Biological and technical complications and failures with fixed partial dentures (FPD) on implants and teeth after four to five years of function

Key words: Fixed partial dentures, technical complications, biological complications, dental implants

Abstract: The aim of this study was to compare the frequency of biological and technical complications with fixed partial dentures (FPDs) on implants, teeth and as mixed tooth-implant supported FPDs over 4 to 5 years of function. All implants belonged to the ITI® Dental Implant System. Group I-I (implant FPD) included 33 patients with 40 FPDs, group T-T (tooth FPDs) 40 patients with 58 FPDs, group I-T (mixed tooth-implant FPDs) 15 with 18 FPD. Of the bridge abutments 144 were teeth and 105 were implants. The median number of units replaced by the FPDs was 3 (range 2–14). The mean age of the patients was 55.7 years (range 23–83). Complete failures resulted in the loss of one FPD in each group. Two implants were lost due to fracture secondarily to development of a bone defect. One tooth had a vertical fracture and 1 tooth was lost due to periodontitis. Biological complications (peri-implantitis, PPD ≥ 5 mm and BOP¹) occurred at 9.6% (10) of the implants. This number was, however, reduced to 5% if the threshold for definition of peri-implantitis was set at PPD ≥ 6 mm and BOP¹. Biological complications occurred in 11.8% (17) of the abutment teeth (NS compared to implants); 2.8% (4) had secondary caries, 4.9% (7) endodontic problems and 4.1% (6) had periodontitis (PPD ≥ 5 mm, BOP¹). Ten out of 32 patients with a general health problem indicated a biological complication, whereas 9 out of 53 patients with no general health problem had a biological complication (χ²: NS). Statistically significantly more technical complications were found in FPDs on implants (χ², P<0.05). The technical complications were associated with bruxism. Out of 10 bruxers 6 had a technical complication whereas 13 out of 75 non-bruxers had such a complication (χ²=0.01). Extensions were associated with more technical complications (13 out of 35 with extensions versus 9 out of 81 without). In conclusion, favourable clinical conditions were found at tooth and implant abutments after 4–5 years of function. Loss of FPD over 4–5 years occurred at a similar rate with mixed, implant or tooth supported reconstructions. Significantly more porcelain fractures were found in FPDs on implants. Impaired general health status was not significantly associated with more biological failures but bruxism as well as extensions were associated with more technical failures.

Ever since the application of osseointegrated dental implants has found wide acceptance for prosthetic treatment, failures and complications have been of special concern. Complications with suprastructures on implants can basically be grouped into technical ones such as loss of retention, fractures of porcelain/framework/secondary parts, screw loosening, and into biological ones which comprise peri-implant radiolucencies, signs of peri-implantitis such as deepening of the peri-implant pocket probing depths and radiographic signs of
loss of osseointegration, i.e. horizontal bone loss and vertical defects. A variety of studies have reported on survival or success rates of different implant systems with their suprastructures. Definitions and criteria for success/survival were discussed. Albrektsson et al. (1986) proposed success criteria for currently used dental implants such as no signs of infection, pain, neuropathies, paresthesia, mobility of the abutment or increased bone loss, which means less than 0.2 mm annually after the first year of function and no peri-implant radiolucencies. Furthermore, a success rate of 85% after 5 years and 80% after 10 years was considered to be a minimal criteria for a successful implant system. Buser et al. (1991, Naert et al. 1992; Wedgwood et al. 1992; Jemt & Lekholm 1993; Hemmings et al. 1994; Balshi et al. 1995).

Besides recording success rates for the implants after 3, 5 or more years, information about technical problems with the suprastructure were often listed. Most technical problems included loosening of the gold screws, fractures of the veneer resin or porcelain, abutment screw fractures or even implant fracture (for review see Brägger 1999).

The design of the FPD may represent a risk factor, i.e. the connection of an implant to a tooth or the presence of extensions. Some studies reporting about mixed implant–tooth supported fixed partial dentures (van Steenberghe et al. 1989, Astrand et al. 1991; Quirynen et al. 1992; Ericsson et al. 1986; Gunne et al. 1999) showed the possibility of connecting teeth with implants with a good prognosis. A comparison of mixed tooth–implant supported FPDs to FPDs on implants showed no difference in bridge stability, survival rate or change in marginal bone loss over 5 and up to 10 years (Gunne et al. 1992; Olsson et al. 1995; Gunne et al. 1999).

