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Review Article

Dental Implant Maintenance for the General Dentist: When, Why and What to Do?

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Abstract

Modern dental implants have high survival rates; however, they are subjected to mechanical and biological complications. Nowadays, more general dentists are involved in the treatment and care of patients with dental implants. It is essential for them to be trained to promote peri-implant health, be able to recognize signs of peri-implant disease and to select proper treatment and maintenance modality to their patients. The objective of this review is to help the general dentist recognize the importance of peri-implant maintenance treatment (PIMT) and to be able to implement implant supportive therapy within their scope of practice.

Keywords: *Dental Implants; Peri-Implantitis; Peri-Implant Mucositis; Supportive Implant Therapy, Radiographic Examination; Maintenance Program*

Abbreviations

PIMT: Peri-implant Maintenance Treatment; PI: Peri-implantitis; BOP: Bleeding on Probing; PD: Probing Depth; PIM: Peri-implant Mucositis; DM: Diabetes Mellites; SPT: Supportive Periodontal Therapy

Introduction

The number of dental implants treatment per year is rising, with more implants being placed, restored and followed up in the general dentist offices. There is an increasing need to understand how peri-implant health can be promoted and maintained throughout the treatment process. Implant's complication, whether due to mechanical or biological factors, are becoming more apparent as increased demands on implants treatment and longer-term care are required. However, evidence from the dental literature is focused on the treatment and management of peri-implant disease, while literature discussing prevention of the disease is scarce. A recent systematic review has concluded that implant therapy should not end at the delivery of the prosthesis and should extend to include peri-implant maintenance treatment (PIMT) [1]. Unfortunately, Specific guidelines on how frequently dental implants need to be followed-up, and what data need to be collected at each follow-up visit to detect early signs of disease are inadequate [2]. Since most of the information is extracted from the periodontal literature on maintaining teeth, confusion exists on the interpretation of indices used to detect early signs of peri-implant disease and what instruments can or should be used around dental implants to be able to maintain health or detect disease?

Aim of the Study

This article aims to introduce the basic principles in implant maintenance and summarizes the best available evidence on what is required to maintain peri-implant health in the scope of general dentist practice.

Definition and Prevalence: The extent of the problem

Peri-implantitis (PI) is defined as an inflammatory lesion that causes crestal bone loss around a successfully integrated dental implant and is manifested as soft tissue erythema, bleeding on probing (BOP), increased probing depth (PD) and suppuration [3]. An important diagnostic feature is the presence of radiographic evidence of bone loss since the implant is restored that exceeds expected normal bone remodeling during the first year of function. The 2017 world workshop on the classification of periodontal and peri-implant disease specified that progressive bone loss exceeding the initial bone remodeling expected during the first year of function or bone levels > 3 mm apical to the most coronal portion of the intraosseous part of the implant are indicative of PI [4].

Peri-implant mucositis (PIM), on the other hand, is a soft tissue inflammatory lesion that affects the peri-implant tissue without involving the surrounding bone [5]. The main clinical feature of PIM is the presence of bleeding on gentle probing, in addition, peri-implant soft tissue shows signs of inflammation and/or suppuration [4]. Clinical criteria for peri-implant tissue health and disease based on 2017 world workshop on the classification of periodontal and peri-implant disease are reviewed in table 1.

	Peri-implant health	Peri-implant mucositis	Peri-implantitis
Soft tissue	No inflammation Pink, firm tissue and no swelling	Signs of inflammation: Localized swelling, erythema, and soft, friable tissue Tenderness localized to the area	Signs of peri-implant tissue inflammation: swelling, erythema, and soft friable tissue
Bleeding on probing	-	++	++
Suppuration	-	+	+
Probing depth	Stable PD Similar to measurement taken at baseline	Maybe increased due to soft tissue condition	Increased PD compared to the measurement taken at baseline Or In the absence of baseline measurement PD ≥ 6 mm
Radiographic bone loss	Absence of bone loss following initial remolding (< 2 mm)	Absence of bone loss following initial remolding (< 2 mm).	Progressive bone loss as compared to baseline radiograph Or In the absence of baseline radiograph Bone level ≥ 3 mm apical to the coronal portion of the intraosseous implant part.

