Causes of Implant Failure and Subsequent Removal: A Retrospective Study in a Hospital Setting

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Purpose: To evaluate the causes and risk factors associated with implant removal as observed in a hospital setting over a 20-year timespan to find the most common causes leading to implant removal. ***Materials and Methods:*** In the present retrospective study, implants removed between 2000 and 2022 were registered and the cause of removal established. All implants were removed by a single operator (P.P.M.) in the Department of Oral Surgery of the George Eastman Dental Hospital in Rome, Italy. Characteristics of removed implants such as implant surface, morphology (bone- versus tissue-level implants), type of restoration (fixed versus removable), mode of retention in the case of fixed restorations (cement- versus screw-retained), and location of the implant (maxillary versus mandibular) were recorded. Patient-level characteristics were also recorded, including patients' systemic health conditions, the medications they were currently taking or had taken, smoking habits, and if they had a previous history of periodontitis. ***Results:*** In total, 381 implants in 381 patients were removed in the 20-year timespan. The most frequent cause of removal was peri-implantitis (82.4% of implants), followed by implant malposition and loss of osseointegration. ***Conclusions:*** The survival time was not affected by the cause of removal, while bone-level implants had a longer survival time versus tissue-level implants. Maxillary implants had a higher prevalence of peri-implantitis compared to mandibular implants. *Int J Oral Maxillofac Implants 2024;40:348–356. doi: 10.11607/jomi.11008*

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Dental implants show high overall survival rates. Moraschini et al[1] found a 10-year survival rate of 94.6% with variation from 73.4%–100%, while Chappuis et al[2] observed a 20-year prospective study survival rate of 89.5%.

However, implant failure may occur and may require implant removal. In terms of time of occurrence, implant failures may be classified as early and late. While early failures occur during the process of osseointegration and before functional loading, late failures happen after osseointegration when prosthetic loading has already been completed.[3] The cause of early implant failure may be related to overpreparation or overheating of the implant site, lack of primary stability, or poor bone quality.[4] Other conditions such as smoking, inflammatory bowel disease, or use of proton-pump inhibitors have also been correlated with early failures.[5] Late failures are mostly due to biologic complications (such as peri-implantitis) or mechanical complications (such as fractures).[6] In this scenario, implants are usually more complicated to remove because they are often—at least in part—osseointegrated.[6] Finally, explantation may further be indicated in cases of severely malpositioned implants. The poor positioning may lead to esthetically displeasing results and can only be solved by removing the implant.[6]

Regarding biologic complications, peri-implantitis can be considered common, however, its prevalence depends on the definition being applied. At the patient-level, a recent systematic review and meta-analysis found a prevalence of 18% and 12% at the implant level.[7]

In 2017, the following definition of peri-implantitis was proposed by workgroup four during the *World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Condition*[8]: Simultaneous presence of bleeding on probing and/or suppuration on probing, probing pocket depth (PPD ± 6 mm), and bone level 3 mm apical of the most coronal portion of the intraosseous part of the implant.

The indications for implant removal versus treatment and preservation of the affected implant relies heavily on the clinician's considerations, their preferred

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choice of treatment, and their present skills. Currently there are few evidence-based indications on when implant removal is needed.

This retrospective study aimed to evaluate the causes and risk indicators associated with implant removal as observed in a hospital setting over a 20-year timespan. The research question was the following: What are the most common causes leading to implant removal? Can risk indicators associated with implant removal be identified?

MATERIALS AND METHODS

Study Design

A retrospective study was conducted over a period of 20 years from 2000 to 2020, in accordance with the Declaration of Helsinki on human studies. Ethics approval was obtained by the Comitato Etico Territoriale Lazio 1 with the following registration no.: 7422 Comitato etico Territoriale Lazio Area 1. The protocol was registered in clinicaltrials.gov (Identifier: NCT06234800). All participants were informed in detail about the objectives of the study, the processing of the data, and then gave their approval by signing an informed consent. All surgeries were carried out by a single experienced surgeon (P.P.M.) in the Department of Oral Surgery at the George Eastman Dental Hospital in Rome, Italy

The primary outcome was to find the most common reasons for implant failures. The secondary outcome was to find the factors that potentially were associated with implant failure (risk indicators) and their duration prior to implant removal.

