Two-stage dental implants inserted in a one-stage procedure
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INTRODUCTION

Extraction of the teeth results in gradual resorption of the bone of the alveolar ridge. As a consequence, the denture bearing area gradually reduces and may become inadequate for denture support. Many patients then complain that their dentures are loose resulting in pain and discomfort during normal oral functioning (van Waas 1990).

Implant stabilised overdentures offer a potential solution for patients presenting with severe mandibular bone resorption. High success rates have been reported for osseointegrated dental implants stabilising overdentures in edentulous mandibles (Albrektsson et al. 1988, Adell et al. 1990, Merieske-Stern 1990, Quirynen et al. 1991, Merieske-Stern et al. 1994, Versteegh et al. 1995, Babbush & Shimura 1993, Spiekerman et al. 1995). In most studies, Brånemark or ITI implants have been used.

Long-term results of mandibular overdentures stabilised with IMZ implants (i.e., with more than 5 years follow-up) are limited to the study of Spiekerman et al. (1995).

The aim of this study was to evaluate clinical and radiographical parameters of peri-implant tissues and the prosthodontic after-care in patients treated with an IMZ implant stabilised mandibular overdenture after a loading period of at least 5 years.

MATERIAL AND METHODS

Patients selection
Forty-three edentulous patients were selected for treatment with mandibular overdentures stabilised by two IMZ implants at the Department of Oral and Maxillofacial Surgery and Maxillofacial Prosthetics between January 1987 and March 1990. The selected patients had been referred by their dentist or general physician because of severe dissatisfaction with their lower denture. Forty patients (10 men and 30 women) with a mean age of 55 ± 11 years (range 36-75 years) agreed to participate in this study. The other three patients were not available for evaluation because they died during the follow-up period (two patients) or had moved abroad (one patient).

Treatment procedures
During the first visit, a routine clinical examination was carried out and diagnostic panoramic and cephalometric radiographs were recorded. The interferaminal bone height was between 12 and 17 mm as measured at the symphysis area on a lateral cephalogram (Cawood V-VI, Cawood & Howell 1988). Two titanium plasma sprayed IMZ implants (IMZ, Friatec, Mannheim, Germany) were inserted in the lower jaw in the canine regions, according to the surgical procedure described in detail by Kirsch (1983). The first three postoperative weeks patients were not allowed to wear the lower denture. After this period, the lower denture was relieved in the implant area, relined with a soft liner and replaced. Abutment connection was performed after a healing period of three months. When an implant appeared to be mobile, it was removed and after a healing period
of four months a new implant was inserted. The subsequent prosthodontic treatment was performed according to a standardised procedure (Batenburg et al. 1993), consisting of the fabrication of both an implant-retained overdenture and a maxillary denture. The implants were connected by a round bar with clip attachment to stabilise the mandibular overdenture. An oral hygiene program was initiated two weeks after abutment connection with frequent recall visits during the first six months. Subsequently, the patients were recalled every six months for a control visit and evaluation of their oral hygiene status.

**Evaluation and data collection**

All patients were recalled for a clinical and radiographical evaluation between January and March 1995. The clinical examination included:

- assessment of the peri-implant soft tissues. The soft tissue indices (plaque index, bleeding index, gingival index) are listed in Table 2.1. After removal of the bar, pocket depths were measured with a periodontal probe (Merritt-B, Hu Friedy, USA) at four sites of the abutment (mesial, buccal, distal, lingual). The probing depth was defined as the distance between the top of the gingival margin and the tip of the periodontal probe.
- assessment of implant mobility both on clinical palpation and with the Periotest® (Periotest, Siemens AG, Bensheim, Germany).
- assessment of lip and chin dysaesthesia, by soft stroking the lower lip and chin with a cotton pellet and pinching with tweezers (Wismeijer et al. 1997).

In spite of their lack of sharpness and standardisation, especially in the interforaminal region, panoramic radiographs were used because they were the only type of radiographs available for this retrospective study. Radiographs were recorded, all with the same radiographic device, immediately prior to the ‘abutment operation’ (i.e., three months after implant insertion (T0), one year after insertion of the overdenture (T1), and at the time of evaluation (T2), were compared with regard to the marginal bone height. The bone height mesially and distally of the implant was related to the implant length according to the criteria in Table 2.1. The highest score per implant was used as outcome value.

