Chapter

The Dental Implant Maintenance

Gayathri Krishnamoorthy, Aparna I. Narayana and Dhanasekar Balakrishnan

Abstract

As dental implant treatment has become a part of mainstream dental therapy, it is imperative to implement dental implant maintenance guidelines to achieve the long-term success of implant prostheses. Earlier, the success of a dental implant was mainly focused on the surgical phase to achieve good primary stability, with time, this belief has taken a major paradigm shift towards implementing and ensuring a periodic recall and following a maintenance phase for dental implants to achieve long-term success. As the dental team strives to attain and maintain the long-term success of implant prostheses, the patient should also recognize that their contribution towards the success of implant prostheses is also equally indispensable. This chapter highlights the importance of maintaining oral hygiene in implant rehabilitated patients and enumerates the implant maintenance protocol to be followed along with the different in-home and in-office procedures which can be implemented to achieve long-term success of the implant and peri-implant structures.

Keywords: dental implants, oral hygiene, maintenance phase, implant survival, oral health

1. Introduction

The dental implant market value globally is expected to increase at a Compound Annual Growth Rate (CAGR) of 11% from 2021 to 2028 [1]. This increase in demand for dental implant market size could be attributed to the numerous applications of implants along with the patient acceptance for implant prostheses. Despite the multitude of advancements made in surgical and technical fields of implant dentistry, the complications faced are still too high [2]. In an observational study that was conducted to evaluate the patient's perception towards implant treatment and maintenance, it was concluded that most people were made aware of the importance of implant oral hygiene measurements and recall, however, the knowledge about implant-related complications and failures was dissatisfying. Although the patients were instructed about the importance of maintaining oral hygiene around implants, only 40.4% had reported having tried cleaning tools for maintenance [3].

We must acknowledge that implant placement requires a multidisciplinary treatment approach wherein a Maxillofacial surgeon, Prosthodontist, Periodontist, Oral Radiologist, Dental Hygienist, and the patient must work as a team to achieve

long-term implant success. Hence, patients are considered as co-therapists in maintaining and achieving long-term implant success [4].

As the ideology of long-term implant success has taken a paradigm shift from attaining primary stability to implementing and ensuring periodic recall and maintenance, it is the responsibility of the dental team to convey the importance of oral hygiene maintenance and regular recall visits to the patients which can help them achieve long-term maintenance health of implant and the peri-implant structures.

Although there is scarce information available in the literature about dental implant maintenance protocols, in this chapter, we intend to compile in toto a detailed description of the various parameters which need to be examined and the measures to be implemented for achieving long-term implant success.

2. Risk factors that contribute to implant failures

The success of a dental implant depends primarily on the level of marginal bone loss, absence of mucosal inflammation, and probing depth. Risk factors that undermine the above criteria for long-term implant success should be explained to the patient and a comprehensive treatment plan must be presented to them. This comprehensive treatment plan must include all recommended dental therapy, possible alternative treatment options, the clinical risk which can be faced during the surgery, and the cost of the treatment. This discussion between the practitioner and the patient will help the patient understand why and how the procedure will be carried out.

Patient-specific risk assessment should include an extensive examination of the candidate and detailed medical and dental history. This will help the practitioner weigh the pre-operative and post-operative risks with implant placement. It is ideal and recommended to classify the implant patients according to their medical condition and associated co-morbidities using the American Society of Anesthesiologists Physical Status Classification System (ASA PS Classification) and co-relate their ASA PS status with the Type of dental treatment (**Table 1**) and their associated risk type (**Table 2**).

Sr. no	Dental treatment	Procedures
1.	Type 1 [5]	Examinations, radiographs, study model impressions, oral hygiene instruction, supra-gingival prophylaxis, simple restorative dentistry
2.	Type 2 [5]	Scaling, root planning, endodontics, simple extractions, curettage, simple gingivectomy, advanced restorative procedures, simple implants(endodontic root forms)
3.	Type 3 [5]	Multiple extractions, gingivectomy, quadrant periosteal reflections, impacted extractions, apicoectomy, plate form implants, multiple root form implants, ridge augmentation, subantral augmentation, unilateral subperiosteal implants
4.	Type 4 [5]	Full arch implants, ramus frame implants, full-arch endosteal implants, orthognathic surgery, autogenous bone augmentation, bilateral subantral augmentation

Table 1.
Type of dental treatments.

ASA PS status	Description	Type of dental treatment				Risk of implant placement
		Type 1	Type 2	Type 3	Type 4	
ASA II [6]	A patient with mild systemic disease who has no functional limitations and well-controlled disease, whose BMI is under 35, is a social drinker or smokes cigarettes, or has well-controlled hypertension	+	Sedation and Stress reduction protocol	IV sedation and stress reduction protocol		Mild
ASA III [6]	A patient with severe systemic disease that is not life-threatening and includes functional limitations caused by the disease, poorly treated hypertension or diabetes, renal failure, morbid obesity, stable angina, or pacemaker.	+	IV sedation Stress reduction protocol Physician	Hospitalization		Moderate
ASA IV [6]	A patient with severe systemic disease that is a constant threat to life that includes functional limitations as a result of severe systemic disease, unstable angina, poorly controlled COPD, symptomatic CHF, recent MI, or stroke less than 3 months prior	+	Postpone all elective surgeries			Severe

Table 2.
Inter-relationship between ASA PS classification, type of dental treatment, and risk of implant placement.

