Is peri-implant maintenance therapy (PIMT) important for preventing peri-implant disease?

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Summary

Systematic review conclusion: Within the limitations of the present systematic review, it can be concluded that implant therapy must not be limited to the placement and restoration of dental implants, but also the implementation of PIMT to potentially prevent biologic complications and hence to increase the long-term success rate. Although it must be tailored to a patient's risk profiling, our findings suggest reason to claim a minimum recall PIMT interval of 5 to 6 months. Additionally, it must be stressed that even with the establishment of PIMT, biologic complications might still occur. Thus, patient-, clinical-, and implant-related factors must be thoroughly explored.

Critical appraisal conclusion

Within the limitations of the present systematic review, the results suggest that regular PIMT reduces the rate of peri-implant mucositis and peri-implantitis, and that 5-6 months should be considered a minimum recall interval for PIMT to prevent peri-implant disease. The findings also show that history of periodontitis significantly increased the incidence of peri-implant disease and suggested more stringent follow-up maintenance at shorter intervals. In addition, patient-, clinical- (surgical and restorative), and implant-related risk factors must be thoroughly considered to potentially prevent biologic complications and hence increase the long-term success rate of implants. Although the results presented in this review is considered as low level evidence, it has given us a better understanding of the importance of regular preventive care in preventing biological complications and increasing the longevity of implant restorations.

Implications for clinical practice

- Patient's considering implant therapy should be adequately informed on: (i) risks for peri-implant disease; (ii) the importance of maintaining proper oral hygiene; (iii) the need long-term regular follow-up and professional maintenance care; and (iv) the need to identify early signs of the disease and to develop preventive treatment strategies, particularly for those at high risk.
- Preventing peri-implant disease and maintaining the peri-implant tissues in health is the responsibility of both the patient and the dental team.
- Preventive care should be aimed at eliminating bacterial plaque through meticulous oral hygiene practices and professional mechanical debridement.
- Modifiable risk factors, such as periodontitis, uncontrolled diabetes and smoking, should be managed before implant placement. Patients with a high-risk profile should be followed up at more frequent intervals to monitor and maintain peri-implant tissue health.
- Implant position, design and placement of prosthetic superstructures should be planned so that it will facilitate proper personal cleaning and professional monitoring and maintenance therapy.
- Clinicians placing implants should ensure that there is adequate attached and unmovable keratinized soft tissue surrounding the implant to facilitate peri-implant health.
- Establishing a radiographic baseline at the time of implant placement is key to monitoring peri-implant bone stability.
- Prosthetic components and superstructures should fit properly to avoid microgaps for biofilm adherence and excess cement at submucosal restorative margins.
- Implant position, design and placement of prosthetic superstructures should be planned so that it will facilitate proper personal cleaning and professional monitoring and maintenance therapy.
- Establishing a clinical (periodontal probing) and radiographic baseline at final prosthesis placement is key to early diagnosis and proper intervention of peri-implant inflammation.
- Debridement of the implant-supported restoration must be directed at three components: the prosthesis, the abutment, and the implant fixture, should its surface become exposed to the oral cavity.

Clinical question

What is the impact of PIMT upon the incidence of biologic complications (i.e., mucositis and peri-implantitis)?

Review methodology

This review methodology was conducted according to the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-analyses.[1] The Newcastle-Ottawa Scale (NOS)[2] was used to evaluate the methodological quality of non-randomized included studies.

Electronic and manual literature searches were conducted by 3 independent reviewers in several databases, including MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials, and Cochrane Oral Health Group databases for articles published up to June 2015 without language restriction. Electronic screening of the grey literature was conducted according to the Assessment of Multiple Systematic Reviews [AMSTAR] guidelines.[3] Additionally, a manual search of periodontics-related journals was done.

Randomized or non-randomized clinical trials, prospective or retrospective cohort studies or case series studies involving humans with a sample size of at least 10 subjects and a minimum follow-up time of 6 months were eligible. Implants had to meet the criteria of rough surface, with or without a smooth surface collar. Studies included in the meta-analysis had to give a clear description of PIMT intervals and biologic complications.

Participants in the studies were patients with mandibular and /or maxillary complete or partially edentulous healthy subjects in need of dental implants to restore oral function. The test group was subjects receiving PIMT at regular recall intervals after implant placement for treatment of peri-implant disease. The control group received no regular PIMT or a longer interval compared to the test group. The primary outcomes measured were the incidence of peri-implant mucositis and peri-implantitis at implant and patient level. Secondary outcomes measured were implant survival and implant failure rates.

Three reviewers independently screened and extracted the data from studies. In case of disagreement, consensus was reached by discussion with a fourth reviewer. In case of unclear data, authors were contacted to provide the data.

A multivariate negative binomial regression was used to examine potential effects of PIMT on the incidence of peri-implant disease, implant success and failure rates.

