DENTAL IMPLANT MAINTENANCE- A REVIEW

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ABSTRACT

The emphasis for long term success of dental implants has shifted over the years from surgical technique and proper fixture placement, to implant maintenance and effective patient home care in recent times. Peri-implantitis has similar etiological, clinical, radiographic and histological features as periodontitis. Clinical parameters, such as probing depth, clinical attachment level, bleeding on probing and mobility, are important indicators for detecting potential peri-implant disease. This article reviews the systematic approach for evaluation of the dental implants, as well as the proper professional and home care required for the long term success of the dental implants.

Key words: Dental Implants; Oral hygiene; Peri-implant probing; Implant maintenance

The use of implants in dentistry to replace missing teeth has become a predictable, routinely used treatment modality in edentulous and partially edentulous patients.\(^1, 2\) The early focus of implant research and treatment addressed the bone-implant interface, the quality and quantity of bone available for surgical procedures, and prosthetic design.\(^3\) But the emphasis for long term success of dental implants has shifted over the years from surgical technique and proper fixture placement, to implant maintenance and effective patient home care in recent times.\(^4\)

Peri-implantitis defined as the inflammatory process affecting the tissues around an osseointegrated implant in function, and resulting in loss of supporting bone, is mainly caused due to the detrimental effects of anaerobic plaque bacteria on peri-implant tissue health\(^1, 5-7\) and the patient must perform daily biofilm removal and maintain regular professional care to prevent it.\(^5, 6, 8-11\) The dental professional’s role is to determine the dental implant patient’s individual and specific self care needs. Recommendations and instructions to patients are often determined by the prosthesis design, location and angulation of the implants, the length and the position of the transmucosal abutments and patient habits such as smoking, oral health motivation and manual dexterity.\(^12\) Before considering implant maintenance procedures and methods to evaluate implant health, it is important to understand the basic differences between a dental implant and a natural tooth. This article discusses the systematic approach for evaluation of the dental implants, as well as the proper professional and home care required for the long term success of the dental implants.

Anatomy and biology of peri-implant soft tissue: Various studies have demonstrated histological, histochemical, and ultra-structural similarities in the architecture of peri-implant and periodontal tissues. But these similarities are limited to the form and function of the analogous epithelial structures. The oral, sulcular and junctional epithelia in the peri-implant soft tissue are nearly identical in form and function to their periodontal counterparts. The height of the epithelial attachment is 2mm and the height of the supracrestal connective tissue is 1mm around dental implants.\(^3,7, 12, 13\)

A junctional epithelium forms and attaches to a titanium dental implant in a manner analogous to the epithelial attachment that forms to a natural tooth, i.e., a hemi-desmosomal attachment.\(^14\) In both cases, the junctional epithelial attachment is an important component of the protective perimucosal soft tissue seal. Similarly the sulcular epithelium that forms adjacent to a dental implant provides cellular immunologic protection analogous to that found in the periodontium. The thick, keratinized oral epithelium provides protection from the mechanical forces of mastication, restorative procedures, and oral hygiene as an when present.\(^8\) But certain dissimilarities exist between the periodontal and peri-implant structures: The gingiva and the supracrestal connective tissue adjacent to teeth are supplied by supraperiosteal vessels, intraosseous vessels and the vessels of the periodontal ligament. The peri-implant mucosa in contrast lacks the vessels from the periodontal ligament and is thus less vascular. Thus the peri-implant tissue has impaired defence capacity against exogenous irritation.\(^16, 17\)

The connective tissue seal does not exist in the peri-implant mucosa. Connective tissue seal with the help of sharpey’s fibres exist in the mucosa around teeth. The fibre bundles in peri-implant connective tissue are oriented parallel to the implant abutment surface.\(^18\)

There are no gingival fibre bundles analogous to the dentope- riosteal and dentogingival fibre bundles found attached to a natural tooth due to the absence of cementum. The immobility of the peri-implant mucosa is derived from the fibres running from the alveolar crest to the free gingiva and from the tonus of the circular fibres running circumferentially around the implant.\(^15\)