Table 1: *Clinical criteria for peri-implant tissue health and disease based on 2017 world workshop on the classification of periodontal and peri-implant disease.*

The prevalence of peri-implant mucositis and peri-implantitis varies between studies but ranges from 19% to 65% for PIM and from 1% to 47% for PI [6-8]. The wide variability of the reported results is due to a lack of consensus on the diagnostic criteria of PI disease, differences on case definition, and disagreement on what is considered an acceptable crestal bone remolding. Nevertheless, it was recognized from early on that PI disease shares many features of chronic periodontal disease with biofilm accumulation acting as the primary etiological factor [7,9].

Prevention of peri-implant disease

Risk factors for peri-implant disease

Careful case selection is the first step in ensuring a successful implant treatment. Identification of risk factors or complications associated with peri-implant disease is a critical step before proceeding with implant treatment. Patient education and involvement in the treatment are mandatory as the control of those risk factors is a long-term commitment. Many patients who need dental implants suffer from tooth loss due to dental/periodontal disease. Previous history of periodontal disease has been strongly associated with future peri-implant disease [10,11]. In fact, many studies identify poor oral hygiene, history of periodontal disease and cigarettes smoking as the three top risk indicators for PI disease [12,13]. Roccuzo., *et al.* followed up 112 subjects who received implant treatment for ten years. Subjects were classified according to their periodontal disease status into healthy periodontium, moderate periodontal disease or severe periodontal disease. All subjects received an individualized supportive therapy during the follow-up period. Results showed that subjects with moderate to severe periodontal disease has significantly more sites with > 3 mm bone loss, more implants with deeper than 6 mm probing depth and higher bone loss at implants sites than subjects with healthy periodontium [14]. Stability of periodontal condition also plays a vital role as treated periodontal disease subjects who had at least one probing depth ≥ 5 mm after completion of periodontal therapy and who received implant treatment were found to have deeper probing depth and more bone loss around the implants compared to subjects who did not have any sites with probing depth ≥ 5 mm at the completion of periodontal therapy. Moreover, treated subjects who did not have any PD > 5 mm were found to have a similar clinical measurement to periodontally healthy subjects [15]. Evaluation of patient commitment to long-term maintenance program is critical as it does ensure not only the control of periodontal disease but also maintenance of oral health in general [16].

Many other risk factors have been identified in the dental literature. In general, risk factors are divided into systemic factors and local factors. Systemic factors are concerned with the general health of the patients. Uncontrolled systemic disease like diabetes mellites (DM) has negative effects on wound healing in addition to the long-term effect on the periodontal condition. A recent metal analysis identified a positive relationship between DM and PI as diabetic patients were two times more likely to have PI [17]. Medication that affects bone metabolism could affect the long-term stability of dental implants. In subjects with parafunctional habits and bruxism, consideration of occlusal factors in the treatment plan is essential for the future prevention of complication and habits, all of which need to be addressed prior to implant treatment [18]. The evidence is inconclusive as to whether smoking is a risk factor for PI. However, a recent meta-analysis found 2-fold higher risk for smokers to develop a peri-implantitis when compared to non-smokers [17].

Local factors include the quality and quantity of soft tissue and hard tissue in the future implant site. Having an adequate amount of keratinized tissue (> 2 mm) surrounding the dental implant has shown to help maintain better oral hygiene [19]. Accurate three-dimensional positioning of the implant, allowing appropriate restorative treatment, also needs to be considered to avoid future mechanical problems of the restoration, permits the removal of excess cement, and to ensure access to oral hygiene and care around the future restoration [20]. Meticulous attention to surgical techniques and avoidance of surgical trauma that may potentially lead to subsequent bone or soft tissue loss is important in preventing future complications, not only during the early healing period but also during subsequent years [3]. Figure 1 shows soft tissue inflammation and loss with exposure of the implant surface as a result of improper implant position.

