Incidence of peri-implant mucositis and peri-implantitis in edentulous patients with an implant-retained mandibular overdenture during a 10-year follow-up period


Abstract
Objectives: The aim of this sub-analysis of two prospective studies was to assess the incidence of peri-implant mucositis and peri-implantitis in fully edentulous patients with an implant-retained mandibular overdenture during a 10-year follow-up period.

Material and Methods: One hundred and fifty edentulous patients with two endosseous implants to support a mandibular overdenture were available from two prospective studies. Clinical and radiographic parameters were assessed at 5 and 10 years of functional loading. Incidence of peri-implant mucositis and peri-implantitis were calculated at implant level and patient level following the Consensus of the Seventh European Workshop on Periodontology on peri-implant diseases.

Results: Incidence of peri-implant mucositis at patient level was 51.9% after 5 years of evaluation and 57.0% after 10 years. Incidence of peri-implantitis at patient level was 16.9% after 5 years of evaluation and 29.7% after 10 years.

Conclusion: Peri-implant mucositis and peri-implantitis do occur in totally edentulous patients and incidence numbers are high.

Conflict of interest and source of funding statement
The authors declare that there are no conflicts of interest in this study and no external funding was obtained.

Mandibular overdenture therapy has been proven a very successful treatment for edentulous patients experiencing problems with their mandibular full removable dentures. Survival of implants and patients’ satisfaction reveals very high scores (Meijer et al. 2009, Lee et al. 2012). These very favourable results do not mean, however, that implant therapy is without technical and biological complications and that there is no need for aftercare (Berglundh et al. 2002, Visser et al. 2006). Peri-implant disease is considered a major complication and is addressed in a number of Consensus Workshops (Lang et al. 2004, Lindhe & Meyle 2008, Lang & Berglundh 2011, Klinge 2012, Sanz & Chapple 2012). Zitzmann & Berglundh (2008) reviewed the prevalence of peri-implant disease: 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. It must be
noted, however, that data from only two study samples were available at the time the review was written. In a
more recent review of Atieh et al. (2013), nine studies with 1497 partici-
pants and 6283 implants were included. Frequency of peri-implant
mucositis was 63.4% in participants and 30.7% in implants, and of peri-
implantitis it was 18.8% in participants and 9.6% in implants. De Waal
et al. (2013) reviewed differences in peri-implant conditions between fully
and partially edentulous subjects. However, due to lack of studies and
different criteria used, no comparison of prevalence between fully and par-
tially edentulous subjects could be made. Overall data on peri-implant-
tis prevalence reported on implant level range from 0% to 3.4% after an
observation period of 5 years and from 5.8% to 16.9% after an observa-
tion period of ≥10 years. Only one clinical study demonstrated data
comparing fully and partially edentulous subjects (Roos-Jansaker et al.
2006). The prevalence of peri-implant mucositis and peri-implantitis was
lower in a fully edentulous group compared with a partially edentulous
group (only implant-based data were available; peri-implant mucositis: 39.6% versus 52.3%; peri-implantitis: 5.8% versus 7.2%).

Several authors mention the differ-
ent threshold levels in definitions
used for peri-implant mucositis and peri-implantitis, making comparison and meta-analyses very difficult
(Klinge 2012, Mombelli et al. 2012,
Atieh et al. 2013, De Waal et al.
2013). Another remark made is that
since multiple implants in the same
patient cannot be considered to be
independent in a statistical sense, it
is recommended that the data are
also presented at the subject level
(Klinge 2012).

There is a need of more long-
term clear defined data to gain more
insight into the incidence of biologi-
cal complications. The aim of this
study was to assess, in two prospec-
tive studies, the incidence of peri-
implant mucositis and peri-
implantitis in fully edentulous patients
with an implant-retained mandibular
overdenture during a 10-year follow-
up period.

