PERI-IMPLANT DISEASES MAY BE ASSOCIATED WITH INCREASED TIME LOADING AND GENERALIZED PERIODONTAL BONE LOSS: PRELIMINARY RESULTS

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The aim of this study was to evaluate the prevalence of peri-implant diseases around Branemark system implants in Brazilians and the possible relationship with periodontal bone loss, systemic condition, and demographic profile. A total of 113 individuals were enrolled in this study, and they received 347 implants. The implants were clinically and radiographically examined and diagnosed as healthy implants, mucositis, or peri-implantitis. The demographic and systemic profiles of the individuals were assessed via questionnaires, and the time of loading was obtained from files. The presence of periodontal bone loss in partially edentulous patients was determined by standardized radiographic evaluation. With regard to implants, the prevalence was 60.5% (n = 210), 32% (n = 111), and 7.5% (n = 26) for healthy tissues, mucositis, and peri-implantitis, respectively. No correlation was found between peri-implant tissue conditions and socioeconomic status, body mass index, smoking status, gender, age, diabetes mellitus, osteopenia, and osteoporosis. Statistically significant positive correlations were found in implants with mucositis and peri-implantitis in relation to time of loading and with peri-implantitis in relation to periodontal bone loss in the 4 quadrants (P < .05). Presence of peri-implant diseases may be associated with the increasing time of loading and generalized periodontal bone loss.

Key Words: peri-implantitis, mucositis, periodontal diseases, systemic condition, dental implants, alveolar bone loss, risk factors

INTRODUCTION

For well over two decades, titanium endosseous implants have been increasingly used as an important alternative to conventional prostheses in total and partially edentulous patients. Consequently, the prevalence of early (no establishment of osseointegration or healing process) and late (breakdown of osseointegration) failures have also increased. Although early failures are related to implant and/or technique factors (material, topography, shape, surgi-
cal procedures) and patient variables (bone quantity and quality), late failures are associated with bacterial infection and/or incorrect mechanical loading. Muco-


misitis is defined as a reversible inflammatory reaction in the soft tissues around osseointegrated implants, whereas peri-implantitis is an infection resulting in a soft tissue inflammation and peri-implant bone loss. Some studies have reported the prevalence of implant failures, but the reasons for these failures have often not been described. It has been demonstrated that peri-implant dis-

eases are not uniformly distributed in all populations; they affect small groups of individuals that present a high risk for their establishment and development. Therefore, some studies have focused on identifying implants and subjects that are more often affected by soft tissue inflammation and progressive peri-implant bone loss than others. The role of some patient habits and systemic and oral conditions have been pointed out as possible risk factors. However, there is no conclusive information about the profile of subjects that present a high risk of developing peri-implant diseases. Therefore, the aim of this study was to evaluate the prevalence of peri-implant diseases around Branemark system implants in Brazilian pa-


tients and the possible relationship with periodontal bone loss, systemic condition, and demographic profile.

MATERIALS AND METHODS

Patient selection

Study subjects were 113 Brazilian patients from Guarulhos University, the School of Dentistry at Piracicaba/UNICAMP and the Brazilian Association Dental School/SP who were consecutively selected during follow-up visits from March 2006 to April 2007. The implants and prostheses had been previously placed by students of the aforementioned dental schools. Inclusion criteria were total or partially edentulous subjects treated with at least 1 machined surface Branemark system implant that had been in function for at least 1 year. Partially edentulous patients had to have at least 1 tooth in each quadrant of the residual dentition to be included. Exclusion criteria included those patients whose files had no information about implant time of loading and surface. In addition, subjects in which implant clinical diagnosis was impeded due to the design of the implant superstructure were also excluded. This protocol was previously approved by the Institutional Committee of Ethics in Dental Research, Guarulhos University. Patients were informed of the characteristics of the study and gave written consent to the described procedures.

Implant examination and diagnostic

Time of loading was checked in subjects’ files. Maxillary or mandibular implant position, presence or absence of teeth, and total number of implants were also recorded. Clinical examinations were assessed by the same operator (P.M.D.), who was trained and calibrated (SEM = 0.014). The following parameters were assessed on 6 sites of each implant using a manual periodontal probe (North Carolina, Hu-Friedy, Chicago, Ill): parameter 1 = local bleeding on probing (BOP), presence (1) or absence (0) of bleeding of up to 15 seconds after gentle probing; parameter 2 = suppuration (SUP), presence (1) or absence (0) of spontaneous suppuration or suppuration after probing; parameter 3 = probing depth (PD), distance between the gingival margin and the bottom of the peri-implant sulcus; parameter 4 = gingival marginal bleeding (GI), bleeding recorded by running a probe along the soft tissue margin. Intra-oral radiographs were obtained from each implant using the long-cone technique. The radiographs were analyzed for peri-


implant bone loss by the same calibrated examiner using smooth components and threads of the implants as reference points (PMD). After clinical and radiographic examinations, the implants were categorized according to the following criteria:

- Healthy: Presence of PD ≤ 5mm without GI/BOP/SUP and radiographic bone loss;
- Mucositis: GI and/or BOP without radiographic bone loss or presence of radiographic bone loss < 3 threads;
- Peri-implantitis: Presence of PD ≥ 5mm with BOP and/or SUP and, radiographic bone loss ≥ 3 threads.