Data Assessment

All patients treated by the last author (P.P.M.) were included.

The influence of many variables on implant removal, prevalence of peri-implantitis, and marginal bone loss (MBL; expressed as a percentage of the implant length or, in case of tissue-level implants, as a percentage of the rough surface portion of the implant) were recoded and analyzed to determine their effect on implant removal.

The following data collected for patient-level factors were smoking status (≥ 10 cigarettes, < 10 cigarettes or no smoking), health status (self-reported), age, sex, and history of periodontal disease. Note that periodontal history was determined by radiographic attachment loss (assessed on panoramic radiograph) and the number of teeth extracted due to periodontal reasons as self-reported by the patients. Oral hygiene was assessed by the patients' full-mouth plaque score. A value > 50% was classified as *poor oral hygiene*.

The following data collected for implant-level factors were: diameter, length, year of placement, site (anterior or premolar/molar) and jaw location (maxillary or mandibular), type of implant surface (smooth or rough), connection type (internal or external), implant microgeometry shape (cylindrical or conical), implant type (screw-shaped, needle, or helix, blade), Tubingen and morphology (bone or tissue level), clinical signs of inflammation (such as mobility, bleeding, suppuration, fistula, swelling and pain), cause of removal (determined clinically by the surgeon), implant inclination (straight or tilted), and implant placement protocol (immediate [type 1] or delayed [type 2, 3 or type 4]). This information was retrieved (if available) by interviewing the patients and, if possible, contacting the implant surgeon if they were different from the surgeon performing the removal procedure.

The surface of the removed implants included different categories of rough surfaces such as alumina oxide, titanium plasma-sprayed (TPS), or sandblasted large-grit acid etched (SLA); however, each category contained only a small number of implants. For this reason, it was decided to group the textured implants into a single category defined as "*rough*".

The amount of bone loss (millimeters) at the time of removal was detected on the mesial and distal aspect of each implant from periapical intraoral radiographs of the implant.

The prosthetic variables were the reconstruction design (single or multiunit, and with or without cantilever) and the years in function of the prosthesis.

Fixed restorations were further divided into the following subcategorizes: single crowns, fixed dental prostheses for partially edentulous patients, fixed dental prostheses for fully edentulous patients, and fixed restorations (further divided based on their type of retention: cement-retained or screw-retained restorations).

The surgical variables were year of removal and the consequent duration of the implant in years.

Data Analysis

Statistical analysis consisted of descriptive statistics for continuous variables (mean, SD, range, median, and interquartile range). Categorical variables were described using absolute and relative frequencies. Given the large sample size, a parametric approach was used throughout the statistical analysis.

The inferential analyses included statistical tests required to study the association between outcomes and independent variables, such as the chi-square test and the Fisher's exact test. The chi-square test was used to assess the association or dependence between categorical variables (eg, cause of removal and periodontal history). Fisher's exact test was used if frequencies of some categories were too low.

Table 1 Patient-Related Variables

Variable	Overall (N = 381)	Percentage (%)
Age (y), mean (SD)	53 (13.6)	
Age group (y)		
≤ 40 years	84	22
41–55 years	124	32.5
56–70 years	129	33.9
> 70 years	44	11.5
Sex		
Male	204	53.5
Female	177	46.5
Smoking status		
Nonsmokers	250	65.6
Smokers	131	34.4
General health		
Health	234	61.4
Diabetes	37	9.7
Treatment with antihypertensives	44	11.5
Depression	26	6.8
Anticoagulant therapy	4	1
Treatment with bisphosphonates	12	3.1
Treatment with corticosteroids	9	2.4
Xerostomia	4	1
Diabetes + antihypertensives	3	0.8
Diabetes + depression	2	0.5
Antihypertensives+ anticoagulants	5	1.3
Depression + bisphosphonates	1	0.3
History of periodontitis		
No	255	66.9
Yes	126	33.1
Behavioral history		
No habit	20	5.2
Smoker	64	40.2
Bruxism	98	25.7
Poor oral hygiene	109	28.6

