*Clinical case*

# Combined Surgical Approach for Disinfection and Regeneration of Peri-Implant Defects. Three Case Report

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## ABSTRACT

Dental implants suffer a high incidence of mucositis and peri-implantitis, which can lead to failure. There are multiple non-surgical and surgical therapeutic approaches for these pathologies, although surgical treatment is indicated for peri-implantitis. Surgery may take the form of access surgery, resective and/or regenerative treatment. In order to achieve biofilm removal and improvement of peri-implant tissues, prior implant decontamination should always be performed. Mechanical, chemical, antibiotic or laser methods may be used to carry out the procedure. This article discusses three clinical cases in which a combined surgical approach was used employing implantoplasty, decontamination with chlorohexidine and orthophosphoric acid, application of local antibiotic (piperacillin/tazobactam) and regeneration via synthetic hydroxyapatite and resorbable membrane, showing favorable clinical outcomes consistent with bibliographical references.

## KEYWORDS

Peri-implantitis; Implantoplasty; Piperacillin; Tazobactam; Hydroxyapatite.

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## INTRODUCTION

Treatment with dental implants is a highly predictable procedure, with survival rates between 94.52% and 96.63%[1]. However, the high frequency of peri-implant mucositis and peri-implantitis has been observed to affect patients. Mucositis is characterized by inflammation of the peri-implant mucosa with no signs of bone loss and affects about 80% of patients and 50% of implants. Peri-implantitis consists of the involvement of hard tissues in addition to the mucosa, and affects between 28 and 56% of patients, as well as between 12 and 40% of implants, according to the 2008 European Peri-implantitis Workshop[2].

There are multiple therapeutic approaches which fall into two main categories: non-surgical and surgical treatment. Non-surgical treatment consists in the removal of biofilm from the peri-implant surface using various means: curettes, ultrasound, abrasive air systems and lasers, which can be accompanied by a variety of disinfection protocols: chlorhexidine, citric acid, minocycline, etc. This treatment is effective for mucositis and the prevention of peri-implantitis but fails to be effective for the latter pathology once established[3,4]. According to the depth of peri-implant defects, various authors recommend a surgical approach, either through access surgery, resective surgery, regenerative treatment, or combined resective-regenerative treatment. Such surgical protocols should be accompanied by disinfection procedures employing chemical treatments or antibiotics. There exists a broad array of antibiotics and combinations thereof suitable for topical application; however, there is no consensus regarding their long-term effectiveness for peri-implantitis suppression[5].

The objective of this study is to assess the effectiveness of a novel combined approach to peri-implantitis treatment using implantoplasty and regenerative techniques accompanied by disinfection with a combination of piperacillin and tazobactam antibiotics.

## CLINICAL CASES

Three clinical cases that were handled by the Oral Surgery and Implantology Service at the Virgen de la Paloma Hospital in Madrid for peri-implantitis treatment are described below.

**Case 1**

A 47-year-old male patient, smoker, no significant medical history, complained of "bleeding during brushing." Inflammation of the peri-implant mucosa in implants at 25 and 26 was observed during intraoral examination. Two years had passed since placement of the implants without any follow-up protocol. During clinical examination, bleeding and suppuration was observed during catheter insertion at probe depths >6 mm. Radiological examination showed the presence of peri-implant bone defects in both implants, with bone loss levels greater than 50% of the implant length at 26 (Figure 1).

**Case 2**

A 62-year-old female patient, with no significant medical history, complained of looseness in the bridge over implants from 12 to 22. The implants had been placed 5 years earlier. An increased catheter probe depth of >4 mm with bleeding upon implant probing was observed at 22, accompanied by radiological bone loss of >2 mm (Figure 2).

