# Prosthetic Complications with Dental Implants: From an Up-to-8-year Experience in Private Practice

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***Purpose:*** *Evaluation of prosthetic complication was performed on 236 patients treated with 528 implants in an 8-year private practice experience.* ***Materials and Methods:*** *The study sample included 55 overdentures (ODs) and 265 fixed partial dentures (FPDs). Among the latter, 231 FPDs were cemented and 34 were screw-retained. The type and frequency of prosthetic incidents were recorded, including adjustments and complications. Statistical analysis was performed using a chi-square test to identify risk factors associated with complications.* ***Results and Discussion:*** *Over this period, 1 abutment fractured and 2 became loose, leading to a cumulative implant component success rate of 99.2%. Patients with removable prostheses had more complications than those with fixed ones, 66.0% versus 11.5%; the difference was significant (*P < *.001). Posterior fixed prostheses had more complications than anterior ones, 11.0% versus 0%; however, the difference was not significant (*P = *.16). The complication rates for cemented and screw-retained prostheses did not differ significantly (10.4% versus 5.9%;* P = *.61). Prostheses with an extension cantilever had more complications, 29.4% versus 7.9%; the difference was significant (*P = *.01). In the OD group, the ball-retained prostheses had a significantly higher rate of complications than the bar-retained ones (77.5% versus 42.9%;* P = *.04). In the FPD group, complications were not recurrent; most occurred during the first 2 years, and the rate of complications did not increase with time. In the OD group, 1.3 incidents per prosthesis were recorded. Incidents were often recurrent, and the rate of complications did not decrease with time.* ***Conclusions:*** *Removable and fixed prostheses were associated with complications at different frequencies and of different types. In the removable group, adjustments and foreseeable complications were numerous, recurrent, and usually easy to manage. Bar-retained prostheses had fewer complications than ball-retained ones. In the fixed group, complications were limited in number and did not increase with time. Complications were restricted to the posterior region.* (Case Series) Int J Oral Maxillofac Implants 2006;21:919–928

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The biologic predictability of dental implants has been extensively documented for all types of indications, including the edentulous and the partially edentulous mandible and maxilla. Prosthetic complications associated with 2-stage Brånemark system[1–17] and 1-stage Straumann implants[18–25] have been assessed. However, the studies that have specifically addressed prosthetic complications with Straumann implants have been carried out in hospital clinics and university centers. Studies performed in these settings have often involved predefined patient selection[26–29] to obtain homogeneous populations of patients. Most implants, however, are placed in private practice, so such studies may have better survival and success rates than those seen in "real-world" environments. In private practice, the patient population includes all types of partially and completely edentulous patients with different health conditions, including patients with bruxing and clenching habits.

There is a paucity of information on prosthetic rehabilitations supported by 1-stage Straumann implants and the complications that may occur in a heterogeneous population treated in a private practice over a long period of time. In a previous long-term study,[30] the survival rate of Straumann implants was investigated in a nonspecialized private practice setting, with an emphasis on short implants; the cumulative success rate at 7 years was 99.4%. The prosthetic complications for the same group of patients are reported herein. The prostheses have now been in function for 3 to 8 years. The aim was to document the type, frequency, and incidence of complications and determine the factors that may predispose patients to prosthetic incidents.

## MATERIALS AND METHODS

### Patients and Prosthetic Restorations

Between January 1995 and December 2000, 236 patients (mean age, 57.5 years) were rehabilitated with 528 Straumann implants (Straumann, Basel, Switzerland) and, subsequently, prostheses. This group included 145 women (61.4%) and 91 men (38.6%). Wide inclusion criteria were used[30] to provide the benefits of implant therapy to the largest number of patients.

Patient age at implant placement ranged from 18 to 89 years. Patients younger than 50 years received 176 (33.3%) implants, patients between 50 and 70 years received 278 (52.6%) implants, and patients more than 70 years old received 74 (14.0%) implants. The patient pool included patients with bruxing habits (26 patients/72 implants [13.6%]), smoking habits (52 patients/106 implants [20.1%]) and medical conditions such as HIV, controlled diabetes, malignant pathologies outside the cervicofacial area, heart disease, and coagulation deficiency (31 patients/77 implants [14.6%]). Bruxers rehabilitated with fixed partial dentures (FPDs) in the posterior region received 1 implant per restoration unit. Flattened cusps were preferred for the restorations, without any further treatment, such as night guards.