Data on prosthodontic aftercare were obtained from the patient records. The prosthodontic evaluation included the need for clip and bar corrections, relining procedures and the need for fabricating new maxillary or mandibular dentures.

<table>
<thead>
<tr>
<th>Score</th>
<th>Plaque index</th>
<th>Bleeding index</th>
<th>Gingiva index</th>
<th>Loss of bone</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No plaque</td>
<td>No bleeding</td>
<td>Normal mucosa</td>
<td>No bone loss</td>
</tr>
<tr>
<td>1</td>
<td>Plaque detected by running a probe across the implant</td>
<td>Isolated bleeding spots after probing</td>
<td>Mild inflammation</td>
<td>Bone loss less than 1/3 of the implant length</td>
</tr>
<tr>
<td>2</td>
<td>Plaque visually detectable</td>
<td>Confluent line of blood</td>
<td>Moderate inflammation</td>
<td>Bone loss between 1/3 –1/2</td>
</tr>
<tr>
<td>3</td>
<td>Abundance of plaque and calculus</td>
<td>Heavy or profuse bleeding</td>
<td>Severe inflammation</td>
<td>Bone loss &gt;1/2</td>
</tr>
</tbody>
</table>
Data analysis
Possible relationships between the clinical and radiographical parameters were tested, with the chi-square test, with a level of significance of 0.05.

RESULTS

Implant survival
The time between the implant insertion and the evaluation ranged from 65 to 96 months (median 74 months). Three implants had to be removed in two patients at abutment connection due to mobility. After a healing period of four months, new implants were inserted. Because these three implants were evaluated approximately 6 years after insertion, they were included in this study and therefore 83 implants in 40 patients could be evaluated. In a third patient, one implant appeared to be clinically mobile after six years of loading. It was striking that the patient had reported recent emotional distress combined with severe clenching. On the panoramic radiograph a small radiolucent line was observed around the implant. At a routine control visit, six months previously, no such signs were obvious. In addition, there were no problems with oral hygiene maintenance and on the panoramic radiograph of one year previously, no signs of radiolucency were observed. The implant was removed and replaced by four new implants in the interforaminal region four months later. At present (follow-up period 18 month, therefore these implants were not included in the evaluation), the implants are clinically stable and the patient functions well with her denture.

Clinical parameters
Table 2.2 summarises the results regarding the plaque, bleeding and gingiva indices at T2.
The mean pocket probing depth was 3.1 ± 1.0 mm (range 1-7 mm). At 31 implant sites (18 implants) the pocket probing depth was more than 4 mm. Five of these implants showed signs of inflammation (bleeding, gingival index >0), while 13 implants (72%) showed gingival hyperplasia without any sign of inflammation. In general, there was no significant association between pocket depth, bleeding index, and gingival index (p > 0.05).
The median periotest value (PTV) was -4 (range -7 to +6). One implant was mobile on palpation and had a PTV of +6.

Radiographical evaluation
Table 2.3 shows the bone height scores related to the implant

<table>
<thead>
<tr>
<th>Score</th>
<th>Plaque</th>
<th>Bleeding</th>
<th>Gingiva</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>0</td>
<td>52</td>
<td>68</td>
<td>69</td>
</tr>
<tr>
<td>1</td>
<td>13</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lost</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>83</td>
<td>83</td>
</tr>
</tbody>
</table>
length according to the criteria defined in Table 2.1. Eighty-four percent of the implants showed no measurable loss of bone height between the scores at T1 and T2. In 11% the bone level was lower at T2 (i.e., the bone score at T2 was higher) as compared to T1 or T0 (Figure 2.1). Peri-implant marginal bone height scores and gingival inflammation or pocket depth were not significantly related (p>0.05).

Table 2.3. Combinations of bone height scores (according to Table 2.1) as assessed on panoramic radiographs at T0 (prior to abutment connection), T1 (one year after insertion of the new dentures) and T2 (at the evaluation).

