Ten-year results of a three arms prospective cohort study on implants in periodontally compromised patients. Part 2: clinical results

Ten-year results of a three arms prospective cohort study on implants in periodontally compromised patients. Part 2: clinical results.

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Running Title: Implants in periodontally compromised patients

Abstract

Objectives: The aim of this study was to compare long-term outcomes of implants placed both in patients treated for periodontitis and in periodontally healthy patients (PHP).

Material and methods: One hundred and twelve partially edentulous patients were consecutively enrolled in private specialist practice and divided in 3 groups according to their initial periodontal condition: PHP, moderately Periodontally Compromised Patients (PCP) and severely PCP. Implants were placed to support fixed prostheses, after successful completion of initial periodontal therapy [**full-mouth plaque score (FMPS)**<25%, **full-mouth bleeding score (FMBS)** <25%]. At the end of active periodontal treatment (APT), patients were asked to follow an individualized Supportive Periodontal Therapy (SPT) program. Diagnosis and treatment of peri-implant biological complications was performed according to Cumulative Interceptive Supportive Therapy (CIST). At 10 years, clinical measures were recorded by two calibrated operators, blind to the initial patient classification, on 101 patients, as 11 were lost to follow-up. The number of sites treated according to therapy modalities C and D (antibiotics and/or surgery) during the 10 years was registered.

Results: Eighteen implants were removed for biological complications. Antibiotic and/or surgical therapy was performed in 10.7 % of cases in PHP, in 27 % of cases in moderate PCP and in 47.2% cases in severe PCP, with a statistically significant differences between PHP and severe PCP (p =0.002). At the final examination, the percentage of implants, with at least one site

which presented a PD ≥ 6 mm, was respectively 1.7 % for PHP, 15.9% for moderate PCP and 27.2% for severe PCP, with a statistically significant difference between PHP and moderate PCP(p =0.005) and PHP and severe PCP (p =0.0001).

Conclusion: Patients with a history of periodontitis presented a statistically significant higher number of sites which required additional treatment. Therefore, patients with a history of periodontitis should be informed that they are more at risk for peri-implant disease. This underlines the value of the SPT in enhancing long term outcomes of implant therapy, particularly in subjects affected by periodontitis. **Moreover, the approach for multiple preventive dental extractions and implant placement, based on the assumption the implants perform better than teeth, should be followed with extreme caution.**

Introduction

During the last decades, the use of dental implants for replacement of missing teeth has become a routine procedure also in the rehabilitation of the periodontally compromised patients (PCP), even though biological complications are underreported (Berglundh et al. 2002) as the prognosis of implant treatment is often reported as survival rates. In a previous publication on the material included in this paper, solid screws 10-year survival rate varied from 98% in periodontally healthy subjects (PHP) to 90% in severe PCP (Roccuzzo et al. 2010). Moreover, the lack of adhesion to SPT was associated with a higher incidence of bone loss and implant loss. These results are in concordance with other recent long-term studies (Tomasi et al. 2008, De Boever et al. 2009, Matarasso et al. 2010, Schmidlin et al. 2010). Nevertheless, in order to better describe the outcomes of implant treatment, the clinical condition around these implants has to be presented (Romeo et al. 2005; Roos-Jansåker et al. 2006, De Boever et al. 2009, Rinke et al. 2010).

Dentitions damaged by severe periodontal disease often cause problems not only to the patient but also to the dentist, in particular regarding the choice of therapy, i.e. to save or to extract (Lundgren et al. 2008). Some may insinuate that dentists are avoiding traditional periodontal therapy in favour of extracting teeth and replacing them with dental implants, based on the assumption the implants perform better than teeth. Nevertheless, the Consensus Report of 6th European Workshop on Periodontology (Lindhe & Meyle 2008) suggested a high incidence of peri-implant diseases with mucositis in about 80% of subjects restored with implants, and peri-implantitis in between 28% and 56%

of subjects. A similar frequency of complications was also reported by Rinke et al. (2010) in a recent practice-based cross-sectional study.

The aim of this study was to prospectively assess the 10-year results of implant therapy in a group of PHP compared to a group of PCP of both moderate and severe grade. Results regarding per-implant pockets, plaque and bleeding on probing around implants and number of teeth lost are described in this article.

Material and methods

Study population

All patients attending the principle investigator (M.R.), a specialist in periodontology, for dental implant therapy between May 15, 1996 and May 15, 1998 were screened for possible inclusion in the study.