Materials and Methods
Patient selection and treatment
Patients for this evaluation originate
from two clinical trials, of which
short-, medium- and long-term
results were published before (Baten-
burg et al. 1998, Heydenrijk et al.
2002a, Meijer et al. 2004, 2009,
Heijdenrijk et al. 2006). For these
trials, patients with resorbed mandi-
bles were included. All patients had
persistent problems with their con-
ventional complete dentures due to
reduced stability and insufficient
retention of their mandibular den-
ture. All patients had a conventional
removable denture in the upper jaw.
The following groups were combined
for the evaluation, making the study
design a sub-analysis of two inde-
pendent prospective studies:

from the study of Batenburg
et al. (1998):

- 30 patients were treated with the
two-stage 4-mm diameter IMZ
cylinder implant with TPS coat-
ing (Dentsply Friadent, Mann-
heim, Germany);
- 30 patients with the two-stage
3.75-mm diameter Bränemark
screw implant with a machined
surface (Nobel Biocare Holding
AG, Zürich, Switzerland);
- 30 patients with the one-stage
4.1-mm diameter ITI solid screw
implant with TPS coating (Insti-
tut Straumann AG, Basel, Swit-
zerland).

from the studies of Heydenrijk
et al. (2002a,b):

- 20 patients were treated with the
two-stage 4-mm diameter IMZ
cylinder implant with TPS coat-
ing;
- 20 patients were treated with the
two-stage 4-mm diameter IMZ
cylinder implant with TPS coat-
ing, but surgery was carried out
in a one-stage procedure;
- 20 patients with the one-stage
4.1-mm diameter ITI solid screw
implant with TPS coating.

Smoking and a history of peri-
odontitis are not known for patients
of both cohorts. Therefore, these
potential confounding factors could
not be analysed. No additional soft
tissue grafting or bone grafting have
been performed at implant place-
ment. With a two-stage technique,
implants were placed submerged;
after osseointegration, during a sec-
ond surgical procedure, a transmu-
cosal abutment was connected. With
a one-stage technique, implants were
placed unsubmerged; a second surgi-
cal is not necessary, because a trans-
mucosal part is integrated into the
implant or a transmucosal abutment
has already been placed at implant
insertion. All patients were treated
under local anaesthesia with an
implant in the right and left canine
region of the mandible. Three
months after implant placement, a
standard prosthetic procedure was
carried out. A new maxillary com-
plete denture and a mandibular
overdenture supported by a bar and
clip attachment were fabricated. All
patients were treated in the same
department (Department of Oral
and Maxillofacial Surgery, Univer-
sity Medical Center Groningen,
Groningen, The Netherlands) by two
two experienced oral-maxillofacial sur-
geons and one experienced prostho-
dontist. Patients received oral
hygiene instructions, according to a
standardized protocol, at the time of
abutment connection, at the time of
placement of the overdenture, 6
months after overdenture place-
ment, 12 months after overdenture
placement, and on a yearly basis. If
plaque and/or calculus were present
at an evaluation period, an additional
visit was planned after 3 months.
Characteristics of the 150 patients
derived from the studies of Batenburg
et al. (1998) and Heydenrijk et al.
(2002a,b) are listed in Table 1. Bone
height was measured on rotational
panoramic radiographs with correc-
tion for distortion (Batenburg et al.
1997). Bone quality was determined
according to Lekholm & Zarb (1985)
on lateral cephalometric radiog-
raphs.

Clinical and radiographic analysis

For determination of incidence of peri-implant mucositis and peri-
implantitis, the following parameters were used:

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the bleeding index according to Mombelli et al. (1987) (score 0: no bleeding when using a periodontal probe, score 1: isolated bleeding spots visible, score 2: a confluent red line of blood along the mucosal margin, score 3: heavy or profuse bleeding);

- probing depth, measured at four sites of each implant (mesially, labially, distally, lingually) by using a periodontal probe (Merit B, Hu Friedy, Chicago, IL, USA) after removal of the bar; the distance between the marginal border of the mucosa and the tip of the periodontal probe was scored as the probing depth;

- peri-implant bone changes; standardized intra-oral radiographs of each implant were obtained using a beam direction device as described by Meijer et al. (1992); analysis was done with a digital sliding gauge (Helios digit E 2056, Schneider & Kern, Niedernhall, Germany). Two-point measurements were made along the implant axis from a fixed reference point to the level of bone (Meijer et al. 1993);

Data collection

The subsequent data collection of clinical parameters of patients was at 5 and 10 years after placement of the overdenture. Radiographs taken at baseline (placement of the overdenture) and 5 and 10 years thereafter, were used for the analysis. Loss of implants and peri-implant surgery due to peri-implant disease were scored from the patient's medical record.

Data analysis

Probing depth was measured at four sites around each implant and bone height measurement was done mesially and distally on the radiograph. It was assumed that the deepest pocket and the largest bone loss would have the most influence on the survival and clinical status of the implant. Therefore, in case of the items probing depth and radiographic bone height the worst score per implant was used as representative. The translation from Modified Bleeding Index into Bleeding on Probing (BoP) was score 0 = BoP− and score 1, 2, and 3 = BoP+.

