Clinical complications with implants and implant prostheses

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The purpose of this article is to identify the types of complications that have been reported in conjunction with endosseous root form implants and associated implant prostheses. A Medline and an extensive hand search were performed on English-language publications beginning in 1981. The searches focused on publications that contained clinical data regarding success/failure/complications. The complications were divided into the following 6 categories: surgical, implant loss, bone loss, peri-implant soft tissue, mechanical, and esthetic/phonetic. The raw data were combined from multiple studies and means calculated to identify trends noted in the incidences of complications. The most common implant complications (those with a greater than a 15% incidence) were loosening of the overdenture retentive mechanism (33%), implant loss in irradiated maxillae (25%), hemorrhage-related complications (24%), resin veneer fracture with fixed partial dentures (22%), implant loss with maxillary overdentures (21%), overdentures needing to be relined (19%), implant loss in type IV bone (16%), and overdenture clip/attachment fracture (16%). It was not possible to calculate an overall complications incidence for implant prostheses because there were not multiple clinical studies that simultaneously evaluated all or most of the categories of complications. Although the implant data had to be obtained from different studies, they do indicate a trend toward a greater incidence of complications with implant prostheses than single crowns, fixed partial dentures, all-ceramic crowns, resin-bonded prostheses, and posts and cores. (J Prosthet Dent 2003;90:121-32.)

In a review of the fixed prosthodontic literature,[1] the incidence of complications and the most common complications were identified in conjunction with single crowns (all-metal, metal ceramic, and resin-veneered metal), fixed partial dentures (all-metal, metal ceramic, and resin-veneered metal), all-ceramic crowns, resin-bonded prostheses, and posts and cores. Conventional fixed partial dentures (27%) and resin-bonded fixed partial dentures (26%) had comparable clinical complications incidences. Conventional single crowns (11%) and posts and cores (10%) were also determined to have comparable complications incidences that were lower than the fixed partial dentures. All-ceramic crowns had the lowest incidence of complications (8%).

One of the purposes of this article is to provide data regarding the types of complications that have been reported in conjunction with endosseous root form implants and associated crowns/prostheses by reviewing the literature from 1981 through 2001. Another purpose is to identify the most common implant complications. A third purpose is to compare the complications incidences associated with implant prostheses with those encountered with fixed restorations/prostheses (single crowns, fixed partial dentures, all-ceramic crowns, resin-bonded prostheses, and posts and cores).[1]

LITERATURE REVIEW

A Medline search of English-language publications was initiated related to success, failure, complications, and clinical studies associated with endosseous root form implants and implant prostheses. Reviewing the reference lists of articles identified through the Medline search revealed additional publications as did extensive hand searching. The literature search covered the years 1981 to 2001. The search focused on publications that contained clinical data regarding success, failure, and complications.[2-218] To be included in the calculated mean data of this report, publications must have presented clinical data that identified the number of implants/prostheses being evaluated, how long they had been in place, and how many were affected by complications. Publications were grouped according to each category of complication (surgical, implant loss, bone loss, peri-implant soft tissue, mechanical, and esthetic/phonetic). The types of complications in each category were identified. The raw data of a particular complication (from all the studies that evaluated that complication) were combined and a mean complications incidence calculated. The mean values of each complication were compared for the purpose of establishing a trend for ranking the complications.

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Table I. Implant surgical complications

	Number of patients studied/affected	Mean incidence
Hemorrhage-related complications	379/92	24%
Neurosensory disturbance	2142/151	7%
Mandibular fracture	1523/4	0.3%

Table II. Implant loss

Arch/prosthesis	Number of implants studied/lost	Mean incidence
Maxillary overdentures	1103/206	19%
Maxillary fixed complete denture	4559/443	10%
Maxillary fixed partial dentures	3297/213	6%
Mandibular fixed partial dentures	2567/157	6%
Mandibular overdentures	5683/242	4%
Mandibular fixed complete denture	9991/255	3%
Maxillary and mandibular single crowns	1512/42	3%

For a specific complication to be included in this study, 3 or more studies must have reported data related to the incidence of that particular complication. Certain complications were reported in a large number of studies whereas others may have only been presented in 3 articles. Therefore the mean percentages present in this article suggest trends rather than absolute incidence values. The trends should be interpreted cautiously because of the large variation in numbers of implants/prostheses evaluated and the lack of statistical analysis.

