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Review Article

Reviewing the Contemporary Management of Peri-Implantitis

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Abstract

Gingivitis and periodontitis are routine findings in the clinic. With the rising use of dental implants in clinical practice, practitioners are certain to encounter peri- implantitis. It has been proven that peri-implant diseases have a similar progression as the diseases around the teeth. Peri-implant mucositis, as the name suggests, is the inflammation of the mucosa around the implant, which is what gingivitis is to a tooth. Correspondingly, peri-implantitis is to an implant what periodontitis is to a natural tooth. Peri-implantitis management is currently insufficient. Being a relatively new disease, its management has been empirical, and research is still underway.

At the same time, because of its resemblance to periodontal illnesses, therapeutic approaches have evolved in a manner similar to periodontal diseases.

Keywords: Peri-Implant Mucositis; Non-Surgical Therapy; Surgical Therapy; Guided Bone Regeneration; Osseointegration

Introduction

Inflammatory reactions to a bacterial biofilm that cause bone loss surrounding an osseointegrated dental implant are collectively referred to as "peri-implantitis." [1]. According to research published in many publications, the prevalence of peri- implantitis ranges from 5–63.4%. The wide range of variability is due to the fact that numerous research studies use a variety of study designs [2]. The frequency of peri- implantitis development was measured by Zitzmann., *et al*. [3]. Lindhe and Meyle estimated that mucositis might occur up to 80% of the time and peri-implantitis could occur somewhere between 28% and 56% of the time in the consensus report of the Sixth European Workshop in Periodontology [1]. In a recent investigation on the prevalence of peri-implant infections, Mombelli., *et al*. found that 20% of implanted patients and 10% of all implants had peri-implantitis. Because of the heterogeneity of the research that was examined, this percentage must be chosen with caution, but it does emphasize the fact that bone remodeling systems frequently result in marginal bone loss within the first few weeks following abutment connection, and that this loss is nearly six times more common in patients with a history of periodontitis than in patients without a history of periodontitis [3].

Contrary to mucositis, peri-implantitis affects the surrounding hard and soft tissues and is a gradual, irreversible condition. Bone resorption, poor osseointegration, increased pocket development, and, in a few rare cases, suppuration are its defining characteristics. In addition to inflammation, other variables, such as implant placement done too deep, may be to blame for bleeding during probing, bone loss, and deep probing depths. In addition, a variety of factors, including implant type and form, connection type, abutment, suprastructure material, and prosthetic suprastructure type, have an impact on implant design. They all take part in preserving the peri-implant environment [4].

Diagnosis

PERI-IMPLANT MUCOSITIS: Similar to how gingivitis develops around real teeth, plaque deposition on the titanium surface and the development of a biofilm appear to be significant contributors to the beginning and development of peri-implant disorders. Different diagnostic standards have been employed in investigations to identify peri- implant mucositis. The most reliable diagnostic technique for peri-implant mucositis diagnosis across all studies has been bleeding on probing [5].

Peri-implant infections are treated surgically and with conservative (non-surgical) methods. Peri-implantitis, which is progressive and permanent and affects both the hard and soft tissues around the implant, is different from mucositis. Bone resorption, poor osseointegration, increased pocket development, and, in a few rare cases, suppuration are its defining characteristics. In addition to inflammation, other variables, such as implant placement too deep, may be to blame for bleeding during probing, bone loss, and deep probing depths. In addition, a variety of factors, including implant type and form, connection type, abutment, suprastructure material, and prosthetic suprastructure type, have an impact on implant design. They all take role in preserving the peri-implant environment [6]. Regular probing depths from the moment the prosthetic component is linked, combined with baseline radiographs, must be documented in order to validate the diagnosis of peri-implant mucositis [7].

PERI-IMPLANTITIS: The course of the illness was assessed using a 2.5 mm attachment loss or a 3.7 reduction in Computer-Assisted Densitometric Image Analysis (CADIA) data over a five-year period. Microbiological tests that proved the presence of several dangerous infections supported these statistics even further. The existence of BOP surrounding dental implants may be a useful diagnostic tool for tracking the stability of peri-implant tissue health [8,9].