Exclusion criteria were:

(1) complete edentulism;

(2) presence of dental implants;

(3) mucosal diseases;

(4) alcohol and drug abuse;

(5) pregnancy;

(6) uncontrolled metabolic disorders;

(7) aggressive periodontitis;

(8) no interest in participating into the study.

Patients were informed that their data would be used for statistical analysis and gave their informed consent to the treatment. The study was performed in accordance with the principles stated in the Declaration of Helsinki.

Pre-treatment clinical examination

Gender, date of birth, smoking habits, medical history at the time of the initial visit and treatment planning were obtained. Moreover, subjects were clinically and radiographically monitored at baseline. Full mouth plaque score (FMPS), full mouth bleeding score (FMBS) and pocket depth (PD) were measured at 4 sites per tooth for all teeth by means of a periodontal probe

(XP23/UNC 15, Hu-Friedy, Chicago, USA), and rounded off to the nearest millimeter

At the baseline, 3 groups were formed on the basis of the clinical diagnosis:

PHP: periodontally healthy patients;

PCP: periodontally compromised patients.

Moreover, PCP received a score (S) on the basis of the number and depth of periodontal pockets according to the following formula:

S = Number of pockets (5-7mm) + 2 Number of pockets ($\geq$8 mm)

These patients were further divided in 2 groups:

Moderate PCP: periodontally compromised patients with S $\leq$ 25

Severe PCP: periodontally compromised patients with S > 25.

Periodontal therapy

Following selection, all patients received appropriate initial therapy, consisting, depending on the cases, in motivation, oral hygiene instruction and scaling and root planning, with the aim to reduce to a minimal level periodontal pathogens. Hopeless teeth were recorded and extracted. Periodontal surgery was performed as needed after re-evaluation. Guided tissue regeneration was pursued, when feasible. Individual treatment was thoroughly discussed with the patients and established according to their personal need and desire. No implant surgery was performed before the assurance of good motivation and compliance from each single patient (FMPS<25%; FMBS<25%).

Implant placement and prosthetic reconstruction

TPS dental implants (Institut Straumann AG, Waldenburg, Switzerland) were placed, under local anesthesia, by the same operator (MR), according to the manufacturer's instructions. Full body screws, hollow screws and hollow cylinders were used, 8, 10 and 12 mm long, 3.3, 4.1 and 4.8 mm in diameter. All implants were placed using a standardized surgical procedure (Buser et al. 2000). The implants were placed with the border of the rough surface approximating the alveolar bone crest leaving the machined neck portion in the transmucosal area. Implants that required bone augmentation and/or sinus lift elevation were not included in the study.

If necessary, an excision of soft tissue was performed in order to allow a close adaptation of the wound margins to the implant shoulder without submerging it. The number, position and type of implants in each patient were determined after a thorough diagnosis of the anticipated needs for the planned prosthesis and the presence of anatomic limitations.

Appropriate healing screws were placed on top of the implants and the flaps were sutured, in a non-submerged fashion. Abutment connection was carried out at 35 Ncm 3-6 months postsurgery, by the same operator. Abutments for cemented restoration were selected according to the intermaxillary space. All patients were provided with implant-supported fixed restorations. All restorations were fabricated in order to facilitate both the oral hygiene procedures and the probing along their circumference. Baseline probing measurements were also recorded around the implants.

Follow up

Patients were recalled at various intervals, depending on the initial diagnosis and the results of the therapy, for supporting periodontal therapy (SPT). Motivation, reinstruction, instrumentation and treatment of re-infected sites were performed as needed. Patients were placed on an individually tailored maintenance care program, including continuous evaluation of the occurrence and the risk of disease progression. If a patient expressed the desire not to attend follow-up examinations, he/she was classified as “drop-out”. The diagnosis and treatment of peri-implant biological complications was performed according to Cumulative Interceptive Supportive Therapy (CIST) (Mombelli & Lang 1998). Depending on the circumstances patients were given: (A) Mechanical cleansing and improvement of patient’s oral hygiene. Removal of hard deposits with soft scalers, polishing with rubber cup and paste. Instruction for more effective oral hygiene practices; (B) Antiseptic therapy with chlorhexidine digluconate or local application of chlorhexidine gel (C) Systemic antibiotic therapy or treatment with local delivery device. (D) Surgical therapy; (E) Explantation. The number of sites treated according to therapy modalities C and D (antibiotics and/or surgery) during the 10 years was also registered.

