Chapter 27

Implant complications encountered during maintenance therapy

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Introduction

Although dental implants have well-documented high success and survival rates, complications do occur. In fact, in a systematic review of the survival and complication rates of implant-supported fixed dental prostheses (FDPs) with a mean observation period of at least 5 years, it was reported that only 66.4% of the patients were free of any complications at this time point [1]. The most frequent complications over the 5-year observation period were fractures of the veneering material (13.5%), peri-implantitis and soft tissue complications (8.5%), loss of access hole restoration (5.4%), abutment or screw loosening (5.3%), and loss of retention of cemented FDPs (4.7%).

Maintenance therapy is essential for monitoring and maintaining the health and stability of a successful implant restoration. The importance of maintenance therapy was demonstrated in a study that reported results of two implant groups of patients over 5 years [2]. Both groups had pre-existing mucositis. However, in the group with no preventive maintenance, the incidence of peri-implantitis at 5 years was 44% compared to 18% in the group with maintenance care [2]. This chapter will discuss the etiology, prevention, and methods for diagnosing and treating these two biological complications during maintenance therapy.

Considering that an increasing number of patients – including those with risk factors for complications – are choosing to have implant-supported restorations, it is important that a successful outcome is achieved and remains stable. This involves maintenance care that preserves the health and integrity of both the hard and soft tissues surrounding a dental implant through prevention and detection of peri-implant diseases – both peri-implantitis and peri-implant mucositis. This can only be achieved through proper record keeping, good home care, and adherence to regular professional maintenance visits. Moreover, in those situations where problems arise, it is imperative to recognize and render treatment at the earliest stage possible.

The vast majority of dental implant problems experienced during the maintenance phase of care are related to inflammation. If the clinician is better able to identify and understand this, prevention and management can be performed more effectively. The importance of more stringent follow-up care for dental implants versus teeth is something that is oftentimes unrecognized and understated as many patients have the erroneous belief that implants are immune to complications. For this reason, it is important to understand the profile of patients who are at the greatest risk for developing these problems and provide strategies for early recognition and intervention.

Diagnosis

The two major dental implant biologic complications encountered during the maintenance phase of care are peri-implant mucositis and peri-implantitis [3, 4]. The former condition is one in which the inflammatory lesion is contained within the soft tissues surrounding the dental implant and is not associated with crestal bone loss beyond that seen with physiologic modeling or remodeling of the hard tissues that occurs following implant placement and loading. While this clinical condition has been called mucositis, it may be misleading because this inflammation can be present in both the presence and absence of keratinized tissue (i.e., gingiva). Inflammation around a dental implant presents a major concern since there is a lack of inserting supracrestal connective tissue fibers as are present with teeth. These inserting fibers can
help mitigate the progression of the inflammatory lesion to the bone. Thus, maintenance care for implant replacements becomes more critical. Peri-implantitis is the condition where bone has been lost around the dental implant due to the pathologic progression of inflammation [5]. It can threaten the survival of dental implants and quite possibly their status as the standard of care for edentulism. It is of utmost importance to distinguish between bone loss on the implant that is related to disease and bone loss that is associated with physiologic modeling/ remodeling.

Diagnosis begins with ongoing assessment at regular intervals and requires accurate record keeping. This should begin when a dental implant is placed and then proceed throughout the treatment and maintenance phases of therapy. For example, radiographs taken at the time of implant placement, restoration, and at the first signs of disease are a key aid in detecting pathological bone loss. Bleeding and increased probing depths should be evaluated at every visit. It is essential before beginning the process of placing a dental implant to recognize those patients who are at increased risk for these biologic complications and be alerted to making a diagnosis of the problem as soon as possible. A thorough medical and dental health history is the first step in this process. Appropriate co-management by the restorative dentist and periodontist will optimize the prognosis for long-term success in the event that biologic complications do occur. As with all other visits, the initial diagnosis should include:

- a current review of the medical history – including medications that were and are currently being taken
- a review of the dental history
- a review of the social history (e.g., smoking and alcohol consumption, to name but two)
- reports of pain or discomfort
- an extraoral and intraoral examination
- identification and possible calculation of plaque and bleeding scores
- a comprehensive periodontal examination to check for the presence of periodontal disease around the remaining natural teeth
- check for the location of calculus and/or residual cement
- examination of the peri-implant soft tissue, including recording pocket depths and clinical attachment levels and any changes from those obtained at prior visits
- examination of the restorative care
- assessment of occlusal wear, fracturing, and chipping of any restorations
- radiographic assessment, as deemed appropriate, for monitoring crestal bone level stability and any changes of the bone-to-implant interface.

