



# Current Approaches for the Non-surgical Management of Peri-implant Diseases

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## Abstract

**Purpose of the Review** Peri-implant diseases are inflammatory reactions to bacterial infections affecting osseointegrated dental implants. In recent years, scientific interest on this topic has increased, as demonstrated by the appearance of a large number of protocols for treating peri-implant mucositis (PIM) and peri-implantitis (PI). The aim of the present narrative review is to provide an overview of the recent (e.g., 2014–present) published protocols for the non-surgical treatment of peri-implant diseases.

**Recent Findings** Several adjunctive measures for mechanical debridement have been proposed and investigated to achieve implant surface decontamination and resolution of mucosal inflammation. However, none of the adjunctive measures has been shown to significantly improve peri-implant conditions compared with non-surgical mechanical debridement alone.

**Summary** Non-surgical approaches for the treatment of peri-implant diseases have been proved to be reliable in reducing clinical signs of peri-implant inflammation (e.g., BoP), although with limited capability to achieve complete disease resolution. Due to the limited benefits from the use of currently proposed adjunctive methods (e.g., chlorhexidine, lasers, photodynamic therapy, systemic probiotics) their application is not recommended until further investigations prove their clinical utility.

**Keywords** Titanium · Dental implants · Peri-implant disease · Peri-implant mucositis · Peri-implantitis · Inflammation · Crestal bone loss

## Introduction

The quality and reliability of implant supported oral rehabilitations of partially and totally edentulous patients have been radically increased during recent decades and feature high long-term implant survival and success rates [1, 2].

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As reported at the World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, peri-implant health was defined at the clinical level by the absence of signs of soft tissue inflammation (e.g., BoP and suppuration) [3••]. Unfortunately, peri-implant diseases, namely, peri-implant mucositis and peri-implantitis, occur. Over the years, several definitions have been applied to define peri-implant mucositis and peri-implantitis [4, 5]. More recently, at the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, peri-implant mucositis and peri-implantitis definitions were adopted as follows [6••, 7••, 8••]:

## Peri-implant Mucositis

- The presence of bleeding and/or suppuration on gentle probing with or without increased probing depth compared with previous examinations
- The absence of bone loss beyond crestal bone level changes resulting from initial bone remodeling

Visual signs of inflammation may vary, and peri-implant mucositis may be present around implants with variable levels of bone support.

### Peri-implantitis

- The presence of bleeding and/or suppuration on gentle probing
- Increased probing depth compared with previous examinations
- The presence of bone loss beyond crestal bone level changes resulting from initial bone remodeling

### Prevalence of Peri-implant Diseases

The world-wide prevalence of peri-implant diseases has been widely investigated: a systematic review of the literature reported a prevalence of peri-implant mucositis of 43% (range 19–65%) and peri-implantitis of 22% (range 1–47%) [9]. More recently, several data from cross-sectional studies have been published, assessing the frequency of peri-implantitis between 13 and 26% [10–14]. However, due to the present wide range of reported prevalences reflecting the high heterogeneity of the applied clinical and radiographic thresholds of disease definition, an adequate estimate of these diseases is difficult [9]. Nonetheless, despite the variety of definitions applied to detect these two clinical scenarios, the interest on this topic has markedly increased during the last decade, as shown by the high number of systematic reviews published [15–19]. The first approach for the treatment of peri-implant diseases has evolved from the classic periodontal treatment including scaling and root planing to interventions aiming at removing the peri-implant biofilm and granulation tissue [20]. The first diagnostic and therapeutic steps to manage peri-implant diseases were summarized more than 20 years ago by Lang and co-workers who proposed the Cumulative Interceptive Supportive Therapy (CIST) protocol [21]. This cumulative protocol includes a sequence of non-surgical interventions (A: mechanical debridement, B: antiseptic therapy, C: antibiotic therapy) followed by surgical procedures (D) and explantation as the last therapeutic step (E). Despite the application of several different treatment modalities, a huge discrepancy between the efficacy of non-surgical therapy around teeth compared with that around dental implants has been reported [20]. Nonetheless, it has been widely accepted that clinicians should attempt to deliver non-surgical interventions around dental implants prior to surgery.

