Technical complications of implant-supported fixed partial dentures in partially edentulous cases after an average observation period of 5 years

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Abstract

OBJECTIVES: The purpose of this prospective long-term study was to evaluate the incidence of the most common technical problems, namely screw loosening, screw fracture, fracturing of veneering porcelain and framework fracture in implant-supported fixed partial dentures (FPDs), and assess the survival and success rate (event-free survival) after 5 years of function. MATERIALS AND METHODS: In 76 partially edentulous patients, a total of 205 3i-implants (machined surface) were placed and restored with 112 implant-supported FPDs (46 single crowns, 81 splinted crowns, seven FPD bridges and 23 FPDs with cantilevers). The survival rate of FPDs supported by implants was 94.5% (CI-95: 90.1-98.8) after an average observation period of 5 years. The success rate (event-free survival) of the FPDs was 80% (CI-95: 87.3-72.7). After an observation period of 5 years the cumulative incidence of screw loosening was 6.7% (CI-95: 1.8-11.5), the cumulative incidence for screw fracture was 3.9% (CI-95: 0.1-7.7). Fracture of the veneering porcelain occurred in 5.7% (CI-95: 1.2-10.2) of all FPDs. Fracturing of the suprastructure framework was rare (1%; CI-95: 0-2.9). The overall complication incidence after 5 years was highest in the group of FPDs with cantilever, which showed the lowest success rate 68.6% (CI-95: 50-87.3), followed by single crowns (77.6%; CI-95: 53.3-100) and splinted crowns (86.1%; CI-95: 59.5-100). No complication occurred in FPD bridges. CONCLUSION: Fixed partial dentures supported by 3i-implants showed low technical complications rates, the most common being loosening of the abutment screw. Managing these complications can cause extra amount of chair-side time and patient dissatisfaction.
Technical complications of implant supported fixed partial dentures (FPDs) in partially edentulous cases after an average observation period of five years

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Keywords: Humans, Dental Implants; Denture, partial, fixed/ adverse effects; Survival rate; Survival analysis; Technical complications, Partially edentulous patients; Dental prosthesis, Implant-supported; Dental Restoration Failure; Dental Abutments; Technical Complications, Competing-risk model; Dental Prosthesis Design, Middle-aged, Dental Prosthesis Retention, Follow-up Studies, Jaw, edentulous, partially

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Abstract

The purpose of this prospective long-term study was to evaluate the incidence of the most common technical problems namely screw loosening, screw fracture, fracturing of veneering porcelain and framework fracture in implant-supported FPDs and assess the survival and success rate (event-free survival) after five years of function.

In 76 partially edentulous patients a total of 205 3i-implants (machined surface) were placed and restored with 112 implant-supported FPDs (46 single crowns, 81 splinted crowns, seven FPD bridges and 23 FPDs with cantilevers). The survival rate of FPDs supported by implants was 94.5% (CI-95: 90.1-98.8) after an average observation period of five years. The success rate (event-free survival) of the FPDs was 80.0 % (CI-95:87.3-72.7). After an observation period of five years the cumulative incidence of screw loosening was 6.7% (CI-95: 1.8-11.5), the cumulative incidence for screw fracture was 3.9 (CI-95: 0.1-7.7). Fracture of the veneering porcelain occurred in 5.7% (CI-95: 1.2-10.2) of all FPDs. Fracturing of the suprastructure framework was rare (1.0%; CI-95: 0-2.9). The overall complication incidence after five years was highest in the group of FPDs with cantilever, which showed the lowest success rate 68.6 % (CI-95: 50.0-87.3), followed by single crowns (77.6 %; CI-95: 53.3-100) and splinted crowns (86.1 %; CI-95: 59.5-100). No complication occurred in FPD bridges.

