Clinical Evaluation of Obesity In Patients with Type 2 Diabetes Mellitus after Periodontal Treatment: A Comparative Study

[1]Muriel Machado MarquezZampiva, [1]ThaynáNáthallyPetry de Paula, [1]Tito Peres Terres Neto, [1]Karine Kiyumi Nakamura, [1]JulioKatuhide Ueda, [1]Patricia Oehlmeyer Nassar, [1]Carlos Augusto Nassar

[1]Western Paraná State University (UNIOESTE), Cascavel, Paraná, Brazil

Abstract

Aim: Periodontitis is often associated with diabetes mellitus and may be considered one of the chronic complications of this disease. Increasing evidence indicates that periodontal disease (gingivitis and periodontitis) has an adverse effect on glycemic control and participates in the pathophysiology of complications related to type 2 diabetes mellitus. Thus, this study aimed to evaluate the influence of obesity on clinical periodontal parameters of patients with type 2 diabetes mellitus with stage II or III periodontitis grade C after conventional periodontal treatment.

Methods: For this study, 36 patients, aged 25 to 65 years, were evaluated; 20 patients with type 2 diabetes mellitus and moderate to severe periodontitis (Non-Obese Group) and 16 patients with type 2 diabetes mellitus with obesity and moderate to severe periodontitis (Obese Group). These patients underwent conventional periodontal treatment and were evaluated using plaque index, probing depth, clinical attachment level, bleeding on probing and gingival crevicular fluid analysis, as well as laboratory tests of glycated hemoglobin, fasting glycemia, total cholesterol, and fractions of triglycerides. Periodontal and laboratory parameters were evaluated at baselineand six months.

Results: The results showed improvements in periodontal and clinical laboratory parameters ($p < 0.05$) in the evaluated periods; however, the non-obese group presented significantly better results when compared to the obese group.

Conclusion: It can be concluded that the presence of obesity may hinder the improvement of periodontal clinical parameters after conventional periodontal treatment in patients with diabetes mellitus and periodontitis.

Keywords: Periodontitis; Obesity; Diabetes Mellitus; Periodontal Diseases

Introduction

Obesity is classified as a chronic metabolic disease consisting of excess in body fat (Pinho *et al.,* 2013). According to the World Health Organization (WHO), the prevalence of overweight and obesity is increasing in many parts of the world at an alarming rate (Pedroni *et al.,* 2013).

Visceral obesity is strongly associated with cardiovascular risk factors and hyperglycemia, increase in apolipoprotein B and low-density lipoprotein (LDL), and a decrease in high-density lipoprotein (HDL) (Linhares *et al.*, 2012). Excess fat in adults is associated with a higher occurrence of diabetes mellitus, hypertension, increased triglyceride, and cholesterol (Pinho *et al.,* 2013) and periodontal diseases (Pischon, 2007). An increase of 5% in body fat weight corresponds to a 30% increase in the risk of developing periodontitis (Pinho *et al.,* 2013), which also demonstrated that individuals with a high body mass index produce a higher level of inflammatory proteins, which could contribute to the development ofperiodontitis.

Diabetes mellitus, is a chronic disease related to a partial or total deficiency in insulin production or resistance to its action, leading to metabolic alterations that result in hyperglycemia and multiple systemic abnormalities.

Correspondence to: Carlos Augusto Nassar, DDS, Periodontology, Dentistry School, Western Parana State University – UNIOESTE, Cascavel, Parana, Brazil. Torres Avenue, 200 – house 249 – Centro –Zipcode85806-095 – Centro – Cascavel – Paraná – Brazil. Fone: + 55 45 991013369. E-mail: canassar@yahoo.com

Diabetes mellitus has a high prevalence in the population: about 10% of the world population has diabetes (Morais *et al.,* 2018). It is estimated that 366 million people worldwide have type 2 diabetes mellitus, probably reaching 552 million people by 2030; for this population, obesity accounts for about 55% of the cases of this disease. In Brazil, 75% of the population with type 2 diabetes is not at an ideal weight, with 42.1% being overweight and 32.9% obese (Freitas *et al.,* 2014).