Table 2 Implant-Related Variables

Variable	Overall (N = 381)	Percentage (%)
Jaw location	381	100
Maxilla	217	57
Mandible	164	43
Area of the mouth		
Anterior (incisors/canines)	106	27.8
Posterior (premolars/molars)	275	72.2
Implant placement year		
Before 2000	34	8.9
2000–2004	67	17.6
2005–2009	119	31.2
2010–2014	105	27.6
2015–2019	56	14.7
Type of implant surface		
Smooth	28	6.9
Rough	353	93.1
Diameter		
> 4 mm	86	22.6
< 4 mm	295	77.4
Length		
> 10 mm	50	13.1
< 10 mm	331	86.9
Placement protocol		
Immediate	14	3.7
Healed ridge	367	96.3
Implant macrogeometry shape		
Cylindrical	313	82.2
Conical	67	17.6
Needle	1	.3
Implant morphology		
Bone level	111	29.1
Tissue level	270	70.9
Inclination		
Straight	368	96.6
Tilted	13	3.4
Sign of inflammation		
Abscess	316	82.9
Mobility	59	15.5
Pain	21	5.5
Bleeding	16	4.2
Suppuration	14	3.7
Swelling	13	3.4
Fistula	8	2.1
Cause of removal		
Peri-implantitis	346	90.8
Hardware	27	7.1
Others	8	2.1
Connection type		
None	20	5.2
Internal	319	83.7
External	42	11

One-way analysis of variance (ANOVA) test was used to compare means of implant duration through more than two levels of a categorical factor. The Pearson's correlation coefficient was estimated to assess the linear association between implant duration and other continuous variables (eg, a patient's age).

The significance level used in analysis was set at 5% ($\alpha = .05$). The *t*-tests reached a power of 92.5% in order to detect a small to medium effect size ($d = 0.35$) in a difference of means between two groups, which assumed the confidence to be at 95%.

Table 3 Prosthetic Variables

Variable	Overall (N = 381)	Percentage (%)
Prosthesis type, N (%)		
Overdenture	6	1.6
Fixed crown	229	60.1
Fixed bridge	123	32.3
Hybrid prosthesis	3	.8
None	20	5.2
Suprastructure design, N (%)		
Single	246	64.6
Multiple without cantilever	112	29.4
Multiple with cantilever	23	6
Type of retention, N (%)		
Removable	15	3.9
Cemented	233	61.2
Screwed	111	29.1
None	22	5.8
Years in function (prosthesis), N (mean)		
None	20	4.0
Fixed	229	3.9
Fixed bridge	123	4.2
Hybrid prosthesis	3	5.0
Overdenture	6	3.2

Table 4 Analysis of the Study Patients (N = 381) and Implants (N = 381)

Implant duration by independent factor	*P* value	Overall (N = 381)	Percentage (%)
Periodontal history, N (mean)	.924		
Yes		126	4.0
No		255	4.0
Smoking, N (mean)	.374		
Yes		131	3.8
No		250	4.1
Restoration type, N (mean)	.542		
Removable		15	4.4
Cemented		233	4.1
Screwed		111	3.8
None		22	3.7
Implant surface, N (mean)	.165		
Smooth		26	4.6
Rough		355	3.9
Prosthesis type, N (mean)	.560		
None		20	4.0
Fixed		355	4.0
Removable		6	3.2
Implant morphology, N (mean)	.049		
Bone level		111	4.4
Tissue level		270	3.8
Age, N (mean)	.042		
≤ 40 years		84	3.7
41–55 years		124	4.0
56–70 years		129	3.9
> 70 years		44	4.7

RESULTS

Population and Implant Characteristics

The sample consists of 381 implants, all of which had to be removed for several reasons. Patient-level characteristics are all presented in Table 1. Patients were recruited among the population who presented to the Department of Oral Surgery at the George Eastman Dental Hospital in Rome, Italy, and required the removal of dental implants.