Periodontal bone loss evaluation

In partially edentulous patients, standardized inter-

proximal radiographies were obtained using the long-

cone technique to assess the radiographic periodontal bone loss in the remaining natural dentition. The radiographic distance between the cement-enamel junction to the most coronal point of the alveolar bone crest was measured in the mesial and distal aspects of each tooth by the same calibrated examiner (J.A.F.). Radiographic bone loss (RBL) was considered when this distance exceeded 3mm in at least 1 site of at least 1 tooth. Therefore, the patients were stratified by the presence of RBL in none, 1, 2, 3, or 4 quadrants.
**Socioeconomic status, demographic profile, and systemic condition**

A feedback form was completed by the same examiner (J.A.F.) for all patients meeting the inclusion criteria, including the following items:

- **Age**
- **Gender**
- **Socioeconomic status:** According to the Brazilian Association of Market Research Institutes\(^1\) (Associação Brasileira de Institutos de Pesquisas Mercadológicas [ABIPEME]), schooling and occupation of the head of the family were worth 0 to 21 points. Other points were awarded according to the number of durable goods owned by the family and the number of rooms in the house, with emphasis on bathrooms, and the number of employees rendering services to the household. ABIPEME criteria classifies the population through the sum of the obtained points, as follows: Class E (0 to 19 points); Class D (20 to 34 points); Class C (35 to 58 points); Class B (59 to 88 points); and Class A (89 points or over). Class A and Class E represent the most and the least favored social strata, respectively.
- **Smoking habits:** Patients were classified using the following classification: current smoker, former smoker, and never smoker.
- **Body mass index:** Body mass index (BMI) was calculated as \[\text{weight (kg)} \div \text{(height m)}^2\]. The subjects were stratified following the criteria: healthy weight = BMI of 18.5 to 24.9; overweight = BMI of 25.0 to 29.9; obesity = BMI ≥ 30.0.
- **Medical history:** Focus on diabetes, osteoporosis, and osteopenia.

**Statistical analysis**

Data were analyzed using Statistical Analysis Software (SAS for Windows, version 8, SAS Institute Cary, NC) and BioEstat 4.0 software (BioEstat 4.0, Sociedade Civil [SAS for Windows, version 8, SAS Institute Cary, NC]). To evaluate the influence of subject-based independent variables (age, gender, socioeconomic status, BMI, smoking habits, diabetes, osteoporosis, osteopenia, periodontal bone loss, dentate or edentulous state) on peri-implant diagnosis, the Pearson \(\chi^2\) (parametric data) or Spearman (nonparametric data) tests were performed. If the same patient had 2 different diagnoses for different implants, the worst diagnosis was used for statistical analysis. To evaluate the influence of implant-based independent variable (time of loading) on peri-implant condition the Pearson \(\chi^2\) test were performed. The significance level established for all analyses was 5% \((P < .05)\).

**Results**

Of 224 individuals examined, 111 failed to meet the inclusion criteria and were excluded from the statistical analysis of these preliminary data. The main reasons for exclusion were no Branemark or no machined surface implants (32.5%), incomplete files (27.0%), implant suprastructure impairing clinical diagnostic (14.5%), and absence of tooth in some quadrant of the residual dentition (26.0%). Thus, the convenience sample was composed of 113 subjects with a total of 347 implants. Subject-based data revealed that 51.3% \((n = 58)\) had healthy peri-implant condition, 36.3% \((n = 41)\) had mucositis, and the remaining 12.4% \((n = 14)\) had peri-implantitis. However, it is important to observe that 51.3% \((n = 58)\) had only healthy peri-implant tissues, 9.6% \((n = 11)\) had both healthy implants and mucositis, 1.8% \((n = 2)\) had healthy implants and peri-implantitis, 6.1% \((n = 7)\) had only peri-implantitis, 4.5% \((n = 5)\) had both peri-implantitis and mucositis, and 26.7% \((n = 30)\) had only mucositis. Also, 21 patients \((18.6\%)\) had received implants in both jaws. Maxillary implants were inserted in 37 patients \((32.7\%)\) and mandibular implants in 55 patients \((48.7\%)\). With regard to implants, the prevalence was 60.5% \((n = 210)\), 32.0% \((n = 111)\), and 7.5% \((n = 26)\) for healthy tissues, mucositis, and peri-implantitis, respectively. For the study, 143 maxillary and 204 mandibular implants were evaluated.

