Peri-implantitis is one of the medical challenges of the 21st century. Implantologists and periodontists around the world are consistently searching for reliable and implementable therapy solutions. The authors presented their preferred protocol of peri-implantitis treatment in this clinical case using a biomimetic bone replacement material and a resorbable collagen membrane.

Peri-implantitis is defined as a local lesion which is associated with bone loss around an osseointegrated implant, whereas peri-implant mucositis is a reversible inflammatory change in the mucosa surrounding the implant.

Peri-implant mucositis is diagnosed by probing, that is followed by bleeding. The mucositis is often not classified as severe and also not taken seriously by the patient.

Based on various examinations, prevalence for peri-implantitis varies significantly between 2 and 58 per cent of all implants (Koldsland et al.). According to a Cochrane report published in 2011, there is insufficient evidence for known peri-implantitis treatments. More research in this field thus needs to be conducted (Esposito et al.).

The authors experience regarding their preferred protocol for peri-implantitis treatment is presented step by step in the following clinical case. The Implacure® (MedTech Dental AG) peri-implantitis set and a regenerative, biomimetic bone replacement material (CERASORB®, curasan AG) were used to replace the lost bone.

Surgical protocol

1. Formation and mobilisation of a mucoperiosteal flap to achieve unconstrained access to the defect area. If possible, the superstructure should be removed.

2. Careful curettage of the infected area, thorough removal of all soft-tissue adhesions on the bone.

3. Decontamination of the implant surface using various burs: both the apical part, that later will come into contact with the bone replacement material, as well as the crestal part, that later will be in contact with mucosa have to be cleaned.

4. Dressing of the entire exposed bone surfaces with sterile gauze and moistening of the gauze with sterile saline solution in order to improve its adhesion to the bone.

5. Application of a gel comprised of 37% phosphoric acid and 2% chlorhexidine onto the entire exposed implant surface in order to eliminate all remaining biofilm.

6. After two minutes, the gel is thoroughly rinsed off with saline solution and the gauze is removed.

7. Dressing the entire implant surface in sterile gauze. The gauze is subsequently soaked with a sodium hyaluronate/piperacillin/tazobactam solution, letting it set for five minutes.


9. The bone replacement material is blended with a sodium hyaluronate/piperacillin/tazobactam solution and autologous blood taken from the defect area or PRP in a sterile container and inserted into the affected area without pressure. The defect area is subsequently covered with a resorbable collagen membrane which was previously soaked in antibiotic solution.

10. Re-adaption of the flap and suturing.
Case presentation

A 59-year-old patient presented to the practice complaining about minor exudate at his dental implants in the anterior region (Fig. 1). Probing revealed a deep circular pocket around the implants during the initial examination. Mobility of the implants was, however, not detected. As suspected, the radiographic examination confirmed an advanced peri-implantitis at the recently placed implants (Fig. 2).

In accordance with the described protocol, a muco-periosteal flap was created in order to obtain full access to the severe four-wall defect (Fig. 3). The implant surface was mechanically cleaned with diamond-coated burs (Fig. 4). Chemical debridement of the surface with subsequent antibiotic impregnation was performed (Figs. 5 & 6).

After completion of the preparatory steps, the bone replacement material consisting of phase-free beta-tricalcium phosphate—which offers optimal conditions for osseous remodelling owing to its micro-, meso- and macro-pores—was inserted as previously described (Fig. 7).

Finally, the surgical area was covered with the biodegradable membrane, and the flap was re-adapted with interrupted sutures in order to achieve a complete and impermeable wound closure (Fig. 8). The radiograph taken immediately after surgery showed the filled defect.
Good osseous consolidation at the enamel-cement junction of the adjacent teeth could be seen on the follow-up radiograph taken 24 months later (Fig. 10).