Results

An extensive number of studies provide data about complications with root form implants and associated prostheses. However, there are no studies that simultaneously evaluated all of the reported complications. With the clinical complications reported in fixed prosthodontics[1] (single crowns, fixed partial dentures, all-ceramic crowns, resin-bonded prostheses, and posts and cores), there were multiple studies that provided data about all or most of the complications reported in conjunction with each type of restoration/prosthesis. Therefore, with implant prostheses it was not possible to calculate an overall complications incidence. The implant complications data are reported by category and have been obtained by combining data from different studies.

The following 6 major categories of complications have been reported: surgical complications, implant loss, bone loss, peri-implant soft tissue complications, mechanical complications, and esthetic/phonetic complications.

Surgical complications

Many surgical complications have been identified in the implant literature, including hemorrhage-related complications,[2-4] neurosensory disturbance,[2-15] adjacent tooth devitalization/damage,[16-20] mandibular fractures,[2,11,21-27] life-threatening hemorrhage,[28-32] air emboli,[33] implant displacement into the mandibular canal,[34] screwdriver aspiration,[35] descending necrotizing mediastinitis,[36] intraocular hemorrhage,[37] and singultus (hiccups).[38] Only 3 of these complications (Table I) have been studied in a sufficient number of data-based publications to be included in this article (neurosensory disturbance, hemorrhage-related complications, and mandibular fracture). The other complications were presented in less than 3 data-based publications or discussed in the form of patient treatment reports with no incidence data available.

Three studies[2-4] were located that provided incidence data regarding hemorrhage-related complications (Table I). Ninety-two of 379 patients were identified as being affected by these factors (hematomas, ecchymosis), for a mean incidence of 24% and a range from 12% to 30%.

Eleven studies[2,3,8-10,11-15,201] present data related to the incidence of neurosensory disturbance after surgery (Table I). Some of these articles also present data from various time intervals subsequent to surgery. Of the 2142 patients treated in the 11 studies, 151 experienced some disturbance after surgery. There was a mean incidence of 7% with a range from 0.6% to 39%. Four studies provided data demonstrating that the incidence of disturbance is significantly lower after 1 year. The number and size of the affected areas decreases with time. A small group of patients exhibited persistent neurosensory disturbance after 5 years.

The occurrence of mandibular fracture in conjunction with implant surgery was reported in 3 studies,[2,11,21] with 4 fractures recorded among 1523 patients treated (Table I). The mean incidence was 0.3% with a range from 0.2 to 0.8%. Six additional articles[22-27] reported this complication but did not provide incidence data.

Implant loss

Implant loss was evaluated in relationship to the following factors: prosthesis/arch, time of loss, implant length, bone quality, and systemic conditions.

Prosthesis/arch

Four types of prostheses were used in the clinical studies to provide definitive prosthodontic treatment. Because the success of the implants and the number/severity of the complications varied with the type of prosthesis that was used, categorization by type of prosthesis was used as a convenient means of reporting com-

Table III. Timing of implant loss

Prosthesis	Number of implants lost	Number lost before prosthesis placement (%)	Number lost after prosthesis placement (%)
Implant fixed complete dentures	248	135 (54%)	113 (46%)
Implant overdentures	293	176 (60%)	117 (40%)
Implant fixed partial dentures	170	104 (61%)	66 (39%)
Implant single crowns	15	7 (47%)	8 (53%)

plications. Also, because there is a lack of standardized terminology related to implant prostheses, the following terms have been selected for use: implant fixed complete denture (fixed-detachable or hybrid prosthesis); implant overdenture; implant fixed partial denture; and implant single crown (single tooth replacement).

Data regarding implant loss with maxillary fixed complete dentures (Table II) were provided in 9 studies[39-47] with a mean loss of 10% (443 of 4559 implants). In the mandible, a 3% mean loss was recorded (255 of 9991 implants) from the combined data of 14 studies.[39-44,46,48-53,178] With implant overdentures (Table II), the mean maxillary implant loss[54-59,203] was 19% (206 of 1103 implants), and the mean mandibular implant loss[5,48,49,54,55,58-73,201,202,205-210] was 4% (242 of 5683 implants). With both implant fixed complete dentures and implant overdentures, the implant loss in the maxilla was much greater than the mandibular implant loss (Table II).