Conclusion: Fixed partial dentures supported by 3i-implants showed low technical complications rates, the most common being loosening of the abutment screw. Managing these complications can cause extra amount of chair-side time and patient dissatisfaction.
Introduction

The use of dental implants is an established procedure for the treatment of partially edentulous patients. A steadily increasing number of partially edentulous patients are being rehabilitated with oral implants (Jokstad et al. 2003). Patients and providers are becoming more and more aware of the undisputable functional and biological advantages of implant restorations compared to conventional fixed and removable prostheses. A study comparing economic parameters of single crowns on implants and three-unit partial dentures on teeth (FDP) even demonstrated a more favorable cost/effectiveness ratio for the implant reconstruction (Bragger et al. 2005b). As effectiveness is a key factor in the complex decision-making process and affects the patient’s preference for a particular treatment, there is need for reliable information on the success and survival of implant-supported suprastructures.

The longevity of prosthetic appliances on implants has been subject of numerous investigations (Jemt et al. 1990; Schmitt & Zarb 1993; Henry et al. 1995; Andersson et al. 1998; Lindh et al. 1998; Wyatt & Zarb 1998; Wennerberg & Jemt 1999; Naert et al. 2002a; Naert et al. 2002b; Andersson et al. 2003; Johansson & Eklfelt 2003; Preiskel et al. 2004). There is report of high survival rates after 10 years of follow-up (Gunne et al. 1999; Lekholm et al. 1999; Bragger et al. 2005a). Recently, a meta-analysis by Pjetursson et al. (2004) reported a cumulative survival rate for FPDs supported by implants of 95.4% (CI-95: 93.9-96.5) after 5 years and 86.7% (CI-95: 90.0–94.8) after 10 years of function.

In contrast to survival, which represents an easily defined end-point, success and failure of a FDP are criteria with wider range of interpretation. In older investigations only implant losses and thus, the losses of crowns were rated as failures (Jemt et al. 1990; Schmitt & Zarb 1993; Henry et al. 1995; Lindh et al. 1998). Technical complications, such as screw loosening, fractures and veneer fractures were ignored. An accepted way to describe the susceptibility to complications is to report the complication-free survival rate. With this way of definition of
success one has to keep in mind, that usually “free of complication” comprises both technical and biological problems. Until recently, only a few study reports differentiated among complications during the maintenance phase. Among these studies, variations in study design, size and composition of the investigated collective, reporting procedures, nonuniform definitions and applied statistical methods hamper a proper analysis and comparison (Berglundh et al. 2002). Therefore, data from existing studies should be interpreted with caution. Pjetursson et al. (2004) found only three studies (Ortorp et al. 1999; Wennerberg & Jemt 1999; Jemt et al. 2003), that met the inclusion criterias for the evaluation of long-term performance of the implant-supported prosthodontic devices.

The purpose of this prospective long-term study is to assess the performance of implant-supported FPDs by evaluating the incidence of technical complications, namely screw loosening, screw fracture, framework fracture and fracture of veneering material. Statistical analysis of the technical complications was performed on the basis of competing risk models, which take into consideration that loss of the suprastructure can also occur due to the biological complication of implant loss.

Material and methods

Seventy-six partially edentulous patients (47 women and 29 men) were rehabilitated with single crowns, splinted crowns and bridges with or without cantilevers on endosseous implants (Osseotite®, 3i-Implant Innovations) in the maxilla and mandible. The requirements of the Declaration of Helsinki (1989) for carrying out prospective clinical studies with human beings and those of the Ethics Commission of the University Hospital Freiburg were met. The average age was 45 years (18-76). Further prosthodontic treatment of the 205 implants involved 112 restorations: 46 porcelain fused to metal (PFM) single crowns, 81 PFM splinted crowns in the form of 36 units, seven PFM bridges and 23 PFM cantilever FPDs. Table 1 provides an overview of the number of implants and restorations placed. UCLA-abutments
were used as prosthodontic posts. For the fabrication of the framework Degudent U (Degussa Corp., Frankfurt, Germany), a gold-palladium-platinum bonding alloy (Au 77.3%, Pd 8.9%, Pt 9.8%) was utilized. Vita Omega (VITA Zahnfabrik H. Rauter Ltd, Bad Säckingen, Germany) was used as a veneering ceramic material. For fixation of single crowns and individually cast posts, gold-coated square head screws (3i-Implant Innovations) were used with a torque of 32 N/cm. Splinted suprastructures were secured with titanium hexagon head screws (3i-Implant Innovations) with a torque of 20 Ncm. Follow-up examinations were scheduled at the time of suprastructure placement, after three months and six months, as well as after one, two, three, four and five years. Four types of technical failures were accounted for: screw loosening, screw fractures, framework fractures and fracture of the veneering porcelain.