3. Diagnostic parameters to evaluate during implant maintenance protocol

The success of any dental prosthesis begins with its maintenance and recall phase. Similarly, after the implants have been placed in the edentulous region, routine recall, evaluation, radiographs, and maintenance are necessary to achieve its long-term success. It is, therefore, the responsibility of the dental team to understand the etiology, provide appropriate preventive treatment and be well-versed with the maintenance protocol which should be performed at regular intervals that will assist the patient to maintain implant health.

The implant maintenance protocol consists of two phases:

3.1 Phase 1: assessment phase

The dentist will assess the patient's medical condition, analyze the risk factor/s which may pose as an etiology for the implant failure (**Table 3**). Along with the medical condition, the dental history of the patient should also be evaluated as it may provide us with information about the patient's oral hygiene and peri-implant status. It has been documented in multiple studies [37–39] that edentulous patients with high plaque scores before implant placement had experienced more implant failures than those with lower plaque scores. Furthermore, it has also been proven that patients treated for their periodontal conditions are more likely to experience

Sr. no	Systemic risk factors	Influence on implant placement	Contra-indication	References
1.	Neuropsychiatric disorders: Epilepsy, schizophrenia, dementia, Parkinson's disease, Alzheimer's disease, Huntington's disease	a. Difficult to maintain oral hygiene predisposing them to periodontal and soft tissue problems b. Accidental swallow of dental instruments c. Difficult to understand the procedure, follow medical instructions, and provide consent d. Alzheimer's disease has shown an association with peri-implantitis [8].	Absolute	[7, 8]
2.	Recent myocardial infarction or cerebrovascular accident	Can trigger post-ischemia complications like cardiogenic shock, myocardial rupture, pericarditis, or chronic ischemic heart disease as observed in 75% of previous myocardial infarction affected patients.	Absolute	[9, 10]
3.	Valvular prosthesis placement	Can cause prosthetic valve endocarditis as observed in 1–3% of patients	Absolute	[9, 11]
4.	Bleeding disorders and patients under anticoagulants for cardiovascular disorders.	a. Can trigger mild thrombocytopenia which may produce abnormal post-operative bleeding b. Major post-surgical bleeding, spontaneous bleeding of the mucous membrane.	Absolute	[9, 12]
5.	Cancer and chemotherapy	a. May affect osseointegration due to bone vascularity reduction and cause dental implant failure. b. Chemotherapy found to jeopardize bone metabolism. c. Intensive chemotherapy can cause lower bone mineral density and a high risk of bone fracture.	Absolute	[7, 13–15]
6.	Respiratory disease	a. Can cause airway hyperresponsiveness b. Can perpetuate asthma if the dental implant surgery is done in a supine position. c. Local anesthetic to be used cautiously in patients with COPD. d. Vasoconstrictors are an absolute contraindication for COPD patients.	Relative	[7, 16–18]
7.	Liver disorder: decompensated hepatic disorder, cystic fibrosis, liver cirrhosis	a. May cause reduced or trouble in producing coagulation factors. b. Due to reduced platelet count can result in uncontrollable hemorrhage in the surgical site. c. Can result in portal hypertension due to hepatic fibrosis during the surgery	Relative	[7, 19]

Sr. no	Systemic risk factors	Influence on implant placement	Contra-indication	References
8.	Endocrine disorders: diabetes mellitus, thyroid disorders, parathyroid disorders, other hormonal disorders.	a. Delayed wound healing, repressed bone formation, and enhanced bone resorption may be seen around implants in diabetic patients. b. Thyroid storm can be induced due to emotional stress, trauma, and infection in hyperthyroidism patients. c. Patients with hypothyroidism may have abnormal bone metabolism which may increase the risk of implant failure. d. Women going through menopause have a higher incidence of periodontitis and osteoporotic alveolar bone which may lead to delayed healing and difficult to achieve success in dental implantation.	Relative	[7, 20, 21]
9.	Immunosuppression	Several case report studies suggest no relationship between HIV and implant failure. It has been proven safe to place implants in patients with controlled HIV	Relative	[22–25]
10.	Osteoporosis	a. No scientific evidence confirms contraindication or implant failure in patients with primary osteoporosis b. In secondary osteoporosis due to accompanying illness or systemic conditions chances of implant failure is more	Relative	[26]
11.	Smoking	a. Increase of implant failure rate 2.5 times more in smokers compared to non-smokers b. In maxilla the chances of implant failure have been reported to be 18% in smokers as compared to 7% in non-smokers c. Smoking cessation before implant placement appears to improve results	Relative	[27, 28]
12.	Age	Many studies have concluded that age is not a significant factor for implant failure unless associated with a systemic disease that may result in bone loss	Relative	[29]
13.	Interleukin-1 genotype	a. No studies to support co-relation between implant failure and IL-1 genotype b. However, a synergistic effect is present between smoking and IL-1 genotype c. Odds ratio of tooth loss increased to 7.7% when smoking and IL-1 genotype is present as opposed to 2.9% when only smoking is present	Relative	[29]

