CLINICAL AND RADIOGRAPHIC EVALUATION OF PERIODONTAL AND PERI-IMPLANT CONDITIONS IN PATIENTS WITH IMPLANT-SUPPORTED PROSTHESIS

Monica H. Abreu[1], Marco A. Bianchini[2], Ricardo S. Magini[2], Cassiano K. Rösing[1,3]

[1] Department of Periodontology, School of Dentistry, Lutheran University of Brazil.
[2] Department of Periodontology, School of Dentistry, Federal University of Santa Catarina.
[3] Department of Periodontology, School of Dentistry, Federal University of Rio Grande do Sul.

ABSTRACT

The aim of the present study was to clinically and radiographically assess the peri-implant and periodontal conditions in partially edentulous patients with implant-supported fixtures installed, at least, one year prior to the study. 41 patients were examined by a calibrated examiner in relation to the following implant-associated parameters: Modified Plaque Index (mPlI), Modified Bleeding Index (mBI), probing depth (PD), clinical attachment level (CAL) and bleeding on probing of the bottom of the crevice (BOP). Also, the remaining teeth were assessed in terms of Plaque Index (PlI), Gingival Index (GI), PD, CAL and BOP. The peri-implant bone loss was evaluated by means of periapical radiographs. Measurements of pre-operatory and final bone levels allowed an estimation of bone loss associated to teeth and a comparison with bone loss around implants. None of the individuals presented late loss of implants until the examination took place. No statistically significant differences were observed between PlI (0.90±0.07) and mPlI (0.82±0.13), or between GI (0.11±0.02) and mBI (0.10±0.02). However, PD, CAL and BOP values were higher in implants than in teeth (Wald Test, p<0.01). Implants presented a mean annual bone loss during the study period of 0.77mm (SE=0.06). Teeth virtually did not present any bone loss (mean value of 0.36%) whereas implants exhibited a bone loss value of 17.11%. Plaque accumulation and marginal inflammation did not differ between teeth and implants. However, subgingival inflammation was higher in implants than in teeth. The destruction measurements suggest greater losses in implants, as expected because of tissue remodelation.

Key Words: *dental implants, periodontal diseases, alveolar bone loss.*

AVALIAÇÃO CLÍNICA E RADIOGRÁFICA DA CONDIÇÃO PERIODONTAL E PERIIMPLANTAR DE PACIENTES PORTADORES DE PRÓTESE IMPLANTO-SUPORTADA

RESUMO

O objetivo do presente estudo foi avaliar clínica e radiograficamente a condição periodontal e periimplantar em pacientes parcialmente edentados, portadores de prótese sobre implante instalada há pelo menos um ano. 41 pacientes foram avaliados por examinador calibrado quanto aos seguintes parâmetros clínicos nos implantes: Índice de Placa modificado (IPlm), Índice de Sangramento modificado (ISm), profundidade de sondagem (PS), nível de inserção clínica (NIC) e sangramento do fundo do crevículo (SS). Também foram registrados o Índice de Placa (IP), Índice de Gengival (IG), PS, NIC e SS dos dentes remanescentes. A perda óssea periimplantar foi avaliada a partir de radiografias periapicais. Mensurações do nível ósseo nas radiografias panorâmicas pré-operatórias e finais permitiram estimar a perda óssea associada a dentes e a fazer comparações com a perda óssea em torno dos implantes. Nenhum dos indivíduos examinados apresentou perda de implantes por falha tardia no período. Não houve diferença estatisticamente significante entre o IPl (0,90±0,07) e o IPlm (0,82±0,13), assim como entre o IG (0,11±0,02) e o ISm (0,10±0,02). Entretanto, PS, NIC e SS foram maiores nos implantes que nos dentes (Teste de Wald, p<0,01). Os implantes tiveram uma perda óssea anual média de 0,77 mm (EP=0,06). Os dentes praticamente não sofreram perda óssea no período do estudo, com valor médio de 0,36%, ao passo que para os implantes, este valor foi de 17,11%. O acúmulo de placa e a inflamação marginal não diferiram nos dentes e nos implantes no grupo de pacientes avaliados. Contudo, a inflamação subgengival foi maior em implantes em relação a dentes. As medidas de destruição analisadas sugerem maiores perdas nos implantes, conforme esperado em função de remodelação tecidual.