Prior to the second half of 1999, titanium plasma-sprayed (TPS) implants were used. After June 1999, sandblasted, large-grit, acid-etched (SLA) implants were used exclusively. Thus, 50% (n = 264) of the implants had an SLA surface, and 50% (n = 264) had a TPS surface.

A total of 465 (88.1%) implants were standard implants (4.1 mm in diameter at the bone level and 4.8 mm at the implant collar), 16 (3.0%) were reduced-diameter implants (3.3 mm at the bone level and 4.8 mm in diameter at the implant collar), 13 (2.5%) were narrow-neck implants (3.3 mm in diameter at the bone level and at the implant collar), and 34 (6.4%) were wide-neck implants (4.8 mm in diameter at the bone level and 6.5 mm in diameter at the implant collar). Three hundred twenty-seven (61.9%) implants were placed in the mandible and 201 (38.1%) in the maxilla, respectively. Most implants supported restorations in the posterior region (premolar and molar areas): 42.8% of the implants were placed in the posterior mandible and 23.7% in the posterior maxilla. Three hundred five implants (58.6%) were ≤ 10 mm; details on the lengths have been given elsewhere.[30] Implants were a mean of 11.1 mm long in the removable-prosthesis group and 10.0 mm long in the fixed-prosthesis group.

Patients who were edentulous in the mandible and had a removable prosthesis in the maxilla were restored with an implant/tissue-supported mandibular overdenture (OD)[31] retained by 2 spherical attachments connected to 2 implants; in 1 patient, magnetic attachments were used. Implant-supported ODs[31] relying on 4 implants connected with bars were indicated if *(1)* the patient had maintained the opposing natural dentition, *(2)* the patient had a fixed prosthesis in the maxilla, *(3)* the patient was edentulous in the maxilla, or *(4)* the patient had immediately loaded implants in the mandible. When the pre-existing removable prosthesis was considered functionally, mechanically, and esthetically satisfactory, it was kept and relined accordingly, after placement of the retentive elements.

The preferred method for treating partial edentulism in the posterior area was to use 2 splinted implants; pontics were used when required. In the latter situation, placement of an implant at either end of the edentulous gap made surgical planning and prosthetic restoration easier (possible variation of pontic and crown mesio-distal dimension) and reduced costs (because 2 implants were used instead of 3). Extension cantilever units were used when the crest was too thin to receive an implant or when the available bone height was insufficient. The fixed restorations were porcelain fused to metal. Zinc phosphate (Zinc Cement Improved; SS White, Gloucester, UK) was used to cement the prostheses.

Assessment of the prosthetic restorations included the following information: position in the oral cavity, number of implants, number of prosthetic units, presence of extension and pontics, and fixation mode (ie, screw-retained or cemented). Prosthesis distribution was as follows: There were 156 single crowns in the posterior area and 15 in the anterior; 63 FPDs in the mandible and 30 in the maxilla; and 1 fixed full-arch prosthesis and 55 ODs, 8 in the maxilla

and 47 in the mandible. Two FPDs with 1 implant each were implant-tooth supported. The mean number of implants per FPD was 2.27 in the mandible and 2.07 in the maxilla. Details related to FPDs are given in Table 1. The majority of the splinted FPDs (90.3%) were supported by 2 implants, with 25.8% consisting of 2 crowns supported by 2 implants with no cantilevers or pontics. The other FPDs supported by 2 implants had 1 (48.4%) or 2 (2.1%) pontic units, an extension (cantilever) unit (11.8%), or both (2.1%). In the fixed prosthesis group, cementation was performed on 85.4% of the implants; screw retention was indicated when the crown-implant junction was located submucosally for esthetic reasons.

