

Retrospective analysis of periimplantitis therapy of 158 implants

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Abstract

Objective

The objective of the retrospective analysis was to evaluate the efficacy of periimplantitis treatment up to a five-year observation period.

Materials and methods

Patients treated for periimplantitis between 2009 and 2015 were included. Before therapy, the patients underwent professional tooth cleaning, defect class diagnosis and thorough mechanical cleaning of the implant surface. In the case of intraosseous defects, a deproteinized bovine bone mineral and a native bilayer collagen membrane were used according to the concept of guided bone regeneration. Retrospectively, plaque index, full-mouth bleeding on probing and probing pocket depth were analyzed before the therapy and at recall visits up to 56 months after therapy.

Results

Out of 22,724 implants, 107 patients with 158 implants underwent periimplantitis therapy and these had been in place for nine months to 15 years. Fifteen implants (9.49%) had to be extracted despite therapy. Most of the periimplantitis infections had occurred within five years after implantation (108 implants; 68.4%). In 45 implants (28.5%), therapy had included guided bone regeneration. Before therapy, bleeding on probing was 100%. Bleeding on probing was absent in 50.0% of implants at 12 months and in 73.1% of implants examined 49–56 months post-therapy. Probing pocket depth was reduced from 4.92 ± 1.93 mm before therapy to 2.67 ± 0.88 mm after 12 months and remained stable up to 56 months post-therapy (2.71 ± 0.30 mm).

Conclusion

Using a treatment approach including a presurgical hygiene phase and considering the defect morphology, periimplantitis therapy was mostly successful in terms of implant survival (90.5%).

Keywords

Periimplantitis, oral hygiene, defect class, guided bone regeneration.

Introduction

Implant therapy is a well-established method to restore missing teeth. However, periimplant tissue infections due to biofilm formation may compromise implant survival. The term “periimplantitis” describes an inflammatory process in the periimplant mucosa with additional signs of bone loss.¹ Periimplantitis occurs in around 10% of implants and 20% of patients.^{1–3} A very recent meta-analysis reported a mean prevalence of 22% (CI: 14–30%) for periimplantitis.⁴

Risk factors for periimplantitis are poor plaque control, history of periodontitis, smoking, uncontrolled diabetes, periimplant cement residue, genetic factors, occlusal overload and history of periimplantitis.^{5,6} Current strategies for periimplantitis therapy include a pretreatment phase with professional tooth cleaning, optimization of plaque control with prosthesis adjustment if necessary and nonsurgical debridement.^{7–9} Afterward, in the surgical phase, a full-thickness flap is prepared and the contaminated implant surface is thoroughly cleaned. Intraosseous defects can be filled using a bone substitute or tissue graft material with or without a resorbable membrane. The postsurgical protocol includes systemic antibiotic therapy and chlorhexidine rinsing during the healing phase, followed by the maintenance phase with regular recall visits, ranging from three to six months.

Regenerative surgical therapy has been shown to predictably obtain partial to full defect fill,¹⁰ although the outcome may be influenced by the defect morphology¹¹ and implant surface.¹² According to the concept of guided bone regeneration (GBR), the use of a deproteinized bovine bone mineral (DBBM) either with or without a native bilayer collagen membrane (NBCM) has been evaluated in various clinical studies and demonstrated marked short-term clinical improvements and promising long-term results.^{12–16} The aim of our retrospective evaluation was to analyze the efficacy of the periimplantitis treatment with or without bone augmentation in patients over a long-term observation period up to five years post-therapy.

Materials and methods

Study population

The retrospective evaluation included 107 patients with 158 implants that were treated for periimplantitis between 2009 and 2015. Im-

plants had been inserted between 1993 and 2014 by the same surgeon (JUW) according to the manufacturers' instructions. Implant systems included Steri-Oss (Nobel Biocare, Zurich, Switzerland), CAMLOG implant system (Cylinder Line, Screw Cylinder Line, Root-Line, SCREW-LINE, SCREW-LINE Promote plus, iSy, CAMLOG Biotechnologies, Basel, Switzerland), ITI and Straumann implants (Straumann, Basel, Switzerland), FRIALIT 2 (Dentsply Sirona, Mannheim, Germany), XiVE (Dentsply Sirona), ASTRA TECH OsseoSpeed (Dentsply Sirona), IMZ Twin-Plus (Dentsply Sirona) and ANKYLOS (Dentsply Sirona). If necessary, bone augmentation procedures were performed before or during the implantation. After completion of the healing phase, the patients were referred back to their dentists or prosthodontists for further prosthetic treatment and follow-up. Later on, some of those patients were referred to our practice again because of periimplantitis.

Therapy

Before periimplantitis treatment, clinical and radiographic evaluation took place. In the case of acute inflammation, anti-inflammatories were locally applied. Patients underwent professional tooth cleaning and periodontal therapy in the case of generalized periodontitis.

Periimplantitis was classified and treated in accordance with Schwarz et al. (**Fig. 1**).^{17,18} After exposing the defects and removing granulation tissue, implantoplasty was performed using diamonds rotary instruments and Arkansas stones finishing burs. Defects were cleaned with sterile saline. Intraosseous defects (defect Classes Ib, c, d and e; **Fig. 1**) were augmented according to the treatment protocol using a DBBM (Geistlich Bio-Oss spongiosa granules, Geistlich Pharma, Wolhusen, Switzerland) and an NBCM (Geistlich Bio-Gide Perio, Geistlich Pharma). The surgical area was carefully closed, a periodontal wound dressing applied (Coe-Pak, GC Europe, Leuven, Belgium) and a radiographic evaluation performed. Patients were advised to rinse cautiously with chlorhexamed 0.2% (GSK, London, U.K.) from the first day postsurgery for one week. Antibiotics were given at the discretion of the surgeon starting 24 h before surgery until suture removal eight days postsurgery. Patients were followed up according to a strict recall schedule in our practice. If necessary, supplementary therapy, such as gingivectomy or implantoplasty, was performed during the follow-up phase.

