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Clinical Review

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Guidance for the Maintenance Care of Dental Implants: Clinical Review

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Abstract

As implant treatment becomes part of mainstream dental therapy, dental offices should implement protocols for individualized, systematic and continuous supportive care of the peri-implant tissues. This review article suggests guidelines for maintenance care of dental implants. The preliminary assessment should begin with updating the patient's medical and dental histories. The clinical implant should be examined to evaluate the following: condition of the soft tissues, plaque index, clinical probing depth, bleeding on probing, suppuration, stability of soft-tissue margins, keratinized tissue, mobility and occlusion. If the clinical signs suggest the presence of peri-implantitis, radiography of the site is advisable, to confirm the diagnosis. Appropriate treatment should be pursued according to any diagnosis reached during the examination, including (but not limited to) instructions on oral hygiene, removal of supra- and sub-gingival plaque and calculus, occlusal adjustment, relining of a removable prosthesis or surgery.

Patients who have undergone successful implant therapy should receive individualized, systematic and continuous supportive care of the peri-implant tissues. Patients at higher risk for peri-implantitis, such as those with partial edentia and pre-existing chronic periodontitis, should be identified and monitored closely.[1-4] Several studies[5-9] have demonstrated that sites of pre-existing infection may act as reservoirs for periopathogens, which can spread to colonize the implant, especially in patients with aggressive periodontitis.[10] Other patients potentially at risk are patients with diabetes mellitus who have poor metabolic control,[2,11,12] those with poor plaque control[13] and those who smoke cigarettes.[3,5]

According to the 2003 American Academy of Periodontology position paper on periodontal maintenance,[14] "patients should be evaluated at regular intervals to monitor their peri-implant status, the condition of the implant supported prostheses, and plaque control." Maintenance principles should include regular evaluation of implants and their surrounding tissues and prostheses; occlusal examination; review and reinforcement of oral hygiene; removal of plaque and calculus; treatment of disease or repair of prostheses, as required; and institution of customized preventive measures.[14] Following restoration of an implant, the patient should be re-evaluated regularly (i.e., every 3 to 4 months) during the first year.[15] After the first year, response of the peri-implant tissues should be assessed, at which time the appropriate

Table 1 Plaque indices commonly used for evaluating plaque on implants

O'Leary and colleagues[18]
% score = no. of tooth surfaces with plaque[a] / no. of tooth surfaces present[b] × 100
Lindquist and colleagues[19]
0 = no visible plaque
1 = local plaque accumulation
2 = general plaque accumulation > 25%
Mombelli and colleagues[20]
0 = no visible plaque
1 = plaque recognized by running probe over smooth margin of implant
2 = visible plaque
3 = abundance of soft matter

[a]Method for determining number of tooth surfaces with plaque: apply disclosing solution to teeth and rinse; examine teeth and record tooth surfaces where disclosing solution remains (on the basis of 4 or 6 surfaces per tooth, at the practitioner's discretion).
[b] Method for determining total number of tooth surfaces present: count total number of teeth and multiply by either 4 or 6 surfaces, depending on the method of counting surfaces with plaque (as described above).

frequency of periodontal maintenance should be determined.[15]

A clear understanding of the signs of disease is crucial, so that early and definitive action can be taken to prevent clinical attachment and bone loss around teeth and implants, which might otherwise go unnoticed until advanced stages.[15] Any procedures to assess or maintain implant health must take into account the unique nature of the implant systems and materials at the soft-tissue interface, as well as the need to minimize accumulation of plaque on the implant surface and ensure ease of removal.[16] This paper suggests a protocol for the maintenance care of dental implants, based on a review of the literature.

Assessment

Updating of Medical and Dental Histories

The assessment begins with updating the patient's medical and dental histories, to ensure that all concomitant conditions and therapies are known and to identify patients in high-risk categories.

Examination of Clinical Implant

Soft-Tissue Assessment: The soft-tissue assessment includes checking for visual signs of gingival inflammation, such as redness, swelling, alterations of contour and consistency, aberrant gingival form or the presence of fistulas.[2]

Plaque Index: It is recommended that some objective form of plaque monitoring be performed and documented at every maintenance visit, to allow longitudinal assessment of oral hygiene. According to Humphrey,[17] consistent use of the selected index is even more important than the choice of index. The plaque control record of O'Leary and colleagues[18] is often used for implants as well as the natural dentition. In addition, implant-specific plaque indices have been described by Lindquist and colleagues[19] and Mombelli and colleagues.[20] These 3 indices are summarized in **Table 1**.

