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REVIEW ARTICLE

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Implant maintenance for the prevention of biological complications: Are you ready for the next challenge?

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Abstract

With increasing knowledge of wound biology and material sciences, the provision of dental implants as a treatment modality has become increasingly predictable and more commonly used to replace missing teeth. However, without appropriate follow up, peri-implant diseases could develop and affect the long-term success of implants. Currently, there is not enough focus on the prevention of peri-implant diseases, as compared to the definition of the disease, its prevalence, and treatment. In the present study, we aim to summarize various factors influencing the successful maintenance of dental implants and highlight current gaps in knowledge. Factors influencing the successful maintenance of dental implants can be divided into three categories: implant-, dentist-, and patient-related factors. Patients with dental implants are often more dentally aware, and this offers an advantage. Compared to gingiva, peri-implant mucosa responds at a different pace to the bacterial challenge. Dental practitioners should be aware of how treatment protocols affect long-term success, and be vigilant in detecting peri-implant diseases at an early stage. Compared to periodontal maintenance, less longitudinal studies on implant maintenance are available, and therefore, there is a tendency to rely heavily on information extrapolated from the periodontal literature. More studies on the significance of implant maintenance care are required.

KEYWORDS

dental implant, implant maintenance, peri-implant complication, periodontal maintenance, periodontal therapy

1 | INTRODUCTION

With improved understanding of wound healing biology and material sciences, implants, as a treatment, have became increasingly successful and predictable.[1,2] However, implants often suffer from more complications compared to teeth, and therefore, require more maintenance care.[3] Early detection and the prevention of peri-implant diseases are necessary for long-term implant survival. As the etiology and pathogenesis of peri-implant diseases are similar in many aspects to periodontal diseases,[4–6] it has been suggested that routine maintenance care of implants should be structured along the guidelines of patients with periodontal diseases.[7] While there is an overwhelming abundance of literature available on the significance of maintenance therapy for periodontal patients,[8,9] less studies report on the significance of implant maintenance care. It has been shown by Axelsson and Lindhe that patients placed on a carefully-designed maintenance therapy program after the completion of active periodontal treatment were able to maintain excellent oral hygiene, healthy gingiva, and an unaltered attachment level, whereas patients not undergo the maintenance therapy program displayed signs of recurrent periodontitis and tooth loss.[9] It could be questioned if regular implant maintenance therapy could result in less peri-implant complications or longer survival of implants.

The aim of this review was to discuss factors affecting the successful maintenance of well-installed dental implants based on implant-, operator-, and patient-related factors. While the failure of implants

could be due to biological and/or technical considerations, this paper will focus on the biological complications, namely peri-implant diseases. The presentations of peri-implant diseases are peri-mucositis and peri-implantitis, sometimes to the extent of requiring explantation.

2 | IMPLANT-RELATED FACTORS

2.1 | Mucosal tissues of implant sites

To better understand implant-related factors that are associated with biological complications, an understanding of the healing response of the peri-implant tissues and differences in response to pathology compared to gingiva is important. The mucosal tissues around teeth and implants differ in several aspects, even in the healthy state. Using block biopsies of beagle dogs, it was determined that healthy mucosal tissues around implants immediately below the junctional epithelium were more collagenous, less vascular, and contained less fibroblasts, as compared to the corresponding gingiva around teeth.[10] In peri-implant tissue, the collagen fiber bundles were arranged parallel to the surface of implant, whereas around teeth, the fibers emerged perpendicularly from the cementum into the connective tissue (CT). Subsequently, it was determined that the gingival and supracrestal CT at the teeth received their blood supply from vessels within the periodontal ligament and supraperiosteal vessels lateral to the alveolar process, whereas peri-implant mucosa received their blood supply solely from the terminal branches of vessels from the periosteum.[11] The 10th European Workshop on Periodontology concluded that peri-implant CT resembled a scar tissue, and the attachment to the transmucosal portion of the implant was regarded as being more susceptible to the development of disease, than the attachment to root surfaces.[12] Nonetheless, proper plaque control was able to prevent subgingival plaque formation at both tissue barriers.[10]