Progression of periodontal disease may be correlated with impaired general health, environmental factors such as smoking as well as genetic risk factors (Genco & Löe 1993). It may be speculated that these factors may influence the longterm prognosis of oral implants as well. Technical failures may also be associated with patient factors such as malocclusion or bruxism.

Aim

The aims of this study were to compare the prevalence of biological and technical complications and failures with fixed partial dentures on implants, teeth and as mixed tooth–implant supported reconstructions after 4 to 5 years of function and to associate biological and technical complications with risk factors.

Material and methods

A total of 85 partially edentulous patients were recruited for the study. All the patients had received fixed partial dentures (FPD) that had functioned for 4 to 5 years.
Table 1. Number of patients, FPDs, implant and tooth abutments examined after 4–5 years of function in 3 groups of FPD (I-I: implant borne, T-T: tooth borne, I-T: mixed implant-tooth borne)

<table>
<thead>
<tr>
<th>Groups</th>
<th>Patients</th>
<th>FPDs</th>
<th>Implants</th>
<th>Teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-I</td>
<td>33</td>
<td>40</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>T-T</td>
<td>40</td>
<td>58</td>
<td>124</td>
<td></td>
</tr>
<tr>
<td>I-T</td>
<td>15</td>
<td>18</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>85</td>
<td>116</td>
<td>103</td>
<td>142</td>
</tr>
</tbody>
</table>

Table 2. Number of complete failures and reasons for loss of abutments in groups I-I, T-T, I-T over 4–5 years of function

<table>
<thead>
<tr>
<th>Failures and reasons for loss</th>
<th>I-I</th>
<th>T-T</th>
<th>I-T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lost FPD</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lost abutments</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Bone defect and secondary fracture of implant (HS)</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Vertical tooth fracture</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Periodontitis</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The patients were divided into 3 groups. Group I-I consisted of 33 patients with 40 FPD on implants, group T-T consisted of 40 patients with 58 FPD on teeth, and group I-T included 15 patients with 18 mixed tooth–implant borne FPD [Figs 1, 2, 3]. Patients from group I-I and I-T were enrolled in a prospective longterm study on the association between periodontal and peri-implant conditions. For the purpose of this study, the data from the 5 year examination of the first 45 consecutive patients with implants were included in the analysis.

The patients from group T-T had received their FPDs in 1989 or 1990. Out of 67 patients 40 responded to the request for a re-examination. Before installing implants and FPDs, the patients had been treated for existing periodontal disease according to comprehensive treatment strategy [Lang 1988]. Patients were enrolled in the maintenance care program at the Clinic for Periodontology and Fixed Prosthodontics, University of Berne, Switzerland, or in private dental practices. Preventive measures such as enforcement of high levels of mechanical and plaque control supplement by longterm application of chlorhexidine gel [Plak out gel®, Hawe Neos, CH-6925 Gentilino, Switzerland] were empha-

sized. All the implants belonged to the ITI® Dental Implant System [Institute Straumann AG, CH-4437, Waldenburg, Switzerland].

The clinical examination at 4 or 5 years after seating the FPD included the assessment of the following parameters at four aspects of each abutment tooth and/or implant: plaque index (PI) [Silness & Loe 1964] for teeth, modified plaque index (mPlI) [Mombelli et al. 1987] for implants, gingival index (GI) [Loe & Silness 1963] for teeth, modified bleeding index (mBlI) [Mombelli et al. 1987] for implants, the distance between the cemento–enamel junction and the free gingival margin for teeth, the distance between the implant shoulder and the mucosal margin (DIM), the probing pocket depth (PPD), the probing attachment level (PAL) and bleeding on probing (BOP).

The assessment of the reconstruction included the following information: Number of units, existence of extensions, type of fixation (screw retained or cemented).

The following occlusal and functional parameters were assessed as well: Type of occlusion, overjet, overbite, centric occlusion, prematurity contacts, slide in centric, balancing interferences, canine or group guidance, bruxism.

General health conditions of the patients were noted: Drug intake (smoking: how many cigarettes per day), systemic disease (yes: classified into groups like cardiovascular disease, coagulation- and hormonal-disturbances, diabetes, rheumatism, metabolic conditions, lipids, cholesterol and others).

