Definition and prevalence of peri-implant diseases


Abstract

Objectives: The aim of the current review was to describe the prevalence of peri-implant diseases including peri-implant mucositis and peri-implantitis.

Material and Methods: A MEDLINE search (PubMed) until December 2007 was conducted and different keywords related to the prevalence of peri-implant diseases were used. Cross-sectional and longitudinal studies including ≥ 50 implant-treated subjects exhibiting a function time of ≥ 5 years were considered.

Results and Conclusion: The current review revealed that only a few studies provided data on the prevalence of peri-implant diseases. Cross-sectional studies on implant-treated subjects are rare and data from only two study samples were available. Peri-implant mucositis occurred in approximately 80% of the subjects and in 50% of the implants. Peri-implantitis was found in 28% and ≥ 56% of subjects and in 12% and 43% of implant sites.

Periodontal diseases are classified into different forms of gingivitis and periodontitis. The term “gingivitis” refers to a gingival inflammation with no signs of loss of supporting tissues, while periodontitis in addition to gingival inflammation is characterized by loss of attachment and bone. Results from clinical and experimental studies revealed that the tissue response to plaque formation at teeth and dental implants is similar (Berglundh et al. 1992, Ericsson et al. 1992, Pontoriero et al. 1994, Zitzmann et al. 2001). The inflammatory lesions that develop in the tissues around implants are collectively recognized as peri-implant diseases. In accordance with the classification of periodontal disease at teeth, peri-implant disease includes two entities: peri-implant mucositis that corresponds to gingivitis and peri-implantitis that corresponds to periodontitis. Definitions of the two peri-implant disease entities were proposed in a consensus report from the 1st European Workshop on Periodontology (EWOP) (Albrektsson & Isidor 1994). While peri-implant mucositis was defined as a reversible inflammatory reaction in the soft tissues surrounding a functioning implant, peri-implantitis described inflammatory reactions associated with loss of supporting bone around an implant in function.

Histological characteristics of peri-implant mucositis and peri-implantitis lesions were analysed in human biopsies. It was reported that the inflammatory cell lesion in sites with peri-implant mucositis was dominated by T cells and had an apical extension that was restricted to the barrier epithelium (Zitzmann et al. 2001). In peri-implantitis, the lesion extended apical to the pocket epithelium and contained large proportions of plasma cells and lymphocytes but also PMN cells and macrophages in high numbers (Gualini & Berglundh 2003, Berglundh et al. 2004).

It is imperative that definitions of peri-implant mucositis and peri-implantitis are simple so that they can be used in clinical practice and in research. In the definitions from the 1994 EWOP, it was stated that mucositis was a reversible inflammatory reaction, while the term “reversible” was not included for peri-implantitis. These definitions may thus imply that the inflammatory process that occurs in peri-implantitis lesions is irreversible and, hence, not possible to treat. Therefore, in the present review, modified definitions of peri-implant mucositis and peri-implantitis will be suggested. Pertinent clinical symptoms will also be identified although issues related to the diagnosis of the two disease entities are reviewed elsewhere (Heitz-Mayfield 2008). Thus, peri-implant disease is a collective term for inflammatory reactions in the tissues surrounding an implant. Peri-implant mucositis is used to describe the presence of inflammation in the mucosa at an implant with no signs of loss of supporting bone. Peri-implantitis in addition to inflammation in the mucosa is characterized by loss of supporting bone.

Detection of inflammation in the peri-implant mucosa requires the use of...
Thus, data on bleeding on probing in peri-implantitis and peri-implant mucositis was recorded from the end-point assessment (implants exhibiting a function time of 9–11 years). Studies were excluded if peri-implant disease was found in 46–51% at 5 years to 70–91% at 10 years. In the study, by Roos-Jansåker et al. (2006), 75% of the implants exhibited bleeding on probing at 9–14 years of function. In three studies, data on bleeding on probing were not evaluated in relation to the presence or absence of bone loss (Scheller et al. 1998, Polizzi et al. 2000, Baelum & Ellegaard 2004).

Material and Methods

Type of studies

Cross-sectional and longitudinal studies on implant-treated subjects with implants exhibiting a function time of at least 5 years were considered. In longitudinal studies, data were obtained from the end-point assessment (⩾5 years). Studies were excluded if <50 subjects were examined.

The prevalence of peri-implant mucositis and peri-implantitis was recorded on subject as well as implant levels. Thus, data on bleeding on probing in combination with information on the presence or absence of bone loss were collected. Data on bleeding on probing without information on bone loss were categorized as “peri-implant disease”.