Fig. 1

Defect classes and treatment protocol according to Schwarz et al.^{17,18}

Ia (buccal vertical bone dehiscence),

Ib (buccal dehiscence and semicircular bone defect to the middle of the implant body),

Ic (buccal dehiscence, circular bone defect, maintained lingual solid bone),

Id (buccal and lingual dehiscence defects),

Ie (circular bone resorption, buccal and oral compacta maintained),

II (supra-alveolar circumferential bone loss).

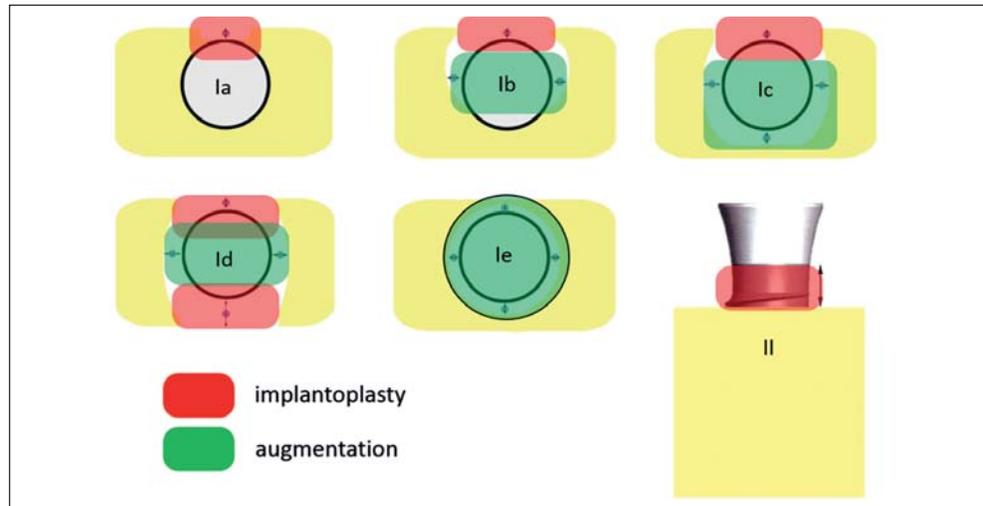


Fig. 1

Analysis

Both hopeless implants extracted before the periimplantitis therapy and implants treated by a different dentist with incomplete data were not included in our evaluation. Data for the clinical evaluation were retrieved retrospectively from the patient files in our practice and included plaque index, full-mouth bleeding on probing (BOP) and probing pocket depth (PPD). PPD was measured from the mucosal margin to the bottom of the probeable pocket mesially, distally, orally and vestibularly at the start of the periimplantitis therapy and during recall visits in our practice at 3, 6, 9, 12, 24, 36, 48 and 49 to 56 months. In order to evaluate possible risk factors for periimplantitis, signs of prosthetic deficiencies at the start of the therapy were analyzed, as was history of periimplantitis. Additionally, patient files were analyzed to identify smoking, bisphosphonate intake and diabetic patients at the time of implantation.

In order to analyze the prevalence of periimplantitis per indication, implants were allocated to one of the following indication classes as defined at the consensus conference of the BDIZ EDI, DGI, DGMKG, DGZI and BDO (national German dental associations) on Oct. 8, 2014:

- Ia: single-tooth replacement in the anterior area;
- Ib: single-tooth replacement in the posterior area;
- IIa: interdental space;
- IIb: free-end situation;
- IIc: greatly reduced residual dentition; and
- III: edentulous jaw.

In an additional subanalysis, implants inserted between 1993 and 2014 were evaluated for primary indication classes and the rate of explanations.

Statistical analysis

The following exploratory tests were performed:

- To test the null hypothesis of no association between indication class and the need for implant therapy, the approximate chi-squared test for association was used. The significance level was set at 5%.
- All pairs of indication classes were tested against each other using the same chi-squared tests. In order to avoid inflation of Type I error due to multiple testing, all *p*-values were multiplied by the number of such comparisons (15; Bonferroni correction).
- Each indication class was compared to all other indication classes pooled using the chi-squared tests already mentioned above. Since there were six comparisons, *p*-values were multiplied by six (Bonferroni correction) to account for multiple testing.

