Nonsurgical Treatment of Peri-implantitis Using a Chitosan Brush with Adjunctive Chemical Decontaminants—A Retrospective Case Series

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Purpose: To evaluate the effect of a simple nonsurgical procedure for the treatment of peri-implantitis. ***Materials and Methods:*** A total of 30 implants across 24 patients diagnosed with moderate to advanced peri-implantitis were treated using a chitosan brush with adjunctive chemicals, ie, 3% hydrogen peroxide and a tetracycline slurry. The treatment was performed a total of three times, with intervals of approximately 3 weeks. ***Results:*** Results showed improvement in both the clinical attachment level (CAL) and bleeding on probing score between the baseline and the re-examinations between 9 months and up to 43 months (mean 26.8 months) after treatment. The mean CAL at baseline was 3.4 mm (range: 1 to 8 mm), while the mean CAL during the final examination was 1.4 mm (range: 0 to 5 mm), demonstrating a mean reduction of CAL of 2 mm (range: 1 to 7 mm; $P < .001$). Of the analyzed implant sites, 72% demonstrated radiographic signs of osseous defect fill varying between 0.1 and 2.2 mm (mean: 1.0 mm). ***Conclusion:*** The results show that this novel treatment strategy may serve as a nonsurgical alternative to reduce parameters of inflammation around implants with moderate to advanced peri-implantitis. *Int J Oral Maxillofac Implants 2022;37:1261–1267. doi: 10.11607/jomi.9602*

Keywords: peri-implantitis, decontaminants, retrospective, case series

Though peri-implantitis is a common clinical problem, there have been few treatment strategies with predictable success rates.[1,2] It is commonly accepted that surgery is the treatment of choice in active peri-implant infections with advanced bone loss. However, the morbidity of such surgical treatment strategies is relatively high, and thus, a clinically effective nonsurgical treatment would be an attractive alternative. Chitosan is a biopolymer that has been shown to be highly biocompatible and completely biodegradable.[3] A dental implant cleaning device made of chitosan has been introduced on the market, and Wohlfahrt et al[4] demonstrated that the use of a chitosan brush had merits in the nonsurgical treatment of dental implants with mild peri-implantitis. Hydrogen peroxide has previously been reported to be effective for disinfecting titanium surfaces.[5,6] Tetracycline has broad antimicrobial capabilities and a low pH, which can aid in the cleaning of implant surfaces and inhibit collagenase in local applications.[7–9] The aim of this study was to investigate a novel nonsurgical treatment protocol for moderate to advanced peri-implantitis using 3% hydrogen peroxide as well as tetracycline dissolved in sterile saline as an adjunct to mechanical debridement with a chitosan brush.

MATERIALS AND METHODS

This was a retrospective case series of a convenience sample that included 30 implants across 24 consecutively treated patients diagnosed with moderate to advanced peri-implantitis; ie, three or more threads were exposed to probing on at least one side combined with pus or significant bleeding. All patients in a recall and follow-up system at the clinic of the treating therapist (R.S.) between September 2014 and June 2017 who presented with peri-implantitis were included in this study. There were no exclusion criteria. The study was approved by the regional ethical board (REK Sor-Ost 2017/1612). Informed consent was signed by all patients. The implant surface types were Brånemark MK III TiUnite (n = 13; Nobel Biocare), Brånemark Turned (n = 2; Nobel Biocare), Astra TiOblast (n = 8; Dentsply Sirona), Straumann SLA (n = 4), and Replace TiUnite

