Technical and biological complications/failsures with single crowns and fixed partial dentures on implants: a 10-year prospective cohort study

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Abstract

Objectives: To assess prospectively over 10 years the incidences of technical and/or biological complications and failures occurring in a cohort of consecutive partially edentulous patients with fixed reconstructions on implants of the ITI Dental Implant System.

Methods: Eighty-nine patients were available, 34 (38.2%) were male, 55 (61.8%) were female. At the 10-year examination (range 8–12 years), they were 58.9 years old (range 28–88 years).

Results: Single crowns (SC): 48 patients had been restored with 69 SC on 69 implants. Five of the implants with the crowns were lost because of biological failures. Two crowns (2.9%) were remade because of technical failures. Total failure amounted to seven (10%). Implant borne fixed partial dentures (I-I FPD): In 29 patients who had been restored with 33 implant borne suprastructures, the total number of failed I-I FPD was 2 (6.1%). Tooth–implant borne fixed partial dentures (I-T FPD): In 21 patients, 22 mixed tooth–implant borne reconstructions were constructed. The number of failed FPD reached 7 (31.8%). Statistically significantly fewer biological failures occurred with I-I FPD compared with the I-T FPDs (ANOVA, Bonferroni, \( P = 0.022 \)). The I-T FPDs experienced statistically significantly more frequent technical failures compared with the other two groups of suprastructures \( (P = 0.003, 0.031) \). Consequences of complications: The occurrence of loss of retention as a complication increased the odds ratio (OR) to 17.6 \(( P < 0.001) \) to end up in a technical failure. Similarly, the event of a porcelain fracture increased the OR for the suprastructure to be a failure at 10 years to 11.0 \(( P = 0.004) \). Treatment of periimplantitis increased the OR to 5.44 \(( P < 0.001) \) to result in a biological failure compared with implants in which this type of treatment was not applied.

Conclusion: The three groups of suprastructures demonstrated marked differences in their patterns of failures and complications. Complications increased the risk for failure. Support by CRF, University of Berne, Switzerland.

The number of patients receiving oral implants to support prosthetic reconstructions of various designs is steadily increasing (Jokstad et al. 2003). It seems, however, that this treatment option has so far reached only a small proportion of the profession dealing with tooth replacement. Most of the edentulous spaces today are, if at all, reconstructed using conventional fixed partial, removable partial or even full dentures. The functional and biological advantages of implant borne reconstructions compared...
with conventional reconstructive dentistry are for many clinical situations indisputable. Therefore, it can be estimated that a considerably increasing percentage of patients seeking dental care will present with implant borne reconstructions in the future. From a socio-economical point of view, the preference for a particular treatment option depends on the effectiveness of such devices during function over prolonged periods of time in relation to the costs arising as well as patient centered outcomes.

In most of the early reports, extensive data were presented restricted to survival/success rates of the implant devices [for a review, see Fiorellini & Weber 1994; Esposito et al. 1998a]. Over the last decade, an increasing bulk of information was collected and published, which was related to the stability or changes in periimplant tissue conditions. Early reports were limited to the assessment of radiographic changes [for a review, see Brägger 1998], but later on, clinical and microbiological parameters were added [Mombelli 1994; Esposito et al. 1998b].

Recently, several reviews have dealt with information on technical aspects of implant dentistry in the maintenance phase.

A conventional review stated that technical complications and failures frequently occur. Most of the complications seemed to be associated with occlusal screws followed by abutment screws and prostheses. These complications were more frequent in bruxist. Screw loosening could be minimized by cementation of the suprastructure. Finally, it was stated that technical failures will add to the financial costs of maintenance [Bragger 1999].

In a systematic review, these trends were confirmed and today some evidence on the frequency and/or incidence of biological and technical complications per patient at least over 5 years exists [Berglundh et al. 2002].

The purpose of this study was to assess prospectively over 10 years the incidences of both technical and biological complications as well as failures occurring in a cohort of consecutive patients with fixed reconstructions on implants.

The three groups of reconstructions: single crowns [SC], implant borne fixed partial dentures [I-I FPD] and tooth–implant borne fixed partial dentures [I-T FPD] were to be compared with respect to differences in the type and incidences of complications and failures. Furthermore, it should be tested if reconstructions with technical and biological complications were at higher risk to result in a failure compared with suprastructures with no preceding events.

