ISSN: 3062-3405

Annals of Orthodontics and Periodontics Specialty
Volume 3, Page No: 19-27
Available Online at: aopsj.com

Cross-Sectional Study

Evaluating Periodontal Health in Type 2 Diabetics with Chronic Complications

Magdalena Kiedrowicz[1*], Elżbieta Dembowska[1], Jadwiga Banach[1], Krzysztof Safranow[2], Sławomir Pynka[3]

1. Department of Periodontology, Pomeranian Medical University, Szczecin, Poland.
2. Department of Biochemistry and Medical Chemistry, Pomeranian Medical University, Szczecin, Poland.
3. Diabetes Outpatient Clinic, M. Curie Hospital, Szczecin, Poland.

***E-mail** ✉ mmadziam@wp.pl

Abstract

Diabetes mellitus micro and/or macrovascular complications are associated with persistent hyperglycemia. Diabetes and periodontitis have a reciprocal relationship, and they are both characterized by inflammation. The purpose of this study was to investigate the relationship between the severity of periodontal disease and the quantity of periodontal tissue damage in type 2 diabetics about the number of chronic vascular problems. 127 individuals with type 2 diabetes who experienced at least one chronic consequence of their diabetes were included in this cross-sectional study. Patients with different vascular complications were compared in terms of the degree of periodontitis, gingival inflammation, and damage to periodontal tissue. In addition, we examined the severity of periodontitis and its associated periodontal characteristics based on the levels of glycaemic control and the existence of macrovascular problems. Individuals with three or four diabetic vascular complications had significantly higher periodontal disease severity and all periodontal clinical parameters than individuals with fewer complications. The severity of periodontitis in patients without macrovascular problems was significantly lower than in patients with macrovascular complications ($P < 0.05$). Patients with poor glycaemic control had worse gingival inflammation, but PD and CAL were not statistically different. Our results showed that the severity of periodontal disease increased as the number of chronic complications associated with diabetes increased. While the amount of periodontal tissue damage remained constant, the degree of gingival inflammation increased with poor glycaemic management.

Key words: Type 2 diabetes, Periodontitis, Diabetic complications, Inflammation

How to cite this article: Kiedrowicz M, Dembowska E, Banach J, Safranow K, Pynka S. Evaluating Periodontal Health in Type 2 Diabetics with Chronic Complications. Ann Orthod Periodontics Spec. 2023;3:19-27. https://doi.org/10.51847/axdaRLPSoJ

Received: 23 April 2023; **Revised:** 27 August 2023; **Accepted:** 01 September 2023

Introduction

The hallmark of diabetes is hyperglycemia, which results from malfunctions in the processes of insulin metabolism [1-3]. Chronic hyperglycemia, dyslipidemia, and oxidative stress can cause long-term organ damage and dysfunction [4]. In patients with type 2 diabetes, inadequate glycaemic control over time results in macrovascular problems (arrhythmia, cardiomyopathy, cerebrovascular disease, peripheral and coronary artery disease, neuropathy, diabetic retinopathy, and nephropathy) as well as microvascular problems (peripheral and coronary artery disease). In individuals with diabetes mellitus, cardiovascular illnesses are the leading cause of death. According to reports, pathogenic pathways like insulin resistance and hyperglycemia are how type 2 diabetes leads to macrovascular problems [5]. Diabetes develops as a result of steadily increasing chronic