The differences diverged further with the development of peri-implant diseases. It was observed that even though the composition of the inflammatory cell infiltrate (ICT) was largely similar for peri-implant mucositis and gingivitis, the apical spread of the ICT was significantly more pronounced in peri-implant mucosa than in the gingiva, with the length being 1.2 mm and 0.9 mm, respectively, in a beagle dog model.[13]

Most of the existing information regarding the histopathological features of peri-implantitis derives from animal studies.[14] However, a recent study determined that the features of peri-implantitis were fundamentally similar in humans as in animals.[15] Biopsies of the entire supracrestal soft tissue portion were obtained from patients with generalized severe chronic periodontitis and severe peri-implantitis. It was observed that for the periodontitis patients, the lesion resided in a well-defined compartment walled by the pocket epithelium and non-infiltrated CT at its lateral and apical portions of the ICT, whereas for peri-implantitis, the ICT occupied a much larger portion and extended to a position apical of the pocket epithelium. Unlike periodontitis, this was not surrounded by a zone of non-infiltrated CT. Furthermore, the area occupied by the peri-implantitis lesions was more than twice as large as the periodontitis lesions, and plasma cells, macrophages, and polymononuclear cells were significantly denser and more numerous in peri-implantitis than in periodontitis.

2.2 | Pro-inflammatory response

A stronger initial pro-inflammatory response was found around implants. One week after placement of single posterior mandibular implants, it was found that the levels of interleukin (IL)-6, IL-8, and macrophage inflammatory protein-1β were approximately threefold higher, and metallopeptidase inhibitor 1 levels were approximately 60% higher at implant sites, as compared to adjacent healthy teeth.[16] These differences subsequently tapered off at the end of the 12-week study period. It was concluded that the pro-inflammatory response was more robust at peri-implant tissues, as compared to adjacent healthy periodontal tissues. Consequences of this stronger initial pro-inflammatory response, however, remain to be explored. It is possible that the pro-inflammatory response around dental implants remained higher over the long term. In a cross-sectional study involving 28 participants with 28 healthy implants and 26 healthy teeth, it was shown that the concentration of cytokines was higher around implants than around teeth, despite the fact that no significant differences in bleeding on probing (BOP), probing pocket depth (PPD), and level of periopathogens existed.[17] In the present study, the concentration of both tumor necrosis factor-alpha and IL-8 around the implants reached almost twofold that compared to teeth, and the concentration of IL-6 was approximately fourfold higher around implants than around teeth. These studies suggest that intrinsic factors related to implants could be responsible for greater cytokine production.[17,18]

2.3 | Position of implants

Similar to teeth, the restorative margins around implants could play a role in the maintenance of soft tissue health. This was demonstrated in a multicentered, randomized, controlled clinical trial (RCCT) conducted by Heitz-Mayfield et al. on implants with peri-implant mucositis.[19] Subsequent to mechanical debridement, implants with supramucosal restoration margins showed significantly more PPD reduction, as compared to implants with submucosal restoration margins. Other potential issues related to implant position that could interfere with the maintenance of implants include poor accessibility for oral hygiene due to prosthetic designs and over-contoured crowns.[20,21] This could arise due to implant mal-positioning, thereby resulting in non-ideal crown contours. Furthermore, the contacts tended to open up between implant and adjacent teeth after a few years in function, potentially leading to food trapping.[22]