The aim of the present narrative review was to summarize the most recent scientific evidence (2014-present) published on the non-surgical treatment of peri-implant diseases.

### Clinical Approaches to Manage Peri-Implant Mucositis

Due to the reversible nature of peri-implant mucositis [22•, 23, 24•], the proposed treatment strategies to manage soft tissue inflammation rely on the paradigm of infection control. More specifically, to reduce the overall bacterial load under a specific threshold, the following three key steps have been investigated:

### Peri-implant Biofilm Removal

Historically, peri-implant surface decontamination has been performed by a combination of hand (i.e., titanium, plastic, Teflon, carbon-fiber) [25••] and mechanical (i.e., abrasive air-powder systems, rubber cup) instruments with conflicting results on the superiority of one versus another modality [26]. These results were corroborated by a large 6-month comparative multicenter study on 141 implants, which failed to detect any statistically significant difference in terms of reduction of mucosal inflammation (i.e., BoP change) among the four investigated tools (i.e., sonic plastic tips, titanium curettes, airflow with glycine powder or rubber cups and polishing paste) [27].

Different results were reported by another group, which compared the efficacy of air-abrasive glycine powder to manual debridement performed with plastic curettes followed by local irrigation with a 0.1% chlorhexidine digluconate solution around 88 implants. At the 6-month follow-up, a statistically significant difference between the two groups with respect to mean probing depth (PD) (1.87 SD 0.38 vs. 2.70 SD 0.37) and BoP (20.83 SD 30.99 vs. 70.45 SD 26.32) in favor of the air-polishing device was observed [28].

Riben-Grundström and coworkers compared the application of a glycine powder air-polishing device to an ultrasonic instrument with a plastic coated tip to decontaminate 36 implants with 3 different surfaces. At the 12-month evaluation, similar changes in both the percentages of sites with PD  $\geq$  4 mm and BoP positive were reported. Therefore, the authors concluded that both devices were “effective in reducing inflammation and number of peri-implant pockets” even though complete disease resolution was difficult to achieve in both groups [29].

More recently, the efficacy of a chitosan brush to debride peri-implant surfaces characterized by clinical signs of inflammation (i.e., PPD  $\geq$  4 mm with concomitant BoP and no detectable marginal bone loss) was compared with titanium curettes in a split mouth 6-month randomized clinical trial (RCT). A statistically significant difference in favor of the chitosan brush was detected only in the early healing phase (i.e., at week 2 and 4), while at the 6-month follow-up this benefit was not observed [30].

## Adjuncts to Implant Surface Disinfection (i.e., Laser, Sodium Hypochlorite, Chlorhexidine, Probiotics, Enamel Matrix Derivative)

Due the difficulties in removing peri-implant biofilms and properly decontaminating implant surfaces, several adjunctive agents have been recently released to the dental market. In particular, the antibacterial [31] and decontamination [32] effects of a diode laser have been reported both in vitro and in vivo studies. Similar results have been reported in a retrospective study including 27 patients rehabilitated with 125 dental implants treated with a combined protocol (i.e., mechanical debridement, diode laser application followed by a local chlorhexidine gel application). A statistically significant difference ( $p < 0.0001$ ) with respect to mean PD reduction was detected between test (2.66 SD 1.07 mm) and control (0.94 SD 1.13 mm) groups as well as the final percentages of sites with BoP (T: 4.95%, C: 59.72%). The present results should be carefully interpreted due to the study design including different sample sizes between tests and controls and imbalance for potential confounding factors such as smoking. Moreover, due to the local application of chlorhexidine gel, the adjunctive benefits of diode laser itself seems difficult to be estimated [33]. These positive findings could not be replicated in a recent study by Aimetti and co-workers who reported the outcomes of a 3-month RCT. A 3× diode laser application as an adjunctive treatment of 220 implants did not yield any statistically significant clinical benefits compared with mechanical debridement alone [34••]. Therefore, at the present time, even though adjunctive application of laser might result in greater BoP reduction in the short-term, due to the lack of long-term data, its routinely use to manage peri-implant mucositis seems unjustified [35••].

