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Research Article

MAINTENANCE PHASE – THE LIFELINE OF DENTAL IMPLANTS

Akshaya Narayanan and Jaishree Tukaram Kshirsagar

Department of Periodontics, Tamil Nadu Govt. Dental College and Hospital, Chennai

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ABSTRACT

Peri-implant hard and soft tissues have such an anatomical framework that they are more prone to inflammation and bone loss when compared to natural teeth. After the surgical phase of implant placement, the emphasis is not only on adequate osseointegration, but is also conjoined with adequate maintenance of the mucoperiosteal-implant seal and peri-implant health. This review highlights the monitoring protocols for effective maintenance of implants to ensure long term success. Preliminary assessment starts with updating patient's medical and dental history. Clinical evaluation should be done in every recall visit and radiographic evaluation can be done as and when required. After reaching a diagnosis, appropriate non- surgical or surgical treatment should be performed with the aim of maintaining implant health and survival, curbing peri-mucositis and/or peri-implantitis progression and its reversibility. Collaborating good professional care with patient's home care is the key for longevity of an implant.

INTRODUCTION

During the early years of oral implantology, the prime focus for prediction of long term survival of implants was on osseointegration. Even now due importance is given to osseointegration, however, fixture placement, prosthesis and esthetics are also regarded as key factors in implant success[1]. Maintaining the peri-implant hard and soft tissue health becomes imperative for prevention of peri-implant disease and necessitates a team work between the dental professionals and the patient[2]. Efficient home care by the patients can eliminate up to 85% of microbial plaque accumulation[3]. Hence, it would not be an exaggeration to refer patients as co-therapists in the maintenance phase where their co-operation remains indispensable[4].

Peri-Implant Anatomy

The mucosa-implant interface serves as a critical barrier between the intraosseous part of the implant and the oral environment[5]. Similar to gingiva the peri-implant soft tissue is mostly covered by keratinized squamous epithelium[6]. This epithelial barrier is a few cell layers thick with hemidesmosome attachments to the "cuff" of connective tissue. This connective tissue is rich in collagen, relatively avascular and acellular mimicking a scar tissue histologically[7]. As the dental implants lack a cementum layer, collagen fibers typically orient themselves in a parallel manner to the implant surface (in contrast to natural teeth where the fibres are perpendicular from cementum to bone), making them much weaker and more prone to breakdown and bacterial invasion[8]. The blood supply from the periodontal ligament does not exist and the vascularity of peri-implant mucosa is mainly through the supraperiosteal blood vessels[9].

Peri Implant Microbiology

Composition of plaque around implants is similar to that of natural tooth. The microbial flora of a healthy implant crevice will predominately be comprised of gram-positive cocci and non motile rods. Diseased implant crevices encompass periodontal pathogens similar to those associated with periodontitis but they are less diverse and frequently include Fusobacterium, Prevotella, Porphyromonas, Streptococcus, Campylobacter, and Neisseria species. Failed implants are often associated with enteric bacteria, spirochetes, and opportunistic bacteria (ie, Staphylococcus aureus). Studies have demonstrated that Staphylococcus aureus is common in deep peri-implant pockets closely linked to suppuration and bleeding on probing but S. aureus is not closely related to chronic periodontitis and seems to be more specific to implant surface contamination[10]. Plaque begins to accumulate as early as the implants are exposed to oral cavity[11,12]. After 3 months of exposure, periodontal pathogens are found around implants and

Corresponding author:* **Akshaya Narayanan
Department of Periodontics, Tamil Nadu Govt. Dental College and Hospital, Chennai

studies have shown that spirochetes can migrate from the residual teeth to the implants 6 months after placement[13,14,15]. Between natural tooth and implant, plaque formation and inflammatory response are similar but studies have shown that their pattern of inflammation is different. Due to decreased blood supply around implants, peri-implant mucosa is less effective than the gingiva in prevention of progression of plaque-related lesions into the adjacent tissue and bone[16]. Hence, maintaining the health of peri implant tissue becomes imperative for long term survival of implants.

Initiation of Implant Maintenance by the Dentist

The position paper on periodontal maintenance, American Academy of Periodontology 2003, has stated "patients should be evaluated at regular intervals to monitor their peri-implant status, the condition of the implant supported prostheses and plaque control"[17]. After restoration of an implant, the patient should be re-evaluated at every 3 months during the first year and based on the response of the peri-implant tissues the appropriate frequency of periodontal maintenance should be determined with a customised strategy[18]. If the patient is clinically stable after one year, follow up interval of 6 months is sufficient[19].

Interaction with the Patient

In the follow up sessions, patient should be asked for comfort and function of the implant. Symptoms such as pain and discomfort stated by the patient should be given due importance as they could be the first signs of implant failure and are often associated with mobility and loosening[20].