Figure 1: *Improper implant position leading to PI. photo is courtesy of Dr. T. Irinakis.*

Deryer., *et al.* 2018 identified 99 putative risk factors for PI in the literature. However, for many of them, further research is needed to confirm their role [17]. For a comprehensive review of the risk factors, Heitz-Mayfield, 2018 and Schwarz, 2018 provide an updated review of the peri-implant disease risk factors [5,21]. Table 2 provides a summary of PI risk factors.

Strong evidence	Potential risks indicators	Limited evidence
History of periodontal disease	Smoking	Residual cement
Poor oral hygiene	Diabetes mellites	Lack of peri-implant keratinized tissue
Lack of implant supportive therapy		Implant position and supra- structure design
		Systemic conditions

***Table 2**: Risk factors for peri-implantitis.*

The importance of PIMT

It is well agreed on that after completion of periodontal therapy; the patient needs to be on a carefully designed maintenance program tailored to their condition. And from the periodontal literature, the patients who do not adhere to their recommended maintenance program experience the recurrence of the periodontal disease [22]. Peri-implant disease shares many features similar to periodontal diseases such as bacterial plaque accumulation, which is the primary trigger for inflammation around teeth and implants. Often, PI is compared to periodontal disease, and PIM resembles gingivitis. However, inflammation was found to be more pronounced in PI disease with a higher concentration of inflammatory cytokines around dental implants when compared with teeth despite similar clinical indices [23]. As with periodontal disease, PIM is considered a precursor to the development of PI, and although it takes longer to resolve, it considered a reversible condition [22,24].

Evidence suggests that subjects who are not on a regular maintenance program have a higher incidence of implant failure and bone loss > 3 mm [14,25,26]. Data from a retrospective study suggests the lack of compliance with the recommend supportive therapy after being diagnosed with PIM resulted in a 43% incidence of PI after five years follow up. Only 18% of those who were compliant with the PIMT had PI after five years [27]. A recent meta analysis concluded that the prevalence of PI was 18% in subjects without a regular maintenance program compared to 9% in participants of a regular program. In addition, the lack of effective PI treatment method highlights the importance of its prevention and the control of PIM before it progresses into PI [28].

The aim of PIMT should be directed towards maintaining tissue health by controlling biofilm accumulation around implants and teeth and therefore controlling the disease. It should permit the detection of the initial signs of PI disease and early intervention and treatment.

Timing and frequency of implant follow-up examination:

Although there is no clear evidence available to suggest the optimal frequency of implant recall and supportive therapy visits [13], clinical evidence advocates implant maintenance follow up should be scheduled once the final restoration is delivered i.e. in the first follow up which is approximately 2 - 4 weeks after the implant-supported prosthesis insertion. In that appointment, the patient's oral hygiene should be reviewed, and adequate access to cleaning around the implant is assessed. Clinical gingival health is evaluated, and a baseline per-implant probing depth is recorded at this visit [29].

After 6-month from restoration insertion, a complete periodontal and peri-implant recall examination is recommended [29]. Supportive Periodontal Therapy (SPT) should be scheduled according to the patient's periodontal condition. Hence, a previous history of periodontal disease, a three-month PIMT is recommended. Otherwise, five to six-month PIMT is advisable [1,30].

At the one-year recall examination, a complete periodontal-peri-implant recall examination is recommended, as well as a radiographic assessment and adjustment of the PIMT frequency as patient condition requires. A yearly follow-up examination is recommended thereafter.