inflammation linked to endothelial dysfunction and atherosclerogenesis. Chronic inflammation is a hallmark of the emergence of diabetes complications. Clinical studies have demonstrated that diabetes patients have higher levels of circulating inflammatory markers. These blood indicators are predictive of the onset and course of problems from diabetes [6]. Bacteria and their byproducts in dental plaque are the main cause of periodontitis, a chronic, infectious illness marked by the inflammatory loss of supporting periodontal tissues [7]. Diabetes and periodontitis are directly connected. Both conditions are characterized by inflammation, and diabetes people have an elevated inflammatory process in their periodontal tissues [8]. According to studies, individuals with diabetes mellitus have a 2-3 times higher frequency of periodontal disease [9]. The severity of periodontal disease is particularly higher in those with poor metabolic control who have had diabetes for a long time [10]. Currently, periodontitis is regarded as the sixth consequence of diabetes [11]. In addition to the known negative consequences of diabetes on periodontal health, periodontal disease impairs glycaemic control in diabetics. In diabetic individuals with periodontitis, glycaemic control deteriorates as a result of an increase in the host inflammatory response brought on by the release of proinflammatory cytokines into the bloodstream [12]. Periodontal infections may raise the risk of diabetes complications, according to current research [13]. Research has shown a correlation between the severity of periodontitis and the prevalence and severity of diabetes consequences in extra-oral tissues, including diabetic neuropathy [14], nephropathy [15], retinopathy [16], and cardiovascular problems [17]. Few studies, meanwhile, evaluate the relationship between periodontal health and all microvascular problems [18]. Our study's objective is to find out how severe periodontal disease is in people with long-term diabetes who have experienced one or more diabetes-related vascular problems.

Materials and Methods

The study was conducted in compliance with the Declaration of Helsinki and was approved by the Pamukkale University Ethics Committee under protocol number 60116787-020/62180. A total of 127 patients who had been diagnosed with type 2 diabetes for more than five years and were experiencing chronic complications related to the disease were selected from patients who were seen in the outpatient clinic at the Department of Endocrinology at Pamukkale University Hospital. The thorough anamnesis form contained the patient's demographic information, including age, gender, body mass index (BMI), waist circumference, smoking status, and length of diabetes. Patients were categorized as overweight or obese based on their waist circumference. The study excluded edentate patients and those with diabetes diagnosed during the previous five years. In addition, participants who had previously received periodontal treatment were pregnant or nursing, or reported using medications that could impact periodontal health were not allowed to participate. Every participant provided written informed permission.

Diagnosis of diabetic microvascular and macrovascular complications

Retinopathy, nephropathy, and neuropathy were taken into consideration for microvascular problems, whereas the existence of peripheral arterial, cerebrovascular, and atherosclerotic cardiovascular illnesses was assessed as macrovascular complications.

Ophthalmoscopy in dilated pupils was used to look for microvascular abnormalities in the retina, such as microaneurysms, hemorrhage, hard exudates, and newly developed weak blood vessels, to diagnose retinopathy. Microalbuminuria from the early morning voids (albumin/creatinine $\geq$ 30 mg/gr) was used to diagnose diabetic nephropathy. If the patient experienced clinical abnormalities of vibration and a loss of motor and superficial deep sensation, neuropathy was noted [19]. The patient's medical records were searched for information on their history of atherosclerotic cardiovascular disease, glycosylated hemoglobin level (HbA1c), total cholesterol (TC), LDL, and HDL cholesterol levels. There were three levels of glycaemic control: good for HbA1c < 7%, fair for HbA1c $\cong$ 7 to $\gtrsim$ 8%, and bad for HbA1c $\gtrsim$ 8 [20].

Table 1. Demographic characteristics of the study population

Characteristic	Mean± std. deviation / n	Percent (%)
Age (years)	59.29 ± 11.91	
Gender (female/male)	73/54	57.5/42.5

BMI		
Female	31.85 ± 0.7	
Male	30.15 ± 0.6	
Waist circumstance		
Normal weight	9	7.1
Female overweight/obese	22/49	17.3/38.6
Male overweight/obese	23/24	18.1/18.9
Smoking		
Smoker/non-smoker	16/111	12.6/87.4
Length of diabetes diagnosis		
5-10 years	34	26.8
> 10 years	93	73.2
HbA1c (mmol/mol)	8.18 ± 1.64	
Glycemic control		
Good (< 7 mmol/mol)	29	22.8
Fair (7-8 mmol/mol)	46	36.2
Poor (≥ 8 mmol/mol)	52	40.9
Total cholesterol (mg/dl)	185.81 ± 42.79	
HDL cholesterol (mg/dl)	47.94 ± 12.97	
Microvascular complications		
Neuropathy	29	22.8
Retinopathy	22	17.3
Nephropathy	10	7.9
Neuropathy + Retinopathy	25	19.7
Neuropathy + Nephropathy	9	7.1
Retinopathy + Nephropathy	15	11.8
Neuropathy + Retinopathy + Nephropathy	17	13.4
The number of chronic complications		
1	34	26.8
2	43	33.9
3	37	29.1
4	13	10.2
Macrovascular complication		
(+/-)	73/54	57.5/42.5
Periodontitis severity		
Stage 1	4	3.1
Stage 2	55	43.3
Stage 3	59	46.5
Stage 4	9	7.1

