

Prevalence and risk indicators of peri-implantitis after 8 to 10 years of function

Prevalência e indicadores de risco de peri-implantite após 8 a 10 anos em função

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Resumo

Introdução: A investigação dos fatores indicadores de risco para as doenças peri-implantares auxilia na prevenção e direcionamento das técnicas de tratamento. **Objetivo:** O objetivo deste estudo transversal foi determinar a ocorrência de peri-implantite e seus potenciais fatores indicadores de risco, além de avaliar as taxas de sucesso e sobrevivência em longo prazo dos implantes dentários após 8 a 10 anos de função. **Material e método:** Foram incluídos cinquenta indivíduos que receberam sua reabilitação implanto-suportada entre 2003 e 2005. Dados demográficos, história médica e odontológica foram coletados e um exame clínico completo foi realizado. A análise multivariada foi utilizada para identificar potenciais fatores indicadores de risco relacionados à ocorrência de peri-implantite. Ao todo, 211 implantes foram colocados; 197 estavam em função, 9 ainda estavam submersos e 5 haviam sido perdidos. **Resultado:** As taxas de sucesso e sobrevivência foram de 81,5% e 97,6%, respectivamente. A mucosite peri-implantar afetou 77,1% dos indivíduos e 52,3% dos implantes. A peri-implantite foi diagnosticada em 14 indivíduos (29,2%) e 25 implantes (12,7%). Indivíduos com osteoporose (OR = 2,84) e sangramento generalizado à sondagem (OR = 8,03) foram significativamente associados a uma maior chance de peri-implantite. Ao nível do implante, a placa visível (OR = 4,45) e as maiores profundidades de sondagem (OR = 4,47) foram significativamente associadas à peri-implantite. **Conclusão:** Por meio desses resultados, nosso estudo sugere que a osteoporose e a inflamação generalizada da mucosa periodontal / peri-implantar aumentam a probabilidade de peri-implantite.

Descritores: Implantes dentários; taxa de sobrevivência; peri-implantite; fatores de risco.

Abstract

Introduction: The investigation of peri-implant diseases risk indicators helps to prevent and target treatment techniques. **Objective:** The aim of this cross-sectional study was to determine the occurrence of peri-implantitis and its potential risk indicator factors, besides to assess the long-term success and survival rates of dental implants after 8 to 10 years of function. **Material and method:** For this, fifty individuals who had received their implant-supported rehabilitation between 2003 and 2005 were included. Data regarding demographics, medical and dental history were collected and a complete clinical examination was performed. Multivariate analysis was used to identify potential risk indicator factors related to the occurrence of peri-implantitis. Overall, 211 implants had been placed; 197 were in function, 9 were still submerged, and 5 had been lost. **Result:** Success and survival rates were 81.5% and 97.6%, respectively. Peri-implant mucositis affected 77.1% of subjects and 52.3% of implants. Peri-implantitis was diagnosed in 14 individuals (29.2%) and 25 implants (12.7%). Subjects with osteoporosis (OR = 2.84) and generalized bleeding on probing (OR = 8.03) were significantly associated with higher odds of peri-implantitis. At the implant level, visible plaque (OR = 4.45) and deep probing depths (OR = 4.47) were significantly associated with



peri-implantitis. **Conclusion:** Through these results, our study suggests that osteoporosis and generalized periodontal/peri-implant mucosa inflammation increase the likelihood of peri-implantitis.

Descriptors: Dental implants; survival rate; peri-implantitis; risk factors.

INTRODUCTION

The use of dental implants for oral rehabilitation of patients partially or completely edentulous has become a widely accepted treatment modality. Despite the high success and survival rates of dental implants, early and late failures may occur. Early failures have been associated with inadequate surgical technique, impaired healing, and inadequate occlusal load distribution. Late failures have been linked to peri-implant infection and occlusal overload¹.

