Original Article

Relationship between Periodontal Disease and Type 1 Diabetes in Adolescents

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Abstract

Aim: The aim of this study was to evaluate the prevalence and severity of periodontal disease (PD) in adolescents with type 1 diabetes mellitus (DM) and assess the relationship with the clinical and metabolic control of diabetes in adolescents. **Material and Methods:** A descriptive and analytical study was conducted in patients of both sexes who had a definite diagnosis of type 1 DM and diabetes duration of at least 3 years. An odontologist evaluated PD using the American Dental Association criteria. The measured glycosylated hemoglobin (HbA_{1c}) levels revealed an association between PD and the duration and metabolic control of DM. **Results:** One hundred and one patients with an average age of 15.02 ± 1.216 years were studied; 59.4% were female. Adolescents with a shorter diabetes duration (3 to 5 years) had a lower prevalence of PD (65.6% versus 34.4%); and for those with a disease duration > 6 years, stages II-IV PD predominated (56.8%, $p<0.05$). The most severe stages of PD were present in young people with ≥ 9% HbA_{1c} ($p<0.001$). Males had a higher prevalence of PD than females in terms of disease duration and metabolic control of diabetes ($p<0.05$). **Conclusion:** The severity of PD was associated with the duration of diabetes and higher glycemic levels, with worse effects for males than females.

Keywords: Periodontal disease; Type 1 diabetes mellitus: Metabolic control

Introduction

Periodontal disease (PD) is a set of immune and inflammatory conditions of infectious etiology that affect tooth-supporting tissues, such as gums, cementum, periodontal ligament and alveolar bone. [1-4] PD is associated with the presence of microorganisms in the dental plaque attached to the enamel and with the microflora of the gingival sulcus, causing inflammatory lesions that result in the damage and destruction of tooth-supporting tissues. [5-7]

In healthy periodontal tissue, the gums are firm and pale pink in color, do not bleed and cover the entire root of the tooth, stabilizing teeth in conjunction with periodontal ligament fibers. [8,9]

In gingivitis, dental plaque and tartar cause gingival irritation, resulting in mucosal redness and edema, with or without bleeding, and with no attachment loss at this stage. In periodontitis, there is destruction of periodontal fibers, and periodontal pockets may be present, depending on the severity of PD. In more advanced stages, molar furcation lesions, tooth mobility, and bone loss may occur, leading to tooth loss. [10,11]

There are many risk factors that an odontologist should evaluate to determine the presence, course and severity of PD, such as gender, race, age, oral hygiene habits, socioeconomic status, medications, drug abuse, smoking, stress, AIDS, malnutrition, osteoporosis, use of steroids and oral contraceptives and the presence of some systemic diseases, such as diabetes mellitus (DM). [12-15]

Type 1 DM is a chronic degenerative disease characterized by impaired glucose metabolism due to an absolute insulin deficiency caused by autoimmune damage to pancreatic beta cells. This type of insulin-dependent DM can be accompanied by multiple metabolic, organs, vascular and infectious complications. When a patient has a systemic disease, the inflammatory response in the oral cavity is altered by the presence of local irritants and infection, accelerating the progression of PD and increasing dental pathology. Diabetic patients also have diminished resistance to infection, with increased salivary glucose levels and a greater tendency to form dental plaque. [16,17]

The association between DM and PD has been studied by several authors, since these patients have a decreased immune response, mainly related to T cells, and altered polymorphonuclear cell (granulocyte) function, causing infections in the oral cavity. [18,19] A higher prevalence and severity of PD has been shown in these patients, possibly due to excessive tissue inflammation, leading to early periodontal attachment and alveolar bone loss. [20,21] An association between periodontitis and poor metabolic control of diabetics has also been reported. Some studies report that effective treatment of periodontal infection reduces

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hyperglycemia, glycosylated hemoglobin (HbA_{1c}) levels and, in many cases, even insulin requirements.

HbA_{1c} is a blood laboratory test that retrospectively estimates the mean glucose concentration measured over a period of 8-12 weeks. HbA_{1c} is currently used to evaluate the metabolic control of diabetic patients, is expressed as a percentage and is correlated with mean glucose levels. When HbA_{1c} levels range from 5% to 6% (80-120 mg/dL), the results are considered normal, and when HbA_{1c} levels are higher than 7-8% (150-180 mg/dL), the results are indicative of decompensated or poorly controlled diabetes. [20,21]

The objective of the present study was to evaluate the prevalence and characteristics of PD in adolescents with type 1 DM and to assess the relationship between diabetes duration and its clinical and metabolic control.

