Review Article

Peri-Implantitis Prevention: A Multi-Level Evidence-Based Approach from Primordial to Quaternary Prevention

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Abstract

Peri-implantitis is an inflammatory disease around soft and hard tissues of the dental implants, and is one of the most common diseases that leads to cases of failure of the dental implant therapy in the long term. The rising prevalence of peri-implant diseases highlights the critical need for prevention protocols, characterized by progressive bone loss and possible loss in implant function. Moreover, it requires a thorough, multi-dimensional preventative approach to preserve patient oral health and overall wellness. This review aims to assess the existing evidence-based prevention strategies for Peri-implantitis, including primordial, primary, secondary, tertiary, and quaternary prevention levels

Keywords: Peri-implantitis, Primordial prevention, Primary prevention, Secondary prevention, Tertiary prevention, Quaternary prevention, Peri-implant mucositis

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Introduction

Peri-implantitis has been defined as a 'peri-implant biofilm-associate3d pathological condition, occurring in tissues around dental implants, and characterized by inflammation in the peri-implant mucosa and subsequent progressive loss of supporting bone'.[1] Clinically, peri-implantitis areas show sign of inflammation, bleeding on probing (BOP) and/or suppuration, increased probing depths and/or recession of the gingival margin, and presence of radiographic bone loss compared with previous examinations.[1-3] Moreover, peri-implantitis remains one of the most challenging conditions in modern implant dentistry. It is highly prevalent and greatly affects a large proportion of individuals with dental implants.[4,5] Peri-implantitis implications are not just cosmetic, they also create scenarios for an implant to fail, decrease oral function while also having a negative impact on the quality of life.[6] This is why a proactive and multi-faceted approach to prevention is crucial. This review intends to provide a systematic account of preventive strategies for Peri-implantitis, placed in primordial, primary, secondary, tertiary and quaternary prevention levels.[2,3] So, mastering these strategies and introducing them into practice, would significantly increase the life span and success rate of dental implantation that patients lead to better oral health.

Methods

An extensive search of peer-reviewed e-journal was performed from 2017 to 2024 using database such as PubMed, Web of Science and also searched in google scholars and retrieved relevant articles from reference list. During search, the key terms included "dental implantitis," "primordial prevention," "primary prevention," "secondary prevention," "tertiary prevention," and "quaternary prevention," "Peri-implant mucositis." This review recognized well-conducted systematic reviews, scoping review and meta-analyses research addressing the impact of the mentioned prevention levels.

Primordial Prevention

Primordial prevention usually involves avoiding the emergence of risk factors for Peri-implantitis. Targeting the underlying causes of the disease aims to create a healthy environment for proper acceptance and integration of the dental implant. Preventative measure is commonly ignored but imperative to ensure success long term.

The Future: Changing Risk Factors Prior to Onset

These primordial prevention strategies are aimed to modify the lifestyle and environmental risk factors that correlating with greater incidence of dental implantitis. Preventive measures include promotion of healthy dietary habits to prevent diseases like diabetes and obesity that have been recognized as prominent risk factors for peri-implant diseases.[2,3] Primordial prevention involves encouraging regular exercise for the maintenance of systemic health and promoting the cessation of smoking, a major contributing factor for both periodontal disease and implantitis.[7] This will provide a favorable environment before implant placement, ensuring proper implant retention and longevity by addressing the necessary oral health factors beforehand. The long-term effect of these lifestyle changes on the condition of the peri-implant tissues is significant.[7] Moreover, primordial prevention also includes initiatives promoting early and standard dental examinations in order to detect and treat undertones such as periodontal disease, which is a major risk factor for the development of implantitis.[2] Specifically managing these factors ultimately improves the odds of a long-term successful implant placement long before the implant is placed. This prevention level prepares for successful implant therapy by developing healthy habits and preventing risk factors.

Primary Prevention

Primary prevention refers to the measures that are taken prior to the placement of the dental implant to prevent the preliminary stage of Peri-implantitis . It is a preventive approch that objectives to minimize the risk factors and improve the factors that conditions that favor successful osseointegration.

Education of patients and changes in lifestyle

It is important that patients should be well informed about the necessities for detailed oral hygiene protocol, both mechanical (brushing/flossing and use of interproximal cleaning aids) and non-mechanical for adequate cleaning in the interstitial area of the implant abutments before starting the implant treatment. General statements on best practices for hand hygiene are essential for successful outcomes long-term.[8] In addition, lifestyle modifications like cessation of smoking,[7] diet changes to limit acid exposure,[2] and systemic diseases like management of diabetes are vital. As the hygiene around the implant improves, the incidence of peri-implant mucositis and the risk of peri-implantitis develop decreases significantly.