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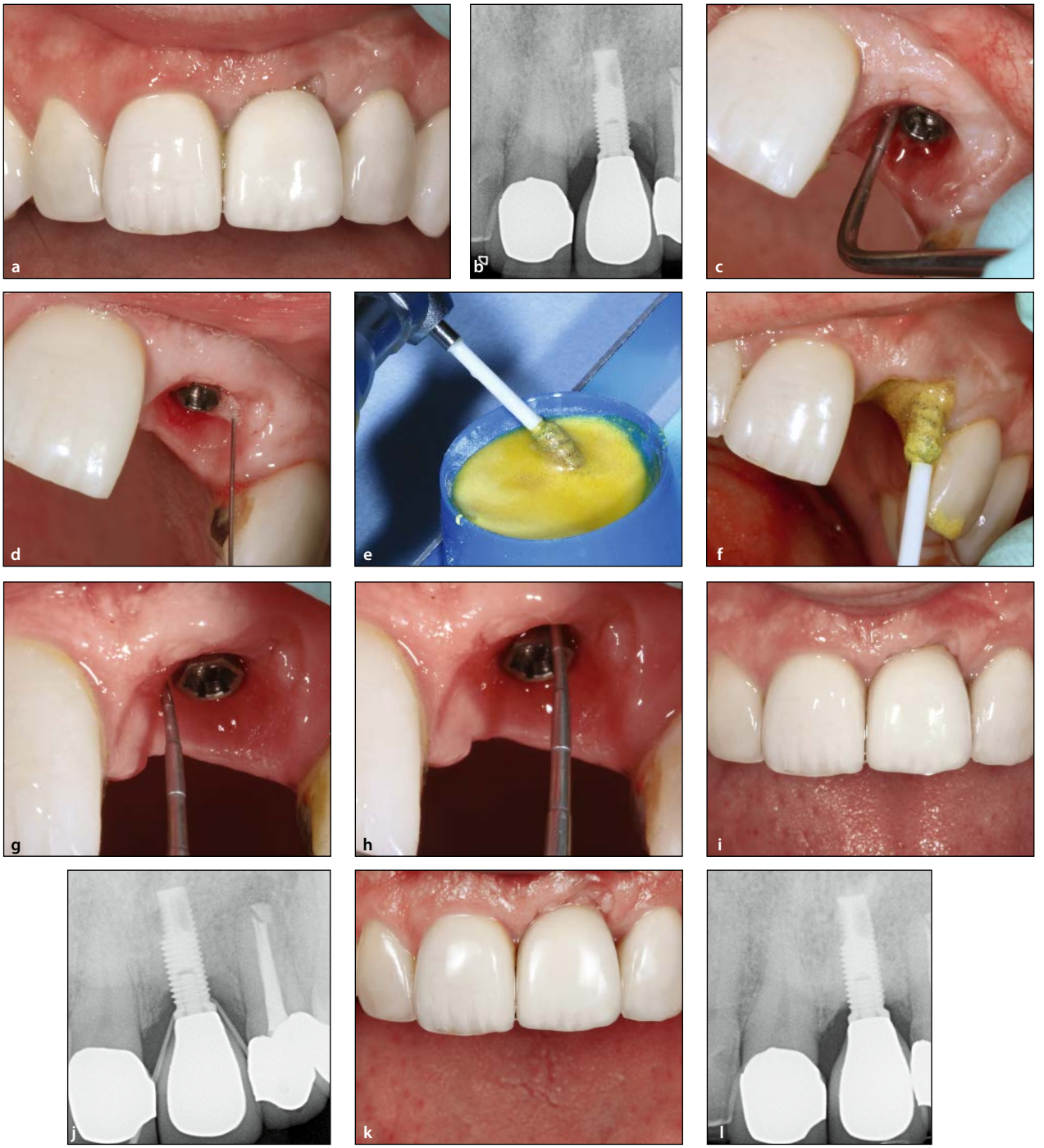

Fig 1 Maxillary left central incisor *(a)* implant-retained crown and signs of inflammation in the surrounding soft tissues, *(b)* marginal bone destruction as seen on radiograph, and *(c)* clinical signs of inflammation with increased probing depths and bleeding and suppuration upon probing. *(d)* Treatment according to the protocol is initiated, including with flushing with 3% hydrogen peroxide. *(e)* After cleaning with the Labrida BioClean brush, a solution of tetracycline-hydrochloride is prepared. *(f)* Tetracycline-hydrochloride solution is applied into the sulcus along the implant using the Labrida BioClean brush. *(g and h)* Follow-up at 10 months with reduced probing depths and only minimal signs of inflammation. (i) No signs of soft tissue retraction compared to baseline. *(j)* Improved bone level as seen on radiograph. (k) At the 3-year follow-up, soft tissues remain at the same level, and *(l)* marginal bone level is significantly improved.

(n = 3; Nobel Biocare). Patients were treated in a standardized fashion (Figs 1 and 2; a supplementary video of this procedure is available at: https://youtu.be/XaELZFKzhRY).

