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Excess Cement and Peri-implant Disease

Donald P. Callan, BS, BA, DDS¹ • Charles M. Cobb, DDS, PhD²

Abstract

Background: Among the dental consumer population, dental implants are an increasingly popular option for replacing teeth and restoring function. Since implants became a common modality, assessments of their success have included improved appearance, restored ability to eat, and longevity of placement. By and large, the most appealing appearance drives the choice of dental implants for the patient. However, patients and dentists should be aware of possible complications that could affect the patient’s oral and systemic health, even when excellent esthetic results are achieved. This article demonstrates an excellent esthetic result even with the presence of excess subgingival cement following placement of a fixed prosthesis associated with no clinical signs of inflammation but with radiographic signs of peri-implant disease.

Methods: Three healthy females sought tooth replacement with dental implants. There were no contraindications for the placement of dental implants and proper surgical protocols were followed as specified by the implant manufacturer. The implants were restored three and one half months post surgery with a cemented crown. Three different restorative dentists were utilized for the three patients. Occlusal evaluations and adjustments were performed for each patient along with proper home care instructions as needed.

Results: The first recall visit showed no clinical signs of inflammation and all patients reported no discomfort, bleeding during routine home care procedures, normal function and acceptable esthetics. A radiograph was taken on each patient. Radiographic bone loss was noted on the mesial or distal coronal portion of the implant body. Mucogingival flaps were elevated on each implant and subgingival dental cement was noted on the three dental implants. The cements were not visible on the radiographs.

Conclusion: When restoring dental implants, the restorative dentist must exert extreme care to remove all dental cement about the implant body. In the cases presented in this report, although the restorations displayed acceptable esthetics and normal function with no clinical signs of inflammation or patient discomfort, excess cement appeared to create a localized inflammatory response that resulted in bone loss about the dental implants.

KEY WORDS: Dental implants, dental restoration, cement, inflammation

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INTRODUCTION
Among the dental consumer population, dental implants are an increasingly popular option for replacing teeth and restoring function from the missing teeth. Since implants became a common modality, assessments of their success have included improved appearance, restored ability to eat, and longevity of placement and maintaining a healthy environment. By and large, appealing appearance drives the choice of dental implants for the patient. However, patients and dentists should be aware of possible complications that could affect the patient’s oral and systemic health, even when excellent esthetic results are achieved. Local inflammation associated with teeth and dental implants is a significant clinical phenomenon and may pose systemic concerns through the inflammatory response of the host. The occurrence of infection, inflammation, and bone loss about teeth and implants will often compromise long-term prognosis, esthetics, function, oral health, and, if extensive, will ultimately lead to tooth and implant failure.¹⁻⁴

Some researchers and implant companies have indicated the crestal bone loss around dental implants is a normal occurrence. Local bone loss about teeth and dental implants is the result of inflammation. Gingivitis and periodontitis are both caused by a diverse population of oral bacteria with similarities of microbial populations existing between implants and natural teeth. Many of the same periodontal pathologic bacteria have been isolated from implants, thus concluding that Periodontitis and Peri-Implantitis are one in the same⁵ and may have systemic concerns.

Implant supported restorations may be retained by either dental retrievable screws or cements.⁶⁻⁷ Attaching the restoration to the implant body with a screw may have problems including loosening of the screw, fracture of the screw, esthetic concerns, increased cost, and a complex restoration.⁸⁻¹⁰ Utilizing dental cements may alleviate most of these problems.¹¹ Applying dental cements on the abutment of dental implant restorations is much the same as crown restorations on natural teeth. Little information has been provided in the literature regarding the potential problems of excess cement being retained subgingivally about dental implants after the completion of the restoration.¹²⁻¹⁴ This report documents three cases illustrating complications that may arise following the cementation of dental crowns on osseointegrated dental implants. One possible problem appears to be the inflammatory response as created by not removing excess subgingival cement.

MATERIALS AND METHODS
Three healthy partially edentulous patients aged 36 to 56 years were evaluated after the placement of dental implants and the final cementation of dental prostheses. All patients were in good health and had no contraindications for the placement of dental implants. Following completion of oral hygiene evaluation, oral hygiene instructions, and necessary periodontal therapy, one dental implant was placed in each patient according to the manufacturer’s protocol. All three patients were allowed to heal for a minimum of 3½ months to a maximum of 4 ½ months after implant placement. Oral hygiene instruction was reviewed with each patient before and after implant place-
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Figure 1: Six months after prosthetic procedures, note the soft tissues about the implants appearing normal in color, texture, and form.

Figure 2: Radiograph revealed bone loss on the mesial of the implant being evaluated. No cement was noted on the radiograph.

ment and at the second surgical procedure. There were no complications following the first and second surgeries and all three patients healed as anticipated. Radiographs were taken prior to implant placement and 3½ months after implant placement. All radiographs showed no bone loss. After healing of the second surgery, the soft tissues appeared normal in color, texture, form, and the patients reported little to no discomfort.

The patients were referred back to the restorative dentist for the completion of the restorative procedures. The cements were selected by each individual restorative dentist as to their preference and were used according to the manufacturer’s specifications. After cementation of the prosthesis, the restorative dentists attempted to remove excess cement about the abutment/prosthesis in the usual fashion.

Six months following the prosthetic procedures, the soft tissues about the implants appeared normal in color, texture, and form (figure 1) and all patients reported no discomfort. Upon probing with a periodontal probe (Williams markings), the pocket depths ranged from 6 to 7 mm in depth and there were no bleeding points. Radiographs revealed bone loss on the mesial or distal of each implant being evaluated (figure 2). The pocket depths were noted on the same side as the radiographic bone loss. Mucoperiosteal flaps were elevated about each implant (figures 3, 4). Dental cement was noted at the most coronal area of each implant that showed radiographic bone loss. On one of the patients, the bone loss so severe the implant was removed while removing the granulation tissue and the excess cement (figure 5).

To verify the identity of the material, a biopsy was taken from one of the patients and submitted to the oral pathology department at the University of Missouri at Kansas City for histological, scanning electron microscopy (SEM), Secondary Electron Imaging, and Electron Dispersion X-ray Analysis (EDS) evaluations. Four particles of a solid hardened material were chipped from the implant abutment/prosthesis interface and placed in a 10% neutral buffered formalin solution. A soft tissue biopsy consisting of gingiva and granula-
tissue was procured circumferentially from around the implant prior to removal of the implant from the alveolus (figure 5). The soft tissue biopsy was also placed in a 10% neutral buffered formalin solution and later processed for routine light microscopy, i.e., sectioned at 7µm thickness and stained with hematoxylin and eosin (H & E).