Materials and Methods

A descriptive analytical study was conducted in male and female adolescent patients with a definite diagnosis of type 1 DM and diabetes duration of at least 3 years who attended the XXI Century National Medical Center Pediatrics Hospital and agreed to participate in the study. A qualified odontologist performed an oral examination and evaluated PD using the American Dental Association (ADA) criteria, [22] calibrated with a Kappa index > 0.86. PD was classified into 4 stages according to PD severity as follows: stage I for gingivitis and stages II, III and IV for periodontitis. In gingivitis, dental plaque causes gingival inflammation, the gingiva is red and may bleed, there is no periodontal attachment loss or tooth mobility, tooth-supporting tissues are still not damaged, and pseudopockets may be present. Stage II, or mild periodontitis, is characterized by the fact that bleeding on probing may be present in the active phase, there is a loss of periodontal fibers, and the pocket depth or attachment loss is 3 to 4 mm. Stage III, or moderate periodontitis, is characterized by bleeding on probing and a pocket depth or attachment loss of 4 mm to 6 mm. Stage IV, or severe periodontitis, is characterized by bleeding on probing and a pocket depth or attachment loss of >6 mm.

Diabetic patients were classified into groups based on the duration of diabetes: those with disease duration between 3 and 5 years and those with a disease duration of more than 6 years.

HbA_{1c} measurements from the previous 2 or 3 years were evaluated to determine the usefulness of the laboratory test for the glycemic control of the studied diabetic patients. Based on the test results, patients were classified as diabetic patients with HbA_{1c} controlled to <7% (120-150 mg/dL) and as diabetic patients with uncontrolled HbA_{1c} > 7% (150-180 mg/dL).

Analysis of the results: The data were collected in a format designed for the study and were later transferred for analysis using descriptive statistics with measures of central tendency and dispersion. For the qualitative variables, frequencies and proportions were used; for the quantitative variables with a normal distribution, the arithmetic mean and standard deviation were calculated. The chi-squared ($\chi 2$) test and Student's t-test were used for the bivariate comparison of means, and ANOVA was used for at least 3 means. Pearson's correlation coefficient was used to evaluate how PD is related to the duration and metabolic control of diabetes and to sex. Significant results were incorporated into the logistic regression to assess the significance of the model. The results were considered statistically significant at $p<0.05$. The analysis was performed in the statistical software package IBM SPSS version 21 Armonk, NY, USA.

Results

The sample included 101 patients, whose mean age was 15.02 ± 1.216 years, ranging from 13 to 17 years; 59.4% of the patients were female, and 40.6% were male. In the oral examination, 51 (50.6%) adolescents had PD, of which 13.9% had gingivitis and 36.7% had periodontitis ($p<0.001$).

The stages found in patients with PD were as follows: stage I PD, 27.5%; stage II PD, 37.3%; stage III PD, 25.5%; and stage IV PD, 9.8%.

Table I shows the assessment of diabetes duration, with diabetic patients categorized into the following 2 groups: those with disease duration between 3 and 5 years and those with disease duration of more than 6 years. The highest percentage of patients with stage II-IV PD was found in the young people who had the longest duration of diabetes. Table 1 shows that patients with a longer DM duration were more likely to have severe stage III-V PD and those with a shorter duration of DM had mild stage 0-I PD. There were significant differences between these stages depending on the duration of diabetes ($p<0.05$).

Table 1: Characteristics of PD in relation to DM duration.

Variables	Diabetes duration			
	3 to 5 years		> 6 years	
	N	%	N	%
Population	58	57.42	43	42.58
Stage 0-I PD	42	65.62	22	34.38
Stage II-IV PD	16	43.24	21	56.76
Fisher's exact test χ^2=4.798, p=0.024				

Table 2 shows that for the 79 patients with HbA_{1c} controlled to<7% (78.22% of the patients), the majority (81.01%) had stage 0-I PD. In contrast, for the patients with poorly controlled HbA_{1c} of > 7%, all 22 (100%) had stage II-IV PD, with more severe oral disease. That is, analysis of the HbA_{1c} levels measured during the previous 2 years in terms of the presence of PD indicated a significant difference between the HbA_{1c} levels: the prevalence of PD was inversely related to the metabolic control of diabetes (p=0.000).

Table 2: PD in relation to the control of HbA1c levels.