Palavras chave: *implantes dentários, doença periodontal, perda óssea alveolar*

INTRODUCTION

Oral rehabilitation with implant-supported prostheses represents a great advance in dental practice. Initially designed to treat complete edentulism (1, 2), dental implants are an advantageous restoration for partially edentulous areas (3), preserving adjacent teeth and allowing easier restoration of large prosthetic spaces.

Despite the high reported success rates in longitudinal studies, implants may present biological, mechanical, iatrogenic or patient-related failures (4). Biological failures are the ones that occur due to incapacity of host tissues to osseointegrate (primary or early failures) or to maintain the osseointegration (secondary or late failures) (5).

Frequently, prognosis of dental implants is reported as survival or failure rates (4, 6). Although it is possible to clearly distinguish a success from a failure, it is not easy to define intermediate stages. The presence of peri-implant radiolucency and mobility characterize a failure, while implants in the process of failure present progressive marginal bone loss, clinical signs of peri-implant infection, even without mobility (7).

A series of investigations has tried to define success parameters for implants in clinical studies. ALBREKTSSON et al. (8) reported that implant success should be mainly defined by radiographic bone loss. BUSER et al. (9), used absence of patient complaint, absence of infection, mobility and marginal radiolucency, combined with the possibility of inserting the crown, as criteria to define success/failure of dental implants. BRÄGGER et al. (10) used peri-implant probing depth>5mm associated with bleeding as a definition of peri-implantitis. This widely used definition may be subjected to criticism.

Periodontal conditions in partially edentulous patients may influence peri-implant health in the same individuals. However, few studies have evaluated the potential association between periodontal and peri-implant conditions in partially edentulous patients and dental implants. Thus, it is of interest to understand the teeth/implants conditions in this growing group of implant users, focusing on clinical and radiographic parameters. The longitudinal perspective of clinical evaluation is the only source of evidence that can provide the clinician with information for the patient about predictability.

The aim of the present study was to clinically and radiographically evaluate periodontal and peri-implant conditions in partially edentulous patients with prostheses over implants for at least one year.

MATERIALS AND METHODS

Experimental design

Cross-sectional observational study.

Selection of the Study Sample

Participating individuals were selected after analysis of the clinical histories of all patients treated in the Study and Research Center for Dental Implants (CEPID) of the Federal University of Santa Catarina, Brazil. The following inclusion/exclusion criteria were used for patient selection.

Inclusion Criteria:

a. Partially edentulous;
b. Implant-supported prosthesis for at least one year;
c. A clinical history containing the pre-treatment orthopantomogram.

Exclusion criteria:

a. Having taken local or systemic antibiotics in the six months prior to examination;
b. Having undergone periodontal treatment in the six months prior to examination;
c. Need of antibiotic prophylaxis to be examined.

Clinical Examination

The following clinical parameters were assessed by a single examiner:

1. Implants:
   a. Modified Plaque Index (mPlI) (11);
   b. Modified Bleeding Index (mBI) (11);
   c. Probing depth (PD): distance between the gingival margin and the most apically probeable portion, in millimeters (12);
   d. Clinical Attachment Level (CAL): distance from the junction implant/crown to the most apically probeable portion, in millimeters (12);
   e. Bleeding on probing of the bottom of the crevice (BOP) (13).

2. Teeth:
   a. Plaque Index (PlI) (14);
   b. Gingival Index (GI) (15);
   c. Probing Depth (PD): distance between the gingival margin and the most apically probeable portion, in millimeters (16);