2.4 | Mode of retention

Care must be exercised when using cement-retained prosthesis, as excess cement has been associated with peri-implant disease development.[23] A prospective clinical endoscopic study found that 34 of 42 implants (81%) with clinical signs of peri-implant disease had excess cement, and 1 month after removal of excess cement, clinical signs of

peri-implant disease were resolved in 25 of 33 implants. Subsequently, Linkevicius et al. concluded that there was more undetected excess cement around restorations when the margins were deeper subgingivally, with significant differences between equigingival, 1, 2, and 3 mm subgingivally.[24] In the present study, excess cement was removed by an experienced prosthodontist before the crowns were removed to assess the amount of remaining excess cement. Using radiographs to evaluate the presence of excess cement was not found to be reliable and useful in only 8–11% of cases. In another retrospective study by Korsch et al., a high percentage of almost 60% of implants was identified as having excess cement when using methacrylate cement.[25] This is especially important for patients with a history of periodontal disease. In a retrospective case analysis of 77 patients with 129 implants, it was found that all 39 implants with excess cement around the restorations in a group of periodontally-compromised patients developed peri-implantitis.[26] In comparison, even though excess cement was similarly present around implants in the group of periodontally healthy patients, 11 implants did not show any signs of peri-implant disease, 20 showed signs of mucositis, and three implants developed early peri-implantitis.

2.5 | Summary for implant-related factors

Soft tissue and inflammatory response around dental implants are different from that of teeth (Table 1). Peri-implant tissues could be more vulnerable to a more rapid breakdown once inflammation sets in, and therefore, continued maintenance of implants for health is of paramount importance. Practitioners should be aware of how surgical and prosthetic procedures can affect the development of peri-implant diseases.

TABLE 1 Summary of soft tissue and inflammatory response differences between teeth and implants

	Teeth	Implants
Vascular supply	Vessels within PDL and supraperiosteal vessels lateral to alveolar process	Terminal branches of vessels from the periosteum, less vascular
Arrangement of collagen fibers	Emerged perpendicularly from cementum into CT	Parallel to surface of implant, more collagenous, less fibroblasts
Reaction to prolonged plaque accumulation	Composition of ICT largely similar for both tissue types	More apical spread of ICT
Active disease stage	ICT walled by pocket epithelium and non-infiltrated CT at lateral and apical portions	Twice as large ICT extending to a position apical of pocket epithelium and not surrounded by zone of non-infiltrated CT
Inflammatory response	Less inflammatory cytokines detected	Presence of more inflammatory cytokines

CT, connective tissue; ICT, inflammatory cell infiltrate; PDL, periodontal ligament.

3 | DENTIST-RELATED FACTORS

3.1 | Implant surface alterations due to instrumentation

Mechanical therapy has been shown to be highly effective in improving clinical parameters and reducing the overall amount of bacteria in patients suffering from periodontitis.[27] The proper selection of instruments for prophylaxis around implants must be carried out, as the instruments used could result in three different modifications to the implant surfaces: (a) increased surface roughness (b) no effect on the surface; and (c) smoothening surface.

It has been shown that there is a direct relationship between implant surface roughness and plaque accumulation, with rough abutments harboring more plaque.[28] Subsequently, it has been proposed that surface roughness below 0.2 μm has no effect on supra- and subgingival plaque accumulation.[29]

Metal instruments were avoided for the scaling of implants, as in vitro studies showed that the use of metal instruments, including ultrasonics with metal tips, titanium-alloy curettes, and stainless steel curettes, resulted in significantly rougher implant surfaces.[30–32] Pure titanium curettes appeared to cause less surface alterations compared to other metal instruments.[31,32] However, plastic-coated scaler tips or curettes, Teflon-coated scaler tips, carbon fiber tips, and air abrasive systems had been proposed for usage due to minimal damage to the implant surfaces.[31–33] However, the oscillation ranges of plastic-coated tips were reduced compared to normal steel tips, and debris had been found to be generated and left behind on implant surfaces under high-power settings.[34] The long-term effect of these debris remains unknown, and it is highly possible that they could potentially be a source of irritation and predispose to plaque accumulation. Furthermore, these tips are bulkier and harder to introduce to the submucosal peri-implant surfaces. Similarly, ultrasonic devices with carbon fiber tips and Teflon-coatings were also found to generate debris, which were left behind on implant surfaces.[32,35] In comparison, polishing with rubber cups and paste was found to have no effect or could even smoothen implant surfaces.[31]