Sr. no	Systemic risk factors	Influence on implant placement	Contra-indication	References
14.	Medications: bisphosphonates	a. Increased risk of developing osteoradionecrosis of the jaw known as Bisphosphonate-related osteoradionecrosis of the jaw (BRONJ) b. Oral bisphosphonates have been associated with an increased risk of implant failure	Absolute	[30–32]
	Anticancer drugs	May cause bone marrow toxicity, immunosuppression which may result in infection, hemorrhage, mucositis, and pain.	Absolute	[9]
	Anticoagulants	a. Chances of experiencing post-operative bleeding problems have been seen only in patients who take high doses of anticoagulants. b. Risk of developing uncontrolled bleeding or life-threatening bleeding is very low. c. Discontinuing anticoagulant therapy before implant placement may also account for increased probability of thromboembolic events	Relative	[33–36]

Table 3.
Lists the different systemic conditions that can pose as a risk factor for implant placement.

implant complications compared to non-periodontal treated patients [40–42]. Hence, to achieve long-term implant survival and success, patients with a previous history of aggressive periodontitis must undergo Supportive Periodontal Therapy (SPT) and diligently follow the regular maintenance phase and recall visits.

A typical maintenance phase should last for 1 h and should be scheduled every 3 months. The following are the parameters that are evaluated during the assessment phase of the implant maintenance protocol.

3.1.1 Peri-implant diagnostic parameters

The diagnostic parameters used to evaluate and monitor oral implants during the maintenance phase should have high specificity and sensitivity. We shall discuss the various peri-implant diagnostic parameters with modified dental indices that will be used during the assessment phase.

3.1.1.1 Plaque and mucosal assessment

Mombelli et al. [43] and Apse et al. [44] modified the plaque and mucosal assessment indices for peri-implant marginal mucosa and plaque evaluation (**Table 4**).

3.1.1.2 Peri-implant bleeding on probing

Similar to natural teeth conditions, the absence of bleeding on probing around peri-implant mucosa suggests a healthy implant soft tissue. In a study conducted by Lang et al. [45], it was concluded that healthy peri-implant sites were characterized

Score	Peri-implant plaque assessment index	Peri-implant marginal mucosa index
	Mombelli et al. [43]	**Apse et al. [44]**
0	No plaque detected	Normal mucosa
1	Plaque is detected only when a probe is run through the smooth marginal surface of the implant	Minimal inflammation and mucosa color change present with mild edema
2	Plaque can be seen by the naked eye	Moderate inflammation with redness, edema, and glazing
3	Abundance of soft matter detected	Severe inflammation with redness, edema, ulceration, and spontaneous bleeding without probing

Table 4.
Peri-implant plaque and mucosal indices.

by absence of bleeding on probing i.e. 0% whereas peri-implant mucositis reported 67% and peri-implantitis reported 91% of bleeding on probing. To avoid false-positive readings for bleeding on probing, Gerber et al. have recommended a minimum pressure of 0.15 N to be applied during the examination [46].

3.1.1.3 Peri-implant probing depth

Probing is an important and realistic diagnostic indicator for monitoring the peri-implant tissues. The probing force required is around 0.2–0.3 N [47] and should always be measured using a periodontal probe from the mid-aspect of the mesiobuccal, buccal, distobuccal, mesiolingual, lingual, and distolingual surfaces of the implant. Probing depth for an implant having a supraosseous platform with healthy mucosa is around 2–4 mm [48]. If the implant had been placed infrosseoulsy the probing depth may be slightly higher. However, an increase in clinical probing depth associated with bleeding on probing should be viewed as signs of peri-implant disease.

3.1.1.4 Width of peri-implant keratinized mucosa

The influence of keratinized tissue around implants is still a controversial issue as there is no consensus in literature regarding the long-term success of implants and the presence or absence of keratinized tissue. However, numerous studies have been conducted which revealed a relationship between lack of keratinized tissue and plaque accumulation [49–52], bone loss [49, 53], increase in soft-tissue recession [51, 52, 54], bleeding on probing [50–53], and greater gingival inflammation [50–53].

3.1.1.5 Peri-implant sulcus fluid analysis (PISF)

PISF has a substantial amount of biochemical mediators which act as a non – invasive host marker for identifying underlying peri-implant diseases. There have been studies conducted which show a positive correlation with PISF and plaque accumulation [55], degree of peri-implant soft tissue inflammation [55], and also the amount of bone resorption [56].

3.1.1.6 Suppuration

Suppuration is a confirmatory indicator of the disease activity and hence immediate anti-infective therapy is recommended [57].

3.1.2 Evaluation of food impaction around implants

Food impaction is one of the most common risk factors for developing peri-implant diseases [58]. Food impaction around implants can cause bleeding, edema, inflammation, halitosis, bone loss, pocket formation, implant mobility, and finally implant failure. The following is a classification for food impaction given by Chopra et al. [59] which will help us diagnose the cause for food impaction.

Class I: Food impaction present between either an implant supporting crown/fixed dental prosthesis (FDP) and the adjacent natural tooth.

Class II: Food impaction present between either an implant supporting a single crown/FDP and a tooth with caries/faulty restoration/crown/FPD.

Class III: Food impaction present between two adjacent implants with either a single crown/FDP.

Class IV: Food impaction below the pontic of an implant with FDP.

Class V: Food impaction around implant-supported/retained dentures.