At every maintenance visit, an examination of the peri-implant tissues should be performed both visually and tactilly. Changes in color, form, texture, and the expression of bleeding and/or suppuration on palpation and probing are changes indicative of inflammatory disease and should be noted. The question often arises whether one should use a metal or plastic probe. Most important is to probe at every visit, be consistent with using the same type of probe (since different probes may vary in diameter, affecting readings obtained), and use the same light force (25 N) while probing (Fig. 27.1).

While pocketing itself cannot predict future disease progression, deeper pockets can clearly harbor more periodontal pathogens leaving the implant at greater risk for inflammation and bone loss [6, 7]. Recording the position of the peri-implant mucosal margin and comparing it with prior observations also allows the clinician to identify ongoing recession and attachment loss, as any changes in these parameters are an indicator for the need to intervene with treatment.

Ascertaining bone levels is also an integral part of diagnosis and this is best accomplished radiographically [8, 9]. However, this will only identify bone levels at interproximal areas. Ideally, a periapical image should be taken when the implant is placed, at the time of prosthesis connection, and periodically thereafter. Signs of soft tissue inflammation, purulence, and probing depth increases should be considered when determining whether radiographs should be exposed. The radiographic images must be parallel to the implant body, should be as consistent as possible with prior images, and should demonstrate the crestal bone levels on the proximal aspects of the implant. Any developing radiolucencies along the implant body or at its apex, and general patterns of developing and ongoing bone destruction, should also be noted [10]. However, in certain instances periapical radiographs may
be difficult to obtain (e.g., when the mandibular ridge and the floor of the mouth are level, or a shallow maxillary vault exists). In these circumstances, a panoramic or computer axial tomogram may be necessary.

Three-dimensional imaging is an area of growing interest and use in practice [11]. While many have embraced this, its routine use in implant dentistry is an area that is still evolving. At this writing, the merits of its ability to display a more accurate rendering of the bone around a dental implant in three dimensions must be weighed relative to the increased exposure of the patient to radiation and whether bone sounding might obtain adequate enough information to help the clinician with diagnostic and therapeutic decisions. Bone sounding is done under local anesthesia by probing through the soft tissue vertically to the bone [12].

**Prevention**

Prior to instituting implant therapy, it should be understood that inflammation can have a major adverse impact on bone homeostasis around the implant. The following are a list of risk factors that suggest extra attention be paid to the development of biologic complications. This requires more frequent maintenance, with an interval exceeding biannual regularity.

**Systemic inflammatory diseases**

It has been well recognized that a number of systemic factors increase the risks for the development of peri-implant diseases. The Sixth European Workshop in their Consensus Statement recognized the risk that uncontrolled diabetes and smoking can provide to developing biologic complications [4]. The evidence regarding the association between diabetes and peri-implantitis is limited because of the small number of studies. Four systematic reviews suggest that no definitive conclusion can be made regarding diabetic patients having a higher incidence of peri-implantitis based on the current literature [13–15]. However, those reviews also pointed out that diabetic control is an important factor when assessing the relationship.

More recently, research efforts have continued to explore additional systemic inflammatory conditions that may impact the development and pathogenesis of peri-implantitis. This understanding has extended to those conditions that may present an “inflammatory dysbalance” to the steady state around an implant. Inflammatory diseases such as rheumatoid arthritis with concomitant connective tissue disease [16] have been evaluated to determine if associations exist. Cardiovascular disease is another area of emerging interest. In a retrospective study, Renvert et al. [17] noted that patients with a history of hypertension had an odds ratio of 8.7 for the development of peri-implantitis, which was significantly higher than the association seen with periodontitis (odds ratio 4.8). These patients are more prone to inflammation as measured by Creactive protein. While no definitive conclusions may be reached, it would be prudent for clinicians to encourage more frequent maintenance if any of these conditions are found in their patients, and to encourage optimal oral hygiene efforts on the part of the patient.

**History of smoking**

When looking at systematic reviews on smoking, the conclusion can be made that there is an increased risk for peri-implantitis in smokers, with odds ratios ranging from 3.6 to 4.6 [14, 18–20]. Moreover, cohort studies and cross-sectional studies frequently have linked smoking to higher implant failure rates. One study [19] reported that 78% of the implants in smokers had the diagnosis of peri-implantitis, while for nonsmokers it was only 64%. For those patients who smoke, cessation of this habit should be encouraged, and where this is not possible, increased frequency of professional maintenance should be encouraged.