Comprehensive patient education remains a crucial component in primary prevention.[2,6]

Appropriate Case Selection and Preoperative Planning

There is paying careful attention to case selection is important to primary prevention.[2,6] A complete medical history, including systemic diseases, tobacco consumption history, periodontal condition that could predispose the patient to implantitis, should be obtained. Proper pre-surgical treatment planning or bone quality and quantity analysis using radiographic aids is significant for implant placement.[9] Moreover, selecting the precise implant site, taking into account the volume of bone available, and the thickness of the soft tissue will reduce the risk of complications even further.[10]

Surgical Techniques and Considerations for Implant Design

Surgical procedures have been found to affect peri-implant health long after implants have been placed.[9,11] This has to be done with minimally invasive techniques, accurate implant position, and careful management of soft tissue around the implants to avoid early inflammation or bone loss. Sufficient soft tissue volume and keratinized mucosa around the implant is an important factor for achieving oral hygiene and susceptibility of bacterial accumulation.[12] Classification of dental implant specifications regarding implant surface and connection design (i.e., platform switching) may also affect the risk of peri-implantitis.[7]

Antibiotics and antiseptics for prophylaxis

Although the routine prophylactic administration of antibiotics remains a matter of controversy, it may be considered in deliberate circumstances in high-risk individuals.[13] Determining which surgical approach to take can be challenging and must consider the specific risk factors for each individual patient as well as the surgical complexity. Local antiseptics applied in the operating theatre may additionally limit the bacterial load and decrease infection risk. [13] But, clinicians must balance the risk of developing antibiotic resistance and strictly follow the antibiotic prescription guidelines.[14] New antibacterial implant materials are a potential area of research for future primary prevention.[5,15]

Secondary Prevention

The secondary prevention is the discovery and treatment of peri-implant mucositis which is the main precursor of the development of the condition possibly before the bone loss became an irreversible process. At this point, rapid intervention is crucial to avoid progression of disease and a less favorable implant prognosis.

Periodic Follow Up and Monitoring for Peri-implant Mucositis

Routine maintenance visits are important for the early diagnosis of peri-implant mucositis.[2,3] During these visits, clinical parameters are monitored (probing depth, bleeding on probing, presence of inflammation). As mucositis is identified early, it can be treated effectively, thus avoiding progression to a more damaging stage, also called implantitis. The interval for follow up appointments requires individualized assessment based on risk factors and clinical presentation of the patients. [16] Regular monitoring cannot be overemphasized.

Use of Diagnostic Tools

Different diagnostic modalities are used for the early diagnosis of peri-implant disease. Peri-implant probing depth (PPD) measurements give information about the level of inflammation and bone loss. Radiographic examination (i.e., periapical or panoramic radiographs) should also be performed to allow assessment of the bone level around the implant and to detect early signs of bone resorption. In combination with clinical evaluations, these diagnostic approaches can help clinicians decide on proper management strategies.[16]

Non-surgical Interventions

In cases of peri-implant mucositis, non-surgical therapy is typically the first-line treatment.[3,4] The main objective of interventions is the removal of the bacterial biofilm on the implant surface and in the surrounding tissues. Professional cleaning, featuring scaling and polishing, is mandatory to remove plaque and calculus from surface.[16] In some cases local antimicrobial therapy is applied, known as the use of antimicrobial agents like chlorhexidine to help reduce bacterial load and diminish inflammation.[16,17] The chosen intervention depends on the severity of the mucositis and the overall condition of the patient.

Tertiary Prevention

Tertiary preventive treatment occurs once the state of disease (peri implantitis) is established which is directed towards managing complications and rehabilitating function and preventing progressive bone loss. The

stage is more interventionist level for treating the preimplant defect.

Surgical Interventions

Surgical measures might be required to control diagnosed Peri-implantitis when non-surgical approaches has limitation.[3,4] These surgical procedure are performed to resect infected tissues, decontaminate the surfaces of the implants, and induce bone regeneration. Surgical methods for treatment are open flap debridement, guided bone regeneration (GBR), and implantoplasty. [9,18] Depending on the severity of the disease, the amount of bone loss, and the overall clinical presentation, the infected area is managed surgically.[9] The staging of the type of surgery undertaken is driven by a combination of patient response to treatment and amount of bone loss during surgical intervention