**Case 3**

A 65-year-old male patient, with no significant medical history, with a single crown implant at 36, complained of food entrapment at 36. Upon intraoral examination,

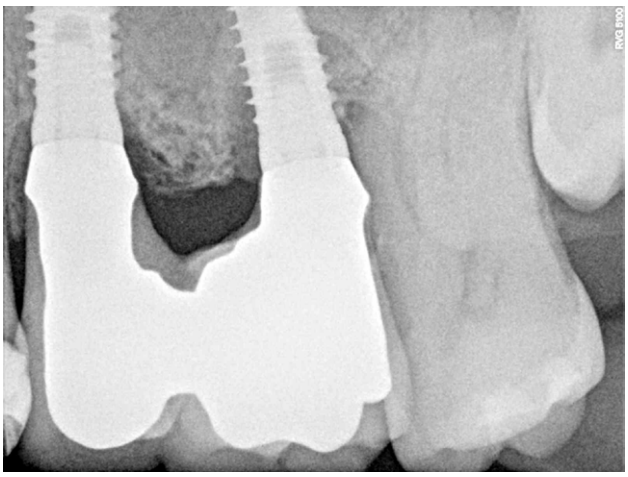

*Figure 1. Case 1: Initial periapical x-ray.*

clinical screw loosening was detected, with consequent corona mobility, food entrapment and inflammation of the peri-implant mucosa. During periodontal and peri-implant assessment, good periodontal health was determined, while at the implant level at 36 bleeding was observed upon catheterization with probe depth at >4 mm. Radiological examination yielded a diagnosis of peri-implantitis, confirmed by the presence of a peri-implant bone defect of around 3 mm (Figure 3).

In all three cases, the need for peri-implantitis treatment was indicated, using a combined surgical protocol consisting of implantoplasty, chemical and antibiotic decontamination, and regeneration using the Implacure® system (MTD, Switzerland).

Following the signing of informed consent, the first phase of the chosen protocol was carried out, which consisted of irrigation of the peri-implant sulcus with a 100/12.5 mg solution of piperacillin/tazobactam seven days prior to surgery.

The surgery was performed under local anesthesia. Intrasulcular incision was made, with mesial and distal discharges and flap raised to full thickness. The defect type was identified: Class Ic in case 1 (Figure 4), Class Ie in case 2 (Figure 5) and a combination of Class II and Class Ie in case 3 (Figure 6). Curettage of the defect was performed with ultrasound and preshaped curettes, and implantoplasty was performed using coarse, medium, and fine diamond burs included with the Implacure® system (Figure 7-9). Once the surface of the implant had been polished, it was chemically decontaminated by applying a 37% orthophosphoric acid gel combined with 2% chlorhexidine for two minutes, while taking the precaution of protecting the bone with gauze (Figure 10). Again, the surface of the implant was decontaminated by applying a gauze soaked in the piperacillin/tazobactam 100/12.5 mg solution and allowing it to act for one minute (Figure 11).

