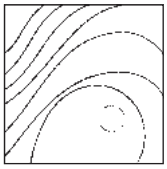
Microbiologic Evaluation of Compromised Periodontal Sites Before and After Immediate Intrasocket Implant Placement



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This study aimed to elucidate the changes in subgingival microflora before the extraction of severely periodontally involved teeth and 1 year after immediate implant placement and provisionalization without flap elevation. Clinical parameters were recorded for 20 maxillary anterior teeth from 10 individuals before and after implant treatment. The clinically observed improvement in the soft tissues was found to be compatible with a less pathogenic flora. Concentrations of periodontopathogens in the periodontal sites were heavily reduced when transformed into peri-implant sites, whereas the relevant counts of the beneficial microorganisms were increased. (Int J Periodontics Restorative Dent 2011;31:e109–e117.)

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Clinical reports have shown the esthetic advantages of a single-stage flapless surgical protocol combined with immediate provisionalization, aiming to maintain the preoperative soft tissue morphology, in restoring single teeth possessing intact and healthy bony sockets.[1–4] Moreover, a single-stage approach for single or multiple adjacent teeth involving endodontically or severely periodontally compromised sockets has been proposed and evaluated clinically.[5,6] According to the described approach, after atraumatic extraction and disinfection of the sockets, the implants were immediately placed, without flap elevation, palatally away from the bone defect area until fully embedded into sound bone. Immediate provisionalization followed, avoiding active loading of the implants (Figs 1a to 1c). The immediate transformation of the diseased periodontal tissues into peri-implant tissues was found to lead to optimal biologic, functional, and esthetic results over a postoperative period of 12 to 36 months.[5,6] The soft tissues were firmly adapted on the abutments,

and the peri-implant space was not probeable. The favorable clinical outcome appeared to be independent from the pre-existing unhealthy environment of the compromised sockets caused by the periodontal destruction (Figs 1d and 1e).

In contrast to implant health, peri-implantitis is associated with complex microflora containing motile rods and spirochetes, specifically with the presence of *Porphyromonas gingivalis* or *Aggregatibacter actinomycetemcomitans*.[7] On the other hand, plaque within the healthy peri-implant sulcus is similar to that of the oral mucosa, with a relative absence of periodontal pathogenic bacteria.[8] However, there is no scientific evidence indicating that peri-implant mucosal inflammation leads to progressive loss of osseointegration following a common pathologic pathway, similar to the mechanism leading to periodontal attachment loss. Moreover, there is no information regarding the microbial recolonization of the peri-implant sulcus that results when compromised periodontal tissues are immediately transformed into peri-implant tissues via the aforementioned surgical technique.

The aim of the present microbiologic study was to compare the composition of sulcular microflora before extraction of severely periodontally involved teeth and 1 year after immediate implantation into the infected and defective sockets.

Method and materials

Clinical procedures

Ten systemically healthy nonsmoking individuals (5 men, 5 women; age range, 50 to 65 years and 51 to 75 years, respectively) participated in the study (Figs 1 and 2). Patients presented one to four maxillary anterior teeth with evidence of severe periodontitis (radiographic bone loss > 80%, third degree mobility) and assessed clinically as terminal (Figs 1a and 1b and 2a and 2b). Periodontal status was based on data from clinical and full-mouth radiographic examinations performed at the time of initial consultation. Four sites were involved in 2 patients, 2 sites were involved in 4 patients, and 1 site was involved in 4 patients. Twenty periodontal sites in total were sampled at baseline, and 20 peri-implant sites were sampled 12 months after extraction of the involved teeth and immediate implant placement. Radiographic evaluation involved periapical radiographs (Figs 1b and 2b), orthopantomograms, and, occasionally, localized volumetric tomography (Accuitomo, J Morita) to confirm the presence of sufficient bone palatally and apically to the sockets that would comfortably house an implant of at least 13-mm length and 4-mm width.

Presurgical preparation included conservative periodontal treatment with full-mouth subgingival scaling, excluding the experimental sites. Clinical parameters were recorded, including pocket depth, attachment loss, Plaque Index, bleeding on probing, suppuration, bone loss, and mobility (Table 1). Antibiotics were prescribed 1 day preoperatively, while patients were instructed repetitively to practice thorough plaque control.