The use of a sodium hypochlorite (NaOCl) gel was recently investigated by Iorio-Siciliano and co-workers as an adjunct to mechanical debridement alone in the management of peri-implant mucositis. More specifically, in a 6-month triple blind RCT it was reported that a 5× application for 30 s of NaOCl gel prior to mechanical debridement with an ultrasonic scaler failed to statistically significantly improve PD and BoP reductions compared with mechanical debridement alone. Moreover, the results indicated that a complete resolution of mucosal inflammation was achieved in 45% of test and 32% of control implants, respectively [36•].

The use of chlorhexidine as chemical adjunct to enhance biofilm control in conjunction with non-surgical periodontal therapy has been widely assessed [37, 38]. Consequently, its application on affected dental implants have been investigated. Recently, a 0.12% chlorhexidine gluconate solution was applied into the peri-implant pockets after mechanical debridement performed with plastic curettes [39]. In addition, the 22 patients diagnosed with 61 implants affected by peri-implant mucositis were prescribed twice daily for 2 weeks chlorhexidine mouth rinses. At the 6-month evaluation, no clinical difference between the antiseptic

and placebo solution was detected with respect to the number of BoP positive sites [39].

On the other hand, the clinical benefits of a single daily session of oral hygiene procedure with adjunctive 0.2% chlorhexidine gel were reported in a 12-week RCT. The 19 test patients displayed after 4 and 12 weeks a statistically significantly lower percentage of residual pockets ( $PD \geq 4$  mm) compared with the 18 controls (33% vs. 55%,  $p < 0.05$ ) despite the fact that one third of the implants was still BoP positive at the final evaluation [40].

A solution containing chlorhexidine 0.03% + 0.05% cetylpyridinium chloride was recently tested over a 1-year period as an adjunct in the treatment of peri-implant mucositis [41]. The rationale behind the use of this solution originates from the successful management of gingivitis [42] associated with reduced side effects of a pure chlorhexidine rinse [43]. At the 12-month follow-up, the twice daily tested solution was not more effective than the placebo rinse for most of the assessed clinical parameters except for the changes in buccal BoP values (47% vs. 23%) ( $p = 0.022$ ). Once more the authors underlined that complete BoP resolution was achieved in 58% of the test cases [41].

Among the adjunctive means to manage peri-implant mucositis, the use of probiotics has been advocated based on their delivery in non-surgical periodontal therapy [44, 45]. In particular, Flichy-Fernández and co-workers reported the positive effects provided by the adjunctive delivery of tablets containing *Lactobacillus reuteri* (dosage: 1 × 30 days) on 23 implants diagnosed with peri-implant mucositis [46]. Adjunctive probiotics delivery yielded an additional PD reduction of 1.09 SD 0.90 mm compared with the placebo group after 6 months. However, these results should be interpreted with caution because BoP values as the primary outcome of peri-implant mucositis therapy were not reported. On the other hand, the present results were not corroborated by recent RTCs, which failed to document the effects of adjunctive probiotics in the treatment of peri-implant mucositis [47, 48].

Furthermore, following the promising results obtained by Froum et al. 2012 [49] on the use of enamel matrix derivatives (EMD) as an adjunct in the treatment of peri-implantitis, Kashfimehr et al. (2017) evaluated the use of EMD around dental implants diagnosed with peri-implant mucositis. Following submucosal mechanical debridement, adjunctive EMD application yielded statistically significantly shallower PDs (median 3.0 vs. 5.0 mm) as well as lower BoP percentages (25% vs. 75.0%) at the 3-month follow-up [50]. The mean findings from the discussed studies are summarized in Table 1.