Following fixation in the buffered formalin solution, the solid particles were washed in ice-cold 0.1 M cacodylate buffer at pH 7.4 for three cycles of 2 hours each. The specimens were then allowed to dry and dehydrate in a dissector for 24 hours. Following drying/dehydration the specimens were affixed to aluminum stubs and sputtered coated with a carbon film. The coated specimens were then examined with the aid of a Philips field emission SEM (model XL-30 ESEM- FEI, Philips Electronic Instruments, Inc., Mahwah, NJ, USA). In addition to routine morphology, the particles were examined by: 1) x-ray microanalysis using electron dispersive x-ray spectroscopy (a.k.a. EDS; Bruker AXS Microanalysis, Ewing, NJ, USA); 2) secondary electron imaging; and 3) x-ray mapping, the latter two procedures using 15 kV accelerating voltage at a 10 mm working distance.

RESULTS

Soft Tissue Light Microscopy

Hematoxylin and Eosin (H&E) stained soft tissue sections revealed a moderately dense fibrosis surrounding numerous embedded foreign material (figure 6). The connective tissues were infiltrated...
by chronic inflammatory cells dominated by lymphocytes and plasma cells. The foreign material was particulate and presented two different staining affinities. There were particles that exhibited an overt affinity for hematoxylin, resulting in a deep purple staining pattern while other particles exhibited a slight affinity for the hematoxylin (figure 7) that resulted in a faint purple-pink staining pattern. Lastly, isolated islands of embedded microbial biofilm were noted near the tissue surface adjacent to the presumed peri-implant pocket area.

**SEM and Secondary Electron Imaging**

All particles were characterized by a relatively amorphous surface topography. Under routine SEM examination, the surface appeared relatively smooth except for the presence of localized deposits of loosened debris. The primary surface features were induced craze lines (cracking), a result of the dehydration process. There was no evidence of soft tissue adherence (figures 8,9). Secondary electron imaging of the same specimen revealed a more roughened and irregular surface topography. However, both routine SEM and secondary electron imaging provided sufficient morphologic evidence to allow differentiation of the material from tooth root or bone.

**Electron Dispersion X-ray Analysis (EDS)**

The EDS scan of the particle surface showed peaks of varying intensities conforming to the following elements: low peaks for sodium and potassium; moderate peaks for carbon and sulfur; moderately high peaks for oxygen, calcium, aluminum, and phosphorus; and a high peak for silicon (figure 10).
Figure 8: Routine SEM of solid particle removed from the implant collar/prosthetic abutment interface. Surface features consisted of dehydration induced crazing and loosened debris. Bar = 500 µm at an original magnification of 40x.

Figure 9: Secondary electron image of same specimen shown in figure 8 indicating a more undulating and roughened surface topography than can be seen using routine SEM imaging techniques. Bar = 500 µm at an original magnification of 40x.

Figure 10: EDS scan of surface of specimen pictured in figures 8 & 9 showing peaks that identify the presence of the following elements (left to right): carbon, calcium, oxygen, sodium, aluminum, silicon, phosphorus, sulfur, potassium, and a second calcium peak.
X-ray Mapping
X-ray mapping confirmed the EDS observations by revealing a consistently uniform and regular pattern of distribution of calcium, phosphorus, silicon, aluminum, and sulfur (figure 11) on the surfaces of the various particles.

DISCUSSION
The surgical dentists and three restorative dentists involved with these cases had extensive implant experience. The restorative dentists were surprised to see the amount of bone loss as indicated by the radiographs at the six month appointment. All three dentists stated they had no indication the bone loss was occurring or the etiology of the bone loss prior to viewing the radiographs. After advising the patients of the bone loss about the implants, the patients agreed to exploratory surgery to determine the cause of bone loss to correct the problem, if possible. During the exploratory surgery on all 3 implant cases, excess cement was noted about the apical portion of the prosthetic margins (figures 3-5).

Histologic evaluation of the biopsy sample revealed solid globular masses, surrounded by fibrosis and a mononuclear inflammatory cell

Figure 11: X-ray mapping of the surface of the same specimen shown in Figures 8 & 9. Note the uniform distribution of calcium (Ca K), phosphorus (P K), aluminum (Al k), silicon (Si K), and sulfur (S K). The last image is a routine SEM to show the surface morphology that corresponds to the location and distribution of the various elements.
infiltrate consistent with a low-grade chronic inflammation. Both the morphology and multiple staining intensities were consistent with residual dental cement. Interestingly, the biopsy exhibited several areas of embedded masses of bacteria as well. The overall impression suggests the high probability of residual cement and bacterial biofilm having been forced into adjacent gingival tissues during instrumentation of the peri-implant sulcus and/or periodontal pocket.

When viewed collectively, the various methods used to examine the hard particles confirm the presence of a non-biologic material, most likely residual dental cement. Routine and secondary electron imaging were used to provide high-resolution images of the surface morphology to rule out biologic origins that might include bone or residual tooth structure (figures 8,9). Furthermore, the morphology appears inconsistent with synthetic bone grafting material, such as hydroxyapatite granules or bioactive glass.

EDS is an analytical technique used for the qualitative elemental analysis or chemical characterization of a sample (figure 10). The high silicon peak, when coupled with the presence of aluminum, is conclusive evidence that the specimen was of non-biologic origins. The uniform distribution of the silicon and aluminum within the specimen, as shown by the x-ray mapping technique (figure 11), is further support for the presence of dental cement.

**CONCLUSION**

This limited study demonstrates that dentists should be aware of the potential problems with cementing permanent restorations with subgingival margins on dental implants. Residual subgingival cement appears to establish inflammatory conditions that resorb bone about the dental implants. It is recommended that clinicians utilize radiopaque cement to allow for radiographic visualization before dismissing the patient.
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Background: Peri-implantitis may be associated with a number of variables ranging from patient related to iatrogenic factors. Peri-implant mucosal tissues may be more vulnerable to plaque induced inflammatory changes due to differences in gingival attachment between implants and natural teeth. Local factors that encourage bacterial growth and reduce implant integration should be considered when diagnosing and treating inflammatory lesions identified around restored implants.