As definition for peri-implant mucositis and peri-implantitis, the consensus reached at the Seventh European Workshop on Periodontology has been used (Lang & Berglundh 2011), being:

peri-implant mucositis (radiographic bone loss < 2 mm): BoP+ and/or suppuration and peri-implantitis; BoP+ and/or suppuration in combination with radiographic bone loss ≥ 2 mm.

Incidence is defined as the number of new cases per population at risk in a given time period. Data of lost implants due to peri-implantitis and of surgical treatment of peri-implantitis were added to data found at the evaluation periods. Data on incidence of peri-implant mucositis and peri-implantitis are presented at implant level (with implants as a statistical unit) and at patient level (with patients as a statistical unit) (Klinge 2012).

Results

Five years after placement of the overdenture, four patients did not attend the evaluation due to sickness and two patients moved without leaving address. Four patients had died. At the 10 year follow-up, seven patients did not attend the evaluation due to sickness and five patients moved without leaving address. In addition, seven patients had died between the 5-year and 10-year follow-up appointment. The assumption was made that not attending the evaluation was independent of the clinical or radiographic condition.

Clinical and radiographic parameters

During the healing phase, two implants were lost. During the functional period between placement of the overdenture and 1 year in function, two implants were lost due to mobility without infection. Between 1 year and 5 years no implants were lost. Between 5 years and 10 years, 10 implants were lost due to peri-implantitis. In all cases, new implants were placed after a 6-months healing period of the implant sites. When considering these numbers, 5-year survival of implants, including the ones lost during the osseointegration period, was 98.7% (97.9% for IMZ-implants, 98.3% for Brä-implants, and 100% for ITI-implants). Ten-year survival rate was 95.3% (91.4% for IMZ-implants, 98.3% for Brä-implants and 99% for ITI-implants). One patient had surgery at both implants to treat peri-implantitis during 1 and 5 years. Five patients had surgery on seven implants for peri-implantitis during 5 and 10 years. Peri-implant mucositis has been treated with nonsurgical debridement, followed by re-instruction of oral hygiene measurements. Peri-implantitis was treated with surgical debridement, followed by re-instruction of oral hygiene measurements. In all cases, there was an adjunctive delivery of antiseptics (chlorhexidine 0.2% mouth rinse). No local or systemic antibiotics were given.

The mean score on the index for bleeding was low at both evaluation periods (Table 2). The mean probing depth was 3.2 mm at T5 and 3.4 mm at T10 (Table 2). The mean loss of marginal bone between baseline and the 5 years evaluation was 1.0 mm (SD = 1.1) and between baseline and the 10 years evaluation 1.1 mm (SD = 1.1) (Table 2). Frequencies of peri-implant bone changes have been depicted in Table 3.

Based on the results of the Modified Bleeding Index, peri-implant bone changes and peri-implantitis scored from the medical record (lost implants due to peri-implantitis and surgical treatment of
peri-implantitis), incidence of peri-
implant mucositis and peri-implantitis were calculated. Incidence of peri-
implant mucositis at patient level was 51.9% after 5 years of evaluation and
57.0% after 10 years. Incidence of peri-
implantitis at patient level 16.9% after 5 years of evaluation and 29.7% after 10 years (Table 4).

The mean plaque score 1 month after placement of the overdenture was 0.4 (SD: 0.8), 5 years after placement of the overdenture it was 0.6 (SD: 0.9), and after 10 years it was 0.4 (SD: 0.8).