Material and methods

Patients of a prospective long-term case cohort study were recruited for a complete clinical and radiographic examination at 1 and 10 years after implant installation [Brägger et al. 1997; Karoussis et al. 2003, 2004a, 2004b]. The partially edentulous patients had been treated comprehensively after assessing their periodontal, endodontic, cariologic, functional and esthetic treatment needs. The treatment plan comprised the use of oral implants for SC, I-I FPD or I-T FPD. All implants were part of the former ITI Bonefit Dental Implant System [Institute Straumann, Waldenburg, Switzerland], which up to 2004 was called the ITI Dental Implant System [Institute Straumann]. From 2004 on, the new name will be the Straumann Implant System® [Institute Straumann]. They were placed according to the manufacturer’s guidelines [Sutter et al. 1988]. After a healing period of about 3 months, the suprastructures were fabricated using the systems components for cemented or screw-retained SC or fixed partial dentures. Frameworks of the I-I FPD and I-T FPD were constructed as 1 piece restorations without the use of any precision attachments nor telescopic crowns. Implant installation and reconstructions was performed by residents and senior staff at the Clinic for Periodontology and Fixed Prosthodontics at the University of Bern, Switzerland. Supportive periodontal care was provided either at the same clinic or at referring dental practices. During recall sessions, all incidences of biological and/or technical complications were noted. In case of a biological complication, a cumulative interceptive antiinfective treatment protocol as suggested by Mombelli & Lang [1998] was applied. Minor technical complications such as occlusal screw loosenings were managed during the recall session. In case of repair or even failures requiring new treatment planning, additional appointments were arranged.

At the 1 and 10-year examination, complete periodontal/perimplant clinical and radiographic assessments were performed for all implants, abutment teeth as well as all the remaining teeth [Karoussis et al. 2003, 2004a, 2004b]. In addition, the characteristics of the suprastructures were coded for the type of reconstruction [cemented or screw retained, number of units, use of extension, connection to teeth, purely implant borne reconstructions]. Any loss of an implant/tooth abutment was marked. At the 10-year examination, some of the implants or tooth abutments had been replaced by an implant or by a new implant. Lost or new reconstructions were marked. The list of technical complications included: Loosening of occlusal screw [LS], fracture of occlusal screw [FS], loss of retention [LR], loosening of abutment screw [LS], fracture of abutment screw [FA], fracture of the metal framework [FF], fracture of porcelain [FP], occlusal contact/intrusion [IN].

The patients’ charts were screened for all incidences of events related to biological and technical complications over the 10 years of observation. Any repairs or replacements were noted. The time in months since delivery of the suprastructure until the first technical and/or biological complication occurred, was noted. Patient risk factors related to general health and parafunction were assessed by means of a questionnaire and intraoral signs for that is, bruxism.

The threshold to define a biological complication was set strictly at a probing pocket depth of 5 mm and bleeding on probing or pus secretion. According to the clinic’s cumulative interceptive supportive therapy concept such sites were treated [Lang et al. 2000].

Statistical analysis

The coded data were listed and grouped according to the type of the suprastructure: SC, I-I FPD, I-T FPD. Descriptive statistics listed the incidences of the various types of complications and failures for tooth/implant abutments, reconstruction as well as patients affected.

The statistical analyses included one-way ANOVA and post hoc multiple comparisons [Bonferroni] of the frequencies of biological and technical failures and various types of complications occurring in the
three groups of patients. The statistical unit was the reconstruction. Mantel-Haenszel odds ratios (ORs) for reconstructions to fail were calculated if complications occurred over the 10 years of observation compared with reconstructions, which were exposed to neither biological nor technical complications.

Results

For the 1-year examination, 127 patients were recruited and evaluated [Brägger et al. 1997]. For the 10-year evaluation, nine [7%] could not be reached because of death and 29 [23%] because they had moved, thus, 89 patients were available. Thirty-four [38.2%] were males and 55 [61.8%] were females. At implant placement, these patients were 49.3 years old [range 19–78 years]. At the 10-year examination, they were 58.9 years old [range 28–88 years]. In these 89 patients, 179 implants of the ITI Dental Implant System [the former Bonefit System, Institute Straumann] had been installed. One hundred and twelve were hollow screws, 49 were hollow cylinder and 18 angulated hollow cylinder implants.

The average observation period was 10 years with a range between 8 and 12 years.

At the 10-year examination, the patients contributed 1770 teeth [19.9 per patient]. During the course of the study, 87 teeth were lost/extracted [4.9%] and from the implants 13 were lost [7.3%] over the 10 years.