Examination of the dental implant during PIMT

The complete examination of dental implants includes some general steps included in the examination of natural dentition. Evaluation of the patient's oral hygiene and plaque control are essential to determine the etiology of the disease. In addition, it is essential to evaluate the following clinical parameters:

Appearance of peri-implant soft tissue

The implant should be surrounded by healthy looking tissue. The peri-implant tissue should be firm, resilient, free of inflammation and should not bleed on gentle periodontal probing [3]. Although keratinized tissue itself does not directly affect implant success, an adequate amount of keratinized tissue is essential for the ability to maintain adequate level of oral hygiene [19,31]. The position of the soft tissue margin in relation to the implant crown has to be adequately related to that of adjacent teeth, especially in aesthetically demanding areas. The color of the tissue should mimic that of adjacent teeth. However, if the tissue is thin, blue color of the metal body of the implant can shine through the tissue [32]. Soft tissue changes in peri -implant disease are identified in figure 2.

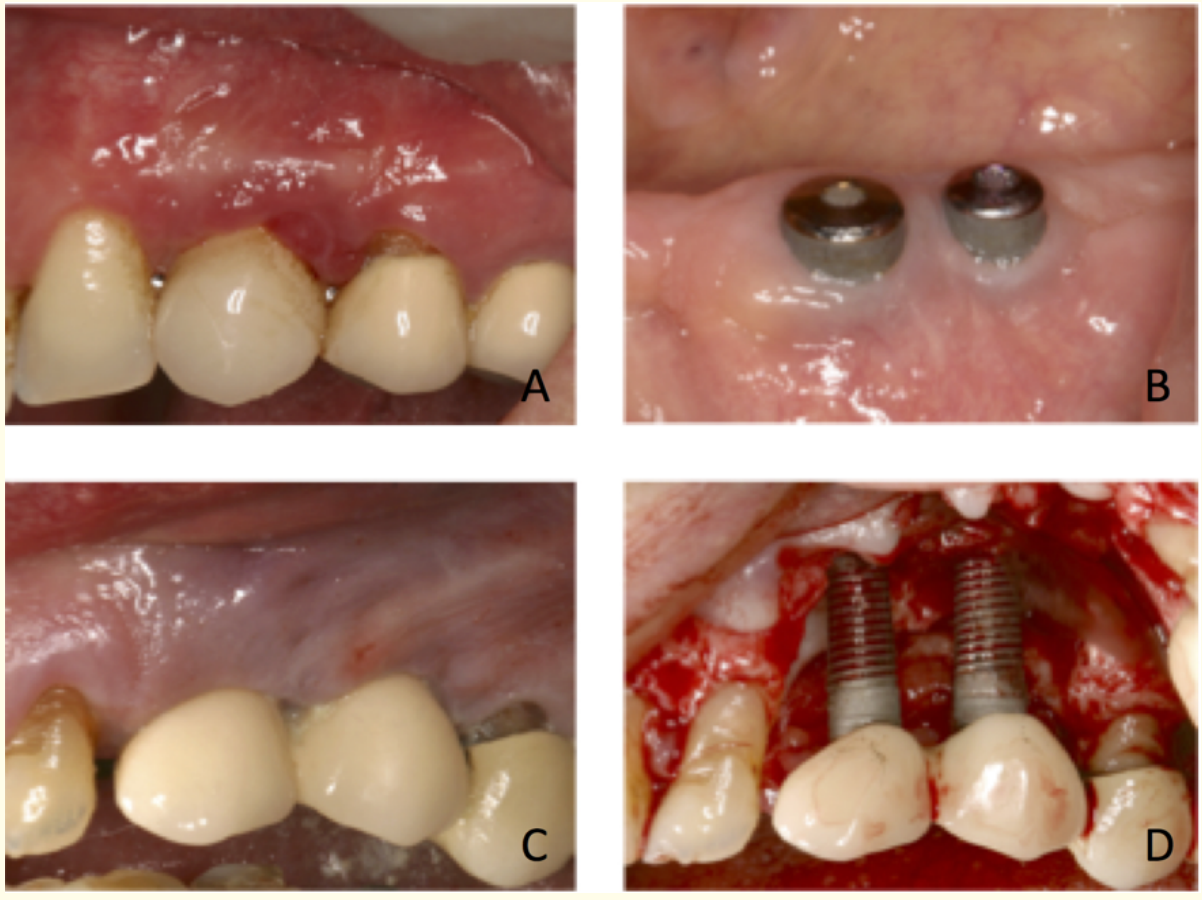

Figure 2: *A. soft tissue inflammation and erythema are highly indicative of peri-implant tissue disease. B. lack of keratinized tissue may complicate oral hygiene and leads to inflammation and exposure of the implant surface. C. significant soft tissue cyanosis around the implant in the cuspid and bicuspid position. D. following the flap reflection of the implants in C. note the sever bone loss almost involving the entire length of the implants. photos are courtesy of Dr. T. Irinakis.*

Probing depth (PD)

Determination of probing depth is essential to both determining the health of tissue and monitoring the progress of the disease. Probing depth should be recorded at six sites around the implant similar to that of teeth [22]. Initially, there was a concern from the dental community that the use of a metal periodontal probe around dental implants might break the epithelial attachment causing permeant damage to the soft tissue adhesion around the implant. However, the consensus now is that conventional probing around dental implants does not damage the implant surface or the soft tissue attachment [22]. Epithelium around implants has been shown to heal within five days after probing providing a light force was used [33]. A force of 0.25N which is similar to that used around teeth is recommended [3]. Similar to teeth, probing depth should be parallel to the implant body (not to the restoration). Obtaining accurate measurement around dental implants is more challenging compared to teeth. Very often the superstructure of the restoration is bulky and interferes with the insertion of the periodontal probe. The use of a plastic probe in this situation may offer an advantage of being flexible and therefore, easier to navigate around the superstructure; however, the metal periodontal probe is still considered the standard for probing around dental implants [32].

