J Clin Periodontol 2012; 39: 490–494 doi: 10.1111/j.1600-051X.2012.01872.x

Journal of Clinical Periodontology

Prevalence of peri-implant diseases. A cross-sectional study based on a private practice environment

Javier Mir-Mari[1], Pedro Mir-Orfila[2], Rui Figueiredo[1,3], Eduard Valmaseda-Castellón[1,3] and Cosme Gay-Escoda[1,3,4]

[1]Department of Oral Surgery and Implantology, Faculty of Dentistry of the University of Barcelona, Barcelona, Spain; [2]Private Dental Practice, Menorca, Spain; [3]IDIBELL Institute, Barcelona, Spain; [4]Oral and Maxillofacial Surgeon, Teknon Medical Center, Barcelona, Spain

Mir-Mari J, Mir-Orfila P, Figueiredo R, Valmaseda-Castellón E, Gay-Escoda C. Prevalence of peri-implant diseases. A cross-sectional study based on a private practice environment. J Clin Periodontol 2012; 39: 490–494. doi: 10.1111/j.1600-051X.2012.01872.x.

Abstract

Aim: To determine the prevalence of peri-implant diseases in private practice patients enrolled in a periodontal maintenance programme.

Material and Methods: A cross-sectional study was carried out in patients with dental implants attending the dental clinic to comply with a periodontal maintenance programme between January and June 2010. Implants with at least 1 year of loading time (range: 1–18 years) were included. A patient-based prevalence analysis of peri-implant diseases was carried out. Additionally, implants were classified into the following categories: healthy, clinically stable, mucositis and peri-implantitis.

Results: A total of 245 patients (964 dental implants) were analysed. Implant and patient-based peri-implantitis prevalences were 9.1% [95% confidence interval (95%CI): 7.5–11.1%] and 16.3% [95%CI: 12.2–21.5%] respectively. Mucositis affected 21.6% [95%CI: 19.1–24.5%] of the studied implants and 38.8% [95%CI: 33.3–45.4%] of the patients.

Conclusions: The prevalence of peri-implantitis in private practice patients enrolled in a periodontal maintenance programme was estimated to be between 12% and 22%. Almost 40% of the patients had mucositis. These prevalences are similar to those published in University environment samples.

Key words: complications; dental implants; mucositis; peri-implantitis; periodontal maintenance

Accepted for publication 22 February 2012

Mucositis and peri-implantitis are the most frequent long-term complications related with dental implants (Berglundh et al. 2002). However, the lack of widely accepted diagnostic criteria for such pathologies makes interpretation of the published prevalences very difficult. The literature reports that peri-implantitis affects 7.8–43.3% of all studied implants (Berglundh et al. 2002, Ferreira et al. 2006, Roos-Jansåker et al. 2006, Zitzmann & Berglundh 2008, Koldsland et al. 2010). Most authors agree that further research is needed to characterize the risk factors, progression and treatment of this disorder. Accordingly, the 6th Workshop in Periodontology (Zitzmann & Berglundh 2008) emphasized the need to readdress future studies, recommending a new approach to this condition based on epidemiological studies with a

Conflict of interest and source of funding statement

The authors declare that there are no conflicts of interest in this study, which was carried out by the "Dental and Maxillofacial Pathology and Therapeutic" research group of the IDIBELL Institute, with the financial support of an educational–clinical agreement in Oral Surgery among the University of Barcelona, the General Health Consortium and the Catalan Health Service. No further external funding was available for this study.

cross-sectional design, samples of between 100 and 500 patients, and clinical and radiological examinations. Focusing on private practice would also be desirable to improve generalization of the published data. Furthermore, this report encouraged researchers to provide additional information on prevalence using the patient as the analytical unit, and also to classify implants into different groups of peri-implant health and disease.

Accordingly, the present study was designed with the main objective of determining the prevalence of peri-implant diseases in private practice patients enrolled in a periodontal maintenance programme.

Additionally, the study aims to determine whether patients with peri-implant disease affecting at least one implant are more prone to have disorders in other implants.