Search strategy

A MEDLINE search (PubMed) was conducted and work published in the English language until December 2007 was included in the review. The following search terms were used: “prevalence”, “peri-implant (periimplantitis)” (Fugro, I. 2002), “peri-implant mucositis”, “peri-implantitis (periimplantitis)”, “biological complications”, “human”, “dental implants”, “complications”, “cross-sectional studies”, “longitudinal studies” and “prospective studies”. Titles and abstracts were screened for information on sample size and function time and full-text analysis was performed in relevant publications.

The literature related to biological complications in implant dentistry was reviewed by Berglundh et al. (2002). The retrieved publications related to peri-implant disease from this review were screened according to the defined criteria. Further manual search included (i) bibliographies of other previous reviews and (ii) in the following journals: Clinical Implant Dentistry and Related Research, Clinical Oral Implants Research, International Journal of Oral and Maxillofacial Implants, International Journal of Periodontics and Restorative Dentistry, Journal of Clinical Periodontology and Journal of Periodontology.

Results

The combinations of search terms resulted in a list of 683 titles (PubMed until December 2007) and, following screening of abstracts, full-text analysis was performed from 99 potentially relevant publications. Applying the defined study criteria, publications were excluded mainly due to the following reasons:

- function time of the implants <5 years,
- sample size <50 at the end point of longitudinal studies (⩾5 years) and
- absence of clinical data regarding bleeding on probing.

Full-text analysis yielded 26 studies eligible for inclusion and eight authors were contacted for further clarification of methods or results. Nine publications related to six different subject samples fulfilled the criteria (Table 1), while 17 studies were excluded (Table 2). From the 29 publications that presented data on peri-implant mucositis or peri-implantitis in the review by Berglundh et al. (2002), only two studies fulfilled the criteria of the current review, while 27 were rejected either due to small sample sizes (<50 subjects) or absence of data on bleeding on probing.

In the cross-sectional study by Fransson et al. (2005) and Bragger et al. (2005), who reported results from one study sample, were also pooled. A similar approach was adopted with respect to the studies by Roos-Jansåker et al. (2006) and Renvert et al. (2007).

Results describing the occurrence of bleeding on probing at implants varied between 24% and 91% (Table 1). Baelum and Ellegaard (2004), who analysed subjects treated with two different implant systems (Astra and ITI), reported that the prevalence of BoP-positive implants increased from 46–51% at 5 years to 70–91% at 10 years. In the study, by Roos-Jansåker et al. (2006), 75% of the implants exhibited bleeding on probing at 9–14 years of function. In three studies, data on bleeding on probing were not evaluated in relation to the presence or absence of bone loss (Scheller et al. 1998, Polizzi et al. 2000, Baelum & Ellegaard 2004).

Peri-implant mucositis

Roos-Jansåker et al. (2006) reported that peri-implant mucositis (BoP and no bone loss) occurred in about 79% of the subjects and 50% of the implants. In the study by Fransson et al. (2008), BoP was found in >90% of the implants without a history of bone loss.

Peri-implantitis

The prevalence of peri-implantitis was addressed in five publications that represented three subject samples with average function times of 9–11 years (Karoüssis et al. 2004a, Bragger et al. 2005, Fransson et al. 2005, 2008, Roos-Jansåker et al. 2006). On a subject level, Fransson et al. (2005, 2008) reported a prevalence of 28%, while in the study by Roos-Jansåker et al. (2006), at least 56%
of the subjects exhibited sites with peri-implantitis. The proportion of implants that demonstrated bone loss in combination with BoP varied between 12% and 43%.

In the study sample analysed by Karoussis et al. (2004a) and Brägger et al. (2005), 15% of the implants exhibited peri-implantitis. In addition, seven of the implants (4%) were lost in five subjects (6%) due to peri-implantitis.

In the cross-sectional study by Fransson et al. (2005), about 28% of the subjects had ≥1 implant with progressive bone loss. Of all 3413 examined Brånemark implants, 422 (12.4%) presented with bone loss that extended to a level corresponding to or apical of the third thread of the implant. The results from the clinical examination of the subjects revealed that 94% of the affected implants exhibited BoP and, thus, validated the diagnosis of peri-implantitis (Fransson et al. 2008).