Errors in probing around dental implants are much higher than around teeth. To maintain the reproducibility of the measurement, a fixed reference point has to be used and the probing angulation should be kept constant throughout different follow up examinations [34]. Probing depth and its indication of the disease has to be carefully interpreted. Around teeth a cut of 5 mm is usually considered a sign of the disease [22], however around implants, probing depth of 5mm could be a normal value especially in situations where the implant head is deeply located subgingivally for esthetic reasons or in cases of over contoured restoration [35]. The thickness of mucosal tissue around the implants especially in partially edentulous situations could also affect PD measurement. Histological studies have shown the probe tip penetrates the soft tissue to reach close to alveolar crest when probing around dental implant [36]. In fact, many healthy implants were found to exhibit > 4 mm of probing depth even after long-term function [35]. Therefore, In evaluating peri-implant tissue health, It is more important to detect changes in the probing depth over time rather than having fixed value to provide an induction of disease [34].

Bleeding on probing (BOP) and suppuration

Bleeding on gentle probing is an indication of inflammatory changes in the soft tissue [37] and is often the first signs of disease. Research indicated that BOP around implants is a significant predictor of the development of the peri-implant disease [7,32,38,39]. Luterbacher., *et al.* evaluated the prognostic value of BOP on implant and teeth and reported that BOP has a higher diagnostic value for disease progression around implant than teeth and absence of BOP is an indication of tissue health [40]. The consensus of the 7th European workshop on periodontology used bleeding on gentle probing as the key parameter for the indication of peri-implant mucositis [3]. Suppuration in the tissue can be an indication of active bone loss and progressive disease [38].

Implant mobility

Mobility can be assessed either manually or through the use of resonance frequency. It is imperative to differentiate between implant mobility and the mobility of the implant restoration. Implant mobility is an indication of loss of integration and a sign of implant failure [41].

Radiographic features of healthy implant tissue

Radiographic examination is an integral part of implant maintenance and follow-up. It is essential to detect and follow the progression of the disease. However, radiographs need to be of good quality and consistent angulation to allow mentoring of peri-implant tissue health.