Implants-level characteristic are presented in Table 2. Mean survival time (ie, years between implant placement and removal) was estimated at 4.0 ± 2.3 years. Independent factors were analyzed for their association with implant survival.

There was a very small, non-significant difference in mean survival (3.9 vs 4.6 years on average, respectively), between implants with modified or non-modified surfaces (see Table 2).

Prosthetics

Not all implants were in function, some were removed before they were restored (5.8%) and they were considered cases of early failures. Tables 3 and 4 shows the characteristics and types of included implant-supported prosthetics, as well as the implant connection type.

The majority of the removed implants displayed a variety of signs of clinical inflammation (see Table 2). Regarding cause of removal, peri-implantitis was by far the most frequent compared to all other reasons, with 314 (82.4%) implants. The second most common cause for implant removal was malposition, which was equally as frequent as loss of osseointegration (4.5%).

Among the clinical signs present, some implants also displayed (59 implants total) mobility. Other causes for removal were identified as functional overload (3.8%), implant fracture (2.5%), abutment screw fracture (0.8%), trauma to adjacent anatomical structures (ie, nerve injury) requiring removal (0.5%), and selection of an inappropriate implant diameter causing prosthetic issues (0.5%). The mean implant survival rate was significantly

Table 5 General Characteristics of the Study Patients (N = 314) and Implants (N = 314) Regarding Peri-implantitis as a Cause of Removal

Variables	*P* value	Overall (N = 314)	Percentage (%)
Mean survival (y), mean (SD)		4.3 (± 2.2)	
Prevalence by arch, N (%)	.063		
Maxillary		172	54.7
Mandibular		142	45.3
Marginal bone loss			71.97
Smoking behavior	.033		
Yes		103	32.8
No		211	67.2
Periodontal history	.537		
Yes		107	33.8
No		207	66.2
Implant surface	.167		
Rough		288	92
Smooth		24	8
Connection type	.059		
Internal		254	80.8
External		40	12.7
None		20	6.3
Prosthetic restoration	.720		
Fixed		286	91
Removable		13	4
None		15	5
Retention type (only for fixed prostheses)	.692		
Cemented		195	68
Screw-retained		91	38
Mean survival (y), mean (SD)	.049		
Bone level		4.4 (± 2.2)	
Soft tissue level		3.8 (± 2.3)	
Surgical treatment for peri-implantitis	–		
Open flap debridement		81	65.9
Resective treatment		23	18.7
Reconstructive treatment		19	15.4

different between bone-level and tissue-level implants (see Table 5).

Implant survival was not significantly affected by the cause of removal, meaning that implants affected by peri-implantitis, implant/screw fracture, and implant malposition (including trauma to anatomical structures and adjacent teeth) all had similar survival rates. Smokers (irrespective of number of cigarettes) did not have a shorter implant survival time compared to nonsmokers in this cohort.

Peri-implantitis

The mean survival of implants removed due to peri-implantitis was 4.3 ± 1.5 years. Characteristics of peri-implantitis affected implants are described in Table 5. The average percentage of MBL at which implants with peri-implantitis were removed was 71.9% ± 7.4%. Note that among implants removed due to peri-implantitis, the majority were in nonsmokers.

There was a marginally significant difference in the number of implants removed due to peri-implantitis between the maxillary and mandibular arch, (*P* = .063), with more implants being removed for this reason in the maxilla. No difference in prevalence of peri-implantitis was found between patients with (33.8%) and without (66.2%) a history of periodontal disease. Further, no difference could be found regarding implant surface, prosthetic reconstruction, or type of connection. Most of the implant that were studied composed of rough surface implants, those of which 81.6% had peri-implantitis. Smooth surface implants represented a much smaller part of the cohort. Note that peri-implantitis was the leading cause of removal in smooth surface implants as well.

In the present study, there was a significant difference in survival time (years) between bone-level and soft tissue-level implants; however, the two implant morphologies did not differ in prevalence of peri-implantitis. Regarding the type of connection, implants with an internal connection were more often removed due to peri-implantitis compared to external connection implants.