As a result, before joining prosthetic components, a health-related baseline must be established. Future data must be compared to baseline measurements to determine the existence of pathology or health. In order for radiography data to determine any potential bone loss close to the implant device, it is necessary to establish a baseline.After implant placement and after the restorative component is connected, baseline radiographs should be performed since bone loss that occurs before this might be brought on by iatrogenic causes or regular bone turnover that continues during the healing process.The restorative platform and the implant threads should be clearly separated from one another on the radiographs, which should be taken evenly and perpendicular to the implant body. Future radiographs will use the implant threads as markers to spot peri implant bone loss. A fresh radiograph is advised if bleeding occurs during probing with increasing probing depths to determine the progression of any additional bone loss in relation to the initial state readings [10]. Suppuration during or after probing is a hallmark of peri-implant disease. It indicates the existence of a current infection as well as pathological alterations, strongly indicating the need for further evaluation and treatment regarding hard tissue complications and peri-implantitis.The loss of implant support results from untreated peri-implantitis. Bone loss begins at the coronal surface of the implant repair and moves apically when the infection progresses from the gingival edge. As a result, implant mobility suggests a total lack of osseointegration and, ultimately, implant failure [11].

Management of peri-implantitis

As mentioned above, when the infection spreads, loss of bone begins at the coronal aspect and move along apically, from the gingival border of the implant repair.

The three steps of the peri-implant therapy process are similar to those used in treating periodontitis [12].

- Systemic phase
- Corrective phase
- Supportive phase

The hygiene phase seeks to establish appropriate plaque management during the systemic phase. The patient has to be instructed on good oral hygiene practices. Individualizing oral hygiene is particularly important since maintaining excellent oral hygiene is usually challenging in the peri-implant area due to prosthetic superstructures. Additionally, the pathogenic microflora has to be diminished to stop disease development. Depending on access and the severity of the Under certain conditions, scaling and root planing may be beneficial in eliminating calculus and bacterial biofilms from the root surface.

Corrective Phase-Non-Surgical: The right equipment, such as plastic, carbon, or titanium curettes, air-powder abrasive devices, ultrasonic devices, photodynamic treatment, or the Er: YAG laser, which are all examples of abrasive devices, can be used to perform non-surgical debridement prior to surgical intervention [13]. Systemic antibiotics, locally applied antibiotics, or topical antiseptics (such as chlorhexidine) may all be used concurrently to lessen bleeding upon probing and pocket depth [14,15]. Ciancio., *et al*. (1995) established the benefits of antimicrobial rinsing using essential oil-containing mouthwashes for the treatment of peri-implant mucositis. Management of peri-implant mucositis does not seem to resolve by local application of antimicrobials alone [15]. Similarly, a single instance of skilled irrigation of the sulcus using chlorhexidine is insufficiently therapeutic. On the other hand, self-administered irrigation with chlorhexidine is useful [16].

Irrigation also reduced calculus and staining. One study indicated that mechanical, non-surgical treatment alone was insufficient to treat peri-implantitis lesions. There were very minimal alterations in bleeding frequency, and probing depths either remained unchanged or deteriorated [17]. Mombelli., *et al*. showed some improvement in clinical measures, including probing depths and

bleeding index, with the use of tetracycline-containing fibers [18]. Buchter., *et al*. proved the therapeutic benefits of slow- release doxycycline-containing formulations in controlled research.[19] In two case studies, it was proposed that using either chlorhexidine gel or minocycline microspheres in addition to treatment would enhance both clinical and microbiological data [20,21]. Renvert., *et al*. discovered the advantage of using minocycline-containing microspheres as an adjuvant in a number of randomized, controlled experiments. The therapy doesn't always completely eradicate the lesions, despite the fact that all of the trials included in the research that employed local antimicrobial administration, in addition to mechanical therapy, showed reductions in BOP and probing depths has been noted [22].