For the purposes of this study, only patients were selected with a complete examination at the 1- and 10-year examinations. Furthermore, patients with any prototypes of prosthetic components were excluded. All the reconstructions were opposed by natural dentitions, SC or fixed partial dentures.

SC

Forty-eight patients had been restored with 69 SC on 69 implants. Most of the porcelain fused to metal crowns were cemented using zinc phosphate cementum and only two were screw retained (Table 1).

Five of the implants with the crowns were lost because of biological complications. Two crowns [2.9%] were remade because of technical complications. The total failure rate of the implant borne SC amounted to seven [10%]. Three patients [6.7%] were exposed to biological failures, whereas two patients [2.9%] were involved in technical failures. Four additional other SC [5.8%] in four patients [8.3%] had demonstrated technical complications neither leading to loss nor remake [surviving] [Tables 1 and 2].

During the 10 years of function, 13 out of 65 implants were diagnosed with peri-implantitis requiring antiinfective therapy [Table 3]. Ten of 13 implants were treated by instruction/motivation for improved homecare, mechanical removal of deposits using carbon curettes, antiiseptics as well as antibiotics. One of the implants was, in addition to the prior listed regimen, surgically treated for retersive pocket elimination, while in two implants a regenerative surgical approach was chosen.

Forty-six [66.5%] out of 69 SC on implants remained free of any complication/failure over the 10 years, while at 23 [33.3%] at some time such an event was observed [Table 4].

I-I FPD

Twenty-nine patients were restored with 33 implant borne suprastructures on 69 implants [Table 1]. One 2-unit FPD, 20 3-unit FPDs, 11 4-unit FPDs and one 10-unit FPD were fabricated. One of these implants [1.4%] has been lost because of biological failure leading to the loss of one [3%] I-I FPD as well. Another I-I FPD had to be replaced because of technical complications (3%). Additional 10 I-I FPD [31%] in 9 [31%] of the patients were exposed to technical complications not leading to failure, i.e. occlusal screw loosening/loss of retention. The total number of failed I-I FPD was 2 [6.1%] after an average time in function of 10 years [Tables 1 and 2].

Eight out of 69 implants required treatment of periimplantitis. Six using anti-septics/anti-biotics and two using additional retersive surgery [Table 3].

Eighteen [54.5%] of the I-I FPD remained completely free of any technical or biological complication/failure [Table 4].

I-T FPD

In the 21 partially edentulous patients receiving 22 mixed tooth–implant borne reconstructions, ten 3-unit FPDs, six 4-unit FPDs, four 5-unit FPDs and two 10-unit FPDs were constructed [Table 1]. As abutments 22 implants were installed and 24 abutment teeth were prepared. One implant [4.5%] failed because of a primary biological complications leading to the loss of one [4.5%] I-T FPD in one patient [4.8%].

Four failures started as technical complications [loss of retention], which later resulted in biological failure [caries] at four abutment teeth [16.7%]. The same four patients eventually also lost the implants because of biological failure. Two [9.1%] additional I-T FPD were remade because of technical complications. In four [19%] patients, four [18%] I-T FPD was noted that had experienced technical complications that did not lead to loss or remake. In the I-T FPD group, the sum of failed FPD reached seven [31.8%] over an observation period of 10 years [Tables 1 and 2].

Three implants were treated for perimplantitis using anti-septics/anti-biotics [Table 3].

Only 11 out of 22 [50%] I-T FPD remained free of any technical or biological complication over the 10 years of maintenance [Table 4].

Comparison of the groups of suprastructures

Statistically significantly fewer biological failures occurred with I-I FPD compared with the I-T FPDs [P = 0.022]. The I-T FPDs experienced statistically significantly more frequent technical failures compared with the other two groups of suprastructures [P = 0.003, 0.031] [Table 1].

The statistical comparison of the frequency of technical complications revealed a higher frequency of occlusal screw loosening in the I-I FPD group compared with SC [P = 0.005] [Table 2]. Loss of retention was more frequently observed in the I-T FPD group compared with the SC [P ≤ 0.001].