Increased adipose tissue mass is usually accompanied by increased insulin resistance. This resistance is due to decreased sensitivity of adipose tissue, muscles, and liver. Both obesity and insulin resistance are metabolic disorders that have similar pathophysiological changes and are also interconnected by several factors (Freitas *et al.,* 2014). Thus, obesity, which is a case of hyperlipidemia, represents one of the significant risk factors for the development of insulin resistance or type 2 diabetes mellitus. During the development of insulin resistance related to obesity, the adipose tissue synthesize and activates proteins with inflammatory actions that influence the intracellular effects of insulin causing damage to GLUT4 translocation to the plasma membrane (Freitas *et al.,* 2014).

Obesity and diabetes mellitus, can also influence and periodontitis with periodontitis being more prevalent and more severe in people with diabetes mellitus than in non-diabetic patients. Lack of insulin in the long term can cause macro- and microvascular diseases that can impact on the periodontal tissues, (Sousa *et al.,* 2014). Due to the high prevalence of cases in diabetic patients, periodontitis could be considered the sixth complication of diabetes mellitus (Maehler et al. 2011).

The aim of this study ws to evaluate the influence of obesity in clinical parameters periodontal of patients with type 2 diabetes mellitus with stage II or III periodontitis grade C after conventional periodontal treatment.

Methodology

The proposed research was a prospective clinical trial, performed at the dental clinic of the Western Parana State University (UNIOESTE). The data collection period lasted six months, and the total time of execution of the research occurred in 18 months. This study was approved by the Human Research Ethics Committee (CEP) of UNIOESTE, under the protocolno. 1.665.010.

For this study 40 patients participated, ranging in age from 25 to 65 years old; from these, 20 patients presented type 2 diabetes mellitus with stage II or III periodontitis (Non-Obese Group), and 20 patients presented type 2 diabetes mellitus and obesity with moderate to severe periodontitis (Obese Group). However, the number of patients in the Obese Group reduced to 16, because four patients were removed from the sample due to non-attendance at the follow-up visits. All diabetic patients were referred by the endocrinologists of the municipality of Cascavel, Parana state, with the pathophysiological diagnosis of diabetes. This sample size was based on calculation using the t-test for independent samples, , with 90% test power and 5% alpha level (for which a minimum of 14 patients per group would be sufficient), as well as previous studies by the group of researchers (Nassar *et al.,* 2014; Toyama *et al.,* 2014; Bernardon *et al.,* 2016).

Following criteria to allow the inclusion in both groups, the patients were of both genders and presented with stage II or III periodontitis grade C, either localized or generalized. They presented with at least four sites having gingival bleeding and inflammation, a probing depth above 5mm, clinical attachment level greater or equal to 4mm (not on the same tooth), free of cavities and no prostheses at the initial clinical examination. The non-obese group, the patients presented only with type 2 diabetes mellitus and periodontitis. The obese group, patients had type 2 diabetes mellitus and obesity (Body Mass Index - BMI> 30) (Cole *et al.,* (2000) and periodontitis. The teeth, for all groups, were reasonably aligned, with a minimum of 20 teeth in each arch, with clinical examination performed on the buccal, lingual/palatal, mesial and distal surfaces. Exclusion criteria included , patients with a positive history of antibiotic therapy in the previous six months; use of steroid or non-steroidal anti-inflammatory drugs, anticoagulants and immunosuppressants in the three months preceding the study; positive history of gestation or breastfeeding; positive history of contraceptive use or any other form of hormone; positive history of smoking or definitive cessation of smoking for at least five years; history of periodontal treatment in the previoussix months.