Statistical analysis

The statistical analysis included descriptive statistics for the clinical parameters assessed at implants and teeth. Statistically significant differences between implant and tooth abutments were assessed by means of the Wilcoxon 2-sample test. Biological and technical complications and failures were calculated separately for abutments and FPDs. Significant differences in the number of biological and technical complications and failures with either implants or teeth as abutments were assessed using chi-square tests. Complications and failures of each reconstructions of group I-I, T-T or I-T were compared using chi-square tests as well. The threshold value for significance was set at $P < 0.05$. Furthermore, frequency analyses were performed for PPD and PAL observed at implants and teeth, in order to test the influence of choosing different thresholds for definition of biological complications.

Results

Number of patients, abutments, FPDs

The total number of patients examined was 85. There were 53 females, 32 males. The mean age was 55.7 years (range 23–83). Of the bridge abutments 144 were teeth, 105 were implants, which supported a total of 116 FPDs. In Table 1, the characteristics of the FPDs were listed. A total of 40 FPDs on implants belonged to group I-I, 58 FPDs on teeth to group T-T and 18 FPDs to the mixed group I-T. The median number of units was 3 (range 2–14). On 26 (24.8%) of the 105 implant abutments the suprastructure were screw retained and on 79 (75.2%) cemented. At the clinical examination, the FPDs had been in function for 40 to 78 months after installation (mean: 56.8 months).

Table 3. Means, standard deviations and statistical test results of the clinical parameters obtained at four sites of each tooth and implant abutment (mesial, buccal, distal, oral) after 4–5 years of function

<table>
<thead>
<tr>
<th></th>
<th>Implants, n=103</th>
<th>Teeth, n=142</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>PI/mPlI</td>
<td>0.24</td>
<td>0.42</td>
</tr>
<tr>
<td>GI/mBlI</td>
<td>0.47</td>
<td>0.57</td>
</tr>
<tr>
<td>Recession</td>
<td>0.61</td>
<td>1.19</td>
</tr>
<tr>
<td>PPD</td>
<td>2.56</td>
<td>0.86</td>
</tr>
<tr>
<td>PAL</td>
<td>3.17</td>
<td>1.32</td>
</tr>
</tbody>
</table>
Failures observed over the observation period
Complete failures had resulted in the loss of 1 FPD in each group [I-I, T-T, I-T] (Table 2). Two implants had been lost due to fracture after development of a bony defect, 1 belonged to group I-I and 1 to I-T. One tooth had a vertical fracture and 1 tooth was lost due to periodontitis. Both teeth belonged to the same reconstruction of group T-T.

Clinical parameters
In Table 3, the means and standard deviations of the clinical parameters assessed at implants and teeth were listed. Significant differences were observed between teeth and implants with respect to mean plaque index (PI), mean modified plaque index (mPII) (0.67 for teeth/0.24 for implants) [Wilcoxon 2-sample test (P≤0.01), whereas mean gingival index (GI), mean modified bleeding index (mBII) (0.56/0.47), recession (−0.38 mm/−0.61 mm), mean probing pocket depth (PPD) (2.61 mm/2.56 mm) and mean probing attachment level (PAL) (3.00 mm/3.17 mm) did not differ significantly between teeth and implants.

Biological complications observed at the examination
In Table 4, biological complications were listed separately for implant and tooth abutments. Biological complications occurred in 11.8% (17) of the abutment teeth and in 9.6% (10) of the implants. Tooth abutments showed in 2.8% (4) secondary caries and in 4.9% (7) endodontic problems (×loss of vitality). Of the tooth abutments 4.1% (6) were judged to have periodontitis, which was defined as BOP+ and PPD ≥5 mm at any site of each abutment. This occurred in 5 patients at 11 tooth abutment sites. Implant abutments demonstrated in 9.6% (10) peri-implantitis [BOP+, PPD ≥5 mm]. This result was found in a total of 5 patients (out of 43) at 19 implant abutment sites.

Fig. 4 demonstrates the cumulative percentage number of sites with PPD and PAL at teeth and implants. The graph of the PPD values for implants and teeth were approximately congruent, whereas the distribution of PAL values of teeth were shifted more to the right side compared to implants, which indicated that at some teeth clinical attachment loss had occurred, i.e. some of the patients included in this material were periodontitis cases.