**Discussion**

**Peri-implant mucositis** does occur in totally edentulous patients with two implants in the mandible to support an overdenture. Incidence after 5 years was 41.2% at implant level and 51.9% at patient level. Incidence after 10 years was 47.0% at implant level and 57.0% at patient level. BoP+ and/or suppuration, as definition for peri-implant mucositis, was also used in the review of Zitzmann & Berglundh (2008). They reported prevalence and peri-implant mucositis occurred in their study in approximately 80% of the subjects and in 50% of the implants. These percentages are higher than in the present study. A reason could be that the present study is composed of totally edentulous patients and the systematic review included studies with totally edentulous patients and partially edentulous patients. Comparison with other studies was difficult because other threshold levels were used in this study. This phenomenon was also mentioned by Klinge (2012), who stated that the different cut-off values for clinical parameters reported in different studies will exert a significant influence on the magnitude of the reported frequencies of peri-implant complications. Atieh et al. (2013) used Modified Bleeding Index of ≥2 and/or suppuration as definition in their systematic review. They estimate the frequency of peri-implant mucositis 30.7% for implants and 63.4% for participants. Recalculation of data of the present study with this definition gives 8.7% at implant level and 12.4% at patient level after 10 years. Percentages reported by Atieh et al. (2013) are much higher than in the present study, where they did not exceed the 15%. Also in this review partially edentulous patients were included. Another definition for peri-implant mucositis, being BoP+ and/or suppuration in combination with probing depth ≥ 4 mm, was used in the study of Roos-Jansäker et al. (2006). They presented 48% of the implants and 76.6% of the patients with peri-implant mucositis. Recalculation of data of the present study with this definition gives 13.7% at implant level and 23.9% at patient level after 10 years. Percentages reported by Roos-Jansäker et al. (2006) are much higher than in the present study. But also in this study partially edentulous patients were present and the authors mentioned that the prevalence of peri-implant mucositis was lower in a fully edentulous group compared with a partially edentulous group.

**Peri-implantitis** does also occur in totally edentulous patients with two implants in the mandible to support an overdenture. Incidence after 5 years was 11.5% at implant level and 16.9% at patient level. Incidence after 10 years was 20.3% at implant level and 29.7% at patient level. Incidence of peri-implantitis is much higher after 10 years compared with 5 years. Probably, the reason is the number of implants (with peri-implantitis) that has been lost and the number of patients treated for peri-implantitis during 5 and 10 years. BoP+ and/or suppuration in combination with radiographic bone loss ≥ 2 mm as definition for peri-implantitis was also used in the review of Zitzmann & Berglundh (2008) and resulted in 28–56% at patient level and in 12–43% at implant level after at least 5 years. These percentages are much higher than in the present study, being 16.9% on patient level and 11.5% on implant level after 5 years. In the two included studies, both totally edentulous patients were present as partially edentulous patients. BoP+ and/or suppuration in combination with radiographic bone loss ≥ 2 mm and in combination with probing depth ≥ 5 mm, as definition for peri-implantitis was used in the systematic review of Atieh et al. (2013). They estimate the frequency of peri-implantitis 18.8% for participants and 9.6% for implants. These percentages are in accordance with the present study with 16.7% and 10.8% (after recalculation), respectively. BoP+ and/or suppuration in combination with radiographic bone loss ≥ 3 mm was used in the study of Roos-Jansäker et al. (2006). They presented 16% of the patients and 6.6% of the implants with peri-implantitis. Also these percentages are more or less the same in the present study, being 14.3% on patient level and 12.1% on implant level after 10 years (after recalculation). These authors mentioned that

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**Table 2.** Mean values and standard deviations of bleeding index (possible score 0–3), probing depth (mm), and peri-implant bone change (mm) at implant level at 5 \((T_5)\) and 10 \((T_{10})\) years after placement of the overdenture

<table>
<thead>
<tr>
<th></th>
<th>(T_5) ((n = 276) implants)</th>
<th>(T_{10}) ((n = 240) implants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean bleeding index (SD)</td>
<td>0.6 (0.7)</td>
<td>0.3 (0.6)</td>
</tr>
<tr>
<td>Mean probing depth in mm (SD)</td>
<td>3.2 (1.1)</td>
<td>3.4 (1.1)</td>
</tr>
<tr>
<td>Peri-implant bone change in mm (SD)</td>
<td>(-1.0 (1.1))</td>
<td>(-1.1 (1.1))</td>
</tr>
</tbody>
</table>

**Table 3.** Frequency distribution of bone loss at 5 \((T_5)\) and 10 \((T_{10})\) years after placement of the overdenture

<table>
<thead>
<tr>
<th>Bone loss</th>
<th>(T_5) ((n = 276) implants)</th>
<th>(T_{10}) ((n = 240) implants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–0.5 mm</td>
<td>38%</td>
<td>30%</td>
</tr>
<tr>
<td>&gt;0.5–1.0 mm</td>
<td>22%</td>
<td>26%</td>
</tr>
<tr>
<td>&gt;1.0–1.5 mm</td>
<td>16%</td>
<td>19%</td>
</tr>
<tr>
<td>&gt;1.5–2.0 mm</td>
<td>6%</td>
<td>9%</td>
</tr>
<tr>
<td>&gt;2.0–2.5 mm</td>
<td>9%</td>
<td>5%</td>
</tr>
<tr>
<td>&gt;2.5–3.0 mm</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>&gt;3.0–3.5 mm</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>&gt;3.5–4.0 mm</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>&gt;4.0 mm</td>
<td>2%</td>
<td>3%</td>
</tr>
</tbody>
</table>
the prevalence of peri-implantitis was lower in a fully edentulous group compared with a partially edentulous group. The definition BoP+ and/or supuration in combination with radiographic bone loss ≥3 mm and in combination with probing depth ≥6 mm was used in the study of Koldsland et al. (2010). They presented 11.3% of the patients and 5.4% of the implants with peri-implantitis. After recalculation with this definition, also these percentages are more or less the same as in the present study, being 10.9% on patient level and 8.6% on implant level after 10 years.