Updating Patient's Medical and Dental History

The patient's medical and dental history should be updated and overall well being should be assured at every recall appointment[21]. Certain systemic conditions are known to interfere with osseointegration and adversely affect implant prognosis. For example, bone to implant contact has been demonstrated to be affected by common systemic diseases such as diabetes and osteoporosis. Smoking can affect the oral flora, soft tissue and hard tissue metabolism.

Inflammatory response of the peri-implant environment can be influenced by medications such as calcium channel blockers and immunosuppressants. Patients medicated with bisphosphonates, may develop Bisphosphonate Related Osteo-Chemo-Necrosis (BROCN) of the jaws, following tooth extraction [22]. Hence, overall good general health is one of the keys to the success of dental implants.

Diagnostic parameters

The clinical and radiographic parameters routinely used to monitor oral implants during maintenance care should be of high sensitivity, high specificity, should be easy to measure and should yield reproducible data[23].

Visual and palpatory assessment

Visual assessment of color, texture, consistency of tissues and gingival margin position should be done. Palpation can be performed for presence of edema, tenderness, exudate or pus. Suppuration is a definite indicator of disease activity and necessitates an anti-infective therapy[24].

Plaque and mucosal assessment

Mombelli *et al* in 1987 and Apse *et al* in 1991 proposed modified indices for the evaluation of the peri-implant marginal mucosal conditions and plaque assessment[25].(Table 1)

Bleeding on probing (BOP)

It has been demonstrated by Lang *et al*. in 1994 that healthy peri-implant sites were characterized by absence of bleeding (0%). In contrast, peri-implant mucositis (67%) and peri-implantitis sites (91%) showed significantly increased BOP[26]. According to Luterbacher *et al* in 2000, presence of bleeding on probing alone is less diagnostically accurate in predicting the development of periodontal disease; but is more valuable for implants[27].

Peri-implant probing

Peri-implant probing should be done regularly during the maintenance phase[28], however, some clinicians do not recommend probing the implant, or waiting three months after abutment attachment to prevent disruption of the perimucosal

Table 1 Peri-implant marginal mucosal conditions and plaque assessment

Score	Mombelli et al. (mPI)	Mombelli et al. (mGI)	Apse et al.
0	No detection of plaque	No bleeding when a periodontal probe is passed along the mucosal margin adjacent to the implant	Normal mucosa
1	Plaque only recognized by running a probe across the smooth marginal surface of the implant	Isolated bleeding spots visible	Minimal inflammation along with color change and minor edema
2	Plaque which can be seen by the naked eye	Blood which forms a confluent red line on mucosal margin	Moderate inflammation with redness, edema, and glazing
3	Abundance of soft matter	Heavy or profuse bleeding	Severe inflammation with redness, edema, ulceration, and spontaneous bleeding without probing

seal[29]. A lesser probing force (0.2-0.3 N) is advocated around implants as the attachment strength of the junctional epithelial attachment zone to the implant is less. Also, the connective tissue zone has only two fiber groups and both are not inserted into the implant [30]. Recommendations for peri-implant probing are listed in table 2[31], figure 1[32]. Generally, successful implants have a probing depth of 3 mm. When the probing depth is 5mm or more, the pocket serves as a protected niche for the bacteria and can present with signs of peri-implantitis[33].

Table 2 Recommendations for peri-implant probing

➢ A flexible plastic probe (Figure 1) is recommended to reduce the risk of scratching the implant's surface and the potential for trauma to the perimucosal seal. ➢ Probing force of 0.2-0.3 N ➢ Dipping the probe in chlorhexidine prior to its usage prevents bacterial infiltration of the peri-implant sulcus[31]. ➢ Probing is done gently, with the plastic probe placed parallel to the long axis of the implant. ➢ Clinical parameters should be recorded and documented for future reference.

Figure 1 Williams Colorvue® Probe[32]

Peri-Implant Sulcus Fluid (PISF) Analysis

Several potential host markers for peri-implant disease activity and progression have been identified in the PISF. A positive correlation of PISF volume with plaque accumulation and degree of peri-implant soft tissue inflammation has been reported[34]; also, association between PISF volume and the amount of bone resorption[35] has also been demonstrated. Early indicators of peri-implantitis detected in peri-implant crevicular fluid include inflammatory biomarkers such as myeloperoxidase, lactoferrin, IL-1β, prostaglandins. MMP-8 for connective tissue destruction phase of peri-implant disease and bone remodeling biomarkers such as OPG, RANK, and soluble RANKL for bone loss around implants seem to be other promising biomarkers[36].

Evaluation of restoration

The integrity and stability of the implant supported restoration must be checked periodically and should be inspected for fractures/chipping of the surface, loose screws, integrity of solder joints, loss of cement seal and excessive wear patterns on the restoration or opposing occlusion[22]. In cement retained restorations, one of the potentially dangerous findings is the presence of sub-gingival cement which can result in peri-implant pathology. Lingual set- screws, screw- retained with ceramic inserts, rubber dam technique and teflon (PTFE) tape technique can be employed to eliminate/control flow of cement[37].

