There were 25 (62.5%), 23 (57.50%) and 24 (60%) females in the three groups, respectively.

Severity of gingivitis as evaluated by gingival index showed that 23 patients (19.16%) had mild, 38 had moderate (31.66%) and 59 had severe (49.16%) gingivitis. Mean gingival index score was 1.98 ± 0.70. An insignificant association (p = 0.079) was found between HbA_1C level and severity of gingivitis, in the mild -

moderately severe category of gingivitis, however severe gingivitis was significantly associated with increasing HbA_1C level (p = 0.012).

Worsening glycemic control had a significant detrimental influence on probing pocket depth (p < 0.05). Comparative results showed that patients with poorly controlled diabetes had worse periodontal condition than well controlled diabetes (Table I and II). Similarly, attachment loss was significantly greater in poorly controlled diabetes compared to control group as well as well controlled diabetes (p < 0.01); however, the difference was not significant between control group and well controlled diabetes (p > 0.05, Table III and IV).

In order to calculate the number of sites having moderate-severe periodontitis, we divided these into groups with ≥ 4 mm and ≥ 6 mm attachment loss. The number of sites with ≥ 4 mm attachment loss in control group, well controlled diabetes, poorly controlled diabetes were 1026 (47.72%), 1262 (63.10%), 1146 (59.68%) respectively, and having ≥ 6 mm attachment loss were 190 (8.83%), 410 (20.50%), 744 (38.75%) respectively.

Table I: Analysis of probing depth (PD) in each tooth type with relation to glycemic level.

Tooth type	Control group	Well controlled glycemic level	Poorly controlled glycemic level	F value in ANOVA	p-value
Max. Incisors	2.70 ± 0.90	3.53 ± 0.86	3.92 ± 0.98	18.49	< 0.001
Max. Canines	2.89 ± 0.82	3.55 ± 0.81	3.93 ± 0.95	14.71	< 0.001
Max. Premolars	2.97 ± 0.68	3.79 ± 0.97	4.34 ± 1.31	18.07	< 0.001
Max. Molars	3.1 ± 0.58	3.86 ± 0.91	4.41 ± 1.28	17.70	< 0.001
Mand. Incisors	2.77 ± 0.86	3.76 ± 0.93	4.27 ± 1.17	23.30	< 0.001
Mand. Canines	2.84 ± 0.65	3.76 ± 0.95	4.27 ± 1.25	21.43	< 0.001
Mand. Premolars	3.01 ± 0.59	3.74 ± 0.88	4.24 ± 1.21	17.71	< 0.001
Mand. Molars	3.18 ± 0.53	3.78 ± 0.89	4.37 ± 1.25	15.75	< 0.001

n = 120, Forty in each group. Groups were matched for age and gender. Max = Maxillary; Mand = Mandibular.
Normal glycemic level (FBS < 120), well controlled glycemic level ($HbA_1C \leq 7$), poorly controlled glycemic level ($HbA_1C > 7$). p-value of < 0.05 considered as significant.

Table II: Analysis of probing depth (PD) within groups.

Tooth type	t-value between control group and well controlled glycemic level	p-value	t-value between control group and poorly controlled glycemic level	p-value	t-value between well controlled and poorly controlled glycemic level	p-value
Max. Incisors	-4.18	< 0.001	-5.80	< 0.001	-1.91	0.059
Max. Canines	-3.62	0.001	-5.20	< 0.001	-1.89	0.062
Max. Premolars	-4.35	< 0.001	-5.83	< 0.001	-2.13	0.036
Max. Molars	-4.33	< 0.001	-5.76	< 0.001	-2.18	0.032
Mand. Incisors	-4.91	< 0.001	-6.51	< 0.001	-2.15	0.035
Mand. Canines	-4.97	< 0.001	-6.37	< 0.001	-2.04	0.044
Mand. Premolars	-4.35	< 0.001	-5.77	< 0.001	-2.10	0.038
Mand. Molars	-3.62	0.001	-5.48	< 0.001	-2.39	0.019

Normal glycemic level (FBS < 120), well controlled glycemic level ($HbA_1C \leq 7$), poorly controlled glycemic level ($HbA_1C > 7$).
(-) minus sign in all the t-test values indicates that mean was higher in the second independent variable. p-value of <0.05 considered as significant.

