Decontamination and Repair Protocol Promotes Positive Outcomes in Peri-implantitis–Affected Implants: A Human Case Series

Marcos Ribeiro Sallé, DDS, MSc1/Daniel Deluiz, DDS, PhD2/Paul Fletcher, DDS3/Monike F. Santoro, DDS, MSc1/Eduardo M. B. Tinoco, DDS, PhD4

1PhD candidate, UERJ – State University of Rio de Janeiro, Department of Periodontology, Rio de Janeiro, RJ, Brazil
2Postdoctoral fellow, UERJ – State University of Rio de Janeiro, Department of Periodontology, Rio de Janeiro, RJ, Brazil
3Associate Clinical Professor, Department of Periodontics, Stony Brook University College of Dental Medicine, Stony Brook, New York
4Professor, UERJ – State University of Rio de Janeiro, Department of Periodontology, Rio de Janeiro, RJ, Brazil

Correspondence to: Dr Marcos Sallé and Dr Daniel Deluiz, Boulevard 28 de Setembro, 157 - 2º andar - sala 10, Rio de Janeiro, RJ - CEP 20551-030. Email: mrsalle0110@gmail.com; Email: danieldeluiz@gmail.com

Submitted November 10, 2020; accepted March 15, 2021

This study assessed the effectiveness and predictability of a readily available protocol for the treatment of peri-implantitis using mechanical debridement, chemical antiseptic surface detoxification, and osseous grafting. Nine patients (seven female and two male, mean age: 56.5 years) with a total of
15 peri-implantitis–affected implants were selected for the trial. Pocket probing depth (PPD), bleeding on probing (BOP), and standardized digital periapical radiographs measurements were taken. Surgical flaps were elevated, and the implant threads were cleaned with a plastic curette. Chemical decontamination was performed by scrubbing solutions of 0.25% sodium hypochlorite (NaClO) and 1.5% hydrogen peroxide (H2O2) around the exposed implant using cotton pellets. Bone defects were filled with a 50/50 mixture of bovine hydroxyapatite and nanocrystalline calcium sulfate (CaSO4). A porcine collagen membrane was placed over the grafted bone defect. Follow-up appointments were scheduled for 1 week, 2 weeks, 3 months, 6 months, 9 months, and 1 year posttreatment. Clinical and radiographic parameters were assessed and compared. At baseline, PPD varied from 5 mm to 7.5 mm, with a mean PPD of 6 mm (± .7 mm). At the 12-month follow-up, PPD varied from 1.5 mm to 4.2 mm, with a mean PPD of 2.5 mm (± .8 mm). The mean PPD reduction of 3.6 mm (59.2%) was statistically significant ($P < .001$). The number of bleeding sites around each test implant decreased significantly from 4 to 0.4 sites between baseline and 12 months ($P < .001$). The mean radiographic bone loss decreased from 4.8 mm (± 1.3 mm) to 2.7 mm (± 1.2 mm; $P < .001$). The proposed method of mechanical decontamination, chemical detoxification, and bone regeneration is clinically effective and reproducible. Clinical peri-implant parameters, as well as radiographic bone levels, were improved and maintained their stability for 1 year using this peri-implantitis treatment protocol. *Int J Periodontics Restorative Dent* 2022. doi: 10.11607/prd.5534

**INTRODUCTION**

The search for an effective treatment for peri-implantitis is a prominent topic of research in the field of implant dentistry. A 26 year longitudinal study found peri-implantitis in 34% of patients and
around 21% of implants.1 Due to variations in the definition of peri-implantitis its prevalence has been found to range from 1% to 47%.2 Similarly, as the resolution of peri-implantitis following treatment has been inconsistent, numerous therapeutic regimens have been proposed to detoxify a contaminated implant surface, debride the adjacent inflamed soft tissue, and regenerate the surrounding bone and soft tissue attachment.3,4

Multiple histological animal studies have shown that re-osseointegration can be achieved on a cellular level using appropriate decontamination and grafting techniques5–7. While human clinical reports describing bone regeneration following treatment for peri-implantitis are numerous,8–12 few show actual histologic evidence of re-osseointegration.13–15

The authors recently demonstrated in a proof of principle human histologic case report that re-osseointegration was feasible following a low cost, readily available protocol of mechanical debridement, antiseptic chemical detoxification and osseous grafting.13 The objective of this study was to clinically assess the effectiveness and predictability of this therapy in a larger number of treated patients and implants.

MATERIALS AND METHODS

The research protocol was approved by the Ethics Committee of XXX under the protocol number: CAEE 82773317.5.0000.5259. All eligible patients signed informed consent forms. All surgical treatments were performed by a single investigator (M.R.S.) who had comprehensive experience in oral surgery.