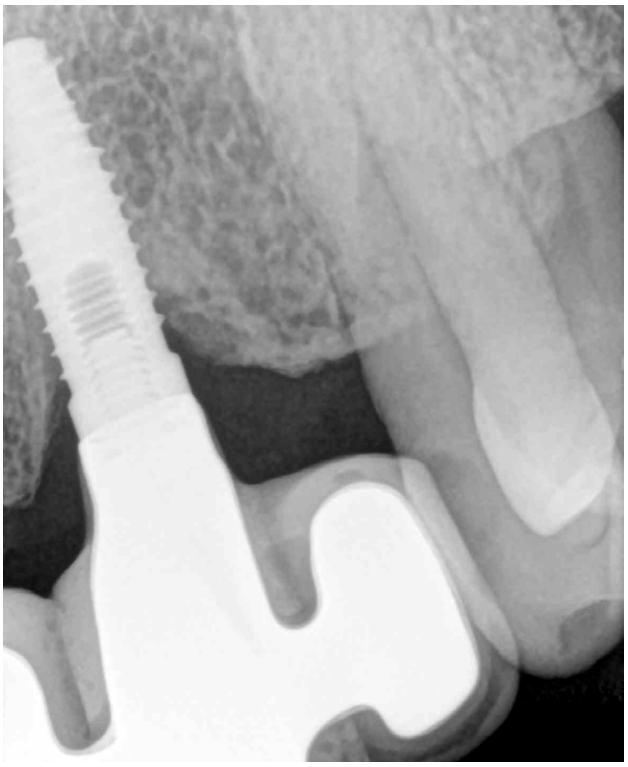

*Figure 2. Case 2: Initial periapical x-ray.*

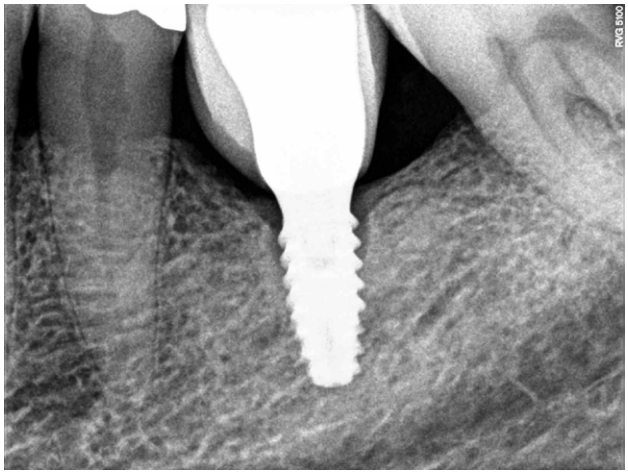

*Figure 3. Case 3: Initial periapical x-ray.*

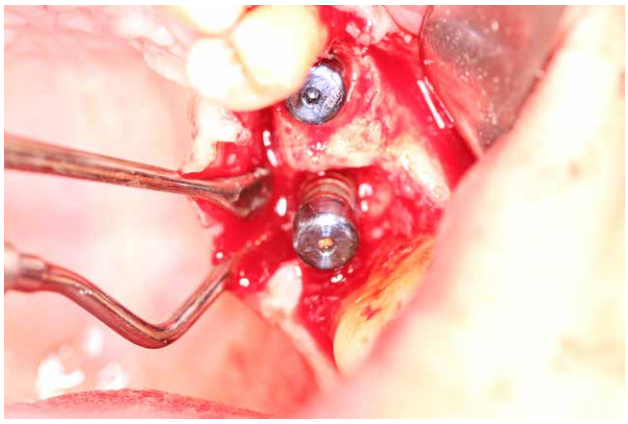

*Figure 4. View of the defect after lifting flap in case 1.*

Regenerative treatment of the peri-implant defect was then performed. Synthetic hydroxyapatite (Osbone®, Curasan, Germany) was used for this purpose, hydrated with a piperacillin/tazobactam solution, and covered with a collagen resorbable membrane (Osgide®, Curasan, Germany) hydrated with the same combination of antibiotics (Figure 12). Finally, submerged healing was fostered using a tensionless suture.

Clinical and radiological follow-up was carried out at one week, after 15 days, and at one, three and six months. After six months of follow-up, a decrease in catheter insertion depth (Table) and in bone defect at the radiological level was observed (Figure 13-15).

## DISCUSSION

There are several therapeutic options for the management of peri-implantitis: using either access surgery or a resective or regenerative procedure, depending on the type of bone defect. In horizontal natural defects, resective treatment by implantoplasty and apical flap displacement is recommended. Regenerative treatment[5,6] is recommended in vertical infra-bony defects and wound dehiscence.

In any event, such surgical procedures must be accompanied by proper disinfection of the defect and the implant surface. Multiple procedures have been proposed for this purpose, including mechanical treatment, use of chemicals and/or antibiotics, or photo-dynamic systems[7]. However, since the objective is to achieve maximum decontamination of the peri-implant substrate, the use of these methods in combination with each other is recommended[8].

Dostie et al.[9] conducted an in vitro study comparing different disinfection methods. Rinsing with a saline solution was performed in all cases, in combination with 1% chlorhexidine, 35% orthophosphoric acid, tetracycline 250 mg, and a mix of cetrimide 0.3 with chlorhexidine 0.1 and EDTA 0.5. Compared to the use of saline solution alone, the bacterial count showed a 33.2% greater reduction when using chlorhexidine (p-0.028); 26.1% more when using orthophosphoric acid ($p<0.05$), and 33.9% more with the application of tetracycline (p-0.027).

However, when analyzing the survival rate of bacteria, a higher percentage of dead cells was observed in the groups treated with chlorhexidine and orthophosphoric acid: 11.8% (p-0.023) and 6.9% (p-0.017) respectively; greater than with the use of saline solution alone. This study shows the clinical results following treatment with a combination of chlorohexidine 2% and 37% ortho-phosphoric acid, showing reductions in the depth of catheter insertion, and no bleeding and suppuration upon probing. These results serve to corroborate the reduction in bacterial load in the peri-implant area.