With implant fixed partial dentures, the maxillary[7,9,74-85] and mandibular[7,9,74-76,78,79,81-84,86,87] implant loss rates were the same (Table II). A mean loss of 6% was recorded in the maxilla (213 of 3297 implants) and a mean loss of 6% in the mandible (157 of 2567 implants).

Sixteen of the 20 studies[4,10,17,88-103,200] that evaluated implant loss with single crowns did not separate the data by arch (Table II). Three studies[97,101,103] identified the arch. The mean implant loss for implant single crowns (maxillary and mandibular data combined) was 3% (42 of 1512 implants).

Timing of implant loss

Nine studies[39,42-44,47,48,50,104,178] provided data about the time (preprosthetic vs postprosthetic) when implants were lost (Table III). With fixed complete dentures, 248 implants were lost in the 9 studies. There were 135 (54%) lost before prosthesis placement and 113 (46%) lost after prosthesis placement. With implant overdentures, 17 studies[2,5,48,54,56,57,61,63-65,67,68,71,201,203,205,208] recorded preprosthetic and postprosthetic implant losses. A total of 293 implants were lost, 176 (60%) of which occurred before prosthesis placement and 117 (40%) occurred after prosthesis placement. The implant fixed partial denture data[7,16,74-76,87,105,106] indicate that 104 of the 170 implant losses (61%) were recorded before prosthesis placement and 66 of the 170 (39%) occurred after prostheses placement. Implant single crown studies[4,91,93,94,97,103] reported that 7 of 15 implants were lost before prosthesis placement (47%) and 8 of 15 were lost after prosthesis placement (53%).

Data regarding the time at which postprosthetic implant loss occurred were presented in 5 studies.[16,94,104,107,108] Of the 122 implants lost, 70 were lost during the first year after prosthesis placement (57%). In the second year after prosthesis placement, 41 implants (34%) were lost, and during the third year after prosthesis placement 11 implants (9%) were lost.

Thirteen studies[7,9,76,77,109-117] presented data regarding the incidence of implant loss relating to implant length. In the studies there were 2754 implants that were 10 mm or less in length and 3015 implants greater than 10 mm long. In the 10-mm or less category, 272 of 2754 implants failed (10%). With the implants greater than 10 mm in length, 105 of 3015 implants failed (3%).

Seven studies[2,3,54,57,59,89,118] permitted a comparison of implant loss when placed into different qualities of bone. There were 3192 implants placed in types I to III bone, and 113 implants were lost (4%). There were 1009 implants placed in type IV bone, and 160 were lost (16%).

Several factors produce systemic changes that have been evaluated for their effect on implant success/failure. These items include smoking,[107,119-126] radiation therapy,[127-137] diabetes,[138-142] chemotherapy,[143-147] osteoporosis,[148,214] hormone replacement therapy,[149-151,204] scleroderma,[152-155] Sjogren's syndrome,[156,157] Parkinson's disease,[158] multiple myeloma,[159] and an HIV-seropositive status.[160] Three of the conditions (smoking, radiation therapy, and diabetes) were evaluated in a manner that provided adequate data for inclusion in this article. For the other conditions, the number of studies reporting definitive data is limited and mean values were not calculated. However, from the limited information, it appears that osteoporosis, scleroderma, chemotherapy, and hormone replacement therapy do not negatively affect implant success.

Nine clinical studies[107,119-126] have compared the effect of smoking on implant loss. In the 9 studies, a total of 4862 implants were placed in nonsmokers, and 1668 were placed in smokers. Of the 4862 implants in non-

Table IV. Peri-implant soft tissue complications

	Number of implants placed/affected	Mean incidence
Fenestration/dehiscence	3156/223	7%
Gingival inflammation/proliferation	17,565/1,060	6%
Fistulas	11,764/117	1%

smokers, 239 (5%) were lost. Of the 1668 implants in smokers, 178 (11%) were lost.

The effect of radiation on implant loss has been reported in multiple articles.[127-137,199,211-213,218] The data have been identified by arch in 16 studies/reports.[127-134,136,137,199,211,215-217] There were 217 maxillary and 1296 mandibular implants placed in patients who had undergone radiation therapy in the 15 studies/reports. Hyperbaric oxygen was used in 5 of the studies.[132,134,211,215,216] Fifty-five of the 217 maxillary implants were lost (25%), whereas 79 of the 1296 (6%) mandibular implants were lost.