**History of periodontitis**

Systematic reviews [18, 21–23] have indicated that although the implant survival rates may not be affected by the periodontal history, peri-implantitis was a more frequent finding in those patients. This is in large part due to the residual pockets around teeth, which act as reservoirs for pathogens that can initiate and perpetuate peri-implant diseases [6, 7]. To prevent the cross-infection of putative pathogens from infected teeth to dental implants, patients must be instructed in proper oral hygiene and treated with periodontal therapies aimed at eliminating all active disease and establishing a maintainable oral environment. This would imply that probing depths of 4 mm or less and furcations that are degree I or less should be established around the remaining teeth before proceeding with dental implant treatment.

**Prosthetic considerations**

The ideal goal is to reproduce the esthetic appearance of a natural tooth with the crown–abutment emerging from a dental implant. Many times, however, anatomy at the site may limit this from occurring, leading the clinician to consider potential compromises in design of the prosthesis. While this may achieve esthetic and functional success, the tradeoff may be limited cleansibility. The following are some of the prosthetic challenges.
**Poor fitting restoration**

Various implant prosthetic designs, in an effort to provide acceptable esthetics, phonetics, and/or function, can limit the patient’s ability to mechanically clean around a dental implant with toothbrushes, interdental brushes, and floss (Fig. 27.2a–d). Moreover, it may also preclude clinical evaluation with probing [24]. It is well recognized that failing to faithfully reproduce the emergence profile of a natural tooth with an implant restoration can result in diminished esthetics. However, there has been less discussion in the literature about the hygienic dilemmas that can be created by these compensations in prosthetic design. The convexities and concavities introduced in the abutment–crown complex may contribute to trapping food, along with inadequate removal of both plaque and calculus around the peri-implant tissues leading to the development of peri-implant mucositis and peri-implantitis [24].

The design of an implant prosthesis should take into account all the potential problems and their consequences. The restorative dentist and laboratory technician must achieve a balance between esthetics, phonetics, function, and hygiene when designing prosthetic contours. Hence, when attempting to correct for a complication arising from the surgical and/or restorative process, the solution may involve substituting one problem for another (Fig. 27.2a–d).

It is important to understand the differences in emergence through the soft tissue between implants and natural teeth if one is to optimize esthetics while minimizing challenges to oral hygiene. Implant platforms and collars are circular in cross-section and have either straight or slightly divergent profiles (Fig. 27.3). In cross-section, implants are smaller in diameter than the teeth they replace and their circular shape does not reproduce those of the natural dentition (Fig. 27.4). Thus, it may be difficult to reproduce the three-dimensional contour of the gingiva as it surrounds the implant abutment and crown.

Though most emergence profiles of natural teeth are straight, the emergence profile of an implant abutment and crown has been recommended to be either concave (to create a space for additional gingival tissue to fill in) or convex (to provide support for the existing gingiva).

![Fig. 27.2](image-url)
An ideal anatomic emergence profile reproduces the relationship between the tooth and its surrounding gingiva (Fig. 27.5a–c). The abutment and crown contours gently diverge as they emerge from the platform up to the height of contour. There are no abrupt changes in this emergence that would create areas of underlying prosthetic tissue (Fig. 27.3). Hence, maintenance care in this circumstance will consist of debridement of the peri-implant sulcus tissue, to which there is relatively unrestricted access.

In the case of a partial ridge lap profile, the abutment and crown contours abruptly shift at an angle greater than 90 degrees, creating an area of underlying prosthetic tissue (Fig. 27.6a–c). Hygienic maintenance in this circumstance is somewhat obviated by the obtuse angle caused by this abrupt shift which limits access to the peri-implant sulcus.

There are a few clinical situations that can lead to fabricating a partial ridge lap profile in the final prosthesis. The first occurs with the implant placed in a favorable position with adequate “running room” for crown development. However, due to gingival biotype, the crown on the implant may not ideally replicate a natural tooth at its cementoenamel junction. Thus, the laboratory technician introduces an abrupt shift in the emergence angle as the restoration emerges through the gingiva (Fig. 24.7).

