Original Article

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Is bleeding on probing a differential diagnosis between periimplant health and disease?

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Abstract

As far as the periimplant anatomy is considered, the question raised is whether or not healthy periimplant tissues present bleeding on probing (BOP). **Aim:** To assess if the criterion BOP is strictly related to periimplant disease (PID). **Methods:** 134 patients were included in this study. All periimplant regions were clinically and radiographically evaluated. Patients were assigned to 3 groups based on radiographic and clinical aspects in the periimplant region: Group A (healthy-sites) - no signs of mucosal inflammation or bone loss; Group B (mucositis) - red and swollen mucosa, but no radiographic bone loss; Group C (periimplantitis) - radiographically confirmed pathological bone loss. After this classification, all periimplant sulci were probed at 4 sites (mesial, distal, buccal, lingual/palatal). Patients' mean age was 51.7±12.4 years, 77 women and 57 men, with a total of 486 osseointegrated endosseous implants. **Results:** Groups A and C showed significant difference in age and implant region distribution (p=0.009 and p=0.008, respectively). After initial clinical and radiographic diagnosis of periimplant status, 33 (20.1%) regions showed BOP in group A. All regions in Group B presented BOP. In Group C, 41 (19.9%) regions showed no BOP. All groups differed significantly considering BOP as diagnosis parameter (p<0.0001). **Conclusions:** BOP was always present in inflamed mucosa, but it was not always absent in healthy mucosa. Not all periimplantitis regions showed BOP. Clinical and radiographic aspects must always be considered together for diagnosis of PID, even if BOP is absent.

Keywords: inflammation, periimplantitis, diagnosis.

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Introduction

The soft and hard tissues around endosseous implants share some similarities with the periodontium. However, differences such as the absence of cementum and periodontal ligament in the periimplant region, orientation of the collagen fibers in the periimplant soft tissue, which is parallel to the implant surface and not inserted in the implant surface and periimplant vascularization must be taken into consideration to provide reliable prognosis[1].

In natural dentition, the junctional epithelium provides sealing on the base

of the periodontal sulcus against the penetration of chemical pathogens and bacterial substances[2]. Rupture of this sealing or lysis of connective tissue fibers attached to the apical cementum to the junctional epithelium, lead to rapid migration of the sulcular epithelium and consequent pathological pocket formation. Since cementum or fiber attachment is not seen around the titanium surface, mucosal seal provides the main barrier against the dissemination of pathological aggressions in the deep periimplant tissues. The sealing around endosseous implants, which has weak adherence to the titanium structure, is provided by the presence of junctional epithelium, sulcular epithelium and connective tissue by hemidesmosomes. The destruction of the mucosal integrity around the titanium leads to the direct extension of the pathological pocket to the bone tissue, which may result in loss of the endosseous implant[1-3].

Several reports emphasize the importance of the presence of healthy gingival tissues around dental implants as being the key factor not only for aesthetics, but also for long-term success[2,4-5]. However, correct and early clinical diagnosis of periimplant disease status is frequently critical, which makes maintenance of the periimplant tissue difficult[6]. According to the Seventh European Workshop on Periodontology, the clinical parameters that indicate periimplant disease are bleeding on probing (BOP) and increased probing depth[7]. Clinical studies have shown that the key parameter for the diagnosis of periimplant mucositis is bleeding on gentle probing. Periimplantitis is characterized by changes in the level of the crestal bone in conjunction with BOP with or without concomitant deepening of periimplant pockets. Presence of pus, gingival recession, fistula, edema and hyperplasia are other common conditions found in periimplantitis sites[6,8]. However, the radiographic detection of periimplant bone loss shows only the involvement of the proximal areas to the implant, and thus periimplant probing as a diagnostic procedure is advisable to detect bone loss on all faces[9]. In addition, probing in periimplant sulci allows evaluating the clinical probing depth, the distance between the marginal soft tissue and a reference point on the implant (for identification of hyperplasia or gingival recession), BOP and suppuration from the periimplant pocket[10].

Regarding the clinical probing depth, it is important to consider that in inflamed tissues around the implants the probe penetrates close to the bone level, while in healthy tissues the probe tip tends to stop at the histological level of connective tissue attached to the implant. The inflamed tissue with loss of connective tissue does not seem to inhibit the penetration of the probe beyond the apical extension of the junctional epithelium[11-12]. Quirynem et al.[13] (1991) found a relation between the bone level identified by the radiographic exam and the penetration of the probe into the periimplant tissue. In screw-retained implants, the probe tip stops 1.4 mm coronally to the bone level.