Five papers[138-142] provided data related to 507 patients with controlled diabetes in whom implants were placed. A total of 1053 implants were placed, and 93 were lost, producing a mean loss of 9% for the combined data.

Bone loss

Fifteen studies[2,3,6,7,39,40,55,75,78,86,92,94,161-163,178] provided data about the marginal bone loss that occurs during the first year. The mean bone loss was 0.9 mm (range from 0.4 to 1.6 mm). The mean loss per year in subsequent years was 0.1 mm (range from 0 to 0.2 mm). One study[178] of mandibular implant fixed complete dentures measured an average total bone loss of 0.9 mm after 10 years and a total of 1.2 mm after 15 years. Another study[202] of mandibular implant overdentures measured an average total bone loss of 1.7 mm after 12 years.

Three studies[3,6,163] presented data that help identify the percentage of patients that experience bone loss versus bone gain and the magnitude of the loss/gain. In the 3 studies, only a small percent of patients (1.5%) experienced bone loss exceeding 2 mm over a 3-year period. Five percent of the patients had 1 to 2 mm of loss, and 23% of the patients experienced 0.1 to 0.5 mm of loss. It is interesting to note that a substantial percentage of patients exhibited no bone loss (34%) or had bone gain (19%). Furthermore, data from 2 of these studies[3,6] show the percentage of patients experiencing bone gain increased from 15% to 34% between 1 and 3 years. One of the studies[163] showed that the bone gain occurred both in the maxilla (6% of the patients experienced bone gain after 1 year and 38% gained bone after 3 years) and mandible (2% of the patients experienced bone gain after 1 year whereas 18% had gained bone after 3 years).

Peri-implant soft tissue complications

Peri-implant complications that have been reported in 3 or more studies include fenestration/dehiscence, gingival inflammation/proliferation, and fistulas (Table IV). The fenestration/dehiscence of implants before second-stage surgery was reported in 6 studies[4,10,39,43,44,164] and ranged between 2% and 13%. The combined data determined that 223 of 3156 implants were affected (Table IV) by fenestration/dehiscence (mean of 7%).

Inflammation and gingival proliferation was reported in 13 studies,[10,11,13,14,39,43,48,54,56,58,60,80,207] with an incidence range of 1% to 32% (Table IV). Combining the data produced an average incidence of 6% with 1060 of 17,565 implants affected. The incidence associated with implant overdentures (395 of 2101 implants affected for an average of 19%) was greater than the incidence with other prostheses.

Ten studies[2,4,10,11,17,39,91,93,94,165] reported on the incidence rate for fistulas at the abutment-implant connection level. The mean incidence from the combined data (Table IV) was 1% (117 of 11,764 implants affected). The incidence ranged from 0.002% to 25%.

Methods of assessing peri-implant health

Several clinical studies have investigated the relationship between implant loss/bone loss and the factors conventionally used to evaluate the periodontal status of natural teeth (presence of plaque, oral hygiene, gingivitis, probing depths, bleeding on probing, presence of attached/unattached tissue, microbiotia present, crevicular fluid, prosthesis–to–soft tissue distance).

There are multiple studies showing no relationship between these periodontal evaluation parameters and implant success. Adell et al[166] determined the conventional clinical periodontal examination methods did not appear to provide a full comprehension of the conditions in the soft tissues adjacent to implants. Lekholm et al[167] indicated the presence of gingivitis and deep pockets were not correlated with marginal bone loss nor the general presence of pathologic changes in the marginal gingiva. Apse et al[168] found no evidence to support a correlation between poor oral hygiene and either implant loss or mucosal health. Mombelli[169] found no significant difference between the plaque index of failed and successful implants. Quirynen[170] stated that the loss in marginal bone height did not clearly correlate with parameters such as the plaque index, the gingivitis index, the presence or absence of attached gingiva around the abutment, or the implant length. Zarb and Schmitt[171] found that successful osseointegration can be maintained irrespective of a patient's oral hygiene perfor-

mance. No significant correlations were found by Wismeijer et al[172] between plaque and bleeding indices and bone loss. Weber et al[173]determined there were low levels of correlation between the individual and cumulative clinical periodontal parameters and radiographically measured bone loss. They suggest these parameters are of limited clinical value in assessing and predicting future peri-implant bone loss.