In addition to chemical decontamination, numerous authors propose the use of intralesional antibiotics. For example, Faggion et al.[10] conducted a meta-analysis in which they observed that mechanical debridement together with topical application of antibiotics achieved greater reductions in the depth of catheterization than mechanical debridement treatment in isolation. (0.49 mm). The second most effective treatment was obtained by the combination of mechanical debridement and PerioChip® (2.5 mg chlorhexidine) (0.4 mm). However, by comparing the combined treatment of debridement together with antibiotics with debridement combined with chlorhexidine, the first group achieved a reduction in the depth of probing averaging 0.262 mm more than the second group.

### Table. Depth of pre-surgical catheter probe and at 6 months after surgery.

| | Case 1 | | Case 2 | | Case 3 | |
|---|---|---|---|---|---|---|
| Probe depth (mm) | Baseline | 6 months | Baseline | 6 months | Baseline | 6 months |
| Vestibular | 6 | 3 | 5 | 3 | 3 | 2 |
| Palatino | 7 | 4 | 5 | 3 | 3 | 3 |
| Mesial | 7 | 3 | 6 | 4 | 4 | 3 |
| Distal | 7 | 3 | 6 | 3 | 4 | 3 |

Javed et al.[11] included 10 articles on the use of local or systemic antibiotics in their systematic 2013 review. Of the 10 studies, six administered the following antibiotics locally: tetracycline + doxycycline, minocycline, doxycycline, and tetracycline combined with hydrogen chloride (HCl) fibers. Five of these studies used non-surgical mechanical debridement techniques prior to the application of the antibiotic. In only one of the studies did patients undergo access surgery. Despite the different protocols used, statistically significant reductions in probe depth were observed in the six studies.

These results are consistent with those observed in the clinical cases described in this article, which show reductions in catheter insertion depth of between 1 and 3 mm after 6 months of follow-up.

It is worth taking note of the study conducted by Rams et al.[12], in which samples taken from 120 patients suffering from peri-implantitis were cultivated and analyzed for susceptibility to the following antibiotics: doxycycline 4 mg/l, amoxicillin 8 mg/l, metronidazole 16 mg/l and clindamycin 4 mg/l. Some 46.7% of patients had clindamycin-resistant bacteria, 39.2% were resistant to amoxicillin, 25% to doxycycline, and 21.7% to metronidazole. In addition, a post-hoc analysis showed that 6.7% of patients were home to species resistant to both amoxicillin 8 mg/l and metronidazole

