A Comparison of Characteristics of Implant Failure and Survival in Periodontally Compromised and Periodontally Healthy Patients: A Clinical Report

Edwin S. Rosenberg, BDS, H Dip Dent, DMD[1]/Sang-Choon Cho, DDS, MSc[2]/Nicolas Elian, DDS[3]/
Ziad N. Jalbout, DDS[4]/Stuart Froum, DDS[5]/Cyril I. Evian, DDS[6]

Purpose: *This study compares implant survival and patterns of implant failure in periodontally compromised and periodontally healthy patients.* ***Materials and Methods:*** *In a private periodontal practice, over a 13-year period, implants were placed in both periodontally compromised and periodontally healthy patients. Implants were classified in 5 different groups according to surface texture. Survival rates in each group were compared according to implant location, diameter, length, and phase of treatment.* ***Results:*** *A total of 1,511 implants were placed in 334 patients. One hundred fifty-one of these patients, classified as periodontally compromised patients (PCP), received 923 implants. The remaining 183 patients, classified as periodontally healthy patients (PHP), received 588 implants. The overall survival rate for implants placed in the PHP group was 93.7%, compared to 90.6% in the PCP group. The survival rate of hydroxyapatite-coated implants was 92.6% in the PHP group and 81% in the PCP group. The survival rate of the turned-surface implants was similar in both groups.* ***Discussion:*** *Two types of implant failure were identified. The first was failure of the implant to osseointegrate. This type of failure occurred early in treatment and appeared to be related to smooth-surface implants placed in bone of low density. Failures of this type were distributed equally between the PHP and PCP groups. The second type of failure was related to peri-implantitis. It was observed most often with implants with hydroxyapatite surfaces, occurred as the result of a progressive condition, and was most prevalent in the PCP group.* ***Conclusion:*** *Further long-term controlled investigations are needed to determine the influences of implant suface and host susceptibility on implant failure in both PHP and PCP.* INT J ORAL MAXILLOFAC IMPLANTS 2004;19:873–879

Key words: *dental implants, implant failure, implant survival, osseointegration, periodontal disease, periodontitis*

[1]Professor, Ashman Department of Implant Dentistry, New York University College of Dentistry, New York, New York.
[2]Assistant Research Scientist, Ashman Department of Implant Dentistry, New York University College of Dentistry, New York, New York.
[3]Director and Assistant Professor, Ashman Department of Implant Dentistry, New York University College of Dentistry, New York, New York.
[4]Faculty, Ashman Department of Implant Dentistry, New York University College of Dentistry, New York, New York.
[5]Director of Clinical Research and Clinical Professor, Ashman Department of Implant Dentistry, New York University College of Dentistry, New York, New York.
[6]Interim Chairman and Director, Postdoctoral Periodontics, University of Pennsylvania School of Dental Medicine, Philadelphia, Pennsylvania.

Correspondence to: Dr Edwin Rosenberg, 1500 Locust Street, Suite 1408, Philadelphia, PA 19102-4314. Fax: +215 735 9886. E-mail: erosen9468@aol.com

As a restorative option, dental implants have shown a high success rate, as documented in the dental literature.[1–9] However, in an attempt to decrease implant failure rates, more attention is being placed on understanding the etiologic and risk factors that lead to the failure of dental implants. There is general agreement that smoking appears to be an established risk factor for implant failure.[10–14] Other factors such as osteoporosis[15–18] and diabetes[19] have fewer controlled documented studies and thus have not been unequivocally established as risk factors. Some clinicians assume that periodontally compromised patients (PCP) present a potentially higher risk for implant failure. The reason for this assumption is that a similar pathogenous bacterial flora forms around diseased teeth and diseased implants, though with some

Table 1 Implant Systems

Surface characteristic	System	Manufacturer	Manufacturer's location
Smooth machined titanium	Brånemark	Nobel Biocare	Göteborg,Sweden
SLA	ITI	Straumann	Waldenburg, Switzerland
TPS	ITI	Straumann	
TPS	IMZ	Biomet/Interpore International	Irvine, CA
AE	Osseotite	3i/Implant Innovations	Palm Beach Gardens, FL
HA	Swede-vent	Paragon	Encino, CA
HA	Screw-vent	Paragon	
HA	Corevent	Paragon	

SLA = sandblasted, large-grit, acid-etched; TPS = titanium plasma-sprayed; AE = acid-etched; HA = hydroxyapatite-coated.

differences in partially and completely edentulous patients.[20–24]

Therefore, to minimize failure, the placement of implants in PCP was not advocated.[25] This recommendation was based on clinical assumptions rather than on evidence-based data. Several publications have challenged this concept by demonstrating successful osseointegration in patients with different types of periodontal disease.[26–28] However, none of these reports offered comparative data between PCP and periodontally healthy patients (PHP).