Evaluation of occlusion

Abutment screw loosening, implant failure and prosthetic failure could result from excessive occlusal forces on the implant. It is recommended to establish a mild contact in centric occlusion and no contact in lateral movements[38], or lateral forces must be evenly distributed[38] without resulting in destructive forces.

Evaluation of Implant Stability

Rigid fixation is the term for absence of clinical mobility of implant. The techniques used to assess rigid fixation are similar to that of natural tooth. Two rigid instruments are used to exert a labiolingual force (approximately 500g) on the implant. Based on the implant mobility scale given by Misch[39], the amplitude of tooth mobility may be rated from 0 to 4 (Table 3).

Table 3 Clinical implant mobility scale

Score	Description
0	Absence of clinical mobility with 500 g in any direction
1	Slight detectable horizontal movement
2	Moderate visible horizontal mobility up to 0.5mm
3	Severe horizontal movement greater than 0.5mm
4	Visible moderate to severe horizontal and any visible vertical movement

This index has low sensitivity and high specificity as it detects the final stage of osseo-disintegration and, therefore indicates a late implant loss[23]. To monitor initial degrees of implant mobility Periotest has been recommended. However, the accuracy of Periotest value for the diagnosis of peri-implantitis and early signs of implant failure is questionable. Its disadvantages are lack of resolution, poor sensitivity, and susceptibility to operator variables[40]. Osstell instrument, a non invasive device based on resonance frequency analysis has been recently developed to measure implant stability. It evaluates the stiffness of the bone-implant interface and also detects increase or decrease in implant stability over time[25].

Radiographic assessment

Radiographs are indicators of crestal bone loss and loss of integrity of component connections. Adell *et al* determined that the mean bone loss for Branemark osseointegrated implants was 1.5 mm for the first year and followed by mean bone loss of 0.1mm/year[41]. The suggested protocol is to obtain a baseline film at the time of insertion of the final prosthesis followed by a periapical/vertical bitewing radiograph at six months and one year recall visits. If no changes or unfavourable clinical signs are apparent, subsequent radiographic examinations may be scheduled every 3 years thereafter. If crestal changes are evident, radiographs must be taken and reviewed every 6 to 8 months until the bone is stable for two consecutive periods[42]. Hence, the frequency of radiographic evaluation should be customised for each patient based on the clinical scenario.

Categorising the Status of the Implant

Based on the clinical and radiographic evaluation, the implants are sorted as surviving, ailing, failing or failed[43,44] (Table 4). Peri-implant pathology includes implant-mucositis and peri-implantitis.

Table 4 Categories of implant status

Surviving implant	Ailing implant	Failing implant	Failed implant
Implants are still in function but have not been tested against success criteria.	Demonstrates bone loss with deeper pockets but appears to be stable when evaluated at 3-4 months interval. Show no inflammatory signs or mobility	Demonstrates progressive bone loss, increasing clinical probing depths, bleeding on probing and suppuration. Shows signs of inflammation but no mobility.	Demonstrates progressive bone loss, clinical mobility, peri-implant radiolucency and a dull sound when percussed. A failed implant is non functional and must be removed.

Peri-implant mucositis

- Reversible inflammatory process in the soft tissues surrounding a functioning implant.
- Has been reported to affect 80% of the subjects using dental implants and 50% of the implants.

Peri-implantitis

- Progressive and irreversible disease of implant-surrounding hard and soft tissues and is accompanied with bone resorption, decreased osseointegration and increased pocket formation.
- Affects between 28-56% of the subjects and between 12-43% of the implants.

The criteria for implant success were revised by Alberktson, Zarb, Washington, and Erickson in 1986[45](Table 5). Recently, the width of the attached gingiva, co-existing medical conditions, smoking, width of the implant, suture material used, genetic and immunological factors like TNF-α and IL-1β have also been identified as markers for implant success[46].

Table 5 Revised criteria for implant success- Alberktson *et al* 1986

1. **Individual unattached implant that is immobile when tested clinically**
2. **Radiograph does not demonstrate evidence of peri-implant radiolucency**
3. **Bone loss that is less than 0.2 mm annually after the implant's first year of service**
4. **No persistent pain, discomfort or infection**
5. **By these criteria, a success rate of 85% at the end of a 5 year observation period and 80% at the end of a 10 year period are minimum levels for success.**

Professional care during maintenance phase

After careful implant assessment, presence of calculus on the implant / abutments should be evaluated. As implants exhibit surface roughness, they pave way for bacterial adhesion and colonization. Protocol for safe instrumentation should be followed to remove the microbial deposits, however, for an implant with a healthy gingival attachment minimal/ no instrumentation may be necessary. The various techniques of implant surface detoxification are listed in table 6[47-61].