This way, despite the fact that BOP is a diagnosis for periimplant disease, it is important to mention that, according to Ericsson and Lindhe[14] (1993), bleeding, though unusual in healthy periodontium, is frequently found in most healthy periimplant tissues. Ferreira et al.[15] (2006) stated that it is still not clearly defined if BOP of periimplant tissues would be a parameter for identifying the presence of periimplant disease. Some studies suggest that periimplant mucosa may be more sensitive to probing forces, causing more BOP when compared with teeth[16-17].

The correct diagnosis of periimplant disease is a critical procedure, which makes it difficult the periimplant tissue maintenance[6]. Actually, a clinical standard to diagnose periimplant disease is based on the presence of BOP with probing pocket depth e”4 mm for mucositis diagnosis and additional radiographic bone loss for correct periimplantitis diagnosis[8]. During the first year after abutment connection, 1 mm of marginal bone loss is allowed, followed by 0.2 mm loss *per* year[18]. Currently, these criteria are still frequently referred to as the “gold standard” for implant success[19].

In the present study, we considered previously established clinical characteristics of periimplant tissues that justify the exclusion criterion of BOP to diagnose the presence of periimplant disease. Based on periimplant anatomy, the tested hypothesis is that healthy periimplant tissues can also present BOP. Thus, the aim of this study was to assess if BOP is directly related to the presence of periimplant disease.

Material and methods

Clinical study procedures were conducted according to the Veiga de Almeida University Ethical Board’s recommendations (Process# 238/10).

Patient Selection

One hundred and thirty-four nonsmoking patients without any systemic disease (77 women and 57 men; mean age of 51.7 ± 12.4 years), presenting a total of 486 osseointegrated endosseous implants, 295 in the maxilla and 191 in the mandible, were randomly selected for this study (Table 1). Patients signed an informed consent form after receiving full information about the study nature and purposes.

Patients were admitted to the study if they had no medical complications, were not taking medications affecting periodontal status as described by Soskolne[20] (1997) and had immediate postoperative radiographs showing the vertical bone level around the implant in order to compare bone levels after osseointegration period. Patients who had undergone any periodontal or periimplant therapy within the last six months were excluded from the study.

All periimplant regions were clinically and radiographically evaluated. Clinical examination of the periimplant sites consisted of visual inspection and palpation, analysis of mucosa color, plaque accumulation, edema and implant mobility. Conventional periapical radiographs using the paralleling technique measured the presence of vertical bone loss adjacent to the implants. The height of periimplant bone around the implant was recorded according to the exposure of the screw. According to the clinical and radiographic characteristics of the periimplant sites, patients were divided into 3 groups. Patients in Group A (healthy sites) showed no

Table 1. Patients' baseline findings.

Parameters	Total N=134	Group A N=69	Group B N=26	Group C N=39	*p*-value* (Odds ratio; CI) AxB	AxC	BxC
Age **	51.7±12.4	48.8±12.2	53.8±9.8	55.4±13.2	0.06	0.009	0.42
Gender¶	77 (57.4%) female 57 (42.6%) male	38 (55%) female 31 (45%) male	16 (61.5%) female 10 (38.5%) male	23 (59%) female 16 (41%) male	0.57 (1.30; 0.51-3.2)	0.69 (1.17; 0.52-2.59)	0.84 (0.89; 0.32-2.48)
Region¶	295 (60.7%) Maxilla 191 (29.3%) Mandible	87 (53%) Maxilla 77 (47%) Mandible	71 (61.2%) Maxilla 45 (38.8%) Mandible	137 (66.5%) Maxilla 69 (33.5%) Mandible	0.17 (1.39; 0.86-2.26)	0.008 (1.75; 1.15-2.67)	0.34 (1.25; 0.78-2.01)
Number of implants¨¶	486	164 (33.7%)	116 (23.9%)	206 (42.4%)	---	---	---

*p-values <0.05 are considered significant; CI: confidential interval; ¶chi-square test; ¨Student T-test

visual clinical signs of inflammation in the periimplant mucosa and no signs of bone loss. In Group B, periimplant sites characterized as mucositis, presence of mucosae presenting red color and swelling, but no signs of pathologic bone loss. Patients in Group C (periimplantitis sites) showed implant mobility and suppuration in some cases, and radiographic signs of pathologic bone loss (more than 2 screws exposed).

After initial classification, the periimplant sulci from Groups A, B and C were gently probed at 4 sites around each implant and the presence of BOP was recorded by a previously trained clinician. Periimplant measurements were recorded using a millimeter conventional U.N.C. periodontal probe, (Hu-Friedy™, Chicago, IL, USA). Then, if bleeding was detected at any of the sites, a classification of BOP was established.