Consequences of complications

The OR for a suprastructure to develop a technical failure following loosening of occlusal screws or loosening of abutment screws were not statistically significantly increased, whereas the occurrence of loss of retention increased the OR to 17.6 [P < 0.001] to end up in a technical failure [Table 5]. Similarly, the event of a porcelain fracture increased the OR for the suprastructure to be a failure at 10 years to 11

Table 1. Number of implants, reconstructions, and patients and their involvement in biological and/or technical failures and/or complications over 10 years of observation

<table>
<thead>
<tr>
<th></th>
<th>SC</th>
<th>I-I</th>
<th>I-T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implants installed/abutment teeth</td>
<td>69</td>
<td>69</td>
<td>22/24</td>
</tr>
<tr>
<td>Reconstructions seated</td>
<td>69</td>
<td>33</td>
<td>22</td>
</tr>
<tr>
<td>Patients receiving reconstruction</td>
<td>48</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td>Implants lost because of biological complications including secondary fractures of hollow body implants</td>
<td>5 (7.2%)</td>
<td>1 (1.4%)</td>
<td>1 (4.5%)</td>
</tr>
<tr>
<td>Reconstructions lost because of biological failure of implants</td>
<td>5 (7.2%)</td>
<td>1 (3%)</td>
<td>1 (4.5%)*</td>
</tr>
<tr>
<td>Number of patients exposed to biological failures of implants</td>
<td>3 (6.7%)</td>
<td>1 (3.5%)</td>
<td>1 (4.8%)</td>
</tr>
<tr>
<td>Abutment lost because of technical complications leading to caries and secondarily to biological failure of implants</td>
<td>NA</td>
<td>NA</td>
<td>4 (16.7%) (T)</td>
</tr>
<tr>
<td>Reconstructions lost because of technical complications leading to biological failure of abutment teeth and implants</td>
<td>NA</td>
<td>NA</td>
<td>4 (18.2%)*†</td>
</tr>
<tr>
<td>Patients with reconstructions lost because of technical complications leading to biological failure of abutment teeth and implants</td>
<td>NA</td>
<td>NA</td>
<td>4 (19%)</td>
</tr>
<tr>
<td>Implants lost because of technical complications</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reconstructions lost because of technical complications</td>
<td>2 (2.9%)</td>
<td>1 (3%)</td>
<td>2 (9.1%)‡</td>
</tr>
<tr>
<td>Patients losing reconstructions because of technical complications</td>
<td>2 (4.2%)</td>
<td>1 (3.5%)</td>
<td>2 (9.5%)</td>
</tr>
<tr>
<td>Surviving reconstruction with technical complications in situ</td>
<td>4 (5.8%)</td>
<td>10 (31%)</td>
<td>4 (18%)</td>
</tr>
<tr>
<td>Patients with surviving reconstruction with technical complications in situ</td>
<td>4 (8.3%)</td>
<td>9 (31%)</td>
<td>4 (19%)</td>
</tr>
<tr>
<td>Number of reconstruction failed because of biological and technical complications</td>
<td>7 (10.1%)</td>
<td>2 (6.1%)</td>
<td>7 (31.8%)</td>
</tr>
</tbody>
</table>

The data were grouped according to the type of suprastructure.
*One-way ANOVA revealed statistically significant differences in the frequency of technical failures of suprastructures between the groups (F = 5.63, P = 0.005). Bonferroni multiple comparisons revealed statistically significant differences between I-T/SC (P = 0.005) and I-T/I-I (P = 0.031).
†One-way ANOVA revealed statistically significant differences in the frequency of biological failures of suprastructures between the groups (F = 3.93, P = 0.022). Bonferroni multiple comparisons revealed a statistically significant difference between I-T/I-I (P = 0.022).
SC, single crowns; I-I, implant borne suprastructures; I-T, implant–tooth borne suprastructures; NA, not applicable.

Discussion

Data from this patient cohort have already been evaluated and published recently. One of the reports focused on the effect of implant design on survival and success rates. A higher survival rate of 95.4% and a statistically significantly lower incidence of periimplantitis (10%) were identified for hollow screws compared with hollow cylinders of the ITI® Dental Implant System (85.7% and 29%, respectively) after 10 years of function [Karoussis et al. 2004b]. Since design aspects were significantly affecting the long-term outcome of the periimplant conditions, only screw type implants were then used to compare partially edentulous patients with a history of periodontitis to a group of patients having lost their teeth because of caries, anodontia or trauma. Lower survival rates (90.5% vs. 96.5%) and statistically significantly more biological complications (28.6% vs. 5.8%) were found in the periodontitis group [Karoussis et al. 2003].

Berglundh et al. [2002] published a systematic review on the incidences of biological and technical complications in implant dentistry. During the literature searches and screening of the abstract and papers, the authors restricted themselves to data extraction from papers with prospective longitudinal design of at least 5 years. As biological complications, the implant loss, sensory disturbances, soft tissue complications, periimplantitis and bone loss > 2.5 mm were defined. Furthermore, data on implant fractures and technical complications related to implant components and suprastructures were collected. The initial search on MEDLINE revealed 1310 titles and abstracts out of which 159 were selected for full-text analysis. Fifty-one papers were then relevant to the question.