Class I–Class V has additional sub-categories based on the etiology of food lodgement [59].

3.1.3 Evaluation of implant mobility

Test for implant mobility is a primary factor for identifying the longevity of implant health. Implant mobility can be tested either by the conventional method or by using automated devices. The conventional method uses two rigid instruments that apply a labiolingual force of 500 g around the implant fixture to test its rigidity. The automated devices currently in use are Periotest and a non-invasive device that works on the principles based on Resonance Frequency Analysis (RFA).

The amplitude of implant mobility can be assessed using the Implant mobility scale given by Misch [60] (**Table 5**).

3.1.4 Occlusal evaluation

Occlusal evaluation must be done at regular intervals. Any deflective or premature contacts that may cause loosening or fracture of abutment screws, implant, or prosthetic failure must be evaluated and corrected. Parafunctional habits if present must be documented and treated accordingly as they may cause rapid bone loss [47].

3.1.5 Crestal bone loss and radiographic evaluation

Loss of crestal bone is a significant indicator of any ongoing peri-implant disease. After the prosthesis delivery, crestal bone loss around implants can be a primary indicator

Scale	Description
0	Absence of clinical mobility in any direction when 500 g force is applied
1	Slight detectable horizontal movement with 500 g force
2	Visible moderate horizontal mobility up to 0.5 mm when a force of 500 g applied
3	Severe horizontal movement of more than 0.5 mm is seen when a force of 500 g applied
4	Moderate to severe horizontal movement along with any visible vertical movement

Table 5.
Clinical implant mobility scale.

of the need for initial preventive therapy. Marginal bone loss of 0 to 0.2 mm after the first year of function is common and acceptable [61–63]. However, a bone loss of 0.5 to 1 mm after the abutment is connected and during the first few years of the prosthesis in function is an indicator of excessive stress at the crestal implant-bone interface [64]. The dentist should evaluate and reduce the cause of stress at the implant-bone interface which could be due to deflective occlusal contacts, cantilever length, or parafunction.

At-home implant care	Types	Description
Brushing [65]	1. Manual 2. Automated/sonic brush 3. Motorized/power brush 4. End tufted brush 5. 5. Tapered rotary brush	a. To be performed twice daily for effective plaque removal around implants. b. Patients should be instructed to follow the BASS technique of brushing. c. To access the interdental or under the implant bar or connector region, a tapered rotary brush can be used. d. Automated/ Sonic brushes are superior to manual brushes in that they effectively remove plaque, provide improved interproximal cleaning without damaging the peri-implant tissue, and can be used by patients with limited dexterity. e. In difficult to access regions especially the posterior area, end tufted brushes or tapered rotary brushes can be used.
Interproximal cleaning aids [65]	1. Floss plastic, braided, satin, woven, yarns, dental tapes, tufted, coated	a. Should be used in a 'shoe-shine rag' fashion. b. Along with the mesial and distal surfaces, the facial and lingual surfaces should also be cleaned using the looping technique for effective debridement. c. Patient should be instructed to place the floss sub-gingivally until resistance is met. d. Dental floss can also be used to deliver antiseptic agents to the implants on daily basis.
	2. Interproximal cleansers: Foam tips, interproximal brushes, disposable wooden picks	a. Chosen based on the size of the interproximal area. b. Caution to be excised in cases where the inter-proximal brush has an exposed metal tip which can damage the peri-implant soft tissue and also the abutment's surface. c. Chemotherapeutic agents can be delivered to the implant surface using the proxy and foam tip interdental brushes.
	3. Water irrigation: Hydro floss, Oracura	a. Water stream should be directed interproximally and horizontally between implants or can cause damage to the peri-implant tissue
Chemotherapeutic agents [65]	Povidone iodine, Chlorhexidine gluconate, lasers, photodynamic therapy, or plant alkaloids	a. Can be used in patients who have recurrent tissue inflammation in the form of rinses, gels, lozenges. b. However, chlorhexidine gluconate has been proven to alter the surface topography of implants, and cause cell cytotoxicity thereby affecting the re-osseointegration potential of implants [66]

Table 6.
At-home oral implant hygiene care aids.

A preventive maintenance appointment should be scheduled every 3 to 4 months and a periapical/ bitewing radiograph should be made every 6 to 8 months. The periapical/ bitewing radiograph must be compared with the baseline radiographs to evaluate the crestal bone changes that have/have not occurred in the early stages of loading.

After 1 year, the previous radiographs must be compared with the recent bitewing radiograph and evaluated for further bone loss. If no changes are observed, a radiographic examination must be scheduled every 3 years, however, if there are noticeable unfavorable changes or crestal bone loss present, a radiographic evaluation must be carried out every 6–8 months along with stress reduction and hygiene maintenance protocol [60].