Statistical analysis
Success was defined as event-free survival. Survival and success probabilities were estimated with the Kaplan-Meier estimator. As some of the patients received more than one FPD, data is clustered. Therefore the variances of the Kaplan-Meier estimates are based on the adjusted formula proposed in Ying and Wei (1994). Further the incidence probabilities for technical failures were estimated with the Aalen-Johansen estimator (Aalen 1978) in separate competing risk models (see Andersen et al. 1993). In each competing risk model implant failure (loss) defines a competing endpoint for the course of the prosthetic device. For analyzing the incidences of screw loosening occurring screw fractures also terminated the course in time. If the respective cause of interest and the competing cause of failure did not occur until the end of the observation period, the observation for the prosthetic device was right censored at the time of the last follow-up examination.

All computations were carried out with the statistical software R (R Foundation for Statistical Computing, Vienna, Austria).
Results

The statistical analysis included 112 prosthetic devices (suprastructures) placed in 76 patients. The FPD-survival rate according to the Kaplan-Meier estimator was 94.5% (CI-95: 90.1-98.8) after a follow-up time of five years. 90 restorations remained free of any complication and were rated as successful. Table 2 shows the estimated success rate (complication-free survival according to the Kaplan-Meier estimator) of the restorations to remain free of any complication over a period up to 81 months. After five years of function it was 80.0% (CI-95: 87.3-72.7). Complications comprised four fractured screws, 14 loose screws in eight FPDs, ten fractured porcelain veneerings in six FPDs and one fractured framework (Table 3). Furthermore, in five cases the prosthetic device had to be removed from the patient’s mouth because of a biological complication. Table 4 provides the time-dependent values of the incidence probabilities with 95%-confidence limits for each of the technical complications estimated by the Aalen-Johannsen estimator. The incidence of screw loosening within a loading time of five years was 6.7% (CI-95: 1.8-11.5). As Table 3 shows, none of the total 14 screw loosenings occurred with splinted crowns or bridges. In six single crowns, screws loosened nine times and in two cantilever FPDs screws loosened five times. Four screws fractured, two in single crowns, one in a splinted reconstruction and one in cantilever FPD (Table 3). This resulted in a calculated incidence for screw fracture of 3.9% (CI-95: 0.1-7.7) within five years of function (Table 4). Fractures of the veneering porcelain were more common. Out of a total number of ten porcelain fractures eight occurred in two cantilever FPDs and another two in single crowns (Table 3). The probability of this technical complication was 5.7% (CI-95: 1.2-10.2) after five years (Table 4). The probability for a framework fracture was 1.0 % (CI-95: 0-2.9) during five years of function (Table 4). There was only one framework fracture of a pair of splinted crowns (Table 3). Besides showing the distribution of the failure events among the different types of restoration, Table 3 also gives
the success rates (incidence of event-free survival) after 5 years of function for the particular FPD types. The lowest event-free survival rate was found for the implant-borne cantilever-bridges (68.6 %; CI-95: 50.0-87.3), followed by single crowns (77.6 %; CI-95: 53.3-100) and splinted crowns (86.1 %, CI-95: 59.5-100). No complications were recorded for implant-supported bridges.