Mean age of the patients was 54.5 ± 13.7 \((\text{range} = 20–79)\), and 74 patients were female \((65.5\%)\) and 39 were male \((34.5\%)\). Age and gender were not associated with peri-implant tissue conditions. According to the ABIPEME index, 10 \((8.8\%)\) patients were found to be Class A, 47 \((41.6\%)\) were Class B, 49 \((43.4\%)\) were Class C, and 7 \((6.2\%)\) were Class D; no patients were Class E. There was no association between peri-implant diseases and socioeconomic status. Regarding smoking status, 21 patients \((18.6\%)\) reported that they were current smokers, 32 \((28.3\%)\) were former smokers, and 60 \((53.1\%)\) had never smoked. For BMI, 40 \((35.4\%)\) patients had healthy BMI, 21 \((18.6\%)\) were overweight, and 52 \((46.0\%)\) were obese. Two patients had diabetes \((1.8\%)\), 10 had osteopenia \((8.8\%)\), and 13 had osteoporosis \((11.5\%)\). There was no correlation \((P > .05)\) between smoking habits, BMI, diabetes, osteoporosis, osteopenia, and peri-implant tissues (Table 1).

Of the patients, 33 \((29.2\%)\) were totally edentulous.
and the remaining 80 (70.8%) had at least 1 residual tooth in each quadrant. Considering the partially edentulous patients, the presence of periodontal bone loss in the 4 quadrants demonstrated a weak, but significant positive correlation with the presence of peri-implantitis ($P = .0083; r = .39$) (Table 2).

Mean loading time of the total implants was 3.4 ± 2.0 years. There was a weak, but significant, positive correlation between increased time of loading and mucositis ($P = .0058; r = .44$) and peri-implantitis ($P = .023; r = .43$). In the same way, there was a significant negative correlation between time of loading and healthy tissues ($P = .001; r = -.38$). The mean times of loading of the implants with peri-implantitis, mucositis, and healthy implants were 5.0 ± 1.7, 4.1 ± 2.5, and 2.7 ± 1.6 years, respectively (Table 2).

**DISCUSSION**

Because progressive implant bone loss can result in complete failure of implants, it seems relevant to know which patient profile presents a high risk of developing peri-implant disease. The analysis of the possible risks for peri-implant diseases is desirable for diagnosis, prevention, and treatment outcomes of dental implants. Therefore, the aim of this study was to evaluate the prevalence of peri-implant diseases around Brånemark system implants placed in Brazilian subjects and the possible relationship with periodontal bone loss, systemic condition, and demographic profile. Because clinical data have demonstrated differences in peri-implant disease rates among the implant systems and surfaces,4,5,13 this study evaluated one specific implant system and surface focusing on demographic, behavioral, medical, and oral variables of the subjects.

A number of studies have related different prevalence and incidence of peri-implant diseases. In a review, Esposito et al4 demonstrated that the average prevalence of implant losses due to peri-implantitis was 2.8% in relation to the total number of failures. In a systematic review, Berglundh et al7 demonstrated that frequencies of peri-implantitis may vary between 0 and 14.4%. In another systematic review, Pjetursson et al14 showed that the incidence of peri-implantitis was 8.6% over 5 years. Ferreira et al8 observed a prevalence of 8.9% for peri-implantitis and 64.6% for mucositis in a group of 212 Brazilian partially edentulous subjects. In this study, considering the number of implants and subjects, the prevalence of peri-implantitis was 7.5% and 12.4%, respectively. In addition, mucositis was found in 32.0% of the implants and 36.3% of the patients. Our data are in agreement

### Table 1

| Mean (± SD) of age according to peri-implant conditions: Percentage of healthy individuals and patients with mucositis or peri-implantitis in relation to demographic, systemic, and socioeconomic variables* |
|-------------------------------------------------|-------------------|-----------------|-----------------|-----------------|
| Age (years, mean ± SD)                          | Total             | Healthy         | Mucositis       | Peri-implantitis |
| Gender                                          | 54.5 ± 13.7       | 54.8 ± 13.06    | 53.9 ± 14.12    | 54.5 ± 15.4     |
| Male                                            | 34.5%             | 35.2%           | 67.4%           | 42.9%           |
| Female                                          | 65.5%             | 64.8%           | 32.6%           | 57.1%           |
| Socioeconomic profile                          | 8.8%              | 7.0%            | 6.5%            | 21.4%           |
| Class A                                         | 41.6%             | 36.6%           | 50%             | 50%             |
| Class B                                         | 43.4%             | 47.9%           | 37%             | 28.6%           |
| Class C                                         | 6.2%              | 8.5%            | 6.5%            | 0%              |
| Class E                                         | 0%                | 0%              | 0%              | 0%              |
| Smoking habits                                  | 53.1%             | 69.0%           | 63.0%           | 57.2%           |
| Never smoker                                    | 28.3%             | 25.4%           | 26%             | 21.4%           |
| Former smoker                                   | 18.6%             | 5.6%            | 11%             | 21.4%           |
| Current smoker                                  | 35.4%             | 38.0%           | 32.6%           | 21.4%           |
| BMI                                             | 18.6%             | 18.3%           | 17.4%           | 14.3%           |
| Healthy                                         | 46.0%             | 43.7%           | 50.0%           | 64.3%           |
| Overweight                                      | 1.8%              | 0%              | 4.3%            | 0%              |
| Obesity                                         | 8.8%              | 11.2%           | 8.7%            | 7.1%            |
| Systemic condition                              | 11.5%             | 14.0%           | 15.2%           | 0%              |