The epidemiology of peri-implantitis is largely unknown, and it has been greatly impacted by the absence of an established diagnostic criteria². Recently, a new classification scheme was performed for periodontal and peri-implant diseases and conditions³. This was important to define the diagnostic parameters of these diseases, reducing the results bias of future studies and facilitating disease identification and treatment. Peri-implant diseases are characterized by inflammation of the surrounding peri-implant tissues and subsequent progressive loss of supporting bone. This condition has been associated with patients with a history of periodontal disease and poor plaque control³. Peri-implant mucositis is a reversible inflammatory condition, which occurs in the soft tissues around implants. There is strong evidence that plaque induce peri-implant mucositis. This disease is characterized by bleeding on probing and visual signs of inflammation³. In a recent meta-analysis⁴ forty-seven studies were selected and prevalences of peri-implant diseases were analyzed. Results showed weighted mean implant-based and subject-based peri-implantitis prevalences of 9.25% and 19.83% respectively. Regarding periimplant mucositis, weighted mean implant-based and subject-based were 29.48% and 46.83% respectively, clearly underscoring the magnitude of the problem.

Several environmental, behavioral, systemic and oral health factors have been associated with the establishment and progression of peri-implantitis, including smoking, history of periodontitis, poor oral hygiene, and diabetes^{4,5}. Other factors such as genetic factors, osteoporosis, occlusal overload, lack of keratinized mucosa, and implant surface roughness have also been investigated⁶⁻⁹. Whereas the amount of evidence linking some of these factors to peri-implantitis has recently increased, proper long-term risk assessment is still scarce in the literature and presents very heterogeneous results.

The aim of this study was to determine the prevalence and risk indicators for peri-implantitis 8 to 10 years after loading. In addition, the long-term success and survival rates of the osseointegrated dental implants were assessed.

MATERIAL AND METHOD

Study Design and Sample

A total of 495 partially-edentulous individuals treated with dental implants at the School of Dentistry at Araraquara (UNESP) were invited to participate in this cross-sectional study. They received oral rehabilitation between 2003 and 2005, which allowed the dental implants to be 8 to 10 years in function. Individuals who received at least one implant were eligible to be included in the study. The exclusion

criteria were individuals that received periodontal treatment and/or antibiotics/anti-inflammatory therapy within the last three months. The protocol of the present study was approved by the Ethics in Human Research Committees of the School of Dentistry at Araraquara (Protocol number CAAE 07513812.3.0000.5416). Written informed consent was obtained from each participant. This study was in accordance with the Helsinki Declaration of 1975, as revised 2004. STROBE guidelines were followed.

Eligible participants were invited to a follow-up visit by telephone calls. Subjects who failed to respond to three consecutive calls in separated occasions were considered uncontactable and were not considered.

Interview and Clinical Examination

At the 8-10-year follow-up, information such as age, medical history, medications and smoking habits was obtained during an interview with patients using a structured questionnaire. In addition, the number of installed implants and region, characteristics of implants and prosthetic rehabilitation aspects were collected from the patients' records.

The clinical examination was carried out by a single trained and calibrated examiner (L.G.N.). Duplicate exams were done 48 hours apart in 10% of the sample, and the intra-examiner correlation was 0.80 (Wilcoxon test $p > 0.05$; Spearman correlation $r = 0.81$). The following parameters were recorded during the clinical exam: plaque index (PI); gingival index (GI); probing pocket depth (PD); bleeding on probing (BOP); clinical attachment level (CAL), suppuration. PI, GI, BOP and suppuration were registered as presence or absence. These parameters were assessed in four sites per implant or tooth and the other parameters in six sites. A North-Carolina periodontal probe (Hu-friedy®, Chicago, IL, USA) was used for teeth, and a Colorvue® plastic periodontal probe (Hu-friedy®) was used for implants.

A panoramic radiography (Dentsply Sirona®, Bonn, Rhineland, Germany) was obtained for each participant for general oral health assessment. Digital periapical radiographs (Saevo®, Ribeirão Preto, São Paulo, Brazil) using a parallel and long cone technique were taken for dental implants. All radiographs were performed at the same oral radiology center.