A second scenario is when the implant is placed in an unfavorable position, being displaced in one or more dimensions off its ideal as determined by the central fossae or incisal edges of the neighboring teeth. Hence, the restorative dentist and laboratory technician partially ridge lap the area to compensate for the malposition.

A third situation is the case of the molar implant restoration. These crowns often display partial ridge lapping even when implant placement has been ideal. This is because a multi-rooted teeth with large mesiodistal and buccolingual widths have been replaced by a single implant which has an implant platform inadequate in diameter to compensate for those widths. Best efforts at developing an emergence profile may reduce the partial ridge lap and may even eliminate it in the buccolingual dimension. However, the mesiodistal dimension will still often serve as a site for plaque retention (Fig. 27.8).

A full ridge lap profile is where the abutment and crown contours abruptly shift at an angle less than 90 degrees, also
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A hygienic standpoint, providing basic masticatory function. However, patients frequently complained of speech complications, discomfort with large open spaces, and poor esthetics. Hence, pink porcelain or composites have been used to obviate these problems, resulting in an inability for patient and the hygienist to keep the area free of plaque and calculus. The hygienic dilemma is further complicated by patients with poor home care, non-compliance with in-office visits, and a predisposition to calculus formation (Fig. 27.11a–e).

Another area of emerging prosthetic concern is the use of restorative parts that are not produced by the original manufacturer to restore the dental implant. Studies have shown that non-original abutments often differ in design of the connecting surfaces and material and demonstrate higher rotational misfit [25]. These differences may result in micro-motion that can lead to crestal bone loss or worse – unexpected implant failure. All clinicians involved in the implant placement and restoration should collaborate in treatment planning and be included in the decision process of which abutment will be selected for the dental implant(s).

Creating a full-arch implant-supported fixed “hybrid” prosthesis. The original design for this metal–acrylic prosthesis involved tall cylindrical abutments that extended from the platform to the prosthesis without any surrounding additional prosthetic material. These “high-water” designs were quite favorable from a hygienic standpoint, providing basic masticatory function. However, patients frequently complained of speech complications, discomfort with large open spaces, and poor esthetics. Hence, pink porcelain or composites have been used to obviate these problems, resulting in an inability for patient and the hygienist to keep the area free of plaque and calculus. The hygienic dilemma is further complicated by patients with poor home care, non-compliance with in-office visits, and a predisposition to calculus formation (Fig. 27.11a–e).

Clinical situations that call for a full ridge lap profile include: severely malpositioned implants (Fig. 27.2); cases where the metal of the implant or abutment is exposed to the oral environment and is of cosmetic concern to the patient; and prostheses that replace deficient bone and gingival tissues (Fig. 27.10).

One example of this is the full-arch implant-supported fixed “hybrid” prosthesis. The original design for this metal–acrylic prosthesis involved tall cylindrical abutments that extended from the platform to the prosthesis without any surrounding additional prosthetic material. These “high-water” designs were quite favorable from

![Fig. 27.7](image1) A slightly concave emergence profile with a partial ridge lap prosthetic contour on the facial surface of a central incisor. Despite ample running room from the platform to the gingival margin, the prosthesis does not develop subgingivally from the circular shape of an implant into the triangular shape of a central incisor in cross section. Thus, the laboratory fabricates a crown with a sudden shift on the facial to maintain similar tooth proportions to the adjacent teeth.

![Fig. 27.8](image2) The diameters of molar implants are frequently inadequate to allow for anatomical emergence profiles in the mesiodistal dimension. Mild to severe traps for food debris and plaque are created by the partial ridge lap profiles.

![Fig. 27.9](image3) (a) A full ridge lap profile. (b) The emergence profile abruptly shifts along its path from the implant platform to the height of contour of the restoration. The angle of the abrupt shift is less than 90 degrees. (c) There is peri-implant sulcus tissue (red) and underlying prosthetic tissue (blue) to maintain.

![Fig. 27.10](image4) A metal–acrylic “hybrid” prosthesis with a pink acrylic flange to replace missing bone and gum volume.
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Nevertheless, when hygiene becomes compromised, revision or remake of the prosthesis may be necessary if the patient is unable to keep the site free of plaque. Screw-retained restorations must be considered in cases where it would be better to remove phonetics, and function. Nevertheless, when hygiene becomes compromised, revision or remake of the prosthesis may be necessary if the patient is unable to keep the site free of plaque. Screw-retained restorations must be considered in cases where it would be better to remove phonetics, and function. Nevertheless, when hygiene becomes compromised, revision or remake of the prosthesis may be necessary if the patient is unable to keep the site free of plaque. Screw-retained restorations must be considered in cases where it would be better to remove phonetics, and function.