3.2 Phase 2: hygiene phase

Following the systematic assessment phase arduously performed by the clinician, it is now the responsibility of the patient, a co-therapist, to meticulously and habitually follow the implant oral hygiene protocol instructed by the clinician. After the implant

In-office implant care	Types	Description
Scaling [65]	Scalers made from plasteel (resin); hi-tech plastic; graphite-reinforced nylon etc.	a. Metallic instruments should be avoided as they can scratch, contaminate or produce galvanic reactions at the implant-abutment interface. b. If the prostheses limit the access to manual scalers, sonic or ultrasonic scalers with plastic or graphite-reinforced nylon tips may be used. c. Depending on the sites of deposits, either horizontal, oblique, or vertical short working strokes with light pressure should be used to prevent inadvertent damage to the peri-implant tissues.
Polishing [65]	Non-abrasive polishing pastes like aluminum oxide, tin oxide, APF free prophy paste, and low abrasive dentifrice	a. Coarse abrasive polishing pastes and air polishing of implant components are contraindicated. b. Air polishing may cause chipping of the porcelain or composite material. c. May result in unwanted pitting or surface irregularities on the implant components and cause detachment of soft tissue from the implant surface due to air pressure.
Chemotherapeutic agents [65]	Dentomycin, PerioChip, Atridox, or subgingival irrigation using chemotherapeutic agents.	a. Plastic irrigation tip may be used to introduce the antiseptic agents to the base of the implant sulcus. b. Neutral sodium fluoride may be used instead of other fluorides which may have an acidic pH and thereby alter the implant surface
Intraoral camera [65]		a. Can be used to educate the patient about the effect of their oral hygiene care. b. Based on the outcome of their previous oral care, any changes required can be implemented. This will help the patients to self-analyze their regular oral hygiene methods and motivate them to make necessary changes or continue with the same.

Table 7.
In-office oral implant hygiene care aids.

placement, patients usually have improper oral hygiene practice either due to the fear of damaging the implant or because of overzealous oral health care practice. Hence, as clinicians, it is important to convey both verbally and visually the different oral health care aids that can be practiced safely by the patients to achieve long-term implant success.

The following are the agendas to be covered in the hygiene phase:

Directing the patient to control the underlying medical conditions which may cause peri-implant diseases and gradually implant failure.

Educating the patient about the importance of maintaining implant oral health and recall visits.

Training the patient to use different In-home hygiene products for the maintenance of implant oral health.

Oral implant hygiene methods can be broadly categorized as At-home implant care (**Table 6**) and In-office implant care (**Table 7**).

4. The implant health scale

The success of an implant should not focus on the implant fixture alone but also on the success of the entire implant prosthesis. A natural tooth in the oral cavity is not described as a success or failure, instead, a health scale is used to determine the condition and survival of the tooth.

Similarly, the implant health scale was introduced by James and further modified by Misch in the year 1993 [67, 68]. The Internation Congress of Oral Implantologists (ICOI), in Italy Consensus Conference, Pisa, on 5th October 2007, further modified the James-Misch Implant scale and approved a health scale with four categories for endosteal implants that describe their clinical conditions i.e. implant success, implant survival (satisfactory and compromised), and implant failure [69] (**Table 8**).

Implant quality scale	Clinical conditions	Prognosis	Treatment planning
I. Implant success	a. No pain or tenderness during any function b. 0 mobility c. <2 mm bone loss from initial surgery period d. No history of exudates	Very good to excellent prognosis	Normal maintenance
II. Satisfactory survival	a. No pain on function b. Zero mobility c. 2–4 mm of radiographic bone loss d. No history of exudates	Good to excellent depending on the condition of the crestal bone	a. Evaluate for stresses b. Keep shorter intervals between hygiene evaluation c. Yearly radiographs
III. Compromised survival	a. May have sensitivity during function b. No mobility c. Radiograph shows bone loss of >4 mm (less than ½ of implant body) d. Probing depth of >7 mm e. May have a history of exudate	Good to guarded prognosis depending on the ability to reduce the stresses once surgical corrections have improved the soft and hard tissues health.	a. Evaluate for stresses b. Start with antibiotics, topical chemotherapeutic agents c. Surgical reentry d. Evaluate the prosthesis for change/ addition of a new implant

Implant quality scale	Clinical conditions	Prognosis	Treatment planning
IV. Failure (clinical or absolute)	Any of the following: a. Pain b. Mobility c. Radiographic bone loss of more than ½ length of the implant d. Uncontrolled exudate e. No longer in mouth	Very poor prognosis	a. Whether a clinical or absolute failure, the implant should be removed. b. Sleper implants, surgically removed implants, or exfoliated implants fall under this category.

Table 8.
Dental implant health scale, international congress of oral implantologists, Pisa, Italy consensus conference, 2007.

After the final implant assessment phase, the clinician should categorize the implant health based on the assessed clinical condition of the implants.

5. Conclusion

The immediate outcome of implant dentistry for patients is usually esthetics and function. But long-term implant prosthesis success depends on an array of factors such as implant quality, implant surgery procedure, peri-implant health, implant/prosthesis mobility, pain, exudate, etc.

A systematic review [70] was conducted to evaluate the different implant oral hygiene methods that are available and are in use by the general public and the dental team for the debridement of plaque and maintenance of implant oral health. It was concluded, that the knowledge that exists among the clinicians and the general public about oral hygiene maintenance is concerning natural teeth and no particular protocol or regimen were being followed [70]. Hence, academics and private clinics must start spreading awareness both verbally and visually about the different implant oral hygiene aids which can be used to achieve long-term implant success.

The only elucidation to achieve long-term successful implant prosthesis is frequent maintenance recalls, regular professional and at-home implant hygiene care, as well as treating any peri-implant pathology at its earliest. In this chapter, we have meticulously compiled in toto the dental implant maintenance protocol and hope that the information provided will be helpful for the implant interdisciplinary team to guide the patient, educate them and simultaneously work with them to achieve long-term implant success.