Case Definitions

The case definition of periodontitis was determined as the presence of four or more teeth with at least one site with $PD \geq 4$ mm, $CAL \geq 3$ mm, and BOP. Implant success was defined as absence of signs of inflammation and bleeding on probing³. Besides that, no peri-implant infection, mobility, persistent pain or dysesthesia, and continuous radiolucency around the implant were accepted¹⁰. Peri-implant health can exist around implants with normal or reduced bone support³. Implant failure was defined as implants that had been lost or removed, or implants that were broken or with mobility. The case definition of peri-implantitis was determined as presence of BOP and/or suppuration, $PD \geq 5$ mm, and radiographic bone loss ≥ 2 mm¹¹. Peri-implant mucositis was defined as presence of BOP and signs of inflammation³ with no radiographic active bone loss regardless of the PD value.

The case definitions of diabetes, osteoporosis, thyroid problems, cardiovascular disease and smoking were performed by a questionnaire and the patients should present a medical diagnosis and treatment. For thyroid problems were considered patients with hypo or hyperthyroidism or patients with any dysfunction on thyroid that interfered with hormone production and required drug therapy. For cardiovascular disease were included patients with hypertension, acute myocardial infarction, angina pectoris, heart valve disease, congenital heart disease, endocarditis, cardiac arrhythmias, myocarditis and tumors in the heart. For smoking, patients were divided in patients who never smoked and smoking or ex-smoking patients.

Data Analysis

For data analysis, the STATA software (Stata for Mac, version 13, Apple Inc., Cupertino, CA, USA) was used. Preliminary analyzes of the association between peri-implantitis and predictive variables were performed using the chi-square test with Fisher correction for analysis at the level of individuals and the chi-square test adjusted for observations of clusters within individuals for analysis at the level of the implants. Generalized Estimating Equations were used to model the association taking into account the clustering of teeth in individuals. The implant was used as the unit of analysis and exchangeable working correlation, logit link and semi-robust standard errors were used to estimate the “odds ratio” and their respective 95% confidence intervals. Adjusted and unadjusted analyzes were performed. Statistical significance was set at 5%.

A purposeful selection of variables was used for the statistical modeling¹². Initially, a preliminary analysis was performed using univariate models, and all the variables associated with $p < 0.25$ were included in the multivariate model. The variables that did not contribute significantly to the multivariate model were assessed for confounding before being eliminated. Multivariate models with and without the potential confounding factors were compared and a change $>25\%$ in the coefficients of the other variables was used to define a variable as a confounding factor. Only age was considered as a confounder and was retained in the final model.

RESULT

Of all the 495 individuals who received implant surgery between 2003 and 2005, 357 (72%) patients were not available or could not be located, 61 (12%) patients declined to participate in the study, and 3 patients passed away. A total of 74 patients agreed to participate, however, only 51 (10%) patients were available for a clinical and radiographic examination, and 1 of these patients was not included in agreement with the exclusion criteria of the study. Thus, the final sample consisted of 50 partially edentulous patients (19 males and 31 females) who had received 211 implants with acid etched surface (Porous® Conexão Sistemas de Próteses, Arujá, Brazil). Overall, 206 implants could be evaluated, and they were categorized as follows: 172 successful, 25 failing, 9 submerged, and 5 implants were lost. Thus, the survival rate was 97.6% and the success rate was 81.5%. Four patients (8%) had lost implants: one patient lost two implants and the others lost one implant. Of these two patients had lost all their implants. Sample and implant characteristics are described in Table 1.

Table 1. Sample distribution according to subject- and implant-level predictors. Analysis based on 48 subjects and 197 implants, exchangeable correlation, binomial distribution

		Subjects		Implants	
		n*	%	n*	%
Subject level variables					
Gender	male	18	37.5	79	40.1
	female	30	62.5	118	59.9
Age	≤40	7	14.6	24	12.2
	41-64	26	54.2	94	47.7
	≥65	15	31.3	79	40.1
Diabetes	no	42	87.5	170	86.3
	yes	6	12.5	27	13.7
Osteoporosis	no	40	83.3	164	83.2
	yes	8	16.7	33	16.8
Thyroid problems	no	40	83.3	155	78.7
	yes	8	16.7	42	21.3
Cardiovascular disease	no	42	87.5	167	84.8
	yes	6	12.5	30	15.2

Table 1. Continued...