Variables	< 7 HbA1c		> 7 HbA1c	
	N	%	N	%
Population	79	78.22	22	21.78
Stage 0-I PD	64	81.01	0	0.00
Stage II-IV PD	15	18.99	22	100.00
χ^2=48.651, p=0.000				

Table 3 shows the severity of PD by sex, duration of diabetes and metabolic control of diabetes. The results showed that 73.3% of females had the least severe cases (stage 0-I PD); the shorter diabetes duration was also observed in females (66.7%), and

females also had the highest metabolic control of their diabetes (96.7%).

Table 3: PD, duration of diabetes and metabolic control of diabetes in diabetic patients by sex.

Variables	Females		Males	
	N	%	N	%
Periodontal disease				
Stage 0-I PD	44	73.3	20	48.8
Stage II-IV PD	16	26.7	21	51.2
Diabetes duration				
< 3-5 years	40	66.7	18	43.9
> 6 years	20	33.3	23	56.1
Metabolic control				
< 7 HbA1c	58	96.7	21	51.2
> 7 HbA1c	02	3.3	20	48.8

χ^2 5.259, p=0.022; PD by sex.
χ^2 5.163, p=0.023; Diabetes duration by sex.
χ^2 29.527, p=0.000; Metabolic control by sex.

Table 4 shows that males were more affected and had a greater risk of having the disease. When the duration of diabetes was > 5 years, the disease had an odds ratio (OR) of 0.218 (confidence interval (CI) 0.17-0.375; p=0.028), and when HbA_{1c} was > 7, stage II-IV PD was present in 72.7% with an OR of 0.523 (CI 0.408-0.646).

Table 4: Severity of PD and relationship with independent variables.

	N	%	#	%	#	%	95%CI	P-value
Sex								
Female	60	59.4	44	73.3	16	26.7	reference	
Male	41	46.6	20	48.8	21	51.2	-0.225 (-0.421 to -0.028)	0.024*
Total			64		37			
Disease duration								
3-5 years	58	57.4	42	72.4	16	27.6	reference	
> 5 years	43	42.6	22	51.2	21	48.8	0.218 (0.017 to 0.375)	0.028*
Total			64		37			
Metabolic control								
< 7 HbA1c	79	78.2	58	73.4	21	26.6	reference	
> 7 HbA1c	22	21.8	6	27.3	16	72.7	0.523 (0.408 to 0.646)	0.000**
Total			64		37			

OR: Odds Ratio; CI: Confidence Interval, * Significance at the p<0.05 level, ** Significance at the p<0.01 level

Table 5 shows the logistic regression between the severity of PD and the independent variables of sex, duration of diabetes and metabolic control of diabetes, with the latter being statistically significant (p<0.05).

Table 5: Logistic regression model using PD severity and independent variables.

Variables	B	Wald	p-value
Sex	-0.931	3.387	0.066
Diabetes duration	0.461	0.934	0.334
Metabolic control	1.342	4.681	0.031

Log-likelihood-2, 112.876[a] gl4; Cox and Snell, r^2 0.178; Nagelkerke, r^2 0.244; Hosmer and Lemeshow χ^2, 0.705 gl4; p=0.951

Discussion

In the studied population, PD was present in more than half of the adolescents, with 13.9% having stage I gingivitis and the remaining 86% having stage II-IV periodontitis. These results show that there is an association between DM and PD and are in agreement with those reported by other authors, who found evidence of an association between various systemic diseases, including DM and periodontal health. [23]

In this study of type 1 diabetic patients, there was a high prevalence of PD compared to the prevalence and severity reported by other authors in the general population and in type 2 diabetics. [24,25]

Adolescents with a shorter diabetes duration (3 to 5 years) had a lower prevalence of PD (65.6% versus 34.4%); and for those with a disease duration > 6 years, stages II-IV PD predominated (56.8%, p<0.05). This is interpreted as the duration of diabetes was a risk factor that influenced the prevalence and severity of PD. Patients with a shorter duration of diabetes had less PD, while those with a longer duration had a higher prevalence and severity of PD.

Using HbA_{1c} levels, the mean blood glucose levels of the last 3 months were evaluated, which helped to determine the metabolic control of diabetes. Patients with hyperglycemia and poorly controlled diabetes had a higher prevalence and severity of PD than those with good diabetic control (HbA_{1c}<7%). Therefore, poorly controlled diabetes not only increases the prevalence of PD but is also a risk factor for severe periodontitis; in other words, the severity of PD is inversely related to the metabolic control of diabetes (p=0.000).