**Table 1 Distribution of the FPDs**

| Prosthesis type | No. |
|---|---|
| Supported by 2 implants | |
| 2 units | 24 |
| 2 units + 1 cantilever | 11 |
| 2 units + 1 pontic | 45 |
| 2 units + 2 pontics | 2 |
| 2 units + 1 cantilever + 1 pontic | 2 |
| Supported by 3 implants | |
| 3 units | 2 |
| 3 units + 1 cantilever | 4 |
| 3 units + 1 pontic | 1 |
| 3 units + 2 pontics | 1 |
| Supported by 4 implants | |
| 4 units + 1 cantilever + 1 pontic | 1 |

### Prosthetic Complications

All prosthetic events, adjustments, and complications were recorded. In the removable prosthesis group, the recorded events included adjustments and repairs. Repairs were categorized either as foreseeable or unforeseeable. Adjustments included reactivation of the female part of the spherical attachment and of the clip. Foreseeable repairs consisted of change of the female part of the spherical attachment, change of the clip, and relining. Unforeseeable repairs included mechanical retention problems (antero-posterior rotation of the prosthesis), repair and replacement of the OD, and complications of the opposing complete denture.

In the fixed restoration group, complications included prosthesis debonding, abutment loosening, screw loosening, abutment fracture, and fracture of the porcelain veneer. Fracture of the porcelain veneer was categorized as either minor or major. A fracture was considered major if it affected esthetics, caused the metallic framework to be visible, resulted in a missing interproximal contact point, or caused the patient to complain of tongue or mastication-related discomfort. All major fractures resulted in prosthesis remake. All other fractures were considered minor and did not lead to prosthesis remake.

### Prosthetic Parameters

To determine the factors that may predispose prostheses to complications, the following occlusal and functional parameters were assessed: prosthesis type (fixed or removable), fixation mode (cemented or screw-retained), presence of an extension cantilever, location in the oral cavity, and presence of bruxing habits.

### Statistical Analysis

Frequency and time of occurrence were recorded for each complication type. An 8-year life table analysis with the cumulative percentage of incident-free prostheses was calculated. The percentage of incident-free prostheses at 1, 2, and 3 years was also determined. The chi-square test was used to identify the risk factors associated with the complications. The threshold value for significance was set at 5%.

## RESULTS

Three biologic failures in 2 patients were recorded: 1 early failure (0.2%) before loading and 2 late failures (0.4%) after 1 and 4 months of loading; the cumulative survival rate was 99.4%. This has remained unchanged since the authors' previous report[30] on these implants. All failed implants were in the mandible; no failures occurred in the maxilla. Twenty-four prostheses (7.5%)—4 ODs, 4 FPDs, and 16 single crowns—were lost to follow-up. The respective reasons have been listed previously.[30]

### Removable Prostheses Group

This group consisted of 55 prostheses and 145 implants; 41 of the prostheses were ball-anchored and 14 were bar-retained. Half of the bar-retained prostheses were immediately loaded. The pre-existing prostheses were kept for 60% of the patients (33 patients/80 implants).

In the ball-retained group, 28 of 41 prostheses (68.3%) were reused, while in the bar-retained group 6 of 14 (42.9%) were reused. The number and the type of interventions are listed in Table 2. Several prostheses had more than 1 complication. Adjustments were divided into reactivation of either the female attachment (10 implants/5 prostheses) or the clip (12 implants/4 prostheses). Foreseeable complications were replacement of the female attachment for 19 prostheses, clip replacement for 3 prostheses, and prosthesis relining for 21. Unforeseeable complications

**Table 2 Details of the Adjustments for the Removable and Fixed Prostheses Groups**

| Event | No. of implants | No. of patients | No. of prostheses |
|---|---|---|---|
| Removable prostheses | | | |
| Adjustments | | | |
| Reactivation of attachment | 10 | 5 | 5 |
| Reactivation of clip | 12 | 4 | 4 |
| Complications | | | |
| Foreseeable | | | |
| Change of attachment | 33 | 19 | 19 |
| Change of clip | 12 | 3 | 3 |
| Need for overdenture relining | 48 | 21 | 21 |
| Unforeseeable | | | |
| Lack of stability (rotation) | 8 | 4 | 4 |
| Magnet wear | 2 | 1 | 1 |
| Fracture of extension bar | 4 | 1 | 1 |
| Tooth fracture on prosthesis | 3 | 2 | 2 |
| Prosthesis fracture and repair | 12 | 5 | 5 |
| Prosthesis fracture and remake | 2 | 1 | 1 |
| Opposing prosthesis fracture | | | 2 |
| Fixed prostheses | | | |
| Complications | | | |
| Abutment loosening | 2 | 2 | 2 |
| Abutment fracture | 1 | 1 | 1 |
| Prosthesis screw loosening | – | – | – |
| Prosthesis debonding | 4 | 3 | 3 |
| Ceramic veneer fracture | | | |
| Major | 10 | 5 | 6 |
| Minor | 15 | 10 | 12 |
| Prosthesis remake | 13 | 8 | 9 |