SC

Combining data from eight reports on single-tooth replacements, Berglundh et al. (2002) calculated a weighted mean of 0.76% implants lost before loading, 2.5% implants lost during function, 0.08% incidences per patient of soft tissue complication, 0.31% of implants with periimplantitis, 1.28% of implants with bone loss > 2.5 mm, no implant fractures, 0.3 incidences per patient of complications with components and 0.17 complications per patient with the suprastructures. These data indicate that every third patient had complications with components and every fifth with the suprastructure over the 5 years. The actual failure rate of the suprastructures, however, could not be extracted from the review.

In the present report over 10 years, three out of 48 patients had complications with components and three out of 48 demonstrated complications with the SC.
Biological failure, loss of retention, and biological failure of suprastructures (the statistical unit is the reconstruction).

**Table 2. Number of different types of technical complications related to components and suprastructures (the statistical unit is the reconstruction)**

<table>
<thead>
<tr>
<th></th>
<th>Components</th>
<th>Suprastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LS</td>
<td>FS</td>
</tr>
<tr>
<td>SC Cemented</td>
<td>67</td>
<td>1</td>
</tr>
<tr>
<td>Screw retained</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>I-I FPD Cemented</td>
<td>25</td>
<td>6*</td>
</tr>
<tr>
<td>Screw retained</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>I-T FPD Cemented</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Screw retained</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

*One-way ANOVA revealed statistically significant differences in the frequency of occlusal screw loosening between the groups (F = 2.14, P = 0.146). Bonferroni multiple comparisons indicated statistically significant fewer incidences in group SC compared with I-I (P = 0.005).
†One-way ANOVA revealed statistically significant differences in the frequency of loss of retention between the groups (F = 23.37, P < 0.001). Bonferroni multiple comparisons revealed statistically significant differences between I-T/SC (P = 0.001).

Table 3. Number of reconstructions exposed to biological complications and attempts to treat

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>69</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>I-I FPD</td>
<td>33</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>I-T FPD</td>
<td>22</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

SC, single crowns; I-I, implant borne suprastructures; I-T, implant-tooth borne suprastructures; FPD, fixed partial dentures.

**Table 4. Number (%) of reconstructions with biological and/or technical complications/failures and number of reconstructions with no complications/failures**

<table>
<thead>
<tr>
<th>Reconstruction</th>
<th>N</th>
<th>With complication/failure</th>
<th>Without complication/failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
<td>69</td>
<td>23 (33.5%)</td>
<td>46 (66.5%)</td>
</tr>
<tr>
<td>I-I FPD</td>
<td>33</td>
<td>15 (45.5%)</td>
<td>18 (54.5%)</td>
</tr>
<tr>
<td>I-T FPD</td>
<td>22</td>
<td>11 (50%)</td>
<td>11 (50%)</td>
</tr>
</tbody>
</table>

SC, single crowns; I-I, implant borne suprastructures; I-T, implant-tooth borne suprastructures; FPD, fixed partial dentures.

**Table 5. Mantel–Haenszel common OR and 95% CI between loss of retention and technical failure, fracture of porcelain and technical failure, episode of periimplantitis treatment and biological failure, loss of retention, and biological failure of suprastructure**

<table>
<thead>
<tr>
<th>Condition</th>
<th>OR</th>
<th>95% CI</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of retention and technical failure</td>
<td>17.6</td>
<td>3.6–86.4</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Fracture of porcelain and technical failure</td>
<td>11</td>
<td>2.1–57.3</td>
<td>P &lt; 0.004</td>
</tr>
<tr>
<td>Episode of periimplantitis and biological failure</td>
<td>5.4</td>
<td>1.5–20.1</td>
<td>P &lt; 0.011</td>
</tr>
<tr>
<td>Loss of retention and biological failure</td>
<td>6.7</td>
<td>1.4–31.9</td>
<td>P &lt; 0.017</td>
</tr>
</tbody>
</table>

The three groups of reconstructions were pooled.

OR, odds ratio; CI, confidence interval.

Unfortunately, five out of 69 crowns were lost because of biological failures of implants—most of them with the hollow cylinder design.

In Berglundh’s review (Berglundh et al. 2002), the 16 papers on I-I FPD revealed a weighted mean incidence of technical complications with components of 0.23 and with suprastructures of 0.24. These data suggest that every fourth patient had a complication with components and every fourth patient had complications with suprastructures over the 5 years of function.