The current investigation presents data comparing implant survival in PCP and PHP to determine whether differences and patterns exist. Implant survival and failure in the PCP and the PHP groups were analyzed relative to implant surface texture, implant location, diameter, length, and phase of treatment. The data have been retrospectively collected over a 13-year period from a private periodontal practice.

MATERIALS AND METHODS

Patient Selection

Patients were selected from a population that was treated between 1986 and 1999. Each patient's past medical and dental histories were thoroughly reviewed prior to the initiation of the treatment. Patients with a history of cardiac, pulmonary, hematologic, metabolic, infectious, genetic, or other systemic disorders that would contraindicate or compromise the placement or healing of implants were excluded from the study.

Presurgical Assessment

Patients with a history that permitted implant placement received a comprehensive clinical and radiographic examination to assess their status, as well as to determine any additional dental requirements. Prior to implant placement, all necessary periodontal, restorative, and endodontic treatment was completed, including extraction of hopeless teeth. Patients were then classified as either PCP or PHP following a thorough clinical and radiographic diagnosis. Patient history or records were used to determine whether tooth loss had a periodontal or nonperiodontal etiology. Patients were classified as periodontally compromised if they had a history of periodontal disease that resulted in tooth loss. Patients were classified as periodontally healthy if tooth loss was not caused by periodontal disease and if no loss of attachment (with the exception of facial or lingual recession) or probing depth greater than 3 to 4 mm was present at the time of implant placement.

Prior to implant placement each patient received a periodontal examination, including an evaluation of probing pocket depth, visual examination for inflammation, and detection of any bleeding on probing. Periodontal treatment and professional maintenance were performed on all patients, and not until there was evidence of health on all remaining teeth was implant therapy performed. The radiographic diagnosis relied on full-mouth periapical films taken with a parallel technique. Panoramic and computed tomographic radiographs were also obtained when necessary and used to determine the surgical and prosthetic treatment plan.

Based upon consultation with the patient and the restorative clinician, an implant treatment plan was determined. This plan included the number of implants to be placed, the location of the implants, and type of definitive prosthesis. Eight implant systems were available for placement depending upon the preference of the clinician. They were classified according to implant surface textures (Table 1).

Surgical Placement

Only after all teeth were determined to be periodontally healthy were implants placed. All implants were placed using a sterile technique in an operatory setting. Full-thickness mucoperiosteal flaps were utilized to provide access to the edentulous implant sites. Preparation of the alveolar bone was performed using low-speed instrumentation with copious saline irrigation. When necessary a surgical guide was employed to aid in the placement of the implants. All implants were placed according to the manufacturer's guidelines and recommendations.

Neomycin ointment was placed on the threads of all cover screws prior to placement and when possible primary closure of all surgical sites was achieved with 4-0 silk sutures. Immediate postoperative radiographs were obtained to verify the proper position and location of the implants. Patients were placed on systemic antibiotics (100 mg doxycycline per day) beginning the day of surgery and continuing for 7 to 10 days postoperatively. In addition, the patients were instructed to use a 0.12% chlorhexidine rinse 3 times daily for the first 4 weeks. Verbal and written postoperative instructions were given to the patients with respect to diet and their provisional prostheses prior to dismissal. They were instructed not to wear any removable prosthesis for a minimum of 3 weeks, to maintain a soft diet, and to avoid any excessive function on the implant sites. The sutures were removed between 7 and 14 days postoperatively, and the patients were recalled on a biweekly basis for the first 3 months and monthly thereafter until the second-stage surgical uncovering. At each of these visits maintenance and periodontal examination were performed.

Second-Stage Surgery

Depending upon the location of the implant (anterior versus posterior, maxillary versus mandibular) and the bone type, the second-stage surgery was performed from 5 to 9 months following initial placement. At this time, crestal incisions with minimally reflected mucoperiosteal flaps were used to uncover the implant and allow for the placement of a healing abutment. Patients were placed on the same antibiotic regimen as previously used and instructed to use chlorhexidine rinse twice daily for 14 to 21 days.

