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Prevalence and risk variables for peri-implant disease in Brazilian subjects

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Abstract

Objectives: The aim of this study was to verify the prevalence of peri-implant disease and analyse possible risk variables associated with peri-implant mucositis and peri-implantitis. The study group consisted of 212 partially edentulous subjects rehabilitated with osseointegrated implants.

Material and Methods: The implants placed were examined clinically and radiographically to assess the peri-implant status. The degree of association between peri-implant disease and various independent variables was investigated using a multinomial regression analysis.

Results: The prevalence of peri-implant mucositis and peri-implantitis were 64.6% and 8.9%, respectively. In univariate modelling, healthy peri-implant subjects presented lower plaque scores, less periodontal bleeding on probing, and less time elapsed since placement of supra-structures. In multivariate analyses, the risk variables associated with increased odds for having peri-implant disease included: gender, plaque scores, and periodontal bleeding on probing. Presence of periodontitis and diabetes were statistically associated with increased risk of peri-implantitis. The only two factors, which did not contribute to the presence of the disease, were the time elapsed since placement of supra-structures and the frequency of visits for maintenance care.

Conclusion: Our data suggest that subjects with periodontitis, diabetes, and poor oral hygiene were more prone to develop peri-implantitis.

Key words: osseointegrated implants; peri-implant disease; peri-implant mucositis; peri-implantitis; risk factors

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The well-documented high success rates of osseointegrated dental implants has lead to their use as a common clinical protocol to reestablish oral health in edentulous and partially edentulous subjects (Adell 1983, Quirynen et al. 1992, Karoussis et al. 2003, Lang et al. 2004). Nevertheless, the long-term maintenance of osseointegration, after incorporation of supra-structures, depends on the healthy preservation of marginal soft and hard peri-implant tissues.

Biological complications in implants, such as peri-implant mucositis and peri-implantitis, have been described in some studies; however, data regarding the prevalence of these conditions are inconsistent (Berglundh et al. 2002, Pjertusson et al. 2004, Fransson et al. 2005, Roos-Jansaker et al. 2006). The presence of different risk variables, together with their role in the aetiopatogenesis of peri-implant disease, needs to be clarified in order to further elucidate the health/disease process affecting the marginal tissues surrounding dental implants. Controversial data is available in dental literature about the risk variables and subjects who present a higher risk of developing peri-implant disease. Moreover, only a few studies have been designed to identify the possible risk variables that may in fact influence the occurrence of peri-implant disease (Brägger et al. 1997, Karoussis et al. 2004, Roos-Jansaker et al. 2006).

The aim of the present study was to identify the prevalence of peri-implant disease in partially edentulous subjects treated with osseointegrated implants, using clinical parameters, as well as to analyse the possible disease association with demographic, behavioural, and biological risk variables.

Material and Methods

The present study was performed in accordance with the Helsinki declaration of human studies and received approval from the Ethics Committee of the Federal University of Minas Gerais. In addition, an informed written consent was obtained from each subject.

All biological complication in teeth and implants were treated after the evaluation.

Inclusion and exclusion criteria

This cross-sectional study included 212 subjects treated with dental implants (Nobel BioCare®, Göthenburg, Sweden; 3i® Implant Innovations Inc., Palm Beach Gardens, FL, USA; Intra-lock® International Inc., Boca Raton, FL, USA) placed according to the manufacturer's guidelines. All partially edentulous subjects treated with osseointegrated implants, performed by post-graduate students, at five dental schools in Belo Horizonte, Brazil were candidates for inclusion in the study. Individuals who had used antibiotic therapy 2 months before the exam were excluded. Smokers and former smokers who had quit smoking at least 3 years before the study were also excluded, which accounted for 8% (17) of the subjects. At the time of examination, all implants should have been in function for no less than 6 months up to 5 years.

Patients' records data

The records of the appointments with the dentist for routine maintenance were checked in the files. This visits consisted of examination, polishing of teeth and implants with rubber cups, and scaling and root planning when necessary. Also reinforcement of oral hygiene care was provided. Subjects were then divided into two groups: the first with a frequency $\leqslant 6$ months (regular visits) and the second with a frequency >6 months (episodic visits).