Type and Quality of radiographs

Ideally, a periapical radiograph showing the entire length of the implant and the periapical area is required. It should be taken parallel to the long access of the implant which is often hard to achieve because of the restoration. Nevertheless, the radiograph should not be

angled more than 15 degrees to be able to show clear and sharp threads on both sides of the implant and the abutment/implant interface [42].

Timing of the radiographic examination

The first baseline radiograph after implant osseointegration is taken at the time of final prosthesis insertion [4,41]. It is used to confirm adequate restoration seating and provides a baseline for the future peri-implant bone level. Although there is not an accepted protocol regarding how frequent radiograph examination should be performed, it is expected that crestal bone remolding takes place during the first year of function. An amount of 1.5 - 2 mm of crestal bone loss is accepted as a normal change [43]. Therefore, taking a radiograph at the first year recall appointment is needed to evaluate the crestal bone level and is considered a baseline for future comparisons [3]. Subsequently, a radiograph is taken when there are clinical signs of peri-implant disease or there is a suspicion that the implant might be losing osseous support [3]. In the absence of clinical disease, the radiograph should be retaken once every two years subsequently [29].

Implant supportive therapy

Plaque control, Oral hygiene and Instrumentation

Since biofilm accumulation around implants has been proven to trigger inflammation and peri-implant disease, the aim of PIMT should be directed towards the elimination of biofilm build up. The clinician should dedicate time to ensure that oral hygiene methods are delivered appropriately, and the patient understands the importance and is cable of performing adequate hygiene around implant and teeth. Manual and electrical toothbrushes are both equally effective as mechanical plaque removal aids and no superiority of one over the other is found [44,45]. Hygiene tools to clean interdental areas such as interproximal brushes are available in the market, and the dentist should recommend the largest size that can fit the interdental space. Also, the use of dental tape to clean interproximal areas and under the pontic should be encouraged. A recent report suggests the presence of the remnant of dental floss after submucosal cleaning of dental implants using dental floss and has warned against the use of floss around implants [46]. However, this recommendation was based on a report of ten patients only. All of the patients were having progressive peri-implantitis and with exposed rough implant surface and therefore, the results should not be generalized. Additionally, self- reported irrigation using an antiseptic mouthwash has shown to be effective in maintaining tissue health [47]. The use of chlorhexidine gel on the other hand, was not more effective than placebo gel in reducing clinical signs of inflammation after mechanical debridement [47]. Evidence strongly proves that mechanical plaque control is adequate to maintain peri-implant health through the disruption of the biofilm [44]. Patients who are having implant supported removal prosthesis should be instructed to clean their prosthesis twice daily with a soft toothbrush and should also be advised to remove the prosthesis at night and store it in a prescribed cleansing solution [29].

Many specially designed instruments have been developed to achieve effective mechanical debridement of dental implants. The use of standard metal scalers that are used in root planning results in damage to the implant surface and increases plaque retention and therefore should be avoided [48]. Plastic scalars first were introduced, as to avoid scratching or damaging the implant's surface. Those instruments might be useful in gentle de-plaquing as they lack rigidity and sharpness needed to remove hard deposits [48]. Other instruments made of pure titanium or ceramic head had been suggested to replace the plastic scalers. Moreover, ultrasonic devices with plastic or Teflon covered tips are found effective to disturb plaque biofilm [49].

Recently, the use of glycine powder and air polish has been recommended to removed biofilm around teeth and implants. Perio-Flow® utilizes glycine powder mixed with water to disturb the biofilm [50]. The mixture is introduced to the periodontal/ peri-implant pocket by a small plastic disposable nozzle. More evidence is needed regarding the effectiveness of this method on the long term, however, its short-term effectiveness seems to be promising [51,52].

In addition to the biological maintenance, mechanical maintenance of the prosthesis should be performed. This includes the adjustment, repair, and replacement, of any or all parts of the prosthesis and prosthetic components that could impair the patient's optimal function. The American college of prosthodontist (ACP) also advises the use of a new prosthetic screw whenever an implant-borne prosthesis is removed [29].