*No statistical correlation was determined on subject level by Pearson $\chi^2$ test or Spearman test.

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with some previous data,\(^8,9\) but are in contrast to others\(^{15,16}\) in which peri-implant infection was reported as a rare event in Branemark systems (<2%). It is important to note that Branemark implants demonstrate bone loss at the first thread during the healing period and during the first year after abutment connection,\(^17\) occasionally confounding the diagnosis of peri-implantitis. Thus, peri-implantitis was defined herein as bone level involving more than 3 threads associated with deep probing depth and clinical signs of inflammation after 1 year of loading. Clarification of this definition is important because, depending on how peri-implantitis is defined; the prevalence may vary a lot, impairing the comparison among the studies.

Although a weak correlation was found between time of implant loading and peri-implant condition, a high time of loading demonstrated a significant positive correlation with mucositis (4.1 ± 2.5 years) and peri-implantitis (5.0 ± 1.7 years). These data are in agreement with previous investigations, demonstrating that peri-implantitis is more frequently found after increasing times of implant function.\(^4,7,14\) Based on these previous findings, it seems rational to expect that the prevalence and incidence of peri-implant diseases will increase as a result of increasing time in the oral cavity.

A positive association was also demonstrated between the periodontal bone loss in the remaining teeth, which probably represent previous or current experience of periodontitis, and peri-implantitis. Although it is not known whether peri-implant diseases may mirror periodontal disease, both diseases seem to have some clinical and microbial similarities.\(^8,19\) Thus, there is some discussion as to whether implant placement in individuals with history of periodontitis presents an increased risk for peri-implantitis development. The present data corroborate those of previous studies in which the presence of peri-implantitis or peri-implant bone loss were associated with periodontal bone loss and/or periodontitis-associated tooth loss.\(^20–24\) Based on these findings, implant placement in patients with history of periodontitis should be carefully considered, and a supportive periodontal and peri-implant program seems to be an excellent suggestion for these individuals. In this study, the patients were not submitted to a supportive periodontal care program, which could have facilitated the high levels of peri-implant diseases (48.7%) in the selected population. Wennström et al\(^25\) reported the importance of a maintenance care program for implant survival in periodontal patients.

Significant relationships between peri-implant diseases and socioeconomic status, systemic condition (body mass, diabetes, osteoporosis and osteopenia), or smoking habits were not found in this study. Previous studies have highlighted smoking and diabetes as risk factors for peri-implant diseases around Branemark implants.\(^8,24,26\) On the other hand, no data were found relating body mass, osteoporosis, osteopenia, socioeconomic state, and peri-implant condition. However, these findings should be interpreted with caution, as the lack of statistical significance in this study for these factors may be related to the low number of subjects with peri-implantitis, systemic diseases, and smoking habits. Succeeding data and further studies should be considered to precisely evaluate the influence of these factors on peri-implant diseases.

In conclusion, this study demonstrated that the presence of peri-implant diseases is associated with the increasing time of loading and periodontal bone loss in the 4 quadrants. It should, however, be

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<td>Mean (± SD) of time of loading in relation to peri-implant conditions: Percentage of healthy individuals and patients with mucositis or peri-implantitis in relation to dentate or edentulous status and periodontal bone loss</td>
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<td>Time of loading (years, mean ± SD)</td>
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<td>Periodontal bone loss (dentate subjects)</td>
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\(^*\)P < .05, Statistical correlation was determined on implant level (time of loading) and subject level (presence or absence of teeth and periodontal bone loss) by Pearson \(\chi^2\) test or Spearman test.

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emphasized again that the data are from patients not submitted to a supportive peri-implant and periodontal care program.

**Acknowledgments**

The authors would like to thank the Professor Renato Mazzonetto from FOP-UNICAMP and Professor Marta Gonzalez Riesco from ABENO for their valuable help in patient recruitment.

**References**