were lack of prosthesis stability around the horizontal axis of 4 prostheses, magnet wear for 1, and tooth fracture on the prosthesis for 2; 5 prostheses fractured and needed repair, and 1 was remade. The fixed components retaining the prostheses were also evaluated. No complications occurred to the spherical anchors. One extension bar fractured without further complications with the underlying bar components. All other complications involved the removable parts of the prostheses and not the fixed retention components.

The mean number of events per prosthesis under follow-up was 1.29 (range, 1 to 5). The percentage of prostheses free of any incident was 34.0%, and 2.0% of the prostheses were remade. After 1 year of loading, 76.4% of the prostheses were free of incidents; after 2 years of loading, 64.7%; after 3 years, 44.0%. The cumulative percentage of incident-free prostheses was 9.9% (Table 3a). In the group that required action, 48.6% underwent a single event, 27.0% underwent 2 events, 13.5% had 3 events, and 10.8% underwent 5 events. For 33% of prostheses experiencing complications, the first incident occurred during the first year of loading; for 22.2%, it occurred during the second year; for 27.9%, it happened during the third year; and for 16.6%, it occurred after the third year. When only the unforeseeable events were considered instead of all events, the cumulative percentage of incident-free prostheses was 76.4% (Table 3b).

Similarly, when the ball- and bar-retained prostheses were separately analyzed, the number of events per prosthesis was 1.5 for the ball-retained restorations and 0.9 for those that were bar-retained. Only 24.4% of the ball-retained prostheses were free of incidents versus 57.1% for the bar-retained; the difference was significant ($P = .04$) (Table 4). In the ball-retained group, 72.5% of the prostheses were free of incident after 1 year of loading; after 2 and 3 years of loading, these values were 52.5% and 37.5%, respectively. Half of the ball-retained prostheses underwent 3 events, the highest number of recurrent events. In the bar-retained group, 92.9% of the prostheses were free of incidents after 1 and 2 years of function and 71.4% after 3 years. The percentages of prostheses subjected to 1, 2, 3, and 5 recurrent events were 54.8, 25.8%, 6.4%, and 12.9%, respectively.

Of the bruxers that received an OD (8 patients/22 implants), 75.0% had an incident. In the nonbruxing group, 62.8% of the patients had such an incident. A bruxing habit could not be identified as a parameter associated with incidents ($P = .86$), as shown in Table 4.

**Table 3a Cumulative Percentage of Event-free Prosthetic Function for the Removable Prostheses Group Over 8 Years (All Events Considered)**

| Time interval (y) | Prostheses at risk | Dropouts | No. of prostheses with event | Event-free prostheses for interval (%) | Cumulative percentage of event-free prostheses |
|---|---|---|---|---|---|
| 0 to 1 | 55 | 3 | 13 | 75.0 | 75.0 |
| 1 to 2 | 51 | 0 | 9 | 82.4 | 61.8 |
| 2 to 3 | 51 | 1 | 13 | 74.0 | 45.7 |
| 3 to 4 | 48 | 0 | 8 | 83.3 | 38.1 |
| 4 to 5 | 25 | 0 | 5 | 80.0 | 30.5 |
| 5 to 6 | 15 | 0 | 5 | 66.7 | 20.3 |
| 6 to 7 | 12 | 0 | 2 | 83.3 | 16.9 |
| 7 to 8 | 12 | 0 | 5 | 58.3 | 9.9 |