In contrast, several other studies identified a relationship between the factors used to evaluate the periodontium of natural teeth and implant success. Kirsch[174] stated that 75% of the implants lost in his study were associated with poor oral hygiene or the lack of attached gingiva. Mombelli, in the same article discussed previously,[169] also found sites with failing implants to be associated with high proportions of microorganisms associated with periodontally diseased states. Henry et al[6] indicated that implant failures were concentrated in patients with more plaque accumulation. Block and Kent[175] found the lack of keratinized gingiva and poor oral hygiene were some of the most common reasons for implant loss. Teixeira et al[176] identified a statistical correlation between bone loss and both the gingival index and the crevicular fluid volume. Salonen et al[177] identified compromised oral hygiene as a possible cause of failure. Lindquist et al[178] found that patients with poor oral hygiene had more bone loss than those with good hygiene. Smoking and poor oral hygiene, when combined, produced the greatest bone loss. Tang et al[179] identified a significant positive correlation between mucosal inflammation and bone loss. They also stated that 1 of the etiologic factors of alvelolar bone loss around implants seems to be plaque-associated marginal inflammation.

Mechanical complications

A large number of mechanical complications have been reported and they include the following items listed in their order of reported frequency: overdenture loss of retention/adjustment (30%); resin veneer fracture of fixed partial dentures (22%); the need for overdenture relines (19%); overdenture clip/attachment fracture (17%); porcelain veneer fracture of fixed partial dentures (14%); overdenture fracture (12%); opposing prosthesis fracture (12%); acrylic resin base fracture (7%); prosthesis screw loosening (7%); abutment screw loosening (6%); prosthesis screw fractures (4%); metal framework fractures (3%); abutment screw fractures (2%); and implant fractures (1%).

Thirty percent of the implant overdentures in 6 studies[2,14,48,56,57,180,203] had complications associated with loss of retention and they needed adjusting to increase the retention (Table V). Five studies[7,76,82,108,181] provided data (Table V) about the incidence of resin veneer fractures on implant fixed partial dentures. Of 663 prostheses evaluated, 144 experienced resin fracture (22%).

A relatively high percentage (Table V) of implant overdentures (mean of 19% with a range from 7% to 44%) required relines either in conjunction with prosthesis placement or during postplacement appointments.[2,5,48,55-57,61,69,70,203] Ten studies[2,5,14,48,49,56,57,69,203,206] reported data (Table V) on fracture of the retentive mechanism used with overdentures. Eighty of 468 prostheses were affected (17%).

Three studies[14,108,182] indicated that 36 of 258 implant fixed partial dentures fractured (14%) when porcelain was used as a veneering material (Table V). In 10 studies,[2,5,14,48,56,61,68-70,206] it was determined that 69 of 570 (12%) implant overdentures fractured (Table V).

Fractures of the opposing prosthesis (Table V) were noted in 12% of the prostheses (20 of 168 prostheses fractured in 3 studies).[14,48,55] The range of fracture was from 4% to 40%. Most of the fractures (12 of 20) were found in opposition to implant overdentures with the remainder in opposition to implant fixed complete dentures (8 of 20).

Fracture of the acrylic resin base[14,43,48,56,183,203] overlying the metal framework of a fixed complete denture or fracture of the implant overdenture occurred in 7% of the prostheses (Table V) with a range from 3% to 24%. Of 649 prostheses evaluated in 6 studies, 47 fractured. The fractures occurred with both overdentures and fixed complete dentures. When the data from 12 studies[13,44,48,76,96,100,106,182-185,203] were combined, a mean prosthesis screw loosening of 7% (312 of 4501 screws fractured) was calculated (Table V) with a range from 0.0% to 38%.

Abutment screw loosening[4,7,17,44,48,55,56,68,86,91,92,94,95,108,112,180,182,184,186-192,203] was detected in 6% (365 of 6256 screws loosened) of the prostheses (Table V). It was found to be as high as 45% with implant single crowns.[17] The average loosening with implant single crowns that used early screw designs was 25%.[4,17,91,92,94,95,186] When the data from 6 recent studies[112,187-191] were combined, the mean incidence was 8%, indicating substantial improvement with new screw designs. The average for implant overdentures was 3%.[48,55,56,68,180] Four percent was recorded with implant fixed partial dentures.[7,86,108,182,184]

Prosthesis screw fracture[7,14,39,44,48,55,76,80,108,183,193-195] was noted almost equally with fixed complete dentures (3%)[14,39,44,48,183,193,194] and fixed partial dentures (5%).[7,76,80,108] The mean incidence was 4% (Table V) but was found to range from 0.0% to 19%. Of 7094 screws evaluated, 282 fractured.