Surgical: If the peri-implantitis has not been cured by the time the patient is re- evaluated, surgery may be advised. Renvert., *et al*. discovered the advantage of using adjunctive microspheres containing minocycline in a series of randomized-controlled experiments. Even though the mean BOP and probing depths in all of the trials included in the study that included local antimicrobials in addition to mechanical treatment showed improvements, the treatment doesn't always completely eradicate the lesions. Renvert., *et al*. concluded that the adjunctive use of microspheres containing minocycline was beneficial in a series of randomized, controlled studies.[23] Although mean improvements in BOP and probing depths were seen in all of the studies included in the analysis that used local antimicrobials in addition to mechanical treatment, the lesions weren't always completely healed as a result of the treatment.

The two broad divisions of surgical management of peri-implantitis are

Resective Surgery
Regenerative Surgery

- **Resective Surgery:** The goal of surgical-resective therapy is to minimize or eradicate pathologic or hyperplastic peri-implant pockets that are too difficult for the patient to reach for proper oral hygiene and/or have proved resistant to initial treatment. Osteoplasty, which minimizes the intrabony defect and moves the mucosal edge apically to diminish the non-accessible area, is used for reparative intervention. Additionally, certain medical professionals do implantoplasty, which entails polishing and sanding any supracrestal or transmucosal implant surfaces. This method lessens plaque buildup and enhances the patient's oral hygiene. Reconstructive surgery may only be used in the non-esthetic zone since it extensively apically displaces the gingiva and exposes the endosteal section of the implant. However, it should be remembered that any alteration of the implant, particularly in the setting of implants, may breach a manufacturer's warranty and should only be undertaken as a last resort to total implant loss [24].
- **Regenerative Surgery:** Regenerative peri-implantitis therapy must not be explored until initial therapy has lessened the symptoms of acute inflammation, much like systematic periodontal therapy [25]. The two principal objectives of regenerative treatment are implant re-osseointegration and peri-implant bone formation. However, a thorough literature review found that when filling peri-implantitis deficiencies is necessary, it is possible to do so after surgical treatment modalities with the concurrent installation of bone replacements. Outcome measures have improved over time when a natural bone mineral has been used, either combined with or without a collagen membrane [26].

In one of our own case reports, we successfully managed a failing implant using a regenerative procedure. Where the failing implant was repositioned, successful bone regeneration was performed using xenograft and GTR membrane [27].

The cumulative interceptive supportive therapy (CIST) strategy was developed by Mombelli and Lang and has gained widespread acceptance since its beginnings. It was designed to tailor treatment of peri-implant lesions in accordance with easily measurable clinical criteria. It presents a sequential sequence of suggested therapies based on the severity of the condition, depending on how serious the lesion is. Short reviews of this procedure and possible alternatives to each section are provided [28].

Part A of the CIST guidelines, which is customarily initiated when plaque and bleeding on probing are evident but pocket depths ≤ 3mm, re-instructs patient's oral hygiene methods and motivates them to start and keep maintenance; mechanical debridement is accomplished using nonmetallic curettes, and surface finish is performed using a rubber cup and non-abrasive polishing paste.

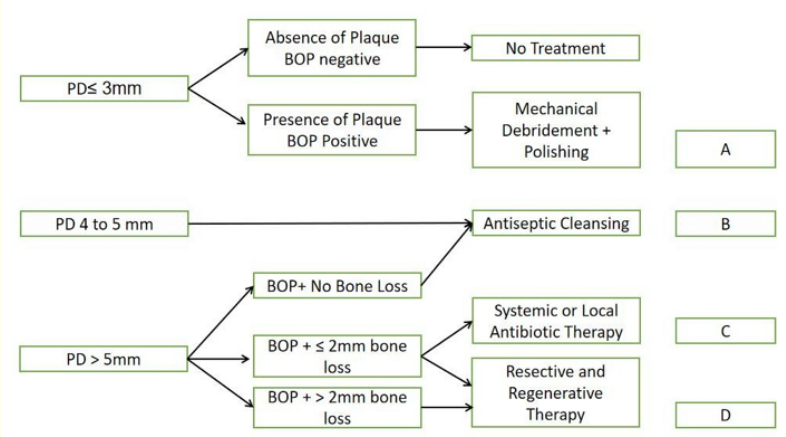

Figure 1: CIST Protocol.