Glycaemic data at the time of implant surgery were checked in subjects' files. For all subjects diagnosed as diabetics at the time of surgery as well as for those who reported having the disease at the time of evaluation, a new exam was requested. Diabetes mellitus was diagnosed if an individual had fasting blood sugar $\geqslant 126$ mg/dl or had been taking anti-diabetic medicine over the past 2 weeks (Diabetes Care 2003).

Peri-implant clinical examination

Two trained periodontists, blinded to the patient's identity and medical history, were calibrated at the beginning of the study to the following parameters: peri-implant and periodontal probing depths (PD), periodontal clinical attachment levels (CAL), and radiographic measurements of peri-implant bone loss (BL). Intra- and inter-examiner reliability was recorded until satisfactory agreement was reached. All unweighted κ scores were greater than 0.75 and intra-class correlation coefficients were 0.90 or higher. All clinical parameter measurements were performed manually at each implant and tooth site to the nearest millimeter, using a Hu-Friedy® PCP-UNC 15 periodontal probe (Hu-Friedy®, Chicago, IL, USA). The clinical exam included the assessment of the following parameters at four aspects of each implant: the modified plaque index (mPLI) according to Mombelli et al. (1987), the peri-implant PD, peri-implant bleeding on probing (BOP), and peri-implant suppuration (S).

Radiographic examination

Radiographic examination was obtained from implants presenting a PD $\geqslant 5$ mm (Brägger et al. 1996) to assess the presence of peri-implant bone loss. The same examiner who carried out the clinical evaluation also performed this procedure. Intra-oral radiographs were taken with a dental X-ray machine operating at 70 kV using the long-cone technique. The BL was recorded as present when the presence of a vertical bone defect in proximal surfaces was identified. Known marks on the implants (smooth parts and threads) were used as reference points.

Peri-implant mucositis was defined as the presence of peri-implant BOP while peri-implantitis was defined as the presence of PD $\geqslant 5$ mm in association with peri-implant BOP and/or S. In addition, following the diagnostic sequence the presence of vertical BL should be confirmed by radiographic exams for all different implant systems (Karoussis et al. 2003). Cases in which the radiographic exams did not confirm bone loss were diagnosed as peri-implant mucositis.

Periodontal clinical examination

In order to assess the subjects' periodontal status, all teeth were examined, except the third molars, under the following parameters: plaque index (PLI) according to Silness & Löe (1964), periodontal PD, CAL and BOP. Periodontitis was diagnosed as the presence of four or more teeth with one or more sites with PD $\geqslant 4$ mm and CAL $\geqslant 3$ mm at the same site (Lopez et al. 2002). The full-mouth plaque scores were stratified as follows: median scores $\leqslant 1$ (good), median scores >1 and <2 (poor), and median scores $\geqslant 2$ (very poor). Periodontal BOP was also stratified as $\leqslant 30\%$ and >30% of sites affected.

Statistical analysis

Individual patient data, including demographic, peri-implant, and periodontal variables, were transcribed into a statistical software program for PC (SPSS 12.0, SPSS Inc., Chicago, IL, USA). Statistical analyses included descriptive statistics for the clinical parameters assessed at four sites of implants and teeth. In order to evaluate the influence of independent variables (age, gender, plaque scores, periodontitis, periodontal BOP, diabetes, time elapsed since placement of supra-structure, and regular professional care visits) in peri-implant disease diagnosis, the Pearson χ^2 test was performed. To investigate the degree of association, the multinomial logistic regression model was used. The outcome was peri-implant disease, by which the risk for having peri-implant mucositis or peri-implantitis was predicted using healthy peri-implant subjects as the reference group. Independent variables included factors that could most probably be associated with peri-implant disease. The Wald statistic was used to determine statistical significance. Unadjusted odds ratios (OR) and their 95% confidence intervals (CI) were calculated for each independent variable. To build the multivariate model, all variables were entered, and those with $p \geqslant 0.05$ were removed one by one from the model. The most adequate statistic test was performed using the Pearson χ^2 test. The adjusted ORs and their CIs were calculated for each variable included in the model.