Surgical treatment of peri-implantitis lesions can be performed in cases with considerable pocket formation (larger than 5 mm) and bone loss after the resolution of acute infection and adequate oral hygiene. Various surgical techniques have been recommended depending on the final objective of the surgical intervention: a) Access for cleaning and decontaminating the implant surface (access flaps). b) Access for cleaning and decontamination plus exposing the affected surfaces for cleaning (apically repositioned flaps) and c) Access for cleaning plus aiming for bone regeneration and re--osseointegration (regenerative techniques), where after decontamination of the implant surface, a graft is placed around the implant, filling the intrabony component of the defect with either autologous bone or bone substitutes followed by placement of resorbable or non-resorbable membrane. Combined regenerative and resective approach has also been performed by Schwarz *et al*[62]. The intrabony component of the defect was treated with a collagen membrane and a bovine xenograft and the supra-bony component with resective surgery. "Cumulative Interceptive Supportive Therapy" (CIST) suggested by Lang and coworkers[63] includes a series of four protocols which describe the criteria for the peri-implant tissue diagnosis as well as the different therapeutic measures that are available to treat and prevent peri-implant infections (Figure 2).

Home Care Regimen for Implats

Mechanical plaque control

It comprises the use of manual or powered toothbrushes as well as interproximal aids. Plaque control is the key for the primary prevention of peri-implant mucositis as well its secondary prevention once treated. Standard recommendations include brushing twice daily with a low abrasive dentifrice, flossing once daily (mesial/distal and facial/lingual), using a rubber-tip stimulator once daily, an antimicrobial rinse if inflammation is present and optionally, a water irrigation unit (not metal-tipped)[21]. Patients with good dexterity can choose among manual squish grip brushes, sonic tooth brushes, ionic tooth brushes and counter rotational powered toothbrushes. However, as the patient ages, it is important to suggest powered tooth brushes[52]. Interproximal cleaning can be done with use of floss, plastic floss, braided flossing cord, satin floss, woven floss, foam tips and interproximal brushes with a plastic coated wire. Interdental or end-tuft brushes can be used in a "shoe-shine rag" fashion to facilitate optimal home care procedures around implants, hard-to-reach areas and ball implant abutments. Powered oral irrigators are beneficial in implant maintenance, however, care must be taken to direct the stream interproximally and horizontally between implants, as improper positioning can cause inadvertent damage to the peri-implant seal[64]. Irrigation using 0.06% chlorhexidine with a special subgingival irrigation tip has been shown to be more effective than chlorhexidine gluconate (0.12%) mouth rinses[65].

Table 6 Implant surface detoxification techniques

Implantoplasty	• When titanium implant surface has been exposed, it is smoothened using rotary instruments. • This technique was recommended by Lang *et al*[47] , reported by Suh *et al*[48] and it aims to reduce the roughness of the titanium surface to decrease plaque adherence.
Air powder Abrasive	• Abrasive powders such as sodium bicarbonate, sodium hydrocarbonate, amino acid glycine[49] or erythritol-chlorhexidine[50] are propelled by a stream of compressed air (pressure of 65-100 psi) to remove biofilm or extrinsic stains from teeth. • It is cautiously used at a 45° angle to the implant.
Polishing	• After hard deposits have been removed, the prosthesis and abutments may be selectively polished with a rubber cup and nonabrasive polishing paste such as aluminum oxide, tin oxide, APF-free prophy paste, and low abrasive dentifrice[51]. • Air polishing of implant components remains controversial. • Some researchers contraindicate its use as it can cause damage to the porcelain or composite material, can create random pitting or undulating wave-type of surface irregularities on the titanium and may detach the soft tissue connection from the implant due to air pressure leading to emphysema.
Curettes	• Non-metal: Made of plastic, carbon, resin-reinforced and resin–unreinforced[49]. • Metal: Efficient in reducing bacteria but causes obvious scratches on the implants[52].
Ultrasonic scaler	• Metal scaler tips were more effective in eliminating bacteria and reducing bacterial adherence than plastic and carbon scaler tips. • The scratches caused by a metal scaler do not significantly affect the amount of biofilm that adheres to the implant surface. • Does not cause temperature change, when cooling system is used properly.
Chemical methods	• Citric Acid- pH1 with a concentration of 40% commonly used[49]. • Chlorhexidine- Debridement of the bone defect around the implant and rinsing the exposed contaminated implant surface with 0.1% or 0.2% CHX followed by GTR with non-resorbable membranes has shown to decrease probing depth up to 3 mm and increase bone level by 1.5 mm-3.6 mm[53,54]. • Ethylene Diamine Tetraacetic Acid (EDTA) - Implant surfaces debrided with titanium curettes were decontaminated with EDTA 24% for 2 min and rinsed with saline. EDTA group demonstrated a decrease of probing depth of 2.6 mm. Main advantage of EDTA is its neutral pH • Hydrogen Peroxide- 3% HP was capable of inactivating attached bacterial cells from human biofilms after immersion for 1 min[56] . In animals, swabbing the implant surface with 10% HP for 1 minute has been shown to decontaminate the implant surface and to allow re-osseointegration[57]. • Saline, Saline Soaked Cotton Pellet and Tetracycline[49] have also been recommended.
Lasers	• Er:YAG Laser: Capable of effectively removing plaque and calculus without any damage to the implant surfaces. • CO2 Laser: Improve new bone formation by effective decontamination • GaAlAs laser: One of the safest for application to any surface type as it does not alter implant surfaces, regardless of the strength at which it is applied[58].
Photodynamic therapy	• Human in vivo study - Dortbudak *et al* 2001: toluidine blue O for 1 minute and irradiation with a diode soft laser with a wavelength of 690 nm for 1minute was shown to decrease 92% of the vital counts of P.gingivalis, P.intermedia and A.actinomycetemcomitans[59] . • This is a topical treatment where only the affected sites requiring antimicrobial treatment are targeted and also, there is no evidence of resistance development in the target bacteria after PDT[60].
Antibiotics	• Local: Useful as adjunctive therapy for mechanical debridement. Eg: Insertion of tetracycline fibers; minocycline microspheres at treatment time and 180 and 270 days later[61]; amoxicillin, metronidazole, and their combination delivered locally have shown significant inhibition of S.sanguinis and P.gingivalis and much lower bacterial resistance[52]. • Systemic: Provides increased antimicrobial level in the peri-implant crevicular fluid