Methods: Two patients presented with clinical and radiographic signs consistent with infection adjacent to restored dental implants. During surgical therapy of the affected areas, dental cement was discovered adhering to abutment and implant surfaces. Management involved thorough debridement of granulomatous tissue, removal of subgingival cement, implant detoxification, and regenerative therapy.

Results: Peri-implant clinical signs of infection abated and radiographic evidence of bone regeneration occurred following surgical intervention on the affected implants. Patients were placed on three month maintenance schedules. Clinically detectable implant stability was discernable one and two years following active patient therapy.

Conclusions: Factors that promote peri-implant bacterial retention can be detrimental to long term success. Excess subgingival cement in close approximation to implant and abutment surfaces appeared to be a significant causative factor in the two cases presented in this article. Cement removal during surgical intervention, decontamination of involved surfaces, and bone grafting resulted in a clinically stable outcome over the two years of post-operative maintenance.

KEY WORDS: Peri-implantitis, iatrogenic causes, peri-implantitis treatment

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INTRODUCTION:
Inflammatory lesions that develop adjacent to implants are collectively referred to as “peri-implant diseases” and may include peri-implant mucositis and peri-implantitis. Peri-implantitis is characterized by the presence of inflammation in the mucosa along with loss of supporting bone.\(^1\) The frequency of peri-implantitis has been reported in many long term studies. However, due to variation in assessment methodology, reliable consensus in the literature is unavailable. Nevertheless, a recent systematic review of cross sectional and longitudinal studies with \(\geq 50\) subjects and \(\geq 5\) years of occlusal function, reported that peri-implantitis was identified in 12-46% of implant sites.\(^2\)

Peri-implantitis is often asymptomatic and typically detected during routine recall examinations. Several clinical indicators used to evaluate periodontal health have also been used to evaluate peri-implant health, including assessment of oral hygiene, peri-implant marginal tissues, and the bone implant interface. Recommended diagnostic parameters for assessing peri-implant health are: probing depth measurements using conventional probing with a light probing force (0.25N), presence or absence of bleeding or suppuration on probing using a light probing force (0.25N), and radiographic assessment of supporting bone levels.\(^1\)

A number of patient-related and implant-related factors may contribute to the development and progression of peri-implantitis. Compelling evidence is available for increased susceptibility to peri-implantitis in patients who smoke, have a history of periodontal disease, and exhibit poor oral hygiene.\(^3\) The impact of IL-1 positive genotype and diabetes must also be considered and specific implant design and surface characteristics may also contribute to the risk and progression of peri-implantitis.\(^3\) Failure to remove excess cement following placement of cement-retained prostheses may also contribute to the development and progression of peri-implantitis. This report documents two patients in whom excess subgingival cement was associated with signs of peri-implantitis. Clinical management strategies and long term therapeutic results are discussed.

CASE REPORTS:
Case 1:
A 64 year old partially edentulous female was referred for evaluation of a draining fistula adjacent to implants #28 and #29. Her medical history was unremarkable. An implant in area #30 had been in place for 14 years, and the implants in area #28 and #29 had been in place for 4 years. Several months following the surgical placement of implants #28 and #29, the patient complained to her general dentist of swelling and a bad taste in her mouth. The general dentist removed the crowns and attempted
non-surgical therapy around the implants. The peri-implant infection persisted and the general dentist referred the patient for consultation. Upon clinical examination (figure 1), a fluctuant swelling was noted on the buccal mucosa interproximal to implants #28 and 29, with bleeding and suppuration evident on probing. Probing depths ranged from 4-8mm around implant #28 and 8-9 mm around implant #29. A periapical radiograph revealed horizontal bone loss around implant #28 and vertical bone loss around implant #29 (figure 2). The decision was made to perform an exploratory surgical procedure to investigate possible etiologic factors and determine the prognosis of involved implants.

Under local anesthesia, crestal and sulcular incisions were made and full thickness mucoperiosteal flaps elevated around the implants. A thin white film was found adhering to the mesial aspect of implant #29, extend-
ing from the implant abutment interface to the first thread (figure 3). On close examination, the white film was determined to be glass ionomer cement. The surgical area was thoroughly debrided and degranulated. Plastic curettes and a rotary rubber cup with pumice were used to completely remove the glass ionomer cement from the implant surface. The implant surface was then decontaminated using $\text{H}_2\text{O}_2$, chlorhexidine 0.12%, and 50mg/ml tetracycline applied for 2 minutes. Decortications were accomplished on the peri-implant bone and Bio-Oss®, bovine cortical bone particles (Osteohealth, Shirley, NY) were placed in the osseous defect (figures 4,5). Two holes corresponding to the implants abutments were made through a 20mm x 30mm Biomend® collagen membrane (Zimmer Dental, Carlsbad, CA) and the membrane was placed over the abutments to cover the bone graft material. The flaps were replaced and sutured with 4-0 Vicryl® sutures (Ethicon, New York, NY) and the patient was placed on 500-mg Augmentin (GlaxoSmithKline, Pittsburg, PA) three times a day for 7 days and a 0.12 % chlorhexidine rinse.

Post-operative healing was uneventful. Implants/abutments remained unrestored during the healing period. At six months, firm keratinized gingiva was identified around both implants and radiographs suggested bone fill associated with implant #29 (figures 6, 7). New crowns were fabricated and delivered. The patient was instructed on oral hygiene techniques and placed on a 3-month maintenance protocol. At 24 months following surgical intervention, the implant was clinically determined to be functioning well without signs of recurrent infection (figure 8).
Case 2:
A 50-year-old partially edentulous female presented to the clinic complaining of pain in the mandibular right posterior sextant. Her medical history was positive for Type II Diabetes with the condition being well controlled with oral hypoglycemic medications. She had an implant placed and restored in the area #30 one year ago. She reported developing a swelling around the implant about 4 months prior, which then disappeared after a only few days. Upon examination, probing depths ranging from 7-10mm with bleeding and suppuration were noted. Radiographic examination revealed severe vertical bone loss adjacent to the implant (figure 9). Incision and drainage of the fluctuant mass was performed and the patient was placed on 500 mg Augmentin (GlaxoSmithKline, Pittsburg, PA) three times per day and 0.12% chlorhexidine mouth rinse for 7 days. Ten days later, healing progressed with minimal complications.