Discussion

In this study low incidences for the different technical complications were observed. With an FPD- survival rate of 94.5% (CI-95: 90.1.0-78.7) the result of this study is well in line with the results of other investigations (Wennerberg & Jemt 1999; Behneke et al. 2000; Naert et al. 2002a; Naert et al. 2002b; Jemt et al. 2003). Pjetursson et al. (2004) reported a cumulative survival rate of 95.0% (CI-95: 92.2-96.8) in their meta-analysis. In the present study loss of the FPDs mainly occurred due to implant loss within the first six months of function, indicating biological misintegration of the implant. The estimated rate of complication-free survival after five years of function was 80.0% (CI-95: 87.3-72.7). This success rate appears to be higher than others reported in literature, although a direct comparison is limited by nonuniform reporting procedures. Wennerberg and Jemt (1999) reported of 70 out of 133 FPDs (53%) in the partially edentulous maxilla that showed no complication during the five year follow-up time. In another study by Örtop et al. (1999) 28 patients out of 58 (48%) presented no complication within a follow-up period of five years. In their recent meta-analysis Pjetursson et al. (2004) calculated a summary estimate of the portion of success, including data from the before mentioned studies. It was 61.3% (CI-95: 55.3-66.8) after five years for implant borne FPDs. In other words, 38.7% of all patients had some complication in the first five years after insertion. Especially frequent fracturing of the veneering material, in particular acrylic resin posed problems (Ortorp et al. 1999; Wennerberg & Jemt 1999).
In this paper, the focus was set on estimating the incidence of the four most common complications using competing risk models. This statistical method takes into account that implant loss represents a competing endpoint to all technical complications, thus giving a closer simulation of reality. A restoration that has to be removed from the patient's mouth because the supporting implant is lost, can no longer suffer from technical complications (see Fig. 1). There are only scarce data on technical complication incidences in the literature and again, non-uniform study design and non-standardized statistical evaluation put limits to the direct comparison of the results. However, overlapping confidence intervals give a hint that the different rates are possibly not significantly different. In this investigation, the screw-abutment-connection seemed to be most susceptible to technical complications during the 81-month follow-up time. In 8 of the 112 inserted suprastructures, there were 14 screw loosenings and four post screw fractures. In the literature, a broad variation of documented probabilities of screw loosening can be found (Jemt et al. 1991; Naert et al. 1991; Jemt & Pettersson 1993; Haas et al. 1995; Johansson & Ekfeldt 2003). With an incidence of 6.7% (CI-95: 1.8-11.5) for screw loosening within five years, the result of the present study is well in line with the results of recent investigations. Pjetjursson et al. (2004) calculated a cumulative incidence of 5.8% (CI-95: 3.8-8.7) for screw loosening after 5 years follow-up in their meta-analysis. Brägger et al. (2001) reported that after four to five years screw loosening occurred in 6.8% of all implants. Recorded fracture rates of post screws vary between 0.5 and 8% (Albrektsson et al. 1988; Hemmings et al. 1994; Zarb & Schmitt 1996; Wyatt & Zarb 1998; Wennerberg & Jemt 1999; Bragger et al. 2001). Pjetjursson et al. (2004) calculated a cumulative five year complication rate of 1.5% (CI-95: 0.8-2.8) for screw fractures. In the present investigation the incidence of fracturing of post screws after five years was slightly higher (3.9%, CI-95: 0.1-7.7).