Metal framework fractures were reported in 13 studies.[2,11,39,43,44,55,56,80,108,183,193,194,203] With fixed complete dentures and overdentures (Table V), there were 2358 prostheses evaluated and 70 fractured (3%). The

Table V. Mechanical implant complications

	Number placed/affected	Mean incidence
Overdenture loss of retention/adjustment	376/113 prostheses	30%
Esthetic veneer fracture (resin)	663/144 prostheses	22%
Overdenture relines	595/114 prostheses	19%
Overdenture clip/attachment fracture	468/80 prostheses	17%
Esthetic veneer fracture (porcelain)	258/36 prostheses	14%
Overdenture fracture	570/69 prostheses	12%
Opposing prosthesis fracture	168/20 prostheses	12%
Acrylic resin base fracture	649/47 prostheses	7%
Prosthesis screw loosening	4501/312 screws	7%
Abutment screw loosening	6256/365 screws	6%
Prosthesis screw fractures	7094/282 screws	4%
Metal framework fractures	2358/70 prostheses	3%
Abutment screw fractures	13,160/244 screws	2%
Implant fractures	12,157/142 implants	1%

Table VI. Most common implant complications (10% or greater incidence)

	Number placed/affected	Mean incidence
Overdenture clip/attachment loosening	376/113 prostheses	30%
Implant loss in maxilla from radiation therapy	217/55 implants	25%
Hemorrhage-related complications	379/92 patients	24%
Resin veneer fracture/fixed partial dentures	663/144 prostheses	22%
Implant loss with maxillary overdentures	1103/206 implants	19%
Overdenture relines needed	595/114 prostheses	19%
Overdenture clip/attachment fracture	468/80 prostheses	17%
Implant loss in Type IV bone	1009/160 implants	16%
Porcelain veneer fracture/fixed partial dentures	258/36 prostheses	14%
Overdenture fracture	570/69 prostheses	12%
Opposing prosthesis fracture	168/20 prostheses	12%
Implant loss in smokers	1668/178 implants	11%
Implant loss with short implants (10 mm or less)	2754/272 implants	10%
Implant loss with maxillary fixed complete dentures	4559/443 implants	10%
Esthetic complication with prostheses	493/47 prostheses	10%

range was from 0.0% to 27%. One study[108] evaluated the incidence of fracture associated with fixed partial dentures (0.5%).

Sixteen studies[10,11,14,39,44,48,55,80,86,108,182-184,189,193,194] reported the fracture of abutment screws (244 of 13,160 fractured) with a mean incidence of 2% (Table V) and a range from 0.2% to 8%. Three percent of the screws fractured with fixed complete dentures[14,39,44,48,193,194] and 1% with fixed partial dentures.[86,108,182,184]

Fortunately implant fracture only occurred with a low incidence of 1% (Table V). In 13 studies[7,14,39,44,75,76,80,100,108,165,181,196,197] reporting this complication, 142 of 12,157 implants fractured. There have been multiple reports of fractures associated with single posterior crowns, but the reports lack detail regarding the total number of crowns placed. Therefore calculation of a mean percentage was not possible.

Esthetic/phonetic complications

Esthetic deficiencies were recorded in 7 studies.[4,14,91,95,106,198,203] A mean complications incidence of 10% was calculated from the combined data in the 7 studies (47 of 493 crowns/prostheses produced esthetic problems).

Phonetic problems were evaluated in 4 studies[56,76,106,203] in association with fixed complete dentures, overdentures, and fixed partial dentures. Of 730 prostheses, 51 created phonetic complications (mean of 7%).