Final clinical examination

After 10 years two calibrated examiners, blinded to the initial classification of the patients, recorded, for each test implant, probing depth (PD) measured at four sites (mesial, buccal, distal and lingual) by means of a periodontal probe (XP23/UNC 15, Hu-Friedy, Chicago, USA), and rounded off to the nearest millimeter.

At the same time the following parameters were collected:

- Implant loss: the time in months for any implant lost;
- plaque score (presence/absence): total score for both teeth and implants (FMPS) and for implants alone (PI), measured at four sites per tooth and implant and expressed as a percentage of examined sites;
- bleeding on probing score (presence/absence): total score for both teeth and implants (FMBS) and for implants alone (BOP), measured at four sites per tooth and implant and expressed as a percentage of examined sites;
- smoking habits;
- **number of missing teeth at baseline**;
- number of extracted teeth during Active Periodontal Therapy (APT);
- number of lost teeth during SPT;
- Complete adhesion to the SPT (yes or no);
- Deepest PD during the SPT;
- Deepest PD at 10-year follow-up;
- number of patients, who required, during the SPT, either C or D therapy modality.

Statistical analysis

Data were expressed as mean ± SD or counts and percentages. Qualitative data were analyzed by means of Chi-square or Fisher's exact test. The normality assumption of the quantitative measures was verified by Shapiro-Wilk test and significance of between-group differences were assessed using Kruskal Wallis rank test. Pairwise comparisons of the groups

were performed by Mann-Whitney test with Bonferroni's adjustment for multiple comparisons. All the tests were two tailed with a significance level set at 5%.

Results

The general characteristics of the population of the present study have been described in a previous publication (Roccuzzo et al. 2010). Briefly, out of the initial 112 patients enrolled in the study, 11 patients did not attend the final examination. Four patients had died, three had moved and 4 patients did not wish to participate or were unable to attend because of severe health problems. Thus, this report includes a study group of 101 individuals: 28 PHP, 37 moderate PCP and 36 severe PCP. No inter-group differences for age, gender, implant type, number of teeth lost during the follow-up and acceptance of SPT were found. Only a small portion of the subjects were smokers: 3 (11.1%) in the PHP, 10 (27%) in the moderate PCP and 5 (13.9%) in the severe PCP, with no significant difference among the groups.

The 101 patients, who attended the 10-year examination, received a total of 246 implants. Two out of 61 (3.4%) implants were lost in PHP, seven out of 95 (7.2%) in moderate PCP and nine out of 90 (10%) in severe PCP (Table 1).

At the initial examination, 8.0 (± 4.7), 9.6 (± 5.9) and 6.4 (± 3.2) teeth per patient were missing in the PHP, moderate PCP and severe PCP groups, respectively. During the therapy preceding implant surgery, 280 teeth (11.6% of the total 2423 teeth present at the initial examination) were extracted. A

mean of 1.7 ± 2.0 teeth were extracted in the PHP group, 2.1 ± 2.2 in the moderate PCP group and 4.3 ± 2.8 in severe PCP group. The difference between severe PCP and PHP and between severe PCP and moderate PCP were statistically significant (p=0.0001 and 0.0003, respectively). No difference was found between PHP and moderate PCP(Table 1).

During the 10-year SPT, 129 teeth (6.0% of the total 2143 teeth) were lost for various reasons. In particular, 26 teeth (4.2% of 624 teeth) were lost in PHP, 49 (6.5% of 753) in moderate, and 54 (7% of 766) in severe. The corresponding mean number of teeth lost per patient was therefore, respectively, 0.9 ± 1.2 for PHP, 1.3 ± 1.6 for moderate, and 1.5 ± 1.7 for severe. The differences did not reach a statistical significant difference (Table 1).

The mean plaque score around the implants still present at the 10-year examination was 16.1 ± 2.4%, 29.0 ± 2.4% and 23.1 ± 2.3% for PHP, moderate PCP and severe PCP, respectively. A statistically significant difference was found between PHP and severe PCP (p=0.0003) (Table 2). The mean BOP was 12.3 ± 2.1% in PHP, 31.0 ± 2.5% in moderate PCP and 30.9 ± 2.6% in severe PCP. A statistically significant difference was found between PHP and both moderate and severe PCP (p=0.0001) (Table 2).