Among the possible causes of loosenings and fractures of the post screws mentioned in literature are fitting inaccuracies of the frameworks, an inadequate torque for tightening the
post screw, loss of preload of the screw, and occlusal overload (Adell et al. 1986; Zarb & Schmitt 1990; Naert et al. 1992). An insufficient framework can lead to a rotation of the post on the hexagon of the implant and thus result in screw loosening (Binon 1996). Scheller et al. (1993) showed that manually tightened screws loosened more frequently than screws tightened with a torque regulator. These findings were supported by an experimental investigation (Binon & McHugh 1996). After applying rotating alternating motion to the implant-post-connection loosenings were more likely to occur with screws tightened 20 Ncm than with screws tightened at 30 Ncm. In the present investigation, the torque for tightening the occlusal screws of the single crowns was 32 Ncm (gold-coated screws) and that of splinted crowns and fixed partial dentures was 20 Ncm (titanium square head screws). Abutment screw design is another crucial factor to joint stability. Application of the correct torque is translated into a preload, producing a clamping force and preventing a one-sided lift-off of the abutment (Schwarz 2000). Manufacturers have made numerous changes with regard to design and material to optimize the preload characteristics. Factors like poor framework adaptation and fatigue of the post screws reduce the preload of the screw and thus weaken the implant-abutment-junction (Binon 1996). As a final failure, metal fatigue of the screw results in a screw fracture. Especially the two-stage systems are vulnerable to abutment screw fracture as occlusal forces are magnified by the long lever to the implant interface (Schwarz 2000).

In the present study the cantilever bridges showed a higher susceptibility to complications, followed by single crowns and splinted crowns, whereas FPD bridges remained free of complications. Some evidence in literature is implicating that two-stage, external hexagon systems like the 3i-system, are prone to complications concerning the implant-abutment connection complex (Goodacre et al. 1999). There is report of a higher incidence of screw loosenings and fractures associated with this type of implant-abutment connection (Walton & MacEntee 1997). Screw complications were found in fully edentulous (Zarb & Schmitt 1990; Kallus & Bessing 1994), partially edentulous (Jemt et al. 1992; Lekholm et al. 1999) as well
as single crown applications (Jemt et al. 1990; Jemt et al. 1991; Jemt et al. 1992; Jemt & Pettersson 1993; Lekholm et al. 1999). It was observed that in external hexagon systems loosenings or fractures of post screws happen much more often in unsplinted crowns than in splinted restorations (Goodacre et al. 1999). In the present study screw loosenings contributed essentially to the higher incidence of complications in the single crown group. Supposing that the geometrical distribution of the implants under the suprastructure influences the load transfer on the abutment screw. (Nolte 1999), a "tripodization" was advocated for two-stage external hexagon screw implants (Jemt et al. 1992; Jemt & Lekholm 1993; Jemt & Pettersson 1993; Taylor et al. 1999), in order to counteract overload due to heavy off-axis occlusal forces. In complex, in-line, partially edentulous and single tooth applications the external hexagonal implant/abutment interface including its connecting screw are exposed to more rigorous loading (Rangert et al. 1997). Johansson and Ekfeldt (2003) also observed an obvious but not statistically significant prevalence of screw loosenings in FPDs with cantilevers in Branemark external hexagon implants. In the present study, screw loosenings in the cantilever bridge group occurred, but porcelain fractures prevailed.

Veneer fractures and spallings are also frequently described complications in therapy with implant-supported fixed partial dentures. Fractures of acrylic veneering are recorded with a frequency between 4-30% (Jemt et al. 1992; Naert et al. 1992; Gunne et al. 1994). By comparison, the fracture rate of 4-17% for ceramic veneered restorations is well below these values (Gunne et al. 1994; Andersson et al. 1995; Avivi-Arber & Zarb 1996; Bragger et al. 2001). In their meta-analysis Pjetursson et al. (2004) found a cumulative incidence of veneering fracture of 13.2% (CI-95: 8.3-20.6) after 5 years. Moreover the group of PFM FPDs showed a significantly higher (P=0.014) summary estimate of the survival portion after five years (96.6%; CI-05: 95.9-97.3%) compared to the survival of 90.4 (CI-95: 79.8-95.6) for the gold-acrylic FPDs, which was mainly attributed to the higher incidence of veneering complication. In the present investigation, nine ceramic veneerings fractured within the five-
year follow-up period (estimated incidence rate 5.7%; CI95: 1.2-10.2 after five years). With seven veneer fractures, the inserted cantilever FPDs contributed substantially to the total number of fractures. Brägger et al. (2001) investigated the frequency of biological and technical failures of fixed partial dentures on implants and on teeth, as well as of mixed tooth-implant-supported suprastructures. They indicated that with fixed cantilever partial dentures, technical problems like veneer fractures or framework fractures are more likely to occur than with restorations without extension. Another factor significantly associated with such technical complications was bruxism. Porcelain fracture was also more frequent in implant-borne restorations than in FPDs supported by natural teeth. These phenomena are explained by the lack of periodontal receptors around osseointegrated implants which diminishes the tactile sensitivity. Implants are exposed to an approximately eight to ten times higher loading during mastication process than natural dentition because of a lower proprioception (Hammerle et al. 1995). An interrelation between porcelain fractures and the long-term survival of the FPD was discovered by Brägger et. al. (2005a). The event of porcelain fracture increased the risk for the suprastructure to become a failure at 10 years compared to a suprastructure with no porcelain fracture However loosening of the prosthetic or abutment screw did not affect the chances for failure.