The yellow threshold lines placed at 5 mm and 6 mm PPD visualize the influence of using various definitions for a complication: If a PPD of ≥5 mm and BOP+ was defined as a complication that needs treatment, 9.6% of the implants had that complication at the 5 years examination. If this threshold line was defined with PPD ≥6 mm and BOP+, the number of implants with a complication was drastically reduced to 5%.

When biological complications were splitted into the different groups of FPDs, group I-I had 6 FPDs, group T-T 13 FPDs and group I-T 3 FPDs with biological complications, which was statistically not significantly different.

Technical complications observed over the observation period
Technical complications occurred at 20.4% (21) of all implants: 2.9% (3) of the units had loss of retention, 10.7% (11) a minor porcelain fracture and 6.8% (7) occlusal screw loosening (Table 5).

Technical complications occurred in 6.3% (10) of the teeth: 0.7% (1) units showed loss of retention and 5.6% (8) of the units a porcelain fracture (Table 5). There were statistically significantly more technical complications at implant compared to tooth abutments.

In 16.5% of the cemented FPDs, a technical complication occurred which was statistically not significantly different from the 11.5% technical complications in screw retained FPDs on implants (Table 6).

Out of 166 FPD 35 had an extension (Table 6). In 13 of these 35 bridges with extensions a technical complication was observed, whereas 9 out of 81 conventional FPD had a technical complication (P≤0.01).

Table 4. Number (%) of biological complications observed in patients, at tooth and implant abutments and at sites. Peri-implantitis and periodontitis were defined as the combined observation of PPD ≥5 mm and BOP+ at a respective site

<table>
<thead>
<tr>
<th>Implant abutments</th>
<th>Patients</th>
<th>Sites</th>
<th>Sites</th>
<th>Patients</th>
<th>Tooth abutments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peri-implantitis</td>
<td>10 (9.6%)</td>
<td>5 (10%)</td>
<td>19 (5%)</td>
<td>11 (2%)</td>
<td>5 (9%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10 (9.6%)</td>
<td>5 (10%)</td>
<td>19 (5%)</td>
<td>11 (2%)</td>
<td>5 (9%)</td>
</tr>
</tbody>
</table>

Fig. 4. Cumulative percentage number of sites with respective millimeters PPD and PAL detected at implants and at tooth abutments. The yellow lines define threshold which may be set for definition of a biological complication.
Table 5. Number (%) of technical complications observed at implant and tooth abutments

<table>
<thead>
<tr>
<th>Technical complication</th>
<th>Implants n=103</th>
<th>Teeth n=142</th>
<th>χ²-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of retention</td>
<td>3 (2.9%)</td>
<td>1 (0.7%)</td>
<td></td>
</tr>
<tr>
<td>Minor porcelain fracture</td>
<td>11 (10.7%)</td>
<td>8 (5.6%)</td>
<td></td>
</tr>
<tr>
<td>Screw loosening</td>
<td>7 (6.8%)</td>
<td>n.a.</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21 (20.4%)</td>
<td>9 (6.3%)</td>
<td>P&lt;0.05</td>
</tr>
</tbody>
</table>

Table 6. Association between risk factors and technical complications

<table>
<thead>
<tr>
<th>Factor</th>
<th>Complication</th>
<th>χ²-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cemented FPD</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Screw retained FPD (n=FPD)</td>
<td>66</td>
<td>13 (16.5%)</td>
</tr>
<tr>
<td>No extension</td>
<td>72</td>
<td>9 (11.1%)</td>
</tr>
<tr>
<td>Extension (n=FPD)</td>
<td>22</td>
<td>13 (37.1%)</td>
</tr>
<tr>
<td>No bruxisms</td>
<td>62</td>
<td>13 (17.3%)</td>
</tr>
<tr>
<td>Bruxisms (n=patient)</td>
<td>4</td>
<td>6 (60%)</td>
</tr>
</tbody>
</table>

Table 7. Association between risk factors and biological complications (n=patient)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Complication</th>
<th>χ²-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy patients</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Impaired general health</td>
<td>44</td>
<td>9 (17%)</td>
</tr>
<tr>
<td>Non-smokers</td>
<td>22</td>
<td>10 (31%)</td>
</tr>
<tr>
<td>Smokers</td>
<td>47</td>
<td>15 (24.2%)</td>
</tr>
</tbody>
</table>

Patient factors
Technical failures were related to the patient risk factor bruxism. Out of 10 assumed bruxers 6 were involved in a technical complication, compared to 13 out of 75 assumed non-bruxers (χ²=0.01) [Table 6].