Surgical procedure

After atraumatic extraction of the periodontally terminal teeth, the sockets were disinfected by gentle removal of the granulation tissue, making sure to avoid tearing the soft tissues unsupported by bone (Fig 2c). Thorough rinsing with saline solution followed. Adjacent sites were treated one by one to avoid interdental soft tissue collapse. Preparation of the implant bed was initiated on the apical third of the palatal surface of the socket palatally toward the nasal floor without flap elevation, avoiding the labial osseous plate. No surgical guide was used. An at least 13-mm-long and 4-mm-wide implant (MKVI Brånemark, Nobel Biocare) was self-tapped with a torque of 42 Ncm after the palatal rim of the implant bed was slightly countersunk.

Prosthetic procedure

A 6-mm-wide alumina ceramic abutment (Ceradapt, Nobel Biocare) or a zirconia abutment (Procera, Nobel Biocare) was tightened using a gold screw with a torque of 32 Ncm after radiographs confirmed its full seating on the implant head. The alumina abutment

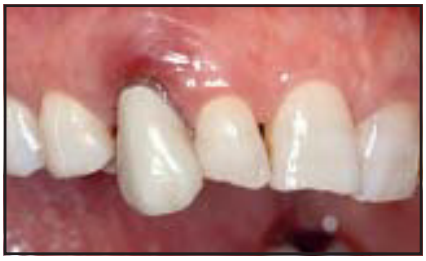
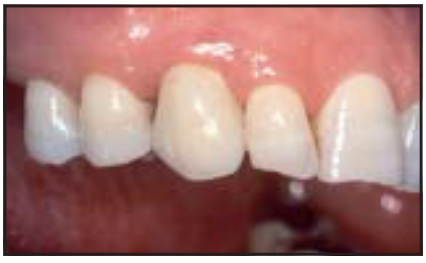
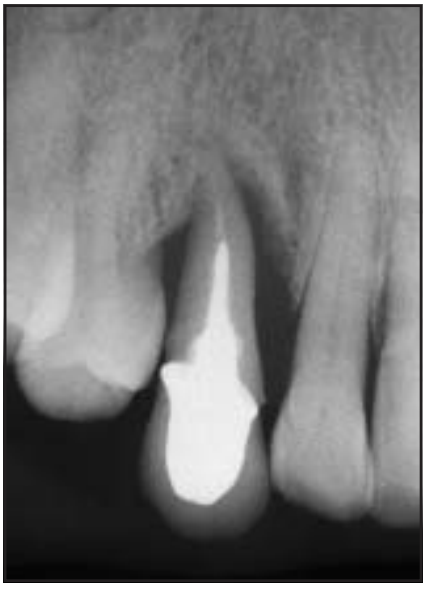


Fig 1a (above) *Maxillary right canine at baseline with severe periodontal distraction, deep periodontal pockets, and pronounced mobility.*

Fig 1b (right) *Periapical radiograph revealing alveolar bone destruction and adequate interproximal support for the adjacent teeth.*

Fig 1c (far right) *Periapical radiograph immediately after implant placement.*





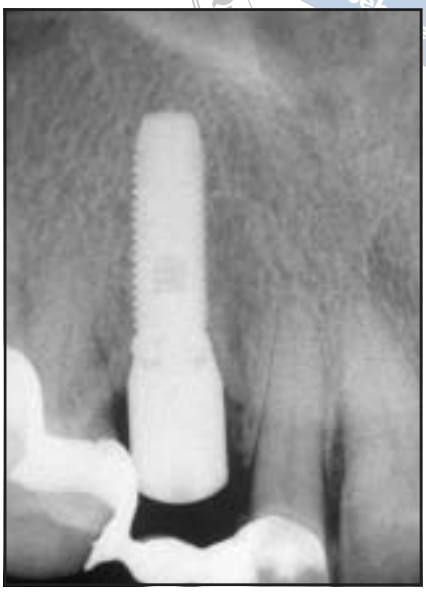
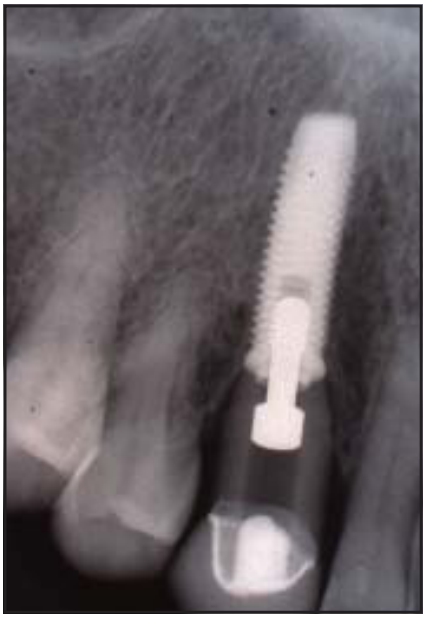