The data presented in the cross-sectional study by Roos-Jansäker et al. (2006) were recalculated by us according to the definitions of the current review. Roos-Jansäker et al. (2006) presented bone loss at implants in categories of number of threads and reported data on peri-implantitis in % of subjects and implants. Because one subject may harbour ≥1 implant with peri-implantitis, the calculated subject prevalence may vary between 56% and 77%. The authors also reported that about 43% of the implants showed bone loss in combination with BoP. That data presented in Table 8 from the study by Roos-Jansäker et al. (2006), however, indicated that 24.8% of the implants had BoP and bone loss that amounted to greater than equal to one thread.

### Discussion

The current review revealed that only a few studies provided data on the prevalence of peri-implant disease. Cross-sectional studies on implant-treated subjects are rare and data from only two study samples were available (Fransson et al. 2005, 2008, Roos-Jansäker et al. 2006). Information from end-point assessments in longitudinal studies ≥5 years was also retrieved. In the majority of publications, the prevalence of peri-implant disease was reported in percentage of implants rather than percentage of subjects.

The definitions of peri-implant disease, peri-implant mucositis and peri-implantitis used in the present review followed the outline presented in the 1st EWOP (Albrektsson & Isidor 1994). Different definitions on peri-implantitis were proposed in recent clinical studies. Thus, Behneke et al. (2002) suggested that peri-implantitis should include presence of clinical inflammation (bleeding, redness, swelling and pus) and progressive bone loss (not defined in millimetres). Ekelund et al. (2003) described peri-implantitis as a combination of inflammation, pain and continuous bone loss, while in the study by Ferreira et al. (2006) the diagnosis of peri-implantitis had to meet the following criteria: (i) PPD ≥5 mm, (ii) BoP and (iii) vertical bone loss. Almost similar criteria for peri-implantitis were presented by Karoussis et al. (2004a), namely PPD ≥5 mm and BoP (or pus) and radiographic bone loss.

Different definitions were also applied by Roos-Jansäker et al. (2006), who presented data from the subject sample also used by Laine et al. (2006) and Renvert et al. (2007). It was suggested that the criteria for peri-implant mucositis in addition to BoP should include probing pocket depth of ≥4 mm, while the detection of peri-implantitis required a threshold value of bone loss after the first year in function (1.8 mm) in combination with bleeding or suppuration after probing.

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**Table 1. Data from publications included in the review**

<table>
<thead>
<tr>
<th>No.</th>
<th>Reference</th>
<th>Study type, implant system</th>
<th>Number subjects/ implants</th>
<th>Mean function time (range)</th>
<th>Peri-implant disease (BoP+*</th>
<th>Peri-implant mucositis % subjects/implants</th>
<th>Peri-implantitis % subjects/implants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scheller et al. (1998)</td>
<td>Prospective, Brånemark</td>
<td>57/59</td>
<td>5 years</td>
<td>24% implants</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>Polizzi et al. (2000)</td>
<td>Prospective, Brånemark</td>
<td>86/163</td>
<td>5 years</td>
<td>27.3% implants</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>Baelum &amp; Ellegaard (2005), Ferreira et al. (2006)</td>
<td>Prospective, Astra and ITI</td>
<td>140 subjects/ 244 imps (5 years), 211 imps (10 years)</td>
<td>5 or 10 years</td>
<td>45.5–51.0% implants at 5 years, 69.5–90.5% implants at 10 years</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>Karoussis et al. (2004a), Bärgger et al. (2005)</td>
<td>Prospective, ITI (hollow screws, hollow cylinder, angulated hollow cylinder)</td>
<td>89/153</td>
<td>10 years (8–12 years)</td>
<td>–</td>
<td>–</td>
<td>15.4–15.7% implants 7 implants (4%) lost in 5 subjects (6%) due to peri-implantitis</td>
</tr>
<tr>
<td>5</td>
<td>Fransson et al. (2005)</td>
<td>Cross-sectional, Brånemark</td>
<td>662/3413</td>
<td>8.49.1 years (5–20 years)</td>
<td>–</td>
<td>–</td>
<td>27.8% subjects 12.4% implants</td>
</tr>
<tr>
<td>6</td>
<td>Roos-Jansäker et al. (2006), Renvert et al. (2007)</td>
<td>Cross-sectional, Brånemark</td>
<td>216/987</td>
<td>10.8 years (9–14 years)</td>
<td>75.4% implants</td>
<td>75.4% implants</td>
<td>79.2% subjects/ 50.6% implants 55.6–77.4% subjects/ 43.3% implants</td>
</tr>
</tbody>
</table>
The definitions of the disease entities presented in the current review provided simple and universal criteria that may be useful in clinical practice and remain independent of the implant systems used. In a systematic review, Berglundh et al. (2002) reported on the incidence of biological complications in implant therapy. While no information was provided regarding peri-implant mucositis, the occurrence of peri-implantitis in prospective studies with at least 5 years of follow-up was presented. It was observed that there was limited information on the incidence of peri-implantitis and that the term "peri-implantitis" was included only in a few studies. Berglundh et al. (2002) applied the definitions of peri-implantitis presented in the 1st EWOP but in the absence of this "direct information", clinical findings from probing and attachment-level assessments as well as results from radiographic examinations were used. Thus, implants that, in addition to bleeding on probing/suppuration, demonstrated probing pocket depth of >6 mm or attachment loss/bone loss of ≥2.5 mm were identified as peri-implantitis. Despite the use of additional variables in the systematic review referred to, data on peri-implantitis were only available in 35–45% of studies on implants supporting overdentures, fixed complete and partial dentures. Berglundh et al. (2002) therefore suggested that the incidence of complications may be underestimated. It was also pointed out that the available information in the literature on peri-implantitis and other biological complications in implant therapy was presented as percentage of implants and not in percentage of subjects. In the current review, data on bleeding on probing were a prerequisite for a study to be included. Furthermore, a sample size of ≥50 subjects and a function time of at least 5 years were also required for inclusion. Five years