A determination was made to surgically explore the area of concern and attempt bone regeneration around the implant. Upon preoperative removal of the implant crown, a white material film was noted adhering to the apical aspect of the abutment along the implant-abutment interface. Closer examination revealed that the white material was glass ionomer cement (figure 10). A full thickness mucoperiosteal flap was accomplished local anesthesia. Upon flap reflection, all granulation tissue was removed and the implant was decontaminated using H₂O₂, chlorhexidine 0.12%, and 50mg/ml tetracycline applied for 2 minutes. Decortications were made in the peri-implant bone and Bio-Oss® bovine cortical bone particles (Osteohealth, Shirley, NY) were placed
in the osseous defect. A hole corresponding to the center of the implants was made on a Biomend® collagen membrane (Zimmer Dental, Carlsbad, CA) and the membrane was placed over the implant using a healing abutment to secure the membrane in place (figure 11). The flaps were replaced and sutured with Vicryl® sutures (Ethicon, New York, NY).

Post-operative healing was uneventful and the implant remained unrestored during the healing period. Six months after surgery, firm keratinized gingiva surrounded the implant and radiographs suggested successful bone fill (figure 12). Clinically there were no signs of peri-implant infection and probing depths decreased to 3-4 mm. At this point, the original abutment and implant crown were replaced. The access opening was filled with flowable light cure composite and occlusal adjustments were completed. The patient was instructed in oral hygiene techniques and was placed on a 3 month maintenance protocol. At 14 months following treatment the implant was determined to be functioning well without signs of recurrent infection (figure 13).

**DISCUSSION**

Attachment of peri-implant tissues to implant and abutment surfaces occurs by junctional epithelium mediated through basal lamina and hemidesmosomes. In contrast to the dento-gingival unit, there are no connective tissue fiber insertions into the implant surface and connective tissue fiber orientation is predominantly parallel to the implant surface. Coronally, connective tissue fiber orientation is circumferential and it exhibits a lower degree of vascularization compared to periodontal attachment. It has been theorized that these differences between peri-implant and dento-gingival tissues render the former more susceptible to plaque induced inflammation. The peri-implantitis cases identified and managed in this article were characteristically rapid in development and progression, and may have been a pathologic response to residual subgingival cement serving as a local plaque retentive factor at the bone-implant interface.

Treatment of peri-implantitis may include nonsurgical and surgical phases. Non-surgical therapy consists of mechanical debridement using ultrasonic or laser devices, either alone or com-
Surgical intervention may involve either resective or regenerative techniques. To date, no methodology has been established as the gold standard for the treatment of peri-implantitis. Based on the Consensus Statement of the Sixth European Workshop on Periodontology, non-surgical therapy for peri-implantitis is unpredictable. Nevertheless, the use of systemic and local antibiotics in conjunction with non-surgical mechanical debridement has been shown effective in reducing bleeding on probing and probing depths in cases of mild to moderate peri-implantitis. In the first case presented in this paper, even though the peri-implantitis was qualified as moderate, it did not respond to non-surgical therapy. Subsequent surgical intervention revealed the apparent etiology and removal of residual cement successfully established peri-implant tissue health. In the second case reported in this paper, the patient presented with peri-implantitis of greater severity and non-surgical therapy, consisting of incision/drainage and systemic antibiotic therapy followed by surgical intervention was required.

The primary objective of surgical treatment of peri-implantitis is to gain access to the implant surface for debridement and decontamination in order to facilitate resolution of inflammatory lesions. The determination of appropriate surgical treatment is influenced by the amount of bone lost, the nature of the osseous defect, and the aesthetic impact of the implant in question. Surgical techniques used to manage peri-implant lesions are essentially modifications of surgical periodontal techniques. Peri-implant probing and bone sounding of suspected peri-implant osseous defects in conjunction with radiographic evaluation should be accomplished early in therapy. This information provides a basis for determining therapeutic approach; implant removal, resective surgery, and/or regenerative procedures.

Resective therapy is used to reduce pockets, correct negative osseous architecture, smooth rough implant surfaces (implantoplasty), and improve the dimensions and/or location of keratinized gingiva. Regenerative therapy is used to reduce pockets with the goal of regeneration of favorable bone dimensions. A recent review, addressing open debridement, surface decontamination, and peri-implant regenerative procedures, revealed encouraging results in animals, but a paucity of data in humans. A prospective cohort receiving access surgery, implant decontamination, and systemic antibiotics recorded favorable defect resolution for 58% of the implants treated. With regard to occlusive membranes, varying degrees of bone regeneration and re-osseointegration have been reported for regenerative procedures with or without the use of barrier membranes. In both of the cases presented in this article, regenerative procedures incorporated barrier membranes and favorable radiographic bone fill resulted.

**CONCLUSION:**

Two partially edentulous patients with restored and functional implants presented for evaluation of peri-implant tissue problems identified by the patients and their restorative dentists. Upon referral, surgical access revealed subgingival cement on the implant and abutment surfaces. Removal of the cement, decontamination of the implant surface, and bone grafting resulted in resolution of the infections, reduction of probing depths, and radiographically apparent bone fill. Using a three month maintenance schedule, favorable
post-operative results have been maintained for one to two years. An important local factor in the development of peri-implantitis in the patients treated appears to have been excess subgingival cement on implant and abutment surfaces. This observation underscores the need for careful control of luting agents and thorough supra-and subgingival removal of excess cement when placing cement-retained crowns on implants.

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Bone Regeneration Around a Failing Implant in an Osteopetrotic Patient: A Clinical Case Report

Eric G. Driver, DDS¹ • Simon R. MacNeill, BDS, DDS²
Charles M. Cobb, DDS, MS, PhD³

Abstract

**Background:** The exact pathogenic mechanism of osteopetrosis is unknown although a deficiency in the osteoclastic enzyme carbonic anhydrase has been observed. Osseous regeneration around failing implants remains a challenging and unpredictable problem. Thus, the pathobiology of osteopetrosis presents an additional complication when treating an osteopetrotic patient presenting with peri-implantitis requiring surgical intervention.

**Methods:** A single case report is presented that involved a 61 year old Caucasian female with an extensive medical history that included a mild form of osteopetrosis and peri-implant disease requiring surgical intervention due to significant bone loss. Treatment of the bony defect involved degranulation, implant detoxification, bone decortications, placement of a particulate osseous graft material, and coverage with a resorbable barrier membrane.