Material and Methods

A cross-sectional study was conducted in patients enrolled in a periodontal maintenance programme (with follow-up visits every 3–6 months) in a private dental clinic in Menorca (Spain). The study was approved by the Ethics Committee of the Balearic Islands (Spain), and complied with the Declaration of Helsinki. The recommendations for peri-implantitis prevalence studies established by the 6th Workshop in Periodontology (Zitzmann & Berglundh 2008) and the Strobe Statement guidelines (Vandenbroucke et al. 2007, von Elm et al. 2007) for cross-sectional studies were also taken into consideration in designing the current research.

All patients with dental implants and more than 1 year of follow-up after loading consecutively attending a periodontal maintenance appointment between January and June of 2010 were enrolled, and they agreed to participate in the study. Implants with machined (Brånemark System, Goteborg, Sweden), TiUnite™ (Nobel Biocare, Zurich, Switzerland) and Osseotite™ (3i, Florida, FL, USA) surfaces were placed by the same surgeon (PMO). Implant geometry was similar for both systems with thread pitches of 0.6 mm for regular platform implants. A total of 245 patients (964 dental implants) with a mean age of 60.1 years [range 20–87 years, standard deviation (SD) = 10.7 years] were analysed.

Two calibrated professionals (JMM and PMO) performed standardized periodontal maintenance check-ups. These included a complete periodontal examination, with probing pocket depth (PPD) (deepest value for each implant was registered), modified plaque and gingival index according to Mombelli et al. (1987) (mPI and mGI), bleeding on probing (BOP) and suppuration. Periapical digital radiographies using the long-cone parallel technique were obtained for the measurement of bone level (BL), counting the number of threads without bone support (Digora v.2.5; Tuusula, Finland). A single researcher assessed the mesial and distal aspects of each implant, and registered the highest value (Pikner & Gröndahl 2009, Koldsland et al. 2010). Twenty randomly selected radiographs were examined twice, 1 week apart, to analyse intra-examiner reproducibility. The intra-class correlation coefficient (ICC) was 0.881 (95%CI: 0.725–0.951; $p < 0.001$), indicating good intra-examiner agreement.

On performing implant-based analyses, the following diagnostic criteria were applied to evaluate the data:

-Health: BL <2 threads without BOP.
-Clinical stability: BL ≥ 2 threads without BOP.
-Inflammation:

- **Peri-implant mucositis:** BL <2 threads with BOP.
- **Peri-implantitis:** BL ≥ 2 threads with BOP or suppuration.

For a patient to be considered healthy or clinically stable, all implants should be classified as healthy or clinically stable. On the other hand, if any of the implants was classified in the inflammation, mucositis or peri-implantitis groups, the patient was considered not healthy. Patients were classified in the group of their worst implant.

Sample size was calculated to estimate the population prevalence of peri-implantitis with 5% precision and 95% confidence. To this effect, peri-implantitis prevalence was estimated a priori to affect 20% of the patients. Thus, a sample size of 245 patients was required.

A more detailed analysis was made in patients diagnosed with peri-implantitis ($n = 40$). To determine whether these patients were more prone to reveal diseased implant sites, a subgroup of 29 patients (199 implants) was created after excluding patients with less than four implants.

A descriptive patient- and implant-based analysis, using the Statistical Package for the Social Sciences (SPSS v.16.0; SPSS, Chicago, IL, USA) was carried out. Ninety-five per cent confidence intervals (95%CI) were estimated from data for all prevalences. Patients with incomplete data (demographic variables, periodontal and radiological examinations) were excluded from the analysis.

Results

The duration of implant follow-up ranged from 1 to 18 years (mean = 6.3 years; SD = 4.3 years). The sample comprised 524 (54.5%) implants placed in the maxilla and 440 (45.6%) in the mandible.

According to the previously mentioned diagnostic criteria, 208 implants presented mucositis, representing a prevalence of 21.6% (95% CI: 19.1–24.5%) and affecting a total of 96 patients [38.8% (95%CI: 33.3–45.4%)]. On the other hand, 88 implants [9.1% (95%CI: 7.5–11.1%)] in 40 patients [16.3% (95%CI: 12.2–21.5%)] were diagnosed for peri-implantitis. The correlations between the different diagnoses, the periodontal examination variables and the follow-up periods are shown in Tables 1 and 2. On the other hand, Table 3 shows the outcomes according to implant surface.