**Table 3b Cumulative Percentage of Event-Free Prosthetic Function for the Removable Prostheses Group Over 8 Years, Considering Only the Unforeseeable Events**

| Time interval (y) | Prostheses at risk | Dropouts | No. of prostheses with unforseeable event | Unforeseeable event-free prostheses for interval (%) | Cumulative unforeseeable percentage of event-free prostheses |
|---|---|---|---|---|---|
| 0 to 1 | 55 | 3 | 8 | 84.6 | 84.6 |
| 1 to 2 | 51 | 0 | 1 | 98.0 | 83.0 |
| 2 to 3 | 51 | 1 | 3 | 94.0 | 78.0 |
| 3 to 4 | 48 | 0 | 1 | 97.9 | 76.4 |
| 4 to 5 | 25 | 0 | 0 | 100 | 76.4 |
| 5 to 6 | 15 | 0 | 0 | 100 | 76.4 |
| 6 to 7 | 12 | 0 | 0 | 100 | 76.4 |
| 7 to 8 | 12 | 0 | 0 | 100 | 76.4 |

### Fixed Prostheses Group

The fixed prostheses group consisted of 265 prostheses and 383 implants (72.5% of all implants). Of the 265 prostheses, 87.2% were cemented, and the majority (86.4%) were placed in the posterior region. In the anterior region, 44.4% of the prostheses were cemented, and the majority of the prostheses (55.6%) were screw-retained. In the posterior region, the majority of fixed prostheses (93.9%) were cemented.

Complications that occurred in the fixed group are listed in Table 2. One abutment fractured after 42 months of loading; 2 abutments became loose, 1 after 8 months and the other after 10 months. All supported single molar crowns. These abutments and crowns had to be replaced with new ones. Prosthesis debonding was recorded for 4 implants in 3 patients. Two of the patients each had a single molar in the mandible; debonding occurred after 9 months in 1 case and after 41 months in the other. The third patient had a 3-unit prosthesis in the maxilla supported by 2 implants with a mesial extension cantilever; that patient experienced debonding after 20

**Table 4 Evaluation of Risk Factors Over the 8-year Follow-up Period**

| | Complication | | | |
|---|---|---|---|---|
| | No | Yes | | |
| Unit/factor | n | n | % | *P** |
| Patient | | | | |
| Removable prosthesis | 17 | 33 | 66.0 | < .001* |
| Fixed prosthesis | 146 | 19 | 11.5 | |
| Fixed prosthesis | | | | |
| Anterior rehabilitations | 25 | 0 | 0 | .16 |
| Posterior rehabilitations | 194 | 24 | 11.0 | |
| Cement-retained | 189 | 22 | 10.4 | .61 |
| Screw-retained | 32 | 2 | 5.9 | |
| With extension | 12 | 5 | 29.4 | .01* |
| Without extension | 210 | 18 | 7.9 | |
| Removable prosthesis | | | | |
| Ball-retained | 9 | 31 | 77.5 | .04* |
| Bar-retained | 8 | 6 | 42.9 | |
| Patient | | | | |
| Bruxer with FPD | 15 | 3 | 16.7 | .74 |
| Nonbruxer with FPD | 131 | 16 | 10.9 | |
| Bruxer with OD | 2 | 6 | 75.0 | .86 |
| Nonbruxer with OD | 15 | 27 | 62.8 | |

*Significant ($P < .05$; chi-square test).

**Table 5 Cumulative Percentage of Complication-free Prosthetic Function for the Fixed Prostheses Group**

| Time interval (y) | Prostheses at risk | Dropouts | No. of prostheses with complications | Complication-free prostheses for interval (%) | Cumulative percentage of complication-free prostheses |
|---|---|---|---|---|---|
| 0 to 1 | 265 | 16 | 11 | 95.6 | 95.6 |
| 1 to 2 | 249 | 1 | 4 | 98.4 | 94.1 |
| 2 to 3 | 248 | 1 | 2 | 99.1 | 93.3 |
| 3 to 4 | 215 | 0 | 4 | 98.1 | 91.6 |
| 4 to 5 | 119 | 2 | 1 | 99.2 | 90.8 |
| 5 to 6 | 72 | 0 | 2 | 97.2 | 88.3 |
| 6 to 7 | 41 | 0 | 0 | 100 | 88.3 |
| 7 to 8 | 27 | 0 | 0 | 100 | 88.3 |

months. All abutments were 4 mm in height. Two of them were occlusally shortened to create the necessary room for the prosthesis, and in 1 case, 4 mm was considered too short with regard to the crown height. No screw loosening was recorded, and no complications were recorded in the anterior region.