For both groups, conventional periodontal treatment was performed, consisting of weekly appointments at the Dentistry clinic located at UNIOESTE. It included, without the restriction of duration, instruction and motivation of oral hygiene, supragingival and subgingival scaling, root planing and coronalpolishing, through manual instrumentation and ultrasound under local anesthesia. For manual instrumentation, Gracey periodontal curettes 5/6, 7/8, 11/12 and 13/14 (Millennium, São Paulo, Brazil) were used, and, for ultrasonic instrumentation, a piezoelectric device was used (DabiAtlante, RibeirãoPreto, Sao Paulo, Brazil). The groups were evaluated after six months, and clinical and laboratory tests were performed at intervals of six months; the patients were re-instructed at all periods. All treatmentswerecarried out by a single operator.

Instructions for the mechanical plaque control was performed in all the visits, being the same for both groups; in addition, supportive periodontal therapy was performed in the groups in the six-month period, and 2 grams of amoxicillin 1 hour priortoantibiotic prophylaxis was prescribed in all the evaluation periods (Lopes et al. 2017).

Clinical Periodontal Evaluation:

A single trained examiner performed the initial clinical examination with a Willians no. 23, periodontal probe, and determined: plaque index of O'Leary, *et al.* (1972): this index divides the tooth surface into four zones - buccal, distal, mesial, and lingual - and designatescodes 0 for absence or 1 for the presence of visibleplaque (dichotomized for absence and presence of visible plaque); probing depth: the distance from the bottom of the sulcus/pocket to the gingival margin, whichwas determined at six points: mesiobuccal, mid-buccal, distobuccal, distolingual/palatal,mid-lingual/palatal and mesiolingual/palatal for each tooth; clinical attachment level: the distance from thecementoenamel junction to the apical extent of the sulcus/pocket, which was determined at six points:mesiobuccal, mid-buccal, distobuccal,distolingual/palatal, mid-lingual/palatal and mesiolingual/palatal for each tooth; bleeding on probing: the presence of bleeding observed after 30 seconds following the probingdepth measurement at the same six points.

Laboratory Evaluation:

Each patient participating in the project was asked, at the initial examination and again after six months, to undergo laboratory tests to verify glycated hemoglobin(HbA1c),fasting glucose, total cholesterol and fractions, and triglycerides.

Gingival Crevicular Fluid (GCF) Evaluation:

With the use of a white conical Robinson CA brush (Microdont, São Paulo, Brazil), prophylaxis was performed, and the entire supragingival plaque of the area was removed at the initial and final periods of the study. Three collections of GCF per patient were performed in the central portion of the buccal and lingual/palatal surfaces of random teeth, with filter paper strips (Whatman grade I) of 2x15mm inserted below the gingival margin for 30 seconds. The paper strips were immediately placed in 0.2% alcohol solution containing ninhydrin for 1 minute. The strips were photographed and analyzed with a computer program (Image-Pro Plus® Version 4.5.0.29, Media Cybernetics, Silver Spring, MD, USA) to determine the amount of absorbed fluid in pixels^2 (Lagos *et al.*, 2011).

Statistical Analysis:

Statistical analysis was performed using BioEstat 5.3 software (InstitutoMamiraua, Amazonas, Brazil). The Shapiro-Wilk test was used to evaluate the normality of the data. After checking the normality of the data for all of the periodontal and laboratory parameters, the means were compared within each group, presented in tables with the corresponding units and measures, and the standard deviation (±) using the test Student's t-test ($p < 0.05$) for comparison of the initial and final analyzes within the same group. For calculation of the variations of the means (Δ), data from the first (baseline) and second examinations (at six months) were used, and analysed using ANOVA test ($p < 0.05$).

Results

The mean values of body mass index and waist-hip circumference in the initial period were taken to confirm the criteria used for patient selection. The obese group presented a higher body mass index (Grade I obesity 34.30 ± 3.88 kg/m2) and a waist-hip circumference (117.88 ± 12.20 cm) 15.00% higher than the non-obese group (BMI 24.46 ± 4.31 kg/m2 and waist-hip circumference 99.75 ± 12.31 cm).