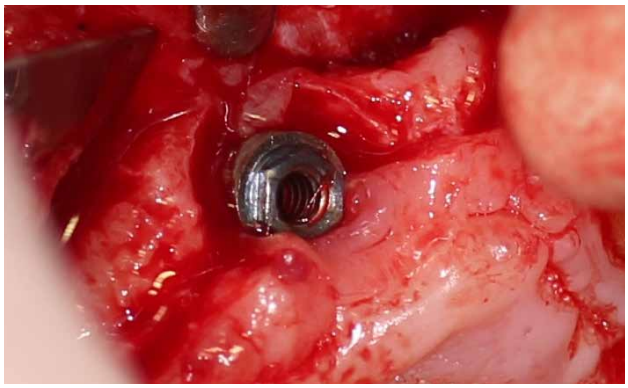

*Figure 5. Circumferential defect in case 2.*

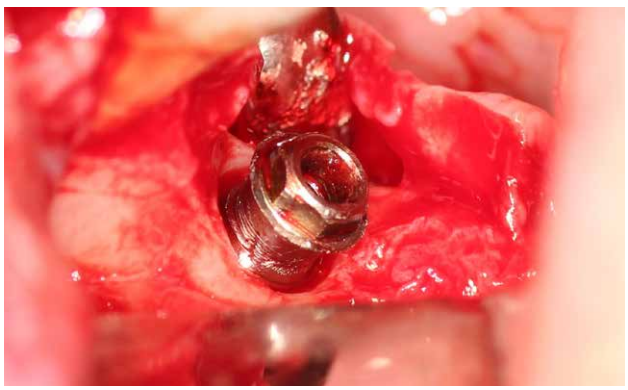

*Figure 6. Horizontal and vestibular composite defect in case 3.*

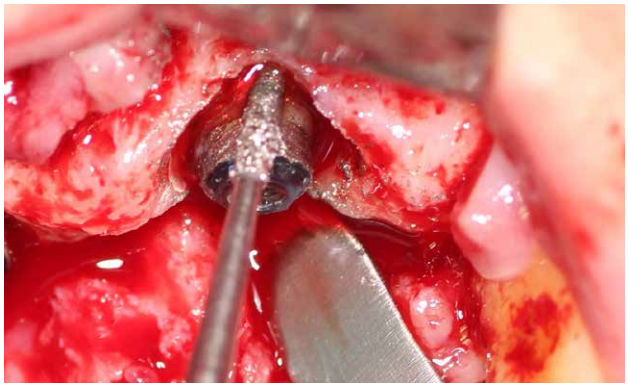

*Figure 7. Implantoplasty with coarse-grained drill bit.*

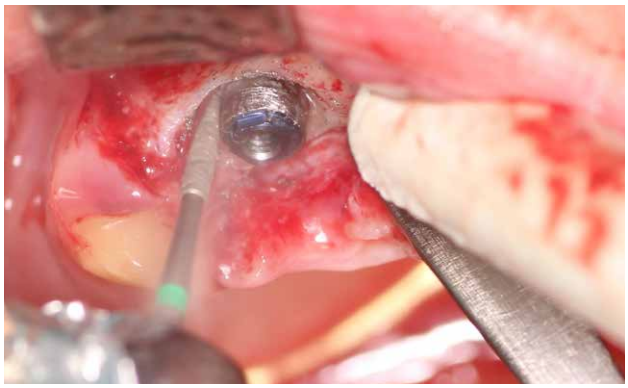

*Figure 8. Implantoplasty with medium-grained drill bit.*

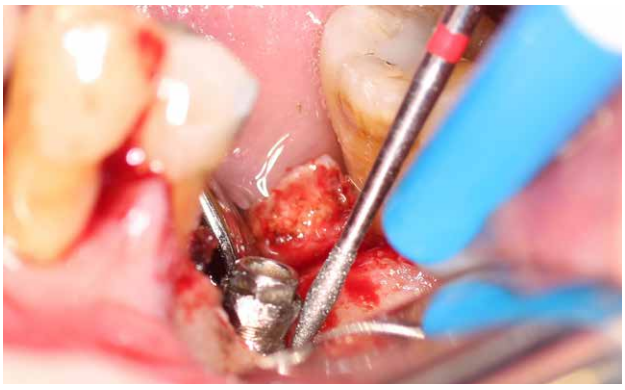

*Figure 9. Implantoplasty with medium-grained drill bit.*

16 mg/l. Overall, 71.7% of the 120 peri-implantitis patients showed pathogens resistant in vitro to one or more of the antibiotics studied.

Given the enormous antibiotic resistance of bacteria present in peri-implantitis, the protocol described in this article proposes the use of a 100/12.5 mg piperacillin/tazobactam solution. Piperacillin is a broad-spectrum semisynthetic penicillin that exerts its bactericidal activity by inhibiting the synthesis of the cell wall and septum. Tazobactam is a beta-lactam that acts as an inhibitor of numerous 0-lactamases, which often produce resistance to penicillin. Tazobactam extends the antibiotic spectrum of piperacillin to include numerous beta-lactamase-producing bacteria that have acquired resistance to piperacillin alone: aerobic and anaerobic gram-positive and gram-negative bacteria[13]. González-Regueiro et al.[14] published a clinical case treated under the same protocols as those described in this study, using the same antibiotic combination of piperacillin/tazobactam, and observed clinical improvements evidenced by the absence of bleeding and suppuration after three months.

These disinfection procedures manage to reduce the bacterial load on the peri-implant defect, achieving improvements in clinical parameters such as the depth of catheterization or bleeding upon catheterization, as well as improvements in peri-implant natural levels. However, to achieve reosseointegration of the implant, it is essential to employ regenerative techniques.

Daugela et al.[15] carried out a meta-analysis on 18 studies in which various regenerative approaches to peri-implantitis were performed. Upon radiological examination they observed increases in natural levels of 1.97 mm (1.58-2.35 mm) on average, with better results after using submerged healing. Improved results were observed in studies that used material coating membrane (2.12 mm) compared to those in which no membrane (1.86 mm) was used.

The use of autologous bone has shown favorable results in terms of reducing the depth of catheterization, either through its application in isolation or in combination with a resorbable membrane[16].