The mean PD at the 10-year examination was 3.1 ± 0.5 mm, 3.5 ± 0.9 mm and 3.9 ± 0.7 mm for PHP, moderate PCP and severe PCP. Only the difference between PHP and severe PCP reached the statistic significance (P=0.000**0**) (Table 2).

Biological complications occurred in all the three groups during the 10-year observation period.

Due to periimplantitis, 10.7% of patients in the PHP, 27% in the moderate PCP and 47.2% in the severe PCP group received treatment C or D of the CIST protocol. A statistical significant difference was found comparing PHP and severe PCP (p=0.002) (Table 3).

Considering only the deepest PD measured around implants during the SPT, the mean deepest PD was 4.2 ± 1.1 mm in PHP, 5.1 ± 1.8 mm in moderate PCP and 5.5 ± 1.7 mm in severe PCP. Both PCP groups showed a statistically higher mean deepest PD compared to PHP (PHP versus moderate PCP: p=0.001; PHP versus severe PCP: p=0.0001). The difference between moderate and severe PCP was also statistically significant (p=0.016).

The mean deepest PD around implants recorded at the 10-year follow-up examination was 3.9 ± 0.7 mm, 4.4 ± 1.1 mm and 4.8 ± 1.2 mm for PHP, moderate PCP and severe PCP, respectively. Again, differences between the three groups were statistical significant (PHP versus moderate PCP: p=0.015; PHP versus severe PCP: p=0.0001; moderate versus severe PCP: p=0.009) (Table 3**a**).

In PHP, 6.6% of the implants displayed a PD $\geq$ 6mm during SPT. The corresponding values were 29.5% for moderate PCP and 45.6% severe PCP. The differences between PHP and both moderate (p=0.0005) and severe PCP (p=0.0001) groups were statistically significant, whereas the difference between moderate and severe PCP was not (Table 3**a**).

At the 10-year examination, 1.7%, 15.9% and 27.2% of the survived implants displayed a PD $\geq$ 6 mm. Again, only the differences between PHP and the

PCP groups were statistically significant (PHP versus moderate PCP: p=0.0005; PHP versus severe PCP: p=0.0001) (Table 3).

Four patients in the PHP group, 11 in the moderate PCP and 7 patient in the severe PCP group did not completely adhere to SPT.

At the 10-year examination, a significant difference was found between moderate PCP adhering and not adhering to SPT concerning PI (25 ± 2.7% versus 38.5 ± 4.8%; p=0.011), BOP (23 ± 2.7% versus 50 ± 4.9%; p=0.0001) and PD (3.2 ± 0.6 versus 4.3 ± 1.2; p=0.008) (Table 4).

In the severe PCP group, significant differences were found for the PI (20.3 ± 2.4% versus 39.6 ± 7.1%; p=**0.003**) and the BOP (27.2 ± 2.7% versus 52.1 ± 7.2%: p=0.0006) comparing subjects who adhered or not to SPT (Table 4).

No statistically significant difference was recorded concerning the number of teeth lost during SPT (Table 4) and the percentage of patients who undergone treatment C or D due to peri-implant biological complications.

On the contrary, statistically significant differences were revealed both in moderate PCP and severe PCP for the deepest PD during SPT (4.5 ± 1.3 versus 6.3 ± 2.0: p= 0.0001; 5.1 ± 1.4 versus 7.2 ± 1.8: p=0.0001), the deepest PD at 10-year (4.0 ± 0.8 versus 5.2 ± 1.3: p= 0.0001; 4.7 ± 1.2 versus 5.7 ± 1.1: p=0.009), the percentage of implants with deepest PD ≥ 6mm during SPT (15.6% versus 58.1%: p= 0.001; 34.7% versus 88.9%: p=0.001) and the percentage of implants with deepest PD ≥ 6mm at 10-year (4.8% versus 42.3%: p= 0.001; 21.7% versus 58.3%: p=0.01) between the patients who adhered and the ones who didn't to SPT (Table 5). No statistical significant differences were found for any of the observed variables in the PHP group (Table 4 and 5).

Discussion

The question if patients with a history of periodontitis are more at risk for peri-implant disease has received increasing attention in the last years. Since the publication of the first part of the present research (Roccuzzo et al. 2010), several studies, most of them retrospective, have been published on this topic (Gianserra et al. 2010, Matarasso et al. 2010, Schmidlin et al. 2010, Simonis et al. 2010, Wahlström et al. 2010, Aglietta et al. 2011, Brägger et al. 2011). The vast majority of these papers concluded that implants in PCP yielded lower survival rates and higher mean marginal BL rates compared with those of implants placed in PHP.