Results

Between 1993 and 2014, a total of 22,724 implants were inserted in 9,429 patients in our practice and patients were then referred back to their prosthodontists or treating dentists for prostheses. During the observation period of our evaluation (2009–2015), 516 of those patients

Fig. 2

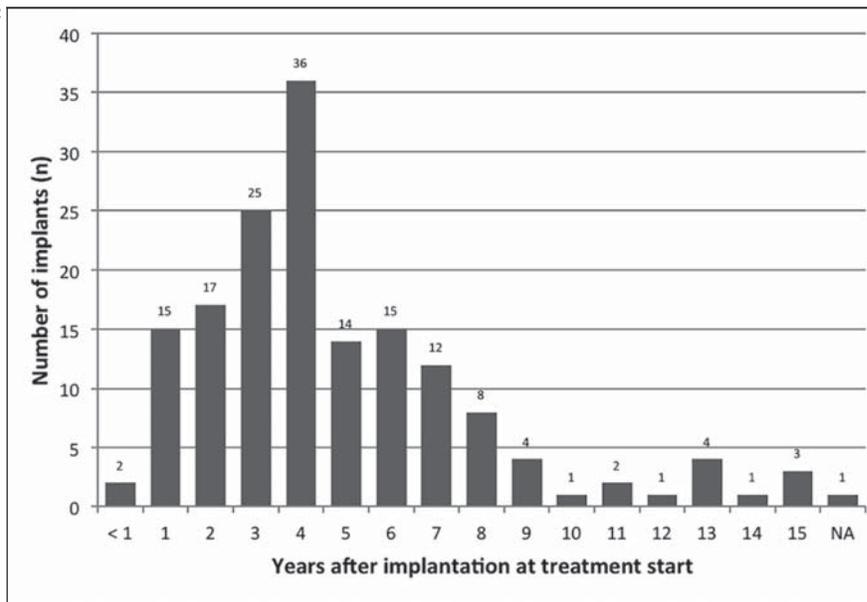


Fig. 2

Time after implantation in years at start of periimplantitis therapy. (NA = unknown; $n = 158$).

with a total of 637 implants were referred back to our practice owing to periimplantitis. Of these, 471 implants were deemed hopeless and extracted immediately (73.9%). Eight implants for which periimplantitis therapy was planned had to be extracted at the start of the treatment phase. Thus, periimplantitis therapy was initiated for 158 implants in 107 patients (24.8%). Analysis of the original patient files established that cemented reconstructions were used in 128 implants (77.6%) and screw-retained reconstructions in 37 implants (22.4%). The 158 implants had been in place for nine months to 15 years (**Fig. 2**). Most of the periimplantitis infections had occurred within the first five years after implant insertion (108 implants; 68.4%). In one implant, this period was retrospectively not clearly determinable. Seventy-two implants treated with periimplantitis therapy were located in the maxilla (45.6%) and 86 in the mandible (54.4%). The distribution of the implantation sites is shown in **Figures 3a and b**. Before the observation period of our evaluation, 17 implants had been explanted owing to periimplantitis and replaced (10.8%). The newly inserted implants developed periimplantitis again.

Of the patients referred back to our practice and treated for periimplantitis, 41 were male (38.3%) and 66 were female (61.7%). The mean age of the 107 patients at the start of the periimplantitis therapy was 58 ± 11 (23–85) years. At the time of implantation, 18 of the 107 patients

were smokers (16.8%), three had received bisphosphonate treatment (3.80%), five had diabetes mellitus (4.67%) and 81 did present any conspicuous medical findings (75.7%), based on the original patient files. The following prosthetic deficiencies of the implants were identified in 25 of the 107 patients (36%): formation of marginal gaps, overcontouring, overload, insufficient biological width, unnecessary splinting and cement residue.

In 52 of the 107 patients (48.6%), generalized periodontitis was diagnosed for 79 implants (50.0%) and treated accordingly. The distribution of the periimplantitis defect classes is shown in **Figure 4**. In 45 implants (28.5%), the therapy included GBR using a DBBM and an NBCM. The remaining 113 implants underwent professional tooth cleaning and were treated according to the implantoplasty protocol. At the start of the periimplantitis therapy, the BOP of the 158 implants was 100.0% and the plaque index was on average $48.5 \pm 26.6\%$ ($n = 88$).

After initiation of the periimplantitis therapy, the mean vestibular PPD of the 158 implants was reduced from 4.93 ± 1.94 mm to 2.67 ± 0.88 mm after 12 months ($n = 123$) and 2.71 ± 0.30 mm after 49–56 months ($n = 32$; **Figs. 5a & b**), therefore on average below the level stated for the definition of periimplantitis.⁹ Stable PPD reduction was also found for implants with long-term follow-up data 49–56 months post-therapy (**Fig. 6**). BOP was absent in 50.0% of 58 analyzed implants at 12 months

Figs. 3a & b

Number of affected implants per site: **(a)** maxilla **(b)** mandible. (*n* = 158).

Fig. 4

Defect classes at the start of periimplantitis therapy according to Schwarz et al.^{17,27}

Figs. 5a & b

(a) Box plot of pocket depth preoperatively and three, six, nine and 12 months after the start of periimplantitis therapy. (m = mesial; v = vestibular; d = distal; o = oral; *n* = 123–158).

(b) Box plot of pocket depth after 24, 36, 48, and 49 and more months after the start of periimplantitis therapy. (m = mesial; v = vestibular; d = distal; o = oral; *n* = 16–158).