Porcelain fracture occurred with 18 prostheses (15 patients/25 implants), 2 screw-retained and 16 cemented. Minor veneer fractures occurred to 12 prostheses and 10 patients (4 men and 6 women), after 4 to 68 months of function (mean, 22 months). This occurred at 8 implants in the maxilla (4 molars and 4 premolars) and 7 in the mandible (1 premolar and 6 molars); all were observed in the posterior region. Major porcelain fractures occurred to 5 prostheses in 5 patients, 3 men and 2 women, after 5, 11, 18, 31, and 40 months.

Nine prostheses involving 13 implants were replaced for 2 men and 6 women; the causes were abutment fracture (1 implant/1 prosthesis/1 patient), abutment loosening (2 implants/2 prostheses/2 patients), and veneer fracture (10 implants/6 prostheses/5 patients). Prosthetic complications occurred in 8.5% of single molar and 7.1% of single posterior (premolar and molar) restorations.

The cumulative percentage of complication-free prosthetic components at 8 years was 99.2%; 90.2% of the prostheses were free of incidents, and 4.1% of the posterior prostheses were replaced. The percentages of complication-free prostheses after 1, 2, and 3 years of loading were 95.6%, 93.9%, and 92.1%, respectively. The cumulative percentage of complication-free prostheses was 88.3%, as shown in Table 5.

FPDs in the posterior region were more prone to complications than those in the anterior region (11.0% versus 0%); however, the difference was not statistically significant ($P = .16$). The complication rate was higher for the cemented prostheses group than for screw-retained ones (10.4% versus 5.9%); again, the difference was not statistically significant ($P = .61$). Prostheses with extension cantilever units underwent more complications than prostheses without extensions (29.4% versus 7.9%), as shown in Table 4; the difference was statistically significant ($P = .01$). Presence of an extension could be identified as a complication risk factor. Most complications (85.7%) occurred in nonbruxing patients. Within the group of bruxers who received a fixed prosthesis (18 patients/49 implants), 83.3% were free of complications. Therefore, a bruxing habit could not be identified as a complication risk factor ($P = .74$), as shown in Table 4.

## DISCUSSION

In this patient population, derived from a private practice, all prostheses were in function for at least 3 years. During an implant use period of up to 8 years, complications with prosthetic components (abutments, occlusal screws) were a rather rare event. One abutment fractured and 2 became loose, leading to a cumulative prosthetic component success rate of 99.2%. The posterior area, and more specifically, single crowns in the molar area, were susceptible to complications, as noted previously.[23] To avoid the risk of abutment loosening, adjacent single crowns were splinted into 2- or 3-unit FPDs; such splinted crowns accounted for 28.0% of all FPDs. In addition, splinting also eases prosthesis removal when needed after a major veneer fracture. Splinting crowns also allows the crown-removal device to exploit the presence of the bridging framework.

The number and frequency of events were different for the fixed and the removable groups; the removable prostheses group sustained more incidents (66.0%

versus 11.5%), as shown in Table 4; this finding is in accordance with other studies.[5,25,33,34] When unforeseeable events alone were considered, 74.0% of the removable prostheses were incident-free after 8 years (Table 6); the number of incidents per prosthesis was reduced to 0.27; and there were no recurrent events. For unforseeable events, the difference between the fixed and the removable groups was no more salient than it was when all incidents were accounted for. This demonstrates that adjustments and foreseeable events were mostly contributing to the number of prosthetic incidents.

Within the removable prosthesis group, the bar-retained group had fewer complications than the ball-retained group (42.9% versus 77.5%). At 3 years, the incident-free prosthesis rate was 71.4 % for the bar-retained group versus 37.5% for the ball-retained. The occurrence of adjustments and both foreseeable and unforeseeable complications were expected events associated with the treatment; after prosthesis delivery, patients treated with a removable prosthesis are expected to require additional attention and follow-up. Thus, the costs associated with the maintenance of an implant–supported overdenture should be incorporated in the overall treatment costs during treatment planning.

In a 36-month survey of loaded Straumann implants, Duncan and associates[25] reported that 35.7% of screw-retained prostheses had a complication (loose occlusal screws, porcelain veneer fracture) while the cement-retained group was complication-free. Similarly, Levine and coworkers,[24] in a survey of single crowns placed on Straumann implants, recorded more complications for screw-retained prostheses than for cemented ones (19.7% versus 1.8%). No veneer fracture was recorded for the screw-retained implants.