		Subjects		Implants	
		n*	%	n*	%
Smoking	never	33	68.8	123	62.4
	ever	15	31.3	74	37.6
Full-mouth visible plaque	<30 sites	37	77.1	148	75.1
	≥30% sites	11	22.9	49	24.9
Full-mouth BOP	<30 sites	20	41.7	81	41.1
	≥30% sites	28	58.3	116	58.9
Full-mouth PD≥4mm**	<10 sites	39	81.3	156	79.2
	≥10% sites	9	18.8	41	20.8
Full-mouth CAL≥4mm**	<30 sites	35	72.9	145	73.6
	≥30% sites	13	27.1	52	26.4
Periodontitis	no	24	50.0	98	49.7
	yes	24	50.0	99	50.3
Implant level variables					
Location	Max ant			56	28.4
	Max post			41	20.8
	Mand Ant			10	5.1
	mand Post			90	45.7
Visible plaque	no			114	57.9
	yes			83	42.1
PD (deepest site)	≤3mm			73	37.1
	≥4mm			124	62.9
Cemented crowns	no			104	52.8
	yes			93	47.2
Number of units	Single			81	41.1
	Multiple			116	58.9
Crown adaptation	No			39	19.8
	Yes			158	80.2
Total		48	100.0	197	100.0

BOP, bleeding on probing; PD, probing depth; CAL, clinical attachment level. *n = number of individuals. **Parameter evaluated only in teeth.

From 197 implants in 48 subjects clinically evaluated, 103 (52.3%) implants were diagnosed with mucositis and 25 (12.7%) with peri-implantitis. At individual level analysis, 37 (77.1%) patients had mucositis and 14 (29.2%) had peri-implantitis. The risk indicator factors evaluation for the peri-implantitis occurrence was based on the data of 48 patients and 197 implants clinically assessed (Table 2). Peri-implantitis was significantly more prevalent in individuals with BOP (full month) in 30% or more of the evaluated sites (including teeth and implants). At implant level analysis, peri-implantitis was significantly more frequent in individuals with osteoporosis and BOP in 30% or more of the evaluated sites.

Table 2. Peri-implantitis distribution according to subject- and implant-level predictors

		Subjects with peri-implantitis			Implants with peri-implantitis		
		No	Yes	p*	No	Yes	p*
Subject level variables							
Gender	male	14	4		71	8	
	female	20	10	0.52	101	17	0.59

Table 2. Continued...

		Subjects with peri-implantitis			Implants with peri-implantitis		
		No	Yes	p*	No	Yes	p*
Age	≤40	5	2		22	2	
	41-64	20	6		85	9	
	≥65	9	6	0.51	65	14	0.38
Diabetes	no	30	12		148	22	
	yes	4	2	0.99	24	3	0.80
Osteoporosis	no	30	10		147	17	
	yes	4	4	0.21	25	8	0.04
Thyroid problems	no	28	12		134	21	
	yes	6	2	0.99	38	4	0.63
Cardiovascular disease	no	30	12		146	21	
	yes	4	2	0.99	26	4	0.87
Smoking	never	25	8		109	14	
	ever	9	6	0.32	63	11	0.43
Full-mouth visible plaque	<30 sites	28	9		132	16	
	≥30% sites	6	5	0.26	40	9	0.22
Full-mouth BOP	<30 sites	18	2		78	3	
	≥30% sites	16	12	0.02	94	22	0.01
Full-mouth PD≥4mm**	<10 sites	28	11		137	19	
	≥10% sites	6	3	0.99	35	6	0.78
Full-mouth CAL≥4mm*	<30 sites	23	12		123	22	
	≥30% sites	11	2	0.29	49	3	0.22
Periodontitis	no	15	9		82	16	
	yes	19	5	0.34	90	9	0.15
Implant level variables							
Location	Max ant				51	5	
	Max post				33	8	
	Mand Ant				8	2	
	Mand Post				80	10	0.58
Visible plaque	no				104	10	
	yes				68	15	0.17
PD (deepest site)	≤3mm				69	4	
	≥4mm				103	21	0.08
Cemented crowns	no				89	15	
	yes				83	10	0.51
Number of units	Single				72	9	
	Multiple				100	16	0.64
Crown adaptation	No				34	5	
	Yes				138	20	0.79
Total		34	14		172	25	

BOP, bleeding on probing; PD, probing depth; CAL, clinical attachment level. *p = p value. Statistical significance p < 0,05.
**Parameter evaluated only in teeth.