Statistical Analysis

The data of each, including clinical and radiographic characteristics, were submitted to descriptive statistical analyses considering age, gender, region and presence of BOP using the statistical software SPSS version 12.0 (SPSS Inc., Chicago, IL, USA). Numerical variables were expressed as frequencies and percentages. The chi-square test was performed to assess the significance of nominal variables between groups. Continuous variables as age were expressed as mean and standard deviation. Then, after Shapiro-Wilk test, ANOVA was applied and parametric analysis (Student's t-test) was used to compare means between groups considering that the variable had a normal distribution. The significance level was set at 5%.

Results

Taking into consideration baseline characteristics, Groups A and C showed statistically significant difference in age and implant region distribution ($p = 0.009$ and $p = 0.008$, respectively). In Group A (healthy periimplant tissue), 131 (19.1%) periimplant regions were characterized by the absence of BOP while 33 (20.1%) regions showed BOP with no clinical or radiographic signs of inflammation. All periimplant regions (100%) in Group B (periimplant mucositis) characterized by clinical signs of inflammation (red color of mucosa and swelling) and no radiographic bone loss, presented BOP. In Group C (periimplantitis), 165 (80.1%) regions around the implants showed BOP together with pathologic bone loss and 41 (19.9%) regions presented no signs of BOP even with bone loss. Periimplant mobility was present in 6 implants in Group C (2.9%). Group A showed no inflammation in mucosa while group B showed inflammation in all periimplant mucosal tissues, helping differential clinical diagnosis. However, group C showed 118 (57.3%) regions without any sign of mucosal inflammation even when pathological bone loss was present. These results distinguished one group from another by this criterion ($p < 0.0001$). All groups had significant differences considering BOP ($p < 0.0001$). Periimplant disease groups (B and C) showed higher incidence of BOP compared to group A, which showed lower incidence of BOP, despite the presence of bleeding. In addition, when comparing disease groups, higher incidence of BOP was observed in group B ($p < 0.0001$ in all analyses comparing BOP among the 3 groups). Table 2 shows the clinical and radiographic findings in each group.

Discussion

This study evaluated the presence of BOP in periimplant regions clinically and radiographically characterized as healthy, mucositis and periimplantitis, excluding BOP as the initial diagnostic factor. Healthy patients presented no signs of visual clinical inflammation (red color or swelling) or radiographic bone loss. Regions affected by mucositis were characterized by visible clinical mucosal inflammation without signs of bone loss, and periimplantitis regions (Group C) were characterized as all regions with bone loss and more than two exposed screws, considering the radiography obtained to determine alveolar bone levels after physiologic remodeling. The main question was: The presence of BOP is really reliable when used as the unique parameter for disease diagnosis? This study showed that after the initial diagnosis

Table 2. Clinical aspects in each group

Parameters*¶	Group A N=164	Group B N=116	Group C N=206	*p* value (Odds ratio; CI)		
				AxB	AxC	BxC
Mucosa color	164 (100%) healthy	116 (100%) red (inflammation)	118 (57.3%) healthy 88 (42.7%) red	<0.0001 (---)	<0.0001 (2.38; 2.08-2.74)	<0.0001 (0.43; 0.36-0.50)
BOP	33 (20.1%)	116 (100%)	165 (80.1%)	<0.0001 (---)	<0.0001 (15.9; 9.58-26.7)	<0.0001 (---)

*Reference for calculation= number of implants; BOP= bleeding on probing, measure considering the presence of bleeding in at least one from the 4 analyzed aspects (mesial, distal, buccal, lingual/palatal); p values <0.05 are considered significant; ¶ chi-square test; (—) non measurable value due to values=0.

considering other clinical and radiographic parameters of periimplant disease, the presence of BOP was secondary for disease identification, taking into consideration that healthy periimplant mucosae (without inflammation or bone loss) showed BOP in 20% of cases.

According to the Seventh Workshop of Periodontology[7] (2011) the presence of BOP characterizes periimplant disease. However, despite BOP being a diagnosis of periimplant disease, bleeding, unusual in healthy periodontium, is found in most healthy periimplant tissues[14] as evident in this work. Therefore, according to Ferreira et al.[15] (2006) it has not been clearly defined whether periimplant BOP could represent a reliable parameter for identifying the presence of periimplant disease. Some studies suggest that periimplant mucosa may be more sensitive to probing forces, causing more BOP when compared with teeth[16-17]. Luterbacher et al.[21] affirm that absence of BOP represents a stable periimplant condition. However, lack of keratinized tissue, a common finding after implant placement surgery, could also simulate an inflamed tissue, due to gingival manipulation and its red aspect, which can also be associated with non-keratinized mucosa. Therefore, swelling, pus and radiographic findings were considered for diagnosis of mucositis.