Part B includes antimicrobial therapy when pocket depths of 4 to 5 mm are identified. Chlorhexidine digluconate is used in this instance to chemically control plaque. It is typically applied as mouth rinses with 0.1% to 0.2% chlorhexidine for 30 seconds with around 10 mL, topical chlorhexidine gel coating (0.2%), and/or local chlorhexidine irrigation (0.2%), twice a day through 3 to 4 weeks. When pocket depths are higher than 5 mm, Protocol C, a systemic or local antibiotic therapy, is started. Radiology should also be utilized to support clinical results. The usual systemic therapy consists of amoxicillin (375 mg/day) and metronidazole (250 mg/day) taken together for 10 days, or ornidazole (1,000 mg/day) or metronidazole (250 mg/day).For ten days, with the use of a controlled release device, local therapy options might include applying antibiotics locally, such as tetracycline fibers and minocycline microspheres.

Following the completion of therapy strategies A, B, and C, a surgical method (D) may very well be pursued. Systemic antibiotics and implant surface cleaning should be in conjunction with surgical intervention for peri-implantitis. A guided tissue regeneration method, either alone or along with autogenous grafts and/or bone replacements (preferably deproteinized bovine xenograft) can be taken into consideration if regeneration therapy is decided.

Supportive Phase: A customized maintenance and care regimen is part of the last stage of treatment. It is recommended to do regular clinical monitoring, with the addition of appropriate radiographic assessment as necessary. Depending on the patient's oral health and risk profile, supportive maintenance therapy must be administered on a regular basis, often every three to six months. This involves reinforcing excellent dental hygiene and engaging a professional to remove biofilm. The history of oral hygiene, diabetes, periodontal health, and smoking habits are the most crucial considerations [29].

Peri-Implant Maintenance: There are numerous approaches to enhance the long-term prognosis of fixtures during placement and repair. Both patient engagement and oral health are essential. Prior to beginning implant therapy, periodontal health should be achieved. Restorations should have well-fitting margins and be cleanable. Keeping the mucosal tissue as near to its native location as possible is also important. After implant therapy is effective, a maintenance program should be initiated. For the most effective disease prevention, this has to be customized for each person and include regular reminders. Each session of the reminder visit includes an inspection, re- evaluation, diagnosis, motivation, and treatment of infected areas, just like a periodontal patient receiving maintenance care. Before enrolling a patient in regular maintenance, baseline data should be collected [30].

Evaluation of the current maintenance protocol: Regular dental biofilm control has been shown to decrease the frequency of peri-implant diseases. Modern dental implant maintenance methods rely on expert disinfection and at-home cleaning in this regard. Mono-tufted toothbrushes and chemical components in dentifrices

and/or mouthwashes may be significant in some situations given the significance of brushing and interproximal cleansing. Currently, achieving long-term success with implant treatment requires oral care teaching and skillful hand biofilm elimination. In a study of 80 partially dentate people with implants who were monitored for five years, it was discovered that maintenance therapy was successful in preventing the progression of peri-implant mucositis to peri-implantitis [31]. In such a study, all participants who first reported mucositis were split into two groups: The control group did not get maintenance treatment and did not visit the dentist at any time throughout the research period, whereas the test group received maintenance care (at least five appointments in the follow-up). People in the maintenance-free group were more likely to develop peri-implantitis (characterized as a pocket depth of 5 mm along with bleeding on peri-implant probing and/or suppuration with peri-implant bone loss) than those who were engaged in the preventative strategy (43.9% vs. 18%). The researchers found that peri-implantitis lesions were linked to the lowest plaque control in both groups, rather than being system- or surface-dependent. Additionally, research has indicated that peri-implant health is related to effective plaque control and that biofilm control is an effective treatment for peri-implant mucositis [32].