In the univariate analysis (Table 3), osteoporosis (OR = 2.48) and generalized BOP (OR = 6.40) were significantly associated with peri-implantitis. A borderline significant association was observed between peri-implantitis and PD \geq 4 mm (p = 0.08). No significant associations were observed for other variables. In the multivariate analysis (Table 4), significant associations between peri-implantitis and osteoporosis (OR = 2.84), diabetes (OR = 0.22), generalized BOP (OR = 8.03), and periodontitis (OR = 0.24) were observed at the patient level analysis. At implant level, peri-implantitis was associated with the presence of visible plaque (OR = 4.45) and PD \geq 4 mm (OR = 4.47). Age was retained in the final model because it interacted with other predictors.

Table 3. Univariable analysis of the association between periimplantitis and subject- and implant-level predictors using Generalized estimating equations. Analysis based on 48 subjects and 197 implants, exchangeable correlation, binomial distribution

		Odds Ratio	95% CI*		p**
Subject level variables					
Gender	male	1			
	female	1.39	0.42	4.67	0.59
Age	\leq 40	1			
	41-64	1.15	0.24	5.37	0.86
	\geq 65	2.26	0.51	9.99	0.28
Diabetes	no	1			
	yes	0.84	0.21	3.38	0.80
Osteoporosis	no	1			
	yes	2.48	1.03	5.95	0.04
Thyroid problems	no	1			
	yes	0.70	0.16	2.99	0.63
Cardiovascular disease	no	1			
	yes	1.13	0.27	4.74	0.87
Smoking	never	1			
	ever	1.55	0.53	4.59	0.43
Full-mouth visible plaque	<30 sites	1			
	\geq 30% sites	1.96	0.67	5.70	0.22
Full-mouth BOP	<30 sites	1			
	\geq 30% sites	6.40	1.49	27.49	0.01
Full-mouth PD \geq 4mm***	<10 sites	1			
	\geq 10% sites	1.22	0.31	4.72	0.78
Full-mouth CAL \geq 4mm***	<30 sites	1			
	\geq 30% sites	0.36	0.07	1.84	0.22
Periodontitis	no	1			
	yes	0.45	0.16	1.32	0.15
Implant level variables					
Location	Max ant	1			
	Max post	2.41	0.59	9.83	0.22
	Mand Ant	2.54	0.40	16.23	0.33
	Mand Post	1.38	0.48	3.95	0.55
Visible plaque	no	1			
	yes	2.21	0.72	6.75	0.17
PD (deepest site)	\leq 3mm	1			
	\geq 4mm	3.60	0.86	14.95	0.08

Table 3. Continued...

		Odds Ratio	95% CI*		p**
Cemented crowns	no	1			
	yes	0.75	0.32	1.77	0.51
Number of units	Single	1			
	Multiple	1.26	0.48	3.32	0.64
Crown adaptation	No	1			
	Yes	0.87	0.30	2.48	0.79

BOP, bleeding on probing; PD, probing depth; CAL, clinical attachment level. *CI = Confidence Interval. **p = p value. Statistical significance $p < 0,05$. ***Parameter evaluated only in teeth.

Table 4. Multivariable analysis of the association between peri-implantitis and subject- and implant-level predictors using Generalized estimating equations. Analysis based on 48 subjects and 197 implants, exchangeable correlation, binomial distribution