In the subgroup of patients with at least 4 implants and a diagnosis of peri-implantitis, 74 implants [37.2% (95%CI: 30.1–44.1%)] matched the definition of peri-implantitis. Figure 1 shows the results of this subgroup.

Discussion

The main objective of this study was to analyse the prevalence of different categories of peri-implant health and

Table 1. Descriptive results for the main study variables among different peri-implant health and disease groups

	Implant-based prevalence [95%CI]	Patient-based prevalence [95%CI]	Follow-up (years)	Probing depth (mm)	mPI (0–3)	mGI (0–3)	Bone level (threads)
Healthy	51.3% [47.8–54.2]	41.6% [35.6–47.9]	6.5 ± 4.5	2.2 ± 1.0	0.5 ± 0.7	0 ± 0	0.2 ± 0.4
Clinical stability	18.2% [15.8–20.7]	13.1% [9.4–17.9]	6.3 ± 4.1	2.4 ± 1.1	0.5 ± 0.7	0 ± 0	2.8 ± 1.1
Inflammation	30.7% [27.8–33.7]	45.3% [39.2–51.6]	5.8 ± 4.1	3.0 ± 1.2	1.0 ± 0.7	1.1 ± 0.4	1.7 + 1.5
Mucositis	21.6% [19.1–24.5]	38.8% [33.3–45.4]	5.8 ± 4.2	2.8 ± 1.0	0.9 ± 0.7	1.1 ± 0.4	0.3 ± 0.4
Peri-implantitis	9.1% [7.5–11.1]	16.3% [12.2–21.5]	6.0 ± 3.9	3.5 ± 1.6	1.2 ± 0.7	1.1 ± 0.4	3.0 ± 1.4

Table 2. Health and disease prevalence in relation to the follow-up periods

	Implant-based prevalence [95%CI] and follow-up (years)			
	≥ 1 year–<5 years	≥ 5 years–<10 years	≥ 10 years–<15 years	≥ 15 years
Healthy	50.2% [46.0–54.7%]	46.8% [41.7–52.5%]	62.1% [52.4–71.1%]	58.9% [47.9–69.9%]
Clinical stability	15.5% [12.2 –18.9%]	25.6% [21.2–30.4%]	9.7% [4.9–15.5%]	15.5% [6.8–23.3%]
Inflammation	26.8% [21.9–32.2]	35.9% [31.7–40.2]	21.4% [15.2–28.9]	32.6% [29.1–36.2]
Mucositis	17.5% [13.6–21.9]	25.8% [22.1–30.1]	15.4% [9.4–21.5]	23.4% [20.2–26.8]
Peri-implantitis	9.3% [6.3–12.9]	10.1% [7.6–12.9]	6.0% [2.7–10.1]	9.2% [7.1–11.7]

Table 3. Health and disease prevalence for the different implant surfaces

	Implant-based prevalence [95%CI] and implant surface			
	Machined	TiUnite	Osseotite	Medium Rough Surface (TiUnite + Osseotite)
Healthy	51.3% [46.0–57.0]	48.0% [43.4–52.1]	61.1% [52.3–69.1]	51.0% [47.2–54.8]
Clinical stability	21.9% [17.2–26.5]	16.2% [13.3–19.3]	17.4% [12.1–23.5]	16.5% [13.8–19.4]
Inflammation	26.8% [21.9–32.2]	35.9% [31.7–40.2]	21.4% [15.2–28.9]	32.6% [29.1–36.2]
Mucositis	17.5% [13.6–21.9]	25.8% [22.1–30.1]	15.4% [9.4–21.5]	23.4% [20.3–26.6]
Peri-implantitis	9.3% [6.3–12.9]	10.1% [7.6–12.9]	6.0% [2.7–10.1]	9.1% [6.8–11.3]
Follow-up (years + SD)	11.25 ± 3.87	3.45 ± 1.94	5.87 ± 1.19	4.00 ± 2.06