Fig 1d (left) *Clinical appearance of the definitive restoration 3 years postoperatively.*

Fig 1e (right) *Postoperative periapical radiograph after 12 months reveals the regenerative process of the interproximal alveolar bone and indicates successful osseointegration.*



was prepared for full coverage intraorally using high-speed drilling with coarse diamonds (Figs 2d and 2e). A cold-curing acrylic resin provisional restoration was bonded with cervical margins at the level of the soft peri-implant crest after all centric and eccentric occlusal contacts were eliminated, thus excluding any active loading of the implant. Adjacent provisional crowns were splinted together for increased stability (Fig 2f).

Laboratory procedures

Sampling

After supragingival plaque removal, subgingival plaque samples were obtained using three sterile no. 30 paper points (ProTaper Universal Absorbent Points, Dentsply) for 10 seconds.[9] One plaque sample was obtained at baseline before the initiation of antibiotic therapy. Another plaque sample was obtained 12 months after implant placement (Figs 2g and 2h). The samples were immersed in 0.9 mL

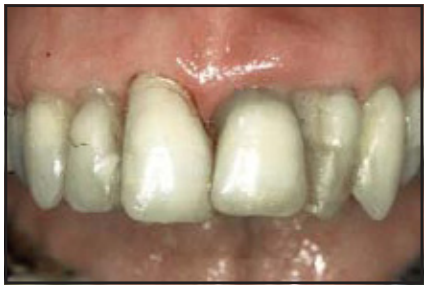
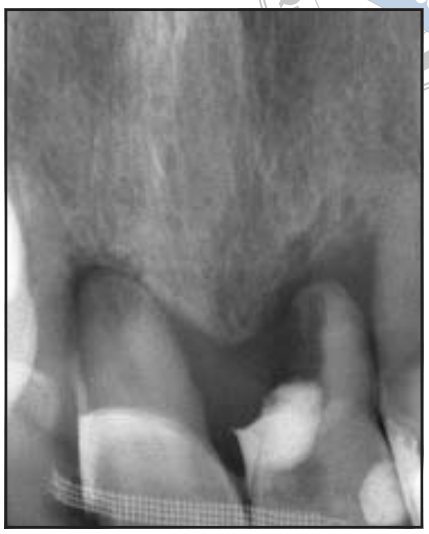


Fig 2a (left) *Maxillary central incisors at baseline with severe periodontal distraction, deep periodontal pockets, and suppuration.*

Fig 2b (right) *Periapical radiograph revealing alveolar bone destruction, external root resorption, and adequate vertical height for implant placement.*



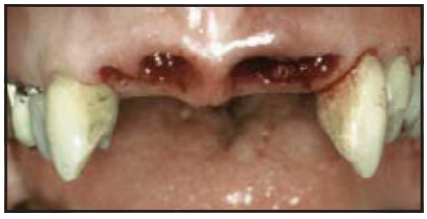


Fig 2c *Atraumatic extraction of the four incisors.*

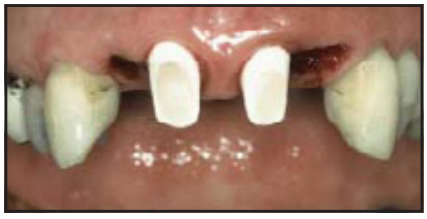
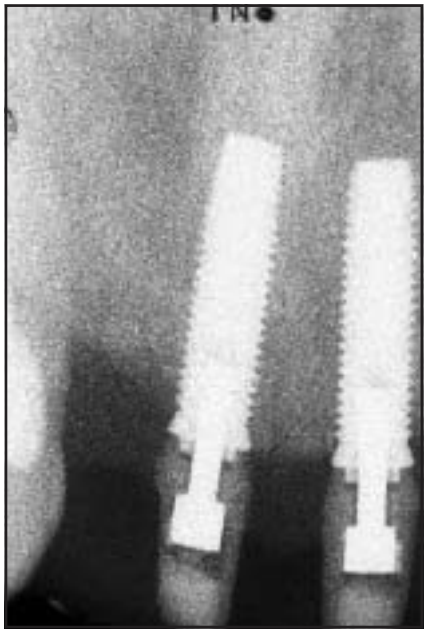