Patients from the dental clinic of the Department of Periodontics and Implantology at XXX, as well as from author’s private office, having bleeding on probing, swollen mucosa, purulence, or pain in the soft tissue around an implant were screened. To further confirm a patient’s suitability for the study, comprehensive anamnesis, a clinical examination including probing of the affected implants, and
Radiographs were used to diagnose the presence of peri-implantitis. Inclusion criteria included: pocket probing depths (PPD) greater than 3 mm, bleeding and/or suppuration on probing (BOP) (SOP) (assessed one minute after probing), and radiographic evidence of progressive vertical bone loss around an implant in function for more than one year. Exclusion criteria included: implant mobility, an implant with less than 1/3 of its length remaining in bone, heavy smokers (≥25 cigarettes/day), evidence of current systemic disease, a history of bisphosphonate therapy, head and neck irradiation during the past 5 years, contraindications to undergoing surgical dental treatment, and noncompliance with the study protocol.

Nine consecutive patients (7 female/2 male) fulfilling the above selection criteria, ranging in age from 52 to 65 years (mean age: 56.5 years), having 15 implants with peri-implantitis (7 premolars and 8 molars), were selected for the trial. PPD and BOP were measured at 4 points around the implant [mesial-buccal (MB), mesial-lingual (ML), distal-buccal (DB) and distal-lingual (DL)] (Figure 1b) with a periodontal probe (PCPUNC 156, Hu-Friedy, Chicago USA). All initial and subsequent PPD were taken by author M.R.S. and confirmed by author M.F.S.

Digital radiographs were taken by attaching an index to a radiographic positioner. This index insured a reproducible x-ray/film incidence angle, allowing for standardized pre and post treatment radiographic comparisons.

All surgical procedures followed the protocol described in our prior study. Patients were prescribed a medication regimen of amoxicillin 250 mg and metronidazole 250 mg tid x 10 days, and instructed to begin one day prior to the procedure. Following local infiltrative anesthesia with 4% Articaine (DFL, Rio de Janeiro, Brazil), intrasulcular, full-thickness buccal and lingual surgical flaps were elevated to gain access to the exposed implant surface and its associated infrabony defect (Figure 1c). A large curette (Prichard, Hu-Friedy) was used to debride the granulomatous tissue from the bony defect around the implant. The implant threads were cleaned using a plastic curette (Implacare II, Hu-
Friedy) in an effort to disrupt or remove all visible plaque and calculus. Once the bony defect and the implant were thoroughly debrided mechanically, the entire surgical site was rinsed with copious amounts of sterile saline.

Decontamination solutions of 0.25% sodium hypochlorite (NaClO), and 1.5% hydrogen peroxide, (H2O2), were prepared by dilution in H2O and stored in 10ml syringes. Small cotton pellets saturated with the NaClO solution were used to thoroughly scrub around the implant collar and between the implant threads. After burnishing for approximately one minute, the solution was rinsed away using sterile saline. The H2O2 solution was then applied using the same protocol. A final thorough irrigation with sterile saline was accomplished subsequent to completing the chemical decontamination procedures.

Bony defects were filled with a 50/50 mixture of bovine hydroxyapatite (Bio-Oss, Geistlich Pharma AG, Switzerland) and nanocrystalline calcium sulfate hemihydrate (CaSO4)(Lumina – Set, Criteria, Brazil). The bone graft material was incrementally placed into the defect and packed with moderate density in an attempt to obtain close graft approximation to the implant surface. A porcine collagen membrane (BioGide, Geistlich Pharma AG, Switzerland) was trimmed to fit over the grafted bony defect (Figure 1d and 1e). The flaps were positioned in a tension free manner to cover the membrane and were sutured with 5-0 nylon sutures (Ethicon Inc.®, Somerville, NJ, USA) (Figure 1f). Ibuprofen 600mg, q12h prn x 3 days was prescribed to minimize discomfort. Patients were instructed to rinse with Chlorhexidine 0.12% bid for 1 minute x 10 days. A periapical radiograph was taken immediately following the surgery.

Follow-up appointments were scheduled 1 week, 2 weeks, 3 months, 6 months, 9 months and one year post treatment. At these visits, the peri-implant area was debrided and oral hygiene instructions were reinforced. (PPD), (BOP) and (SOP) measurements were recorded at post-operative visits, except at one and two weeks follow-up, (Figure 2a, b, c and d). Periapical radiographs were taken.
PPD changes were assessed by calculating the difference in mean probing depths between baseline and the 12-month follow up. Additionally, the differences from baseline to 3-months and 3-months to 12-months were compared to assess the stability of the outcomes. The change in the number of deep peri-implant pockets (≥5mm) was also assessed between time points. BOP was analyzed by assessing the difference in the mean number of bleeding sites for each implant at each time period. Radiographically, the linear distance from the base of the bony defect to the implant platform was recorded using computer software (Carestream Image Suite (Carestream Health, Rochester, USA))(Figure 3, 4 and 5). These measurements were compared between baseline and 12-months.