A recent systematic review looked into the effects of different mechanical instruments on implant surfaces and identified 34 studies suitable for inclusion, of which three were in vivo studies.[36] Implant surfaces were divided into smooth and rough surfaces. Metal instruments generated an increase in surface roughness of smooth surface implants, whereas non-metal instruments and rubber cups, with or without paste, produced little to no change. Titanium curettes also resulted in an increase of surface roughness, but to a lesser extent than other metal instruments. For rough surface implants, metal curettes and ultrasonics with metal tips caused significant damage to the implant surfaces, whereas there were no significant changes caused by

non-metal instruments and air abrasives. The use of metal instruments and diamond burs was only necessary when removal of rough implant coatings was required. The study concluded that there was moderate evidence supporting the usage of rubber cups for smooth surfaces and non-metal instruments for rough surfaces.

Compared to in vitro studies, in vivo studies were less common. Kawashima et al. conducted a prospective study comparing ultrasonic scaling with a carbon, plastic, or metallic tip.[37] A single round of instrumentation was performed 1 week after abutment connection, and the surfaces were examined using a scanning electron microscope. All three methods of instrumentation resulted in a significantly lower amount of remaining plaque and calculus, with no differences among the different tips used. However, the use of metallic tips resulted in significantly rougher surfaces, whereas the carbon and plastic tips did not affect surface roughness. Therefore, appropriate instruments must be selected for implant debridement, as scratches created on either the fixture surface or supra-structure, due to use of inappropriate instruments, can be plaque retentive and form ecological niches for microbial growth and proliferation.

3.2 | Debridement protocol

3.2.1 | Mechanical debridement with or without chlorhexidine

Chemical plaque control agents have been used for treating patients suffering from periodontitis, as there can be difficulties in effectively removing bacterial flora by mechanical therapy alone. An example commonly used is chlorhexidine. However, the use of chlorhexidine during mechanical debridement of implants might not confer additional benefits. A randomized, single-blinded, parallel clinical trial compared the local application of chlorhexidine and chlorhexidine mouthrinse 10 days postoperatively with no chlorhexidine in 16 patients with 28 implants with signs of peri-implant mucositis.[38] Mechanical debridement was done using plastic scalers and rubber cups with polishing paste, and the patients were followed up for 3 months. It was concluded that chlorhexidine did not offer additional benefits over mechanical debridement in terms of clinical outcomes and microbiological findings, and that mechanical debridement alone was effective in resolving peri-implant mucositis. The lack of additional benefits from the use of chlorhexidine was found in another RCCT comparing the full-mouth disinfection approach against a single session of debridement in 11 patients.[39] In addition to chlorhexidine swabbing of the oral mucosa during an instrumentation visit, the test group also subsequently rinsed with chlorhexidine for 2 week. Both modalities led to significant clinical and microbiological improvements, with no differences between the groups after a follow up of 8 months. This finding of no added advantage was also found when chlorhexidine was used for the cleaning of hydroxyapatite-coated implants or in an experimental animal study involving monkeys.[40,41]

These results were in agreement with a 3-month RCCT conducted by the International Team for Implantology Implant Complication Research Group.[19] The implants were first mechanically debrided using titanium-coated Gracey curettes or carbon fiber curettes, and cleaned using rubber cups and polishing paste. The patients were then randomized to a test group of daily application of 0.5% chlorhexidine gel or a control group with placebo gel. There were significant reductions in the number of sites with BOP, PPD, and total DNA counts from baseline to follow up, with no statistical differences between the test and control groups. In the present study, the patients had good oral hygiene with full-mouth plaque scores of less than 25%. Therefore, it can be concluded that, in patients with good oral hygiene, the additional application of chlorhexidine had a minimal effect on the treatment outcomes of peri-implant mucositis, and mechanical therapy was sufficient.