The connective tissue found immediately adjacent to a dental implant is histologically similar to scar tissue; that is, it is rich in collagen in poor in cellular elements.\(^15\) The collagen content is greater and the number of fibroblasts are less as compared to the connective tissue around teeth.\(^16\) These differences also
make the peri-implant tissue more susceptible to mechanical and bacterial challenges.\textsuperscript{15}

There is greater probe penetration around implants as compared to teeth due to the absence of a biologic seal. It was seen that the average penetration of the periodontal probe at healthy sites was around 2 mm for implants and around 0.7 mm for teeth. At implant sites the probe tip displaced the junctional epithelium as well as the connective tissue in a lateral direction and stopped close to the bone crest. At tooth sites, however, the tip of the probe constantly terminated coronally to the apical portion of the junctional epithelium. This study showed that the epithelial attachment of the junctional epithelium to the implant is week as compared to that with teeth.\textsuperscript{19}

Faster rate of disease progression around implants as compared to teeth is seen.\textsuperscript{20}

These structural differences in peri-implant tissues compared to tissues around teeth make them more susceptible to the development of inflammation & bone loss when exposed to plaque accumulation or microbial invasion. Peri-implant disease: Peri-implant disease refers to the inflammatory processes in the tissues surrounding an implant. Peri-implant mucositis refers to the reversible inflammatory process in the soft tissue surrounding a functioning implant whereas Peri-implantitis refers to an inflammatory process additionally characterized by loss of peri-implant bone.\textsuperscript{15, 21}

Clinical signs and symptoms of peri-implant disease\textsuperscript{22} includes, a) edematous peri-mucosal tissue, b) bleeding after gentle probing with a blunt instrument, c) suppuration, d) loss of supporting bone, e) progressive loss of osseointegration, f) vertical bone destruction with associated peri-implant pocket and g) mobility of the fixture and continuous radiolucency.

Maintenance of Implants: The long-term success of implants depends on the patient’s strong commitment to perform dental maintenance care and effective home care procedures. The dental professional must evaluate and assess peri-implant tissues, establish and perform clinical maintenance protocols, suggest effective home care procedures, and provide educational materials. There should be a proper balance of implant clinical care and the patient’s home-care techniques. Ideally, the patient should be recalled every 3 months during the first year and at least every 6 months thereafter.\textsuperscript{22, 24}

The periodontal parameters used to evaluate the peri-implant tissues include, presence of plaque and calculus, probing depths, bleeding on probing, mobility, occlusal status, stability of prosthesis, width of keratinized tissue around implants, radiographic appearance of implant and peri-implant structures and clinical appearance of peri-implant tissue.\textsuperscript{22}

Plaque and calculus: Dental plaque is the main etiological factor for causing peri-implant mucositis and peri-implantitis, which have similar clinical and histological features as gingivitis and periodontitis respectively.\textsuperscript{2} Differences between tooth and implant biologies make dental implants more susceptible to detrimental effects of dental plaque.\textsuperscript{25} Plaque biofilm development and maturation have similarities for natural teeth and dental implants, ultimately leading to the formation of calculus if left undisturbed. Pathogens commonly associated with peri-implantitis are Aggregatibacter actinomycetem comitans, Prevotella intermedia, Porphyromonas gingivalis, Peptostreptococcus micros and Fusobacterium nucleatum.\textsuperscript{26} These potentially pathogenic bacteria colonize the soft tissues surrounding the implant within six months of implant insertion, triggering an inflammatory response, if oral hygiene is not maintained.\textsuperscript{22, 27} Implants placed in partially edentulous patients are at an increased risk for implant infection as compared to implants placed in completely edentulous patients. This suggests that natural teeth may serve as a reservoir for periodontal pathogens that may extend their growth to contiguous implants in the same oral cavity. Also the micro flora in partially edentulous implant patients is more pathogenic than fully edentulous patients.\textsuperscript{28, 29} Thus an even more meticulous oral hygiene regimen is needed for partially edentulous implant patients.\textsuperscript{28}