Fig. 27.11  (a) Acrylic–metal “hybrid” prosthesis on day of insertion with full ridge lap contours. (b) The prosthesis 3 years post insertion. The patient had not returned for hygiene appointments and noted spontaneous, intermittent, moderate pain in the area of his midline. (c) The prosthesis was removed and revealed a severe accumulation of calculus and debris. (d) A stalactite-like projection of calculus had formed in the center. (e) An ulceration of the oral mucosa caused by the calculus projection was the source of the patient’s pain.

Finally, when efforts are made to meet patients’ expectations for optimal esthetics and in some instances where implants are placed in positions that are not optimal due to ridge position or prior bone loss, pink restorative materials may be needed to facilitate the esthetics,
the prosthesis several times a year at maintenance visits. Adjunctive devices for home care such as a Proxabrush® (Sunstar Americas, Schaumberg, IL, USA), end-tufted brush, or Waterpik® (Water Pik, Inc., Fort Collins, CO, USA) should be considered where traditional brushing and flossing fail to remove plaque completely.

Another issue that should be considered is inflammation at the implant–abutment junction [26]. Clinicians may wish to consider placing the abutment into an autoclave or soaking it in an antimicrobial agent (i.e., chlorhexidine, povidone–iodine, or diluted bleach solution) prior to its final insertion to reduce plaque levels.

**Residual cement**

The deleterious impact of retained cement on gingival health may be related to surface roughness, which in itself may cause inflammation. However, dental cement’s surface topography may also provide a positive environment for bacterial attachment. Residual cement may remain because of implant positioning as the superstructure may hamper mechanical nonsurgical debridement and obviate access to the subgingival space [27]. Also demonstrated has been a direct correlation between residual cement and the depth of the restorative crown margin. It would serve as a valuable asset if a radiograph exposed at the time of crown cementation could identify residual cement. However, many of the commonly used cements are radiographically undetectable [28]. Moreover, some cements may also adversely encourage putative pathogen growth. In addition, a study by Linkevicius and colleagues has uncovered an association between peri-implantitis and residual cement in patients with a history of periodontal disease [29]. This additive effect may well be related to the hyper-inflammatory nature of periodontitis patients combined with the cement acting as a nidus for bacterial growth.

To avoid leaving residual cement, it would be best to use screw retention for the final restoration, even if the implant is angled in its placement (Fig. 27.12a–d). This is not practical in some instances due to added costs and possible

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**Fig. 27.12** (a) Four-week healing with Osstel Smartpeg (Osstel, Baltimore, MD, USA) in place at the maxillary right implant site. The implant has achieved good stability. The peg suggests that there is a slight labial angulation from the ideal related to the hard tissue anatomy of the area. (b) Final restoration blends in with the surrounding environment with regard to tissue match with the adjacent teeth along with the soft tissue height, consistency, and color (prosthetic care: Eric J. LePine, DMD Yardley, PA, USA). (c) Palatal view allows visualization where the screw access hole is covered by composite material. This retrievability is made possible with a specially designed abutment (angulated screw channel abutment, Nobel Biocare, Yorba Linda, CA, USA). (d) Good bone maintenance is achieved six months following seating of the final restoration.
bulk to the restoration. If the decision is made to cement the final prosthesis, consider using cements that are radiographically visible and do not encourage the growth of periodontopathic bacteria [28]. Prior to seating the final crown intraorally, consider using an extraoral analog of the abutment to extrude any excess cement [30]. Lastly, sub-gingival areas should be thoroughly examined for residual cement soon after the final restoration is cemented.

**Occlusal disturbances**

Defining occlusal overload is difficult due to differences in the magnitude, duration, direction, and frequency of the applied occlusal load and the tolerance threshold of the host. Nevertheless, occlusal evaluations should be performed with articulation paper markings obtained in centric occlusion and under elicited parafunctional movement.