Table III: Analysis of severity and extent of attachment loss (AL) in each tooth type with relation to glycemic level.

Tooth type	Control group	Well controlled glycemic level	Poorly controlled glycemic level	F value in ANOVA	p-value
Max. Incisors	3.82 ± 0.67	4.14 ± 0.92	4.74 ± 0.66	14.75	< 0.001
Max. Canines	3.89 ± 0.93	4.19 ± 0.89	4.79 ± 0.98	9.65	< 0.001
Max. Premolars	3.99 ± 0.97	4.31 ± 0.92	5.08 ± 0.95	13.67	< 0.001
Max. Molars	4.05 ± 1.02	4.40 ± 0.90	5.31 ± 0.93	18.55	< 0.001
Mand. Incisors	4.08 ± 0.94	4.37 ± 0.93	5.08 ± 0.96	11.70	< 0.001
Mand. Canines	4.05 ± 0.87	4.28 ± 0.92	5.14 ± 0.85	16.77	< 0.001
Mand. Premolars	4.03 ± 0.94	4.30 ± 0.92	5.13 ± 1.00	14.10	< 0.001
Mand. Molars	4.07 ± 0.89	4.41 ± 0.89	5.31 ± 0.94	19.84	< 0.001
Extent of periodontal disease					
Mean % of sites with ≥ 4 mm AL	19.84 ± 13.50	23.51 ± 17.10	35.03 ± 22.37	7.73	0.001
Mean % of sites with > 6 mm AL	3.43 ± 2.91	7.13 ± 5.95	20.92 ± 15.13	37.36	< 0.001

Normal glycemic level (FBS <120), well controlled glycemic level ($HbA_1C \leq 7$), poorly controlled glycemic level ($HbA_1C > 7$).
Buccal and lingual sites of each tooth except 3rd Molars were measured (Maximum sites per individual=56)
Maximum sites measured were 2150 in forty patients of control group
Maximum sites measured were 2000 in forty patients with well controlled glycemic level
Maximum sites measured were 1920 in forty patients with poorly controlled glycemic level
p-value of <0.05 considered as significant

Table IV: Analysis of attachment loss (AL) within groups.

Tooth type	t-value between control group and well controlled glycemic level	p-value	t-value between control group and poorly controlled glycemic level	p-value	t-value between well controlled and poorly controlled glycemic level	p-value
Max. Incisors	-1.74	0.086	-6.10	< 0.001	-3.31	0.001
Max. Canines	-1.49	0.138	-4.21	< 0.001	-2.85	0.006
Max. Premolars	-1.50	0.136	-5.01	< 0.001	-3.63	< 0.001
Max. Molars	-1.62	0.109	-5.74	< 0.001	-4.44	< 0.001
Mand. Incisors	-1.35	0.180	-4.66	< 0.001	-3.35	0.001
Mand. Canines	-1.15	0.252	-5.63	< 0.001	-4.29	< 0.001
Mand. Premolars	-1.29	0.198	-5.01	< 0.001	-3.80	< 0.001
Mand. Molars	-1.69	0.094	-6.04	< 0.001	-4.39	< 0.001
Extent of periodontal disease						
Mean % of sites with ≥ 4 mm AL	-1.06	0.289	-3.67	< 0.001	-2.58	0.012
Mean % of sites with > 6 mm AL	-3.53	0.001	-7.17	< 0.001	-5.36	< 0.001

Normal glycemic level (FBS < 120), well controlled glycemic level ($HbA_1C \leq 7$), poorly controlled glycemic level ($HbA_1C > 7$)
Buccal and lingual sites of each tooth except 3rd Molars were measured (Maximum sites per individual = 56)
Maximum sites measured were 2150 in forty patients of control group
Maximum sites measured were 2000 in forty patients with well controlled glycemic level
Maximum sites measured were 1920 in forty patients with poorly controlled glycemic level
(-) minus sign in all the t-test values indicates that mean was higher in the second independent variable.
p-value of <0.05 considered as significant

Extent of attachment loss (as indicated by mean percent sites respectively with AL of ≥ 4 and ≥ 6 mm) was also significantly higher ($p < 0.05$) in poorly controlled diabetics. (Tables III and IV).