Inadequate oral hygiene is indicated by the appearance of plaque or bleeding. Checking the patient's oral hygiene and introducing or reinforcing the appropriate plaque control measures are both necessary. Instruments that are softer than titanium should be used to clean implants, such as plastic scaling tools, floss, interdental brushes, or polishing with a rubber cup and paste. Unlike metal and ultrasonic scalers, it has been demonstrated that they do not cause the implant surface to become rough [33].

Peri-implantitis Prevention: When taken as a whole, the technical challenges in treating peri-implantitis and the substantial resource demands point to the necessity for a major emphasis on preventative measures. Therefore, in implantology, preventing peri-implantitis ought to be a key goal. A continuum between peri-implant mucosa that is healthy and peri-implant mucositis and peri-implantitis occurs, as stated in the consensus report from the XI European Workshop on Periodontology [34]. In order to prevent the evolution of peri-implant mucositis into peri-implant mucositis, it is essential to treat both peri-implant mucositis and pre-existing peri-implant mucositis [35].

Supportive periodontal therapy has been shown to be crucial in the field of periodontology for stopping the onset or recurrence of periodontal disorders [36,37]. A patient's risk profile informs the protocol's design [34]. Similar to this, frequent dental implant maintenance has been suggested as a smart way to avoid peri-implant irritation [38].

Another advancement in the treatment of peri-implantitis is the creation of LAPIP. Procedure for treating peri-implantitis with laser support. Additionally, laser therapy has been used to clean exposed implant surfaces and promote bone formation around implants. There have been many different lasers used, but the Er: YAG laser has garnered the most attention. According to Schwarz., *et al*. the advantages of employing lasers to treat peri-implantitis are insufficient to justifiably modify the way the condition is treated [39].

Advancement in Biomaterials in Preventing and Treating Peri-implantitis: Polymers that have been hydrated form a hydrogel. These biomaterials are made of sturdy, cross-linked networks of organic or synthetic molecules that include internal gaps that can accommodate the storage of biological medications. Polysaccharides (like dextran and chitosan) and proteins (like gelatin and fibrin) are well-researched examples of natural polymers employed in the production of hydrogels [40].

Layer-by-layer (LbL) coating deposition is another contemporary technique that might result in more efficacy and fewer negative effects when it comes to the controlled release of antimicrobial compounds. Self assembly, a fundamental idea in LbL technology, relies on non covalent connections between molecules, which indicates that these interactions may be harmed by outside variables resulting from the environment.Large molecules' three-dimensional structures are maintained by the dynamic nature of such noncovalent interactions, which can display stimulus responsiveness to different physical, chemical, or biological stimuli, such as temperature, light, pH, ionic strength, redox agent, and enzymes. According to the pathogenesis of peri-implantitis as it is now understood, distinct phases of the illness are often marked by a considerable pH range inside the peri-implant tissue. Each stage of inflammation will directly influence the microbial composition as a result of acid- base circumstances. Due to the fact that Gram-negative anaerobic bacteria species frequently thrive at comparatively higher pH values, the alkaline pH may contribute to peri-implant infections. Therefore, LbL devices might distribute antimicrobial

agents under various pH circumstances and start the release of drugs to treat peri- implantitis as necessary.

Biomolecules and drugs have been included in a LbL system to be administered to the troubled implant sites in order to increase the effectiveness of the mechanical debridement of peri-implant pockets. The potential of this system to include pharmaceuticals and the adaptable chemical characteristics of polyelectrolytes for coating any surface make the technology appealing, even if the majority of the results about the biomedical uses of LbL self-assembly have been generated from *in vitro* investigations [41,42].

Graphene Oxide Films: An in-vitro investigation in beagles using films loaded with minocycline hydrochloride and coated on implant abutments for the treatment of peri- implantitis showed a satisfactory therapeutic effect [43].