Prosthetic Phase

Following adequate healing after second-stage surgery (approximately 4 to 6 weeks), fabrication of the prosthesis commenced. When indicated, a provisional prosthesis was fabricated and evaluated during the prosthetic treatment phase. Delivery of the definitive prosthesis typically occurred within 2 to 3 months after second-stage healing. In certain cases a provisional prosthesis was worn for up to 6 months prior to delivery of the definitive restoration. Regardless of the situation, each patient was recalled monthly during the prosthetic phase for periimplant maintenance and assessment of healing.

Maintenance Phase

All patients were recalled and evaluated at least every 3 months (several patients were recalled every 2 months) through 1999. At each recall visit, individual implants were assessed for mobility and clinical signs of inflammation.[29,30] Removable and screw-retained appliances were removed at least once a year to check for mobility. Probing was performed around implants as well as natural teeth, and any bleeding on probing[31] was noted and locally treated with either scaling and root planing (natural teeth) or surface cleaning with a Cavitron Jet (Dentsply Professional, York, PA) and plastic instrument (implants). Appropriate radiographs were obtained as needed.

Implant Failure

In accordance with the criteria of Albrektsson and associates,[29] an implant was determined to have failed if it demonstrated clinical mobility, evidenced continuous radiolucency around the implant, or displayed continuous bone loss which necessitated removal or surgical intervention. These findings were noted at the patient's implant maintenance visit or upon presentation with a specific complication. Failures were classified into 5 stages according to the time of failure. Stage 1 was the period between placement of the implant and second-stage surgery to uncover the implant. Stage 2 was the period between second-stage surgery and placement of the definitive prosthesis. Stage 3 was the first year after placement of the definitive prosthesis. Stage 4 began after the definitive prosthesis had been in place for 1 year and lasted until 5 years after prosthesis delivery. Stage 5 began 5 years after delivery of the definitive prosthesis.

RESULTS

A total of 1,511 implants were placed in 334 patients. One hundred fifty-one patients were classified as PCP and received 923 implants. One hundred eighty-three patients were classified as PHP and received 588 implants. The distribution of PCP and PHP by age, gender, and jaw can be found in Table 2.

Of the 1,511 implants placed, 123 failed. This represents an overall implant survival rate of

Table 2 Demographics and Implant Distribution

	PCP	PHP	Total
Patients			
Number	151	183	334
Gender (M/F)	71/80	65/118	136/198
Mean age (y)	61.1	49.5	54.0
Implants			
Maxilla	519	277	796
Mandible	404	311	715
Total	923	588	1,511

Table 3 Survival Rate by Surface Texture

Surface	Placed	Failed	% survival
PCP			
Turned	359	38	89.4
SLA	4	0	–
TPS	374	16	95.7
AE	23	1	95.7
HA	163	31	81.0
Total	923	86	90.7
PHP			
Turned	293	24	91.8
SLA	3	0	–
TPS	105	6	94.3
AE	106	1	99.1
HA	81	6	92.6
Total	588	37	93.7

Survival rates were not calculated for groups with less than 10 implants.

Table 4 Survival Rate by Location

	Maxilla						Mandible					
	Anterior			Posterior			Anterior			Posterior		
Surface	Placed	Failed	% survival	Placed	Failed	% survival	Placed	Failed	% survival	Placed	Failed	% survival
PCP												
Turned	68	6	91.2	118	17	85.6	58	8	86.2	115	7	93.9
TPS	60	0	100	152	8	94.7	35	4	88.6	127	4	96.8
AE	6	0	–	9	1	–	0	0	–	8	0	–
HA	34	5	85.3	68	22	67.7	3	0	100.0	58	4	93.1
Total	168	11	93.4	347	48	86.2	96	12	87.5	308	15	95.1
PHP												
Turned	38	3	92.1	65	9	86.1	69	3	95.6	121	9	92.6
TPS	32	2	93.7	34	3	91.2	8	0	–	31	1	96.8
AE	19	0	100.0	35	1	97.1	10	0	100.0	42	0	100.0
HA	27	0	100.0	24	2	91.7	3	0	–	27	4	85.2
Total	116	5	95.7	158	15	90.4	90	3	96.7	221	14	93.7

Survival rates were not calculated for groups with less than 10 implants.