Rough-surfaced implants, such as implants sprayed with titanium plasma for humans[21] and porous anodized implant surfaces for dogs,[22] have been shown to accumulate greater amounts of plaque than smooth-surfaced implants, which may increase the risk for peri-implantitis. Bacterial adhesion has also been shown to be influenced by surface roughness in vitro, with higher subgingival bacterial load occurring on rough surfaces.[23] However, other studies[24,25] have demonstrated no correlation between inflammatory response and the roughness of abutment surfaces,[24] no effect of rough surfaces on bacterial species succession in the biofilm[25] and no evidence that characteristics of the implant surface significantly affect the initiation of peri-implantitis.[26] Although there is conflicting evidence, caution is advised when monitoring rough surface implants exposed in the mouth because of a potentially greater tendency for plaque to accumulate.

Clinical Probing Depth: Probing is an important and reliable diagnostic parameter in the longitudinal monitoring of peri-implant soft tissues.[2,17,27-31] The safety of probing around implant restorations has been well established, and this procedure does not seem to jeopardize the integrity of oral implants.[2,11,17,27-29,31,32] Etter and colleagues[32] reported that "healing of the epithelial attachment" is complete 5 days after clinical probing.[32] Unfortunately, an alternative school of thought, with no basis in scientific evidence, still exists that does not advocate any probing around dental

implants. Whenever possible, measurements should be taken with a periodontal probe from the midaspect of the mesiobuccal, buccal, distobuccal, mesiolingual, lingual and distolingual surfaces of the fixture. Many authors[11,17,27-32] have recommended use of a plastic periodontal probe, whereas 2 recent papers[2,3] have suggested conventional metal periodontal probes, because they do not appear to cause any damage to either the mucosal attachment or to the implant. However, to the authors' knowledge, no empirical studies have been conducted to validate this recommendation.

During the first session after installation of the prosthesis, it is important to establish the baseline value for clinical probing depths.[2,31] Probing depths for conventionally placed implants, with supraosseous implant platforms, generally range between 2 and 4 mm if the tissues are healthy.[31] Implants placed at bone level or at an infraosseous level may exhibit slightly greater clinical probing depths. Increases in both clinical probing depth and bleeding on probing over time are usually associated with loss of attachment and loss of bone and should be viewed as signs of peri-implant disease.[2,3,17,31,33,34]

Bleeding on Probing: A prospective study of implants confirmed that, similar to the situation for natural teeth, absence of bleeding on probing had high negative predictive value and thus can be interpreted to represent stability of the peri-implant soft tissues.[35,36] Furthermore, when positive results on microbiologic tests occurred in conjunction with a rate of bleeding on probing of 75% or more, positive predictive values were greater for implants than for teeth.[36] Therefore, periodic recording of this parameter in conjunction with measurement of probing depth can be recommended for monitoring the condition of peri-implant soft tissues.[2,17,31] Gerber and colleagues[37] demonstrated that 0.15 N of pressure might represent the threshold (i.e., minimum pressure) to avoid false-positive readings for bleeding on probing around oral implants.

Suppuration: Suppuration has been associated with peri-implantitis in case reports. However, the sensitivity and specificity of suppuration as a marker for initial peri-implantitis or its progression have not been determined.[31,38-40]

Stability of the Soft-Tissue Margins: Peri-implant probing should include determining the location of the soft-tissue margin relative to a fixed landmark on the implant or its suprastructure. This information provides a means of assessing the clinical attachment level around implants.[2,31] Nevertheless, increasing recession may expose the implant surface and rougher surfaces may lead to more accumulation of plaque. So any apical migration of the gingival margin should be noted and monitored, even though there is no evidence that gingival stability is important for implant survival over the long term.[34]

Presence of Keratinized Tissue: There is no consensus in the literature regarding the influence of the presence or absence of keratinized tissue on the long-term health of implants. Some studies have revealed an association between lack of keratinized tissue and slight bone loss,[38,41] greater accumulation of plaque,[41-44] increased soft-tissue recession,[43-45] increased bleeding on probing[38,42-44] and greater gingival inflammation.[38,41-44] However, another study showed no relationship between keratinized tissue width and implant survival.[34] In the absence of keratinized mucosa around implants, the indications for soft-tissue grafting are unclear, and intervention will depend on case-by-case evaluation.[31]