**Results:** Radiographs taken eight months after the osseous graft procedure demonstrated stable bone levels and 100% osseous regeneration.

**Conclusions:** Regeneration of osseous support around a failing implant in a patient with mild osteopetrosis is possible using the surgical techniques described in this case report.

**KEY WORDS:** Dental implants, osteopetrosis, bone graft

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INTRODUCTION

Osteopetrosis (a.k.a. Albers-Schönberg disease or marble bone disease) was first described in 1904 by Albers-Schönberg.\(^1\) Traditionally, two major clinical forms of the disease are noted: The disorder is generally discussed as having two distinct clinical presentations: an autosomal dominant adult (benign) type that is associated with relatively few symptoms\(^2\) and the autosomal recessive infitile (malignant) type that is typically fatal during infancy or early childhood if untreated.\(^3\) Although a diversity of clinical and hereditary types of osteopetrosis shows that defects in several different genes and a variety of biological disturbances cause this disorder, the pathogenesis involves failure of osteoclastic-mediated resorption of host bone.\(^4,5\)

Normal bone growth and physiologic turnover is achieved by a balance between cell mediated bone formation (osteoblasts), and cell mediated bone resorption (osteoclasts). Although the exact pathogenic mechanism of osteopetrosis is unknown, a deficiency in the osteoclastic enzyme carbonic anhydrase has been observed.\(^5-7\) The absence of carbonic anhydrase results in a defective proton (H\(^+\)) pump which, in turn, prevents the development of the localized acidic environment required for effective resorption of bone.\(^5-7\)

Because osteoblastic function is unaffected, bone formation continues and eventually becomes excessively dense. Bone thus affected typically exhibits increased radiographic density characterized by a chalky white presentation that, paradoxically, is unable to resist average stressors and thus easily fractures.\(^6,7\) The incidence of osteopetrosis has been reported at 1 in 20,000 to 500,000 for the dominant form and 1 in 200,000 for the recessive form.\(^6\) The disorder is generally diagnosed through skeletal x-rays with confirmation by bone density tests and/or bone biopsy.\(^6\) Full blown osteopetrosis can lead to anemia and leukopenia due to encroachment of osseous structure upon the marrow spaces.\(^6\)

Although the clinical severity of the disease varies widely, given the osteoclastic dysfunction inherent to osteopetrosis, it may be argued that results of intra-oral osseous grafting may be compromised. Even with allograft materials, osteoclastic mediated bone resorption must precede osteoblastic mediated bone apposition. Thus, the pathobiology becomes a potential complication to consider when treating an osteopetrotic patient presenting with peri-implantitis that requires surgical intervention.

Several techniques and modalities have been proposed for regenerating the supporting structures around implants demonstrating peri-implantitis.\(^7-11\) Treatment of peri-implantitis, depending on severity of bony involvement, may involve a simple non-surgical therapy with the adjunctive use of local and/or systemic antibiotics or may require more aggressive therapy such as access flap surgery, implant decontamination via ultrasonics, air-abrasion or lasers followed by osseous grafting.\(^7-11\) The purpose of this article is to present a case report showing osseous regeneration around an implant with peri-implantitis in a patient with a mild form of osteopetrosis.

METHODS

Patient Presentation

The patient, a 61 year old Caucasian female presented to the University of Missouri-Kansas City, School of Dentistry, Graduate Periodontics Clinic on February 2, 2009 for evaluation of peri-implant disease involving a dental implant in the #19 posi-
tion. The patient related an extensive medical history including a physician-diagnosed osteopetrosis. The patient had been seen in 1993 by an orthopedic specialist after a motor vehicle accident to rule out an incidental finding of sclerotic vertebrae. Subsequent long bone surveys were performed and demonstrated sclerosis bilaterally in the proximal femur and skull. The patient denied a family history of bone disease and personal history of fractures. The presence of sclerotic changes in the vertebrae as well as the metaphysical areas of the long bones was consistent with a diagnosis of osteopetrosis tarda. Two separate measurements of serum and urine NTX (N-telopeptide of type 1 collagen) revealed levels at the upper limits of the normal range, suggesting the presence of osteoclastic activity. However, bone density values were significantly elevated with T-scores of 7.7 and 8.8 for the spine and hip, respectively. These findings indicated that bone density was 7-8 standard deviations above the reference population norm. In October of 2006 the patient was involved in a second motor vehicle accident and suffered a fractured left femur. Open reduction and internal fixation with titanium plates and screws were utilized to stabilize the fractured segments. In June of 2007 this hardware had to be removed and replaced due to a non-union of healing. In July of 2007 the new hardware was removed along with much of the femur and replaced with a substitute titanium femur.

In December of 2006, the patient had three endosseous implants placed in the areas of #19, #29, and #30. Implant #19 was restored in December of 2007 with a cement retained restoration using self-curing resin cement (RelyX 3M ESPE). The initial periodontal evaluation revealed probing depths of 6-8mm around implant #19 with bleeding on probing (Figures 1,2). Occlusal evaluation revealed no heavy centric contacts, lat-

Figure 1: Pre-treatment view of maxillary and mandibular left posterior sextants showing generalized poor oral hygiene. Implant in #19 area exhibits chronic inflammation.

Figure 2: Pre-treatment view of lingual tissues in area of #19 (implant) and #20.
eral, or non-working interferences. Radiographic evaluation revealed bone loss to the third major thread on the distal of implant #19 (Figure 3). Various treatment options were presented to the patient with her consenting to have surgical based guided tissue regeneration (GTR) performed.

**Treatment**

Anesthesia was obtained by mandibular inferior alveolar and long buccal injections, using 72mg of Lidocaine 2% with 0.036 mg epinephrine. The abutment and cemented restoration on implant #19 were removed as one unit, following which a fetid odor and the presence of highly inflamed and irritated sulcular tissues were noted (Figure 4). In addition, overextended porcelain and excess residual cement were observed on the abutment, extending in some areas to the junction between the abutment and implant platform (Figure 5).