3.2.2 | Glycine powder air polishing

In recent years, air polishing has been found to be effective in removing subgingival biofilm,[42] and is increasingly used for periodontal maintenance therapy. The repeated usage of glycine powder has been shown to result in minimal modification of implant surfaces or deposition of glycine particles on moderately rough surface implants.[43] A pilot study was conducted comparing the efficacy of ultrasonic scaling with carbon fiber tip alone against ultrasonic scaling with glycine powder air polishing on implants with peri-implant mucositis. The study concluded that both treatment modalities led to similar clinical outcomes in terms of PPD and bleeding index reduction.[44] However, a more recent study suggested that glycine powder air polishing is more effective than manual debridement with local chlorhexidine application, with this protocol resulting in a mild additional, but significant, reduction of PPD and plaque at 6 months.[45]

3.2.3 | Other methods of decontamination

Acid has been shown to have an antibacterial effect, and the use of phosphoric acid as a method of debridement around implants was tested in a randomized, split-mouth study on mandibular overdentures supported by four implants connected with a bar splint.[46] Mechanical debridement was carried out using carbon fiber curettes, followed by polishing with rubber cups and polishing paste. In addition, the test side received 35% phosphoric acid for 1 minute. Gingival index (GI), BOP, and PPD showed significant reductions for both test and control sites after 5 months, with significantly greater reductions in GI at the test sites compared to the control sites. Reduction in the number of colony-forming units was significantly greater at the test sites at both the 1- and 5-months follow-up visits. However, more postoperative pain was initially reported by patients after the application of phosphoric acid, and the use of phosphoric acid has not been replicated in other studies.

The potential of tetracycline fibers, a local delivery antimicrobial capable of prolonged release, being used for the treatment of peri-implant diseases was explored in a controlled case series of eight patients with peri-implant mucositis and/or peri-implant mucosal hyperplasia.[47] Scaling and the local application of tetracycline resolved mucosal hyperplasia in four of five test implants, whereas

scaling alone using stainless steel curettes had no effect on mucosal hyperplasia in two control implants. A trend toward improved BOP was observed in the test implants over the 12-week trial, whereas other clinical parameters including plaque, PPD, attachment levels, and probing bone levels showed no differences between the test and control implants. Minocycline microspheres also demonstrated some potential as an adjunctive measure. When compared with topical chlorhexidine gel as an adjunctive measure in the non-surgical treatment of incipient peri-implantitis, it resulted in an additional reduction of PPD, which was sustained over 12 month.[48]

3.3 | Standard of clinical practice

The 7th European Workshop on Periodontology proposed that baseline clinical parameters and radiographs should be established at the time of prosthesis installation.[49] Thus, this will serve as the reference to identify the development of subsequent peri-implant disease. This is especially important for implants that are submerged for esthetic reasons.

3.4 | Summary for dentist-related factors

Timely mechanical debridement using appropriate instruments is required during maintenance care to control the initial phase of peri-implant diseases. Debridement protocols using chemical plaque control agents have not been shown to be superior to mechanical debridement alone. More in vivo and long-term studies regarding debridement protocols and adjunctive agents or devices are necessary.

4 | PATIENT-RELATED FACTORS

4.1 | Compliance

In contrast to studies about the compliance of periodontal patients, there have been few regarding the compliance of patients receiving implant therapy. To date, there have been three such studies.[50–52] Cardaropoli and Gaveglio reported a 5-years retrospective study involving 96 patients from a periodontal specialist clinic.[51] Maintenance therapy was started 3 month after active therapy, and the patients were recalled every 3, 4, or 6 months, depending on their oral hygiene and clinical parameters. It was determined that patients who had dental implants placed were more compliant with the recall appointments than patients without: 88% of patients with dental implants were considered to be compliant, whereas a lower percentage of 65% was reported for patients without dental implants. No significant difference in terms of compliance was observed between patients who received solely non-surgical periodontal therapy and patients who received surgical periodontal therapy.