After mechanical debridement with titanium curettes in cases where calculus was found, treatment was performed with a chitosan brush (Labrida BioClean) seated in an oscillating dental bur piece (ER10M,

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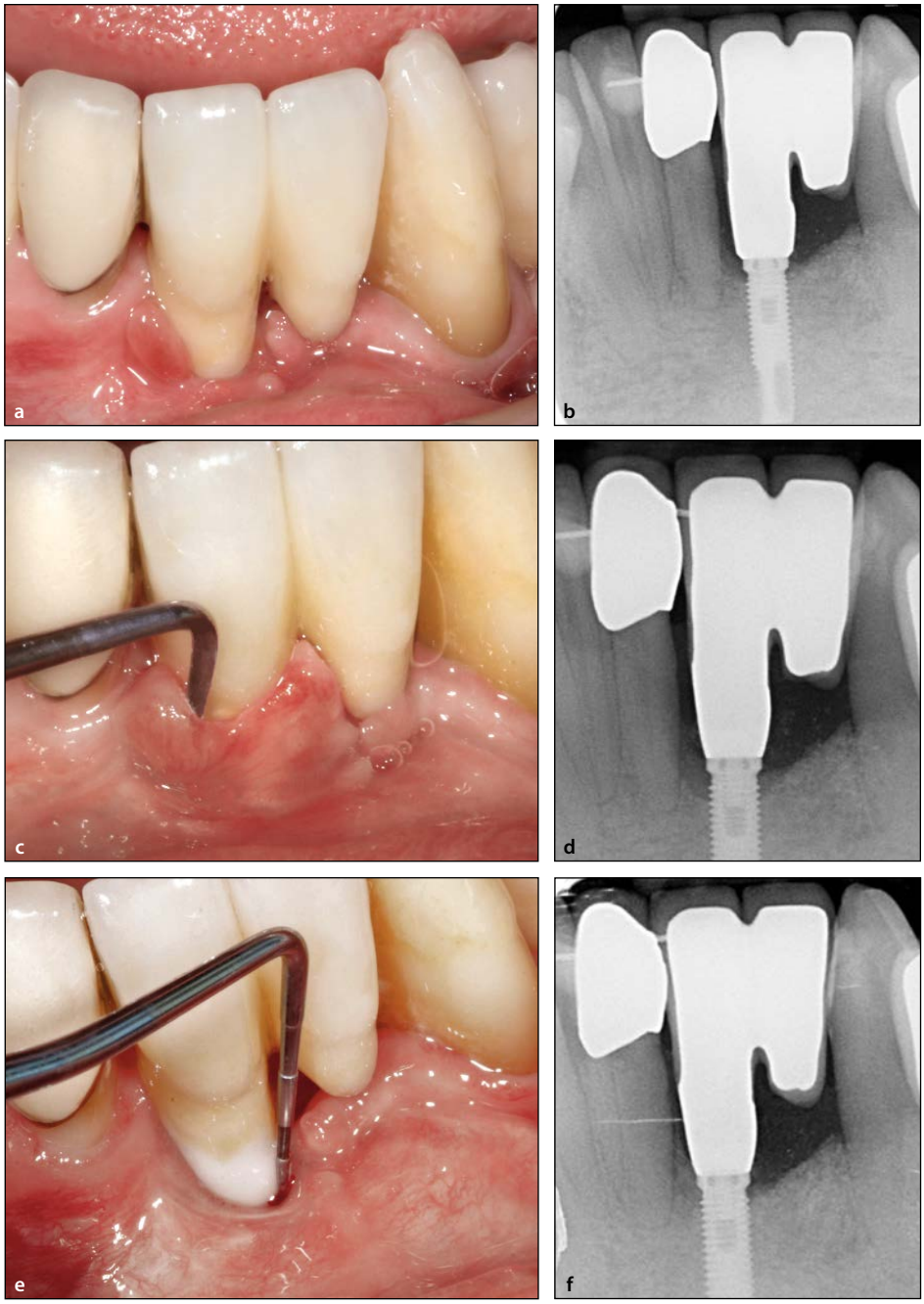

Fig 2 *(a)* This patient, diagnosed with Papillon Lefevre, was treated with an implant-retained crown in the mandibular left central incisor. *(b)* Baseline radiograph demonstrating normal marginal bone level. *(c)* During a follow-up visit, pronounced inflammation was disclosed, and pocket probing around the implant revealed deep pocket sand several exposed threads. *(d)* Radiograph demonstrating marginal bone destruction. *(e)* At recall 3 years after treatment, there was normal probing depth and no clinical signs of inflammation. *(f)* The marginal bone returned to healthy levels.