Mobility: Mobility should be assessed routinely, either manually or by automated means such as the Periotest dental measuring instrument (Siemens, Bensheim, Germany) or the Ostell instrument (Ostell, Gothenburg, Sweden).[41,46] If only one implant in a multiunit splinted prosthesis has mobility, the mobility may be masked. Therefore, it has been suggested that fixed, multiunit, retrievable implant-retained prostheses be removed periodically to assess mobility, gingival health and hygiene status.[17] The cause of any mobility should always be ascertained, specifically whether it is due to failure of the prosthetic or failure of osseointegration. If the implant as a whole becomes mobile, it is deemed to have failed and should be removed.[2,17,31]

Occlusion: Occlusion schemes should provide for adequate posterior support at an appropriate occlusal vertical dimension. Eccentric guidance should be used to ensure optimal distribution of

the potentially destructive effects of excursive occlusal parafunction.[47,48] If technical complications occur, they should be treated accordingly. Parafunctional habits should be documented and treated, since application of excessive concentrated force can cause rapid and substantial peri-implant bone loss.[17]

Bone Level: If clinical signs suggest the presence of peri-implantitis, radiography of the site should be performed to confirm the diagnosis.[2,3,31,40] However, radiography during maintenance care should be performed on the basis of need, not predetermined protocols. An attempt should be made to standardize the radiographic technique so that the interface between implant and bone is well delineated.[2,31] The choice of imaging modality must be tailored to the patient's individual clinical and anatomic circumstances.[17] Complete seating of the associated abutment and/or restoration, absence of restorative overhangs and removal of all restorative cements should also be verified, because these areas may predispose the patient to long-term complications.[15] To facilitate accurate reading of radiographs (should they be needed in the future), it is important to establish baseline bone levels after implant placement and again after insertion of the prostheses.[2,3,31] Dental implants with machined surfaces and external hex connections will be subject to initial remodelling around the coronal part of the implant (1.5 mm during the first year and 0.1 mm per year thereafter).[49] Over the years, the macro- and microstructural aspects of implant design have been changed in the attempt to reduce marginal bone resorption during healing and under functional load.[50] Macrostructural advances include addition of microthreading at the implant neck,[51] use of an internal connection to create a more stable biological seal[52] and platform switching.[53,54] The most important microstructural aspect is treatment to generate a moderately rough surface (e.g., porous anodized surface,[55] fluoride-modified surface,[56] surface treated by large-grit sandblasting and acid-etching).[57] Dental implants that incorporate those macro- and micro-structural changes seem to have reduced initial crestal bone remodelling during healing and under functional load.[58-61] Evaluation of marginal bone levels should take into account the particular implant system, to avoid misdiagnosis of peri-implantitis in cases of normal remodelling.

Diagnosis

Healthy

If there are no clinical signs of inflammation, the patient's implants are classified as healthy.

Implant Mucositis

Mucositis is defined as a localized inflammatory lesion within the soft tissue, without progressive bone loss, apart from the original 0.2–2.0 mm cratering that occurs shortly after abutment connection around some osseointegrated implants. Mucositis may be identified clinically by redness and bleeding on gentle probing (pressure < 0.15 N).[15,31,62]

Peri-implantitis

Peri-implantitis is characterized by a localized inflammatory lesion that incorporates bone loss around an osseointegrated implant. In cases of peri-implantitis, the mucosal lesion is often associated with suppuration or deepening of the clinical probing depths and is always accompanied by bleeding on probing and loss of supporting marginal bone beyond the original bone loss.[2,15,31]

Treatment

Whenever any abnormality is identified, appropriate treatment should be pursued according to the diagnosis reached during the examination. Such treatment may include, but should not be limited to, instructions on oral hygiene, removal of supra- and sub-gingival plaque and calculus, occlusal adjustment, relining of a removable prosthesis or surgery.

Home Care

Evidence suggests that plaque control is as critically important for the maintenance of dental implants as it is for natural teeth.[13,16] Therefore, it is imperative that patients understand their role and responsibility in maintaining their implants. Ideally, a home care assessment should have been performed before placement of the implant fixture,[17] but whether or not an initial assessment was performed, review and reinforcement at subsequent maintenance appointments are essential.