Full thickness buccal and lingual mucoperiosteal flaps were reflected via sulcular incisions with a distal release. Granulation tissue was removed using ultrasonics and manual instrumentation. After degranulation, bone loss to the third major thread was noted on the distal of the implant and extended to the buccal and lingual (Figures 6, 7). The exposed implant surface was detoxified using micro air-abrasion followed by application of a tetracycline paste. The tetracycline (TCN) paste was prepared by mixing the contents of a single 250 mg capsule with just enough sterile saline to give it a thick but adaptable consistency when applied with cotton pellets. The TCN paste was allowed to sit for 5 minutes and then was rinsed with copious amounts of sterile saline. A new sterile implant cover screw was placed and torqued to the manufacturer recommended specification. The area distal and buccal of the implant was decorticated using a small round bur to help stimulate the regional acceleratory phenomenon (Figure 8). Once numerous bleeding points were visualized, the osseous defect was grafted with Puros Allograft® (Zimmer Dental, Carlsbad, CA) and covered with a resorbable cross-linked collagen membrane (Figure 9), BioMend Extend® (Zimmer Dental, Carlsbad, CA). Passive primary closure was achieved utilizing a periosteal release and resorbable sutures. Detailed home care instructions were delivered and the patient was appointed for post-operative suture removal at two weeks. The patient was prescribed appropri-
Driver et al

ate analgesics, antibiotics, and 0.12% chlorhexidine gluconate (CHX) rinse for the healing period. At the two-week post-operative appointment, all sutures were in place, no signs of infection were present, and the patient reported

Figure 4: Coronal view of implant and soft tissue wall of the associated gingival pocket showing clinical signs of severe inflammation.

Figure 5: View of prosthesis and reflected mirror image showing over-extended porcelain on to abutment collar and residual dental cement.

Figure 6: Surgical exposure of circumferential bony defect.

Figure 7: Coronal view of circumferential vertical-angular intrabony defect.
minimal discomfort with no post-operative complications. All sutures were removed and the surgical site was irrigated with 0.12% CHX. Home care instructions were reinforced and the patient was appointed for the uncover procedure.

A new periapical film was taken (Figure 10) and the grafted area uncovered after 5 months of healing via a crestal incision that was designed to
preserve a band of keratinized tissue on the buccal. Excellent osseous integration was observed on the distal, buccal, with new bone formation up to the occlusal aspect of the implant platform on the distal and lingual (Figure 11). The cover screw was removed and the previous restoration was delivered after correcting the deficiencies involving retained cement and over-extended porcelain (Figure 12). The restoration abutment screw was torqued to the manufacturers recommended level, and a peri-apical film was taken to ensure that the abutment was fully seated. A cotton pellet followed by composite filling material was used to close the occlusal access. The occlusion was verified to ensure that no heavy centric contacts, lateral, or non-working interferences were present. Resorbable interrupted sutures were used for tissue closure on the mesial and distal of the newly placed restoration. The patient returned 6 weeks later for placement of a buccal free gingival graft to improve the band of keratinized gingiva.

Post-treatment Result
A post-operative peri-apical film was taken in October 2009 to verify bone levels 3 months after placement of the restoration (Figure 13). Radiographs indicated that bone levels were stable and that 100% osseous regeneration was achieved around the failing implant.

DISCUSSION
Although an increasingly common procedure, osseous regeneration around failing implants remains a challenging and unpredictable problem. It will continue to become more prevalent and necessary as an increasing number of implants are placed in a wide variety of practice settings. It should be emphasized that proper treatment planning should be performed at all levels of implant therapy to help minimize preventable causes of
implant failures. In the current case presentation, 100% osseous regeneration was achieved around a failing implant in a patient with a mild form of osteopetrosis but, never-the-less, with reduced osteoclastic activity. By utilizing predictable and tested GTR techniques combined with adjunctive detoxification techniques, an excellent result was obtained. Micro air-abrasion as discussed by Dennison has demonstrated effectiveness in eliminating bacterial contaminates from microporosities of the roughened and/or plasma-spray coated implant surface. When exposed to the subgingival environment, the irregular implant surface topography promotes colonization by bacteria but is also resistant to manual instrumentation or ultrasonics. Manual and ultrasonic instrumentation cannot access the bacteria and their by-products located within surface porosities. On the other hand, the small particles (100 microns) of sodium bicarbonate used in air-abrasion instruments are capable of penetrating surface porosities and thereby help to eliminate bacteria and their toxic by-products. TCN has long been used as a local and systemic medication to help control periodontopathic bacteria. The manner in which TCN was used in this case report is similar to that presented by Zablotsky et al. The TCN paste had enough consistency to stick to the exposed implant surface but still maintain enough aqueous property to infiltrate the micro-porosities of the roughened implant surface. The dual detoxification technique used in this case may have helped promote a more predictable GTR result by eliminating both the presence of bacteria and their endotoxins.

Implant supported restorations may be retained by either retrievable screws or dental cements. Cemented implant restorations have become the restoration of choice due to their relative simplicity. Advantages of cemented implant restorations include elimination of potential loosening of the prosthesis screw, better esthetics, and control of occlusion. If not managed properly, there is a risk of residual excess cement on apical portions of the abutment, the implant itself, or in the surrounding soft tissues. These factors have been associated with peri-implant disease. Indeed, Wilson reported the presence of retained cement on 34 of 42 implants, all exhibiting peri-implant disease. Excess retained dental cement acts similar to calculus in the sense that it facilitates colonization of bacteria similar to those involved in chronic periodontitis, thereby suggesting that periodontitis and peri-implantitis have a similar pathogenesis. The inability to effect subgingival oral hygiene due to the excessive dental cement likely facilitates a shift from a microbial complex normally associated with health to a complex of gram-negative bacteria generally associated with disease.

In the present case report, it was known that there was a reduced level of osteoclastic function secondary to the systemic osteopetrosis. It was therefore decided that decortication using a round bur would help stimulate the regional acceleratory phenomena thereby stimulating healing and bone formation. In theory, the decortication technique creates channels through the cortical plate into the underlying cancellous bone which, in turn, allows migration of osteoprogenitor cells into the grafted bony defect. It should be noted, however, that Greenstein, et al. have challenged the benefits of decortication with respect to increasing
Regeneration of osseous support around a failing implant in a patient with mild osteopetrosis is possible using the combined technique of degranulation with manual and ultrasonic instrumentation, detoxification with air-abrasion and tetracycline paste, followed by decortication and grafting with allograft bone augmentation material.