Plaque has been shown to develop more rapidly and in larger amounts around titanium implant abutments than around natural teeth\textsuperscript{30} (Figure 2). This is true for all types of implants, because virtually all types of implants have titanium abutment heads. The implant body type does not affect the extent of plaque accumulation. A plaque-disclosing solution should be used to obtain an objective plaque index.\textsuperscript{31} The adherence and tenacity of calculus around implants is less binding, as titanium is not porous as root cementum and there is no calculus embedded into it. Hence calculus can be easily removed with short, exploratory working strokes with light pressure without damaging the surrounding soft tissues. Oral hygiene techniques should be reassessed and reinforced, and the patient should be shown areas of accumulated plaque, debris or calculus.\textsuperscript{31, 32}

Peri-Implant probing: Probing depths around teeth are an excellent and proven means to assess the past and present health of natural teeth. Likewise, probing depth indices are often used to evaluate dental implant health. However, relating implant sulcus depth to health is controversial as the probe goes through the junctional epithelial attachment, displaces connective tissue laterally and stops close to the alveolar bone. Greater probing depth is seen around implants as compared to teeth in health.\textsuperscript{32}

Peri-implant probing should be performed only where signs of infection are present. Routine probing around dental implants should not be performed, because this procedure could damage the weak epithelial attachment around dental implants, possibly creating a pathway for the ingress of periodontal pathogens.\textsuperscript{33} Metal probes should not be used around dental implants to avoid scratching the abutment and implant surface. Titanium is an ideal implant material because of its strength, low density and biocompatibility, but it is a soft metal that is subject to physical wear. Scratching of the rela-
tively soft titanium surface may create irregularities conducive to plaque and calculus accumulation, as well as can impede or prevent effective accretion removal or oral hygiene. If a scratch occurs, plaque will have a direct “highway” below the tissues. Using metal probes also carries the risk of causing galvanic corrosion, which can lead to crestal bone loss. Hence, commercially available plastic or nylon periodontal probes should be used when investigating the crevicular depth around dental implants (Figure 3).

The correct pressure recommended for probing should be 20 g, yet conventional probing often exerts a force more than 5 times this level. Thus, a pressure sensitive plastic periodontal probe could address this issue and would be ideal for probing around dental implants. Peri-implant probing should not be done for 3 months from placement. Probing depth can be influenced by the thickness and type of mucosa surrounding the implant. Increasing probing depths over time may reflect tissue hyperplasia and/or loss of coronal integration of the implant, and can be a prime indicator of an ailing implant. Measurement of the attachment levels should be included relative to a fixed reference point on the abutment or prosthesis. Loss of attachment along the implant surface is of major concern. Therefore, accurate baseline data at restoration delivery will allow subsequent evaluation of probing depths and attachment levels. Probing should be done every 3 to 4 months for 1 year after prosthesis delivery.

Bleeding on Probing: The bleeding on probing correlates with inflammation and is an indicator of sulcus health. Easily ulcerated sulcular epithelium representing inflammation from plaque is the primary cause of bleeding when probing. Bleeding can also be provoked by undue pressure on the probe. The presence of bleeding after probing depth measurement indicates inflammation at the tissue-implant interface at that site, and the cause of the inflammation must be determined and corrected. However, as previously mentioned, routine probing is not recommended. It is important to note that the tissues surrounding a dental implant have fewer blood vessels than teeth; therefore inflammation is typically less around implants than around teeth.

Mobility: Mobility is a primary determining factor for implant health and is usually the first clinical criterion evaluated for a dental implant. A mobile implant indicates failure to achieve osseointegration and is suggestive of the presence of connective tissue between the implant and the bone. Mobility is a sign of an end stage disease and cannot be used to detect the early stages of peri-implant pathology. An implant with greater than 0.5 mm horizontal mobility or any vertical mobility should be removed to avoid continued bone loss and future compromise of the implant site.

A healthy implant moves less than 73 microns, hence it appears as zero clinical mobility as the human eye cannot detect such small amounts of mobility. This minute amount of mobility in a healthy osseointegrated implant is due to the flexure of the underlying bone. Two rigid instruments applying a labiolingual force of approximately 500 g can be used to assess implant mobility. Alternatively, a Periotest (Gulden-Medizintechnik, Bensheim an der Bergstrasse, Germany) can be used to assess implant mobility. It is a computer-mechanical device, developed by Schulte, that measures the dampening effect or attenuation degree against objects by developing a force of 12 to 18 N against a piston like device, which then measures the distance the piston recoils into the chamber after striking an object. A soft of mobile object gives higher recordings than a hard or rigid object. The recordings range from negative 8 to positive 50 and the degree of clinical mobility of an implant corresponds to values ranging from negative 8 to positive 9. More recently, a nondestructive resonance frequency analysis technique to measure implant stability and osseointegration has been introduced and provides similar valuable information as to the clinical movement and bone density around implants.