The biological complications (peri-implantitis and periodontitis defined with PPD ≥5 mm and BOP+) were not statistically significantly related to patient risk factors (Table 7). Of the patients with some indication for impaired general health 31% demonstrated a biological complication. This number was only 17% in apparently healthy patients (NS). Only 3 of 22 smokers were involved in a biological complication, in contrast to 7 out of 62 non-smokers [Table 7].

Discussion

Failures with tooth supported FPDs
Two abutment teeth (1.4%) out of 144 totally restored teeth were lost over the 4 to 5 years of observation time. In group T-T only 1 out of 58 originally placed FPDs was completely lost (1.7%). These data have to be related to reports on conventional fixed partial dentures. Creugers et al. [1994] had performed a meta-analysis selecting data on the durability of conventional FPDs on teeth. Applying strict selection criteria for a meta-analysis, the material from 7 out of 42 publications on conventional FPDs was analyzed. Longterm survival of 4118 FPDs was 95% at 5 years, 90% at 10 years and 75% at 15 years.

Complications with tooth abutments
Much more detailed information with not only reporting the survival of FPDs on teeth but also listing the frequency of biological and technical complications with such restorations was presented in a few studies (Nymann & Lindhe 1979; Bergenholtz & Nymann 1984; Landolt & Lang 1988; Reichen & Lang 1989). These studies reported on the complications encountered with abutment teeth supporting different types of FPDs. Bergenholtz & Nymann [1984] and Nymann & Lindhe [1979] listed complications with extensive FPDs in periodontitis cases, whereas Landolt & Lang [1988] reported on short FPDs with extensions and Reichen & Lang [1989] on conventional short FPDs, both latter groups in patients with minimal periodontal tissue loss. The observation periods ranged from 4.6 to 8.6 years. Technical failures were similar in the 3 groups and added up to 7–8% with the exception of much more failures of FPDs with extensions on root canal treated teeth with custom made posts and anchors (Landolt & Lang 1988). Biological complications were loss of vitality in 15% of the prepared abutment teeth (Bergenholtz & Nymann 1984). In FPDs with extensions a biological complication was observed in 23.4% [Landolt & Lang 1988], whereas a biological complication was noted in 7.6% of the abutments from conventional FPDs [Reichen & Lang 1989].

With 11.9% biological complications and 6.2% technical complications observed at abutment teeth over 4–5 years in this report similar results had been obtained as in other patients groups.

Failures with FPDs on implants
After 5 years of function, 2 out of 105 implants were lost due to fracture. Fracture of hollow-screw implants of the ITI® Dental Implant System occurred after development of a bony defect. This failure rate of 2% was in accordance with other studies reporting about failure rates with implants for FPDs in partially edentulous patients. Lindh et al. [1998] demonstrated with a meta-analysis of 10 publications [1986–1996] a survival rate of implants of 93.6% after 6–7 years. A total of 2116 implants from various manufacturers were included in the report. The success criteria were used according to Albrektsson et al. [1986]. Esposito et al. [1998] published on the basis of 73 selected studies data on early and late failures of Brånemark implants. Over a 5-year period there was a biologically related failure rate of 7.7%. A distinction between different causes of biological failures could only be found in a few studies, but the number of implants failed due to peri-im-
plantitis seemed to be extremely low. An average prevalence of implant losses due to peri-implantitis was 2.8% in relation to the total number of biological failures. Buser et al. [1997] recorded after 5 years 9 implant failures out of 488 ITI implants, which resulted in a 98.2% survival rate. Reasons for implant losses were listed as: early failures during the healing period (2), implant fracture (1), untreated peri-implantitis (2), progressive bone loss (1) and implant mobility (3).