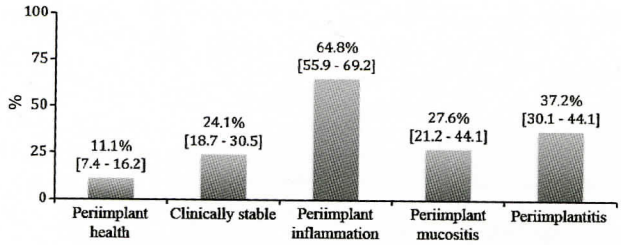

Fig. 1. Results of the implant-based analysis in a subgroup of patients (n = 29) with at least 4 implants and a diagnosis of peri-implantitis.

disease in the private practice setting. The patient peri-implantitis prevalence ranged between 12% and 22%, with mucositis being a common finding (39%).

One of the main limitations of the present study is related to the research design used. Cross-sectional studies are suitable for determining the prevalence of a disease, but they cannot accurately identify its risk factors.

Most of the studies on peri-implantitis base their outcomes on samples of patients treated in Universities. This offers an important number of advantages, including homogenous samples, highly experienced and calibrated examiners, and compliant patients (follow-up visits might be financially rewarded). On the other hand, studies based on private practice are more complex and imply less controlled conditions and more heterogeneous samples. In spite of this, a study performed in a private practice should add additional information about peri-implantitis, and probably can increase the external validity of the results, as the great majority of patients are treated in private dental offices.

One of the main factors defining peri-implant disease as a highly controversial subject is that many studies base their results on implants rather than on patients. The results of the present report support this statement, as the proportion of patients with peri-implantitis (16%) was considerably higher than the percentage of affected implants (9%).

The 6th Workshop in Periodontology (Zitzmann & Berglundh 2008) recommended an epidemiological approach to peri-implantitis, using cross-sectional studies. To our knowledge, only four cross-sectional studies aiming to analyse the preva-

lence of mucositis and peri-implantitis have been published to date. Roos-Jansåker et al. (2006), in a study of 218 patients and involving a follow-up of 9–14 years, found that 16% of the patients had peri-implantitis. However, Zitzmann & Berglundh (2008) reinterpreted these results using different diagnostic criteria for peri-implantitis and stated that the prevalence in this material would be of 55.6%. Koldsland et al. (2010) likewise reported the importance of diagnostic criteria in relation to peri-implantitis outcomes. Depending on the threshold used, the prevalence of peri-implantitis ranged between 11% and 47%. Another paper by Ferreira et al. (2006), involving 221 patients and a mean follow-up of 42 months, reported a prevalence of peri-implantitis at patient level of 8.9%. This prevalence was significantly lower than that reported in the present study, probably because this study only included non-smoking patients, and the mean follow-up time was considerably shorter with 3.5 years. Rinke et al. (2011) based their investigation on patients treated in a dental private clinic and found prevalences of 11.2% and 44.9% for peri-implantitis and mucositis respectively.

All patients included in our sample followed a periodontal maintenance programme. This fact might explain the low values of the Mombelli Index, especially in the disease groups (peri-implantitis: mPI: 1.2 ± 0.7 and mGI: 1.1 ± 0.4). A higher prevalence of peri-implant diseases might be expected among non-compliant patients.

According to Mombelli & Décaillet (2011), peri-implant disease (mucositis or peri-implantitis) definitions include inflammation with or without bone loss as a requirement for diagnosis. These definitions may be excluding an important group composed of implants with clinically healthy tissues but that have lost bone support as a result of a remodelling process or after successful treatment of peri-implantitis. These fixtures can probably be maintained on a long-term basis if patients are committed to a strict periodontal maintenance programme, and if risk factors have been controlled. It can be observed that while bone level is very similar (clinical stability 2.8 ± 1.1 *versus* peri-implantitis 3.0 ± 1.4 threads without bone support), periodontal parameters (probing, mPI and mGI) are considerably lower in the stability group. The differences regarding bone support may increase over time, as disease progression is expected in the peri-implantitis group. Further research is needed to analyse the progression of both groups, and to determine whether changes from peri-implantitis diagnosis to a situation of clinical stability increase the long-term survival of these implants.