The normality of the data was assessed using the Shapiro-Wilk test. The student paired-t test was used to assess normal distribution data, while the Wilcoxon paired test was used to compare non-normal distribution parameters. Statistical analysis was performed using R (Foundation for Statistical Computing, Vienna, Austria) computer software.

RESULTS

All surgeries healed uneventfully. All patients were conscientious as they appeared for all follow appointments and maintained a high level of oral hygiene.

Pocket probing depth

At baseline, PPD at 4 points (MB, DB, ML, DL) around the 15 test implants varied from 5mm to 7.5mm, with a mean PPD of 6mm (+.7mm). At the 12 month follow up, PPD varied from 1.5mm to 4.2mm, with a mean PPD of 2.5mm (+.8mm). The mean PPD reduction of 3.6mm (59.2%) was statistically significant (p<.001). Pocket depth measurements at 3, 6, and 9 months were also listed (Table 1). Figure 1 illustrates the decrease in PPD for each of the 15 implants over time.

Table 2 compares the reduction in mean PPD around the test implants at different time points in the study. Although 3.6 mm (59.2%) of mean pocket depth reduction was achieved between baseline...
and 12 months, most of this decrease occurred between baseline and 3 months (3.38mm). The decrease in PPD was found to be statistically significant between baseline and 3-months and baseline and 12-months, but not between 3-months and 12-months (p <0.01).

Bleeding on probing

The number of bleeding sites around each test implant decreased significantly between baseline and 12 months (p <0.001)(Table 3). The 2 bleeding sites were found at the 12-month follow-up in one patient.

Radiographic measurements

The decrease in mean radiographic bone loss from 4.8mm (±1.3mm) at baseline to 2.7mm (±1.2mm) at the 12 month follow up was found to be statistically significant (p <0.001) (Table 4). This 2.16mm of radiographic bone fill is equivalent to a 43.5% increase in visible calcified material abutting the implant surface.

DISCUSSION

Following implant surface decontamination and osseous grafting, multiple human clinical studies have demonstrated post-operative radiographic evidence of bone fill with close bone to implant approximation upon clinical re-entry.11,12 Histologic evidence of re-osseointegration is still considered to be a challenging goal though.10

As new direct bone-to-implant contact can only be ascertained by histological section, it is not possible to confirm its occurrence in clinical trials. A human histologic case report was recently published demonstrating re-osseointegration was achievable utilizing a specific systematic protocol.13 The results of this case series study, consisting of 15 consecutively treated implants with peri-implantitis, illustrate the clinical and radiographic reproducibility of this surgical-regenerative technique.
Pre-treatment pocket depths were measured, but initial attachment and recession levels were not assessed given the tenuous nature of soft tissue adherence to an implant surface and the variable amount of recession that might occur following surgery depending on implant surface topography. Consequently, total post-treatment pocket reduction, reduction in BOP, and radiographic bone fill were evaluated as measures of success. All implants showed improvements in clinical and radiographic metrics at 3, 6, 9 and 12 months following treatment. Mean total pocket reduction, consisting of soft tissue readherence and bone fill minus any recession that might have occurred, was 3.6mm. This compared with a reduction of 2.8mm in a recent systematic review. The mean number of bleeding upon probing sites were reduced from 4 ± 0.0 to 0.4 ± 0.83, which is similar to the results achieved by Dalago et al. (0.5 ± 0.27) using open flap debridement, citric acid decontamination and implantoplasty. Bassetti et al. have also demonstrated significant reductions in BOP using adjunct local drug delivery or photodynamic therapy, even though their 1-year follow-up results show higher BOP rates (1.74±1.37 and 1.55±1.26, respectively). Mean radiographic bone loss was reduced by 2.1mm. The reductions in BOP and PPD were viewed as clinical signs of reduced inflammation in the peri-implant mucosa as well as an indicator of treatment efficacy.

While plastic curettes have been shown to be unreliable at completely removing plaque, they cause minimal damage to a smooth implant surface as they disrupt surface biofilm colonies. Although there have been reports of plastic residue left on an implant surface following the use of plastic curettes, there was no residual inflammation or evidence of clinical healing impairment of the peri-implant tissues following the decontamination protocol utilized in this study.

The antimicrobial effectiveness of NaClO is based on its high pH as it interferes with bacteria cytoplasmic membrane integrity by irreversible enzymatic inhibition and alterations in cellular metabolism and phospholipid degradation. H2O2 has a potent oxidative effect on microorganisms and reinforces the activity of NaClO as it has been shown to promote cell wall lipopolysaccharide...
endotoxin removal. The effectiveness of both antiseptics, along with copious amounts of sterile saline irrigation, combined with thorough mechanical debridement and decontamination, are all thought to have contributed to the favorable results demonstrated in this trial.