Technical complications with FPDs on implants

Technical complications were loss of retention 2.8% [3] and minor porcelain fractures 10.4% [11]. Screw loosening happened in 6.6% of the implants (7). The rate of technical complication was higher in FPDs on implants. Technical complications related to the type of fixation [cemented/screw retained] showed no difference of the frequency of such complications [not considering screw loosening]. Screw retained suprastructures had technical complications in 11.5% and cemented suprastructures in 16.5% [NS]. Behr et al. [1998] compared the complication rate with prostodontic components and reconstructions on ITI and IMZ dental implants. The aim of that study was to compare the complication rate of 2 implant systems with different prostodontic components: rigid, conical or resilient support of the suprastructure. In 66 patients, 138 ITI implants were inserted, whereas 31 patients received a total of 50 IMZ implants. Over an average observation period of 3.5 years (range from 0.5 to 8 years), not only implant survival was recorded, but also prostodontic complications such as screw loosening, fractures of screws, inserts (intramobile elements, intramobile connectors) and abutments as well as fractures of metal framework and veneers. With the ITI system, 28.8% of all devices placed exhibited such problems during the observation period. With the IMZ system, this rate was significantly higher (P≤0.05), in that 77.4% of all reconstructions required a repair at some point. The various complications were divided into those occurrences which affected only the suprastructure, i.e. failures of frame-work, veneers, bar devices or other retentive elements, and those which involved implant components per se, such as screws and abutment components. In the first category, adverse effects occurred more frequently with ITI-supported prostheses (15.1%) versus IMZ suprastructures (6.4%). Regarding complications with implant components, the rate with IMZ components was considerably higher (71%) compared with ITI (13.5%). This was mainly due to the presence of intramobile elements [IME] and connectors [IMC] in the IMZ system. Precise fitting, non-resilient abutment components leading to rigid connections of suprastructures, proved to be clinically more successful than resilient anchor components.

In a recent review [Brägger 1999], the published information on technical failures and complications was summarized. A careful analysis of the reported events clearly demonstrated that these problems occur frequently and may include up to 50% of the restorations examined. Failures and complications with implant and abutment components as well as with materials of the prostheses resulted in frequent repairs and even remakes. The use of a morse taper connection of the abutment implant interface and the preference for cementation has resulted in the present study in few complications related to implant components, whereas the porcelain fractures were clearly more frequently seen on implants. An explanation for this phenomenon could be the lack of periodontal receptors around osseointegrated implants, leading to a decrease of tactile sensitivity. For this reason, the suprastructures could be more exposed to shear/stress during the normal masticatory process [Hämerle et al. 1995; Keller et al. 1996; Mühlbradt et al. 1998].

Clinical parameters

At the 4–5 years examination – in general – favourable clinical conditions were encountered in the 3 groups of patients with various types of FPDs. Plaque accumulation and signs of inflammation were low at tooth and implant abutments. Nevertheless, the mean PI at teeth (0.67) was significantly higher than the mean mPII at implants (0.24). Therefore, patients seemed to clean implant abutments better compared to tooth abutments. This is in accordance with another study [Brägger et al. 1997] in which it was suggested that implant patients would devote a greater attention to implant sites during home care procedures.

PPD, PAL, recession and GI/mBII did not significantly differ between teeth and implants, which is in accordance with other studies (van Steenberghe et al. 1993; Olsson et al. 1995), where Plaque- and Gingivitis-Indices as well as PPD and PAL were similar at implants and teeth.

When the threshold for definition of peri-implantitis was set at PPD ≥5 mm and BOP+, 10 (9.6%) of the implants and 19 (4.5%) of the examined sites had a biological complication. Frequency analysis of the percentage number of sites with 1 to 8 mm PPD and PAL indicated that a low percentage of sites had a PPD of ≥5 mm or even ≥6 mm (Fig. 4).

Comparisons with other studies were difficult because the threshold for definition of peri-implantitis was not always the same. Nevertheless, these results seemed to be in a somewhat lower range, compared to data reported by Ellegaard et al. [1997]. After an observation period of 60 months, 92% of the implant abutments in periodontally compromised patients demonstrated no probing pocket depths over 6 mm and 63.1% showed no PPDs over 4 mm respectively.

Mixed implant–tooth borne FPDs

The mixed implant–tooth borne FPDs did not show evidence of a higher risk for technical or biological complications, which compares favourably with other studies [Gunne et al. 1992; Astrand et al. 1991; Olsson et al. 1995]. Olsson et al. [1995] had followed 23 patients with bilateral free end situations [Applegate Kennedy Class I] in the mandible and with a complete denture in the maxilla. On one side, the patients were restored with an FPD connecting the most distal tooth with an implant. The other side received an FPD on implants all ad modum Brånemark. Neither biological nor technical complications were higher in the group with the combined tooth–implant connection. These results were in accordance with Ericsson et al. [1986], van
Steenderbeke [1989], Krämer [1990], Naert [1991], Brägger et al. [1997] and earlier reports on the same patient material by Astrand et al. [1991] and Gunne et al. [1992]. At the 5-years’ examination, 87% of the primarily fabricated bridges were stable. Four of the free-standing purely implant borne bridges had been lost and 2 of the combined version had been lost. Technical maintenance in the fourth and fifth year comprised 3 complications with horizontal gold screws, 1 occlusal gold screw loosening and in one case fracture of occlusal material. Recently, the 10-years’ follow-up report on these cases confirmed that mixed tooth-implant borne FPDs may be recommended as a predictable and reliable treatment alternative [Gunne et al. 1999].