Management of Peri-implant Defect

Peri-implant defects management is a key area of tertiary prevention.[2,3] Such defects, are symptoms of bone loss surrounding the implant, which are best managed through GBR, bone grafting or guided tissue regeneration (GTR).[9,12] These types of surgery are designed to restore the volume of bone, which helps enhance the implant as well as the longterm prognosis.[12] Since the final outcome of this technique is dependent on the parameters, such as defect size, localization, bone quality or patient comorbidities.[9] Optimizing prosthetic functions to reduce mechanical stress. Modifying the prosthesis is a third-level prevention[2,19] as it aims to reduce mechanical overload on peri-implant tissues. There are limitations to this study, including that poorly designed or ill-fitting prostheses can cause damage and loss of bone tissue. The mechanical stress can be reduced, and healing can be promoted by adjusting the prosthesis by modifying the occlusal contacts or optimizing the fit of the restoration.[19] Some authors have recommended removing the existing prosthesis and replacing it with a newer design that allows a better access to hygiene and maintenance.[18] The aim is to return to normal function and minimize subsequent bone loss.

Quaternary Prevention

Quaternary prevention aims to minimize overtreatment and unnecessary intervention,[20] promoting ethical behaviour and shared decision-making. This category seeks to avoid damage from over or untimely treatment.

Decision-Making in Treatment Planning (Ethics)

In dental implantology, ethical issues are one of the most important components in all dimensions and directions including the dimension of quaternary prevention.[6,21,22] It is up to clinicians to be thoughtful in weighing the potential risks and benefits of various treatment options, taking into account the patient's overall health, preferences, and prognosis. It is important to avoid aggressive/overly invasive treatment with a limited chance of success. A shared decision-making approach with good communication between the clinician and the patient establishes a treatment plan that matches the patient's values and expectations.[10]

Steering Clear of Aggressive Surgeries with Poor Prognosis

Sometimes, aggressive surgeries are not beneficial and have high risks themselves.[9,10] Clinicians should carefully weigh the risks and benefits before embarking on invasive and potentially harmful procedures, and clinicians should carefully quantify the predictors that inform the likelihood of success. This is usually done following a more conservative approach, avoiding more invasive interventions as far as possible. [3] It reduces the burden on patients and avoids complications from extensive surgery.

Informed Consent and Patient-Centered Care

Quaternary prevention has a patient-centered focus.[6,21,22] Clinicians must engage patients in the decision-making process by presenting information in a clear and easily understandable way about the risks and benefits of treatment options. Informed consent, the process in which the patient willingly provides agreement while having full knowledge of the doctor, operation, and subsequent repercussions. [10] This helps build trust and allows the treatment plan to match the wishes and expectations of the patient.

Discussion

The prevention of Peri-implantitis requires an integrated approach on all five levels of prevention. Primordial prevention sets the stage by targeting modifiable risk factors prior to their onset. For primary prevention, patients are well educated, careful case selection, and meticulous surgical techniques can minimize the risk of the disease occurrence. Key Points Secondary prevention involves the early detection and intervention in order to prevent progression of disease. If peri-implantitis is already established, tertiary prevention offers effective management approaches. Finally, quaternary prevention contributes to ethical and patient-

centered treatment choices, preventing unnecessary and sometimes harmful interventions.

Evidence-based clinical guidelines and scientific publications are valuable, but clinical care may vary, resulting in challenges regarding implementation of these preventive measures, including patients' compliance with oral hygiene instructions, the cost-effectiveness of comprehensive preventive care.[8] Optimal prevention strategies include interprofessional collaboration between dentists, periodontists, oral hygienists, dental therapists, general practitioners, and medical doctors with varying specific competencies to identify risk factors correctly and perform periodic screening of at-risk populations.[6,8] Novel device materials with smart antibacterial properties and new generation diagnostic tests are emerging technologies that may provide more preventative options. [5,15] More studies are needed to bridge knowledge gaps, assess the efficacy of new technologies and create standardized protocols for vaccination and treatment of Peri-implantitis . Studies examining long-term outcomes, cost-effectiveness models, and the effect of different preventive strategies on patient quality of life are especially important.

Conclusion

Prevention of peri-implantitis is a complex task that needs a broad, multi-layered strategy. Through primordial prevention, evidence based patient education, meticulous treatment planning and surgical intervention, early identification and management of complications, and good ethical decision making, clinicians can heavily influence the long-term outcome of dental implants in terms of both functional and aesthetic considerations of the quality of life of patients. Continued mapping, variation in protocols, implementation of evidence-based preventive strategies, promotion of interprofessional collaboration, and research into optimising prevention and management are essential. Ongoing research and development of novel technologies are essential for optimizing current solutions and establishing new strategies for addressing this major clinical problem. In the end, a high long-term implant success rates will contribute to improved oral health and quality of life for patients.

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