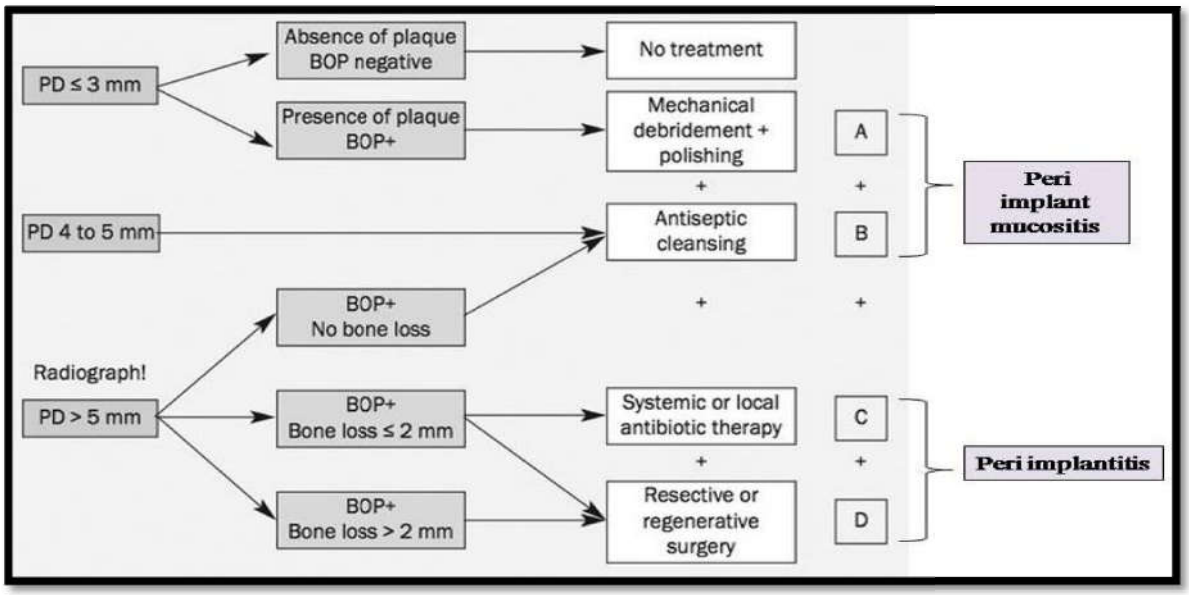

Figure 2 CIST protocol by Lang *et al* 2004. A: Mechanical debridement, B: Antiseptic therapy, C: Antibiotic therapy, D: Regeneration / Resective therapy

Chemical plaque control

Triclosan/copolymer toothpaste reduce plaque and gingival inflammation, fluoride-containing mouth rinses have demonstrated plaque control comparable to chlorhexidine gluconate mouth rinses and are able to reduce pro-inflammatory molecules in peri-implant crevicular fluid. Reduction in plaque index, gingival index, and bleeding index has been observed with Listerine, an essential oil mouth rinse, used twice daily for 30 seconds directly after mechanical brushing[66]. Chlorhexidine gluconate (0.12%) is used for plaque control in post restorative phases after implant placement. Chlorhexidine gel has also been proven to be effective[52].

CONCLUSION

Recall and review of implant patients should be scheduled every three months for the first year to help prevent infection and implant failure. After one year the interval between maintenance visits should be based on the patient's general health, implant status and home care. This review highlights the diagnostic parameters to assess the peri implant environment, identify patients who are at risk for mucositis/peri-implantitis, institute a proactive approach to curb progression of disease activity, execute treatment in a timely manner and emphasise the patients on the need for meticulous home care. After adequate osseo-integration and final prosthesis insertion, the patient and the dentist should work together towards the long term success of the implant, acknowledging the significance of maintenance of peri-implant health through regular follow up visits and quintessential home care. Hence, it would be apt to term the maintenance phase as the lifeline of dental implants.