Periodontal assessment

The same examiner (GTC) conducted all periodontal and radiographic measurements of the patients. The Williams periodontal probe was used to measure periodontal parameters, including gingival index (GI), plaque index (PI), probing depth (PD), bleeding on probing (BOP), and clinical attachment level (CAL). The current number of teeth was noted. Plaque index and gingival index were assessed at four surfaces per tooth while probing depth and clinical attachment level were computed at six surfaces per tooth. Clinical periodontal measures and panoramic radiographs were used to assess the severity of periodontitis [21].

Data processing and statistical analyses

Version 22 of the Statistical Package for the Social Sciences (SPSS) was used to analyze the data. Categorical variables were represented by numbers and percentages, whereas continuous variables were represented by mean and standard deviation. The data's normality was examined using the Shapiro-Wilk test. Both the Mann-Whitney U-test and the Kruskal-Wallis test were used to analyze statistical significance between groups. The differences between categorical variables were examined using Pearson chi-square analysis. The threshold for statistical significance was set at $P \leq 0.05$.

Results and Discussion

127 patients with type 2 diabetes who had at least one of the diabetic microvascular complications were included in this study. **Table 1** displays the participants' demographic information. About 75% of the individuals had been diagnosed with diabetes for more than ten years. 41% of patients had inadequate glycemic control. Ten participants (7.9%) had nephropathy, 29 participants (22.8%) had neuropathy, and 22 participants (17.3%) had retinopathy. In 66 patients, at least two microvascular problems were found (52%).

Of the study population, 57.5% of patients had macrovascular diabetes complications. Stage 3 and stage 4 severe periodontitis was present in sixty-eight (53.6%) of the individuals. **Table 2** summarises the number of teeth and the distribution of periodontal characteristics based on diabetic problems. The more chronic diabetes-related issues there were, the fewer teeth there were.

Table 2. Clinical periodontal parameters are distributed based on the consequences of diabetes.

Characteristic	The number of micro and macrovascular complications				p-value	Macrovascular complication		P-value
	1	2	3	4		+	–	
The number of present teeth	$23.3 \pm 3.4^{*}$	$22.6 \pm 3.3^{\#}$	$19.7 \pm 5.6^{*\#}$	$19 \pm 6.3^{*\#}$	0.008^{a}	20.9 ± 5.2	22.52 ± 4	0.115^{b}
PI	$1.23 \pm 0.3^{*}$	$1.3 \pm 0.3^{\#}$	$1.54 \pm 0.3^{*\#}$	$1.53 \pm 0.3^{*\#}$	0.000^{a}	1.41 ± 0.3	1.32 ± 0.3	0.131^{b}
GI	$1.56 \pm 0.3^{*}$	$1.63 \pm 0.2^{\#}$	$1.84 \pm 0.2^{*\#}$	$2.06 \pm 0.3^{*\#}$	0.000^{a}	1.78 ± 0.3	1.63 ± 0.3	0.017^{b}
PD	$2.8 \pm 0.3^{*}$	$2.92 \pm 0.4^{\#}$	$3.38 \pm 0.5^{*\#}$	$3.69 \pm 0.7^{*\#}$	0.000^{a}	3.19 ± 0.6	2.98 ± 0.4	0.026^{b}
CAL	$3.07 \pm 0.4^{*}$	$3.15 \pm 0.5^{\#}$	$3.74 \pm 0.5^{*\#}$	$4.09 \pm 0.5^{*\#}$	0.000^{a}	3.49 ± 0.6	3.26 ± 0.5	0.034^{b}
BOP (%)	$77.2 \pm 14.8^{*}$	$76.9 \pm 11.3^{\#}$	$85.3 \pm 15^{*\#}$	$92.8 \pm 11.7^{*\#}$	0.000^{a}	83.1 ± 14.7	78.3 ± 13.6	0.053^{b}