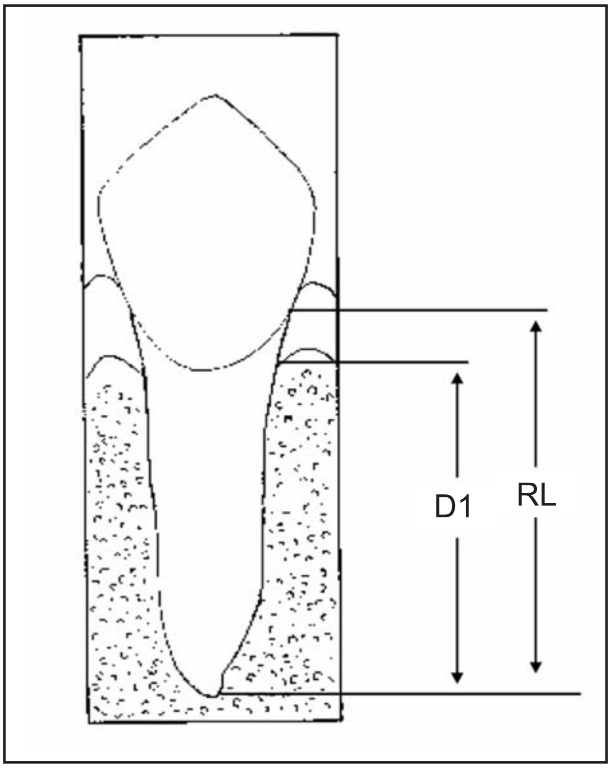

Fig. 1: Schematic drawing of the measurements of bone level on orthopantomograms.

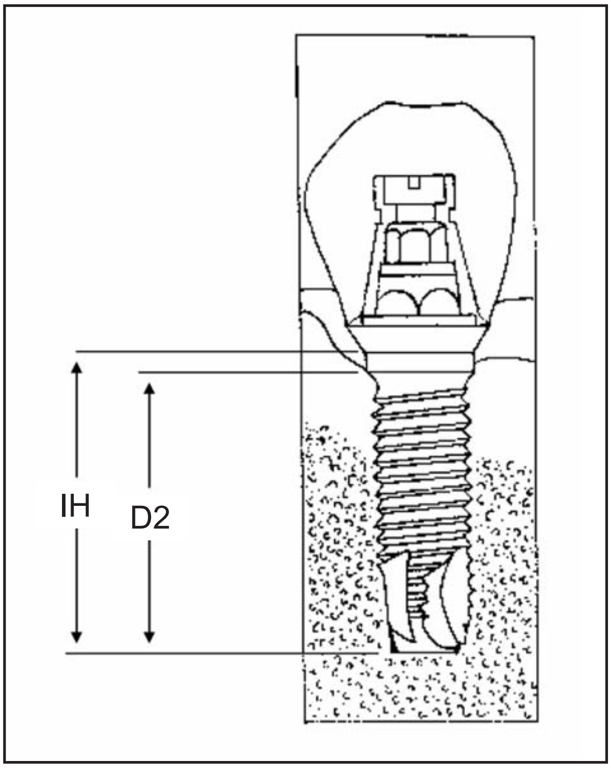

Fig. 2: Schematic drawing of peri-implant bone level on orthopantomograms

d. Clinical Attachment Level (CAL): distance from the cementum-enamel junction to the most apically probeable portion, in millimeters (16);
e. Bleeding on probing of the bottom of the crevice (BOP) (17).

Examination was performed with a North Carolina periodontal probe (Neumar, São Paulo, SP, Brazil). Measurements were assessed at four sites (distal, buccal, mesial and lingual/palatal) of each implant and remaining teeth, rounded to the closest millimeter.
In order to test for reproducibility, double measurements were taken with a 40 minute interval in 10 patients with the same characteristics as those of the study sample. Weighted kappa (±1 mm) values for probing depth and clinical attachment level in teeth were 0.86 and 0.83, respectively. In implants, these values were 0.96 and 0.78 respectively.

Radiographic Examination
Periapical radiographs of implants and orthopantomograms were performed in all patients included in the study. Implants were radiographed using a Rinn localizer (XCP instruments, Rinn Corporation Elgin, IL, USA), F radiographic films (Eastman Kodak Company, Rochester, NY, USA) in a 70 kVp X-Ray equipment (Dabi Atlante, Ribeirão Preto, SP, Brasil). Processing of the periapical radiographs was performed manually by the time/temperature method. Orthopantomograms were processed automatically. All radiographs were taken at the Radiology Department of the Federal University of Santa Catarina.
In periapical radiographs, the distance from the marginal osseous level to the implant platform was measured in millimeters, in mesial and distal aspects of each implant.
The mesial and distal bone height of all remaining teeth was evaluated in orthopantomograms by a similar method to that described by SCHEI et al. (18). The distance from the cementum-enamel junction to the apex (root length – RL) and the distance from the most coronal portion of supporting bone to the apex (D1) were measured (Fig. 1). With these measurements, the mesial and distal bone levels were estimated using the following formula:

$$\text{Bone Level (\%)} = 100 - \frac{D1 \times 100}{RL}$$

TABLE 1. Characteristics of the Sample	
Characteristic	
Number of patients	41
Male/Female ratio	13/28
Mean age (range)	46.83 (22-70)
Number of implants	110
Number of teeth	950
Mean number of implants per patient (range)	2.68 (1-11)
Mean number of teeth per patient (range)	23.17 (6-30)
Mean time after implantation in months (Standard Error)	45.06 (SE=2.62)
Mean time after prosthesis setting in months (Standard Error)	30.65 (SE=2.27)