Conflict of interests

The authors declare no conflict of interest.

DOI: http://dx.doi.org/10.5772/intechopen.101187

Author details

Gayathri Krishnamoorthy, Aparna I. Narayana* and Dhanasekar Balakrishnan
Manipal College of Dental Sciences, Manipal Academy of Higher Education, Manipal, India

*Address all correspondence to: aparna.narayan@manipal.edu

IntechOpen

References

[1] Dental Implant Market Size, Share & Trends Analysis Report by Implants Type (Titanium, Zirconium), by Region (North America, Europe, Asia Pacific, Latin America, MEA), and Segment Forecasts [Internet]. 2021-2028. Available from: https://www.grandviewresearch.com/industry-analysis/dental-implants-market

[2] Pjetursson BE, Asgeirsson AG, Zwahlen M, Sailer I. Improvements in implant dentistry over the last decade: Comparison of survival and complication rates in older and newer publications. The International Journal of Oral & Maxillofacial Implants. 2014;**29**:308-324. DOI: 10.11607/jomi.2014 suppl.g5.2

[3] Brunello G, Gervasi M, Ricci S, Tomasi C, Bressan E. Patients' perceptions of implant therapy and maintenance: A questionnaire-based survey. Clinical Oral Implants Research. 2020;**31**(10):917-927. DOI: 10.1111/clr.13634

[4] Garg K, Duarte F, Funari K. Hygeinic maintenance of dental implants. Journal of Practical Hygiene. 1997;**6**(2):13-17

[5] Misch CE. Diagnosis and treatment planning: Medical evaluation. In: Misch CE, editor. Contemporary Implant Dentistry. 3rd ed. St. Louis: Mosby; Elsevier; 2007. pp. 51-102

[6] Doyle DJ, Goyal A, Bansal P, Garmon EH. American Society of anesthesiologists classification. In: StatPearls. Treasure Island (FL):StatPearls Publishing; 2021

[7] Yu H, Zhou A, Liu J, Tang Y, Yuan Q, Man Y, et al. Management of systemic risk factors ahead of dental implant therapy: A beard well lathered is half shaved. Journal of Leukocyte Biology. 2021;**110**(3):591-604. DOI: 10.1002/JLB.6MR0621-760RR

[8] Dominy SS, Lynch C, Ermini F, et al. Porphyromonas gingivalis in Alzheimer's disease brains: Evidence for disease causation and treatment with small-molecule inhibitors. Science Advances. 2019;**5**(1):eaau3333

[9] Hwang D, Wang HL. Medical contraindications to implant therapy: Part I: Absolute contraindications. Implant Dentistry. 2006;**15**(4):353-360. DOI: 10.1097/01.id.0000247855.75691.03

[10] Schoen F. The heart. In: Kumar V, editor. Robbins and Cotran: Pathologic Basis of Disease. 7th ed. St. Louis, MO: Saunders; 2005. pp. 584-586

[11] Chambers H. Infective endocarditis. In: Goldman L, editor. Cecil Textbook of Medicine. 22nd ed. St. Louis, MO: Saunders; 2004. pp. 1795-1796

[12] Weyant RJ. Characteristics associated with the loss and peri-implant tissue health of endosseous dental implants. The International Journal of Oral & Maxillofacial Implants. 1994;**9**:95-102

[13] Eisenschenk A, Witzel C, Lautenbach M, Ekkernkamp A, Weber U, Kuntscher MV. Does chemotherapy impair the bone healing and biomechanical stability of vascularized rib and fibula grafts? Journal of Reconstructive Microsurgery. 2007;**23**(1):35-40

[14] Fan C, Foster BK, Wallace WH, Xian CJ. Pathobiology and prevention of cancer chemotherapy-induced bone growth arrest, bone loss, and osteonecrosis. Current Molecular Medicine. 2011;**11**(2):140-151

[15] Crofton PM. Bone and bone turnover. Endocrine Development. 2009;**15**:77-100

[16] Boulet LP, O'Byrne PM. Asthma and exercise-induced bronchoconstriction in athletes. New England Journal Medicine. 2015;**372**(7):641-648

[17] Harrington N, Prado N, Barry S. Dental treatment in children with asthma—a review. British Dental Journal. 2016;**220**(6):299-302

[18] Devlin J. Patients with chronic obstructive pulmonary disease: Management considerations for the dental team. British Dental Journal. 2014;**217**(5):235-237

[19] Leung DH, Narkewicz MR. Cystic fibrosis-related cirrhosis. Journal of Cystic Fibrosis. 2017;**16**(2):S50-S61

[20] Wu YY, Xiao E, Graves DT. Diabetes mellitus related bone metabolism and periodontal disease. International Journal of Oral Science. 2015;**7**(2):63-72

[21] Chiha M, Samarasinghe S, Kabaker AS. Thyroid storm: An updated review. Journal of Intensive Care Medicine. 2015;**30**(3):131-140

[22] Rajnay ZW, Hochstetter RL. Immediate placement of an endosseous root-form implant in an HIV-positive patient: Report of a case. The Journal of Periodontology. 1998;**69**:1167-1171