<table>
<thead>
<tr>
<th></th>
<th>Number of implants</th>
<th>% of implants</th>
</tr>
</thead>
<tbody>
<tr>
<td>No differences between T1 and T2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>T1</td>
<td>T2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>total</td>
<td>70</td>
<td>84</td>
</tr>
<tr>
<td>Scores at T2 &gt; scores at T1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T0</td>
<td>T1</td>
<td>T2</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>total</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Lost implants</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Prosthodontic aftercare

After overdenture insertion, the patients visited their dentist 16 times on average (range 6 to 32 times) during the 5-8 years follow-up period. Eight of these 16 visits were due to routine control visits, while the other visits were to adjust the dentures or the suprastructure. Twenty patients (all treated before 1989) had been provided with plastic clips, while the other patients had a mandibular overdenture with metal clips. Fifty-three clips (including all plastic clips) in 34 patients had to be replaced and 18 new bars (16 patients) were made. Four new maxillary dentures and seven new mandibular overdentures have been made during the follow-up period. Mandibular overdentures were relined 34 times in 24 patients, while 19 maxillary dentures were relined in sixteen patients.

DISCUSSION

At the time of evaluation, the vast majority (94%) of the implants were still functioning well. For an implant to be regarded a “success”, several clinical and radiographical criteria, as suggested by Albrektsson et al. (1986) must be met. A successful implant must be immobile and there must be absence of clinical signs and symptoms such as pain, infection and paraesthesia. Implant mobility is indicative for lack of osseointegration, possibly related to the presence of inflammation or functional overloading. Therefore, immobility should be a hard success criterion, and a mobile implant should be regarded a failure. According to the criteria suggested by Albrektsson et al. (1986, 1991), immobility of clinical testing is required. Smith & Zarb (1989) additionally required a solid ringing sound on percussion as a sign of immobility. The periotest value (PTV) has been proposed as a more objective evaluation of the periodontal health status of natural teeth (d’Hoedt & Schramm-Scherer 1988, Olivé & Aparico 1990, van Scotter & Wilson 1991), and has been suggested to be a reliable and reproducible objective quantification of bone apposition around an implant (Teerlinck et al. 1991, van Steenberghe & Quirynen 1993).

In our material, one implant was mobile on palpation; this implant showed a PTV of +6. Thus, according to the Albrektsson criteria this implant must be regarded as a failure. Radiographically, vertical bone loss around this implant could be observed. Although the cause for this bone loss was not obvious, it might be associated with occlusal overloading, presumably due to clenching (Quirynen & van Steenberghe 1992). One implant had a PTV of +5 and was clinically immobile while more than 2/3 of the implant length was covered with bone. All other implants were immobile and scored a PTV £0. Normal PTV ranges for most implant systems have previously been determined to vary from < +5 to +8 (d’Hoedt & Schramm-Scherer 1988). Furthermore, absence of palpable movement of a natural tooth has been described to correspond to PTV of < +10 (van Scotter & Wilson 1991). Although normal PTV ranges for IMZ implants in the mandible with titanium inserts have not been described previously, it seems reasonable to regard a PTV of < +5 as “normal” based on these figures. The results of our study are compatible with this cut-off point, although we do not have an explanation for the relatively low PTV for the mobile implant.

Our results indicate that most patients had healthy peri-
implant tissues. The outcomes of the clinical parameters are in accordance with previous reports on implant-stabilised over-dentures (Quirynen et al. 1991, Mericske-Stern et al. 1994, Gotfredsen et al. 1993, Naert et al. 1994, Batenburg et al. 1994, Boerrigter et al. 1997). Probably, this relates to the performance and maintenance of adequate oral hygiene based on the strict initial oral hygiene program during the first six months and subsequent six months evaluations of the oral hygiene status. A striking finding in our material was the low bleeding prevalence. As suggested by Mericske-Stern et al. (1994), absence of bleeding on probing is reliably associated with maintenance of healthy peri-implant tissues. Of the implants that were in place at evaluation, only one implant showed a bleeding index > 1. This finding supports the high level of clinical health of peri-implant tissues.