Extensions (pooled data of all 3 groups)

In a preliminary report by Hämmerle et al. [1998] detailed information on the frequency of biological and technical complications with FPDs in combination with extensions were listed. A total of 115 fixed partial dentures on 239 abutment teeth were examined 5 to 16 years after cementation. About 50% of the restored abutment teeth had a root canal treatment and most of them a cast post and core. Biological problems [loss of vitality, periapical lesion, carious lesion, advanced marginal periodontitis] were found in 14.2% of the abutments. Technical problems [loss of retention, fracture of metal frame, fracture of crown build ups, fracture of porcelain, fracture of abutment tooth] were encountered in 15% of the abutment teeth. Loss of retention and carious lesions were much more frequently observed in initially CO₂-negative teeth.

Patient factors

No statistically significant association could be shown between general health problems and biological complications although the data may suggest a trend. Similarly, no significant correlations between smoking and biological complications were noted.

This is in contrast to other reports, that clearly indicated significant correlations between those factors. Weyant [1994] for example, found such an association with implant survival and the medical status of the patients. Smoking and alcohol consumption were considered as risk factors for implant healing after implant placement. In some other studies [Bain & Moy 1993; de Bruin et al. 1994], it was also concluded that the effect of cigarette smoking significantly compromised the implants healing period and furthermore increased the failure rate during an observation period of 6 years. Lindquist et al. [1997] found in a 10-year follow-up study more loss of mean marginal peri-implant bone loss in smokers than in non-smokers, and this was correlated to the amount of cigarette consumption. Poor oral hygiene led in both groups, smokers and non-smokers, to greater peri-implant bone loss, but this factor had a higher impact on bone loss among smokers. The results of the present study were in agreement with observations by Smith et al. [1992]. In that study no correlation was found between implant failure and general health factors in medically compromised patients. It was proposed that local factors like bone quality and quantity and surgical/prostodontic techniques were probably more significant for the outcome than associated medical conditions. Reasons for such findings in the present study could be the relatively short observation period (4–5 years) and the fact that in general the oral hygiene standards were above average. In addition only a few of the participants were heavy smokers in which peri-implant and periodontal breakdown would have shown up.

The association between bruxism and technical complications showed a significant correlation. Six out of 10 bruxers experienced technical complications, whereas 13 out of 75 non-bruxers had such a complication [mostly porcelain fractures]. These observations support the need for protective splints for such superstructures and to clarify guarantee aspects in this high risk group of patients. In this respect, it has to be noted that the diagnosis of parafunction may be clinically very difficult and not all the patients may have been correctly grouped.

In conclusion, favourable clinical conditions were found at tooth and implant abutments after 4–5 years of function. Loss of FPDs over 4–5 years occurred at a similar rate with mixed, implant or tooth supported reconstructions. Significantly more porcelain fractures were found in FPDs on implants. Impaired general health status was not significantly associated with more biological failures but bruxism as well as extensions with more technical failures.