Fig 2d *Immediate intrasocket implant placement followed by insertion of the transmucosal ceramic abutments.*

Fig 2e (right) *Postsurgical periapical radiograph.*



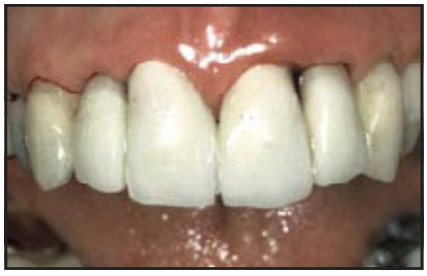


Fig 2f *Immediate provisionalization. Occlusal contacts were eliminated to prevent any active loading of the implants.*

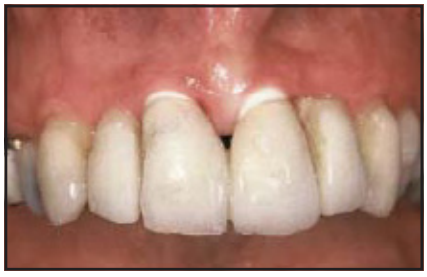


Fig 2g *Twelve months postoperatively, the soft peri-implant tissues maintained their original architecture adequately supported by the transmucosal abutments and the cervical portion of the provisional restoration, presenting mild labial recession.*

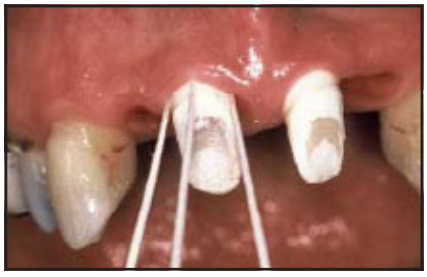


Fig 2h *Microbial sampling 12 months postoperatively from the shallow peri-implant crevice.*

Table 1 **Clinical parameters of periodontal sites before tooth extraction and peri-implant sites after implant placement**

Clinical parameters	Baseline (teeth, n = 20)	12 mo (implants, n = 20)
Mean probing depth (mm)	7.8 ± 1.8	1.8 ± 0.8
Mean attachment loss (mm)	7.5 ± 2.5	—
Plaque Index	100%	15%
Bleeding on probing	100%	5%
Suppuration	30%	—
Bone loss	> 50%	—
Mobility	92.7%	—

of sterile reduced transport fluid, prereduced anaerobically,[10] and transferred to the laboratory within 10 minutes after collection.

Processing of the plaque samples

Samples were dispersed for 60 seconds using a Vortex mixer (IKA Works). Aliquots of 0.1 mL of suitable 10-fold dilutions were spread on selective media kanamycin-vancomycin lyophilized blood (KVL-B) and tryptic soy bacifrocin vancomycin agar (TSBV)[11] and non-selective media enriched tryptic soy agar (ETSA),[12] which were incubated anaerobicaly. The applied culturing procedure and the characterization and identification of the bacterial species have been described meticulously in previous studies.[13,14]

Dark-field microscopy

One drop (0.01 mL) of the dispersed plaque suspension was applied to a microscopic slide and examined using dark-field microscopy. Two hundred cells per optical field were counted and differentiated into five groups: cocci, rods, fusiforms, helicoid-shaped organisms (ie, spirochetes), and motile rods other than spirochetes.[15]

Handling of the data

For the presentation of the different target species, a descriptive method involving the isolation frequencies, colony-forming units per milliliter (CFU/mL), and mean of the total flora percentage was used.

Results

The clinical parameters of the preoperative periodontal sites transformed to the postoperative peri-implant sites 1 year later presented remarkable improvement (Table 1).

The dark-field microscopic examination of the dispersed plaque samples from the gingival pocket and peri-implant crevice shows the distribution of bacterial morphotypes separately. Sixty-nine percent of the samples at baseline showed microscopic evidence of spirochetes. After 12 months, spirochetes were seen in 2% of the peri-implant samples (Table 2).