		Full-model			Final (reduced) model				
		Odds Ratio	95% CI*		p**	Odds Ratio	95% CI		p
Age	≤40	1				1			
	41-64	0.76	0.20	2.88	0.69	1.03	0.35	3.03	0.96
	≥65	2.03	0.59	7.01	0.26	2.84	0.89	9.07	0.08
Diabetes	no	1				1			
	yes	0.17	0.03	0.86	0.03	0.22	0.05	0.87	0.03
Osteoporosis	no	1				1.00			
	yes	2.83	1.03	7.81	0.04	2.87	1.06	7.82	0.04
Full-mouth visible plaque	<30 sites	1							
	≥30% sites	1.60	0.51	5.06	0.42				
Full-mouth BOP	<30 sites	1				1.00			
	≥30% sites	6.56	1.69	25.54	0.01	8.03	1.95	32.98	0.004
Full-mouth CAL≥4mm***	<30 sites	1							
	≥30% sites	0.51	0.11	2.38	0.39				
Periodontitis	no	1				1			
	yes	0.30	0.11	0.84	0.02	0.24	0.10	0.58	0.001
Location	Max ant	1							
	Max post	1.92	0.39	9.50	0.43				
	Mand Ant	3.05	0.58	15.92	0.19				
	Mand Post	2.14	0.65	7.02	0.21				
Visible plaque	no	1				1			
	yes	4.42	1.39	13.99	0.01	4.45	1.43	13.89	0.01
PD (deepest site)	≤3mm	1				1			
	≥4mm	4.70	0.91	24.43	0.07	4.47	1.09	18.35	0.04

BOP, bleeding on probing; PD, probing depth; CAL, clinical attachment level. *CI = Confidence Interval. **p = p value. Statistical significance $p < 0,05$ ***Parameter evaluated only in teeth.

DISCUSSION

In the present study, the reported implant success and survival rates of 81.5% and 97.6% respectively, after a period of 8 to 10 years of function, should be considered a very satisfactory

result. According to Albrektsson et al.¹³, 1986, an implant system could be considered effective if a minimum success rate of 80% was achieved after 10 years of function. Similar survival rates were obtained in a retrospective study, whose analysis resulted in a 10-year implant survival rate of 98.8% and a success rate of 97%¹¹.

A high prevalence of mucositis was observed in this study, 77.1% and 52.3% at individual and implant level respectively. These results are in accordance with the study of Lindhe, Meyle¹⁴, that identified the presence of mucositis in 80% of subjects and 50% of sites restored with implants. However, a systematic review of 2015¹⁵ evaluated fifteen articles and estimated weighted mean prevalences of peri-implant mucositis of 43%. The concern related with the high prevalence of mucositis is due to the risk of untreated sites developing into periimplantitis¹⁶, especially if they are not included in a preventive maintenance program. While mucositis can be treated successfully with non-surgical mechanical debridement, this treatment modality has limited efficacy for peri-implantitis. Therefore, the treatment of early sign of inflammation is essential to prevent or limit marginal bone loss¹⁷.

Peri-implantitis has been considered one of the major reason for late implant loss. However, its prevalence value varies considerable in the literature. According to the systematic review of Derks, Tomasi¹⁵, the prevalence of peri-implantitis was 22% (range, 1 to 47%). The prevalence of peri-implantitis in our sample amounted 29.2% at individual level and 12.7% at implant level. Similar values were reported in other studies. Atieh et al.¹¹ reported the occurrence of peri-implantitis in 18.8% of participants and 9.6% of implants.

For adequate diagnosis and prevention of peri-implantitis, annual radiographic exams are requested from the moment of prosthetic crown placement³. However, as this study is a retrospective study and the patients were not in follow-up after implant and prosthetic crown placement, anterior periapical radiographs were not obtained. Therefore, it was not possible to perform a comparative of activity and extension of bone loss caused by the peri-implantitis of each patient. This is a limitation of the study, where we are based on the current clinical and radiographic findings of patients to configure them with periimplant diseases or periimplant health.