A regimen for thorough oral hygiene, customized according to the condition of the tissue and the extent of plaque and calculus around the implants, should be implemented.[17] Home care devices and aids that have been shown to be safe for use around implant surfaces include interdental brushes with nylon-coated core wire, soft toothbrushes (both manual and power), end-tuft brushes, gauze, many types of floss (e.g., plastic, braided nylon, coated, floss with stiffened end to clean under bridges [Superfloss, Proctor & Gamble, Cincinnati, OH], dental tape, Postcare implant flossing aid [Sunstar Americas Inc., Chicago, IL]), stannous fluoride gel and chlorhexidine.[17,30,63,64] Home care instructions should be customized according to implant design and accessibility. For example, smaller-diameter toothbrush heads, such as end-tuft brushes, may be helpful for areas that are difficult to access.

Scaling and Root Planing

Scaling and root planing procedures entail the use of plastic curettes and fine polishing pastes. Professional maintenance should include removing both hard and soft deposits with plastic scalers.[17,63-68] Some plastic instruments are highly flexible and can be difficult to use when removing calculus from implant surfaces.[17] Plastic instruments reinforced with graphite are more rigid and can be sharpened.[17] Traditional stainless steel,[63-68] titanium[65-67,69] and gold-tipped[65-67,69] instruments may scratch the implant surface, which facilitates biofilm growth. Traditional ultrasonic tips also seem to significantly damage the implant surface.[63,65-67] Recent studies have shown that newly developed plastic-covered[70] and novel metallic copper alloy[71] ultrasonic scaler tips have minimal effects on the titanium surface of implants. Polishing with a fine polishing paste does not appear to scratch the implant surface; however, there have been conflicting results regarding the use of air-polishing abrasives on implant surfaces.[64-67] To date, no studies have linked scratching of the implant surfaces to increased incidence of mucositis or peri-implantitis.[14]

Occlusal Adjustment

In addition to peri-implant inflammation (discussed above), traumatic occlusion is another potential cause of breakdown of bone around the implant.[72,73] It is therefore important to perform an occlusal examination during the implant maintenance consultation. Studies performed on monkeys suggested a possibility of bone resorption around implants with 180 μm of excess suprastructure height, even in the absence of inflammation in the peri-implant tissue.[72,73] In clinical studies, an association between loading conditions and marginal bone loss around oral implants or complete loss of osseointegration has been reported, but a causative relationship has not been shown.[74] For fixed restorations, light centric contacts and avoidance of noncentric interference are recommended.[17,48] During the occlusion assessment, shim stock should be held only with tightly clenched teeth, to ensure avoidance of excessive occlusal loading of implants.[17]

Further Interventions

If the examination protocol outlined above yields evidence of implant mucositis or peri-implantitis, further interventions may be necessary. Mechanical debridement, supplemented with application of chlorhexidine, may be beneficial for patients with peri-implant mucositis, reducing plaque, inflammation and probing depth and allowing gain in clinical attachment level.[75]

Conversely, nonsurgical therapy of peri-implantitis has not been as successful.[76,77] Other treatments, such as erbium-doped yttrium aluminum garnet (Er:YAG) laser therapy or use of air abrasives[78] or diode laser irradiation,[79] have been investigated as methods to decontaminate the implant surface. However, only limited data are available in the literature, and so far there is no definitive evidence that any of these methods improve clinical conditions in cases of peri-implantitis.[78,79] Caution is advised if the practitioner uses techniques with an insufficient evidence base.

Another nonsurgical option for the treatment of peri-implantitis is local administration of Arestin [minocycline hydrochloride microspheres 1 mg (Ora-Pharma, Horsham, PA)].[80,81] That treatment led to slight improvements in clinical and microbiological parameters for up to 12 months.[80,81]

Surgical interventions that have been used to treat peri-implantitis include resection associated with implantoplasty[82] or regenerative therapy.[83] Surface decontamination is important during

treatment of peri-implantitis, but decontamination alone will not lead to substantial re-osseointegration on a previously contaminated implant surface.[84] So far, there is no consensus in the literature about which treatment is better for peri-implantitis. We hope to address these procedures in greater detail in a subsequent paper.

Conclusions

This paper has outlined a standardized, evidence-based assessment and intervention protocol to assist practitioners in the maintenance care of dental implants. Now that implant therapy is part of mainstream dental treatment, it is important to identify patients who are at risk for peri-implantitis, institute an appropriate maintenance protocol, and document and treat any lesions that might occur in a timely manner. A proactive approach to identifying implant mucositis lesions is advisable, as an animal model has shown that this condition can progress to peri-implantitis.[22]

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