When assessing the types of prosthetic restorations that were removed due to peri-implantitis, the vast majority were fixed restorations (95.7%) and only 13 (4.3%) were removable. Among all implants with fixed restorations removed due to peri-implantitis, the majority were cement-retained and about one third were screw-retained; note that, once again, these differences were not significant.

In some cases, prior to implant removal, an attempt was made to treat the implants failing due to peri-implantitis. In such cases, implants were removed due to progression of peri-implantitis. Moreover, the implants were eventually removed due to progression of peri-implantitis. In 32.4% (123 implants) of cases, the implants had undergone surgical treatment for peri-implantitis with either an open flap debridement, a resective modality, or a reconstructive modality. Of the treated implants, 65.9% of them had received open flap debridement, 18.7% (23 implants) had received a reconstructive modality (with a resorbable membrane

and a bone graft), and respective treatment was performed in 19 implants (15.4% of the total). In this case, the exposed implant threads were removed with an implantoplasty procedure where the flap was apically positioned.

None of the treated implants received nonsurgical therapy alone for the treatment of peri-implantitis prior to explanation. On the other hand, surgical treatment of peri-implantitis was always preceded by nonsurgical submucosal instrumentation. Figure 1 shows an implant removal due to peri-implantitis.

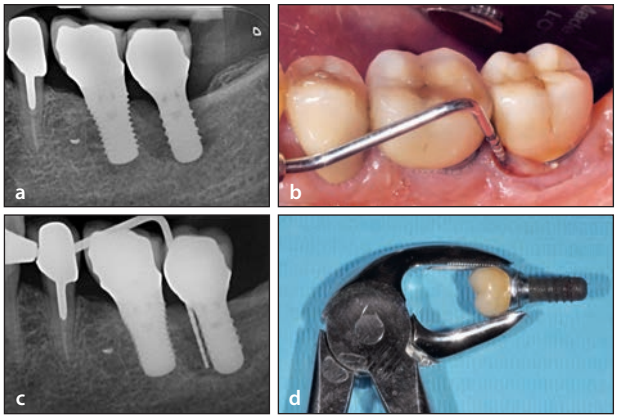

Fig 1 *(a)* Failing dental implant in the mandibular left quadrant. *(b)* Deep pocket probing with bleeding and suppuration. *(c)* Radiograph with a periodontal probe indicating defect depth. *(d)* Extracted implant.

DISCUSSION

In the present study, the majority of implants were removed due to late failures for various causes while only 5.8% of implants were lost due to early failures. This relatively low value (in comparison with the rate of late failures found in the sample) could potentially depend on the fact that many patients had a follow-up several years after they had received implant treatment. According to Basson et al,[5] the rate of early failures was approximately 1.99%, while Kang et al[9] found an early failure rate of 4.4% in a single implant system. In addition, Feher et al[10] reported a rate an early implant failure of 0.7%. The rate of early failures reported in the present sample was higher; however, this population was not well controlled and the implants were almost always placed elsewhere. This could also explain the variability observed in the present study.

In the present sample, the mean implant duration was estimated at 4.0 ± 2.3 years. Among causes of removal, over 80% of the implants had to be removed due to peri-implantitis. Derks et al[11] found that bone loss in cases of peri-implantitis accelerated in a nonlinear fashion. After 5 years post-placement, 73% of the analyzed implants had at least 1 mm of bone loss and 81% of the patients had detectable bone loss after 3 years from implant placement. The present findings are comparable with this data because peri-implantitis (requiring implant removal according to the surgeon) was detected after an average of 4 years after implant placement. This is a relatively shorter period of time compared to the data found in the literature[12] that reported, based on the *Consensus Report of the Sixth European Workshop* in Periodontology, an incidence of mucositis of up to 80% and of peri-implantitis between 28% and 56% after 10 years.

Possibly this could depend on the patient population included in this sample. Many patients requested medical attention due to pain or discomfort of implants placed elsewhere. Furthermore, data on timing of implant placement were extrapolated from the patient's own recollection, which could have been faulty and imprecise.