Table 5a Survival Rate by Diameter

	Diameter					
	≤ 4 mm			> 4 mm		
Surface	Placed	Failed	% survival	Placed	Failed	% survival
PCP						
Turned	353	36	89.8	6	2	66.7
TPS	30	9	70.0	344	7	98.0
AE	20	0	100.0	3	1	–
HA	163	31	82.0	0	0	–
Total	566	76	86.6	353	10	97.2
PHP						
Turned	261	23	91.2	32	1	96.9
TPS	11	1	90.9	94	5	94.7
AE	75	1	98.7	31	0	100.0
HA	78	6	92.3	3	0	–
Total	425	31	92.7	160	6	96.2

Survival rates were not calculated for groups with less than 10 implants.

Table 5b Survival Rate by Length

	Length								
	< 10 mm			10 to 13 mm			> 13 mm		
Surface	Placed	Failed	% survival	Placed	Failed	% survival	Placed	Failed	% survival
PCP									
Turned	18	4	77.8	209	16	92.3	132	18	86.4
TPS	39	3	92.3	317	13	95.9	18	0	100.0
AE	1	1	–	18	0	100.0	4	0	–
HA	20	3	85.0	94	21	77.7	49	7	85.7
Total	78	11	85.9	638	50	92.2	203	25	87.7
PHP									
Turned	46	5	89.1	124	9	92.7	123	10	91.9
TPS	1	0	–	89	6	93.3	15	0	100.0
AE	22	0	100.0	36	1	97.2	48	0	100.0
HA	16	3	81.3	42	2	95.2	23	1	95.7
Total	85	8	90.6	291	18	93.8	209	11	94.7

Survival rates were not calculated for groups with less than 10 implants.

92.15%. The survival rate of implants placed in the PHP group was slightly higher than that of implants placed in the PCP group (93.7% versus 90.7%) (Table 3). When the data were analyzed according to surface texture, only HA-coated implants showed a significant difference in implant survival between the 2 groups. HA-coated implants failed 2.5 times more often in the PCP group (19%) than in the PHP group (7.4%). In the maxilla, HA-coated implants failed more in the PCP group than in the PHP group (Table 4). In the PCP group, turned wide-diameter and TPS regular-diameter implants had a lower survival rate, 66.7% and 70%, respectively (Tables 5a and 5b).

Analysis of the failure patterns revealed a clear difference between the 2 groups. In the PHP group 94.6% of failures occurred at stage 1, 2, or 3. In the PCP group 74.4% of failures occurred at stage 1, 2, or 3. A higher percentage of late failure in the PCP group compared to the PHP group (25.6% versus 5.4%) was documented. This finding was more evident in the HA-coated implant group (Table 6).

Table 6 Implant Failure According to Stage of Treatment

	Stage				
Surface	1	2	3	4	5
PCP					
Smooth	18	12	5	2	1
TPS	7	2	0	7	0
AE	1	0	0	0	0
HA	6	11	2	11	1
Total	32	25	7	20	2
PHP					
Smooth	10	10	2	2	0
TPS	6	0	0	0	0
AE	1	0	0	0	0
HA	4	0	2	0	0
Total	21	10	4	2	0

Stage 1 = The period between placement of the implant and second-stage surgery to uncover the implant; stage 2 = the period between second-stage surgery and placement of the definitive prosthesis; stage 3 = the first year after placement of the definitive prosthesis; stage 4 = the period beginning after the definitive prosthesis had been in place for 1 year and lasting until 5 years after prosthesis delivery; stage 5 = the period beginning after the definitive prosthesis had been in place for 5 years.

DISCUSSION

Several clinical studies have attempted to show the success and failure rates of implants in periodontally compromised patients.[26–28] To the authors' knowledge, this is the first study that presents a comparison between these 2 groups, PCP and PHP, in regard to implant survival.

The overall survival rate found in the present study was above 90% and could be considered very favorable considering the large diversity of the cases treated and the long follow-up period. However, the high failure rate of HA-coated implants evidenced in this study is consistent with other studies on the long-term survival of HA-coated implants.[32–34] The elimination of HA-coated implants from the total number of implants placed increases the overall survival rate to 93.9% for the PHP group and 92.9% for the PCP group. The PCP group showed the highest failure rate with HA-coated implants.