For the full-arch fixed complete dentures, every second patient was exposed to a complication with the suprastructure, while every fifth patient was exposed to complications with components over the 5 years. For overdenture patients, the technical complications were even higher with about two incidences of complications with the suprastructure and 1.5 incidences.
per patient of complications with the components.

**I-I vs. I-T FPD**

In a previous report, the 5-year data on biological and technical failures and complications had been presented for the I-I and the I-T patient group of this cohort [Brägger et al. 2001]. Comparisons were made to another group of patients receiving conventional FPD on teeth. Already at 5 years, one FPD per group had been lost because of biological failure leading secondarily to the fracture of two hollow screw implants. Technical complications occurred at 20% [21/103] of all implants: Three of the units had loss of retention, 11 a minor porcelain fracture and seven had occlusal screw loosening. Since the data of the three groups of reconstructions were pooled for the comparison of the implant to the tooth situation, no detailed comparison in the I-T FPD group to the I-I FPD patient group is available. The 5-year data could demonstrate, however, significant negative effects of bruxism and the existence of extension – again the three groups of reconstructions were pooled for these calculations.

Only a few reports have presented comprehensive data on FPD over 10 years or more: The survival of I-I FPD over 10 years was 102/123 (82.9%) in a study by LeKholm et al. [1994] and 16/20 (80%) in a report by Gunne et al. [1999]. In the present report 31/33 (93.9%) survived an average observation period of 10 years.

The corresponding survival data for the I-T FPD were 11/12 (91.7%) [Jent et al. 1989], 18/20 (90%) [Gunne et al. 1999] and 12/15 (80%) [Steflik et al. 1995].

Probable one of the best study designs to compare I-T FPD vs. I-I FPD was proposed by Åstrand et al. [1991]. Twenty-three patients were restored in one mandibular posterior segment using a purely implant borne superstructure, whereas the contralateral mandibular posterior region received a mixed tooth-implant borne reconstruction. Twenty out of the 23 patients were available for a 10-year follow-up examination [Gunne et al. 1999]. Since some implants were lost, four I-I FPD and two I-T FPD were lost already at 5 years. At the 10-year examination, one abutment tooth had been lost because of caries and endodontic complications. The lost I-T FPD was replaced with a new FPD after placement of an additional implant. The FPDs were reported to be stable (not mobile) in 80% for the I-I and in 85% for the I-T FPD. For the implant success rate of 88% after 10 years, it was noted that all the lost implants (eight out of originally 69) had been lost during the first 2 years of the study. All the abutment screws were still tight, whereas in five FPDs occlusal screws had to be retightened at 10 years. Already at the 3- and 5-year examination, some of the gold screws had been retightened. The results of Gunne et al. [1999] with 18/20 surviving I-T FPD indicated that there was no disadvantage in connecting implants to teeth which was confirmed by Jent et al. [1989] with 11/22 surviving FPD at 10 years.

This is in contrast to our results where a statistically significantly higher rate of FPD losses in the I-T FPD group was obvious. This is mainly because of the fact that when working with a one-piece framework, as applied for all I-T FPD of the present study, loss of retention might be detrimental for the development of caries. It has also to be stressed that most of the lost tooth abutments were root canal treated and restored with a cast post and core. Thus, in the present report in four FPD losses, the reason was first loss of retention, which led to further biological problems, i.e. quick caries progression at the abutment teeth.

In a prospective evaluation of implants connected to teeth, Block et al. [2002] reported that five root canal-treated abutment teeth had to be removed because they fractured at the interface of the post within the tooth. These failures occurred between 3 and 4 years of function. The study material consisted of 30 patients with 60 implants and 60 abutment teeth. From the vital abutment teeth none was lost [Block et al. 2002].

The frameworks in the patients from Gunne et al. [1999] were constructed in two parts, which were connected with a precision attachment. Obviously, with this design, the authors did not report problems related to frequent intrusion or loss of retention that lead to caries in just one case.

For treatment planning and patient information, the complication/success rates achieved with suprastructures on implants should also be compared with conventional prosthetic long-term results when using teeth as abutments. In two systematic reviews [Creugers et al. 1994; Scurrui et al. 1998], very similar survival data were calculated for conventional FPD: 90%/92% at 10 years and 74%/75%, respectively, at 15 years.