TEQ-Y, NSK). To facilitate access for both the treatment procedure and CAL measurements, prosthetic suprastructures were removed from 22 of the implants during clinical measurements and treatments. Since the restorations were not overcontoured or mounted onto deeply seated implants, accessing the implants with cemented suprastructures for treatment and CAL measurements was unproblematic. Because the primary objective was to measure the effectiveness in hindering progression of peri-implant attachment loss, it was judged that CAL differences were a more exact parameter of treatment results than pocket probing depth measurements (Fig 1). At each time point, treatment with a combination of 2 minutes with 3% hydrogen peroxide (Aas ProduksjonslabAS) applied with a syringe (Fig 1d), followed by 2 minutes with tetracycline-hydrochloride (Arco Interpharma AS) in sterile saline (sodium chloride 9 mg/mL, Fresenius Kabi) with a concentration of 150 mg/mL as chemical detergent adjuncts to the chitosan brush (Figs 1e and 1f), was performed. This treatment was repeated two more times with intervals of approximately 3 weeks between each procedure. All treatments and clinical measurements were performed by a board-certified prosthodontist

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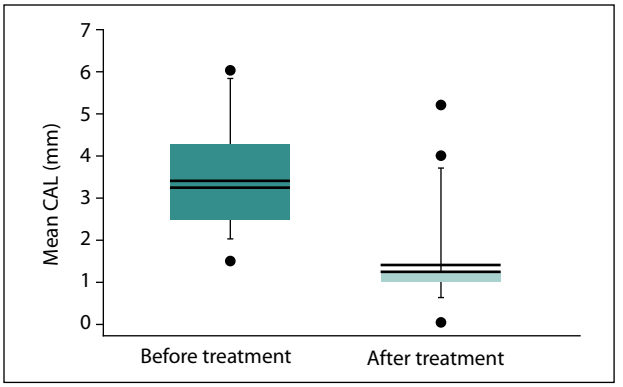

Fig 3 Clinical attachment level (CAL) before and after treatment with Labrida BioClean and adjunct chemical decontamination.

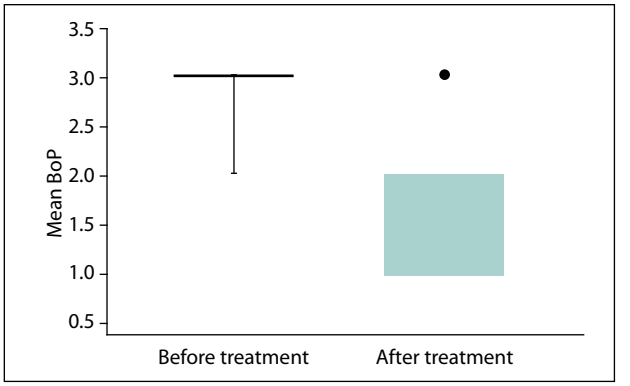

Fig 4 Modified bleeding on probing index (mBoP; categorial scale 0, 1, 2, 3) before and after treatment with Labrida BioClean and adjunct chemical decontamination.

(R.S.). Clinical examinations included the registration of clinical attachment level (CAL) measured from the top of the implant to the base of the clinical pocket at baseline prior to treatment and at follow-up visits as the primary parameter, and a modified bleeding on probing index (mBoP)[10] and radiographic measurements as secondary parameters. Intraoral radiographs positioned as parallel to each implant as possible were taken prior to the intervention and during follow-up visits using Eggens holders. Digital intraoral radiographs, connected to and analyzed with a standard commercial software system (Planmeca Romexis 6.0), were used. Patients were re-examined between 9 and 43 months after the initial treatment, with a mean follow-up of 28.3 months (median 30 months). Analysis of radiographs was performed by a board-certified radiologist (A.V.) in a blinded fashion, with the dates of the initial and follow-up radiographs removed. The radiologist placed demarcations mesially and distally on each radiograph where he judged the bone level to be situated, and without knowledge of when the radiographs were taken, ie, before or after treatment. All the radiographs were presented to the radiologist in a randomized fashion. Differences in bone levels were measured using the digital radiographic software and recorded for further analyses. Statistical analyses comparing clinical parameters and radiographic measurements between baseline and the final examination time points were performed with Sigma Plot version 13.0 (Systat Software) using Mann-Whitney *U* test at an alpha level of $\alpha = .05$.