TABLE 2. Location of implants

Área	Upper	Lower
Incisors	16	1
Canines	3	2
Premolars	26	22
Molars	14	26
Total	59	51

The most coronal portion of the bone support was defined where the periodontal ligament space displayed normal width. Whenever the cementum-enamel junction was masked by restorations, its location was estimated at the level corresponding to the cementum-enamel junction of the adjacent tooth. The same procedure was repeated in the pre-treatment orthopantomograms of each patient, to allow for the comparison of radiographs. Based on these results, bone level alterations over the pre-treatment to the post-treatment period were estimated. Radiographic bone loss was calculated as follows:

$$\text{Radiographic Bone Loss (\%)} = \text{Final bone level (\%)} - \text{Initial bone level (\%)}$$

Similar measurements were performed in implants, using final orthopantomograms and taking the implant height (IH) and the distance from the most coronal portion of the osseous support to the implant apex (D2) as a reference (Fig. 2). Radiographic bone loss in implants was calculated assuming that the implant was inserted with its platform at the bone level by the following formula:

$$\text{Radiographic bone loss (\%)} = \text{Final bone level (\%)} = 100 - \frac{D2 \times 100}{IH}$$

All measurements were performed by a calibrated examiner, with the aid of a negatoscope, 7 times magnification and electronic digital caliper 727 (Starrett Ind. Com. Ltda, Itu, SP). Calibration was tested by double analysis of radiographs from 10 patients, with a one-week interval. The agreement coefficient was of 0.96, with a mean difference of 0.03±0.92 for the orthopantomograms. The agreement coefficient was 0.95 for the periapical radiographs, with a mean difference of 0.11±0.32.

Ethical Considerations

The study protocol was approved by the Ethical Committee of the Federal University of Santa Catarina. Patients signed an informed consent. After examination, maintenance/treatment was performed.

Final Study Sample

Following evaluation of approximately 500 clinical histories, 70 individuals were contacted by telephone, since they apparently fulfilled the inclusion criteria. Of these, 50 agreed to participate and were given appointments. One was excluded for having received periodontal surgery recently, one refused radiographs; another two did not show up for the appointments; four had taken antibiotics and were excluded; and one did not sign the informed consent. Thus, 41 individuals participated in the study.

Table 1 shows the characteristics of the sample and Table 2 exhibits implant distribution. All implants were cylindric and had smooth surfaces (Master Screw, Conexão Sistemas, São Paulo, SP).

Data Analysis

Linear models were used to analyze the data. The individual was considered the statistical unit and

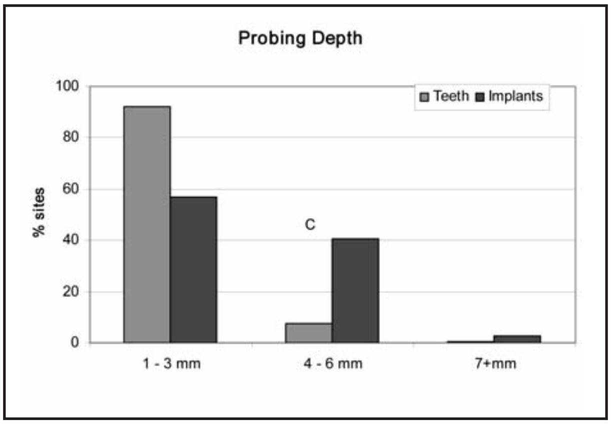

Fig. 3: Percent distribution of sites by PD in teeth and implants.