In a more recent retrospective study by Frisch et al., involving 236 patients with 540 implants seen in a private practice, patients were advised to attend 3-monthly recalls after receiving implant-supported restorations.[52] The rate of non-compliance increased over the first 3 years, but overall, a relatively high patient compliance rate of 86–94% was reported after completion of implant therapy. No correlation was detected for host-related factors, including age and sex, or surgical complexity. A negative correlation was detected for geographic distance, suggesting that patients who stayed further from the clinic were less compliant with follow-up appointments. Similarly, when analyzed as a secondary outcome parameter, a high compliance rate of over 90% was also reported in a group of patients with mandibular implant-supported overdentures.[50]

4.2 | Self-performed hygiene procedures

A recent systematic review aimed at evaluating the effect of self-performed mechanical oral hygiene procedures on peri-implant soft tissue health considered five studies to be suitable for inclusion, of which three were RCCT and two were cohort studies.[53] All three RCCT compared powered toothbrushing against manual toothbrushes, and although the use of powered toothbrushes led to an improvement in clinical parameters over time, the studies had a high potential risk of bias, and therefore, the strength of recommendation was considered to be weak. The authors concluded that there was currently little evidence on the maintenance care of implants performed by patients themselves, and self-performed home care was largely based on information from cleaning of teeth.

4.2.1 | Interproximal cleaning

Although there has been no RCCT that has looked specifically into self-performed interproximal cleaning around implants, one study compared two different interdental brushes when administrated by a trained dental nurse.[54] The results were analyzed on patient and site levels, and the use of both interdental brushes resulted in significant reductions of plaque scores from baseline. Alarmingly, a recent case series showed that dental floss might shear off during interproximal cleaning around dental implants, and therefore, lead to an increased risk of peri-implant disease progression.[55] However, given that this was a case series of 10 patients, more evidence is necessary before a clear conclusion can be made.

4.2.2 | Mouthrinses

A double-blind, parallel RCCT suggested that the use of an essential oil mouthrinse twice daily reduced plaque formation and improved peri-implant gingival health.[56] That study was industry funded.

4.3 | Control of risk factors

European researchers, Renvert and Polyzois and Renvert and Quirynen, conducted two separate consensus meetings and included identification of risk factors for the development of peri-implant mucositis and peri-implantitis, respectively, within their discussions.[57,58] A systematic search of the literature was conducted, but due to the heterogeneity of the data involved, a narrative review approach was eventually chosen. The authors concluded that inadequate plaque

FIGURE 1 Summary of factors influencing successful implant maintenance

control, history of periodontal disease, and smoking are risk indicators for the development of peri-implant disease. Other factors that could also increase susceptibility to the development of peri-implantitis include diabetes mellitus and genetic polymorphism.

4.4 | Summary for patient-related factors

Patients' compliance with appropriate oral hygiene devices and regular maintenance therapy are essential for the long-term maintenance of dental implants. Generally, patients with dental implants are more compliant with recalls, and this could be a major advantage. More information is necessary for self-performed hygiene procedures specific to dental implants. Patients who smoke and/or those with a history of periodontal disease are more susceptible to the development of peri-implant diseases, and should be counselled on smoking cessation and the maintenance of periodontal health.