Results

Two hundred and twelve subjects who fulfilled the inclusion criteria were evaluated in a total of 578 implants and 4687 teeth. The implant system distribution was homogeneous in the sample, 183 (35.3%) Nobel Biocare®, 191 (31.7%) 3i® Implant Innovations Inc., 204 (33.0%) Intra-lock® International Inc. In this study, it was found that 26.4%

Table 1. Periodontal and peri-implant status (n = Total number of subjects)

Subjects	$n = 212$	%
Periodontal PD $\geqslant$ 4 mm	37	17.4
CAL $\geqslant$ 3 mm	41	19.3
Periodontal BOP	174	82.1
Peri-implant PD $\leqslant$ 3 mm	199	93.8
Peri-implant PD = 4 mm	88	41.5
Peri-implant PD $\geqslant$ 5 mm	45	21.2
Peri-implant BOP	156	73.5
Peri-implant mucositis	137	64.6
Peri-implantitis	19	8.9

PD, probing depth; CAL, clinical attachment level; BOP, bleeding on probing.

($n = 56$) of the subjects had healthy peri-implant tissues and 64.6% ($n = 137$) had peri-implant mucositis, while the prevalence of peri-implantitis was observed in 8.9% ($n = 19$). The prevalence in implants for peri-implant mucositis was 62.6% ($n = 362$) whereas for peri-implantitis it was 7.44% ($n = 43$). Periodontitis was diagnosed in 14.2% ($n = 30$). The distribution of periodontal and peri-implant PDs, BOP, and periodontal CAL are shown in Table 1. In a total of 2290 evaluated sites, 101 (4.4%) had peri-implant PD $\geqslant$ 5 mm, most of which (72.2%) presented a peri-implant PD $\leqslant$ 3 mm. Because of overhanging in supra-structures, only 1% of the sites were excluded because we were unable to perform PD procedures. Demographic and behavioural data, as well as the association between peri-implant disease and a variety of independent variables, were analysed in the univariate model (Table 2). The mean loading time of the implants was 42.5 (SD = 17.1) months. Healthy peri-implant subjects were younger ($\leqslant$45 years of age) and female ($p < 0.05$). Higher total plaque scores were statistically associated with peri-implant disease, and a very poor status of oral hygiene was highly associated with peri-implantitis. The periodontal status was statistically associated with a worse peri-implant condition; this could be observed through the association found among the presence of peri-implant disease, the diagnosis of periodontitis, and the presence of periodontal BOP > 30%. In our study we observed that subjects with diabetes were more susceptible to develop peri-implant mucositis and peri-implantitis. Statistically significant differences were found in peri-implant conditions in subjects presenting implants with more than 42 months after the incorporation of the supra-structure. Only the frequency of visits to the dentist to provide maintenance care was not statistically associated with the outcomes of peri-implant mucositis and peri-implantitis (p>0.05).

The degree of association of all independent variables was tested using the multinomial logistic regression analysis, as presented in Table 3. This model showed that age and gender were positively associated with peri-implant disease; nevertheless, age was not associated with peri-implant mucositis. The association between plaque scores and peri-implant disease seems to be dose dependent; subjects with higher plaque

Table 2. Association between peri-implant mucositis, peri-implantitis and independent variables

Variable	$n = 212$ (100%)	Healthy (%)	Peri-implant Mucositis (%)	Peri-Implantitis (%)
Age (years)*				
$\leqslant$45	70 (33.0)	34.29	58.57	7.14
>45	142 (67.0)	22.55	67.60	9.85
Gender*				
Male	115 (54.2)	18.27	70.43	11.30
Female	97 (45.8)	36.09	57.73	6.18
Plaque score* (median)				
Good (0.3)	43 (20.28)	41.87	55.81	2.32
Poor (1.3)	123 (58.01)	25.21	66.66	8.13
Very poor (2.5)	46 (21.71)	15.31	67.39	17.3
Periodontitis*				
Yes	30 (14.2)	30.01	43.33	26.66
No	182 (85.8)	25.83	68.13	6.04
Periodontal BOP*(%)				
>30	165 (77.8)	26.67	64.24	9.09
$\leqslant$30	47 (22.2)	25.53	65.96	8.51
Diabetes*				
Yes	29 (13.7)	17.25	58.62	24.13
No	183 (86.3)	27.87	65.57	6.56
Time since placement of supra-structure* (months)				
>42	95 (44.8)	27.37	63.16	9.47
$\leqslant$42	117 (55.2)	25.64	65.81	8.55
Maintenance visit				
$\leqslant$6	94 (44.3)	29.79	61.70	8.51
>6	118 (55.7)	23.73	66.95	9.32

*$p < 0.05$.
BOP, bleeding on probing.