**Conventional reconstructions**

Often the study designs would not render a continuous observation period for all the restorations. Thus, in a 10-year longitudinal study actually only 52% of the 688 evaluated crowns had been in service for 5–10 years [Walton 1999]. From those crowns, one out of 240 (0.4%) on vital teeth was a failure but this increased to 5% for non-vital teeth (five out of 166).

Anterior crowns were exposed to significantly more retreatments than posterior crowns. Twenty-five out of 668 of the crowns needed retreatment. This occurred within the first 5 years after cementation [range 11–66 months]. The reasons for retreatment were coronoradicular fractures (24%), root fractures (32%), periodontal complications (16%), caries (8%), loss of retention (16%) and esthetic complications (4%). Altogether the repair and the failure rates of the crowns during 5–10 years of service were both 3%.

In a second study, Walton [2002] reported on FPDs placed in private practice. Thirty-seven percent of the FPDs had been in function for 5–10 years and 34% even for 10–15 years. The failure rates were 7% between 5 and 10 years and increased to 11% for the older group. Repairs increased from 1% to 4% in the 10–15 years group. The retainers on non-vital abutment teeth failed in 8% between 5 and 10 years and in 21% in 10–15 years whereas this was 2% and 5% for retainers on vital teeth.

Forty-five FPDs were failures/repairs with retreatments. All events occurred between 7 and 137 months. If abutment teeth were rated ‘at risk’ but still used for anchorage, 17% failed within 5–10 years and 37% of those failed between 10 and 15 years. This implies that if doubtful abutments or teeth considered at risk are to be used for new FPDs, the replacement of such a doubtful abutment with implants might be justified!!

When a cohort of 92 patients, who received 115 fixed partial dentures with cantilevers on teeth, was reevaluated at about 10 years (range 5–16 years), 18 (16%) complete-
ly failed FPD were noted. Twenty percent of abutment teeth and 34% of the original 115 FPD were affected by technical or biological problems (Hämerle et al. 2000).

A very valuable way to describe the performance of a device is to list the percentage number with no failures and no complication at all.

Örtorp & Jemt (1999) collected information on the complications experienced with FPD-based on laser-welded titanium frameworks. Fifty-eight patients with 68 FPDs were followed for 5 years.

Twenty-eight out of 58 (48% of the patients) had no complications at all while three out of 68 FPDs were failures. Five prostheses with porcelain veneers had to be redesigned owing to esthetic and functional reasons. One prosthesis was shortened because of the loss of two implants. From the eight FPDs veneered with resin, one had to be redesigned and one shortened. Fracture of the veneering material was a frequent observation and occurred in 13% of the FPDs. While seven of the FPDs had minor fractures that could be polished, some had to be repaired in the laboratory repeatedly.

Evaluating the complications that occurred with unilateral maxillary prostheses on implants, Wennnerberg & Jemt [1999] reported that 70 out of 133 patients (53%) had no complication during the 5 year follow-up. The other 63 patients experienced 139 biological and technical complications. Fifty-five were related to veneer components, 12 to esthetic, three to phonetic and five to stomatopathic problems. Only two of the FPDs were lost because of loose implants. Seventeen out of 139 complications were mucosa problems.

Complications leading to failure

For reconstructions exposed to biological or technical complications, the OR to finally result in a complete failure of the superstructure were obviously increased.

Occlusal screw loosening did not affect the chances to result in failure compared with reconstructions with no screw loosening. Retightening solved the problem in most cases.

More deleterious were the event of a porcelain fracture and even worse the loss of retention. Loss of retention often preceded not only technical but also biological failure of the reconstruction. This was mainly because of the mixed tooth implant borne suprastructures where the loss of retention led to the carious destruction of abutment teeth. As shown previously in the material with FPD with extensions, a close correlation and a significant association were observed between the occurrence of loss of retention and carious lesions at the affected abutment tooth (Hämerle et al. 2000). This was even more pronounced at root canal treated teeth with cast posts and cores.

Summary

- The percentage of failed reconstructions after 10 years of function was 10.1% for SC, 6.1% for I-I FPD and 31.8% for I-T FPD.
- The percentage of reconstructions without any biological nor technical failure/complication was 66.5% for SC, 54.4% I-I FPD, 50% for I-T FPD.
- I-I FPD had statistically significantly fewer biological complications compared with the I-T FPD.
- I-T FPD had statistically significantly more frequent technical failures compared with SC and I-I FPD.
- Loss of retention was statistically significantly more frequent in I-T FPD compared with SC.
- Loosening of occlusal/abutment screws did not increase the risk to result in a failure of the superstructure compared with FPD without screw loosening.
- Loss of retention and/or porcelain fracture increased the risk to result in failure of the FPD compared with FPD without fracture of porcelain.
- Implants treated for periimplantitis were at higher risk to fail compared with implants with no biological complication.
- FPD exposed to either technical and/or biological complications are at higher risk to fail compared with FPD without preceding complications.