DISCUSSION

Differences in cultural, socioeconomic, dietary and oral hygiene practices in a given population affect the burden of oral diseases including periodontal disease[15] which makes one set of population different from the other. In a study conducted in Pakistan, diabetic patients with poor oral health were shown to have an increased severity of periodontal disease.[10] Assessment of periodontitis in type 2 diabetic patients with good oral hygiene in a Pakistani population is not yet unequivocally documented; this lacuna in knowledge prompted the present research.

In order to ascertain how the severity of periodontal disease is affected by glycemic level, an analysis of the relationship of probing depth (PD) and attachment loss (AL) in each tooth type, with the glycated haemoglobin level ($HbA_1C < 7$ and > 7) was done in comparison with the control group. Results obtained from the present study are comparable to the results reported by Thomson *et al*., in their study conducted in a general population of healthy adults.[9] In both the studies, probing depth and attachment loss were more in posterior teeth. A noteworthy finding was the insignificant difference in mean percent sites with AL between the control group and well controlled diabetes group ($p > 0.05$), conversely the poorly controlled diabetes group had higher ($p < 0.05$) mean percent sites AL than the other two groups. Periodontal PD was significantly higher in the well controlled diabetic group and poorly controlled diabetes ($p < 0.05$) than the control group. A study conducted in Sri Lankan urban population of type 2 diabetes,[16] illustrated that percentage of sites of 4 mm and 5 mm PD were significantly higher ($p < 0.01$) in diabetic group; however, percentage of sites with 3 mm and 4 mm AL were insignificantly ($p > 0.05$) higher in the diabetic subjects. Comparing with the above study, it can be inferred that periodontal inflammation gets worse even in well controlled diabetes; however, AL gets affected largely with the poorly controlled diabetes.

The association of diabetes and periodontal inflammation is the subject of several studies with variable results, perhaps due to differences in methodology.[16-20] Research studies in type 2 diabetes by Preshaw *et al*., Silvestre, Campus and Firatli have shown a positive association between severity of periodontal disease and glycemic control.[16-19] Contrary to these results, Ueno[20] were unable to show a significant association of type 2 diabetic subjects compared to controls. Considering the available data, the sample population in above mentioned studies was not categorized according to oral hygiene. Poor oral hygiene has been associated with periodontal attachment loss and missing teeth in a diabetic sample in Pakistan.[10] The present study revealed the findings of periodontal disease status in diabetic patients with good oral hygiene only. Furthermore, the tooth specific results delineate the extent and severity of attachment loss in different regions of oral cavity.

Increase in AL with the increase in glycemic level as shown in our results implies that poorly controlled diabetes does modify the extent and severity of advanced periodontal disease. This conclusion is in fact not new, but most of the studies which have shown the positive association between glycemic control and periodontal disease have not excluded the confounding factors, most important of which is smoking and poor

oral hygiene. Secondly, most of the studies have presented their results in the form of collective mean or total percentage of each periodontal disease parameter, however, in the present study; disease status in every tooth was recorded separately. Results of individual tooth analysis of periodontal status strengthen the evidence that glycemic control is a significant risk factor in causing advanced periodontal disease even after matching age in the studied groups and excluding the role of poor oral hygiene and smoking.

Recommendations: There is a need to carry out similar studies involving individual tooth analysis of periodontal disease in type 1 diabetics as well, because type 1 diabetes tends to affect younger individuals, with different dentition, and hence its impact on oral health may be different.

With the increasing evidence of affects of poor glycemic control on periodontal condition, the physicians and dentists should work in close liaison to give a prompt and a comprehensive management plan to diabetic patients.

CONCLUSION

Periodontal status as estimated by probing depth and degree of attachment loss deteriorates significantly with poor glycemic control in diabetes.

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