References

1. Silverstein L, Garg A, Callan D, Shatz P. The key to success: maintaining the long-term health of implants. *Dent Today*1998; 17:104, 106, 108-11
2. Izadi M, Moghareabed A, Nasiri S, Tavakoli M, Yaghini J. Maintenance of Dental implants: A review. *J Dent Sch* 2013; 31(4): 242-252.
3. Keracher CM, Smith WS. Oral health maintenance dental implants. *Dent Assist*. 2010; 79:27-35; quiz 36.
4. A.K. Garg, F. Duarte, and K. Funari, "Hygeinic maintenance of dental implants," *Journal of Practical Hygiene*, vol. 6, no. 2, pp.13-17, 1997.
5. Lindhe J, Berglundh T.The interface between the mucosa and the implant. *Periodontol* 2000 1998; 17: 47-54.
6. Mombelli A, van Oosten MA, Schurch E Jr, Land NP.The microbiota associated with successful of failing osseointegfrated titanium implant. *Oral Microbiol Immunol* 1987; 2: 145-151.
7. Berglundh T, Lindhe J, Ericsson I,Marinello CP, Liljenberg B, Thomsen P. The soft tissue barrier at implants and teeth. *Clin Oral Implants Res* 1991; 2: 81-90.
8. Ikeda H, Shiraiwa M, Yamaza T, *et al*. Difference in penetration of horseradish peroxidase tracer as a foreign substance into the peri-implant or junctional epithelium of rat gingivae. *Clin Oral Implants Res* 2002; 13:243-251.
9. Berglundh T, Lindhe J, Jonsson K, Ericsson I. The topography of the vascular systems in the periodontal and periimplant tissues in dog. *J Clin Periodontol* 1994; 21: 189-193.
10. Dahlen G, Wikstrom M. Occurrence of enteric rods, staphylococci and Candida in subgingival samples. *Oral Microbiol Immunol* 1995; 10:42-46.
11. Edgerton M, Lo SE, Scannapieco FA. Experimental salivary pellicles formed on titanium surfaces mediate adhesion of streptococcocci. *Int J Oral Maxillofac Implants* 1996; 11: 443-449.
12. Leonhardt A, Berglundh T, Erricson I, Dahlén G. Putative periodontal pathogens on titanium implants and teeth in experimental gingivitis and periodontitis in beagle dogs. *Clin Oral Implants Res* 1992; 3:112-119.
13. Mombelli A, Marxer M, Gaberthuel T, Grunder U, Lang NP. The microbiota of osseointegrated implants in patients with a history of periodontal disease. *J Clin Periodontol* 1995; 22: 124-130.
14. Aspe P, Ellen RP, Overall CM, Zarb GA. Microbiota and crevicular fluid collagenase activity in the osseontegrated dental implant sulcus: a comparison of sites in edentulous and partially edentulous patients. *J Periodontal Res* 1989; 24: 96-105.
15. Quirynen M, Listgarten MA. Distribution of bacterial morphotypes around natural teeth and titanium implants and modum Branemark. *Clin Oral Implants Res* 1990; 1: 8-12.
16. Mozhgan Izadi, Ahmad Moghareabed, Saman Nasiri, Mohammad Tavakoli, Jaber Yaghini. Maintenance of Dental Implants: A Review. *Journal of Dental School* 2013; 31(4):242-252.
17. Cohen RE; Research, Science and Therapy Committee, American Academy of Periodontology. Position paper: Periodontal Maintenance. *J Periodontol*. 2003; 74(9):1395-401.
18. Schumaker ND, Metcalf BT, Toscano NT, Holtzclaw DJ. Periodontal and periimplant maintenance: a critical factor in long-term treatment success. *Compendium Contin Educ Dent*. 2009; 30(7):388-90, 392, 394, passim; quiz 407, 418.
19. Berglundh T, Lindhe J, Ericcson I, Marinello C, Liljenberg B. Soft tissue reaction to de novo plaque formation at implants and teeth. An experimental study in the dog. *Clin Oral Implants Res* 1992; 3: 1-8.
20. 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. *Int J Oral Maxillofac Implants* 1990; 5: 272-281.
21. Susan S Wingrove, "Dental implant maintenance: the role of the Dental Hygienist and Therapist", Clinical Practice, Dental Health Volume 50 No 5 of 6 September 2011.
22. I. Stephen Brown, D.D.S. The Realities of Dental Implant Maintenance. The Brown PerioDontaLetter; 220 South 16th Street, Suite 300, Philadelphia, PA 19102 (215) 735-3660.
23. G.E. Salvi and N.P. Lang, "Diagnostic parameters for monitoring peri-implant conditions," *International*