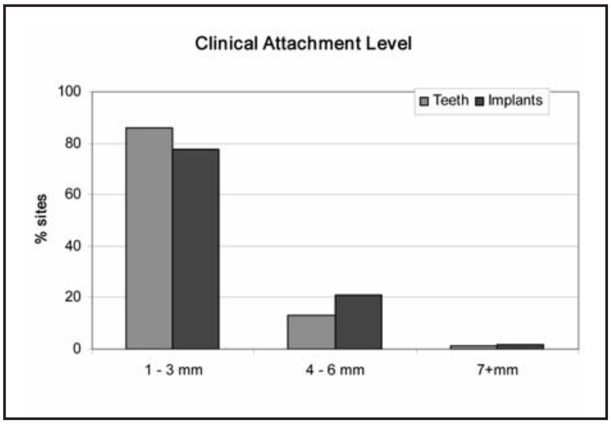

Fig. 4: Percent distribution of sites by CAL in teeth and implants.

estimates were adjusted to multiple observations in teeth and implants in each participant. Wald tests were used to compare teeth and implants and p-values were adjusted for multiple comparisons as needed. The significance level was set at 0.05. Analyses were performed with STATA 9.1 Intercooled Version (State College, TX, USA). Results are presented as means and standard error.

RESULTS

The results of the present study involve analyses in the whole sample. None of the evaluated patients had late loss of implants in the study period. However, in these individuals, three implants were lost by early failure (during the osseointegration process) and three implants were removed from one patient due to paresthesia in the area. None of the examined individuals is under systematic maintenance.

Means and standard error for the parameters are listed in Table 3. No statistically significant difference was found between mPlI and PlI or between mBI and GI. However, PD and CAL were higher in implants than in teeth (p<0.01). The mean percentage of bleeding sites was 25.1% for teeth and 50.9% for implants.

More than 90% of teeth sites had PD between 1 and 3 millimeters. In implants, 56.82 % of sites displayed PD up to 3 millimeters, while 40.68% of sites was in the 4-6 mm range. A small percentage of sites displayed PD 7mm (Fig. 3).

Figure 4 shows the percentage of sites, in teeth and implants, for different ranges of CAL. Both in teeth and implants, the majority of sites displayed CAL up to 3mm.

The mean bone loss in implants evaluated in periapical radiographs was 2.66mm (SE=0.14). The highest mean bone loss for implants evaluated in periapical radiographs was 2.88mm (SE=0.14). Since the mean time after implantation was 45.06 months, a mean annual loss of 0.77mm (SE=0.06) was calculated. When the worst loss per implant

TABLE 3. Mean and Standard Error of clinical parameters evaluated in 4 sites per tooth/implant

Parameter	Teeth		Implants		
	Mean	SE	Mean	SE	p*
PlI/mPlI	0.90	0.07	0.82	0.13	0.54
GI/mBI	0.11	0.02	0.10	0.02	0.62
PD (mm)	2.27	0.06	3.36	0.13	0.0001
CAL (mm)	2.03	0.14	2.51	0.16	0.01
Maximum PD (mm)	3.13	0.08	4.51	0.17	0.0001
Maximum CAL. (mm)	2.94	0.17	3.50	0.17	0.01
BOP (%)	25.1	2.0	50.9	3.8	0.0001
* Wald Test					

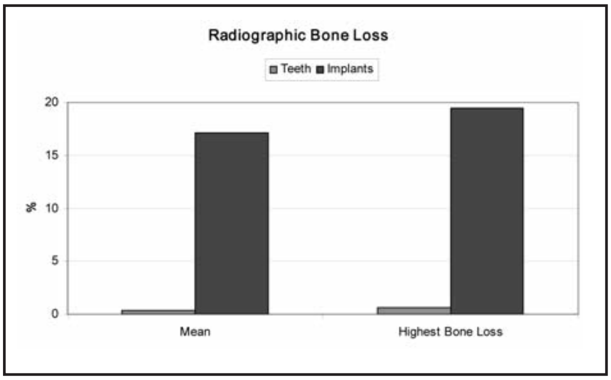

Fig. 5: Mean radiographic bone loss (%) and highest bone loss (%) in teeth and implants, evaluated in orthopantomograms.

was considered, the mean annual loss was 0.85mm (SE=0.07).
The mean time between the initial and final orthopantomograms was 53.39 months (SE=2.23). In this period, the analysis revealed that teeth practically did not experience bone loss, with a mean value of 0.36%. Implants displayed a mean radiographic bone loss of 17.11% since implantation (Fig. 5).