Discussion

While improved oral hygiene and professional cleaning prove to be very effective in treating periodontitis, peri-implant lesions do not react correspondingly. This does not mean that good oral hygiene and professional tooth cleaning are redundant as peri-implantitis prevention. However, conservative therapy proves to be inefficient once peri-implantitis has developed. Non-surgical approaches by means of laser or powder jet show moderate results. Systemic chemotherapy and mechanical debridement have also largely been without success. The use of photodynamic therapy has also proven to be unsuccessful. In summary, it can be said that non-surgical therapy approaches are not suitable for reliably treating peri-implantitis.1, 4

Surgical treatment seems to be only the promising therapy approach. A surgical resection treatment is, however, only partially effective. In 2003, Leonhardt stated that surgical and antimicrobial treatments were successful in more than half of the cases for a period of five years. In 2008, Heitz-Mayfield et al. were able to demonstrate that using an antimicrobial protocol with surgical access via mobilisation of a flap stopped the progression of peri-implantitis in 90 per cent of the cases over a period of one year, while the bleeding on probing persisted in more than 50 per cent of these cases.5

Unfortunately, not all cases of peri-implantitis are suitable for regeneration. The crater shape with four walls does not typically occur in implants with thin fascial and lingual walls. In some of these cases the defect is associated with a complete loss of the surrounding bone crest, which turns regenerative measures into an unpredictable treatment alternative.

The decontamination of the implant surface proves to be the crucial step in all proposed treatment approaches. The complex topography of modern implants offers ideal conditions for bacterial growth. The decontamination of these surfaces sometimes seems impossible, particularly if non-surgical treatment is pursued. There are diverse options for surface decontamination. Anti-infective treatments with chlorhexidine, tetracycline, metronidazole, citric acid, laser and photodynamic application help in disinfecting the implant. Mechanical debridement with titanium, plastic or steel curettes, implantoplasty or powder jet should remove the biofilm. Most clinicians select a combination of these therapies assuming that as a result surface decontamination can successfully be obtained.

Implantoplasty ensures a complete decontamination of the implant surface, there are, however, four essential concerns: heat generation, accumulation of residue of milled material in the surrounding tissue, damage to the implant surface and impairment of the implant structure. Heat generation can be contained through careful and abundant irrigation, and an adapted bur selection. Some authors presume that milling residue has not been clinically verified in rejection reactions. Reducing the micro- and macro-roughness of the implant surface has mainly proven advantageous in preventing bacterial colonisation. The required abrasion thickness on the implant is ultimately not a decisive factor for reduced stability.6, 7

Conclusion

The existing scientific findings and the clinical experiences obtained with the presented system, thus allow the conclusion that the protocol proves to be a successful and understandable method for the sanitation of peri-implant defects, when lost bone substance is simultaneously regeneratively replaced. The fully synthetically produced, biomimetic beta-tricalcium phosphate granulate has proven to be successful in this treatment. By means of a restitutio ad integrum it is possible to return the weakened implant site not only mechanically, but also biologically, to a functional condition, which is the prerequisite for a successful long-term sanitation.

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Literature
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Dr Michael Norton, former president of the Academy of Osseointegration, summed up a problem of the implant market, stating “Dentists have to rely on the word of manufacturers and the FDA or CE marks to feel sure that the implants they are using are being manufactured to a standard one would expect of an implantable dental device. Sadly, this is often not the case.”

Impurities on sterile-packaged implants, in particular organic particles from the production or packaging process (Figs. 1–3), are highly suspected of being responsible for incomplete osseointegration of dental implants or even loss of bone in the early healing period.

Four consecutive studies over a period of more than ten years conducted in close cooperation with the University of Cologne and the Charité–University Medicine Berlin, both in Germany, have shown that neither CE (French: Conformité Européenne) marking nor U.S. Food and Drug Administration clearance can provide a reliable
indication of the cleanliness of dental implants. Scanning electron microscopy (SEM) imaging and elemental analysis (EDS) of more than 250 dental implants from over 200 brands were used to establish one of the largest, most comprehensive databases in implant dentistry. Recent analyses in 2018, revealed a continually growing number of implants with severe pollution, compared with previous reports. Areal pollution and particles containing iron, copper, chromium, nickel, tungsten and sulphur, and large quantities of stainless-steel particles, as well as remnants of polytetrafluoroethylene and other significant organic contaminations, give cause for concern.