Journal of Oral and Maxillofacial Implants, vol. 19, pp. 116-127, 2004.
24. B. Klinge, M. Hultin, and T. Berglundh, "Peri-implantitis," *Dental Clinics of North America*, vol. 49,no. 3, pp.661-676, 2005.
25. Minkle Gulati, Vivek Govila, Vishal Anand, Bhargavi Anand. Implant Maintenance: A Clinical Update. International Scholarly Research Notices Volume 2014, http://dx.doi.org/10.1155/2014/908534
26. N. P. Lang,A.C.Wetzel, H. Stich, and R.G.Caffesse, "Histologic probe penetration in healthy and inflamed peri-implant tissues," *Clinical Oral Implants Research*, vol. 5, no. 4, pp. 191-201, 1994.
27. S. Luterbacher, L. Mayfield, U. Bragger, and N. P. Lang, "Diagnostic characteristics of clinical and microbiological tests for monitoring periodontal and peri-implant mucosal tissue conditions during supportive periodontal therapy (SPT)," *Clinical Oral Implants Research,* vol. 11, no. 6, pp. 521-529, 2000.
28. Lang NP, Wetzel AC, Stich H, Caffesse RG. Histologic probe penetration in healthy and inflamed peri-implant tissues. Clin Oral Implants Res 1994; 5:191-201.
29. Bauman GR, *et al*. Clinical parameters of the evaluation during implant maintenance, *International Journal of Oral and Maxillofacial Implants* 1992; 7: 220-227.
30. S. Humphrey, "Implant maintenance," Dental Clinics of North America, vol.50, no.3, pp. 463-478, 2006.
31. L. D. T. Mortilla, C. E. Misch, and J. B. Suzuki, "The dental hygienist's role in implant evaluation & assessment," *Journal of Practical Hygiene*, vol. 17, pp. 15–17, 2008.
32. http://www.hu-friedy.com/products/williams-colorvue-probe-kit.html
33. D. Buser, H. P. Weber, and N. P. Lang, "Tissue integration of non-submerged implants. 1-year results of a prospective study with 100 ITI hollow-cylinder and hollow-screw implants," *Clinical Oral Implants Research*, vol. 1, no. 1, pp. 33-40, 1990.
34. A. Niimi and M. Ueda, "Crevicular fluid in the osseointegrated implant sulcus: a pilot study," The *International Journal of Oral & Maxillofacial Implants*, vol. 10, no. 4, pp. 434-436, 1995.
35. A. Behneke,N. Behneke, B.D'Hoedt, andW.Wagner, "Hard and soft tissue reactions to ITI screw implants: 3-year longitudinal results of a prospective study," *International Journal of Oral and Maxillofacial Implants*, vol. 12, no. 6, pp. 749-757, 1997.
36. Pinar Emecen-Huja, Iquebal Hasan, Craig S. Mille. Biologic Markers of Failing Implants. *Dent Clin N Am* 59 (2015) 179-194.
37. Steven Present and Robert A. Levine, Techniques to Control or Avoid Cement Around Implant-Retained Restorations, Compendium of Continuing Education in Dentistry, June 2013, Volume 34, Issue 6.
38. Kim Y, Oh TJ, Misch CE, Wang HL. Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. *Clin Oral Implants Res* 2005; 16:26-35.
39. Gross MD. Occlusion in implant dentistry. A review of the literature of prosthetic determinants and current concepts. *Austr Dent J* 2008; 53: S60-68.
40. N. Meredith, "Assessment of implant stability as a prognostic determinant," *International Journal of Prosthodontics*, vol. 11, no.5, pp. 491-501, 1998.
41. Adell R, Lekholm U, Rockler B, Brånemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. *Int J Oral Surg*. 1981; 10:387-416.
42. C. E. Misch, "An implant is not a tooth: a comparison of periodontal indices," in Contemporary Implant Dentistry, C. E. Misch, Ed., chapter 41, pp. 1055-1072, Mosby, Elsevier, 3rd edition, 2007.
43. el Askary AS, Meffert RM, Griffin T. Why do dental implants fail? (partII). *Implant Dent* 1999;8:265-77
44. Truhlar RS. Perimplantitis - Causes and treatment. *Oral Maxillofac Surg Clin North Am* 1998;10:299-308
45. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: A review and proposed criteria of success. *Int J Oral Maxillofac Implants*. 1986; 1:11-25.
46. Kaneesh Karthik, Sivakumar, Sivaraj, Vinod Thangaswamy. Evaluation of implant success: A review of past and present concepts, *J Pharm Bioallied Sci*. 2013 Jun; 5(Suppl 1): S117-S119.
47. N. P. Lang, T. G. Wilson, and E. F. Corbet, "Biological complications with dental implants: their prevention, diagnosis and treatment," *Clinical Oral Implants Research*, vol. 11, pp. 146-155, 2000.
48. J.-J. Suh, Z. Simon, Y.-S. Jeon, B.-G. Choi, and C.-K. Kim, "The use of implantoplasty and guided bone regeneration in the treatment of peri-implantitis: two case reports," *Implant Dentistry*, vol. 12, no. 4, pp. 277-282, 2003.
49. Pilar Valderrama and Thomas G. Wilson Jr, "Detoxification of Implant Surfaces Affected by Peri-Implant Disease: An Overview of Surgical Methods," *International Journal of Dentistry*, vol. 2013, Article ID 740680, 9 pages, 2013. doi:10.1155/2013/740680
50. Drago L, Del Fabbro M, Bortolin M, Vassena C, De Vecchi E, Taschieri S. Biofilm removal and antimicrobial activity of two different air-polishing powders: an in vitro study. *J Periodontol* 2014; 85:e363-e369.
51. R. E. Goldstein and K. J. Nimmons, "The expanding esthetic practice: implantmaintenance-part 2," Contemporary Esthetics & Restorative Practice, pp. 2-25, 2005.
52. Wang, Y., Zhang, Y. and Miron, R. J. (2016), Health, Maintenance, and Recovery of Soft Tissues around Implants. *Clinical Implant Dentistry and Related Research*, 18: 618-634. doi:10.1111/cid.12343
53. C. H. Hämmerle, I. Fourmousis, J. R. Winkler, C. Weigel, U. Brägger, and N. P. Lang, "Successful bone fill in late peri-implant defects using guided tissue regeneration. A short communication," *Journal of Periodontology*, vol. 66, no. 4, pp. 303-308, 1995.
54. B. Lehmann, U. Bragger, C. H. Hammerle, I. Fourmousis, and N. P. Lang, "Treatment of an early implant failure according to the principles of guided tissue regeneration (GTR)," *Clinical Oral Implants Research*, vol. 3, no. 1, pp. 42-48, 1992.