The results of this study are consistent with a study by Nevins and Langer[26] on the success of

osseointegrated implants in the treatment of recalcitrant periodontal patients. They reported on 309 turned-surface Brånemark System implants placed in patients whose periodontal disease had been categorized as recalcitrant. The success rates in that study were 97% in the mandible and 98% in the maxilla. Mengel and colleagues[27] reported on 36 turned-surface Brånemark System implants placed in patients treated for generalized severe adult periodontitis. The implant success rates were 85% in the maxilla and 93% in the mandible (89% overall).[27] In the present study, 359 turned-surface implants were placed in PCP. Thirty-eight of these failed, yielding a survival rate of 89.4%, which is comparable to that reported by Mengel and colleagues. In the present study the survival rate of turned implants placed in the PHP group was 91.8%. Another report by Ellegaard and coworkers[28] using textured-surface implants (ITI [Straumann] and Astra Meditec, Göteborg, Sweden) reported success rates of 95.0% and 100%, respectively, for implants placed in PCP. The report included information on bone loss and pocket formation during a 5-year follow-up period. The absence of a control group of PHP renders much of the data collected in regard to bone loss, plaque, bleeding, keratinized gingiva, and pocketing of limited value in identifying patterns of implant failure. It also does not allow a comparison of long-term success rates of dental implants in PHP versus PCP. Nevertheless, all these studies showed high success rates for implants placed in PCP.[26–28]

Several studies examined the influence of periodontitis on the nature of the microbiota in partially edentulous patients.[23,24,35] They concluded that the same periodontal microbiota colonize periodontally compromised teeth and implants placed in patients with periodontally compromised teeth. However, they also demonstrated that these implants could be well maintained during an observation period of 3 years.[35]

A recently published prospective study showed an association between periodontal and periimplant conditions over 10 years in partially edentulous patients.[36] Marginal bone level at 10 years was significantly associated with smoking, implant location, full-mouth probing attachment levels, and change, over time, in full-mouth probing pocket depths. This association underscores the findings of the present study, which showed that high levels of implant survival can be achieved with a well-controlled maintenance and monitoring program.

In the current study periodontal health was established and maintained for all remaining natural teeth during the study period.

Two clear types of failures were distinguished in this study:

- *Failure to osseointegrate:* This type of failure typically occurs with turned-surface implants placed in the posterior maxilla. It can occur up to 1 year after loading (ie, through the end of stage 3; see Table 6). This type of failure occurred relatively frequently in both the PCP group and the PHP group (failure rates of 25.6% and 5.4%, respectively). No significant differences were found between the PCP group and the PHP group, which indicates that a history of periodontitis in a particular site or patient does not affect the healing process of osseointegration.
- *Peri-implantitis-related failure:* This type of failure, which occurs after 1 year of loading (ie, in stages 4 or 5), typically occurred with HA-coated implants. Failure occurred more frequently in the PCP group than in the PHP group (25.6% of the time versus 5.4%; see Table 6). One possible explanation for the difference between the 2 groups in this pattern of failure is the influence of the host, which plays an important role in the variable inflammatory process and may be significant in patients with a history of periodontal disease. Another possible explanation could be related to local factors. A reduced quantity of hard tissue in the PCP group may be related to periodontal loss prior to tooth extraction. Moreover, implants in this group may have been affected by loss of soft tissue, ie, attached gingiva, which has been shown to be a factor in the success of HA-coated implants over the long term.[32,33] More research is needed on the history of bone and soft tissue loss prior to implant placement in patients classified as "periodontally compromised" to evaluate the local factors affecting implant success and failure in these patients.

CONCLUSION

This retrospective investigation appears to indicate that with adequate customized recall and maintenance programs following implant placement and loading, implants placed in PCP have survival rates similar to those of implants placed in PHP. Implants with HA-coated surfaces showed a greater failure rate, which occurred later in the follow-up period in PCP. Smooth-surface implants had a greater failure rate in low-density bone. TPS and AE surfaces showed high success rates in both the PCP and PHP groups in almost all clinical situations. Further long-term controlled investigations are needed to determine the

influence of the implant surface and host susceptibility on implant failure in PHP as well as in PCP.

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