DISCUSSION

The present study involves a retrospective analysis of periodontal and peri-implant conditions in patients with dental implants. A cross-sectional observational design was chosen. This kind of study design has limitations and advantages. The fact that it precludes a systematic evaluation of initial conditions and the standardization of clinical procedures is undoubtedly a disadvantage. On the other hand, the analysis of individuals that were not initially enrolled in a study may reflect a more real situation (19, 20).
The sample used in this study is from the Study and Research Center for Dental Implants of the Federal University of Santa Catarina, an important center in the country. As expected, in some cases, the analysis of clinical histories was complicated by incomplete information and sub-optimal recording of the data (21, 22), similarly to other studies (23, 24), where there is no standardization of data recording. Within this context, 70 potentially eligible patients were contacted following the analysis of approximately 500 clinical histories. Of these, 50 were actually reached. At the time of examination, 9 individuals were not enrolled in the study due to the previously specified reasons, which do not generate suspicion of negative events related to the implants. It is important to note that this study does not claim representativity, since the more satisfied individuals tend to participate in this type of evaluation (25).
The patients' mean age was 46.83 (range 22-70) years. This range could suggest selection bias. However, the majority of individuals were in the fourth decade. Moreover, the aim of the present study was to assess periodontal and peri-implant conditions after implantation. Thus, the time after implantation and after the insertion of the crown was 45.06 and 30.65 months, respectively. The fact that the difference between these times was small was an asset to the study. Approximately two thirds of the volunteers were females. This is consistent with the majority of studies in Dentistry, since women seek dental care more frequently than men (26, 27), consequently having more implants.
The number of implants and teeth per individual is variable. Thus we performed individual rather than site analysis in order to avoid the influence of polarization of disease (28, 29).
The results of the study indicate satisfactory periodontal and peri-implant conditions in the evaluated patients. In relation to the supragingival plaque-related parameters, individuals presented low PlI, mPlI, GI and mBI. Overall, these data suggest that these individuals had good standards of oral hygiene, with minimal inflammatory signs around teeth and implants. The comparison between teeth and implants did not show any statistically significant differences in PlI and mPlI. This is an interesting finding, since despite the fact that novelties tend to receive better attention, oral hygiene did not vary intra-individually. Studies have demonstrated that compliance of patients with oral hygiene is related to the profile of the patient (30).
Similarly to the plaque indices, inflammation did not differ between teeth and implants in this study. The correlation between supragingival plaque and gingivitis/mucositis was demonstrated herein. It is important to emphasize that the level of inflammation is extremely low, reflecting an excellent pattern of plaque control.
Very low values of supragingival plaque-related parameters were also found by BRÄGGER et al. (12) in a cross sectional study and by KAROUSSIS et al. (31) in a 10 year longitudinal study. In both studies individuals were under maintenance. In our investigation, no systematic maintenance was warranted.

The selection of cases for any given treatment is of utmost importance and this is not different for implants. The Center has tried to select candidates with good patterns of oral hygiene. It is probable that individuals that invest in such a treatment are part of a differentiated group that is careful with oral hygiene.

Socioeconomic status is also associated to supragingival plaque control (32, 33). Individuals in this study were not from the low socioeconomic level, since the treatment is not free. An analysis of the income of the volunteers revealed that the majority earns more than 4 times the minimum wage in the country. Additionally, the prevalence of women in the sample might contribute to better oral hygiene practices.

The present study also evaluated subgingival plaque-related parameters (PD, CAL, BOP). All these parameters displayed higher values in implants than in teeth. It is known that inflammation can facilitate probe penetration and the parameters are all assessed with a periodontal probe (34, 35). Thus, for the purpose of this investigation, PD and BOP are considered indicators of an inflammatory process. Tissue destruction was considered by CAL and radiographic analyses.

The higher PD observed in implants (3.36mm) as compared to teeth (2.27mm) is probably the consequence of the differences between periodontal and peri-implant tissues. Similarly to teeth, the peri-implant mucosa is lined by a keratinized oral epithelium, continuous with a junctional epithelium which is bound to the implant by a basal lamina and hemidesmosomes. (36). However, in the connective tissue of the peri-implant mucosa, collagen fibers are parallel to the implant surface. No radial fibers are inserted in the implant surface as in the periodontium. This characteristic facilitates probe penetration. SCHOU et al. (37) evaluated healthy and inflamed gingiva and peri-implant mucosa and concluded that a deeper penetration of the probe occurs in implants as compared to teeth, even with low degrees of inflammation.