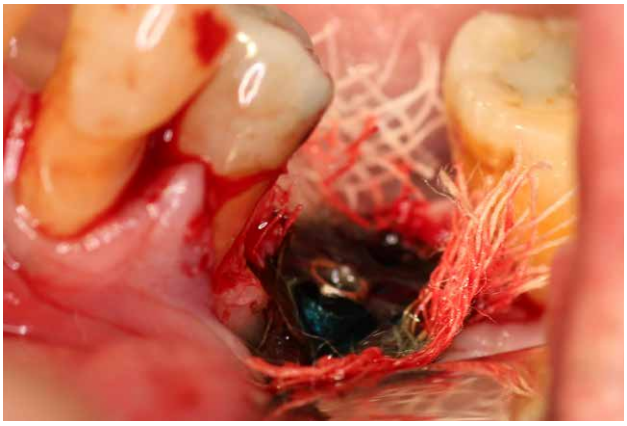

*Figure 10. Application of 37% orthophosphoric acid gel and 2% chlorhexidine.*

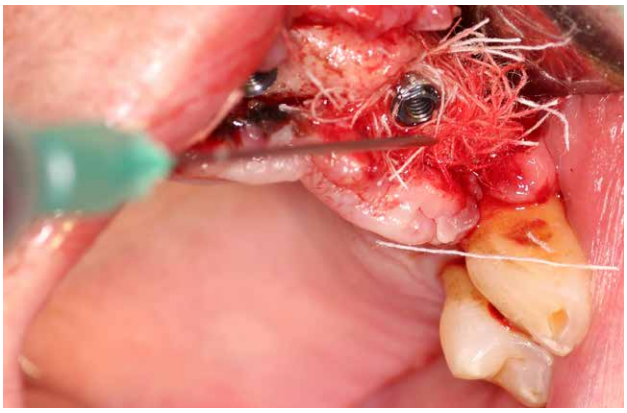

*Figure 11. Application of piperacillin/tazobactam to the implant surface.*

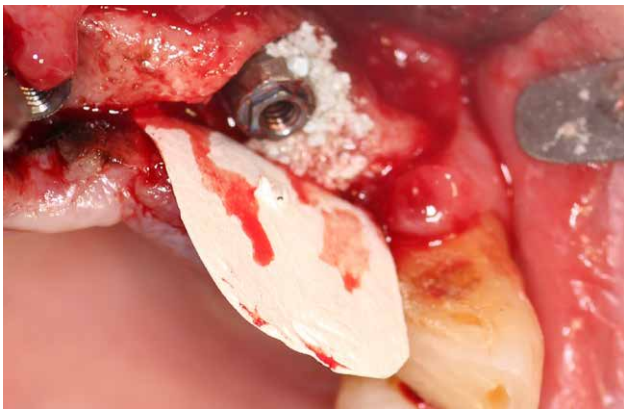

*Figure 12. Defect regeneration.*

In addition, a number of biomaterials have been proposed as fillers, including the use of titanium granules, which has shown favorable results in filling the peri-implant defect, as well as an increase in implant

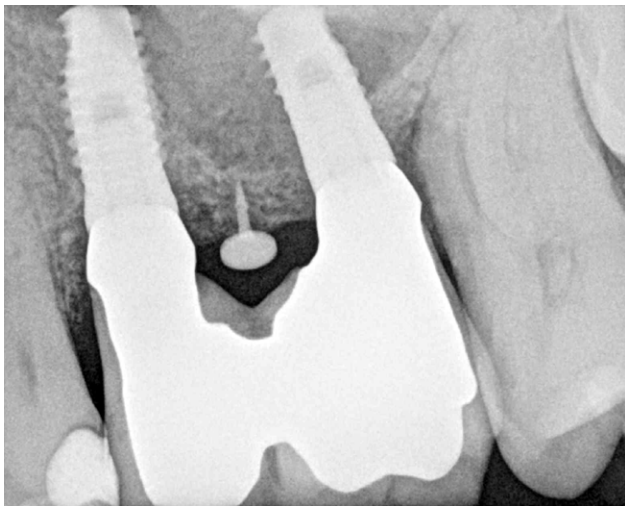

*Figure 13. X-ray exam at 6 months of follow-up to case 1.*

stability quotient (ISQ) of 1.6 units[17]. The use of bovine xenografts in deep defects has shown reductions in the sound depth of between 2.1 and 3.5 mm[18]. No significant differences have been observed between the use of bovine xenografts or the application of titanium granules, either clinically or upon radiological examination[19].