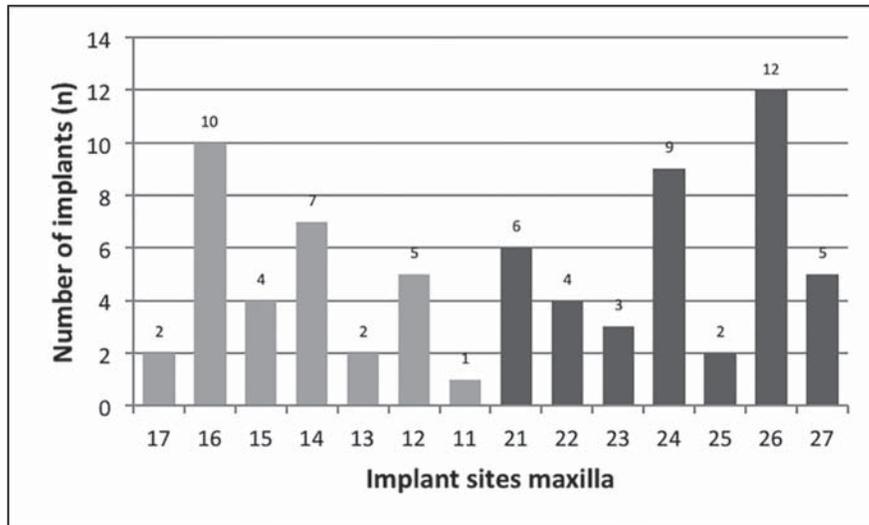


Fig. 3a

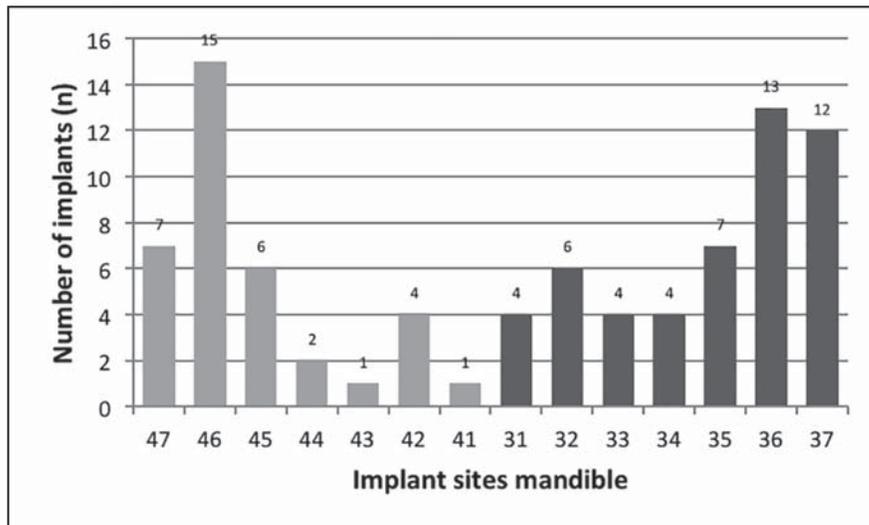


Fig. 3b

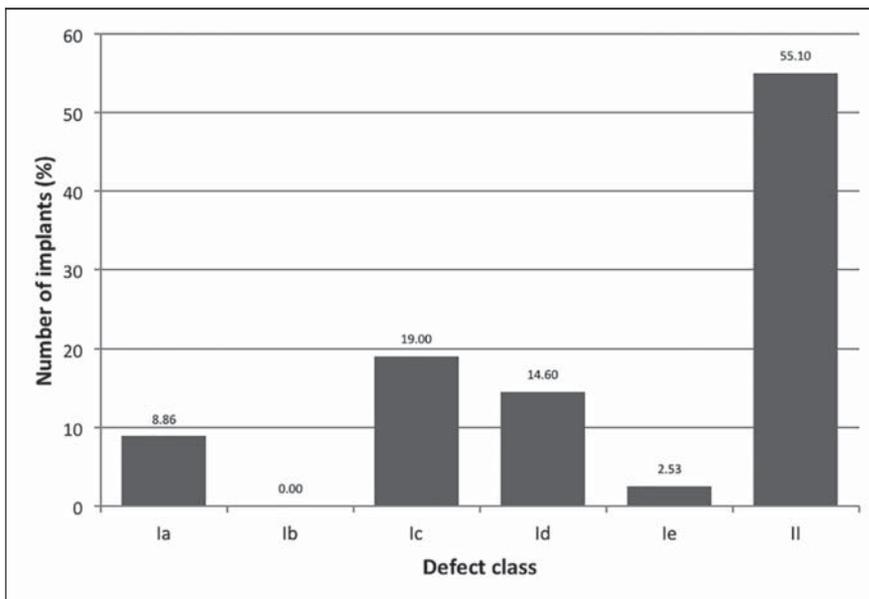


Fig. 4

Fig. 5a

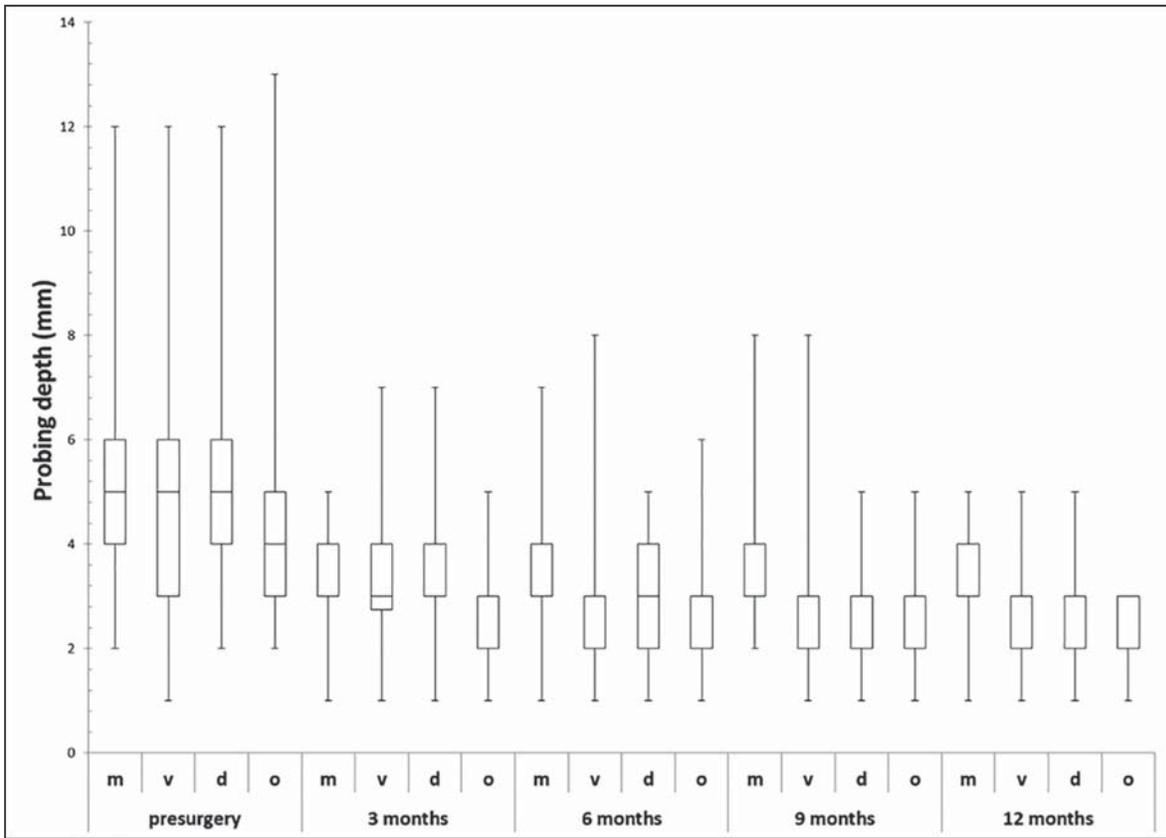


Fig. 5b