Every analysis of groups of teeth/patients performed with means is subjected to the mathematical phenomenum “regression towards the mean”. In order to minimize this effect, the present study also analyzed the maximum PD in each tooth/implant. Similarly to the analysis of all sites, implants displayed statistically significant higher PD values than teeth.

For a better clinical understanding of the situation, we analyzed the frequency distribution of sites with PD of 1-3, 4-6 and 7+ millimeters. In this analysis, teeth exhibited a higher frequency of shallow PD as compared to implants. When deep PD were considered, a large proportion of implants exhibited larger values than teeth. This finding has an interesting interpretation: it is known that higher PD values are associated to the presence of larger amounts of biofilm. (38) Studies suggest that an increase in PD has an important meaning in the kinetics of the health/disease process. However, longitudinal studies performed in teeth do not consider PD as a single predictor of destruction (39, 40). However, higher PD values seem to be more acceptable in implants than in teeth, despite the lack of scientific supporting evidence.

The other inflammatory parameter was BOP. It is associated to the subgingival inflammatory process. In teeth, it has been shown that the absence of BOP is an excellent predictor of clinical attachment stability (17). In implants its predictive meaning is still not well known. However, similarly to PD, the implants presented twice the percentage of bleeding as compared to teeth, which is an undesired sign of inflammation.

Tissue destruction was clinically evaluated by CAL. Implants presented statistically significant higher values of CAL than teeth in all analyses. This finding is difficult to interpret, since teeth are exposed to the oral environment for longer periods as compared to implants, especially taking into consideration the age range of the individuals participating in this study. However, a higher cumulative destruction was detected in implants. In a study design like the one used herein, lacking a CAL measurement immediately after crown insertion, the direct comparison is impossible. On the other hand, the measurement performed indicates the distance from the implant/crown junction to the deepest probeable depth. Thus, part of the observed distance accounts for the crown component of the implant. In this sense, these values are important for a future longitudinal investigation. However, cross-sectional studies have used this parameter as a destruction indicator, which is questionable (12).

The frequency distribution of CAL 1-3, 4-6 and 7+mm was quite similar in teeth and implants. Comparatively, the distribution is very different from that of PD. This indicates that the inflammatory status is, in such a design, more significant than the destruction. The time after implantation might be responsible for this finding.

The limitations regarding tissue destruction described for the present study are minimized by the radiographic analysis. The analysis employing relative bone height in orthopantomograms has an interesting meaning, since it reduces the differences between distinct radiographs. In teeth, practically no bone loss was detected during the study period. This is in accordance with the knowledge that periodontal disease has a low progression rate. Taking into consideration a time length less than 5 years in radiographs, significant bone losses would not be expected, especially in patients with good oral hygiene.

Supposing that implants were inserted at the bone level, a significant loss of bone was detected by all sites analysis as well as by the worst site in each implant analysis. Obviously, it is important to realize that immediately after implantation, bone remodeling occurs, leading to lower bone height. Studies have quantified this remodeling and estimate that it should be less than 1.5mm during the first year and about 0.2mm thereafter (2).

Periapical radiographs of the implants were taken to estimate the observed bone loss. A mean annual loss of 0.77mm was calculated for the period. This value is, however, higher than expected from data in the literature. However, clinical impact is not affected, since the majority of implants has no more than subclinical inflammation. The model of analysis could also account for some overestimation of tissue loss.

The analysis of the patients performed in the present study contributed to the understanding of the behavior of implants in partially edentulous individuals. Standardized prospective longitudinal evaluations are needed to further scientifically support this treatment approach. It is also important to remember that the results of the present study do not indicate that implants have better outcomes than teeth.

The results of this study, taking into consideration its design, allow us to conclude that in partially edentulous individuals, plaque accumulation and gingival inflammation do not differ between teeth and implants. However, subgingival inflammation, represented by PD and BOP is higher in implants than in teeth. The destruction parameters suggest greater losses in implants, as expected due to tissue remodeling.

CORRESPONDENCE
Cassiano Kuchenbecker Rösing
Rua Dr. Valle, 433/701
90560-010 – Porto Alegre – RS Brazil
ckrosing@hotmail.com

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