In the present study, in which all prostheses were in function for at least 3 years, the cemented prostheses were subject to more complications (10.4% versus 5.9%). However, the difference in complication rates between cemented and screw-retained prostheses was not significant. In addition, no screw loosening was recorded. The lack of screw loosening might be related to the fact that most of the screw-retained prostheses (72.3%) were located in the anterior region, where the mechanical environment is less demanding. Indeed, for screw-retained single crowns placed mostly (92.1%) in the posterior area, Mericske-Stern and associates[23] reported a screw loosening rate of 18.6% during the first year.

Some authors[25] have suggested that prosthetic complications are likely to arise after 3 years of loading, as the time in function increases. For FPDs, however, a 5-year survey by Behneke and associates[19] does not support this conclusion; neither does the present study. In several studies, most complications have been observed in the first year postloading than in subsequent years.[16,19,21] Because the number of events did not seem to increase with time over an 8-year period, and because of the low occurrence of biologic and prosthetic events, the use of screw-retained prostheses to assure retrievability and thus facilitate reintervention may be of limited relevance. This is strengthened by the fact that screw-retained restorations in the posterior region are expected to have a higher complication rate than cemented ones, especially during the first year of loading.[16,23,25] Cementation is usually more cost effective and renders implant therapy more affordable to a larger number of patients. In the authors' practice, screw retention was proposed only in the esthetic zone, where the prosthesis-implant interface was located submucosally, to avoid problems associated with cement diffusion in the soft tissues.

The complication rate for single crowns placed in the posterior area was 7.3%. Other authors have reported complication rates in the 10% to 20% range.[13,17,23] However, most of the complications in these studies have been related to occlusal screw loosening, which is without significance for prosthesis integrity. In the present report, porcelain fractures occurred in 7.3% of the prostheses. Some studies have reported no veneer fracture after 3 or more years of loading[19,25] or found this complication to be a rare event[23] (0.9%, 1/107). On the other hand, higher fracture rates have also been reported; 15.3% (55/359) by Wennerberg and colleagues,[16] 11.6% (5/43) by Vermylen and associates,[17] and 10.6% (11/103) by Brägger and colleagues.[21]

Brägger and colleagues[21] associated veneer fracture with bruxism; however, such a correlation was

**Table 6 Comparison Between the Fixed and Removable Prostheses Groups When Only Unforeseeable Events Were Considered for the Removable Prostheses Group**

| | Fixed prostheses | ODs* |
|---|---|---|
| Percentage of incident-free prostheses | | |
| Cumulative | 88.3 | 76.4 |
| At 1 year | 95.6 | 84.6 |
| At 2 years | 93.9 | 82.4 |
| At 3 years | 92.1 | 75.0 |
| More than 8 years | 90.2 | 74.0 |
| No. of incidents per prosthesis | 0.1 | 0.3 |
| Percentage of prostheses remade | 3.4 | 2.0 |

*Unforeseeable events only.

**Table 7a Cumulative Percentage of Complication-free Prosthetic Rehabilitation for the Removable Prostheses Group Over 8 Years—All Biologic* and Prosthetic Events Taken into Consideration**

| Time interval (y) | Prostheses at risk | Dropouts | No. of prostheses with event (biologic or prosthetic) | Event-free prostheses for interval (biologic and prosthetic) (%) | Cumulative event-free prostheses rate (biologic and prosthetic) (%) |
|---|---|---|---|---|---|
| 0 to 1 | 55 | 3 | 16 | 69.2 | 69.2 |
| 1 to 2 | 51 | 0 | 10 | 80.4 | 55.7 |
| 2 to 3 | 51 | 1 | 13 | 74.0 | 41.2 |
| 3 to 4 | 48 | 0 | 8 | 83.3 | 34.3 |
| 4 to 5 | 25 | 0 | 5 | 80.0 | 27.4 |
| 5 to 6 | 15 | 0 | 5 | 66.7 | 18.3 |
| 6 to 7 | 12 | 0 | 2 | 83.3 | 15.3 |
| 7 to 8 | 12 | 0 | 5 | 58.3 | 8.9 |

*Biologic data are from Nedir and associates.[30] Events taken into consideration were failure and peri-implantitis.