Clinical Periodontal Evaluation

Table 1 shows plaque index and probing depth values for both groups at baseline and six months. Both parameters in the obese and non-obese groups showed significant improvements ($p < 0.05$) over the evaluation periods. When compared, the obese group showed a significantly lower reduction in the plaque index.

Table 2 shows the mean values of probing depth, clinical attachment leveland analysis of the crevicular gingival fluid area in both groups at baseline and six months, and in both parameters in the obese and non-obese groups presented significant improvements ($p < 0.05$). When compared, the non-obese group showed a significant reduction in the mentioned parameters. Also, when the means of changesbetween groups were compared, there was a statistically significant difference ($p < 0.05$).

Table 1. Plaque Index and Bleeding on Probing

	Plaque	Index	Bleeding	Probing
	Obese	Nonobese	Obese	Nonobese
Initial	61.03 ± 30.25 [A]	62.36 ± 16.93 [A]	49.66±43.34 [A]	24.91 ± 24.52 [A]
6months	38.86 ± 24.88[B]	31.77 ± 28.10 [B]	24.42± 23.12[B]	10.10 ± 10.05 [B]
Δ (0-6 m)	22.17 ± 6.81	30.59 ± 7.84*	25.20 ± 20.32	14.99 ± 12.34

The values represent mean standard deviation and are expressed in percentages.

Different letters: Statistically significant differences between means within the same group and of the same parameter - $p < 0.05$. *Statistically significant difference between Δ (means variations) between groups and in the same parameter - $p < 0.05$.

Table 2. Probing Depth, Clinical Attachment Level, and Gingival crevicular fluid value.

	PD(mm)		CAL (mm)		GCF (pixels²)	
	Obese	**No Obese**	**Obese**	**No obese**	**Obese**	**No obese**
Initial	3.78±0.42^{A}	3.54±0.73^{A}	4.20±0.67^{A}	3.97±0.38^{A}	4542.44±821.92^{A}	5618.23±2797.20^{A}
6months	3.28±0.64^{B}	2.89±0.42^{B}	3.68±0.75^{B}	3.11±0.62^{B}	3475.13±1115.91^{B}	3688.24±1901.35^{B}
Δ (0-6 m)	0.51±0.20	0.67±0.21*	0.53±0.10	0.85±0.22*	1067.31±300.59	1929.99±652.58*

The values represent mean standard deviation and are expressed in millimeters and pixels²

Different letters: Statistically significant difference between means within the same group and of the same parameter - p <0.05.
*Statistically significant difference between Δ (means variations) between groups and in the same parameter - p <0.05.

Laboratory tests

Table 3 shows the values of glycated hemoglobin (HbA1c) and fasting glucose in both groups at baseline and six months. The results for the mean levels of glycated hemoglobin (HbA1c) and fasting glucose showed that there was a significant decrease at six months. This decrease was significantly lower in the obese group than in the non-obese group (p-value p=0.001), demonstrating the effect of obesity on diabetic patients.

Table 4 shows the triglycerides and total cholesterol values in both groups at baseline and six months. The results for mean total cholesterol levels showed that there was a significant decrease in levels by the end of 6 months in both groups (P<0.05). However, triglyceride levels only showed a significant reduction in the non-obese group. When the variations of the mean of the parameters between the two groups were compared, the non-obese group showed a significantly higher reduction.

Table 5 shows the HDL and LDL values in both groups in periods of zero and six months. In these two parameters evaluated, there was no statistical significance either between the evaluated periods or between the changes of the means when observed the two groups.

Discussion

The influence of diabetes on periodontal disease has been established, but the effect of periodontal disease and its treatment on diabetes control is still under onging inveestigation. The possible relationships between periodontal disease and obesity in diabetes have not been studied. Therefore, this study aimed to evaluate the influence of obesity on clinical periodontal parameters in patients with type 2 diabetes mellitus and stage II or III periodontitis grade C after conventional periodontal treatment.

Table 3. HbA1cand fasting glucose values.