Table 2. Reasons for exclusion of publications

<table>
<thead>
<tr>
<th>No.</th>
<th>Authors, year</th>
<th>Study type, implant system</th>
<th>Number subjects/implants at endpoint</th>
<th>Mean function time (range)</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Attard &amp; Zarb (2002)</td>
<td>Retrospective, Brånemark</td>
<td>50/163</td>
<td>16.6/18.3 years (thyroid/control)</td>
<td>No BoP</td>
</tr>
<tr>
<td>2</td>
<td>Behnke et al. (2002)</td>
<td>Prospective longitudinal ITI</td>
<td>83/285</td>
<td>5.8 years (max 8.7)</td>
<td>No BoP</td>
</tr>
<tr>
<td>3</td>
<td>Dudic &amp; Mericske-Stern (2002)</td>
<td>Prospective ITI</td>
<td>119/258</td>
<td>9.35 years (5–15 years)</td>
<td>Peri-implant parameters were assessed, but no report on BoP</td>
</tr>
<tr>
<td>4</td>
<td>Ekelund et al. (2003)</td>
<td>Prospective, Brånemark</td>
<td>30/179</td>
<td>20 years</td>
<td>Small sample at 20 years, no BoP</td>
</tr>
<tr>
<td>5</td>
<td>Ellegaard et al. (2006)</td>
<td>Prospective, Astra and ITI</td>
<td>68/262 at placement</td>
<td>– (1–12 years)</td>
<td>No clear data about number of drop-outs and failures at 5 and 10 years, average function time not mentioned</td>
</tr>
<tr>
<td>6</td>
<td>Hardt et al. (2002)</td>
<td>Retrospective, Brånemark</td>
<td>97/346</td>
<td>5 years</td>
<td>No clinical exam (no BoP)</td>
</tr>
<tr>
<td>7</td>
<td>Hellden et al. (2003)</td>
<td>Prospective longitudinal, Cresco</td>
<td>52/190</td>
<td>5 years</td>
<td>No BoP</td>
</tr>
<tr>
<td>8</td>
<td>Johansson &amp; Ekfeldt (2003)</td>
<td>Retrospective, Brånemark</td>
<td>76/218</td>
<td>53.9 months (1–7 years)</td>
<td>Part of the cohort reported in Karoussis et al. (2004a, b) and Brägger et al. (2005); data splitted in patients with/without history of periodontal disease</td>
</tr>
<tr>
<td>9</td>
<td>Karoussis et al. (2003)</td>
<td>Prospective longitudinal, ITI (hollow screws)</td>
<td>53/112</td>
<td>10 years</td>
<td>Same cohort as reported in Karoussis et al. 2004a and Brägger et al. 2005; no additional data</td>
</tr>
<tr>
<td>10</td>
<td>Karoussis et al. (2004b)</td>
<td>Prospective longitudinal, ITI</td>
<td>89/165</td>
<td>10 years (8–12 years)</td>
<td>No BoP</td>
</tr>
<tr>
<td>11</td>
<td>Kourtis et al. (2004)</td>
<td>Retrospective, IMZ, Friailt, Freehex, Frialoc</td>
<td>405/1692</td>
<td>4.6 years (1–12 years)</td>
<td>No BoP</td>
</tr>
<tr>
<td>12</td>
<td>Laine et al. (2006)</td>
<td>Retrospective, Brånemark</td>
<td>120/601</td>
<td>– (≥2 years)</td>
<td>Patient selection (with/without peri-implantitis) by purpose (not a random sample), mean function time not specified</td>
</tr>
<tr>
<td>13</td>
<td>Mericske-Stern et al. (2001)</td>
<td>Prospective ITI</td>
<td>72/109 at placement (consecutively admitted)</td>
<td>4.3 years (&gt;1–9 years); 26 sub/109 imps &gt;5 years</td>
<td>Small sample size at 5 years, no BoP (not specified)</td>
</tr>
<tr>
<td>14</td>
<td>Nickenig et al. (2006)</td>
<td>Retrospective, Brånemark, ITI</td>
<td>83/142</td>
<td>4.7 years (2.2–8.3 years)</td>
<td>No clinical exam (no BoP)</td>
</tr>
<tr>
<td>15</td>
<td>Örtorp &amp; Jemt (2006)</td>
<td>Prospective, Brånemark</td>
<td>112/603</td>
<td>10 years</td>
<td>No BoP</td>
</tr>
<tr>
<td>16</td>
<td>Strietzel et al. (2004)</td>
<td>Retrospective, Friailt</td>
<td>504/1554</td>
<td>6.2 years (max 134 months)</td>
<td>No BoP</td>
</tr>
<tr>
<td>17</td>
<td>Wennström et al. (2004)</td>
<td>Prospective, Astra (with machined or roughened surface)</td>
<td>47/137</td>
<td>5 years</td>
<td>Small sample at 5 years</td>
</tr>
</tbody>
</table>
may be considered as a short period taking into account that epidemiological studies on periodontal disease include subjects who had teeth in function and exposed to microbial challenge for decades. The limit of 50 subjects may also be considered as a low threshold in view of the sample sizes used in epidemiological studies on teeth. This assumption is in accordance with observations made in a recent review on the longevity of teeth and implants by Tomasi et al. (2008). They reported that the number of subjects evaluated in studies on teeth was considerably (about 10 times) larger than that in studies on implants.