It appeared from the review of Tomasi & Derks (2012) that only two research groups applied earlier suggested definitions. Worldwide there is still lack of uniformity in definitions used, leading to different results that are not easily comparable. These authors address the need for consensus and propose to stick to earlier consensus statements of the Seventh European Workshop on Periodontology. This need for consensus appears also from the present study. Different threshold levels lead to different percentages of incidence. The definition of peri-implant mucositis, as proposed by the European Workshop, is BoP+ and/or supuration and the definition of peri-implantitis is BoP+ and/or supuration in combination with radiographic bone loss ≥2 mm (Lang & Berglundh 2011).

Future reports should contain numbers based on these definitions.

At the First European Workshop on Periodontology in 1993 it was agreed that bone changes should be calculated after initial healing had been uneventful and osseointegration was achieved as anticipated. This means that bone changes following implant installation due to remodeling has to be distinguished from bone loss due to a subsequent infection (Albrektsson & Isidor 1994). Mean peri-implant bone loss, calculated from placement of the overdenture to 5 and 10 years was 1.0 and 1.1 mm, respectively. In the present study, standardized intra-oral radiographs were used, so comparison is done with other 10-year studies which have made intra-oral radiographs to evaluate peri-implant bone levels. Intra-oral radiographs were used in the study of Naert et al. (2004), who reported 1.2 mm bone loss for bar-connected Branemark implants during the entire 10-year follow-up. Telleman et al. (2006) reported 2.2 mm bone loss for bar-connected ITI-implants after 10 years. Bone loss reported in the present study is comparable to the results of the mentioned studies. A mean bone loss of 0.1 mm between 5 and 10 years is very little, but one must keep in mind that 10 implants were removed during that period which had a substantial amount of bone loss due to peri-implantitis. This bone loss was not part of the calculation at the 10-years’ evaluation.

Table 3 gives an insight in the severity of bone loss at the 5-years evaluation and at the 10-years evaluation. Eighteen percent of the implants revealed more than 2 mm peri-implant bone loss after 5 years and 16% after 10 years. It is possible that the percentage was lower at 10 years, because a number of implants with peri-implantitis were removed after 5 years. On the other hand, more than 50% of the implants revealed less than 1 mm bone loss.

From this study it is concluded that:
- peri-implant mucositis and peri-implantitis do occur in totally edentulous patients
- incidence of peri-implant mucositis at patient level was 51.9% during 5 years of evaluation and 57.0% after 10 years, calculated with the threshold level as proposed by the Seventh European Workshop on Periodontology.

Table 4. Incidence of peri-implant mucositis (BoP+ and/or supuration) and peri-implantitis (BoP+ and/or supuration in combination with radiographic bone loss ≥2 mm) at implant level and at patient level at 5 (T5) and 10 (T10) years after placement of the overdenture

<table>
<thead>
<tr>
<th></th>
<th>Peri-implant mucositis</th>
<th>Peri-implantitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>T5 implant level</td>
<td>41.2%</td>
<td>11.5%</td>
</tr>
<tr>
<td>T5 patient level</td>
<td>51.9%</td>
<td>16.9%</td>
</tr>
<tr>
<td>T10 implant level</td>
<td>47.0%</td>
<td>20.3%</td>
</tr>
<tr>
<td>T10 patient level</td>
<td>57.0%</td>
<td>29.7%</td>
</tr>
</tbody>
</table>

References


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**Clinical Relevance**

**Scientific rationale for the study:** Endosseous implants are frequently used to support a mandibular overdenture. It is important for patients and clinicians to know whether this therapy is subject to peri-implant complications.

**Principal findings:** Peri-implant mucositis and peri-implantitis do occur in totally edentulous patients and incidence numbers are high.

**Practical implications:** Strict oral hygiene measurements throughout life are mandatory to keep peri-implant complications to a minimum.