## Patient-Administered Oral Hygiene Procedures

In addition to professionally administered mechanical and adjunctive procedures, optimal patient-administered biofilm control regimes are crucial in the management of peri-implant mucositis.

**Table 1** Main interventions and outcomes among the included studies for the treatment of peri-implant mucositis

Author	Follow-up time (months)	PPD baseline (mm)	BoP baseline	BoP index	Intervention	PPD follow-up (mm)	BoP follow-up	Complete resolution (%)
Lupi et al. (2017)	6	2.51 ± 0.24	45.83 ± 39.47	*	Glycine powder	1.87 ± 0.38	20.83 ± 30.99	NR
Riben-Grudström et al. (2015)	12	NR	43.9 ± 7.3	*	Glycine powder	NR	12.1 ± 3.8	92 (pat)
Wohlfart et al. (2019)	6	4.29 ± 1.50	1.35 ± 0.85	**	Oscillating brush	3.95 ± 1.27	0.74 ± 0.80	86.4 (site)
Lerario et al. (2016)	12	5.22 ± 1.34	90.09	***	Diode laser	2.54 ± 0.98	4.95	NR
Aimetti et al. (2019)	3	3.5 ± 0.7	48.3 ± 26.9	***	Diode laser	2.9 ± 0.6	23.2 ± 23.5	62.1 (site) 34.5 (impl)
Iorio-Siciliano et al. (2019)	6	3.93 ± 1.09	33 of 33	****	Sodium hypochlorite gel	3.04 ± 0.46	18 of 33	45 (impl)
Menezes et al. (2016)	6	2.85 ± 0.60	75.82 ± 33.98	***	0.12% Chlorhexidine Gluconate	2.49 ± 0.60	45.76 ± 34.85	38 (impl)
Hallström et al. (2017)	3	69% of sites with PD ≥ 4 mm	NR	*****	Brush-on gel containing 0.2% chlorhexidine digluconate	NR	33% sites with PD ≥ 4 mm	NR
Pulcini et al. (2019)	12	3.36 ± 0.78	58.64 ± 27.49	*****	0.03% CHX and 0.05% cetylpyridinium chloride mouth rinse	2.50 ± 0.43	10.42 ± 13.74	58 (impl)
Flichy-Fernández et al. (2015)	12	3.55 ± 0.40	1.39 ± 0.78	*****	<i>Lactobacillus reuteri</i>	2.46 ± 0.92	1.30 ± 0.70	73.9 (impl)
Pena et al. (2019)	3	3.10 ± 0.74	100	*****	<i>Lactobacillus reuteri</i>	2.88 ± 0.62	64	32 (impl)
Hallström et al. (2016)	6	4.3 ± 1.1	54	*****	<i>Lactobacillus reuteri</i>	3.7 ± 1.3	14	NR
Kashefimehr et al. (2017)	3	4.50 (4.00–5.00)	75.00 (75.00–100.00)	*****	EMD	3.00 (2.00–4.3-7)	25.00 (0.00–50.00)	30 (impl)

: number of BoP-positive implants

NR not reported

\*BOP-Index: percentage, dichotomous values, positive if bleeding occurs within 30 s from the stimulation

\*\*mBOP-Index: recorded using a 3-graded index 30 s after probing (Roos-Jänsaker et al. 2007)

\*\*\*BOP-Index: percentage, dichotomous values, under light force (0.25 N) (Lang et al. 1986), probing at six sites around implant

\*\*\*\*BOP-Index: percentage, dichotomous values, probing at four sites around implant, under light force (0.25 N) (Lang et al. 1986)

\*\*\*\*\*BOP-Index: four sites/implant, recorded using a 3-graded index (Renvert et al. 2009)

\*\*\*\*\*BOP-Index: percentage, dichotomous values (Jepsen et al. 2015)