$P < 0.05$ statistical significance, *significantly different from one complication, #significantly different from two complications, a: Kruskal-Wallis test, and b: Mann Whitney U test

Patients with three or four diabetic complications had significantly higher levels of PI, GI, PD, CAL, and the percentage of BOP than those with one or two complications ($P < 0.05$), but there was no difference in the number of teeth or periodontal parameters between those with one or two complications **(Table 2)**. Regarding the occurrence of macrovascular problems, there was no statistically significant difference in periodontal measures such as the number of teeth, BOP%, and PI ($P > 0.05$) **(Table 2)**. Subjects with macrovascular problems had significantly greater rates of GI, PD, and CAL ($P < 0.05$) **(Table 2)**. **Figure 1** displays the severity distribution of periodontitis by the number of problems associated with diabetes. Stage 2 periodontitis was more prevalent in patients with 1 and 2 diabetes complications, but stage 3 periodontitis was frequently found in those with 3 and 4 difficulties. **Figure 2** illustrates the degree of periodontitis when macrovascular problems are present. Compared to patients without macrovascular problems, those with macrovascular complications had more severe periodontitis ($P < 0.05$).

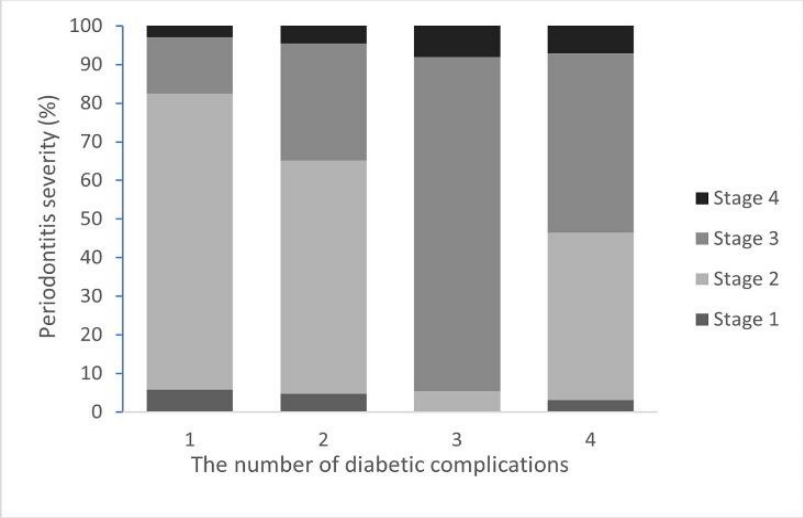

Figure 1. Distribution of periodontitis severity according to the number of diabetic complications

No significant difference was found in the number of teeth compared to glycemic control levels (P > 0.05).

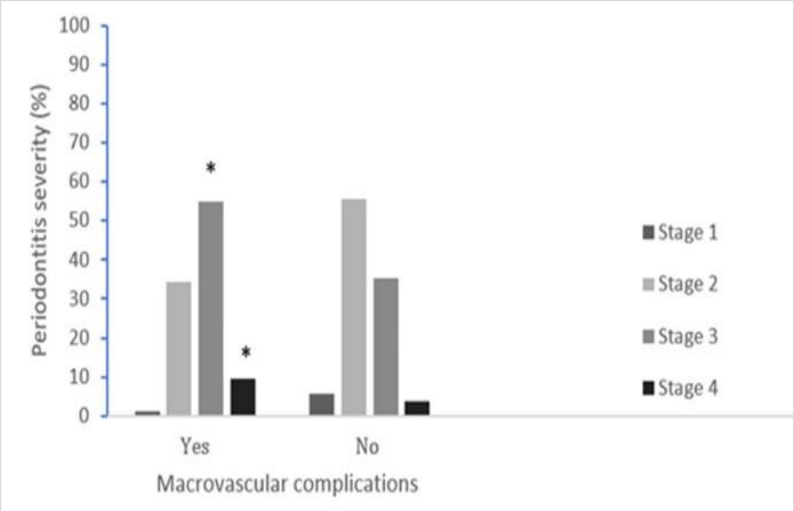

Figure 2. Periodontitis severity according to the presence of macrovascular complications; * P < 0.05 vs patients without macrovascular complications