[23] Baron M, Gritsch F, Hansy A-M, Haas R. Implants in an HIV-positive patient: A case report. International Journal of Oral & Maxillofacial Implants. 2004;**19**:425-430

[24] Achong RM, Shetty K, Arribas A, Block MS. Implants in HIV-positive patients: 3 case reports. Journal of Oral and Maxillofacial Surgery. 2006;**64**: 1199-1203

[25] Shetty K, Achong R. Dental implants in the HIV-positive patient – Case report and review of the literature. General Dentistry. 2005;**53**: 434-437

[26] Otomo-Corgel J. Osteoporosis and osteopenia: Implications for periodontal and implant therapy. Periodontology 2000. 2012;**59**:111-139

[27] Wilson TG Jr, Nunn M. The relationship between the interleukin-1 periodontal genotype and implant loss. Initial data. Journal Periodontology. 1999;**70**:724-729

[28] Bain CA, Moy PK. The association between the failure of dental implants and cigarette smoking. The International Journal of Oral & Maxillofacial Implants. 1993;**8**:609-615

[29] Hwang D, Wang HL. Medical contraindications to implant therapy: Part II: Relative contraindications. Implant Dentistry. 2007;**16**(1):13-23. DOI: 10.1097/ID.0b013e31803276c8

[30] Marx RE, Sawatari Y, Fortin M, Broumand V. Bisphosphonate-induced exposed bone (osteonecrosis/ osteopetrosis) of the jaws: Risk factors, recognition, prevention, and treatment. Journal of Oral and Maxillofacial Surgery. 2005;**63**:1567-1575

[31] Ruggiero SL, Mehrotra B, Rosenberg TJ, Engroff SL. Osteonecrosis of the jaws associated with the use of bisphosphonates: A review of 63 cases. Journal of Oral and Maxillofacial Surgery. 2004;**62**:527-534

[32] Starck WJ, Epker BN. Failure of osseointegrated dental implants after diphosphonate therapy for osteoporosis: A case report. The International Journal of Oral & Maxillofacial Implants. 1995;**10**:74-78

[33] van Steenberghe D, Quirynen M, Molly L, Jacobs R. Impact of systemic diseases and medication on osseointegration. Periodontology 2000. 2003;**33**:163-171

[34] Beirne OR. Evidence to continue oral anticoagulant therapy for ambulatory oral surgery. Journal of Oral and Maxillofacial Surgery. 2005;**63**:540-545

[35] Madrid C, Sanz M. What influence do anticoagulants have on oral implant therapy? A systematic review. Clinical Oral Implants Research. 2009;**20**(4): 96-106

[36] Froum SJ. Dental Implant Complications: Etiology, Prevention, and Treatment. 2nd ed. United Kingdom: Wiley-Blackwell; 2015

[37] van Steenberghe D, Klinge B, Linden U, et al. Periodontal indices around natural and titanium abutments: A longitudinal multicenter study. The Journal of Periodontology. 1993;**64**:538-541

[38] Ferreira SD, Silva GLM, Costa JE, Cortelli JR, Costa FO. Prevalence and risk variables for peri-implant disease in Brazilian subjects. Journal of Clinical Periodontology. 2006;**33**:929-935

[39] Salvi GE, Aglietta M, Eick S, et al. Reversibility of experimental peri-implant mucositis compared with experimental gingivitis in humans. Clinical Oral Implants Research. 2012;**23**:182-190

[40] Hardt CRE, Grondahl K, Lekholm U, Wennstrom JL. Outcome of implant therapy in relation to experienced loss of periodontal bone support. A retrospective 5-year study. Clinical Oral Implants Research. 2002;**13**:488-494

[41] Karoussis IK, Salvi GE, Heitz-Mayfield LJA, et al. Long-term implant prognosis in patients with and without a history of chronic periodontitis: A 10-year prospective cohort study of the ITIR dental implant system. Clinical Oral Implants Research. 2003;**14**:329-339

[42] Ong CT, Ivanovski S, Needleman IG, et al. Systematic review of implant outcomes in treated periodontitis subjects. Journal of Clinical Periodontology. 2008;**35**:438-462

[43] van Oosten MMAC, Sch¨urch Jr. E, Land NP. The microbiota associated with successful or failing osseointegrated titanium implants. Oral Microbiology and Immunology. 1987;**2**(4):145-151

[44] Apse P, Zarb GA, Schmitt A, Lewis DW. The longitudinal effectiveness of osseointegrated dental implants, The Toronto study: Peri-implant mucosal response. The International Journal of Periodontics & Restorative Dentistry. 1991;**11**(2):95-111

[45] Lang NP, Wetzel AC, Stich H, Caffesse RG. Histologic probe penetration in healthy and inflamed peri-implant tissues. Clinical Oral Implants Research. 1994;**5**(4):191-201

[46] Gerber JA, Tan WC, Balmer TE, Salvi GE, Lang NP. Bleeding on probing and pocket probing depth in relation to probing pressure and mucosal health around oral implants. Clinical Oral Implants Research. 2009;**20**(1):75-78

[47] Humphrey S. Implant maintenance. Dental Clinics of North America. 2006;**50**(3):463-478