55. J. C. Wohlfahrt, S. P. Lyngstadaas, H. J. Rønold *et al*., "Porous titanium granules in the surgical treatment of peri-implant osseous defects: a randomized clinical trial," *The International Journal of Oral & Maxillofacial Implants*, vol. 27, no. 2, pp. 401-410, 2012.
56. M. Gosau, S. Hahnel, F. Schwarz, T. Gerlach, T. E. Reichert, and R. Bürgers, "Effect of six different peri-implantitis disinfection methods on in vivo human oral biofilm," *Clinical Oral Implants Research*, vol. 21, no. 8, pp. 866-872, 2010.
57. M. Alhag, S. Renvert, I. Polyzois, and N. Claffey, "Re-osseointegration on rough implant surfaces previously coated with bacterial biofilm: an experimental study in the dog," *Clinical Oral Implants Research*, vol. 19, no. 2, pp. 182-187, 2008.
58. Mellado-Valero A, Buitrago-Vera P, Solá-Ruiz MF, Ferrer-García JC. Decontamination of dental implant surface in peri-implantitis treatment: a literature review. *Med Oral Patol Oral Cir Bucal*. 2013 Nov 1; 18(6):e869-76.
59. O. Dörtbudak, R. Haas, T. Bernhart, and G. Mailath-Pokorny, "Lethal photosensitization for decontamination of implant surfaces in the treatment of peri-implantitis," *Clinical Oral Implants Research*, vol. 12, no. 2, pp. 104-108, 2001.
60. H. Gursoy, C. Ozcakir-Tomruk, J. Tanalp, and S. Yilmaz, "Photodynamic therapy in dentistry: a literature review," *Clinical Oral Investigations*, vol. 17, no. 4, pp. 1113-1125, 2012.
61. Salvi GE, Persson GR, Heitz-Mayfield LJ, Frei M, Lang NP. Adjunctive local antibiotic therapy in the treatment of peri implantitis II: clinical and radiographic outcomes. *Clin Oral Implants Res* 2007:18:281-5.
62. Schwarz F, Sahm N, Iglhaut G, Becker J. Impact of the method of surface debridement and decontamination on the clinical outcome following combined surgical therapy of peri-implantitis: a randomized controlled clinical study. *J Clin Periodontol* 2011:38:276-84.
63. NP Lang, Tord Berglundh, Lisa J. Heitz-Mayfield, Bjarni E. Pjetursson, G E. Salvi, Mariano Sanz. Consensus Statements and Recommended Clinical Procedures Regarding Implant Survival and Complications. Group 4 Consensus Statement. Volume 19, Supplement, 2004.
64. R. E. Goldstein and K. J. Nimmons, "The expanding esthetic practice: implantmaintenance-part 2," Contemporary Esthetics & Restorative Practice, pp. 2-25, 2005.
65. Felo A, Shibly O, Ciancio SG, Lauciello FR, Ho A. Effects of subgingival chlorhexidine irrigation on peri-implant maintenance. *Am J Dent* 1997; 10:107–110.
66. Ciancio SG, Lauciello F, Shibly O, Vitello M, Mather M. The effect of an antiseptic mouthrinse on implant maintenance: plaque and peri-implant gingival tissues. *J Periodontol* 1995; 66:962-965.

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