Evidence suggests that Peri-implant mucositis is a reversible condition [5]. If it's not controlled, mucositis often progresses into peri-implantitis with the associated bone loss and implant surface exposure. Many modern implants have a rough surface with each having a unique surface topography. Although rough surfaces have an advantage of enhancing osteointegration, it can be challenging to debride and decontaminate once bacterial biofilm accumulates on it. Scientific evidence on the effectiveness of non-surgical and surgical methods for treatment of peri-implantitis is limited [53]. However, the predictability of successful treatment is increased with early diagnosis and when intervention is not delayed [54]. Therefore, a referral to a specialist for further treatment should be done once signs of peri-implantitis are detected.

Conclusions

A structured implant maintenance program is necessary for the long-term success of dental implants. Without it, the risk of implant complications and loss is increased. The focus of this review was to help the general dentist recognize the importance of PIMT and to be able to implement implant supportive therapy within their scope of practice. As with periodontal supportive therapy, PIMT focuses on the prevention of the disease by reviewing relevant medical and dental history and identifying risk factors for PI. A detailed clinical and radiographic examination is required to reach a diagnosis of peri-implant health, PIM, or PI. Based on this the frequency of the PIMT is determined and adjusted to the patient condition. Also, the necessity to refer for advance treatment is determined. Each visit should include an assessment and review of self-administered plaque control, and mechanical biofilm removal is done. Figure 3 summarises the steps followed during the PIMT visit. The treatment of peri-implantitis is beyond the scope of this review and was not discussed. Nevertheless, it is essential to recognize that the first step in the treatment of PI is eliminating bacterial biofilm from the surface of the implant by providing implant supportive therapy.

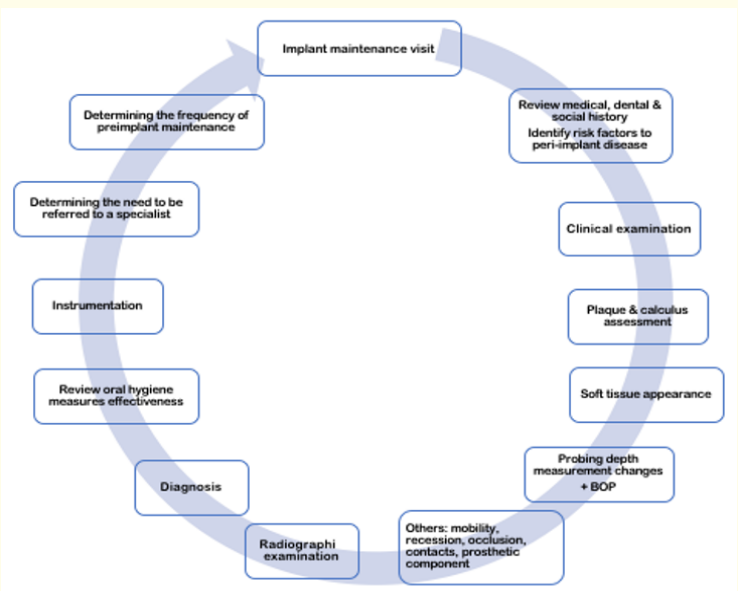

Figure 3: *PIMT starts by reviewing relevant medical and dental history and identifying risk factors for PI. A detailed clinical and radiographic examination is required to evaluate the peri-implant soft tissue condition, PD, BOP, and radiographic bone level. Comparing current and previous records help to detect stability of clinical condition. Using that information, a diagnosis of peri-implant health, PIM, or PI is reached. The frequency of the PIMT is determined and adjusted to the patient's condition. Also, the necessity to refer for advance treatment is determined. Each visit should include assessment and review of self-administered plaque control and professional mechanical biofilm removal.*

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Conflicts of Interest

The author declares no conflict of interest.

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