Most common implant complications

Because of the volume of implant data and the number of reported complications, the complications comparison has been divided into 2 tables. Those complications with a mean incidence of 10% or more are

Table VII. Most common implant complications (<10% incidence)

	Number placed/affected	Mean incidence
Implant loss in diabetic patients	1053/93 implants	9%
Acrylic resin base fracture	649/47 prostheses	7%
Neurosensory disturbance	2142/151 patients	7%
Prosthesis screw loosening	4501/312 screws	7%
Fenestration/dehiscence prior to Stage II surgery	3156/223 implants	7%
Phonetic complications	730/51 prostheses	7%
Abutment screw loosening	6256/365 screws	6%
Gingival inflammation/proliferation	17,565/1,060	6%
Implant loss in mandible from radiation therapy	1296/79 implants	6%
Implant loss with maxillary fixed partial dentures	3297/213 implants	6%
Implant loss with mandibular fixed partial dentures	2567/157 implants	6%
Implant loss in nonsmokers	4862/239 implants	5%
Implant loss in Types I-III bone	3192/113 implants	4%
Implant loss with mandibular overdentures	5683/242 implants	4%
Prosthesis screw fractures	7094/282 screws	4%
Metal framework fractures	2358/70 prostheses	3%
Implant loss with longer implants (>10 mm)	3015/105 implants	3%
Implant loss with mandibular fixed complete dentures	9991/255 implants	3%
Implant loss with single crowns	1512/42 implants	3%
Abutment screw fractures	13,160/244 screws	2%
Fistulas	11,764/117 implants	1%
Implant fractures	12,157/142 implants	1%
Mandibular fractures	1523/4 patients	0.3%

Table VIII. Comparison of prosthesis complications incidences[1]

	Number of prostheses studied/number affected by complications	Mean incidence
Conventional Fixed Partial Dentures	3272/866	27%
Resin Bonded Prostheses	7029/1,823	26%
Conventional Single Crowns	1476/157	11%
Posts and Cores	2784/279	10%
All-Ceramic Crowns	4277/357	8%
Implant Prostheses	*	*

*It was not possible to calculate an overall complications incidence for implant prostheses since there were no studies that simultaneously evaluated all or most of the reported complications. It was noted that there was a trend toward a greater number of complications associated with implant prostheses.

presented in Table VI and the complications with a mean incidence less than 10% are presented in Table VII.

Complications incidence comparison of prostheses

For the clinical complications reported in fixed prosthodontics,[1] an overall complications incidence was calculated for conventional single crowns, conventional fixed partial dentures, all-ceramic crowns, resin-bonded prostheses, and posts and cores. The incidence calculation was possible because there were multiple clinical studies related to each of these prostheses that simultaneously evaluated either all or most of the reported complications associated with that particular prosthesis. However, with implant prostheses, multiple clinical studies that simultaneously evaluated all or most of the reported complications were not available.

Even though it was not possible to calculate an overall complications incidence for implants and their associated prostheses, there appears to be a greater number of clinical complications associated with implant prostheses than any other types of prostheses evaluated (Table VIII). Conventional fixed partial dentures (27%) and resin-bonded prostheses (26%) were associated with the next greatest number of complications. The remaining crowns/restorations were comparable in the number of reported complications (conventional single crowns, 11%; posts and cores, 10%; and all-ceramic crowns, 8%).

SUMMARY

Although it was not possible to calculate an overall complications incidence for implant prostheses, available studies suggest there are a greater number of clinical complications associated with implant prostheses. The literature identified the following 6 categories of complications associated with implant prostheses: surgical complications, implant loss, bone loss, peri-implant soft tissue complications, mechanical complications, and esthetic/phonetic complications. The most common surgical complications associated with implants were hemorrhage-related complications (24%), neurosensory disturbance (7%), and mandibular fracture (0.3%). Implant loss ranged from a high of 19% with maxillary overdentures to a low of 3% that occurred with both mandibular fixed complete dentures and single crowns. Implant loss was greater with implants that were 10 mm or less in length (10%) compared with implants greater than 10 mm long (3%); and in the presence of type IV bone (16%) compared with types I to III bone (4%). Smokers had greater implant loss (11%) than nonsmokers (5%). Radiation treatments to the maxilla resulted in a greater implant loss (25%) than the mandible (6%).

The mean bone loss occurring during the first year was 0.9 mm, and the subsequent loss per year after the first year was 0.1 mm. The most common peri-implant complications were fenestration/dehiscence (7%), gingival inflammation/proliferation (6%), and

fistulas (1%). There were 14 mechanical complications identified in the literature and the incidence ranged from 30% (implant overdenture clip/attachment loss of retention) to 1% (implant fractures). Esthetic complications occurred with a mean incidence of 10% and phonetic complications were recorded with a mean incidence of 7%.

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