In apparent contrast with these results, Wahlström et al. (2010) concluded that, in the short term, overloading and bruxism seem more hazardous for implant treatment, compared with a history of periodontitis. Similarly, Gianserra et al. (2010) stated, in a 5-year multicentre retrospective cohort study of 1727 patients, that a previous history of periodontal disease may not have a significant impact on implant failures up to 5 years after loading. These results may underestimate the value of the SPT in enhancing long term outcomes of implant therapy, particularly in subjects affected by severe periodontitis. It must be noted, however, that owing to the retrospective nature of the studies, these conclusions need to be interpreted with extreme caution. Moreover, the Kaplan-Meier analysis, presented in the first part of our research, clearly shows that the difference between PHP and PCP is negligible during the first 5 years, but becomes more pronounced later on. Our results are in accordance with the findings of Karoussis et al. (2003) who first demonstrated that a 5-year follow-up is usually not sufficient to evaluate

the differences in the clinical outcomes of the various groups of patients. The need for prospective observational studies was presented by a recent systematic review (Safii et al. 2010) based on the evidence that periodontitis subjects are at significantly higher risk for implant failure and greater marginal bone loss as compared with periodontally healthy subjects.The results of this research compare well with a similar recent study (De Boever et al. 2009) with a similar implant maintenance protocols. **One limit to the statistical analysis of the present study is that, when several implants are placed dependent data are observed. Ideally, each patient should be the statistical independent unit.**

There are opinions among clinicians that the prognosis of complex periodontal therapy may not match the high levels of success of treatment with implants. As a consequence more and more teeth are extracted on the assumptions that implants perform better than periodontally compromised teeth and that their longevity is independent of the individual's susceptibility to periodontitis (Lundren et al. 2008). In reality, during the 10-year SPT, 129 teeth were extracted, corresponding to 6.0 % of the 2143 teeth. The corresponding mean number of teeth lost per patient was 0.9 $\pm$ 1.2 for PHP, 1.3 $\pm$ 1.6 for moderate PCP and 1.5 $\pm$ 1.7 for severe PCP, with no significant difference among the three groups. It is important to note that in this analysis third molars were also included similarly to Tonetti et al. (1998) and Ng et al. (2011) and that the number of teeth that were extracted was reported, regardless of the clinician providing the service and the reason for the extraction. This may reduce the differences among the groups. Other authors, McLeod et al. (1997), Tonetti et al. (2000) Checchi et al. (2002), Pretzl et al.

(2008), Matuliene et al. (2010), Martin et al. (2010) Miyamoto et al. (2010) have instead included only non-third molars. Nevertheless these preliminary results seem not to support a frequent current approach for multiple preventive dental extractions and implant placement based on the assumption the implants perform better than teeth.

The number of implants with a PD ≥ 6mm varied among the 3 groups, both during the entire period of SPT and at the time of final 10-year examination. The differences were statistically significant between PHP and both PCP (Table 3**a**). Our data support the need for a SPT where clinical and radiographic parameters should be re-assessed at every follow-up visit in order to detect peri-implant infections as early as possible and to intercept the problems with appropriate therapy (Mombelli & Lang 1998).

According to the Sixth European Workshop on Periodontology peri-implant mucositis describes an inflammatory lesion that resides in the mucosa, while periimplantitis also affects the supporting bone (Lindhe & Meyle 2008). While these definitions are considered adequate, the diagnostic criteria for them are less clear. Based on longitudinal clinical studies the Seventh EWP **(**Lang & Berglundh 2011) suggested that the time of prosthesis installation should be chosen to establish baseline criteria representing homeostasis following implant installation with or without subsequent abutment connection. To establish baseline, a radiograph should be obtained to determine alveolar bone levels after physiologic remodelling, and peri-implant probing assessments performed.