Table 3. Multinomial logistic regression analysis

Variable	Adjusted OR (95% CI) Peri-implant mucositis	Adjusted OR (95% CI) Peri-implantitis
Age > 45 years	1.3 (1.0–1.7)	1.7 (1.3–2.8)
Male	1.7 (1.5–2.9) $p = 0.0027$	2.7 (2.1–6.3) $p = 0.0018$
Plaque Score (poor)	1.9 (1.2–2.3) $p = 0.0021$	3.8 (2.1–6.8) $p = 0.0024$
Plaque Score (very poor)	2.9 (2.0–4.1) $p = 0.0027$	14.3 (9.1–28.7) $p = 0.0019$
Periodontitis	1.7 (1.0–1.8)	3.1 (1.1–3.5)
Periodontal BOP > 30% sites affected	3.2 (2.0–3.3) $p = 0.0025$	3.4 (2.1–5.6) $p = 0.0017$
Diabetes	1.2 (1.0–1.8)	1.9 (1.0–2.2)
Time since placement of supra-structure > 42 months	–	–
Maintenance visits < 6 months	–	–

Unadjusted and adjusted odds ratio (OR) and 95% confidence intervals (CIs) for the risk of peri-implant mucositis and peri-implantitis.
OR and 95% CI are obtained from multinomial logistic regression analyses using individuals with healthy peri-implant tissues.
BOP, bleeding on probing.

scores presented a worse peri-implant condition. The OR for plaque score, considered very poor for peri-implantitis (OR = 14.3, 95% CI 9.1–28.7), was much higher when compared with the same level of plaque scores in peri-implant mucositis (OR = 2.9, 95% CI 2.0–4.1). The same result occurred when poor oral hygiene was observed, but the differences in OR values were lower (Table 3). As in univariate modelling, the periodontal status directly affected the peri-implant condition, in other words, a higher percentage of periodontal BOP sites >30% (OR = 3.4, 95% CI 2.1–5.6) and the diagnosis of periodontitis were positively associated with peri-implantitis (OR = 3.1, 95% CI 1.1–3.5). Subjects with uncontrolled diabetes, checked in the last glycaemic control exams, presented higher risks of developing peri-implantitis (OR = 1.9, 95% CI 1.0–2.2). The adjusted ORs for peri-implantitis were higher than those for peri-implant mucositis for all variables included in this model. Age, periodontitis, and diabetes were not significantly associated with peri-implant mucositis in an adjusted model. The only independent variables that were not associated with the main events were the frequency of visits to the dentist for maintenance care and the time elapsed since placement of supra-structure.

Discussion

The prevalence of peri-implant mucositis and peri-implantitis in this population was 64.6% and 8.9%, respectively. As reported in other studies, the prevalence values of peri-implant disease vary considerably; nevertheless, similar findings have been reported. Pjetursson et al. (2004) reported, in a systematic review, that in follow-up studies of at least 5 years, the cumulative incidence of peri-implantitis was 8.6%. In another similar review, Berglundh et al. (2002) found peri-implantitis prevalence in 6.4% of partially edentulous subjects in study periods of over 5 years. Despite the diverse criteria applied, different follow-up time periods, and different implant systems evaluated, the results of the present study are quite similar to those presented in previous literature. However, an estimation of the frequency of peri-implant disease is difficult and depends on the criteria used to separate health from disease; therefore, comparisons among studies in relation to disease prevalence rates are complex because of the inconsistency in assessment procedures. The variability in the prevalence of peri-implant disease could be explained by the different clinical parameters used to assess and define the disease in the studies, by the differing groups evaluated, and possibly by the different length time of the studies. These results should be interpreted with some caution as some studies have reported peri-implantitis prevalence as a failed implant rate, which could reflect upon lower disease rates. Moreover, the early stages of disease could not be included in those analyses.