A statistically significant difference in GI and BOP (%) was seen between those with fair glycaemic control and those with poor glycaemic control (P < 0.05). Higher PD and CAL were noted as glycaemic control deteriorated, but the difference was not statistically significant (P > 0.05).

Our study compared the degree of periodontal inflammation and the severity of periodontitis in a sample of people with type 2 diabetes who had been living with the disease for a long time and had developed several systemic problems. Therefore, in patients with type 2 diabetes, the micro and macrovascular problems that characterize the chronic inflammatory load posed by diabetes were assessed jointly. Full-mouth periodontal measures were used to assess the clinical and radiographic severity of periodontal disease. This study examined periodontal inflammation and alveolar bone loss in individuals with type 2 diabetes who had chronic problems to address the changes in the periodontium caused by both micro and macro-angiopathic abnormalities. The severity of periodontitis was elevated in our research population when various vascular diabetes

complications were present. Additionally, it was discovered that the existence of macrovascular problems exacerbated the deterioration of periodontal tissue. Endothelial dysfunction is the cause of problems in diabetes. The degree of oxidative stress and the rise in glycosylated intermediate proteins both accelerate the damage brought on by glucotoxicity and hyperlipidemia. When overt diabetes is diagnosed, macro and microvascular problems appear in around 30–50% of cases, and the rise in micro and macrovascular injury starts during the prediabetic phase [22]. One of the variables influencing the frequency of microvascular problems is the length of diabetes. About 40% of individuals with diabetes who have had the disease for more than ten years are said to develop nephropathy, while about 70% of patients develop retinopathy [23]. Diabetics have a compromised immunological response. At the site of infection, macrophage, seeding, and opsonization activities are all compromised. Complications arise as a result of systemic diseases' progressive inflammation. Prolonged inflammation triggers the oxidative process, which results in increasing tissue damage that is irreversible. In particular, persistent hyperglycemia has a significant role in the emergence of chronic problems [22]. Intracellular hyperglycemia results from prolonged exposure of cells to high glucose concentrations, especially in vascular cells with a low ability for glucose transport. As a result, endothelial vascular cells are the primary target of hyperglycaemic damage, together with an increase in oxidative stress [24]. The pathophysiology of periodontal disease is similar to that of many chronic diseases, including diabetes, and is typified by an inflammatory host response to bacterial pathogens that accumulate on the surface of the teeth [12]. According to some theories, increased levels of proinflammatory mediators in the bloodstream brought on by periodontal disorders may raise systemic inflammatory loading, impairing diabetics' ability to control their blood sugar levels and potentially resulting in microvascular problems [25]. By triggering the pathways that result in the production of advanced glycation end products, a sustained hyperglycaemic state raises oxidative stress, inflammation, and apoptosis [26]. People who have both diabetes and periodontitis are at a higher risk of problems as a result. According to a summary, there is a connection between the severity of periodontitis and problems from diabetes [12]. Nonetheless, there is evidence that diabetic patients with periodontitis experience more severe diabetes consequences than people without periodontitis [26]. Although there are several contributing factors to the association between periodontitis and other diabetic problems, the hyperglycaemic condition appears to be the primary mechanism. The risk of complications from diabetes is reduced by 25% for every 1% decrease in HbA1c [27]. According to a systematic review that examined research on how periodontal disease affects diabetics' glycaemic control, untreated periodontitis causes diabetes patients' glycaemic control to deteriorate over time [28]. According to a workshop report by the European Society of Periodontology and the International Diabetes Federation, patients with diabetes experienced a 0.27–0.48% drop in their HbA1c levels three months following periodontal therapy [29]. Deepened periodontal pockets are more likely to form in those with diabetes, suggesting a reciprocal link between the two conditions [30]. Blood glucose management has been shown to be useful in improving the healing process of periodontitis, in addition to the beneficial benefits of periodontal therapy on diabetics' glycaemic control [31]. High HbA1c levels may raise the risk of systemic consequences of diabetes in diabetics with periodontitis [32]. In people with severe periodontitis, this risk is 3.2 times greater for cardiorenal mortality, 2.5 times higher for macroalbuminuria, and 3.5 times higher for end-stage kidney disease [33]. Amiri *et al*. [34] discovered a strong correlation between diabetic retinopathy and the degree of periodontitis. Poor glycaemic management has been shown to impact the prevalence and severity of periodontitis, and microvascular problems have been identified as a risk factor for severe periodontitis in people with type 2 diabetes [18]. The risk of periodontitis is 2.43 times higher in people with type 1 diabetes if they have microvascular diabetic problems, but it is 2.48 times higher in people who have both microvascular and macrovascular diabetic issues [35]. Kocher *et al*. found that uncontrolled diabetes influences the evolution of periodontal disease and tooth loss. They also utilized glycated hemoglobin as a continuous criterion to examine whether there is a threshold that results in impaired periodontal repair [36]. Individuals with uncontrolled diabetes comprise 41% of the patients in our study. We found that individuals with many chronic problems of type 2 diabetes had more severe periodontitis, more inflammation of the periodontal tissue, and fewer teeth than patients with one or two diabetic comorbidities. Only periodontal inflammation was found to be related to the degree of glycaemic control. Diabetic individuals have vascular issues in their eyes, kidneys, and nerves, as well as in other organs like the heart. Major cardiovascular problems can be decreased in part by identifying and preventing these issues [5]. In those with diabetes, periodontal disease has been linked to an increased risk of cardiovascular disease and subclinical atherosclerosis [37]. By joining the circulation with inflammatory molecules and associated mediators produced locally in inflamed periodontal tissues, periodontal bacteria, and their byproducts increase the systemic inflammatory burden. The vascular endothelium's