The HbA_{1c} levels indicated that 78.2% of patients with controlled diabetes had stage 0-I PD, and the remaining patients with HbA_{1c} > 7% had stage II-IV PD, so a direct relationship was found between the metabolic control of diabetes and PD (p=0.000). [26]

These results are in agreement with the studies conducted by Jirdal A. et al. [27] in type I diabetic patients, where the researchers found that the severity of PD increased with poor HbA_{1c} control. Silvestre FJ et al. [28] also examined the prevalence of PD in type I diabetic patients and related PD to the metabolic control and duration of diabetes. Comparison of the results with those of non-diabetic patients showed that the group with poorly controlled diabetes had a higher prevalence and severity of PD. In the present study, 27.3% of the adolescents with poorly controlled diabetes had stage 0-I PD, and the majority of those with poorly controlled diabetes had severe PD stages, demonstrating a direct relationship between poorly controlled DM and PD severity. Hyperglycemia and immunological deficiencies in diabetic patients are factors that can cause oral infections that lead to PD.

Additionally, Costa KL et al. [29] revealed the importance of diabetes control by measuring HbA_{1c} levels; the researchers found better periodontal health in the patients with lower HbA_{1c} levels and found an association between the progression of periodontitis and increased HbA_{1c} levels. The above suggests that the control of PD can improve glycemic control and vice versa: glycemic control decreases the prevalence and severity of PD. [30,31]

A higher proportion of the females had stage 0-I PD (73.3% versus 48.8% in males), and females had a shorter duration of DM (p<0.005).

Adequate metabolic control was significantly more common for female patients, while males had a higher risk for the presence of factors causing PD. This deficiency in males could be related to differences in attitude, where females show greater compliance with the treatment plan. Moreover, males with poorly controlled diabetes can experience many complications; more than half of them need support from the family in addition to institutions to control and treat their diabetes. Another factor that could influence diabetes control is that the population in this study visited a public hospital; patients with higher purchasing power can visit private institutions, so socioeconomic status may be another factor that can influence patients who did not achieve good metabolic control and received subpar treatment for the disease.

Conclusion

In the present study, the prevalence of PD was found to be associated with poorly controlled diabetes. The treatment of periodontitis is essential in diabetic patients because an effective treatment of PD improves blood glucose levels; thus, it is suggested that efforts should be made to prevent the onset of PD.

In the multidisciplinary management of these patients, specialist doctors should take the participation of the stomatologist into account since infections in diabetic patients make hyperglycemia worse. This type of hyperglycemia can only be controlled if, in addition to diet, insulin and ancillary treatment, PD is prevented and treated.

Some limitations of the present study should be considered. This study was cross-sectional. The socioeconomic level was not analyzed despite reports indicating that this factor influences the outcome of disease control and suggesting that populations with a higher socioeconomic level can more easily access information on disease control, better understand instructions regarding treatment and develop more self-care skills. These results are valid for the studied population but cannot be extrapolated to the entire Mexican population.

Apart from these limitations, the results may be relevant because of the use of a large population of type I diabetic patients. These findings, which have revealed the needs of this population, can be useful for identifying and thus designing promotion and follow-up strategies; the results may serve as a basis for future follow-up or intervention studies of adolescents.

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Conflict of Interest

All authors disclose that there was no conflict of interest.