CONCLUSION

Occlusal analysis was also scrutinized for any heavy centric contacts, lateral interferences, and non-working interferences. Studies by Salvi and Bragger25 and Adell et al.26 have demonstrated the destructive effects of occlusal disharmony on implants. In this scenario a short 8.0 x 5.0 mm diameter implant was placed in December of 2006. A short (< 10mm) implant was necessary due to close proximity of the inferior alveolar canal to the alveolar crest. The short implant was then restored with a tall restoration leading to a 1:1 crown:root ratio. A pre-prosthetic vertical ridge augmentation would not have improved the situation due to normal ridge heights. An inferior alveolar nerve repositioning surgery was recommended to facilitate placement of a longer implant but declined by the patient.

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Disclosures
The authors report no conflicts of interest with anything mentioned in this article.

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peri-implantitis is characterized by bone destruction around dental implants due to the host immune-inflammatory response induced by biofilm accumulation. Several approaches have been proposed to treat peri-implantitis, including mechanical debridement, antimicrobial therapy, and resective or regenerative surgical therapy. The present case report describes a peri-implantitis case treated by a surgical open flap debridement, decontamination of the implant surface with povidone-iodine and fill of the adjacent osseous defect with autogenous bone graft. After 20-month follow-up, the pocket depth reduction and radiographic fill of the defect could be observed. Therefore, it can be concluded that this therapeutic approach could promote clinical and radiographic improvements to the patient. However, more randomized controlled clinical trials are necessary for further understanding about the best approaches for the treatment of peri-implantitis.

**KEY WORDS:** Peri-implantitis, dental implants, guided bone regeneration

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INTRODUCTION
Peri-implant diseases are characterized by inflammatory lesions that involve tissues around dental implants, which is a result of biofilm accumulation. They can be classified into peri-implant mucositis or peri-implantitis.\textsuperscript{1} Peri-implant mucositis corresponds to an inflammatory reaction in the implant surrounding soft tissues, whereas peri-implantitis is the inflammation of the soft tissues and involves the loss of supporting bone around an implant.\textsuperscript{2,3} Clinically, this inflammation is detected by the presence of bleeding on probing;\textsuperscript{1} other clinical signs (e.g., suppuration, redness, and swelling) may be observed.\textsuperscript{4} Radiographs may be required to evaluate bone loss around implants due to peri-implantitis and differentiate it from the normal bone remodeling.\textsuperscript{5} In studies about peri-implantitis prevalence, the reported estimate is that it occurs in about 28\%\textsuperscript{6,7} to 56\%\textsuperscript{8} of individuals and between 12\%\textsuperscript{7} and 43\%\textsuperscript{8} of the implants. Therefore, the peri-implantitis treatment is a topic of increasing interest. However, only a few studies have provided data on the prevalence of peri-implant diseases; therefore, these data may be underestimated.\textsuperscript{3,9}

For treating peri-implant mucositis, the non-surgical mechanic therapy is effective in reducing the tissue inflammation; the adjunctive use of antimicrobial mouth rinse can improve the results of this therapy.\textsuperscript{10} With respect to peri-implantitis, the non-surgical mechanic therapy has not demonstrated to be equally effective.\textsuperscript{10} Therefore, surgical therapies have been proposed for treating peri-implantitis, including open flap debridement as well as resective or regenerative approaches.\textsuperscript{3,11}

Although some studies are aimed at establishing protocols treatment for peri-implantitis, there is no consensus about the best way to perform the implant surface debridement, decontamination, and regeneration of the bone defect.\textsuperscript{12} In this context, the aim of the present paper is to report a case of peri-implantitis treated with a surgical approach of open flap debridement for implant surface decontamination with iodine solution associated with a regenerative approach using autogenous bone graft.

CASE REPORT
A 43-year-old white male, presenting a good general medical condition was referred to the Graduate Clinic of the Piracicaba Dental School reporting bad breath as chief complaint. He also reported he had difficulty maintaining hygiene on a dental implant placed 2 years before, as well as bleeding in this area. Clinical examination revealed a dental implant (replacing the inferior left first molar) that has never received crown reconstruction; the implant presented a probing depth (PD) of 5 mm and bleeding on probing (BoP). Additionally, there was a bridle that made proper implant cleaning very demanding (Figure 1). Radiographs showed a crater-like peri-implant bone defect (3 mm) involving three implant screws (Figure 2). Thus, the diagnosis of peri-implantitis was established. The patient was informed about his problem and all the treatment options for the case; thereafter, he consented for the treatment as follows.

The initial treatment consisted of oral hygiene instructions, mechanical treatment with intrasulcular brushing and subgingival 10\% povidone-iodine Riodeine\textsuperscript{®} (Rioquimica\textsuperscript{™}, São José do Rio Preto, SP, Brazil) irrigation,
which was performed during 5 to 7 minutes in a single session. Despite the improvement of the general oral hygiene observed afterwards, the dental implant still showed inflammation signs after 1-month of follow-up. Then, a surgical approach was proposed for implant surface decontamination and filling of peri-implant defect with autogenous bone graft. Under local

**Figure 1:** Initial clinical aspect of the dental implant that was diagnosed with peri-implantitis.

**Figure 2:** Initial radiographic aspect of the dental implant that was diagnosed with peri-implantitis.

**Figure 3:** Peri-implant defect visualization after mucoperiosteal flap elevation. Note the presence of extensive granulation tissue.

**Figure 4:** Peri-implant defect visualization after granulation tissue removal.
anesthesia Alphacaine® (DFL™, Rio de Janeiro, RJ, Brazil), two incisions were made mesially and distally to the dental implant; a mucoperiosteal flap was raised to allow implant and bone defect visualization (Figure 3). After complete granulation tissue removal, the implant surface and bone defect could be observed (Figure 4). The implant surface decontamination was performed using gauze soaked with 10% povidone-iodine. Afterward, autogenous bone graft was obtained from an adjacent area and placed into the peri-implant defect to cover all implant screws (Figure 5). The flap was then repositioned and sutured (Nylon 5.0, Ethicon™, São José dos Campos, SP, Brasil). After this surgical procedure, the patient was instructed to take analgesics (500 mg sodium dipyrone every 6 h for 2 d) and to discontinue toothbrushing around the surgical site for 15 days after surgery. During this period, plaque control was achieved with a 0.12% chlorhexidine rinse twice a day. After this period, gentle toothbrushing with a soft-bristle toothbrush was allowed. Sutures were removed after 7 days; the patient was enrolled in a periodontal maintenance program (i.e., professional plaque control and oral hygiene instruction) weekly during the first month, then monthly during the consecutive months. After 20-mouth follow-up, a reduction of probing depth to 3 mm and radiographic bone fill could be observed (Figure 6).