ongoing inflammatory burden from bacteria exacerbates atherogenesis, raising the risk of cardiovascular disease. Circulating levels of oxidative stress indicators, TNF-, and C-reactive protein are statistically higher in diabetes patients with periodontitis; however, following periodontal therapy, these molecules have been shown to significantly decrease [38]. CAL was shown to be the most significant periodontal parameter in terms of the advancement of atherosclerosis in a study examining the connection between periodontal changes and cardiovascular parameters in patients with type 2 diabetes [39]. Diabetic patients with severe periodontitis have a 3.2-fold greater rate of cardiorenal mortality incidence compared to those with mild and moderate forms of the disease [40]. According to our research, cases with macrovascular problems had a considerably higher prevalence of stage 3 and stage 4 periodontitis. This finding indicates that the atherosclerosis process is associated with a higher degree of periodontitis severity.In the current investigation, it was found that the presence of both many microvascular and macrovascular diabetes problems increased the degree of periodontal inflammation and the severity of alveolar bone loss. Our results are crucial in explaining how microangiopathic alterations in the periodontium brought on by chronic diabetes affect the degree of alveolar bone loss. The cross-sectional design of this study, however, means that the findings cannot be used to elucidate the causal relationship between diabetic micro- and macro-angiopathic changes and periodontitis.

Conclusion

In this study, we found that as the number of chronic diabetes-related problems rose, so did the severity of periodontitis. This implies that in diabetic patients with several systemic problems, periodontitis may be a persistent cause of chronic inflammation. In these situations, treating periodontitis may help lower oxidative stress and systemic inflammatory loading. Consequently, it appears that long-term prospective trials are required to examine how periodontal therapy affects diabetic complications.

Acknowledgments: We appreciate the assistance with statistical analyses provided by Hande Senol of the Department of Biostatistics, Faculty of Medicine, Pamukkale University.

Conflict of interest: None

Financial support: None

Ethics statement: The Ethics Committee of Pamukkale University authorized the study's protocol, which was number 60116787-020/62180.

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