The average bone loss (percentage) at which implants were removed in the present sample was 71.9% ± 7.4%. In cases of late failures, Wentorp et al[13] found similar data with a relative bone loss of 66.2% ± 23.7%. Removal of implants affected by peri-implantitis is generally recommended when bone loss exceeds 50% of the implant length, as this is associated with a poorer prognosis of surgical treatment of peri-implantitis.[14]

History of periodontitis is one of the most acknowledged risk factors for developing peri-implantitis. Roos-Jansåcker (part 2 and part 3),[15,16] Roccuzzo et al,[17] and Karoussis et al[18] found an odds ratio of 5.0 for implants placed in patients with a history of periodontitis compared to periodontally healthy patients, which was similar to Koldsland's et al[19,20] reported odds ratio of 6.0. Evidence also shows that current periodontitis, especially in severe forms, may represent a strong indicator for peri-implantitis.[11,21] On the other hand, the present sample could not confirm an association between history of periodontitis and peri-implantitis. This is in line with other evidence in the literature. Marrone et al[22] found no significant association between history of periodontal disease and smoking in a sample of 112 implant patients with a 5-year follow-up. In the present sample, the lack of association could potentially be due to the method of assessing periodontal disease because it was determined on panoramic images, which are known to be imprecise when measuring alveolar bone levels. Furthermore, the investigator relied on the patients to report the reason for tooth loss which could lead to imprecise findings.

Smoking is considered to be a risk factor for early and late dental implant failures.[23] This is in accordance

with our data, which showed that the leading cause of implant removal in both smokers and nonsmokers was peri-implantitis. According to the systematic review by Dreyer et al,[24] there was a statistically significant association between smoking and peri-implantitis, with a 2-fold higher risk of developing peri-implantitis for smokers than for nonsmokers. In the present cohort, however, no significant difference was found in the rate of peri-implantitis between smokers and nonsmokers. Although the reason for this observation was not fully understood, it could be explained by the fact that smoking is a self-reported variable and patients may not always be truthful regarding such habits.

Regarding surfaces, rough implant surfaces have also been associated with a higher risk of developing peri-implantitis. This is thought to be related to a higher rate of bacterial adhesions and growth on rough surfaces.[25] In the present study, the modified implant surface group included several different surfaces (SLA, TPS, or TiUnite), but it was decided to group the implants into two major categories, just as other authors did.[26] Because of this, the vast majority of our samples were rough surface implants (314 implants), while only 24 implants had a smooth/machined surface. Marrone et al[22] reported a statistically significant association between rough (TPS) surface and peri-implantitis in an adult population on average 8.5 years after placement. This contrasts with the results of the present study, in which there was no significant association between the frequency of peri-implantitis among the removed implants and the type of surface texture (smooth vs rough). On the other hand, some studies in the literature[27] did not find a significant association between surface roughness and the rate of peri-implantitis. In the present study, the relatively small number of smooth surface implants could explain the lack of a significant association, and therefore results must be interpreted with great care.

The number of implants failing—and thus requiring explantation—due to peri-implantitis was higher in the maxilla in the present cohort with a marginally significant difference ($P = .063$). This finding aligns with the results by Rosen et al[28] who reported an increased relative risk of 1.24 regarding the development of peri-implantitis in maxillary implants versus mandibular implants. However, peri-implantitis has been reported to be higher in the maxillary arch by previous studies.[29]

Regarding the implant design, bone-level implants are commonly placed with a stage-two submerged procedure and soft tissue–level implants usually heal transmucosally. Soft tissue–level implants have a transmucosal segment, which is an integral part of the implant body, and thus the prosthetic margin shifts coronally away from the crestal bone. Because of this, there is no micro gap present at the bone level as seen in bone-level implants. In the present study, the survival time was greater for bone-level implants than for soft tissue–level implants; however, the rate of peri-implantitis was similar among implant morphologies. This contrasts with some evidence reported in the present literature that suggests that soft tissue–level implants could be less susceptible to peri-implant disease.[11,30] On the other hand, a recent retrospective study on a large patient cohort also found a longer implant retention time for implants placed with a stage-two submerged protocol, such as bone-level implants compared to tissue-level implants with a transmucosal healing protocol.[28]