**DISCUSSION**

Because of the similarities between the inflammatory diseases induced by biofilm accumulation on teeth and implants, some approaches that have been proposed to treat peri-implant diseases were initially based on previous evidences for treatments of periodontal diseases. In this context, the primary goal of
peri-implant disease treatment is the reduction of microbial challenge and control of the inflammatory reaction to re-establish a healthy peri-implant tissue. The therapeutic modalities for peri-implantitis comprise a non-surgical approach and surgical approach. The non-surgical approach includes mechanical debridement alone or combined with anti-septic agents or laser devices. The surgical approach includes open flap surgery that may be associated with resective or regenerative techniques. Although the non-surgical therapy could be effective for treating peri-implant mucositis, it does not seem to be as effective for peri-implantitis as it is for teeth. In peri-implantitis, the surgical approach has shown to perform better than non-surgical techniques.

The surgical approach allows better access to defects and provides a better access for implant surface decontamination. In this context, the literature reports that only mechanical debridement on roughened implant surfaces contaminated with bacteria may have limited effect; the adjunctive use of chemical agents is recommended to improve treatment outcomes. However, there is no evidence in the literature to demonstrate a superior decontamination method. In order to decontaminate the implant surface, a wide range of methods have been proposed in the literature, such as mechanical debridement, the use of antiseptics/antibiotics and laser therapy. In an experimental study, the influence of the non-surgical approach associated with non-submerged healing and the surgical approach associated with various implant surface decontamination methods (laser therapy; ultrasonic debridement; plastic curettes associated with local application of metronidazole gel) and submerged healing was evaluated in peri-implantitis lesions in dogs. The authors observed that all treatments resulted in improvement of clinical parameters; however, the surgical approach associated with implant surface decontamination and submerged healing leads to better radiographic improvement. Moreover, when the specimens were evaluated histologically, surgical approaches also demonstrated better bone–implant contact compared to non-surgical approach.

In the present case, the surgical approach was performed and associated with decontamination of the implant surface using gauze soaked with 10% povidone-iodine solution. Povidone-iodine solution is considered an inexpensive and nonhazardous broad-spectrum antiseptic that has been used as an adjunct in periodontal therapy; it has demonstrated by a systematic review that it may improve PD reduction during scaling and root planing. The application of povidine-iodine with gauze was chosen to avoid damage to implant surface by metal curettes and ultrasonic tips or risk of surgical emphysema by air powder abrasives. Additionally, the correction of peri-implant defect should be one of the treatment objectives to allow efficient biofilm control by the patient and to eliminate micro-environments favorable for a pathogenic microbiota. The correction of these defects can be obtained by resective or regenerative techniques; however, the latter are preferable because the ultimate goal of peri-implantitis treatment is to regenerate lost tissue and re-establish the osseointegration along the previously contaminated implant surface. Autogenous
bone, xenografts, alloplastic materials and membranes have been used in regenerative techniques, which demonstrate variable levels of bone fill and re-osseointegration.

In an animal model study, the regenerative treatments for bone defects around implants were evaluated. The defects were randomly assigned to receive the following: a bioabsorbable membrane; a mineralized bone xenograft; or a combination of both. The results showed non-significant difference regarding the range of bone fill among all the three treatments. In a clinical study, the treatment of peri-implantitis defects using autogenous bone grafts was evaluated in 25 implants diagnosed with peri-implantitis from 17 patients. During the observation period of up to 3 years, the use of autogenous bone graft demonstrated to be an efficacious treatment approach for restoring hard tissue lost by peri-implantitis. In another clinical study, three different techniques of bone regeneration in peri-implantitis lesions were compared: autogenous bone graft alone or associated with resorbable or non-resorbable barrier. At the 3-year follow-up evaluation, it was observed that all treatments revealed significant improvement of peri-implant probing depth from baseline; however, differences in surgical approach did not affect the treatment outcome. Therefore, this study concluded that the additional application of barrier does not improve the overall treatment outcome. This is in accordance with a case-control study comparing the use of a bone substitute alone or associated with a resorbable membrane with a follow-up over 3 years where no significant difference in defect bone fill was observed. The current literature demonstrates no additional beneficial effect on the use of membranes associated with grafts, membrane exposure as a frequent complication, and the use of autogenous bone graft is effective for treating peri-implant bone defects. Therefore, it was decided to use autogenous bone graft alone in the present case to avoid complications related to membrane exposure during the healing period.

Regarding the amount of defect bone fill, the chosen material as well as the peri-implant defect configuration are important and play a key role in treatment. A clinical study investigating the impact of defect configuration on the clinical outcome of surgical regenerative therapy using a xenograft in combination with a collagen membrane in peri-implantitis lesions demonstrated that intra-bony/circumferential defects tend to obtain higher improvements in probing depth reduction and clinical attachment level when compared with circumferential defects or semi-circumferential associated with buccal dehiscence at 6 and 12 month follow-up. In the present report, the peri-implant defect presented a favorable anatomical configuration. Despite a buccal bony dehiscence, the mesial, distal and lingual bone crest still remained in the level of the top of the implant, which could allow the autogenous graft placement and reposition of the mucoperiosteal flap in an adequate position. The radiographic examination after 20 month follow-up reveals the defect filling (Figure 6). However, the radiographic image cannot elucidate the type of healing or if re-osseointegration has occurred in fact. Nevertheless, this result does not discredit the clinical benefits obtained in this case by the regenerative approach, such as probing depth reduction and peri-implant...
defect filling, which can promote better conditions for adequate hygiene and a less favorable environment for anaerobic pathogens.

**CONCLUSION**

The therapeutic approach for treatment of peri-implantitis using open flap debridement and iodine solution associated with autogenous bone graft was able to promote clinical and radiographic benefits in the case reported. However, it is not established in the literature which conditions for adequate hygiene and a less favorable environment for anaerobic pathogens.

**Disclosure**

The authors report no conflicts of interest with anything mentioned in this article.

**References**


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