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Résumé

Le but de cette étude a été de comparer la fréquence des complications biologiques et techniques avec des prothèses partielles fixes sur des implants (FPDs), dents et mélange dents-implants durant quatre à cinq ans de mise en fonction. Tous les implants apparaissent au système implantaire ITI®. Le groupe I-I (implant FPD) comprenait 31 patients avec 40 FPDs, le groupe T-I (dents FPDs) 40 patients avec 58 FPD, le groupe T-T (melange dents-implants FPDs) quinze avec 18 FPD. Cent quatre-vingt-quatre piliers de bridge étaient des dents et 105 des implants. Le nombre moyen d’unités remplacées par FPDs était de trois, de deux à quatre. L’âge moyen des patients était de 56 ans, de 23 à 81. Des échecs complets aboutissaient en une perte d’un FPD dans chaque groupe. Deux implants ont été perdus dès la fracture secondaire au développement d’une lésion osseuse. Une dent a eu une fracture verticale et une dent a été perdue due à une parodontite. Les complications biologiques [parodontalite, PPD>5 mm et BOP+] sont apparues dans 10% [10] des implants. Ce nombre était cependant réduit à 5% si le seuil de définition de la parodontalite était placé à PPD>6 mm et un BOP+. Les complications biologiques sont apparues dans 12% des dents piliers [n.s. comparées aux implants]. Trois pour cent avaient des caries secondaires, 5% des problèmes endodontiques. Trois pour cent avaient des caries secondaires, 5% des problèmes endodontiques et 4% avaient des parodontites (PD>5 mm, BOP+). Dix des 52 patients avec un problème de santé générale ont eu une complication biologique tandis que neuf des 53 patients sans aucun problème de santé générale avaient une complication biologique [χ²; n.s.]. Statistiquement, plus de complications techniques ont été trouvées au niveau des FPDs sur implants [χ², P<0.05]. Les complications techniques étaient associées au bruxisme. Six des 10 patients qui bruxaient avaient une complication technique tandis que 15 des 75 non-bruxeurs avaient une telle complication [χ²<0.01]. Des extensions étaient associées à davantage de complications techniques [13 des 35 avec extensions contre neuf des 81 sans extension].

Zusammenfassung

Ziel dieser Studie war es, die Häufigkeit von biologischen und technischen Misserfolgen mit feststehenden Zahnprothesen (FPDs) auf Implantaten und Zähnen sowie bei gemischten Zahn-Implantatgetragenen FPDs


Resumen

La intención de este estudio fue comparar la frecuencia de las complicaciones biológicas y técnicas con dienturas parciales fijas (FPDs) sobre implantes, dientes y combinaciones de FPDs soportadas por diente-implante a lo largo de 4 a 5 años de función. Todos los implantes pertenecieron al sistema de implantes dentales ITI. Grupo II [implante FPD] incluyó 53 pacientes con 40 FPDs, grupo T-T [FPD dental] 40 pacientes con 58 FPDs, grupo I-T [FPDs combinados diente-implante] 13 con 18 FPDs. 144 de los pilares de los puentes fueron dientes y 105 fueron implantes. El número medio de unidades sustituidas por los FPDs fue de tres (rango 2-14). La edad media de los pacientes de 55,7 años (rango 23-83). Los fracasos completos resul taron en la pérdida de un FPD en cada grupo. Se perdieron dos implantes debido a fracturas secundarias al desarrollo de un defecto óseo. Un diente sufrió una fractura vertical y un diente se perdió debido a periodontitis. Ocurrieron complicaciones biológicas (periimplantitis PPD>3 mm y BOP>¹) en un 9,6% [10] de los implantes. Este número fue, fue de todos modos reducido al 3% si el umbral para la definición de peri-implantitis se situó en un PPD>3 mm y BOP>¹. Las complicaciones biológicas ocurrieron en un 11,8% [17] de los dientes pilares [NS comparados con implantes]. 2,8% [4] tuvieron caries secundarias, 4,9% [7] problemas endodonticos y 4,9% [6] tuvieron periodontitis (PPD>3 mm, BOP>¹). de 10 pacientes con un problema de salud general indicaron una complicación biológica mientras que de 53 pacientes sin problemas de salud general tuvieron complicaciones biológicas (P<0,05). Se encontraron más complicaciones técnicas estadísticamente significativas en FPDs sobre implantes [P<0,05]. Las complicaciones técnicas se asociaron con bruxismo. 6 de 10 bruxeros tuvieron complicaciones técnicas, mientras que 1 de 57 no bruxistas tuvieron dicha complicación (P<0,01). Las extensiones de los asociaron con mayores complicaciones técnicas [13 de 35 con extensiones frente a 9 de 81 sin ellas]. Se concluye, que se encontraron condiciones clínicas favorables en piales dentarios y de implantes tras 4-5 años de función. La pérdida de FPD a lo largo de 4-5 años ocurrió en una tasa similar con reconstrucciones mixtas soportadas por implantes y dientes. Se encontraron significativamente más fracturas de porcelana en FPDs sobre implantes. Un estado de salud general dismi nuído no se asoció significativamente con fracasos biológicos pero el bruxismo al igual que las extensiones se asociaron con mayores fracasos técnicos.

References