The present study also contributes information on the condition of implants placed in peri-implantitis diagnosed patients (i.e. patients who have at least one implant with peri-implantitis) (Fig. 1). As most risk factors [e.g. smoking and antecedents of periodontitis (Heitz-Mayfield 2008, Schwarz & Becker 2010, Serino & Ström 2009, Rinke et al. 2011)] affect all fixtures in the same manner, an evaluation was made of whether peri-implant diseases in most cases represent a generalized condition. Our findings seem to support this hypothesis, as only 11.1% of the implants placed in patients diagnosed with peri-implantitis were considered healthy.

The prevalence of peri-implantitis in private practice based patients enrolled in a periodontal maintenance programme ranges from 12% to 22%. Patients with mucositis were a common finding (39%). These prevalences are similar to those published in University environment samples. Lastly, peri-implantitis seems to be a generalized disorder, since usually most of the implants in patients diagnosed with such conditions are affected by the disease.

References

Berglundh, T., Persson, L. & Klinge, B. (2002) A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. *Journal of Clinical Periodontology* **29**(Suppl 3), 197–212 discussion 232–233.

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P. & STROBE Initiative (2007) The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* **370**, 1453–1457.

Ferreira, S. D., Silva, G. L., Cortelli, J. R., Costa, J. E. & Costa, F. O. (2006) Prevalence and risk variables for peri-implant disease in brazilian subjects. *Journal of Clinical Periodontology* **33**, 929–935.

Heitz-Mayfield, L. J. (2008) Peri-implant diseases: diagnosis and risk indicators. *Journal of Clinical Periodontology* **35**, 292–304.

Koldsland, O. C., Scheie, A. A. & Aass, A. M. (2010) Prevalence of peri-implantitis related to severity of the disease with different degrees of bone loss. *Journal of Periodontology* **81**, 231–238.

Mombelli, A. & Décaillet, F. (2011) The characteristics of biofilms in peri-implant disease. *Journal of Clinical Periodontology* **38**(Suppl. 11), 203–211.

Mombelli, A., van Oosten, M. A., Schürch, E. Jr & Land, N. P. (1987) The microbiota associated with successful or failing osseointegrated titanium implants. *Oral Microbiology and Immunology* **2**, 145–151.

Pikner, S. S. & Gröndahl, K. (2009) Radiographic analyses of "advanced" marginal bone loss around branemark dental implants. *Clinical Implant Dentistry and Related Research* **11**, 120–133.

Rinke, S., Ohl, S., Ziebolz, D., Lange, K. & Eickholz, P. (2011) Prevalence of periimplant disease in partially edentulous patients: a practice-based cross-sectional study. *Clinical Oral Implants Research* **22**, 826–833.

Roos-Jansåker, A. M., Lindahl, C., Renvert, H. & Renvert, S. (2006) Nine- to fourteen-year follow-up of implant treatment. part II: presence of peri-implant lesions. *Journal of Clinical Periodontology* **33**, 290–295.

Schwarz, F. & Becker, J. (2010) Etiological factors. In: Schwarz, F. & Becker, J. (eds). *Peri-implant infection: etiology, diagnosis and treatment*, pp. 45–47, London: Quintessence.

Serino, G. & Ström, C. (2009) Peri-implantitis in partially edentulous patients: association with inadequate plaque control. *Clinical Oral Implants Research* **20**, 169–174.

Vandenbroucke, J. P., von Elm, E., Altman, D. G., Gøtzsche, P. C., Mulrow, C. D., Pocock, S. J., Poole, C., Schlesselman, J. J., Egger, M. & STROBE Initiative (2007) Strengthening the reporting of observational studies in epidemiology (STROBE): explanation and elaboration. *Epidemiology*(Cambridge, Mass.) **18**, 805–835.

Zitzmann, N. U. & Berglundh, T. (2008) Definition and prevalence of peri-implant diseases. *Journal of Clinical Periodontology* **35**, 286–291.

Address:
R. Figueiredo
Facultat d'Odontologia - Universitat de Barcelona
Campus de Bellvitge
Pavelló de Govern 2a planta, Despatx 2.9
08907 - L'Hospitalet de Llobregat
Spain
E-mail: rui@ruibf.com