Main results

Thirteen clinical trials were included in the qualitative, and 10 clinical trials in the quantitative analysis.

Implant level

For mucositis, a history of periodontal disease showed negative effects ($z = -8.12$, $P < 0.001$; lower mucositis with larger number of patients with history of periodontitis). Moreover, PIMT interval was shown to significantly influence the incidence of mucositis at this level ($z = 8.64$, $P < 0.001$). Significant effects of treatment ($z = -19.04$, $P < 0.001$), history of periodontitis ($z = -14.64$, $P < 0.001$; increased peri-implantitis with larger number of patients with history of periodontitis), and mean PIMT ($z = -29.31$, $P < 0.001$) were obtained for peri-implantitis. Additionally, a significant effect was found for the intervals of PIMT on the incidence of peri-implantitis at this level ($z = -5.26$, $P < 0.001$).

Patient level

For mucositis, there were significant effects of treatment ($z = -14.36$, $P < 0.001$), history of periodontitis ($z = -5.83$, $P < 0.001$; lower mucositis with larger number of periodontal disease patients), and mean PIMT interval ($z = -21.07$, $P < 0.001$; lower peri-implantitis with larger interval). PIMT range did show an influence on mucositis at this level ($z = -3.07$, $P = 0.002$). For peri-implantitis, the same negative binomial model was applied. Significant effects of treatment ($z = -16.63$, $P < 0.001$), history of periodontal disease ($z = 3.79$, $P < 0.001$; increased peri-implantitis with larger number of patients with history of periodontal disease), and mean PIMT ($z = -3.94$, $P < 0.001$) were observed. In addition, PIMT interval demonstrated a significant effect on the incidence of peri-implantitis at this level ($z = -26.51$, $P < 0.001$).

Mean PIMT had a statistically significant effect on implant survival rate ($z = -7.88$, $P<0.001$) and implant failure rate ($z = -30.59$, $P = 0.001$). PIMT interval significantly influenced the incidence of mucositis (at implant level only) ($z = 8.64$, $P < 0.001$) and peri-implantitis ($z = -5.26$, $P <0.001$).

History of periodontitis also showed a statistically significant effect on implant failure rate ($z = 38.03$, $P <0.001$). Results suggest that 5 to 6 months is a reasonable interval for PIMT.

Conclusion

Within the limitations of the present systematic review, it can be concluded that implant therapy must not be limited to the placement and restoration of dental implants but to the implementation of PIMT to potentially prevent biologic complications and hence heighten the long-term success rate. Although it must be tailored to a patient's risk profiling, our findings suggest reason to claim a minimum recall PIMT interval of 5 to 6 mo. Additionally, it must be stressed that even in the establishment of PIMT, biologic complications might occur. Hence, patient-, clinical-, and implant-related factors must be thoroughly explored.

Commentary
Background and importance

Peri-implant soft tissue healing and health differs significantly to that of natural teeth. Key characteristics of peri-implant soft tissues are deeper probing depth, weaker connective tissue attachment, reduced vascular supply, and more pronounced inflammatory tissue response, making the implant more vulnerable to bacterial accumulations and other external stimulations.[4,5]

Biological complications of peri-implant tissues; namely, peri-implant mucositis and peri-implantitis are a frequently encountered problem, characterized by the inflammatory destruction of the tissues surrounding the implant as a result of biofilm formation on the prosthesis, the abutment and the implant fixture, should its surface become exposed to the oral cavity.[4] Microbial colonization in the form of dental plaque biofilms and the host inflammatory response in the peri-implant tissues have been considered as the critical etiological factors for the development of peri-implant diseases.[6] However, several other etiological factors and risk indicators such as; history of periodontitis, excess cement, smoking, diabetes, absence of keratinized mucosa, implant characteristics, and occlusal overload could also increase the incidence of peri-implant diseases.[7]

The diagnostic criteria for peri-implant diseases are mainly clinical and radiographic.[6] Peri-implant mucositis is a reversible inflammatory process characterized by inflamed or erythematous peri-implant mucosa and bleeding with probing with no evidence of loss of the supporting bone.[6,8] Peri-implantitis on the other hand is characterized by both soft tissue inflammation and progressive loss of supporting bone leading to the formation of a peri-implant pocket >5mm, bleeding or suppuration on probing, and, radiographically, a characteristic symmetrical ''saucer-shaped'' bone

destruction (or ''crater'') around the implant. [6,8]

Peri-implant diseases are common following implant therapy.[9] Recent systematic reviews estimate that the frequency of peri-implant mucositis was 63.4% of participants and 30.7% of implants, and that of peri-implantitis were 18.8% of participants and 9.6% of implants. A higher frequency (36,3%) of occurrence of peri-implant diseases was recorded for smokers.[9] Another meta-analyses estimated a weighted mean prevalence of peri-implant mucositis and peri-implantitis of 43% (CI: 32-54%) and 22% (CI: 14-30%), respectively.[10]