In the present sample, the prevalence of periodontitis was found in 14.2% of the subjects. Higher rates of periodontitis have been reported in previous studies (AAP 2005). Variability of prevalence rates could be explained by different methodologies, classification systems, and clinical criteria used to identify affected subjects. In our study, the relatively low periodontitis prevalence could be influenced by two factors: the tight diagnosis criteria used to define the disease and the absence of smokers in the sample. In the same vein, subjects who receive implants should be treated for periodontal disease before the placing of the implant or should at least be part of a periodontal supportive therapy to control the disease. Thus, we can conclude that periodontitis prevalence found in the present sample is high for subjects rehabilitated with osseointegrated implants.

In the present study, 73.5% of subjects presented peri-implant BOP; similar findings have been reported in literature (Leckholm et al. 1986b, Quirynen et al. 1992). However, some studies have reported lower rates of peri-implant BOP (Adell et al. 1986, Brägger et al. 1997, Nishimura et al. 1997). Possible explanation for these differences pointed toward the probe force used in the probing procedures around implants (Salvi & Lang 2004). In a study conducted by Leckholm et al. (1986b), the authors found no correlation between BOP and radiographic, microbiologic and histological changes around implants. An animal model study confirmed these previous results, showing that PD measurements at clinically healthy gingival failed to provoke bleeding, whereas BOP was recorded from the majority of healthy implant sites (Ericsson & Lindhe 1993). It is not clearly defined if peri-implant BOP could represent a reliable parameter for the identification of the presence of peri-implant disease. Some studies have suggested that the peri-implant mucosa may be more sensitive to probing forces, and this factor could indeed account for higher BOP in these tissues when compared with teeth (Jepsen et al. 1996, Leckholm et al. 1986b). However, Luterbacher et al. (2000) have shown that the evaluation of bleeding on probing at implants could be a valuable parameter for monitoring changes in peri-implant tissues. Furthermore, this study showed higher positive and negative predictive values for implant sites compared with tooth sites. They also suggested that the absence of peri-implant BOP could indicate a stable peri-implant condition. Similar results were confirmed by Lang et al. (2000).

An important point in this study is the relatively short mean implant loading time in the evaluated sample (42.5 months). Follow-up studies of at least 5 years are recommended by the literature (Albrektsson & Sennerby 1991). Thus, the present study illustrates that the peri-implant disease prevalence rates found herein are high in relation to the relatively short period of implant loading time. Regarding this point, it must be pointed out that early failures and bone remodelling associated with short observation intervals of the implants could lead to an overestimation of peri-implantitis. However, this issue was minimized due to diagnosis criteria adopted to define the disease. Only implants showing pocket formation (PD $\geqslant$ 5 mm) and bleeding and/or suppuration after probing were radiographically evaluated. We consider that this strategy had an impact in minimizing the possible confounding factors in peri-implantitis diagnosis regarding the bone remodelling associated with the short time of implant function. Moreover, the multinomial logistic regression analysis did not maintain the time as placement of supra-structure $>$42 months as a significant factor associated with the disease, showing that this variable, in the present study, did not have an impact in the presence of peri-implantitis.

Most of the reports presented in dental literature are referent to only one implant system. The present study evaluated three different implant systems that were extensively evaluated in clinical research. The evaluation of different types of implants could more accurately reproduce a true clinical situation, as that clinical practice is not restricted to one exclusive implant. As evaluating the disease in a specific implant system was not the scope or the present study, we do not present data on this issue. However we believe that peri-implant disease does not seem to be a system-related condition, but more likely a disease associated with several risk factors and host susceptibility. Nonetheless, some data have shown different prevalence rates among implant system, such as the Branemark® system and the ITI® and IMZ® systems. Different implant designs and surface characteristics favoring plaque retention might, at least, partly explain these differences (Esposito et al. 1998a). In our study all of the implants are both screw-shaped and two-stage implants, with very similar design and surface characteristics. In this manner, the fact of evaluating different systems in the present study possibly did not influence the results.

Another specific issue related to this study is the fact that the subjects were non-smokers. The small number of former smokers in the sample is due to the protocol adopted by the schools for implant placement. Smokers and former smokers who had been smoking within the 3 years before to the study were not eligible for the present study. The exclusion of patients who are smokers eliminated tobacco use as a confounding factor or even as a risk factor in the occurrence of peri-implant disease. This is a risk variable that could account for lower success rates and possibly for higher rates of peri-implant infections as well as influence implant treatment results (Haas et al. 1996, Lindquist et al. 1997).