\*\*\*\*\*mBI: recorded using a 3-graded index (Mombelli et al. 1987)

\*\*\*\*\*BOP-Index: dichotomous values at implant level → recorded assigning a binary score to each implant (0 absence, 1 presence)

\*\*\*\*\*BOP-Index: dichotomous values, percentage of bleeding in six sites per implant, 15 s after gentle probing

Nonetheless, the evidence of the superiority of powered vs. manual tooth brushes as well as the efficacy of twice daily patient's administered antiseptic rinse seem to be negligible [51•]. Moreover, the application of a chlorhexidine gel failed to provide clear benefits in the management of peri-implant soft tissue inflammation [52]. Finally, even-though systemic delivery of azythromycin might result in better clinical outcomes when compared with the mechanical debridement alone [53], its use seems unjustified to manage peri-implant mucositis [51•].

### Clinical Approaches to Manage Peri-Implantitis

Due to the irreversible nature of peri-implantitis, characterized by progressive marginal bone loss, the non-surgical interventions are based on the following steps:

#### Peri-implant Biofilm Removal

Mechanical decontamination methods of the implant surface have been pointed out to be crucial in order to achieve resolution of mucosal inflammation. However, due to several differences between teeth and dental implants (i.e., macro and micro characteristics of the implant surface), debriding and decontaminating peri-implant surfaces are more challenging than those around teeth. Therefore, various tools have been introduced into the market to debride peri-implant surfaces. In particular, a new oscillating chitosan brush was tested in a 6-month single-group multi-center study including 63 patients diagnosed with initial peri-implantitis. Although the results indicated statistically significant improvements of PD and BoP scores between baseline and follow-up, due to the lack of a control group no definitive conclusions could be drawn [54].

An additional study protocol compared the efficacy of monotherapy with an air-polishing device containing glycine powder with mechanical debridement with carbon fiber curescopes and chlorhexidine digluconate after 12 months [55]. At the final evaluation, no statistically significant differences were found between the groups with respect to plaque index, PD, mucosal recession, and clinical attachment level, while lower BoP values were detected in the air-polishing group.

Currently, besides the multitude of methods proposed for the mechanical debridement of implant surfaces, there is little research investigating the efficacy of such devices. Therefore, no clear clinical recommendations can be provided on which tool should be selected to accomplish professional mechanical debridement around dental implants.

### Adjuncts to Mechanical Debridement (i.e., Lasers, Photodynamic Therapy, Sodium Hypochlorite)

Although potential benefits of photodynamic and laser therapy on implants affected by peri-implantitis were reported [56], conflicting results on their use as an adjunct to mechanical debridement are available [57••].

In a single cohort retrospective study involving 15 subjects with 23 implants with a sand-blasted and acid etched (SLA) surface, Mettraux et al. (2016) reported promising 2-year results in terms of PD and suppuration reduction despite the fact that complete resolution of inflammation was not achieved, as shown by 43% of sites still BoP positive [58]. Similar results were reported by Bassetti and co-workers who performed a 12-month RCT to test the adjunctive benefits of a 2× PDT application. In particular, the test group failed to show any statistically significant difference of BoP scores compared with controls treated with minocycline hydrochloride microspheres (1.74 SD 1.37 vs. 1.55 SD1.26) [59].

The adjunctive benefits of a sodium hypochlorite solution (Perisolv®) to mechanical debridement alone was tested in a RCT with a split-mouth design including sixteen patients [60]. At the 3-month evaluation, significant improvements in terms of BoP positive sites as well as PD reduction were observed in both groups when compared with baseline. Nonetheless, since no statistically significant difference was detected between groups, it was concluded that mechanical debridement with adjunctive use of sodium hypochlorite was equally effective in the reduction of mucosal inflammation as conventional non-surgical mechanical debridement alone.