Emerging evidence show that there is an increased risk for conversion of peri-implant mucositis to peri-implantitis in patients not diagnosed, or if they are not receiving supportive therapy.[11] A recent study suggested that peri-implantitis is a common condition and that several patient- and implant-related factors influence the risk for moderate/severe peri-implantitis.[12]

Peri-implantitis is a progressive chronic inflammatory process that if not diagnosed and/or treated appropriately and timeously, may lead to gradual destruction of the supporting bone, and potentially implant loss.[13] With increasing number of dental implants being placed annually and the fact that peri-implant diseases' prevalence increases with the number of years in implant function,[14] one can expect that peri-implant disease will increasingly become a significant challenge to clinicians, threatening the success and longevity of dental implant therapy." Tarnow[15] places this nicely in perspective with the following quote from his article: *"In addition, because at least 10% of all implants being placed this year will have peri-implant disease after 10 years, it makes us realize how important this is. The estimate that 1 million implants were placed last year worldwide should serve as an eye-opener. If conservatively 10% of all implants will have this problem, then 100,000 per year will need our attention. It should also be mentioned that life in the mouth is a hostile environment for both teeth and implants. We therefore will see more peri-implantitis on implants as they spend more time in the mouth. This is just like teeth."* Therefore, as the number of implants placed per year continues to increase it is becoming increasingly important for the clinician to ensure that patients are properly informed and that they are receiving appropriate and regular long-term supportive treatment to ensure that there implants remain disease free. Recent evidence indicates that without a regular maintenance programme including clinical reevaluation, plaque control, oral hygiene instruction and other professional preventive measures, the benefits provided by dental implants cannot be maintained on a long-term basis and biological complications such as peri-implant mucositis and/or peri-implantitis may result.[16,17]

To date, current approaches to implant maintenance are empirical with no evidence-based guideline or protocol for prevention of peri-implant diseases. Additionally, there is currently no reliable evidence to identify the most effective intervention for treating peri-implantitis.[18] If the clinician is better able to identify and understand the etiology, pathogenesis and characteristics of peri-implant disease, prevention and management can be performed more effectively. The present systematic review aims at assessing the impact of maintenance therapy on the incidence of peri-implant diseases.

Are the results valid?

The present systematic review had major limitations affecting the quality and validity of the evidence presented. Overall, the primary studies included in the study were based upon convenience samples of limited sample size, questionable study design producing low-level evidence, an unclear or high risk for bias, and therefore may not provide a true reflection of the effect of PIMT on peri-implant disease. Furthermore, follow-up time and PIMT interval range analysed varied considerably and may not accurately demonstrate its true impact on the incidence of peri-implant disease.

The number of studies and sample sizes were too small to analyse the effect of extraneous variables (i.e. smoking, systemic conditions, bone quality, implant location, peri-implant mucosal dimensions, implant design and surface characteristics, number of implants, placement protocols, loading protocols, follow-up period, type of prosthesis) on the incidence of peri-implant disease. These confounding variables could affect the reliability of the evidence presented. In view of the abovementioned limitations, caution should therefore be exercised when interpreting the data and extrapolating directly from the findings to daily implant practice.

What are the key findings?

An incidence rate ratio (IRR) is a relative measure of the effect (peri-implant disease) of a given exposure (PIMT) or the approximation of the relative risk of a non-exposure to PIMT. IRR is calculated by dividing the incidence of peri-implant disease amongst the exposed population (PIMT) by the incidence amongst the non-exposed population (no-PIMT). Subjects receiving PIMT had 0.9369 times the rate (risk) of having mucositis and 0.7056 times the rate of having peri-

implantitis at implant level compared to subjects not receiving PIMT. (Rate ratios are often interpreted as if they were risk ratios, e.g., subjects receiving PIMT had 0.9369 times the risk of getting mucositis compared to subjects not receiving PIMT, but it is more precise to refer to the ratio of rates rather than risk.) PIMT intervals had a significant effect on the incidence of mucositis at implant level and peri-implantitis at implant level and patient level. The findings of this review suggest 5-6 months to be a reasonable interval for PIMT. History of periodontitis significantly increased the incidence of mucositis and peri-implantitis at both implant and patient level. Mean PIMT and periodontitis showed significant effects on implant failure rate. The systematic review showed that PIMT has a positive impact on peri-implant tissue health as well as implant survival rate.