	HbA1c (%)		Fasting glucose	
	Obese	**No obese**	**Obese**	**No Obese**
Initial (0)	8.55 ± 2.05^{A}	10.20 ± 2.74^{A}	179.04 ± 65.32^{A}	202.55±112.18^{A}
6months	7.10 ± 1.70^{B}	6.87 ± 2.07^{B}	132.68 ± 57.23^{B}	143.25±48.71^{B}
Δ (0-6 m)	1.45 ± 0.30	3.33 ± 0.90*	46.36 ± 8.11	59.30 ± 7.21*

The values represent means and standard deviationsfor HbA1c (%) and mg/dLfor fasting blood glucose.
Different letters: Statistically significant difference between means within the same group and of the same parameter - p <0.05.

*Statistically significant difference between Δ (means variations) between groups and in the same parameter - p <0.05.

Table 4. Blood triglyceride and total cholesterol concentrations.

	Triglycerides		Total	Cholesterol
	Obese	**No obese**	**Obese**	**No Obese**
Initial (0)	194.58±118.02^{A}	223.51±130.52^{A}	208.42± 64.79^{A}	200.98± 12.85^{A}
6months	186.02±176.96^{A}	139.49 ±57.28^{B}	180.33± 64.69^{B}	122.66 ±45.06^{B}
Δ (0-6 m)	8.48 ± 31.98	84.02 ± 40.56*	28.30 ± 21.28	78.30 ± 34.36*

The values represent means and standard deviationsin mg/dL

Different letters: Statistically significant difference between means within the same group and of the same parameter - p <0.05.
*Statistically significant difference between Δ (means variations) between groups and in the same parameter - p <0.05.

Table 5. HDL and LDL blood concentrations.

	HDL		LDL	
	Obese	**No obese**	**Obese**	**No Obese**
Initial (0)	43.39 ± 11.46 [A]	44.65 ± 11.50 [A]	85.88 ± 37.61[A]	92.87 ± 21.23[A]
6months	46.98 ± 15.22 [A]	49.37 ± 13.25 [A]	74.95 ± 45.48 [A]	74.20 ± 44.05 [A]
Δ (0-6 m)	-3.50 ± 3.30	-4.72 ± 2.50	11.10 ± 7.5	18.59 ± 15.68

The values represent mean standard deviation and are expressed in mg/dL

Statistically significant difference between means exams within the same group and of the same parameter - $p < 0.05$.

Obesity may influence local periodontal conditions, and periodontitis may be a risk factor for glycemic control in patients with diabetes because periodontopathogenic bacteria and their by products in inflamed periodontal tissue may provide a constant source of systemic challenges to the diseased host (Gerber *et al.,* 2016). This concept is yet to be verified.

Most obesity epidemiological studies use BMI as a method to evaluate excess body fat due to its easy applicability in research (Saito *et al.,* 2001; Genco *et al.,* 2005). However, the accuracy of this method for defining obesity can be questioned, since it does not distinguish between adipose mass and muscle mass. Thus, it is necessary to associate BMI with abdominal circumference measurements, since this eliminates the inconsistencies of BMI (Khader *et al.,* 2008).

Regarding periodontal clinical parameters, the results of this study show that there is a statistically significant improvement of periodontal disease in both groups (tables 1 and 2). Obesity may influence periodontal conditions, and this systemic condition may negatively influence the outcome of conservative periodontal treatment. Such an impact was demonstrated in our results (Tables 1 and 2) and has also been described in a recent systematic review (Gerber *et al.*, 2016). Thus, clinicians may now consider a weight reduction program as an adjunct treatment concept for periodontal health with an expected positive effect after 6 and 12 months (Gerber *et al.,* 2016).