RESULTS

In total, 24 patients with 30 implants were included in the analysis. Of these, 2 patients had incomplete clinical data on 1 of 2 implants, and 3 patients lacked all clinical data. Also, 2 patients had no final radiographs for 1 out of either 2 or 3 total implants, and 3 patients had radiographs that were deemed uncertain to analyze by the radiologist. The 3 patients lacking clinical data were excluded from clinical data analysis, and the 2 patients with no final radiographs for 1 implant were excluded from radiographic analysis. Thus, 21 patients with 25 implants were included in the analyses of clinical data, and 22 patients with 25 implants were included in the analyses of radiographs. In 21 patients with 23 implants, reductions in both the CAL and mBoP were observed between baseline and the re-examinations between 9 months and up to 43 months (mean 26.8 months) after treatment (Figs 3 and 4). Mean CAL at baseline was 3.4 mm (range: 1 to 8 mm), ranging from 3 to 8 mm when counting only affected sites, while mean CAL at the final examination time points was 1.4 mm (range: 0 to 5 mm), ranging from 0 mm and up to 7 mm when counting only initially affected and treated sites, demonstrating a mean CAL reduction of 2 mm (range: 1 to 7 mm) ($P < .001$). Implants with CAL values < 3 mm at one or more sites were still registered with peri-implantitis if at least one site showed a CAL level of ≥ 3 mm combined with significant bleeding and/or pus upon probing. These values were included in the mean CAL values.

A reduction in CAL with no improvement in mBoP was observed in one patient with two implants. In one patient with one treated implant, there was an initial reduction in mBoP from an index of 3 to an index of 1, but no early change in CAL. In this specific case, the patient was re-treated, which led to a reduction in CAL. One smoking patient showed initial improvement in mBoP, but inflammation eventually reoccurred. The baseline radiographic sign of bone loss varied from 0 to 7.8 mm (mean: 2.6 mm) when all sites were included, (ie, both mesial and distal sites as measured by the radiologist) while at the terminal examination time points, the corresponding values varied between 0 and 7.4 mm (mean: 2.1 mm). A total of 18 (72%) of the included implant sites demonstrated radiographic signs of osseous defect fill

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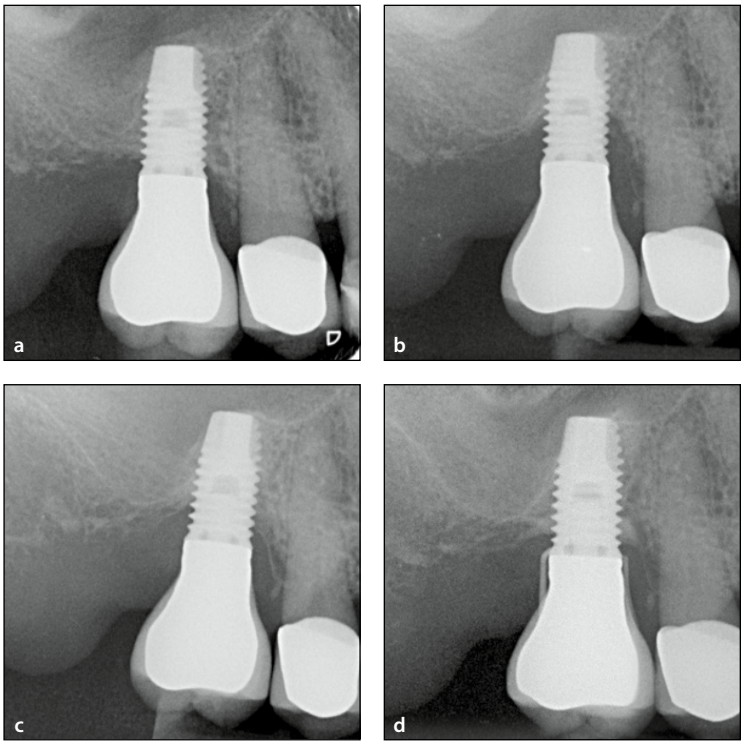

Fig 5 *(a)* Baseline radiograph showing normal marginal bone level around an implant in the maxillary right first molar. *(b)* Pronounced bone destruction and inflammation around the implant 1 year later. *(c)* 6 months after treatment, there were signs of improvement on the radiograph. *(d)* The marginal bone level returned to normal 3 years after treatment.