In the literature several studies report of framework fractures especially in full-arch implant-supported fixed restorations in the edentulous maxilla and mandible (Zarb & Schmitt 1990; Naert et al. 1992; Jemt & Lekholm 1993; Jemt et al. 2003). Framework fracture in FPDs is rare (Wyatt & Zarb 1998; Wennerberg & Jemt 1999; Gotfredsen & Karlsson 2001; Andersson et al. 2003). Pjetursson et al. (2004) reported a cumulative five year complication rate of 0.8 (CI-05: 0.4-1.8) for metal framework fractures. In the present investigation only one framework fracture in a splinted crown was observed. Causes might be poor dimensioning the metal frameworks, inappropriate framework design, use of an unsuitable alloy, FPD design
with excessive extensions and parafunction (Sones 1989; Zarb & Schmitt 1990; Stewart & Staab 1995; Bragger et al. 2001).

**Conclusion**

Technical complications occurred at low rates for FPDs supported by 3i-implants. However they always cause extra chair time for the patient. Therefore informing the patient about possible maintenance requirements should become a standard in prosthodontic rehabilitation on implants. In this study, particularly screw loosenings and screw fractures occurred during maintenance period. With regard to evidence from other investigations with external hex junction implant systems, our results implicate the need to improve the implant-abutment connection of the tested 3i-implants.

**Acknowledgements**

The authors thank 3i Implant Innovations, Inc. (West Palm Beach, FL, U.S.A.) for financial support.
Figures and Tables

Table 1: Number of implants and restorations placed

<table>
<thead>
<tr>
<th></th>
<th>single crowns</th>
<th>splinted crowns</th>
<th>bridges</th>
<th>cantilever bridges</th>
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<tr>
<td>number of restorations</td>
<td>46</td>
<td>36</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>number of implants</td>
<td>46</td>
<td>81</td>
<td>17</td>
<td>61</td>
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<tr>
<td>percentage of restorations (%)</td>
<td>41.1</td>
<td>32.2</td>
<td>6.2</td>
<td>20.5</td>
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<tr>
<td>percentage of implants (%)</td>
<td>21.5</td>
<td>37.9</td>
<td>7.9</td>
<td>28.5</td>
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Table 2: Kaplan-Meier estimator: number at risk, event free survival in %, (CI-95 in brackets)