Occlusal evaluation: Bone loss can take place due to improper occlusion or parafunctional habits. Occlusal evaluation should be done on a regular basis. Occlusal overload can cause, loosening of abutment screws, implant failure or prosthetic failure. Any sign of occlusal disharmony or premature contacts, should be resolved. Implant –protected occlusion should have light centric occlusion and no contact on lateral excursions. The occlusal scheme should be relatively flat and should not have any prominent cusps. Patients with parafunctional habits should be given a night guard to protect the implant prosthesis. Psychological counseling and stress reduction techniques should be advocated for such patients.

Width of keratinized tissues: It is seen that an adequate amount of firm keratinized gingiva is needed around implants to assist the patient in performing proper oral hygiene measures. Loose non-keratinized mucosa is not capable of forming a tight adaptation to the abutment surface, and a mucosal margin can be easily deflected or pulled from the abutment surface. Greater plaque accumulation, bleeding on probing, gingival inflammation, recession, and probing depths is seen in cases of implants surrounded by a loose mobile tissue, thus increasing the chances of periimplantitis. Thus adequate attached gingiva is needed for improved soft tissue health, greater patient satisfaction and fewer complications.

An adequate zone of firm keratinized tissue surrounding the implant is also needed to enhance esthetic blending and resist trauma by oral hygiene measures and forces of mastication. Also a zone of firm keratinized tissue creates prosthetic friendly environment, which facilitates precise prosthetic procedures such as tissue retraction and impression making. In addition, an adequate zone of attached gingiva around the dental implant will be beneficial to resist numerous additional mechanical challenges such as abutment connection procedures, removal and replacement of provisional abutments, implant level impression procedures, preparation and delivery of subgingival restorations, framework try-ins, removal and placement of healing abutments and the movement allowed by resilient attachments securing removable implant prosth-
Radiographs: Radiographic interpretation is one of the easiest clinical tools to use to assess implant crestal bone loss. This is the most reliable method of evaluating implant status including the peri-implant bone destruction (figure 4), detection of any peri-implant radiolucency and implant-abutment connection. It is important to establish a radiographic baseline at the time of prosthesis delivery. It is recommended that postoperative implant radiographs be taken at the following intervals: at restoration delivery, at 6 months after prosthesis insertion, and then annually for the first 3 years. If no complications develop in that time, then monitoring radiographs can be taken every 2 years. Anticipated crestal bone loss is 1mm for the first year, with an average 0.1mm subsequent bone loss in the following years. Greater bone loss occurs in maxilla than mandible. Rapid bone loss can occur as a result of trauma from occlusion. A clear depiction of the threads of the implant on the radiograph indicates the use of proper angulation. A peri-implant radiolucency indicates the presence of surrounding soft tissue and is a sign of implant failure. The cause may be from infection, iatrogenic (heat-induced), or due to local bone healing disorders. On rare occasions, apical radiolucency is observed in relation to a non-mobile implant. It can occur due to infection, overheating, contamination from drill or due to perforation of lateral cortical plates of bone. The cause of apical radiolucency must be removed which includes aggressive curettage, and in some cases sectioning and removal of apical portion of the implant.

Certain limitations exist with the radiographic evaluation method such as it only illustrates clearly the mesial and distal crestal levels of bone. The facial aspect, which generally is the first to demonstrate early bone loss is not seen. Also, a 40% decrease in density is necessary to produce traditional radiographic changes and can at times be misleading.

Other Factors: Other significant factors for the long-term health and stability of dental implants are an accurate fit of the implant components, accurate passive framework fit, favourable occlusal forces, and a commitment to continuous professional care. It is recommended that supra-structures be removed annually to accurately assess implant mobility, gingival health, and hygiene status.