During the period of observation, 18 implants were removed for biological complications. Antibiotic and/or surgical therapy was performed in

10.7 % of cases in PHP, in 27 % of cases in moderate PCP and in 47.2% cases in severe PCP, with a statistically significant differences between PHP and severe PCP (p =0.002). It must be noted, however, that implants presented a TPS surface, which was a common surface over a decade ago. Later on, new surfaces, such as sandblasted and acid-etched (SLA), were introduced. The minor micro-roughness should be particularly important in PCP, since it is suggested that peri-implantitis is influenced by surface characteristics. (Berglundh et al. 2007, Albouy et al. 2008, Albouy et al. 2009). A new investigation is currently in progress to assess the long-term clinical and radiographic results around solid screws SLA implants, placed in patients with excellent compliance (FMPS<15%) and to compare the results with the ones obtained in the present research.

In accordance with Lundgren et al. (2008), good long-term prognosis in the management of periodontitis-affected patients is plaque control efficient enough to maintain healthy periodontal tissues. In the same way, a central part of implant therapy should be adequate infection control around implants to maintain healthy peri-implant tissues. It is important to encourage dental teams to take the responsibility of carefully monitoring the treated patients and carrying out measures to prevent and treat periodontal or peri-implant lesions that may occur／re-occur. It is also relevant to prepare patients to comply with the necessary measures to ensure a good long-term prognosis for the treatment provided.

In conclusion, patients with a history of periodontitis should be informed that they are at higher risk for peri-implant disease. Moreover, patients have to be strongly motivated to strictly adhere to SPT as it has

proven to be a key factor in enhancing long term outcomes of implant therapy by controlling re-infection. **Finally, the approach for multiple preventive dental extractions and implant placement, based on the assumption the implants perform better than teeth, should request extreme caution.**

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Table 1. Number of implants at baseline and lost during Supportive Periodontal Therapy (SPT);
Mean number of teeth missing at baseline, extracted during Active Periodontal Therapy (APT) and during SPT.

	Implants at baseline	Implants lost during SPT	Teeth missing at baseline	Teeth extracted in APT	Teeth lost during SPT
PHP	61	2	8.0 ± 4.7	1.7 ± 2.0	0.9 ± 1.2
Moderate PCP	95	7	9.6 ± 5.9	2.1 ± 2.2	1.3 ± 1.6
Severe PCP	90	9	6.4 ± 3.2	4.3 ± 2.8	1.5 ± 1.7
Statistical difference between:					
PHP-moderate PCP		p=0.48	p= 0.3098	p= 0.6723	p=0.2170
PHP-severe PCP		p=0.20	p= 0.1177	p= 0.0001	p=0.1769
Moderate PCP-severe PCP		p=0.61	p= 0.0146	p= 0.0003	p=0.7695

Table 2. Clinical parameters around the implants at the 10-year follow-up
Pl= plaque score (presence of dental plaque);
BOP= presence of bleeding on probing;
PD= probing depth.

	Pl at 10-year	BOP at 10-year	PD at 10-year (mm)
PHP	16.1 ± 2.4%	12.3 ± 2.1%	3.1 ± 0.5
Moderate PCP	29 ± 2.4%	31 ± 2.5%	3.5 ± 0.9
Severe PCP	23.1 ± 2.3%	30.9 ± 2.6%	3.9 ± 0.7
Statistical difference between			
PHP-moderate PCP	p=0.0003	p=0.0001	p= 0.0626
PHP-severe PCP	p=0.04	p=0.0001	p= 0.0000
Moderate PCP-severe PCP	p=0.09	p=0.98	p= 0.0319

Table 3a. Number of patients treated with CIST C/D, deepest PD around implants and percentage of implants with deepest PD ≥ 6mm (CIST= cumulative interceptive supportive therapy).

	Patients at baseline	Patients drop-out	Patients treated with CIST C/D	Deepest PD during SPT (mm)	Deepest PD at 10–year (mm)	Implants with deepest PD ≥ 6mm during SPT	Implants with deepest PD ≥ 6mm at 10-year
PHP	32	4	10.7%	4.2 ± 1.1	3.9 ± 0.7	6.6 %	1.7%
Moderate PCP	42	5	27%	5.1 ± 1.8	4.4 ± 1.1	29.5%	15.9%
Severe PCP	38	2	47.2%	5.5 ± 1.7	4.8 ± 1.2	45.6%	27.2%
Statistical difference between							
PHP-moderate PCP			p=0.10	p= 0.001	p=0.015	p=0.0005	p=0.005
PHP-severe PCP			p=0.002	p= 0.0001	p= 0.0001	p=0.0001	p=0.0001
Moderate PCP-severe PCP			p=0.07	p=0.016	p= 0.009	p=0.02	p=0.07

Table 3b. Number of patients treated with CIST C/D, deepest PD around solid implants and percentage of solid implants with deepest PD ≥ 6mm (CIST= cumulative interceptive supportive therapy).