The cultivable flora from the periodontal and peri-implant samples showed a complex bacterial community of gram-positive and gram-negative anaerobic and facultative bacteria (Table 3). The samples obtained from the periodontal sites yielded a mean total viable count of 116.2×10^6 CFU/mL; the peri-implant samples 12 months later yielded 41.4×10^6 CFU/mL. In total, 14 taxa among the total cultivable flora were selected as target species to be evaluated.

Table 2 Observation frequency (%) and microbial count (%) of different bacterial morphotypes enumerated by dark-field microscopy from crevicular samples from teeth and implants

Bacterial morphotypes	Baseline (teeth, n = 20)		12 mo (implants, n = 20)	
	OF	MC	OF	MC
Cocci	100	59	100	63
Rods	95	24	92	30
Motile rods	39	6	16	5
Fusiform rods	54	14	50	15

OF = observation frequency; MC = microbial count.

Table 3 Isolation frequency (%) and mean proportion (%) of 14 target bacterial species in intracrevicular samples from teeth and implants

Bacterial species	Baseline (teeth, n = 20)			12 mo (implants, n = 20)		
	IF	CFU/mL × 10^6	MP	IF	CFU/mL × 10^6	MP
A actinomycetemcomitans	5	8.4	7.2	5	2.2	3.7
A israelli	20	2.9	2.5	5	1.4	2.3
Actinomyces spp	50	4.7	4.0	50	5.5	9.3
B forsythus	30	9.7	8.3	10	1.9	3.1
C rectus	50	2.2	4.5	35	2.5	4.2
Capnocytphaga spp	60	2.4	2.1	50	2.0	3.4
E corrodens	35	6.0	5.2	25	1.0	1.7
Fusobacterium spp	75	10.6	9.1	70	5.0	8.4
P gingivalis	75	22.5	19.4	45	2.2	3.7
P intermedia/nigrescens	50	9.4	8.1	45	2.5	4.1
P micros	35	1.5	1.3	20	1.3	2.2
S sputigena	45	2.8	2.4	15	1.5	2.5
Streptococci spp	100	6.5	5.6	100	8.6	14.4
Veillonella spp	45	4.4	3.8	60	4.0	6.5

IF = isolation frequency; CFU = colony-forming unit; MP = mean proportion.

Discussion

After extraction of a periodontally compromised tooth, healing takes place without complication if no other treatment is applied. The pathogenic microbial flora that originally caused the periodontal destruction and initially remained housed in the infected socket are automatically altered through the ecologic shift that follows the extraction and the defense mechanism of the host. When the physiologic process of healing is concluded, a partially bone-filled edentulous ridge has been formed through the regenerative response that takes place,[16,17] while the soft tissue architecture that is not adequately supported has collapsed.

Favorable clinical results have been reported when patients suffering from periodontal disease were treated with osseointegration.[18,19] It has been shown histologically[20,21] and proven clinically[22–24] that immediate implant placement into the extraction sockets of teeth that were periodontally involved is a viable approach to successful osseointegration. The main advantage of such an approach is the reduction of treatment duration. The prerequisites are an atraumatic extraction, thorough removal of the granulation tissue, and further socket disinfection. To guarantee adequate visual access and to allow membrane coverage of the implant, if so required, the elevation of a flap has been considered mandatory.

Denuding the bone from the periosteum momentarily jeopardizes the normal blood supply to the surgical site and inevitably leads to further bone loss.[25] In the present investigation, this was avoided by not elevating a flap; therefore, during wound healing, the host defense mechanism and regenerative potential were brought to the site and kept in action by the uninterrupted blood supply.[26] Efforts for a general reduction of the microbial load were made by the preceding conservative periodontal therapy and the preoperative initiation of antibiotic coverage, along with daily rinses with chlorhexidine postoperatively.

While thorough removal of the granulation tissue could not be guaranteed because of limited visual and operative access through the narrow opening of the socket, the most important step toward site disinfection was tooth extraction followed by rinsing with saline solution. Thus, the infected cementum of the root surface that had been acting as the main source, continuously providing the area with periodontopathogenic bacteria, was eliminated.