The relatively high percentage of implants with pockets of more than 4 mm associated with gingival hyperplasia without any sign of inflammation suggests that these pockets must be regarded ‘pseudo-pockets’. Given the high standard of oral hygiene generally seen in these patients, no adverse effects are to be expected from this clinical situation with regard to the implant prognosis.

High plaque scores are usually correlated with high bleeding scores and other parameters related to gingival health. The lack of any significant association between pocket depth, bleeding index, and gingival index we found in our study has been reported previously (Mericske-Stern 1990, Naert et al. 1994), and is likely attributable to the limited number of implants with higher scores on the indices. However, in a prospective longitudinal study, Mericske-Stern et al. (1994) demonstrated a higher bleeding prevalence with increased plaque or increased probing depths.

Another clinical criterion for “success” relates to paraesthesia as a possible surgical risk due to damage of the mental nerve (Ellies & Hawker 1993). Although paraesthesia as a result of mental nerve damage has been reported previously (Wismeijer et al. 1997) none of our patients experienced a paraesthesia in lip and chin region. Provided the surgical procedure has carefully been carried out, insertion of two IMZ implants in the interforaminal region may therefore be regarded a safe procedure in this respect. The risk of nerve damage is probably higher when four implants are inserted.

Radiographical criteria for “success” include absence of peri-implant radiolucency and a vertical bone loss of less than 0.2 mm annually following the implant’s first year of functioning (Albrektsson et al. 1986). Regarding the former item, the implant that appeared to be mobile after six years showed a peri-implant radiolucent line on the orthopantomogram, and should be regarded a failure according to this criterion as well. Due to the retrospective nature of the present study we were only able to compare the marginal bone height on the panoramic radiographs recorded three months after implant insertion, (T0), one year after insertion of the new dentures (T1), and at the time of evaluation (T2). As shown in Table 2.3, the bone level around 70 (84%) implants at the evaluation was comparable to the level one year after denture insertion. Nine implants (11%) showed a reduced peri-implant bone height at T2 as compared to T1. However, there is no evidence to show whether this bone loss occurred in an episodic or continuous manner.
Our findings do not support those of previous studies (Spiekermann et al. 1995, Albrektsson et al. 1988), in which an annual bone loss ranging between 0.07 and 0.54 mm has been reported. However, our assessments are based on a less discriminating scale because panoramic radiographs were the only type of radiographs available for this retrospective study. In prospective research projects the use of reproducible intra-oral radiographs are preferable, allowing for more reliable quantification of peri-implant bone loss (Meijer et al. 1992, Meijer et al. 1993).

According to Albrektsson’s criteria, the evaluation period must be at least five years. Of the originally inserted implants (n=80 in 40 patients), four implants were lost and one implant appeared to be mobile. Three of the lost implants were replaced and could be included in the present evaluation as they have been in place for 67 and 73 months, respectively. Thus, of 83 implants, five implants (6%) must be regarded ‘failures’ according to the Albrektsson criteria. This success rate is in accordance with the results of most previous studies on overdentures (Quirynen et al. 1991, Mericske-Stern et al. 1994, Babbush & Shimura 1993, Spiekermann et al. 1995, Parel 1986, Naert et al. 1988, Enquist et al. 1988). The reason for the failures during the healing period is uncertain. The most likely explanations include surgical trauma or bacterial infection. The loss of an implant after a loading period of six years is even more obscure.

In three previous studies in which the prosthodontic aftercare was assessed (Mericske-Stern 1990, Versteegh et al. 1995, Boerrigter 1996) the frequency of common prosthodontic adjustments was comparable to our results. In our patient material, the clip and bar construction had to be adjusted relatively often. A possible explanation may be that for the patients treated until 1989 (20 patients) a round bar with a plastic clip was fabricated. In many cases, the plastic clips appeared to cause wear to the bar to an extent that made its replacement necessary. Another disadvantage of plastic clips is that they cannot be activated. Therefore, it was decided to provide the other 20 patients with a mandibular overdenture with a metal clip.

From this study, it can be concluded that the clinical and radiographical peri-implant tissue condition appears to remain adequate for IMZ implants connected by a bar to provide proper support and long-term stability for a mandibular overdenture.
References