Adipose tissue may represent a reservoir of inflammatory mediators. Thus, excess body fat may increase the probability of an exaggerated host inflammatory response in both periodontal disease diabetes (Ritchie, 2007). An important cytokine found in obese patients is Plasminogen Activator Inhibitor (PAI-1), whose action is to inhibit clot degradation, increasing the risk of vascular diseases and contribute to a more active periodontal disease in these individuals (Saito *et al.,* 2001). Obesity is also associated with high plasma levels of tumor necrosis factor α (TNFα) and its soluble receptors, resulting in a high risk of developing hyperinflammation in the periodontal tissue and contributing to the resistance to insulin absorption. In obesity, adipocytes can induce the activation of proinflammatory cytokines such as TNF-α, protein matrix metalloproteinases, which increase the destruction of periodontal tissues (Genco *et al.,* 2005; Sarda *et al.,* 2016).

Obese people have a ten times greater predisposition to develop type 2 diabetes. The main factors contributing to this are lipotoxicity, glucose toxicity, and increase in proinflammatory cytokines. Adipose tissue acts an extensive reservoir of biologically active mediators such as TNF-α and other adipokines, such as leptin, resistin, and adiponectin, all of which may be directly related to periodontal disease (Chapper *et al.,* 2005). Impaired neutrophil functions, in type 2 diabetes patients, but not obese patients, are impaired, contributing to the increase in the depths of periodontal pockets and the severity of periodontal disease (Saito and Shimazaki, 2008). The fundamental mechanism connecting periodontitis, diabetes, and obesity seems to be an exaggerated immune response. In addition, obesity raises the levels of inflammatory mediators, also favoring diabetes and exacerbating the periodontitis (Song *et al.,* 2016).

Despite a significant increase in reported associations between periodontal disease and systemic diseases in recent years, the fundamental biological mechanisms for these associations are not yet fully explained. These relationships need to be further explored with a concentric view to developing strategies that could prevent or control these complications (Ritchie, 2007; Nagpal *et al.,* 2015).

Among the biological mechanisms that might explain why diabetes mellitus affects the periodontal tissues are microangiopathy, genetic predisposition, alterations in collagen metabolism, the inflammatory response of the host, and the quality of the subgingivalmicrobiota (Queiroz *et al.,* 2011). Persistent hyperglycemia may also contribute to an increase in bone mass loss, demonstrating that inflammatory cells such as monocytes and macrophages harbor receptors for advanced glycation end-products (AGEs), and the accumulation of AGEs in patients with type 2 diabetes can also intensify a pro-inflammatory response to periodontal pathogens (Toyama *et al.,* 2014; Nagpal *et al.,* 2015).

The results of the present study demonstrate that obesity can impact on both diabetes and periodontitis. A possible accumulation of AGEs may result in increased concentration of proinflammatory cytokines, including interleukin 1-β (IL-β) and TNF-α, which are insulin antagonists, and prostaglandin E-2 (PGE-2), resulting in destruction of connective tissue. Simultaneously, the periodontal infection and inflammation may induce a chronic state of insulin resistance, contributing to the cycle of hyperglycemia and formation of AGEs, amplifying the pathways of degradation of connective tissue. There is evidence suggesting a strong bidirectional relationship between periodontitis and diabetes suggesting that periodontitis could induce or maintain a chronic inflammatory state, indicated by the concentration of C-reactive protein (CRP), IL-6 and fibrinogen, increasing serum levels of IL-6 and TNF-α, inducing or aggravating insulin resistance (Sousa *et al.,* 2014; Maehler *et al.,* 2011; Nassar *et al.,* 2014). Inflammatory cytokines, such as IL-1 and TNF-α, are known to stimulate insulin resistance and several other chronic inflammatory complications, including periodontitis. In addition, the fact that TNF-α and IL-6 are produced in adipose tissues also supports a relationship between obesity, type 2 diabetes mellitus, and periodontitis (Kalsi *et al.,* 2015).