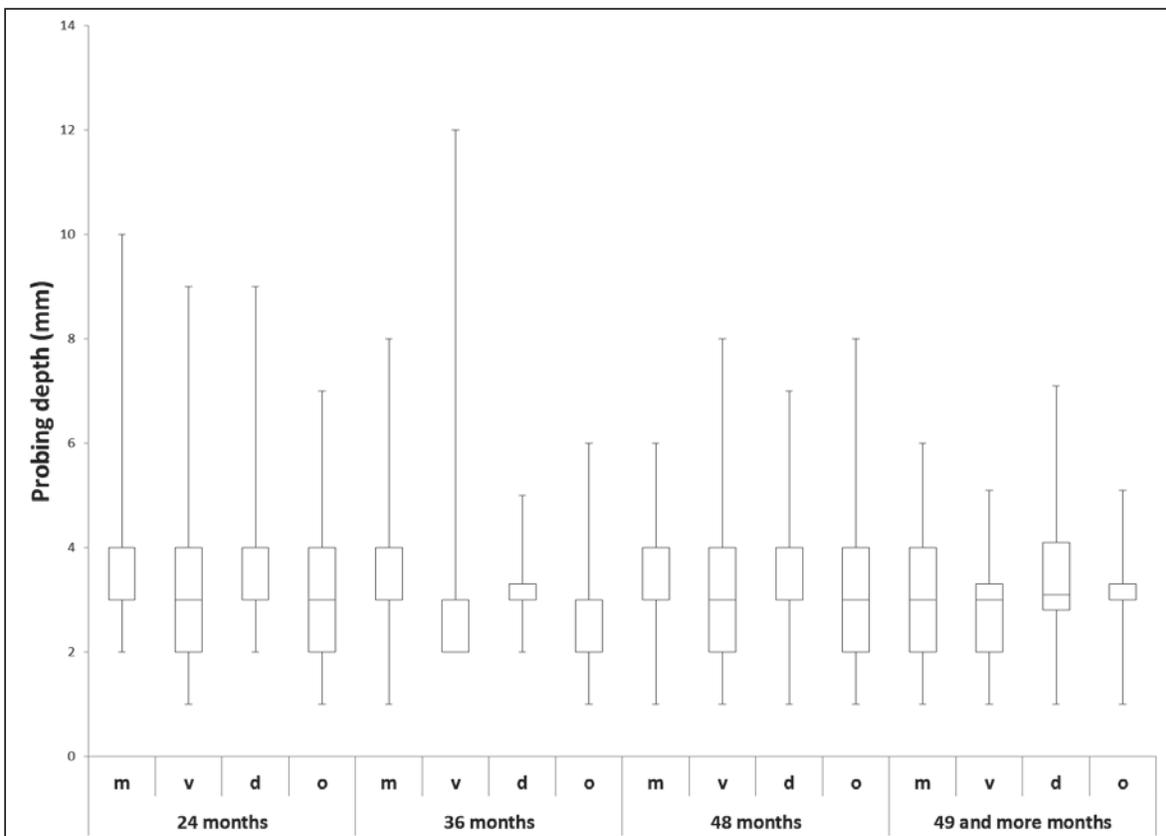


Fig. 6

Pocket depth after 49 and more months compared with pocket depth at 12 months in all treated implants. (m = mesial; v = vestibular; d = distal; o = oral; 12 months: $n = 158$; 49 and more months: $n = 16$).