Roos-Jansaker et al.[20] compared the use of hydroxyapatite alone with the use of membrane-covered hydroxyapatite. After five years of follow-up, significant bone regeneration levels were observed in both groups ($p<0.001$), with mean regeneration levels of 1.3 mm. These positive results are supported by what can be observed in the set of cases used for this study, where regeneration of defects between 2 and 4 mm is observed.

In contrast, Schwarz et al. [21] showed unfavorable results regarding the use of synthetic hydroxyapatite. They compared the use of nanocrystalline hydroxyapatite with the use of BioOss® bovine biomaterial coated with swine resorbable membrane. After four years of follow-up, worse results were observed in the hydroxyapatite group in terms of reductions in probe depth: 1.1-0.3 mm as compared to 2.5-0.9 mm. In addition, only radiological bone defect regeneration was observed at 5 points, compared to 8 points in the BioOss® group. However, the small sample size of the study should

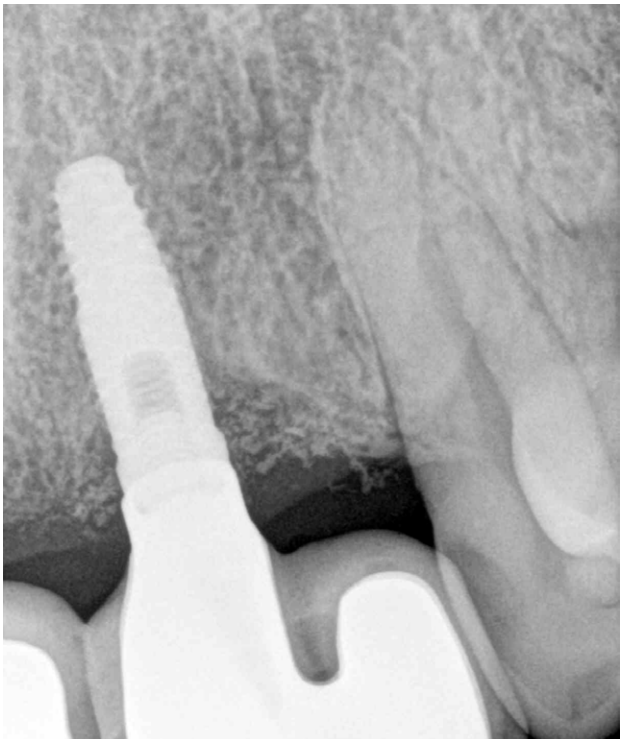

*Figure 14. X-ray exam at 6 months of follow-up to case 2.*

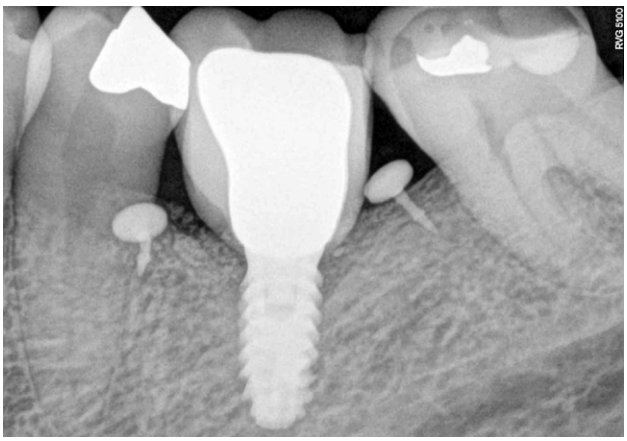

*Figure 15. X-ray exam at 6 months of follow-up to case 3.*

be considered: only 19 patients in total, as well as the bias of comparing a group in which membraneless biomaterial has been applied with another group in which biomaterial with membrane was used.

Currently, trial use of stem cells and morphogenetic proteins (BMP-2) for the treatment of peri-implantitis in animals is being conducted, with increased regeneration and reosseointegration being observed[22].

## CONCLUSION

A combined therapeutic approach shows favorable results at the clinical and radiological levels, coinciding with the outcomes described in the literature.

This new approach constitutes a comprehensive decontamination and regeneration treatment system that shows clinical and radiological improvement after 6 months of follow-up.

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