The relationship between peri-implant disease and periodontal variables has been previously documented (Jepsen et al. 1996, Toljanic et al. 2001, Roos-Jansaker et al. 2006). The periodontal BOP, which could reflect the amount of inflammation of the gingival tissues, emerges as a risk variable for the development of peri-implant disease. Oral hygiene status has been consistently pointed out by studies as having an important effect on peri-implant health (Salvi et al. 1999, Zitzmann et al. 2001). In this study's results, very poor oral hygiene was highly associated with the presence of peri-implantitis. These findings support early reports in literature that demonstrated the association among inflammatory signs, such as BOP with deficient oral hygiene and the occurrence of peri-implant disease (Brägger et al. 1997, Karoussis et al. 2004). This fact also highlights the primary role of plaque in disease occurrence.

The treatment of partially edentulous subjects with implants is a common procedure. This study demonstrated the association between the presence of periodontitis and the occurrence of peri-implantitis, thus showing that individuals with periodontitis were more likely to develop peri-implant inflammatory lesions. Previous studies have also established this association (Papaiouannou et al. 1996, Hämmerle & Glauser 2004), highlighting that the presence of residual periodontal pockets may represent niches of infection for adjacent implants (Mombelli et al. 1995, Brägger et al. 1997, Karoussis et al. 2003). Despite the association found in the present study, as well as in previous literature, some studies indicate that subjects with a history of periodontitis can in fact maintain healthy peri-implant tissues (Baelum & Ellegaard, 2004, Karoussis et al., 2004). Furthermore, some studies have shown that genetic variation (polymorphism) is related to the presence of peri-implantitis as well as found within the presence of periodontitis. In a recent study, Laine et al. (2006) found evidence that the IL-1RN gene polymorphism is associated with peri-implantitis and may represent a risk factor for this disease. It is currently unclear whether or not such risk factors are associated with the development of peri-implant disease (Tonetti 1998).

Little is known about the influence of diabetes, after prosthetic reconstruction, in subjects rehabilitated with dental implants (Esposito et al. 1998b). One should pay close attention to patient selection in an attempt to avoid treating subjects who have poor metabolic control with dental implants. The subject who is a candidate to receive an implant should present good systemic health, including the control of diabetes. It is well known that adults with diabetes experience a higher risk of developing periodontitis and are also more prone to infection (AAP 2000). It is possible for the same effect to occur in subjects treated with osseointegrated implants; however, previous reported results have proven to be quite controversial (Abdulwassie & Dhanrajani 2002). Our results showed that poor metabolic control in diabetic subjects increased the risk of developing peri-implantitis.

Our study points to a higher susceptibility in older individuals, while other studies claim that younger subjects had actually shown worse peri-implant conditions (Rutar et al. 2001). However, additional variables, not determined in the present investigation nor in the study conducted by the aforementioned authors, should be considered so as to account for this phenomenon.

Conclusion

Within the limits of the present research, periodontal variables (BOP and periodontitis), together with plaque scores, seem to account for the higher risk in the development of peri-implantitis. In this study, frequency of visits for maintenance care does not seem to have influenced the peri-implant health status. Poor metabolic control in diabetic subjects did not present a statistically significant association with peri-implant mucositis; however, these subjects did present a higher risk of developing peri-implantitis. In this manner, the control of oral hygiene and the periodontal status should be monitored before and after the placement of dental implants, so as to avoid, or at least minimize, the risk of developing peri-implant disease in subjects rehabilitated with implants.

The findings of the present study further elucidate the need for longitudinal investigations regarding risk variables and the inflammatory process that affects peri-implant tissues. These prospective studies should identify and clarify the potential risk effects of demographic, behavioural, and biological variables in inflammatory processes which could lead to peri-implant disease.

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Clinical Relevance

Scientific rationale: Prevalence data regarding peri-implant disease are controversial. Little is known about risk factors that may affect peri-implant tissues.

Principal findings: Peri-implantitis was found in 8.9% of the patients. Main risk factors that contributed to the presence of the disease included: poor oral hygiene, periodontal bleeding, presence of periodontitis, and diabetes.

Practical implications: It is important that periodontal health and metabolic control be established and maintained in subjects rehabilitated with osseointegrated implants. Longitudinal studies are necessary to further elucidate the role of risk variables that could affect peri-implant health.