How can the clinician know which implants are not affected by these impurities? With the variety of implant systems offered on the market it has become increasingly difficult for dentists to choose a safe system for their practice. The CleanImplant Foundation has set itself the goal of providing exactly this information worldwide. This independent non-profit organisation is supported and controlled by a scientific advisory board, which is chaired by renowned scientists and practitioners. In 2017 this board set the criteria for the CleanImplant Trusted Quality Mark. Implant companies and systems already carrying this seal are MIS V3, MegaGen AnyRidge, BTI UnicCa, bredent blueSKY (Fig. 4), NucleOSS T6 and NDI Replicate. Other implant systems are currently in the process of examination.

Objective analysis of dental implants

The CleanImplant Foundation established a thorough and accredited testing procedure that guarantees unbiased results for the new global quality seal (see information box “The five-step approach” on the left).

Practitioners interested in a personalised certificate for their practice and implant manufacturers who want to apply for the new quality mark will find more information and a corresponding newsletter at the project’s website www.cleanimplant.com.

The five-step approach

Step 1: Random sample collection
For the Trusted Quality Mark, five samples of each implant type will be collected for thorough analysis using a mixture of mystery shopping (two samples) and direct factory order (three samples) to ensure that samples are selected randomly.

Step 2: ISO Class 5 cleanroom environment
All implants have to be unpacked and analysed in the scanning electron microscope under cleanroom conditions according to ISO Class 5 (DIN EN ISO 14644-1).

Step 3: SEM analysis process accreditation
All collected samples are subjected to the same quality analysis protocol. Laboratories have to prove a quality management system according to DIN EN ISO/IEC 17025 and undergo regular audits and reassessments by external independent accreditation bodies.

Step 4: Full-size high-resolution SEM imaging
This technique produces approximately 400 single high-resolution SEM images of a single implant sample. Images are digitally composed to one large image with an extremely high resolution providing a perfect overview of the implant cleanliness.

Step 5: Peer review process
Two members of the scientific advisory board independently review the comprehensive report of analysis and correspondent clinical documentation.

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Connection between periodontal and peri-implant health emphasised

EuroPerio9 was held in Amsterdam from 20 to 23 June and was the largest congress to date with more than 10,000 attending. There was great interest in the causes and successful management of periodontitis and peri-implantitis. Two new classifications provided answers to the aetiology. Scientifically based and practice-oriented presentations demonstrated how to prevent and, if necessary, treat these inflammatory diseases.

Three out of four Swiss patients state that prevention is the main reason for them to visit the dentist. They want to make sure that their teeth stay in good condition. They aim to keep previously restored teeth or implants for as long as possible. However, not all patients are aware of the fact that dental health also depends on intact periodontal or peri-implant tissue.

At EuroPerio9, renowned experts presented two new classifications as the basis for all preventive, as well as therapeutic measures. They were developed at a workshop conducted by the American Academy of Periodontology (AAP) and the European Federation of Periodontology (EFP) in November 2017: According to the classification, there is only one form of periodontitis, for which the treatment is classified into four stages, depending on its severity and complexity. As explained in detail in Amsterdam, current research results indicate that what was formerly considered aggressive periodontitis cannot be distinguished from chronic periodontitis by microbiological or immunological criteria. According to the new diagnostic system, the disease is classified as chronic, which means that recall treatment is necessary for the remainder of the patient’s life.

Periodontal therapy largely unchanged

Every dental examination is based on a detailed medical history combined with targeted diagnostics containing as much detail as possible: The dentist records systemic risk factors such as diabetes or smoking and identifies any potentially increased tendency to inflammation. Hard and soft tissues are examined and periodontal pockets are probed in a screening test according to PSR (Periodontal Screening and Recording). In case of abnormal findings, the periodontal status is then recorded and therapy is initiated where necessary. This treatment begins with professional biofilm management, by using, for example, rotary cups and polishing com-