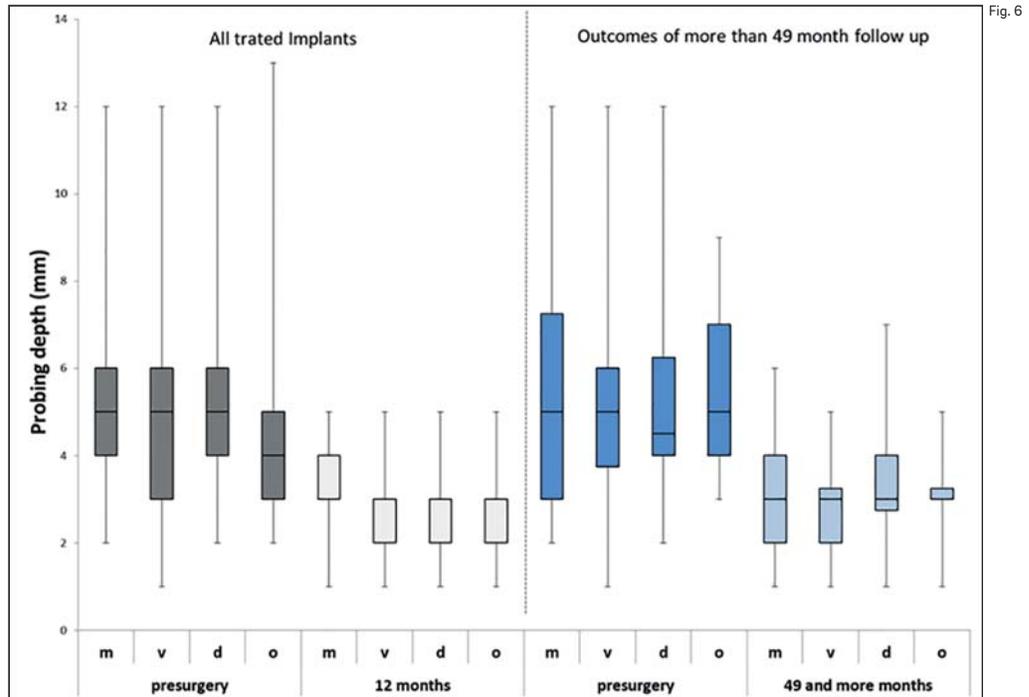
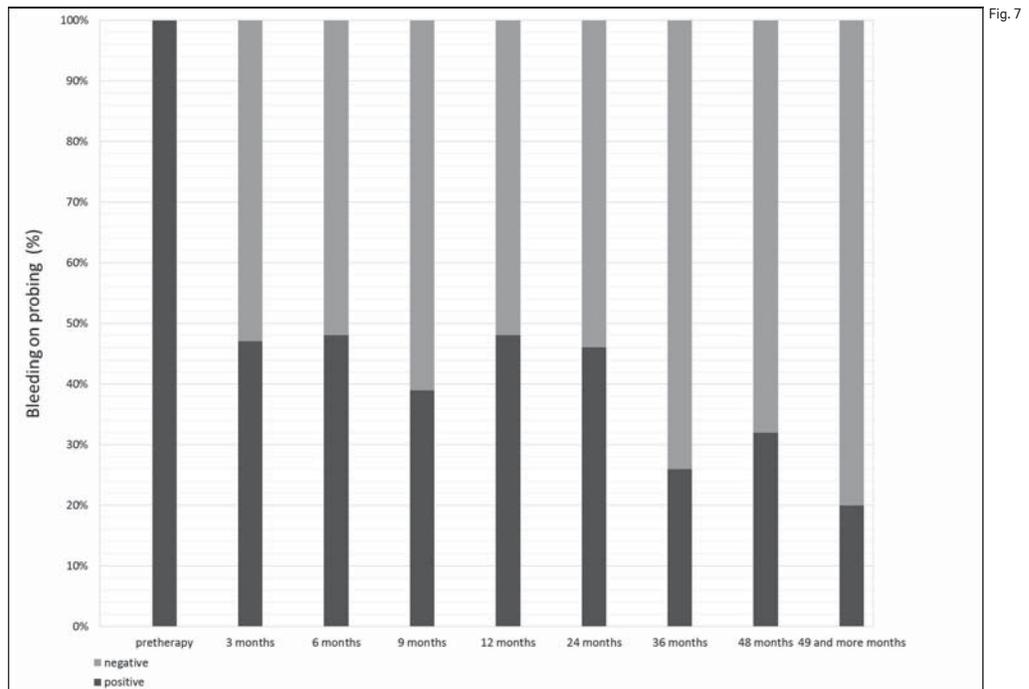


Fig. 7

Number of implants showing BOP before periimplantitis therapy and at recall visits up to 49 and more months after the start of the therapy. ($n = 8-158$).



after the periimplantitis therapy and in 73.1% of 26 implants evaluated with long-term data available 49–56 months post-therapy (**Fig. 7**).

During the follow-up period, one treated implant had to undergo additional gingivectomy and eight repeated implantoplasties. Despite treatment, 15 implants had to be explanted

during the follow-up period (9.49%), three of these in patients with diabetes, one in a smoker and two in which the therapy included an intraosseous defect treatment.