Table 1 CAL and Radiographic Defect Fill Changes

Change (mm)	CAL gain (n = 25)		Radiographic defect fill (n = 25)	
	n	%	n	%
> 2	12	48.0	1	4.0
> 1–2	9	36.0	7	28.0
0–1	4	16.0	10	40.0
0	0	0	1	4.0
< 0 to –1	0	0	4	16.0
< –1 to –2	0	0	2	8.0

Frequency analyses. Numbers are reported at implant level.

varying between 0.1 and 2.2 mm (mean: 1.0 mm; Figs 1b, 1j, 1l, 2e, 2h, 5b, 5c, and 5d). Of the included implants, 6 (24%) had radiographic signs of bone loss as interpreted by the radiologist, varying between 0.15 and 1.3 mm (mean: 0.56 mm), and one case was interpreted as having no change in bone level (Table 1).

DISCUSSION

Currently, the consensus is that peri-implantitis should be treated surgically if a nonsurgical method has failed and in cases of recurrence.[11] Numerous methods have been described, but few long-term follow-up studies report consistent successful results in treating peri-implantitis surgically.[12] Furthermore, morbidity is seldom discussed in connection to surgical intervention. The retraction of soft and hard tissues can also have detrimental effects on esthetics after surgery.

A number of nonsurgical treatment methods of peri-implantitis have been described with different devices, such as metal hand instruments, ultrasonic scalers, airflow devices, and lasers in combination with photodynamic therapy. As most of the published articles describe short-term follow-up periods and small differences in treatment results between test and control groups, no definite conclusion can be drawn concerning the effectiveness of nonsurgical peri-implantitis treatments based on the current scientific literature.[13,14]

The etiology of peri-implantitis has been discussed intensely, and a multitude of reasons for how peri-implant bone and soft tissue inflammation leads to tissue destruction have been presented.[15] The consensus is that the cause is related to the formation of microbial plaque on implant surfaces, leading to soft tissue inflammation and the subsequent loss of implant-supporting bone.[16] As in conventional periodontal treatment, the first aim in the treatment of peri-implantitis should be to remove the biofilm and clean the surfaces exposed to microbial growth.[17,18]

In the treatment protocol presented here, an oscillating brush was used. The fibers of the brush were made of chitosan, a fast-dissolving bioinert marine biopolymer,[19] and therefore, the risk of a foreign body reaction is minimal. Removal of the biofilm is the main focus, but microorganisms residing in the soft tissues of the peri-implant may also be affected since the brush will remove some of these tissues during the procedure. The chitosan brush serves as a good carrier of chemical agents, such as hydrogen peroxide, which has been proven to be effective in the disinfection of titanium surfaces exposed to microbial growth.[5,6] After the cleaning and disinfection procedure, a tetracycline slurry was administered around the surface of the treated implant with the aim of reducing microorganisms on the titanium surface as well as in the surrounding soft tissues. Chemical agents vanish rather quickly in normal periodontal treatment due to the flow rate

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of gingival crevicular exudation; however, the biology surrounding an implant is different,[20] and the effect of sulcus fluid flow is less pronounced compared with the periodontal pocket. Hence, it may be hypothesized that chemical agents may have an improved substantivity in a peri-implant crevice compared with a gingival crevice. In a study by Stabholz et al,[21] the irrigation of gingival pockets was performed with a 50 mg/mL tetracycline solution. Tetracycline was present up to 16 days after just one episode of irrigation. In addition, Christersson et al[22] reported that the topical application of 100 mg/mL tetracycline-HCL led to significantly greater CAL gain compared to scaling and root planing alone. The method presented here included repeated treatments using 150 mg/mL topical tetracycline-HCL, ie, at a concentration three times greater than that used in the study by Stabholz et al.[21] When reintervention was performed at 3 weeks, yellowish remnants were regularly observed on the implant surfaces, which may be an indication of the presence of tetracycline remnants in the crevices.