[48] Lang NP, Berglundh T, Heitz-Mayfield LJ, Pjetursson BE, Salvi GE, Sanz M. Consensus statements and recommended clinical procedures regarding implant survival and complications. The International Journal

of Oral & Maxillofacial Implants. 2004;**19**:150-154

[49] Bouri A Jr, Bissada N, Al-Zahrani MS, Fadoul F, Nounen I. Width of keratinized gingiva and the health status of the supporting tissues around dental implants. The International Journal of Oral & Maxillofacial Implants. 2008; **23**(2):323-326

[50] Chung DM, Oh TJ, Shotwell JL, Misch CE, Wang HL. Significance of keratinized mucosa in maintenance of dental implants with different surfaces. Journal of Periodontology. 2006;**77**(8):1410-1420

[51] Schrott AR, Jimenez M, Hwang JW, Fiorellini J, Weber HP. Five-year evaluation of the influence of keratinized mucosa on peri-implant soft-tissue health and stability around implants supporting full-arch mandibular fixed prostheses. Clinical Oral Implants Research. 2009;**20**(10):1170-1177

[52] Adibrad M, Shahabuei M, Sahabi M. Significance of the width of keratinized mucosa on the health status of the supporting tissue around implants supporting overdentures. The Journal of Oral Implantology. 2009;**35**(5):232-237

[53] Ross-Jansaker AM, Renvert H, Lindahl C, Renvert S. Nine-to fourteen-year follow-up of implant treatment. Part III: Factors associated with peri-implant lesions. Journal of Clinical Periodontology. 2006;**33**(4):296-301

[54] Zigdon H, Machtei EE. The dimensions of keratinized mucosa around implants affect clinical and immunological parameters. Clinical Oral Implants Research. 2008;**19**(4): 387-392

[55] Niimi A, Ueda M. Crevicular fluid in the osseointegrated implant sulcus: A pilot study. The International Journal of Oral & Maxillofacial Implants. 1995;**10**(4):434-436

[56] Behneke N, Behneke B, D'Hoedt B, Wagner W. Hard and soft tissue reactions to ITI screw implants: 3-year longitudinal results of a prospective study. The International Journal of Oral & Maxillofacial Implants. 1997;**12**(6) :749-757

[57] Klinge M, Hultin M, Berglundh T. Peri-implantitis. Dental Clinics of North America. 2005;**49**(3):661-676

[58] Bidra AS. Nonsurgical management of inflammatory periimplant disease caused by food impaction: A clinical report. The Journal of Prosthetic Dentistry. 2014;**111**:96-100

[59] Chopra A, Sivaraman K, Narayan AI, Balakrishnan D. Etiology and classification of food impaction around implants and implant-retained prosthesis. Clinical Implant Dentistry and Related Research. 2019;**21**(2): 391-397. DOI: 10.1111/cid.12716

[60] Misch E. In: Misch CE, editor. An Implant is not a Tooth: A Comparison of Periodontal Indices in Contemporary Implant Dentistry. 3rd ed. Mosby: Elsevier; 2007. pp. 1055-1072

[61] van Steenberghe D, Lekholm U, Bolender C, Folmer T, Henry P, Herrmann I, et al. Applicability of osseointegrated oral implants in the rehabilitation of partial edentulism: A prospective multicenter study on 558 fixtures. The International Journal of Oral & Maxillofacial Implants. 1990;**5**(3):272-281

[62] Adell R, Lekholm U, Rockler B, Brånemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw.

International Journal of Oral Surgery. 1981;**10**(6):387-416. DOI: 10.1016/s0300-9785(81)80077-4

[63] Cox JF, Zarb GA. The longitudinal clinical efficacy of osseointegrated dental implants: A 3-year report. The International Journal of Oral & Maxillofacial Implants. 1987;**2**(2):91-100

[64] Oh TJ, Yoon J, Misch CE, Wang HL. The causes of early implant bone loss: Myth or science? The Journal of Periodontology. 2002;**73**(3):322-333. DOI: 10.1902/jop.2002.73.3.322

[65] Gulati M, Govila V, Anand V, Anand B. Implant maintenance: A clinical update. International Scholarly Research Notices. 2014;**2014**:908534. DOI: 10.1155/2014/908534

[66] Krishnamoorthy G, Narayana A, Balkrishnanan D. Chlorhexidine for the treatment of peri-implantitis- is it a benison? Journal of Long-Term Effects of Medical Implants. DOI: 10.1615/JLongTermEffMedImplants.2021039510

[67] Misch CE. The implant quality scale: A clinical assessment of the health disease continuum. Oral Health. 1998;**15**:15-25

[68] Misch CE. Implant success or failure: Clinical assessment in implant dentistry. In: Misch CE, editor. Contemporary Implant Dentistry. St. Louis, MO. Elsevier; 1993. pp. 33-66

[69] Misch CE, Perel ML, Wang HL, Sammartino G, Galindo-Moreno P, Trisi P, et al. Implant success, survival, and failure: The International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference. Implant Dentistry. 2007;**17**(1):5-15. DOI: 10.1097/ID.0b013e3181676059

[70] Louropoulou A, Slot DE, Van der Weijden F. Mechanical self-performed oral hygiene of implant supported restorations: A systematic review. The Journal of Evidence-Based Dental Practice. 2014;**14**(60):9.e1. DOI: 10.1016/j.jebdp.2014.03.008