<table>
<thead>
<tr>
<th>time in months</th>
<th>number of FPDs</th>
<th>number of patients</th>
<th>Event-free survival (CI-95)</th>
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<tr>
<td>0</td>
<td>112</td>
<td>76</td>
<td>100.0 (-- --)</td>
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<tr>
<td>12</td>
<td>101</td>
<td>71</td>
<td>88.4 (94.0 – 82.8)</td>
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<tr>
<td>24</td>
<td>97</td>
<td>68</td>
<td>85.7 (91.8 – 79.6)</td>
</tr>
<tr>
<td>36</td>
<td>91</td>
<td>66</td>
<td>82.1 (88.8 – 75.5)</td>
</tr>
<tr>
<td>48</td>
<td>81</td>
<td>57</td>
<td>81.1 (88.3 – 73.9)</td>
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<td>60</td>
<td>73</td>
<td>51</td>
<td>80.0 (87.3 – 72.7)</td>
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<td>80.0 (87.3 – 72.7)</td>
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<tr>
<td>81</td>
<td>3</td>
<td>2</td>
<td>80.0 (87.3 – 72.7)</td>
</tr>
</tbody>
</table>
Table 3: Incidence of complication in the four different types of FPDs. Note that some of the compromised restorations had multiple complications of one kind (number of occasions in brackets). There was one single crown and one cantilever bridge that suffered from two different complications, therefore the number given in “FDPs with event” is not equal to what results by summarizing the numbers in the columns of these two particular restorations.

<table>
<thead>
<tr>
<th></th>
<th>all FPDs (occasions)</th>
<th>splinted crown</th>
<th>bridge</th>
<th>single crown</th>
<th>cantilever bridge</th>
</tr>
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<tbody>
<tr>
<td>no complication</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>implant loss</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>screw loosening</td>
<td>8 (14)</td>
<td>0</td>
<td>0</td>
<td>6 (9)</td>
<td>2 (5)</td>
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<tr>
<td>screw fracture</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>framework fracture</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>porcelain fracture</td>
<td>6 (10)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>4 (8)</td>
</tr>
<tr>
<td>FDPs with event</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>incidence of event-free survival after 5 years (CI-95%)</td>
<td>86.1 % (59.5 – 100)</td>
<td>100% (--)</td>
<td>77.6 % (53.3 – 100)</td>
<td>68.6 % (50.0 - 87.3)</td>
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</tr>
</tbody>
</table>
Table 4: Aalen-Johannsen estimator: Cumulative incidence of events in % (CI-95 in brackets)

<table>
<thead>
<tr>
<th>time in months</th>
<th>screw loosening</th>
<th>screw fracture</th>
<th>framework fracture</th>
<th>porcelain fracture</th>
</tr>
</thead>
<tbody>
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<td>12</td>
<td>4.5 (0.6 – 8.4)</td>
<td>0.9 (0 – 2.8)</td>
<td>0.0</td>
<td>2.7 (0 – 5.7)</td>
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<tr>
<td>24</td>
<td>4.5 (0.6 – 8.4)</td>
<td>1.9 (0 – 4.5)</td>
<td>1.0 (0 – 2.9)</td>
<td>3.6 (0.1 – 7.2)</td>
</tr>
<tr>
<td>36</td>
<td>5.5 (1.2 – 9.8)</td>
<td>3.9 (0.1 – 7.7)</td>
<td>1.0 (0 – 2.9)</td>
<td>4.6 (0.6 – 8.5)</td>
</tr>
<tr>
<td>48</td>
<td>5.5 (1.2 – 9.8)</td>
<td>3.9 (0.1 – 7.7)</td>
<td>1.0 (0 – 2.9)</td>
<td>5.7 (1.2 – 10.2)</td>
</tr>
<tr>
<td>60</td>
<td>6.7 (1.8 – 11.5)</td>
<td>3.9 (0.1 – 7.7)</td>
<td>1.0 (0 – 2.9)</td>
<td>5.7 (1.2 – 10.2)</td>
</tr>
<tr>
<td>72</td>
<td>6.7 (1.8 – 11.5)</td>
<td>3.9 (0.1 – 7.7)</td>
<td>1.0 (0 – 2.9)</td>
<td>5.7 (1.2 – 10.2)</td>
</tr>
<tr>
<td>81</td>
<td>6.7 (1.8 – 11.5)</td>
<td>3.9 (0.1 – 7.7)</td>
<td>1.0 (0 – 2.9)</td>
<td>5.7 (1.2 – 10.2)</td>
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</table>
Figure 1: Box-arrow diagrams of competing risk models for analysing the incidences of technical complications in prosthetic devices.
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