Conclusions

The three groups of suprastructures demonstrated marked differences in their patterns of failures and complications. Preceding complications increased the risk for failures.

Some of the technical failures and complications reported in this paper today may seem to be irrelevant because of the continuous development of the components. Thus, by the exclusive use of full screws of the ITI® Dental Implant System, the introduction of a controlled torque device and technical improvements of the abutment and transfer system, some risks might have been eliminated or heavily reduced. Nevertheless, the creation of such data sets as presented here should be encouraged because of its impact on the treatment decision.

Methoden: 89 Patienten standen zur Verfügung, 34 (38.2%) waren männlich, 55 (61.8%) waren weiblich. Zum Zeitpunkt der Untersuchung nach 10 Jahren (Bandbreite 8–12 Jahre) betrug das Alter 58.9 Jahre (Bandbreite 28–88 Jahre).

Resultate: SC: 48 Patienten waren mit 69 Einzelkronen auf 69 Implantaten versorgt worden. Für die Implantate mit den Kronen gingen aufgrund biologischer Misserfolge verloren. Zwei Kronen (2.0%) mussten aufgrund technischer Misserfolge neu angefertigt werden. Die totale Misserfolgsrate betrug 10%.

I-I FPD: Bei 29 Patienten, welche mit 33 implantatgetragenen Rekonstruktionen versorgt worden waren, betrug die totale Anzahl an fehlgeschlagenen I-I FPD 2 (6.1%). I-T FPD: Bei 21 Patienten wurden gemischte Implantat-Zahn getragene Rekonstruktionen eingerichtet. Die Anzahl der FPD mit Misserfolgen betrug 7 (31.8%). Mit I-I FPD traten im Vergleich zu I-T FPD statistisch signifikant weniger biologische Misserfolge auf (ANOVA, Bonferroni, \( P < 0.001 \).

Resultados: SC: Se restauró a 48 pacientes con 69 corona unitarias sobre 69 implantes. Cinco de los implantes con coronas se perdieron debido a fracasos biológicos. Dos coronas (2.9%) se rehicieron debido a fracasos técnicos. Los fracasos sumaron siete (10%). I-I FPD: En 29 pacientes que se habían restaurado con 33 superestructuras soportadas por implantes, el número total de fracasos I-I FPD fue de 2 (6.1%). I-T FPD: En 21 pacientes se construyeron 22 reconstrucciones mixtas soportadas por diente-implante. El número de FPD fracasados alcanzó siete (31.8%). Ocurren menos fracasos biológicos estadísticamente significativos con I-I FPD comparados con los I-T FPD (ANOVA, Bonferroni, \( P < 0.001 \).


Resumen

Objetivos: Valorar prospectivamente a lo largo de 10 años las incidencias de las complicaciones y fracasos técnicos y/o biológicos que ocurrieron en una cohorte de pacientes parcialmente edéntulos consecutivos con reconstrucciones fijas sobre implantes de sistema de implantes dentales ITI®.

Métodos: Se dispuso de 89 pacientes, 34 (38.2%) varones, 55 (61.8%) hembras. En el examen de los 10 años (rango 8–12 años), tenían 18.9 años (rango 28–88 años).

Resultados: SC: Se restauró a 48 pacientes con 69 corona unitarias sobre 69 implantes. Cinco de los implantes con coronas se perdieron debido a fracasos biológicos. Dos coronas (2.9%) se rehicieron debido a fracasos técnicos. Los fracasos sumaron siete (10%). I-I FPD: En 29 pacientes que se habían restaurado con 33 superestructuras soportadas por implantes, el número total de fracasos I-I FPD fue de 2 (6.1%). I-T FPD: En 21 pacientes se construyeron 22 reconstrucciones mixtas soportadas por diente-implante. El número de FPD fracasados alcanzó siete (31.8%). Ocurren menos fracasos biológicos estadísticamente significativos con I-I FPD comparados con los I-T FPD (ANOVA, Bonferroni, \( P < 0.001 \).

Conclusión: Estos tres grupos de superestructuras demostraron marcadas diferencias en sus patrones de fracasos y complicaciones. Las complicaciones aumentaron el riesgo de fracaso.

References


Brägger et al. Technical and biological complications with FPD on implants