References

1. Sjodin B, Edblad E, Sondell K, Dahlén G. Minor manifestations of periodontal diseases in young adults with type 1 diabetes mellitus. Periodontal and microbiological findings. Acta Odontol Scand. 2012; 70: 589-596.
2. Socransky SS. Microbiology of periodontal disease-present status and future considerations. J Periodontol. 1977; 48: 497-504.
3. Page RC, Kornman K. The pathogenesis of human periodontitis: An introduction. Periodontology. 2000 1997; 4: 9-11.
4. Kinane DF, Marshall GJ. Periodontal manifestations systemic disease. Aust Dent J. 2001; 46: 2-12.
5. Van Dyke T, Dave S: Risk factors for periodontitis. J Int Acad Periodontal 2005; 7: 3-7.
6. Poplawska KA, Siewko K, Szpak P. Association between type 1 diabetes and periodontal health. Adv Med Sci. 2014; 59:126-131.
7. Preshaw PM, Bissett SM. Periodontitis: Oral complication of diabetes. Endocrinol Metab Clin North Am. 2013; 42: 849-867.
8. Mealey BL, Ocampo GL. Diabetes mellitus and periodontal disease. Periodontol 2000. 2007; 44: 127-153.
9. Matesanz Pérez P, Matos Cruz R, Martínez AB. Enfermedades gingivales: una revisión de la literatura. Avances en Periodontología e Implantolología. 2008; 20:11-25.
10. Kinane DF, Marshall GJ. Periodontal manifestations systemic disease. Aust Dent J 2001; 46: 2-12.
11. Gamonal JA, López NJ, Aranda W. Periodontal conditions and treatment needs, by CPITN, in the 35-44 and 65-74 years old population in Santiago, Chile. Int Dent J. 1998; 48: 96-103.
12. Han DH, Lim S, Kim JB. The association of smoking and diabetes with periodontitis in a Korean population. J Periodontol. 2012; 83: 1397-1406.
13. Sanz Sánchez I, Bascones Martínez A. Otras enfermedades periodontales. I: Periodontitis como manifestación de enfermedades sistémicas. Av Periodon Implantol. 2008; 20: 59-66.
14. Daniel R, Gokulanathan S, Shanmugasundaram N, Lakshmigandhan M, Kavin T. Diabetes and periodontal disease. J Pharm Bioallied Sci 2012; 4: 280-292.
15. Garofalo GS. Relationships between diabetes mellitus and periodontal disease: current knowledges and therapeutic prospects. Clin Ter. 2008; 159: 97-104.
16. Zhou X, Zhang W, Liu X, Zhang W, Li Y. Interrelationship between diabetes and periodontitis: role of hyperlipidemia. Arch Oral Biol. 2015; 60: 667-674.
17. Mattson JS, Cerulis DR. Diabetes mellitus: A review of the literature and dental implications. Compendium. 2001; 22: 757-772.
18. Ochoa SP, Ospina CA, Colorado KJ, Montoya YP, Saldarriaga AF, et al. Periodontal condition and tooth loss in diabetic patients. Biomédica. 2012; 32: 52-59.
19. Kasaj A, Gortan-Kasaj A, Willerhausen B, Hoffmann O, Angelov N. The relationships of periodontitis and diabetes mellitus. Acta Med Croatica. 2007; 6: 369-374.
20. Seppala B, Seppala M, Ainamo J. A longitudinal study on insulin-dependent diabetes mellitus and periodontal disease. J Clin Periodontol.1993; 20: 161-165.
21. Tervonen T, Karjalainen K. Periodontal disease related to diabetic status. A pilot study of the response to peridontal therapy in type 1 diabetes. J Clin Periodontol 1997; 24: 505-510.
22. American Diabetes Association. Report of the Expert Commitee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care 1997; 20: 1183-1197.
23. Otomo Corgel J, Pucher JJ, Rethman MP, Reynolds MA. State of the science: chronic periodontitis and systemic health. J Evid Based Dent Pract. 2012; 12: 20-28.
24. Pucher J, Stewart J. Periodontal disease and diabetes mellitus. Curr Diab Rep. 2004; 4: 46-50.
25. Mealey BL, Rose LF. Diabetes mellitus and inflammatory periodontal disease. Curr Opin Endocrinol Diabetes Obes. 2008; 15: 135-141.

26. Merchant AT, Josey MJ. Commentary: Periodontal Treatment and Inflammation in Diabetes: Association or Causation?. J Periodontol. 2016; 10: 1113-1116.

27. Jindal A, Parihar AS, Sood M, Singh P, Singh N. Relationship between severity of periodontal disease and control of diabetes (glycated hemoglobin) in patients with type 1 diabetes mellitus. J Int Oral Health. 2015; 7: 17-20.

28. Silvestre FJ, Miralles L, Llambes F, Bautista D, Solá-Izquierdo E, Hernández-Mijares A. Type 1 diabetes mellitus and periodontal disease: Relationship to different clinical variables. Med Oral Patol Oral Cir Bucal. 2009; 14: E175-E179.

29. Costa KL, Taboza ZA, Angelino GB, Silveira VR, Montenegro R, Haas AN, et al. Influence of Periodontal Disease on Changes of Glycated Hemoglobin Levels in Type 2 Diabetes Mellitus: A Retrospective Cohort Study. J Periodontol 2017; 88: 17-25.

30. Al Khabbaz AK, Al Shammari KF, Hasan A, Abdul Rasoul M. Periodontal health of children with type 1 diabetes mellitus in Kuwait: a case control study. Med Princ Pract.2013; 22: 144-149.

31. Taylor GW, Borgnakke WS. Periodontal disease: associations with diabetes, glycemic control and complications. Oral Dis. 2008; 14: 191-203.