**Table 7b Cumulative Percentage of Complication-free Prosthetic Restorations for the Fixed Prostheses Group Over 8 Years—All Biologic* and Prosthetic Events Taken Into Consideration**

| Time interval (y) | Prostheses at risk | Dropouts | No. of prostheses with complications | Complication-free prostheses for interval (biologic and prosthetic) (%) | Cumulative complication-free prostheses rate (biologic and prosthetic) (%) |
|---|---|---|---|---|---|
| 0 to 1 | 265 | 16 | 14 | 94.4 | 94.4 |
| 1 to 2 | 249 | 0 | 4 | 98.4 | 92.9 |
| 2 to 3 | 248 | 1 | 3 | 98.8 | 91.7 |
| 3 to 4 | 215 | 0 | 4 | 98.1 | 90.0 |
| 4 to 5 | 119 | 2 | 2 | 98.3 | 88.4 |
| 5 to 6 | 72 | 0 | 1 | 98.6 | 87.2 |
| 6 to 7 | 41 | 0 | 0 | 100 | 87.2 |
| 7 to 8 | 27 | 0 | 0 | 100 | 87.2 |

*Biologic data are from Nedir and associates.[30] Events taken into consideration were failure and peri-implantitis.

not confirmed by the present study. It is possible that cuspid flattening and adequate laboratory technique helped to reduce the occurrence of porcelain fractures. Furthermore, in the present study, 1 implant per restoration unit was planned for bruxers.

In the removable prostheses group, wear of the retaining components (40% of the prostheses), prosthesis relining (38.2% of the prostheses), and reactivation of the attachment (16.4% of the prostheses) were the most frequent prosthetic incidents. Intuitively, activation and wear of the attachment system might be regarded as inevitable events. However, the present data invalidate this assumption, since 83.6% of the prostheses did not require attachment activation, and 60% did not have their attachment replaced. The fact that the majority of prostheses were not affected by these complications suggests that attachment weakening or wear is not inevitable but is probably related to other unidentified variables that remain to be determined under finer scrutiny.

The prosthetic approach in the present patient population was to change the female parts for both supporting implants even when only one showed signs of wear. In the group of ball-retained overdentures, the number of adjustments and complications were maintained at a consistent level over time.

Prosthesis fracture occurred in 5 patients (10.0%). Metal-reinforced prostheses probably would have decreased the occurrence of this complication but would also have increased the treatment cost.

The biologic incidents, failures and peri-implantitis, involving the same implants were previously followed over a 7-year period.[30] It was found that in addition to 1 early and 2 late failures, 6 implants were subjected to peri-implantitis (2 implants supporting ODs and 4 supporting FPDs). Subsequent to this report, the implants have not undergone any additional biologic incidents. Therefore, the combination of these 2 reports could provide interesting information on all incidents, biologic and prosthetic, that can

occur to an implant-supported rehabilitation. Tables 7a and 7b relate, for the removable and fixed prostheses respectively, the cumulative incident-free (biologic and prosthetic) implant treatment rate for the prosthetic rehabilitation as a unit. Comparison with Tables 3a and 3b shows that the figures are very close and suggests that the vast majority of the incidents contributing to the rate of prosthetic complications were prosthetically related rather than biologic. In a literature review, Goodacre and associates[32,33] reported that a greater number of clinical complications was associated with implant-supported prostheses when compared to tooth-supported prostheses. The present study supports this conclusion with respect to removable prostheses but not with respect to fixed implant-supported prostheses. The present data suggest that fixed implant-supported restorations are linked with complications of any type less often than tooth-supported restorations.

## CONCLUSION

Based on the data analyzed in this study, removable and fixed prostheses displayed different types and frequencies of complications. In the removable group, adjustments and foreseeable complications were numerous, recurrent, and usually easy to manage. Their number did not decrease with time, and the cumulative percentage of incident-free prostheses, including foreseeable and unforeseeable events, was 10.2% after 8 years. Bar-retained prostheses had fewer complications than ball-retained ones. In the fixed group, complications were limited in number and did not increase with time. Complications were generally restricted to the posterior region. The cumulative percentage of complication-free fixed prostheses was 88.5% after 8 years. Finally, these private practice results compare well with the results obtained at university centers.

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