The impressive transformation of the deep periodontal pockets into shallow peri-implant crevices was produced by the intimate adaptation of the soft tissues against the smooth sterile surface of the ceramic abutment. While the histologic determination of the nature of this adaptation remains unknown, it has been shown that by following traditional surgical procedures, a long epithelial attachment is expected to develop against the pure alumina ceramic abutment surface, similar to that which develops around natural teeth.[27,28]

Several studies have indicated the role of the remaining dentition as a microbial reservoir and a source of implant contamination, confirming the need for thorough periodontal therapy preceding implant therapy.[29–32] Peri-implant microbial flora variation is also expected among patients as it relates to the potential recontamination from the adjacent natural dentition and the host defense system of the individual.[18,33]

The findings of the present investigation are in agreement with previous investigations showing a direct drop in the microbial morphotypes after alteration of the clinical parameters.[15,19] The minimal presence of spirochetes around the healthy peri-implant sites has also been confirmed by other investigations where spirochetes were only observed postoperatively in partially edentulous patients, in contrast to those who were fully edentulous.[13,18] All microorganisms isolated from the severely compromised periodontal sites were also found in peri-implant sites; however, in different quantitative concentrations. In the peri-implant sites, an increase in the beneficial microbes was observed (*Actinomyces spp*, *Streptococci spp*, and *Veillonella spp*), whereas a decrease in the periodontopathogens took place (*Fusobacterium spp*, *P gingivalis*, and *P intermedia/nigrescens*). These findings confirm once again the principle of the quality of preoperative microflora determining the postoperative quality in the peri-implant sites.[18,33]

The periodontopathogens *P gingivalis, T forsythensis, C rectus,* and *S sputigena* were observed in peri-implant sites, although in lower numbers and isolation frequencies in comparison to periodontal sites. This can be seen as a risk factor for future inflammatory breakdown. However, the stable clinical condition of the peri-implant tissues that house these microorganisms supports the hypothesis that the favorable oral hygiene preformed by patients along with the active defense mechanism of the host manage to control microbial proliferation, thus prohibiting the development of inflammatory reactions.[34] A possible explanation for the persisting presence of the previously mentioned bacteria in the peri-implant environment in spite of the ecologic change that took place can be drawn from their ability to penetrate deeply into the tissues and maintain their colonies in the area postoperatively.[35]

The presence of *A actinomycetemcomitans* was only recorded in 1 site of the 20 that were examined (high concentration in the periodontal site and reduced concentration in the peri-implant site). The persisting presence of the specific microorganism in the successful peri-implant site, which was notably combined with slightly compromised clinical parameters, can also be explained by the pronounced tissue penetration ability described for the previously mentioned periopathogenic bacteria.[36] Low isolation frequency for this microorganism has also been reported in other relevant investigations,[18,37] while the postoperative elimination of *A actinomycetemcomitans* and *P gingivalis* has been reported when implant placement took place at a later session than tooth extraction.[38,39]

At the time of sampling of the subgingival plaque 12 months postoperatively, the healthy peri-implant tissues were firmly adapted against the transmucosal abutment and the original deep periodontal pocket did not exist anymore. However, the results of the present study cannot explicitly determine whether the observed microbial changes preceded or resulted from tissue readaptation. In any case, it has been shown that in compromised sites, implant survival is not affected by immediate or delayed placement.[40] Moreover, a recent systematic review of the literature has shown that implants can be successfully placed into sites with periapical and periodontal infection.[41] Further investigations are required regarding the role of early and incremental recolonization of the newly formed peri-implant space so that the process of health establishment when periodontally compromised tissues are immediately transformed into peri-implant tissues can be understood fully.

Conclusions

- Immediate atraumatic implant placement in extraction sockets of periodontally compromised teeth can be a viable modality for successful osseointegration followed by a favorable shift of the microbial crevicular flora, compatible with the clinically observed improvement of the peri-implant tissues.
- The observed clinical improvement of the peri-implant tissues was microbiologically connected with a favorable shift of the periopathogenic flora housed preoperatively in the periodontal sites.
- In the peri-implant sites, a quantitative increase of the beneficial microorganisms was observed, while in contrast, the periopathogens presented a quantitative decrease. The isolation frequencies of the so-called occasional periopathogens remained the same, also presenting a quantitative decrease.

Acknowledgments

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