One of the most challenging aspects in the evaluation of the efficacy of a specific treatment protocol is that a combined mechanical and chemical intervention is investigated. Recently, in a 12-month retrospective case series, significant improvements in terms of PD and BoP reductions and radiographic bone gain were reported following repeated applications of a combined approach including mechanical debridement, subgingival chlorhexidine irrigation, and systemic antibiotics [61]. Although the application of a combined non-surgical protocol yielded positive outcomes at 1 year, the lack of a control group failed to reveal superiority of this treatment modality compared with mechanical debridement alone [61]. Studies details are reported in Table 2.

### Limitations

The evidence summarized in the analyzed literature presents several major limitations making comparisons among studies difficult.

**Table 2** Main interventions and outcomes among the included studies for the treatment of peri-implantitis

Author	Follow-up time (months)	PPD baseline (mm)	BoP baseline	BoP index	Intervention	PPD follow-up (mm)	BoP follow-up	Complete resolution (%)
Wohlfahrt et al. (2017)	6	5.15 (4.97–5.32)	1.86 (1.78–1.93)	*	Oscillating brush	4.0 (3.91–4.19)	0.64 (0.54–0.75)	71.1 (site)
John et al. (2015)	12	3.7 ± 1.0	99.0 ± 4.1	***	Glycine powder	3.2 ± 1.1	57.8 ± 30.7	NR
Mettraux et al. (2016)	24	7.5 ± 2.6 (buccal) 7.7 ± 2.1 (oral)	100	***	Diode laser	3.6 ± 0.7 (buccal) 3.8 ± 0.9 (oral)	43	57 (impl)
Bassetti et al. (2014)	12	4.19 ± 0.5	4.03 ± 1.66	***	PDT	4.08 ± 0.81	1.74 ± 1.37	31.6 (pat)
Roos-Jänsaker et al. (2015)	3	5.38 ± 1.88	0.97 ± 0.12	**	Chloramine gel	3.63 ± 2.06	0.38 ± 0.46	50 (impl)
Estefanía-Fresco et al. (2019)	12	6.8 ± 1.69	99	****	CHX and systemic antibiotics	4.61 ± 1.22	71	49 (impl)

: mean number of BOP-positive sites per implant  
 : median PPD and interquartile range (IQR)  
 NR not reported

\*mBOP-Index: recorded using a 3-graded index 30 s after probing (Roos-Jänsaker et al. 2007)

\*\*BOP-Index: percentage, dichotomous values, probing at six sites around implant, positive if bleeding occurs within 30 s after probing

\*\*\*BOP-Index: percentage, dichotomous values, under light force (0.25 N) (Lang et al. 1986), probing at six sites around implant

\*\*\*\*BOP-Index: percentage, dichotomous values, probing at four sites per implant, positive if bleeding occurs within 15 s after probing

First, a homogeneous case-definition of peri-implant mucositis and a highly heterogeneous definition of peri-implantitis were detected. Second, despite the fact that most of the studies reported a power calculation, the question of what should be considered the primary outcome measure in the management of peri-implant mucositis (i.e., BoP or PD change) is still a matter of debate. In addition, in most of the studies the role of implant surface characteristics was not considered since several implant systems with different surface roughnesses were treated. Finally, despite increasing evidence underlying the importance of an adequate width (i.e.,  $\geq 2$  mm) of keratinized and attached peri-implant soft tissue seal [62], the characteristics of the soft tissue conditions were poorly reported in the included studies.

### Conclusions

Based on the level of evidence of the last 5 years, non-surgical approaches in the management of peri-implant diseases have been shown to be effective in reducing signs of bleeding on probing even-though complete resolution of inflammation still remains unpredictable. On the other hand, in cases of advanced peri-implant lesions, the use of non-surgical protocols should aim at preparing healthier soft tissue conditions prior to adjunctive therapy including reconstructive and resective surgery. Finally, patient’s enrolment in a tailored supportive therapy program seems crucial to monitoring peri-implant conditions before and after treatment.

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### Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Informed Consent** To perform the present study, informed consent was not required.

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