The cross-sectional approach used by Fransson et al. (2005, 2008) and Roos-Jansåker et al. (2006) provided information on the prevalence of peri-implant disease among subjects who had implants in function for approximately 10 years. The results regarding the subject prevalence of peri-implantitis in the two samples, however, were different. The higher prevalence reported in the study by Roos-Jansåker et al. (2006) may be explained by differences in maintenance procedures. Also, the percentage of implants with peri-implantitis reported in the study by Roos-Jansåker et al. (2006) was larger than that presented by Fransson et al. (2005, 2008) and by Karoussis et al. (2004a) and Brägger et al. (2005).

Conclusions

Few studies provided data on the prevalence of peri-implant diseases. Cross-sectional studies on implant-treated subjects are rare and data from only two study samples (662 and 216 subjects) were available. Peri-implant mucositis occurred in 80% of the subjects and in 50% of the implant sites. Peri-implantitis was identified in 28% of subjects and in 50% of the implant sites. Peri-implantitis was identified in 28% and >56% of subjects and in 12% and 43% of implant sites, respectively.

Despite the fact that dental implants have been used as a routine procedure for >25 years in the treatment of edentulous and partially edentulous subjects, the design of clinical studies evaluating the outcome of such treatment in most cases remains longitudinal in character and includes small groups of subjects. For the purpose of providing sufficient information on the prevalence of peri-implant disease, an epidemiological approach is preferable. Thus, using a cross-sectional design and a study sample with an appropriate size, i.e. 100–500 implant-treated subjects, clinical and radiographic examinations should be performed. The subjects may vary regarding age, gender, implant-supported reconstructions, as well as number and function time of implants. In addition, the subjects should ideally be recruited from private or public dental clinics, rather than university clinics and, hence, provide information on the “effectiveness” rather than “efficacy” in implant therapy. Subject-based data should be provided regarding prevalence of peri-implant disease. The extent of the disease needs to be described, i.e. the proportion of affected implants for each subject. In the presence of peri-implantitis, the severity of the disease, i.e. the amount of bone loss, should be reported.

References


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