The present study showed that 20% of patients considered clinically and radiographically healthy had BOP and all the periimplant regions with a clinical aspect of inflammation (Group B - mucositis) had BOP, which lead to the conclusion that BOP is always present in inflamed mucosa, but it will not always be absent in healthy mucosa, obviously due to periimplant anatomical reasons that, even in healthy conditions, do not limit penetration of the probe beyond the barrier in the epithelial junction. However, future studies are required, including *in vivo* analysis in order to show how the probe penetration can stimulate bleeding in healthy and diseased periimplant mucosa.

Quirynem et al.[13] (1991) found a relation between the bone level identified by the radiographic exam and the penetration of the probe into the periimplant tissue. In screw-retained implants, the probe tip appears to stop 1.4 mm coronally from the bone level. In addition, the type of probe used to measure clinically the depth does not seem to influence the result. Christensen et al.[22] used different types of probe to characterize CPD around endosseous implants and they concluded that the differences between the analyzed probe types during the research were not larger than 0.1 mm. In this study only one type of probe was used, which standardized the obtained results.

Another important consideration is that previous studies claim that when changes in the clinical parameters indicate disease (BOP, increased probing depth); the clinician is encouraged to take a radiograph to evaluate possible bone loss. The results of the performed research showed that 56% of the regions affected by pathological bone loss (periimplantitis – Group C) showed healthy mucosa, which in many cases leads the clinician not to perform a radiographic exam and to an erroneous healthy diagnosis. Therefore, the radiographic exam must be always considered as a follow-up measure and not only due to the presence of BOP, for if BOP is not present and bone loss has been triggered, possible subclinical periimplantitis may be developing. The clinical aspect as well as the radiographic aspect must be used as a diagnostic factor of periimplant disease, even if BOP is absent, instead of BOP guiding the radiographic analysis. In Implantology, the follow-up should be performed by clinical and radiographic examination at least once a year, to identify underlying bone loss in an apparently healthy periimplant gingival tissue and restore bone health before the implant failure. In case of rapid progression of periimplantitis, the following question arises: would rapid progression of periimplantitis be a consequence of a late diagnosis based solely on the clinical aspect of the mucosa?

From all patients with more than two exposed threads (pathological bone loss), 20% did not show BOP. How can this be explained? The study hypothesis is that in some patients, even with pathological bone loss, the mucosal epithelium remains adhered limiting the penetration of the probe into the tissue due to some of the following reasons: (1) bacterial penetration into the connective tissue is faster and triggers a more aggressive inflammatory response in periimplant bone, which would justify progressive bone loss without prior involvement of the mucosa; (2) at some point, mucosal inflammation might occurr with subsequent periimplant bone loss and spontaneous mucosal healing after routine cleaning procedures performed by the patient, as mucositis is characterized for being a reversible lesion, but the underlying bone shows pathological loss resulting from prior involvement due to the irreversibility of periimplantitis; (3) the thickness of the mucosa may influence the dissemination of the disease to the underlying bone limiting the damage to the thick mucosa, but further studies are needed.

Correct diagnosis of periimplant disease is still difficult to establish. Mobility of implants indicates the final stage of the disease, characterized by complete loss of the bone/implant interface[10]. Therefore, according to Heitz-Mayfield[6] (2008), mobility cannot be a parameter for early diagnosis of periimplant disease, but it may indicate complete lack of osseointegration, which requires the implant to be immediately removed. In order to be able to intervene in the development of periimplantitis before advanced bone loss, it is important to diagnose the disease in its initial stage[10]. In addition, according to Leitão et al.[23] (2005) even when significant inflammatory signs are absent in periimplant tissue, the qualitative detection of pathogens may indicate risk of periimplantitis, requiring stricter postoperative control.

In summary, several cases of failure found in this research were not directly related to the presence of BOP. BOP is always present in inflamed mucosa, but it will not always be absent in healthy mucosa. It is also important to consider that not all tissues presenting pathologic bone loss show clinical signs of inflammation. In the present study was considered that BOP alone cannot distinguish between the presence and absence of periimplant health and other factors involving a thorough clinical and radiographic characterization of the disease should be considered. The clinical aspect as well as the radiographic aspect must be always used as a diagnostic factor of periimplant disease, even if BOP is absent. The authors expect that this research can contribute to a better diagnosis of periimplant disease, thus reducing the rate of failures in implantology.

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