External connection implants were more frequently removed in our study due to peri-implantitis compared to internal connection counterparts. Evidence in the literature suggests that external connection implants may be associated with greater crestal bone loss; however, to the author's knowledge, no human studies have evaluated the prevalence of peri-implantitis when comparing types of connections. Koutouzis et al[31] summarized the evidence on microbial leakage in different types of connections and concluded that bacterial infiltration was reduced when internal conical connection systems were used. In a systematic review investigating the differences in bone levels among internal versus external connection implants, the authors reported consistently lower bone resorption around implants with internal conical connections compared to external connections.[32] This is somewhat in line with the present results; note that data in literature could be found only for crestal bone resorption and/or remodeling but not for the prevalence of peri-implant diseases.[33]

Regarding mode of retention, cement-retained prostheses may be predisposed to increased rates of peri-implantitis if excess cement is present. In the present study, the presence of cement on the removed implant surface was not noted; however, evidence in the literature has highlighted the potential role that excess submucosal cement has in predisposing patients to peri-implant disease. In the systematic review in 2017 by Staubli et al,[34] they reported that the prevalence of cement was found to be between 33% and 100% among implants with peri-implantitis. In a retrospective study by Linkevicius et al,[35] the prevalence of peri-implantitis in cement-retained restorations was found to be 75%, whereas only 0.8% of the screw-retained restorations displayed peri-implantitis. The explanation behind the pathogenic influence of cement is believed to lie in its effect as a predisposing factor for biofilm accumulation due to its rough surface in conjunction with a limited access to the submucosal region.

In the current study, peri-implantitis was by far the main cause of implant removal (82.4% of all implants). The majority of the fixed implant-supported

restorations (63.7%) were cement-retained and among these, 83.7% were removed due to peri-implantitis, which highlights the high prevalence of both cement-retained restorations and peri-implantitis in the present study. However, no significant differences could be found in occurrence of peri-implantitis between implants with cement-retained or screw-retained restorations ($P = .692$).

Regarding the treatment of peri-implantitis, a recent meta-analysis reported an average failure rate of implants after peri-implantitis surgery of approximately 1% after 1 year and 4% after 3 years. After 3 years, nonreconstructive peri-implantitis surgeries showed a significantly higher failure rate compared to reconstructive modalities (8% vs 1%, respectively).[36] Disease progression with further MBL was found to be the main cause for removal. In the present study, approximately a third (32.4%) of the eventually removed implants, due to peri-implantitis, were treated with various surgical approaches; however, these were unable to stabilize the peri-implant condition and halt peri-implantitis progression. The implants were therefore removed due to continued bone loss and presence of mucosal inflammation.

Good oral hygiene and compliance with peri-implant maintenance therapy are usually associated with lower risk of developing peri-implant mucositis and peri-implantitis. On the other hand, patients failing to comply with the recommended maintenance intervals tended to develop peri-implantitis and required substantially more treatment compared to those who attended their maintenance appointments regularly.[17,37] In the present study, the majority of the patients did not undergo regular supportive peri-implant care. According to Monje et al,[38] the rate of compliance with supportive peri-implant care approximated 40%, which reached about 60% when patients had already been treated for peri-implantitis. This implies that there is a high rate of patients who do not comply with the recommended supportive peri-implant care. This could be due to patients who are not being adequately informed at the time of implant placement (as reported by Monje et al)[38] or patients who have a low socioeconomic status. In any case, the high percentage of patients not complying with maintenance appointments could contribute to the extremely high prevalence of peri-implantitis in the sample.

CONCLUSIONS

The current sample distinctly showed that peri-implantitis was the predominant cause of removal. The mean MBL at implant removal was at around 72%. Notably, in this described cohort, no significant association between potential risk factors and the occurrence of peri-implantitis was identified.

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The authors report no conflicts of interest.

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