Fig. 1: Good individual oral hygiene and professional biofilm management, e.g. with cups and brushes, helps support periodontal and peri-implant health. Fig. 2: An air scaler efficiently performs the initial debridement, as part of initial periodontal therapy. Fig. 3: Implants and superstructures can be successfully cleaned with ultrasonic devices and special plastic instruments during postoperative care or non-surgical therapy. (Source: © W&H)
pounds (Fig. 1), and comprehensive instructions in oral hygiene. Sonic or ultrasonic systems remain an effective alternative or supplement to manual instruments for sub-gingival debridement and biofilm management (presentation by Prof. Dr Ulrich Schlagenhauf; Fig. 2). Supplementary use of photodynamic therapy, air polishing or local and systemic antibiotics is not adequately documented (Prof. Dr Sema Hakki). According to Dr Sergio Bizzarro, improved biomarker diagnostics may lead to an increase in customised patient therapy in the future.

**Primary prevention of inflammations**

The key statement of the first classification for peri-implant inflammations is that periodontitis, mucositis and peri-implantitis are a result of biofilm. One has to admit, however, that therapy is not always successful. These inflammatory diseases need to be prevented before they occur by means of good oral hygiene and professional biofilm management. A practice-based randomised study found that most patients maintain their peri-implant health by attending recall visits two to four times a year, regardless of the mechanical means of treatment that are used. The risk of peri-implant inflammation is significantly higher in periodontitis patients. The same goes for patients who have had initial treatment, but are not yet included in a recall programme (UPT). Good biofilm management and preliminary periodontal treatment are particularly important preconditions for a planned implantation.

**Proper implantation**

Implantation and implant restoration are performed following standard surgical and prosthetic protocols. High-performance implantology motors combined with surgical contra-angle handpieces are available for the insertion of the implant. Large volumes of cooling fluids at low speeds are required to prevent the bone from overheating. Once the implant has been screwed to its end position, its eventual stability can be measured safely and accurately by utilising resonance frequency analysis (RFA). A load protocol oriented to the ISQ value prevents the implant from developing micro-movement, thus improving the prognosis. As stated in the consensus document presented at EuroPerio, the potential role of the above-mentioned biological and biomechanical factors in the development of peri-implantitis still requires clarification.

**First probe, then treat**

Healthy peri-implant tissue does not show any signs of redness, swelling or bleeding, neither does it secrete pus when probed. Based on the consensus document, Prof. Dr Giovanni Salvi explained the importance of regular probing—preferably with a flexible probe, as implant components often tend to obstruct the procedure. In the case of mucositis or initial peri-implantitis already being present, the non-surgical removal of hard deposits and biofilm should be attempted first. For this purpose, ultrasonic power and special instruments designed to protect the implant should be employed (Fig. 3; piezo scaler Tigon+ with 1I, W&H). In case of no remission, the recall frequency needs to be increased. However, specific recommendations, applicable to individual cases, are not yet available in this context.

According to an unpublished study presented by Prof. Salvi, the supportive use of photodynamic therapy or locally applied antibiotics does not significantly reduce bleeding on probing in patients presenting with mucositis or initial peri-implantitis. This finding is similar to the one with periodontitis and, according to a systemic overview, also applies to subgingival air polishing. Professor Stefan Renvert states that whether an implant can remain in position with peri-implantitis depends on the possibility of retaining the implant-based prosthesis. Additional factors include the patient’s general health, as well as their financial resources. Regenerative treatment may be indicated with 3- or 4-wall bone defects. Moreover, an implant can be removed rather atraumatically using piezo-surgical instruments.

**No implantology without periodontology**

In a small symposium presented by the Austrian dental company W&H, oral surgeon and periodontologist Dr Karl-Ludwig Ackermann explained that he does not insert implants in affected patients without prior periodontal treatment. This procedure is based on many years of experience and a clinical strategy, which is based on the so-called NIWOP-workflow, meaning “no implantology without periodontology”. This workflow, developed on the basis of the 11th EFP workshop, was impressively confirmed at EuroPerio9. EFP President Prof. Anton Sculean, who chaired the symposium, stated: “A large number of implants are being placed these days and periodontitis has become a major problem. W&H has recognised this and is pursuing the right strategy, following the principle of NIWOP.”

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