Calcium sulfate hemihydrate porosity and hydroscopic properties promote the adsorption and infiltration of platelets and growth factors. Calcium ions released during its resorption activate platelets to release bone morphogenetic proteins (BMPs) and platelet-derived growth factors (PDGFs) that stimulate angiogenesis, osteogenic proliferation, and differentiation of mesenchymal stem cells. Additionally, CaSO₄ retards epithelial and connective tissue ingrowth. The bovine hydroxyapatite xenograft is osteoconductive and similar in structure and chemical composition to the inorganic component of human bone. Its porosity encourages vascular infiltration, the diffusion of nutrients from surrounding tissues, osteoblastic cellular ingrowth, and cellular adhesion to its surface.

The outcomes obtained in this trial were stable to its one year end point. Notwithstanding the outcomes of this case series study, if this protocol is to be identified as a treatment of choice for the management of peri-implantitis, the efficacy of this previously histologically validated regenerative approach needs to be confirmed in a larger, multi-armed clinical trial, having longer term follow ups, and the inclusion of control cases.

CONCLUSIONS

The proposed method of mechanical decontamination, chemical detoxification and bone regeneration is clinically effective and reproducible. Clinical peri-implant parameters, as well as radiographic bone levels, were improved and maintained their stability for one year using this peri-implantitis treatment protocol.

ACKNOWLEDGMENTS
The authors certify that they have no conflict of interest in the subject matters or materials discussed in the present manuscript.

REFERENCES


FIGURE Legends

Figure 1 (a) Initial aspect; (b) peri-implant pocket probing; (c) surgical access showing the bone defect; (d) biomaterial filling; (e) graft covered by bovine collagen barrier; (f) repositioned sutured flap

Figure 2: (a) clinical aspect 14 days post-op; (b) clinical aspect 12-months post-op; (c) Initial periapical radiography; (d) final periapical radiography

Figure 3: Radiographic measurements on baseline and 12-months post-op

Graph 1: Mean pocket probing depth over time by implant
### Table 1: Descriptive statistics of the pocket probing depth (mm) over time in the sample (n=15)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>6(±.7)</td>
<td>5</td>
<td>5.6</td>
<td>6</td>
<td>6.5</td>
<td>7.5</td>
</tr>
<tr>
<td>3-months</td>
<td>2.7(±.8)</td>
<td>1.5</td>
<td>2.2</td>
<td>2.5</td>
<td>3</td>
<td>4.2</td>
</tr>
<tr>
<td>6-months</td>
<td>2.7(±.7)</td>
<td>1.5</td>
<td>2.2</td>
<td>2.5</td>
<td>3.1</td>
<td>4</td>
</tr>
<tr>
<td>9-months</td>
<td>2.7(±.8)</td>
<td>1.2</td>
<td>2.2</td>
<td>2.5</td>
<td>3.1</td>
<td>4</td>
</tr>
<tr>
<td>12-months</td>
<td>2.5(±.8)</td>
<td>1.5</td>
<td>1.9</td>
<td>2.2</td>
<td>2.8</td>
<td>4.2</td>
</tr>
</tbody>
</table>

### Table 2: Comparison of the mean pocket probing depth between time points

<table>
<thead>
<tr>
<th></th>
<th>Mean Difference</th>
<th>Average Variation (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-months / Baseline</td>
<td>-3.383</td>
<td>-55.917</td>
<td>0.000</td>
</tr>
<tr>
<td>12-months / Baseline</td>
<td>-3.600</td>
<td>-59.236</td>
<td>0.000</td>
</tr>
<tr>
<td>12-months / 3-months</td>
<td>-0.217</td>
<td>-3.318</td>
<td>0.346</td>
</tr>
</tbody>
</table>

### Table 3: Descriptive statistics of the bleeding on probing sites over time in the sample (n=15)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Frequency/Implant (%)</th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>4(0)</td>
<td>100</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3-months</td>
<td>0(0)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6-months</td>
<td>0(0)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9-months</td>
<td>0.2(±.56)</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>12-months</td>
<td>0.4(±.83)</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

### Table 4: Descriptive statistics of the mean bone level radiographic measurement (mm) by time points in the sample (n=15)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Minimum</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>4.8(±1.3)</td>
<td>1.3</td>
<td>4.4</td>
<td>4.8</td>
<td>5.7</td>
<td>6.4</td>
</tr>
<tr>
<td>12-months</td>
<td>2.7(±1.2)</td>
<td>0.9</td>
<td>1.7</td>
<td>2.8</td>
<td>3.4</td>
<td>5.5</td>
</tr>
</tbody>
</table>
Figures

Fig 1
Fig 2

Fig 3