Regarding the risk of peri-implant diseases, several authors have reported that subjects with a history of periodontal disease may be at greater risk for implant failure. Schwarz et al.¹⁸ in a narrative review, showed that there is an increased risk of developing peri-implantitis in patients who have a history of chronic periodontitis, poor plaque control skills and no regular maintenance care after implants therapy. Surprisingly, we identified a negative relationship in the multivariate analysis between the presence of periodontitis and peri-implantitis prevalence (OR = 0.24). This unexpected result may be justified by the parameters used in the present study to define the presence of periodontitis and the comparatively small sample size. On the other hand, our data demonstrate that the presence of sites with PD \geq 4 mm (OR = 4.47) and the presence of visible plaque (OR = 4.45) around the implant were significantly associated with a higher occurrence of peri-implantitis. Moreover, individuals with bleeding on probing in more than or equal 30% of sites (OR = 8.03) was at a significantly higher risk of developing peri-implantitis. The systematic review by Zangrando et al.¹⁹ showed that patients diagnosed with periodontitis undergoing appropriate therapy and regular maintenance could be successfully treated with dental implants (implant survival rate of 92.1% after 10 years of follow-up). Residual pockets, noncompliance with a regular maintenance program, and smoking were described as negative factors for long-term implant outcomes.

Although previous studies have found a positive association between smoking habits and peri-implantitis prevalence^{4,20} this correlation is contradictory²¹. In the present study, individuals that smoked 10 cigarettes or more per day were considered smokers. Only 2 patients were classified as smokers and 13 patients were former smokers. Thus, smokers and former smokers were included in a single category to enable the statistical analysis. According to our results, the

smoking habit was not associated with an increased occurrence of peri-implantitis. Ata-Ali et al.²¹ in their prospective cross-sectional study involving heavy smokers and non-smokers may conclude that smoking, when analyzed alone, does not influence immunological and microbiological parameters in dental implants. Although smoking habit is not considered an absolute contraindication for dental implants treatment, it is a relevant factor for the initiation and progression of peri-implantitis and with that, peri-implant marginal bone loss¹⁷.

Guobis et al.²² in a systematic review verified that osteoporosis cannot be considered a significant risk factor for implant success. On the other hand, Alsaadi et al.²³ reported significant correlation between the osteoporosis and implant failure. The osteoporosis presence was significantly associated with higher peri-implantitis prevalence at individual level in our study (OR = 2.84). Despite our limited sample size, the association between osteoporosis and peri-implantitis observed in the present study suggests that this relation needs to be more investigated under other methodological approaches including laboratorial hormonal examinations.

Naujokat et al.²⁴ in a systematic review of 22 clinical studies and 20 publications in the aggregate literature concluded that patients with poorly controlled diabetes have impaired osseointegration, a high risk of periimplantitis, and a higher level of implant failure. However, Dowell et al.²⁵, evaluating 50 implants in 35 individuals stratified by glycated hemoglobin levels, observed that there was no evidence of clinical failure and healing changes associated with dental implant therapy in individuals with type 2 diabetes mellitus, controlled based on glycated hemoglobin levels. In the present study, the presence of type-2 diabetes mellitus had a protective effect for peri-implantitis (OR = 0.22). However, laboratory tests were not conducted to check the blood sugar levels in the patients considered to have type-2 diabetes. Moreover, there were only six patients with diagnose of diabetes in our sample. Consequently, these limitations could have influenced the results obtained in the present study.

All patients included in this study received implants from the same manufacturer. Therefore, the surface roughness and other implant characteristics could not be evaluated as risk indicators for peri-implantitis. The high patient's evasion observed could be related to the retrospective character of this study where in the recall evaluation was performed after a relatively long period from the prosthetic rehabilitation. These patients were not included in a regular maintenance program after the treatment with osseointegrated dental implants. Most of them (72%) were not available or could not be located for a clinical and radiographic examination of the implants after 8-10 years of function. Since conflicting results could be observed in the literature regarding risk indicators for peri-implantitis, prospective studies are required in order to determine true risk factors for peri-implantitis.

The success and survival rates of osseointegrated implants after 8-10 years of function were 82% and 97.6%, respectively. The prevalence of mucositis and peri-implantitis was 52.3% and 12.7% for implants and 77.1% and 29.2% for patients. Subjects with osteoporosis and with full-mouth BOP scores $\geq 30\%$ of the sites as well as implants with visible plaque and sites with PD ≥ 4 mm were more susceptible to peri-implantitis. Therefore, our results, notwithstanding the limitations of the study regarding sample size, suggest that osteoporosis, diabetes and generalized periodontal/peri-implant mucosa inflammation increase the likelihood of peri-implantitis.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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