Evaluation of the original data files for the 158 treated implants established that bone augmentation procedures using a DBBM and an

Table 1

Implant system	Number of implants inserted	Number of explantations	% loss due to explantations
ANKYLOS	191	5	2.62
ASTRA TECH	1177	21	1.78
CAMLOG .Cylinder Line	4888	578	11.80
CAMLOG Screw Cylinder Line	1783	63	3.53
CAMLOG ROOT-LINE	289	21	7.27
CAMLOG SCREW-LINE	747	34	4.55
CAMLOG SCREW-LINE Promote plus	8014	105	1.31
CAMLOG iSy	62	2	3.23
Dentegris	6		0.00
FRIALIT 2	2042	234	11.50
IMZ TwinPlus	499	67	13.40
ITI	37	1	2.70
Nobel	11		0.00
Straumann	324	30	9.26
XiVE	2430	53	2.18
Others	155	15	9.68
Implant type not classified	69	10	14.50
Total	22724	1239	5.45

NBCM had been performed in 20 implants (12.7%) before or simultaneously with the implantation. Autologous bone had been used additionally for one of these. No initial augmentation had been performed in 127 implants (80.4%), while this information was not available for 11 implants (6.96%). The augmentation rate of all 22,724 implants inserted between 1993 and 2014 was 31%. In an additional subanalysis, for all 22,724 implants, the explantation rate was evaluated per implant system (Table 1). Of these, 1,239 implants were explanted owing to periimplantitis (5.45%). The highest rates of explantations were noted for the CAMLOG Cylinder Line, FRIALIT 2 and IMZ TwinPlus.

Statistical analysis of the null hypothesis of no association between indication class and the need for implant therapy applying the chi-squared test yielded a p -value of 0.0056. Thus, at the 5% level of significance, the hypothesis of no differences across indication classes with respect to the need for periimplantitis therapy might be withdrawn. Comparing the implant indication classes between all 22,724 implants and the 158 implants that underwent periimplantitis therapy, free-end situations (indication Class IIb) tended to be more frequent in the periimplantitis group ($p = 0.07$), while interden-

tal spaces (indication Class IIa) were significantly less frequent ($p = 0.02$). The frequencies of all other indication classes were not significantly different between all inserted implants and implants that underwent periimplantitis therapy (Fig. 8). However, in 2,728 of all 22,724 inserted implants (12%), the indication class could not be evaluated retrospectively.

Discussion

The retrospective evaluation presented here focused on the treatment of patients with implants placed between 1993 and 2014 in our practice and later treated again owing to periimplantitis. Of the implants that received periimplantitis therapy with or without GBR, treatment was successful in terms of stable reduction in PPD and BOP and implant survival of 90.5%, as only 15 of the 158 implants had to be extracted despite periimplantitis therapy over the observation period of our evaluation.

Our findings are in accordance with several reviews reporting successful surgical therapy of periimplantitis despite disease progression or recurrence.^{7,10,19,20} A recent meta-analysis compared the results for PPD reduction and radio-

Table 1

Distribution of implant systems: overall inserted implants and implants affected by periimplantitis between 1993 to 2014.

Fig. 8

Distribution per indication class at the time of implantation for implants treated for periimplantitis compared with all inserted implants. (All implants: $n = 22,724$; periimplantitis-affected implants: $n = 158$).

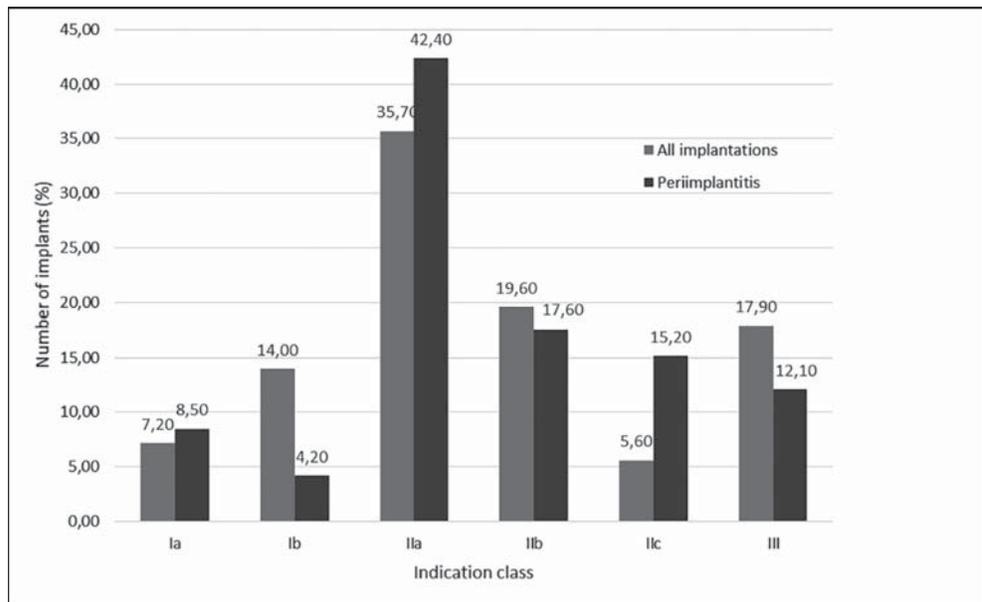


Fig. 8

graphic bone fill for different surgical approaches.¹⁹ Greater PPD reduction and radiographic bone fill were found when grafting materials and membranes were applied compared with procedures that used access flaps, debridement and resection. In another meta-analysis, greater PPD reduction and gain of clinical attachment were found when bone grafts and membranes were applied compared with a nonsurgical therapy.²¹ However, regenerative therapy has been shown to be more effective in contained, circumferential intrabony defects than in defects with buccal dehiscences or a predominantly suprabony component.¹¹ Therefore, in our evaluation, a treatment concept considering defect morphology according to the classification of Schwarz et al. was applied.^{17, 18} Interestingly, 36.1% of the implants with periimplantitis presented with a defect morphology allowing bone augmentation procedures. For financial reasons, in only 28.5% of the implants did periimplantitis therapy include bone augmentation. This included defect Classes Ib, c, d and e. The defect morphology of the remaining implants treated for periimplantitis corresponded to 55.0% Class II and 8.9% Class Ia defects. These defect types were therefore treated by anti-infective, resective therapy only.