Implant maintenance regimens are based on individual’s need, home care ability, patient maintenance and skill. Oral hygiene aids for implant maintenance are manual scalers, sonic and ultrasonic scalers, polishing devices, manual and electronic toothbrushes, dental floss, interproximal brushes and antimicrobials.

Professional cleaning devices
Manual instruments: Instruments made of metal, such as stainless steel, should be limited to natural teeth and should not to be used to probe or scale dental implants. The rationale for this well-documented conclusion is that stainless steel is very hard and can scratch, contaminate or cause a galvanic reaction at the implant abutment interface. Stainless steel scaling instruments may abrade the implant surface, stripping off any surface treatment such as hydroxyapatite (HA), as the instrument’s hardness is greater than the titanium alloy the implant is fabricated from. Ideally, the hand periodontal scalers for cleaning dental implants can be plastic, Teflon, gold-plated or made of wood. When using gold-plated curettes, sharpening of the instruments should not be done as the gold surface could be chipped, exposing the hand metal underneath this coating.

Sonic and ultrasonic scalers: Sonic and ultrasonic scaler tips may mar the implant surface leading to micro roughness and plaque accumulation. The stainless steel tip may also lead to gouging of the implant’s polished collar. However, special attachments, such as nylon sleeves and plastic inserts, can be used with metal sonic and ultrasonic instruments for scaling around dental implants.

Polishing devices: Air powder polishing units can damage the implant surface and should be avoided. The air pressure can detach the soft tissue connection with the implant, leading to emphysema. Also, the use of baking soda powder in these units can strip off any surface coating on the implant. Titanium or titanium alloy surfaces of dental implants can be polished using a rubber cup along with a non-abrasive polishing paste (figure 7) or a gauze strip with tin oxide.

Oral irrigators: Subgingival irrigation with antimicrobials such as chlorhexidine gluconate can be carried out with oral irrigators, but care should be taken that the cannula is inserted properly, to avoid gouging the surface. Also the cannula should not be inserted to the base of the sulcus, so as to avoid fluid distention into surrounding tissues.

Home care cleaning devices
Manual or electric toothbrushes: A medium sized short head soft toothbrush is ideally suited for the cleaning of dental implants. Since implants are considerably more sensitive in terms of erosion through mechanic force, using manual toothbrushes with bristles made of synthetic material and featuring rounded ends is recommended. Brushes with hollow bristles should not be used, as they serve as niches for bacterial growth. Modified bass brushing technique should be followed. Recently, automated mechanical toothbrushes have been advocated as a daily mode of tooth cleansing. These toothbrushes are superior to the manual toothbrushes. The electric toothbrush is significantly better in removing plaque. The electric toothbrush makes dental care more intensive and is better fitted to the individual arrangement and nature of the teeth.

Dental Floss: A toothbrush is not suited to the cleaning of interdental areas. In order to deal with this problem, the use of dental floss is highly recommended. Patients need to be instructed on the proper technique of using the dental floss. Su-
Interproximal Brushes: Interproximal brushes should be used with caution. They should be used by implant patients only after being shown their proper use. They are available with interchangeable tips of various shapes. The brushes may have an exposed tip of metal wire that can easily scratch the titanium surface of the abutment. Also, if enough pressure is exerted or if the brushes are worn, the wire substructure can scratch the implant or abutment surface. The plastic-coated wire brush is the only type of interdental brush that should be used with dental implants. (Figure 9).

Antimicrobials: Twice-daily use of an antimicrobial mouth rinse, such as a chlorhexidine gluconate has been found to be an effective means for maintaining oral hygiene. Chlorhexidine mouth rinses have been shown to be effective in reducing plaque around implants. Long term use of antimicrobials such as chlorhexidine gluconate, cetylpyridium chloride or phenolic compounds may be used along with brushes and floss to minimize staining.

Conclusion
The emphasis for long term success of dental implants has shifted over the years from surgical technique and proper fixture placement, to implant maintenance and effective patient home care in recent times. The differences in the peri-implant structures as compared to the periodontal structures make them more susceptible to plaque mediated destruction. Early recognition of a failing/ailing implant is essential. Professional care and oral home care measures are two critical factors which determine long term success of implants. The patients needed to be motivated and instructed about the importance of proper oral hygiene maintenance on the dental implant prosthesis.

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