The results of this study lends further support to findings of previous studies that long-term maintenance care and frequency of maintenance visits are essential to reduce the risk of peri-implantitis, and to enhance implant survival.[9,19] The finding that history of periodontitis increases the incidence of peri-implantitis is also in agreement with a recent study suggesting that susceptibility confers higher risk of implantitis.[12]

How are the results of this review applicable in clinical practice?
Are these interventions feasible?
The findings of this study, although a very low level evidence, remain very clinically relevant to daily implant practice. Early diagnosis and identifying risk factors during treatment planning and throughout therapy, together with regular long-term follow-up are fundamental principles in preventing disease and selecting appropriate treatment protocols. Long-term maintenance care at more frequent intervals for high-risk groups is essential to reduce the risk of peri-implant disease. Patients receiving implant treatment must be duly informed on the risk for peri-implant diseases and the need for regular preventive care.[9,20]

It is important that implant placement and prosthetic reconstructions need to allow proper personal cleaning, diagnosis by probing, and professional plaque removal.[20] Peri-implant mucositis is a reversible condition therefore early diagnosis is imperative for initiating preventive care. Patient-administered mechanical plaque control alone should be considered the current standard of care for preventing and managing peri-implant mucositis.[20] Treatment of peri-implant mucositis usually includes mechanical debridement of biofilm and calculus either by professional intervention and/or by home-use oral-hygiene techniques, with or without the adjunctive use of antimicrobials.

Based on the available data, it seems that the nonsurgical therapy of peri-implantitis is not effective in disease resolution because only limited improvements in the main clinical parameters have been reported and there is a clear tendency for disease recurrence. It is therefore recommended to consider advanced therapies, such as surgical interventions, when nonsurgical peri-implant surgery is unable to achieve significant improvements in the clinical parameters.[7,21,22] Treatment of peri-implantitis should be tailored to the severity of the lesion which ranges from mechanical debridement to implant removal. Several nonsurgical and surgical treatment alternatives exist, and there is little consensus on superior treatment methods. For more detailed non-surgical and surgical treatment protocols, readers can refer to the following clinical literature. [7, 21,22,23, 24]

Do benefits outweigh the potential harms and costs?
"*Peri-implant disease is not an easy, predictable disease to treat once it is passed the mucositis level into the bone. Therefore, the key is prevention based on proper implant design, proper placement, and correct contours for ease of hygiene. This, along with meticulous maintenance care by both the dentist and the patient, will mean that we won't "revisit" these implants.*" [15]

Furthermore, treatment of peri-implantitis can be inconvenient and uncomfortable for the patient, and appropriate treatment is demanding in terms of resources and costs. Thus, as the global number of individuals that undergo implant retained restorative therapy increases, peri-implantitis will increasingly become a major and growing problem in dentistry.[12]

It is best to prevent peri-mucositis, which is the precursor of periimplantitis. Long-term regular follow-up and maintenance care is key to preventing peri-implant disease. Early diagnosis will ensure that appropriate therapy is initiated to reverse peri-implant mucositis. Additionally, long-term maintenance care, especially for high-risk groups, is essential to reduce the risk of peri-implantitis and subsequent implant failure.

To summarize, prevention incur less risk of peri-implant disease, discomfort, emotional stress, and costs associated with surgical treatment protocols associated with managing peri-implantitis or ultimate removal a failed implant.

Clinical Resolution

Within the limitations of the present systematic review, the results supports the fundamental principle that dental implants necessitate regular long-term attention to peri-implant maintenance through rigorously employed regular professional follow-up and patient self-management. This review has highlighted the importance of proper oral hygiene and more stringent follow-up care is suggested, with recall intervals every 5-6 months.

The findings shows that history of periodontitis significantly increased the incidence of peri-implant disease, therefore clinicians should pay particular attention to patients with periodontal disease, with regard to periodontal therapy and adherence to regular periodontal maintenance. In addition, patient-, clinical- (surgical and restorative), and implant-related factors must be thoroughly considered to potentially prevent biologic complications and hence increase the long-term success rate of implants. Although the results presented in this review is low level evidence, it has given us a better understanding of the importance of regular preventive care in preventing biological complications and increasing the longevity of implant restorations.

Future research should focus on quality study design and adherence to standardized guidelines for diagnostic criteria for measuring outcome parameters, and especially patient reported outcomes. Well-designed studies with attention to inclusion criteria and larger sample sizes will allow for analysis of treatment outcomes at multivariable level to identify sources of heterogeneity.

Further investigations should also focus on optimal ways for treating peri-implant mucositis and peri-implantitis that can provide evidence-based therapeutic protocols for peri-implant disease.

Disclosure and Disclaimer

Dr Johan Hartshorne is trained in clinical epidemiology, biostatistics, research methodology and critical appraisal of research evidence. This critical appraisal is not intended to, and do not, express, imply or summarize standards of care, but rather provide a concise reference point for dentists to aid in understanding and applying research evidence from referenced early view or pre-published articles in top ranking scientific publications and to facilitate clinically sound decisions as guided by their clinical judgement and by patient needs.

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