For the regenerative treatment of intraosseous defects, we applied a DBBM and an NBCM. Our findings are in accordance with other reports that found encouraging results of periimplantitis treatment using a DBBM with or without an

NBCM. In a case series of 51 consecutively treated patients who presented with periimplantitis, Froum et al. used enamel matrix protein, a combination of a platelet-derived growth factor with anorganic bovine bone or mineralized freeze-dried bone and an NBCM.¹⁴ Bone level measured by periapical radiographs or bone sounding increased and remained stable up to 7.5 years after periimplantitis therapy. Positive results in terms of PPD reduction and radiographic bone fill after one year were also found using a DBBM and an NBCM in intrabony defects with a PPD > 5 mm.¹⁵ Using a DBBM, Aghazadeh et al. reported reduced PPD after 12 months and a higher likelihood of radiographic defect fill compared with autogenous bone.¹³ In two other studies, a significant defect reduction was achieved using a DBBM in implants with crater-like defects at the one-year follow-up.^{12, 16} These results, together with the data of our retrospective evaluation, demonstrate that periimplantitis treatment using a DBBM and an NBCM in defects with suitable defect morphologies may be clinically effective.

In our retrospective evaluation, only a quarter of the implants affected by periimplantitis underwent therapy while all other implants were regarded as hopeless and explanted. We support recommendations of other authors to include patients with implants in a strict maintenance program^{7, 8} as poor oral hygiene is a well-known risk factor for periimplantitis.⁸ However, this was probably not ensured in many of the cases

included in our evaluation, as almost half of the patients presented with generalized periodontitis at the start of the periimplantitis treatment. Therefore, periimplantitis may have proceeded in many implants to a stage that required explantation. In fact, a recent analysis demonstrated that implants provided with prostheses delivered by general practitioners were at higher risk of moderate and severe periimplantitis.²² Dentists who follow up on implant patients should be sensitized and should be instructed to establish strict maintenance programs according to consensus statements, especially regarding diagnosis of mucositis. Regular clinical monitoring with professional plaque removal and reinforcement of oral hygiene may also have been a main factor of the long-term success of the 158 implants that received periimplantitis therapy in our evaluation.

Simultaneous bone augmentation procedures at the time of implantation may bear higher risk of periimplantitis.^{23,24} The results of our retrospective evaluation, however, established that only 12.7% of the implants that received periimplantitis therapy had initially been inserted together with bone augmentation. Bone augmentation in all 22,724 inserted implants was 31%. The results indicate that implants in augmented sites are not more susceptible to periimplant infection than implants inserted without bone augmentation. Nevertheless, clear conclusions must first be drawn in clinical studies including both hopeless implants and implants suitable for periimplantitis therapy.

Various clinical studies have found smokers to be at higher risk of developing periimplant infections.^{6,25} A meta-analysis by Atieh et al. found a significantly higher frequency of periimplant disease in smokers (36%).² This is in accordance with the results of our retrospective evaluation, in which 16.8% of the patients who underwent periimplantitis therapy were smokers and 16.7% of the smokers had already undergone explantation and re-implantation previously. Uncontrolled diabetes and the intake of bisphosphonates are two additional risk factors for periimplantitis.^{6,25} In our retrospective evaluation, 4.67% of the patients were diabetic and 3.80% received bisphosphonates at the time of implantation. Lindhe et al. demonstrated that 5% of the patients that had undergone periimplantitis therapy and 23% of the patients in which explantations were performed despite the therapy had diabetes.⁶ These results support the conclusion that implant patients with

diabetes are at higher risk and should be informed accordingly. Similarly, bisphosphonates have been found to increase the risk of implant failure due to impaired implant osseointegration. However, a review has shown that successful long-term results of implant therapy can be achieved in patients despite bisphosphonate intake.²⁶ Our retrospective evaluation, however, does not provide a clear conclusion for negative effects of bisphosphonate intake or diabetes mellitus on the long-term survival of implants.

In an additional subanalysis, the overall explantation rate of implants placed between 1993 and 2014 was calculated to be 5.45%. Three implant systems presented with a failure rate of more than 10%. However, the number of periimplantitis patients who were not referred back and treated elsewhere is not known. Therefore, the analysis does not allow for definitive conclusions of the prevalence of periimplantitis affecting implants inserted in our practice.

Conclusion

In our retrospective evaluation, data from patients who were referred for periimplantitis treatment were analyzed. Using a treatment approach that included a hygiene phase and that considered defect morphology, PPD and BOP were improved and remained stable over more than four years post-therapy. Retreatments or explantations may be necessary and should be considered part of periimplantitis therapy. The results of our evaluation demonstrated that periimplantitis can be treated successfully and with good long-term results if a treatment approach is chosen based on defect morphology and on consensus recommendations and if patients are enrolled in a strict maintenance program. However, owing to the retrospective character of this evaluation, it is recommended that scientifically sound clinical trials be performed to further evaluate the efficacy of the periimplantitis treatment described here.

Competing interests

The expenses for statistical data analysis and description were covered by Geistlich Pharma, Wolhusen, Switzerland. Other than that, the authors declare that they have no competing interests.

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