5 | SUGGESTED CLINICAL PROTOCOL

A typical implant maintenance protocol normally includes the same procedures performed during a routine recall for patients with natural dentition.[59] This comprises of an update of the patient's medical history, followed by complete oral examination, including assessment of clinical parameters around teeth and implants. As previously discussed, baseline clinical parameters and radiographs should be established at the time of prosthesis installation.[49] These serve as a reference point to identify the development of subsequent peri-implant diseases. Various periodontal parameters have been proposed in clinical practice for assessing peri-implant health or disease.[60] These include plaque accumulation, BOP, suppuration, PPD, and radiographic findings. Probing around implants should be done with a force of 0.15 N, as probing around implants demonstrated higher sensitivity compared to probing around teeth.[61] In addition, occlusion and the physical integrity of the prosthesis should be evaluated. Particular attention should be paid to patients with poor plaque control, a history of periodontal disease, and those who smoke.[57,58] Should there be any suspicion of losing osseous support, radiographic examination is carried out. This is followed by the removal of plaque present and appropriate management of any other presenting complications. Finally, future recalls would be scheduled based on individual needs. If the patient presents with peri-implantitis, further treatment might be necessary, and appropriate follow-up appointments should be scheduled. The Cumulative Interceptive Supportive Therapy for implants was proposed by Lang et al. for the management of implants with biological complications.[62] A sequence of four protocols is employed depending on the severity and extent of the lesion. These include mechanical debridement, antiseptic cleaning, local or systemic antibiotic therapy, and finally, a surgical approach.

6 | FUTURE RESEARCH DIRECTIONS

Currently, there is no evidence to suggest the frequency of recall intervals necessary or any specific hygiene treatments being superior.[63] A systematic review focused on whether supportive implant treatment was effective in the prevention of complications and found that 56% of initially-screened studies did not assess clinical parameters around

dental implants during follow-up appointments, and only two studies provided specific information on treatment rendered at recall visits.[63] Furthermore, there have been no published data comparing different maintenance protocols to date. Therefore, future reports should incorporate baseline and follow-up clinical data to assess the efficacy of particular supportive protocols.[49] There were some initial data demonstrating the importance of preventive maintenance in the development of peri-implant disease. Costa et al. examined 80 participants 5 years after being diagnosed with mucositis, and concluded that the prevalence of peri-implantitis was 18% and 43.9% in patients with and without preventive maintenance, respectively.[64] Lack of maintenance subsequent to the diagnosis of mucositis was associated with an odds ratio of 5.92 for developing peri-implantitis. More recently, a systematic review compared the effects of regular peri-implant maintenance intervals after the placement of dental implants against no regular intervals or longer intervals on the incidence of peri-implant disease, implant survival rate, and implant failure rate.[65] Thirteen studies were deemed to have met the inclusion criteria, and the authors concluded that maintenance therapy intervals had significant effects on the incidence of mucositis and peri-implantitis at both implant and patient levels. A recall interval between 5 and 6 months can be considered reasonable because of the significant reduction in the incidence of peri-implantitis. This should be tailored to individual patients' risk profiles, accounting for the risk indicators previously mentioned.

In spite of different considerations involved in the provision of maintenance therapy for teeth and implants, it has been shown that it is still possible to maintain dental implants in a healthy condition, provided that a strict treatment protocol and regular maintenance care are provided and followed. A recent study reported by Tan et al. found that with proper management of known risk factors before implant placement, followed by a strict maintenance protocol, periodontally-healthy and periodontally-susceptible patients performed equally well after a period of 6 years.[66] This, therefore, highlights the importance of maintenance care. Given the increasing number of implants being placed in recent years and in the foreseeable future, it is inevitable that the maintenance of implants and the treatment of peri-implant disease are set to become the next challenge in implant dentistry.

7 | CONCLUSIONS

From the literature analyzed in the present study, the following guidelines to successfully prevent peri-implant diseases should be considered (Figure 1):

(a). active periodontal disease would first need to be treated, and implant installation should only be performed in patients with no residual periodontal pockets;
(b). regular and individually-tailored supportive therapy are essential to long-term implant success;
(c). the organization of a structured maintenance system is a prerequisite to any implant therapy;
(d). prosthetic reconstructions need to allow access for plaque control and must not impinge on efficient oral hygiene practices

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