The peri-implant niche as modified by the implant surface: The release of titanium particles and biological implant problems are caused by the biocorrosion of the implant surface [44].Biological friction at the implant-abutment interface or prolonged exposure of the metal surface to the biofilm can cause implant corrosion and wear. Titanium ions and micro- or nanoparticles that have been freed may have an effect on the nearby tissues and may intensify macrophages' inflammatory responses [45].

As a moderator of the peri-implant microbiota structure, titanium It has long been known that titanium is biocompatible, and implants are a successful method of replacing missing teeth. The association between peri-implant microbiota, dissolved titanium levels, and peri-implantitis was evaluated by Diane Daubert, MS., *et al*. in 2020. The results indicated a function for these products in changing the structure and diversity of the peri-implant microbiota and suggested a link between titanium dissolving products and peri-implantitis [46].

Discussion

The level of diagnostic and therapeutic complexity, as well as the multifactorial influence of diseases linked with peri-implant mucositis and peri-implantitis, are reflected in current evidence. Long-term data show that surgical results after peri- implantitis therapy are uncertain in terms of inflammation control, but effective in terms of preventing additional bone breakdown and implant failure [47].

The much more significant component of peri-implant disease management is accurate diagnosis. A history of periodontitis, poor dental hygiene, diabetes, smoking, alcohol use, hereditary features, the lack of keratinized mucosa, and the type of implant surface are indeed risk factors for peri-implantitis [48,49].

Following a definitive diagnosis, the implant's prognosis According to De Waal., *et al*. experience of the surgical team," "amount of bone loss," and "smoking" are the criteria that reflect the prognosis of peri-implantitis surgical intervention [50].

The features of implant surfaces significantly influence the prognosis of operative peri-implantitis treatment. Inflammation was lower on machined or smooth surfaces than on the modified surface of the implant. Conversely, in multilevel research, this variable was not identified as a predictive factor [51].

Koldsland., *et al*. carried out an investigation on the short-term consequences of periimplantitis surgical therapy and its prognostic markers. He stated that resective peri-implantitis therapy helps reduce inflammation. However, bleeding on probing and suppuration were still apparent, which necessitated examination and long-term maintenance. The existence of suppuration and more than 7 mm of bone loss before surgical treatment lowers the efficacy of the surgical treatment and further maintenance. The location of the implant also plays a role and influences the treatment's final outcome. Especially relative to approximal locations, lingual and buccal sites tend to have fewer pockets and less bleeding on probing. There could be various explanations for this. First, there is greater mucosal recession at the buccal and lingual locations. Second, the alveolar bone of adjacent teeth is higher, which may cause a bony inclination toward the implant. Furthermore, the location of the implant site also affects the convenience of oral hygiene maintenance [52]. As dental implants are used increasingly often as a therapeutic option, the prevalence of peri- implant problems will rise. In clinical practice, it's crucial that all patients getting dental implants are made aware of the potential for peri implant problems. Since poor oral hygiene is the primary cause of most difficulties, it is crucial to practice good oral hygiene. Whenever there is an increase in the peri-implant probing depth, a radiograph needs to be taken. All factors that contribute to peri-implantitis should be addressed or, if possible, avoided once the condition has been identified. The surgical treatment choice should be determined in

part by the extent of peri-implant bone loss and the kind of peri-implant bony defect.

After the procedure, maintaining proper oral hygiene is essential for the peri-implant tissue's continued health. A tailored maintenance recall program needs to be used until all peri-implant parameters are stable and consistent with health. A condition known as peri-implantitis is an infection of the tissues surrounding implants and bone resorption.

Conclusion

The most effective method to treat peri-implantitis has not been agreed upon by experts in the field. Nevertheless, current protocols should be kept in mind prior to determining the diagnosis, prognosis, and treatment plan of peri-implantitis. A general image of some clinical improvement with the use of anti-infective therapy in terms of resolution of inflammation and bone repair emerges, even though research addressing various peri-implantitis treatment techniques is not comparable.

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