Because of high vascularization, the inflamed periodontium may act as an endocrine source of inflammatory mediators (such as TNF-α, IL-6, and IL-1), and this may influence glucose and lipid metabolism. In view of the fact that osteoblasts, which are involved in bone remodeling, also express Toll-like receptors (TLRs) 1, 4, 5, 6, and 9, while osteoclasts express TLR-1, 2, 3, 4, 5,6,7,8 and 9, it is probable that TLRs and their signaling within the alveolar bone may cause an inflammatory response to invading pathogens, initiating a cascade of proinflammatory cytokines within the alveolar bone. This may lead to a release of IL-1, TNFα, and PGE_2, and a possible stimulation of osteoblast inhibition and activation of osteoclasts through the nuclear receptor activator Kappa-β (NFk-β) (Song *et al.,* 2016; Queiroz *et al.,* 2011). In patients with periodontitis and type 2 diabetes mellitus, effective glycemic control may improve bleeding rate through improved inflammation in periodontal tissues. Furthermore, periodontal treatment may improve the periodontal inflammation and glycemic control with an elevation of adiponectin and reduction of glycated hemoglobin (HbA1c) (Song *et al.,* 2016; Queiroz *et al.,* 2011). The finding of this study are in agreement with such concepts.

Finally, diabetic patients are prone to having high levels of total cholesterol, LDL, and triglycerides, and this can be increased even further with obesity, even when blood glucose levels are well controlled. The role of periodontitis in this is still unclear but hyperactivity of white blood cells, which is caused by hyperlipidemia, may also increase the production of oxygen radicals that are often associated with the development of periodontitis, and this decline in antioxidant capacity in patients with periodontitis could also trigger the development of resistance to insulin (Nagpal et al. 2015; Kalsi et al. 2015).

In conclusion, conventional periodontal treatment can significantly improve diabetic parameters especially when obesity is not associated. The presence of obesity may hinder the improvement of periodontal clinical parameters after conventional periodontal treatment in patients with diabetes mellitus and periodontitis.

Conflict of interest

All authors declare that they have no conflict of interests.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All individuals included in the study consented to participate in it.

Acknowledgments

This study was supported by the Foundation for Post-Graduate Education (CAPES) and Araucaria Foundation, Brasilia, Brazil, and Western Paraná State University (UNIOESTE), Cascavel, Paraná, Brazil.

References

Bernardon P, Toyama G, Costa K, *et al.* Effects of Initial Periodontal Treatment in Moderately Compensated and Decompensated Type 2 Diabetic Patients. *British Journal of Medicine & Medical Research* 2016; **13**: 1-13.

Chapper A, Munch A and Shermann C.Obesity and periodontal disease in diabetic pregnant women. *Brasilian Oral Research* 2005; **19**: 83–87.

Cole TJ, Bellizzi MC, Flegal KM and Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal* 2000; **6**: 1240-1243.

Freitas MC, Ceschini FL and Ramallo BT. Insulin resistance associated with obesity: anti-inflammatory effects of physical exercise. *Revista Brasileira de Ciência e Movimento* 2014; **22**: 139-147. *(in Portuguese)*

Genco RJ, Grossi SG, Ho A, Nishimura F and Murayama Y.A proposed model linking inflammation to obesity, diabetes and periodontal infections. *Journal of Periodontology* 2005; **76**: 2075–2084.

Gerber FA, Sahrmann P, Schmidlin OA, Heumann C, Beer JH and SchmidlinPR. Influence of obesity on the outcome of non-surgical periodontal therapy a systematic review. *BMC Oral Health* 2016; **16**: 81:90.

Kalsi DS, Chopra I and Sood A. Association of lipid profile test values, type 2 diabetes mellitus, and periodontitis. *Indian Journal of Dentistry* 2015; **6**: 81-84.

Khader Y, Khassawneh B, Obeidat B, *et al.* Periodontal status of patients with metabolic syndrome compared to those without metabolic syndrome. *Journal of Periodontology* 2008; **79**: 2048-2053.

Lagos MLP, Sant'ana ACP, Greghi SLA and Passanezi E. Keratinized gingiva determines a homeostatic behavior of gingival sulcus through transudation of gingival crevice fluid. *International Journal of Dentistry* 2011; **11**: 1-6.