	Patients at baseline	Patients drop-out	Patients treated with CIST C/D	Deepest PD during SPT around solid implants (mm)	Deepest PD at 10–year around solid implants (mm)	Solid implants with deepest PD ≥ 6mm during SPT	Solid implants with deepest PD ≥ 6mm at 10-year
PHP	32	4	10.7%	4.2±0.9	4.0±0.7	5.8%	2.0%
Moderate PCP	42	5	27%	5.1±1.7	4.4±1.1	30.1%	18.0%
Severe PCP	38	2	47.2%	5.5±1.7	4.8±1.2	45.6%	27.2%
Statistical difference between							
PHP-moderate PCP			p=0.10	p=0.002	p=0.029	p=0.0001	p=0.005
PHP-severe PCP			p=0.002	p=0.0001	p=0.0001	p=0.0001	p=0.0001
Moderate PCP-severe PCP			p=0.07	p=0.027	p=0.027	p=0.04	p=0.19

Table 4. Clinical parameters around the implants at the 10-year follow-up in relation to adhesion to SPT in the three groups.

Pl= plaque score (presence of dental plaque);
BOP= presence of bleeding on probing;
PD= probing depth.

	Adhesion to SPT	Number of patients	Pl	BOP	PD (mm)	Teeth lost during SPT
PHP	No	4	11.4 ± 4.8%	11.4 ± 4.8%	3.0 ± 0.4	0.3 ± 0.5
	Yes	24	17.2 ± 2.7%	12.5 ± 2.4%	3.1 ± 0.5	1.0 ± 1.2
Moderate PCP*	No	11	38.5 ± 4.8%	50 ± 4.9%	4.3 ± 1.2	0.9 ± 0.8
	Yes	26	25 ± 2.7%	23 ± 2.7%	3.2 ± 0.6	1.5 ± 1.9
Severe PCP**	No	7	39.6 ± 7.1%	52.1 ± 7.2%	3.9 ± 0.7	2.7 ± 2.8
	Yes	29	20.3 ± 2.4%	27.2 ± 2.7%	3.9 ± 0.8	1.2 ± 1.1

* Statistically significant difference for Pl (p= 0.011), BOP (p= 0.0001) and PD (p= 0.008) between subjects adhering and not adhering to SPT.
** Statistically significant difference for Pl (p= 0.003) and BOP (p= 0.0006) between subjects adhering and not adhering to SPT.

Table 5. Number of patients treated with CIST C/D, deepest PD around implants and percentage of implants with deepest PD ≥ 6mm in relation to adhesion to SPT in the three groups.

	Adhesion to SPT	Number of patients	Patients treated with CIST C/D	Deepest PD during SPT (mm)	Deepest PD at 10–year (mm)	Implants with deepest PD ≥ 6mm during SPT	Implants with deepest PD ≥ 6mm at 10-year
PHP	No	4	0%	3.5 ± 0.5	3.5 ± 0.5	0	0
	Yes	24	12.5%	4.3 ± 1.1	4.0 ± 0.8	8.0%	2.1%
Moderate PCP*	No	11	36.4%	6.3 ± 2.0	5.2 ± 1.3	58.1%	42.3%
	Yes	26	23.1%	4.5 ± 1.3	4.0 ± 0.8	15.6%	4.8%
Severe PCP**	No	7	71.4%	7.2 ± 1.8	5.7 ± 1.1	88.9%	58.3%
	Yes	29	41.4%	5.1 ± 1.4	4.7 ± 1.2	34.7%	21.7%

* Statistically significant difference for deepest PD during SPT ($p= 0.0001$), deepest PD at 10-year ($p= 0.0001$), percentage of implants with deepest PD ≥ 6mm during SPT ($p= 0.001$) and of implants with deepest PD ≥ 6mm at 10-year ($p= 0.001$) between subjects adhering and not adhering to SPT.

** Statistically significant difference for deepest PD during SPT ($p= 0.0001$), deepest PD at 10-year ($p= 0.009$), percentage of implants with deepest PD ≥ 6mm during SPT ($p= 0.001$) and of implants with deepest PD ≥ 6mm at 10-year ($p= 0.01$) between subjects adhering and not adhering to SPT.