A total of 22 patients had long follow-up periods, and the tendency was quite clear. The inflammation parameters remained low, and there was radiographic evidence that the marginal bone levels remained stable in the majority of the patients who had been followed for more than 2 years. Furthermore, in 17 implants, there were radiographic signs of bone fill. It can be challenging to determine where the bone level is situated via radiographs alone without additional clinical information. Moreover, it can be difficult to intepret cases where the lingual bone level is intact. To avoid bias in the clinical results, a separate and blinded radiographic examiner was used. With the use of individual radiographic stents, more comparable radiographs may have been achieved in cases where there were small differences before treatment and at recall visits. On the other hand, thorough use of an Eggens holder with an experienced clinician taking the radiographs will give fairly accurate measurements in the majority of cases. In some patients, the bone level even returned to the ideal height. Though this level of bone return could only be seen in cases where a sufficient amount of time had passed since treatment, noticeable CAL reduction occurred rather quickly, after just two to three treatment procedures. One patient with two implants was followed for less than 12 months. This patient passed away for reasons unrelated to the oral condition, but the treated implants showed inflammation-free tissues and CAL reduction during the last follow-up, 9 months after treatment. It should also be noted that none of the patients in the study were given extra attention with regard to professional cleaning besides normal general follow-up procedures, ie, every 6 to 12 months. This was to avoid risking the treatment effect being a result of professional cleaning procedures or extra professional attention. Concerning adverse effects of the treatment, the patients reported having minor postoperative soreness for a few days in the soft tissues surrounding the treated implants. No other side effects, (eg, soft tissue recessions) were registered.

The majority of patients included in this sample had the TiUnite (Nobel Biocare) surface implants, which have previously been reported to be extra prone to development of peri-implantitis, as well as difficult to decontaminate and treat for peri-implant inflammation.[23–25] Hence, the results of this study are remarkable, as the majority of participants had healthy peri-implant tissues throughout the observation period, as well as stable bone levels and bone fill up to initial marginal bone height in a few cases. The overrepresentation of Brånemark MK III implants in this case series does not necessarily confirm or imply that this implant is more prone to developing peri-implant infections than the other implants included. Brånemark MK III is the most common dental implant used in Scandinavia, and this influenced the number of patients with this type of implant who subsequently developed peri-implant disease.

Smoking is clearly a negative factor in the treatment of peri-implantitis,[26] and although there were a few smokers in this group of patients, no conclusions can be drawn regarding treatment efficiency for smokers suffering from peri-implantitis in this study.

The increase in resistance to antibiotics resulting from the use of tetracycline is an escalating issue in many countries, and one must view the use of antibiotics critically. It is common to prescribe orally administered antibiotics during both the nonsurgical and surgical treatment of peri-implantitis, and doses of up to 15 g are often prescribed. Although the present study used locally administered tetracycline in this treatment protocol, it only amounts to a fraction of that used in a systemic antibiotic protocol.

As discussed earlier, the large majority of the suprastructures used in the patients included in this study were screw-retained. This meant that the suprastructures could be disconnected in most of the cases when treating the implants affected with peri-implantitis, which substantially improved access. CAL measurements were also relatively simple and precise in these cases (Figs 1c, 1g, and 1h). The relatively few cemented suprastructures were not excessively overcontoured, making access for treatment and measurements around implants rather easy. No conclusion can therefore be drawn regarding the effectiveness of treating peri-implant infections with this protocol in cases with excessively overcontoured and cemented suprastructures with limited accessibility. In those cases, drilling through the suprastructure, locating the center screw,

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and making the implant at least temporarily screw-retained should be considered. Otherwise, surgery is an option, though if hygiene is hampered and leads to problems with peri-implant infection, this may eventually lead to reccurring problems. No evaluation comparing treatment effects on posterior vs anterior implants or maxillary vs mandibular implants was performed. This would call for a much larger population and may be interesting to investigate in a follow-up study with a greater number of patients. Although this case series contains a limited number of patients, the results are encouraging and can inspire further research.

CONCLUSIONS

Despite the limitations of this case series and the limited number of patients included in the analysis, the evidence indicates that this novel treatment strategy may serve as a nonsurgical alternative to reduce inflammation around implants with moderate to advanced peri-implantitis. With regard to hard tissue attachment, most patients had stable bone levels throughout the observation period, and there were also clear signs of bone level gain in a number of patients. A randomized clinical trial will be necessary to further explore these early findings.

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