Lopes CCP, Busato PMR, Manica MFM, *et al.* Effect of basic periodontal treatment on glycemic control and inflammation in patients with diabetes mellitus type 1 and type 2: controlled clinical trial. *Journal of Public Health* 2017; **25**: 443-449.

Linhares RS, Hortal BL, Gigante DP, Dias-da-Costa SD and Olinto MTA. Distribution of general and abdominal obesity in adults in a city in southern Brazil. *Cadernos deSaúde Pública* 2012; 28: 438-448.

Maehler M, Deliberador TM, Soares GMS, Grein RL and Nicolau GV. Periodontal disease and its influence on the metabolic control of diabetes. South Brazilian Dentistry *Journal* RSB O 2011; **8:** 211-218. (in Portuguese)

Morais EF, Pinheiro JC, Leite RB, Santos PPA, Barboza CAG and Freitas RA. Matrix Metalloproteinase-8 Levels in Periodontal Disease Patients: A Systematic Review. *Journalo f Periodontal Research* 2018; **53**: 156-163.

Nagpal R, Yamashiro Y and Izumi Y. The Two-Way Association of Periodontal Infection with Systemic Disorders: An Overview. *Mediators of Inflammation* 2015; **15**: 1-9.

Nassar PO, Poleto R, Salvador CS, Felipetti FA and Nassar CA. One-stage full-mouth disinfection and basic periodontal treatment in patients with diabetes mellitus. *Journal of Public Health (Weinheim)* 2014; **22**: 81-86.

O'Leary TJ, Drake PB and Naylor JE. The plaque control record. *Journal of Periodontology* 1972; **43**:38.

Pedroni JL, Rech RR, Halpern R, *et al.* Prevalence of abdominal obesity and excess fat in students of a city in the mountains of southern Brazil. *Ciência & Saúde Coletiva***2013;18**: 1417-1425.

Pinho CPS, Diniz AS, Kruze I, *et al.* Prevalence of abdominal obesity and associated factors among individuals 25 to 59 years of age in Pernambuco State, Brazil. *Cadernos de SaúdePública* 2013; 29:313-324.

Pischon T. Obesity, inflammation, and periodontal disease. *Journal of Dental Research* 2007; **86**: 400-409.

Queiroz APG, Orzechowski PR, Pedrini DL, Santos SSF and Leão MVP. Inter-relationship between periodontal disease, diabetes and obesity. *Brazilian Journal of Periodontology* 2011;**21**:16-21.

Ritchie CS. Obesity and periodontal disease. *Periodontology 2000* 2007;**44**:154-163.

Saito T, Shimazaki Y, Koga T, Tsuziki M and Ohshima A. Relationship between upper body obesity and periodontitis. *Journal of Dental Research* 2001; **28**: 1631-1636.

Saito T and Shimazaki, Y. Metabolic disorders related to obesity and periodontal disease *Periodontology 2000* 2008; **18**: 162-170.

Sarda T, Rathod S, Kolte A, Bodhare G and Modak A. Expression of periodontal inflammation into left ventricular hypertrophy in Type 2 diabetes mellitus: A cross-sectional study. *Contemporary Clinical Dentistry* 2016; **7**: 343-348.

Song IS, Han K, Park YM, *et al.* Severe Periodontitis is Associated with Insulin Resistance in Non-Abdominal Obese Adults. *Journal of Clinical Endocrinology and Metabolism* 2016; **101**: 4251-4259.

Sousa JNL, Nobrega DRM and Araki AT. Profile and perceptions of diabetic about the relationship between diabetes and periodontal disease. *Revista de Odontologia.UNESP* 2014; **43**: 265-272.

Toyama G, Fellipetti FA, Bertoldo KP, *et al.* Evaluation of different periodontal treatments modes for patients with type 2 diabetes mellitus. *Journal of Public Health* 2014; **22**:529-534.