Finite element studies [31, 32] have suggested that the occlusal load is concentrated at the implant marginal bone. A recent systematic review [33] suggested that occlusal overloading was positively associated with peri-implant marginal bone loss but poor oral hygiene was still the key causative factor. Another occlusal concern relates to the physical forces associated with food impaction at implant sites. Much like the natural dentition, sites where food impaction (i.e., open contacts) may occur can produce inflammation around the dental implant and overload the body’s compensatory abilities. Information is coming to light that points to ongoing growth and development of the patient’s maxilla and mandible beyond the years of pubertal growth, leading to open contacts between implants and natural teeth [34]. Other adverse occlusal consequences secondary to growth and development include discrepancy in buccal–lingual landmarks, along with the development of infra-occlusion between the implant and the opposing arch. Conversely, when implants are splinted to natural teeth in a fixed restoration, teeth may appear to “intrude” from the fixture [35], when in essence it is the physiologic growth of the jaw that causes them to “walk out” from under the prosthesis. To prevent occlusal failure, implant-supported prostheses must be evaluated at every maintenance visit to detect developing disharmonies and if found, adjustment must be performed to eliminate this adverse factor to implant survival. Consideration should also be given to an ablative shield (i.e., nightguard and/or dayguard appliances) in those patients who demonstrate parafunctional habits of clenching and grinding.

**Soft tissue considerations**

Maintaining the peri-implant tissues in health is the responsibility of both the patient and the dental team (hygienist, restorative dentist, periodontist). Preventing the recurrence of inflammatory diseases involves ongoing plaque control and, where necessary, treatment that establishes a local environment to support this. Initially, the patient’s plaque control techniques must be observed and possibly modified to a level deemed effective. The clinician must emphasize the need to thoroughly clean the peri-implant crevice circumferentially as the lesion of peri-implant mucositis is more intense than that of gingivitis around teeth and is less likely to return to a baseline level of health. There are many plaque control implements to aid in this process. Choosing the most appropriate one for the patient may be challenging especially when looking at this from an evidence-based perspective [36]. Furthermore, most studies suggest that professionally administered therapies applied on either a local or systemic basis are at best successful approximately 38% of the time for treating peri-implant mucositis [37, 38]. The therapist must take into account the motivation of the patient (though studies suggest that dental implant patients are more highly motivated to comply) [39], their manual dexterity, implant position [40], design of the restoration, and tissue quality (e.g., absence of gingiva surrounding the restoration) [41]. In addition, local application of antimicrobial (chlorhexidine or phenolic compounds) or anti-inflammatory rinses may be recommended.

It is not enough for the therapist to simply discuss plaque control with the patient; proficiency should be demonstrated by the patient and may require several follow-up visits. Shortening the interval between professional maintenance visits must also be considered, especially if the patient has inflammatory risk factors or if a patient is unable to or less than willing to maintain proper plaque control.

Managing pocket depth and ensuring a circumferential zone of gingiva [42] are important considerations for long-term implant maintenance. In the case of deep pocket depths in areas where esthetics are not a concern and no bone loss has occurred, surgery may be needed or possibly, based on emerging case report information [43], the use of laser-assisted care implemented to reduce the pocket depth (Fig. 27.13a, b). Achieving these goals may require a combination of approaches, including apically repositioned flaps/soft tissue resection with or without implantoplasty [44, 45], soft tissue grafting with pedicle procedures, free soft tissue autograft, acellular dermal matrix, or subepithelial connective tissue grafts [12, 46].

In general, with a single tooth or unsplinted implant restoration the patient should be able to brush and floss into the crevice. The implant restoration may mimic a tooth, but the subgingival anatomy can be very different as the implant abutment is usually narrower than the cervix of a natural tooth. The patient needs to adapt floss
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by the therapist. Many implant restorations are part of a mixed implant–naturally dentate oral environment. There must be a concentrated effort to maintain the periodontal health of the remaining natural teeth together with the health of the peri-implant tissues.

Debridement of the implant-supported restoration must be directed at three components: the prosthesis, the abutment, and the implant fixture if its surface is exposed to the oral cavity. The restoration can be debrided, as with any other prosthesis, using appropriate instrumentation that avoids damaging the restorative material. The abutment needs to be instrumented to remove any accumulated plaque and calculus biofilm while avoiding damage to the integrity of its smooth convex surface. No one approach accomplishes this goal in all situations and each scenario may require a customized approach to achieving a plaque- and calculus-free environment. Use of conventional metal instruments designed for the natural dentition has been called into question as they have been shown to damage the implant abutment’s surface [49–51].

Alternative options may involve air-powder abrasion, specially designed sonic or ultrasonic instruments with padded tips or titanium and non-metal instruments manufactured for implant use. Non-metal instruments have demonstrated minimal or no damage to both machined and rough titanium surfaces with good adaptation to abutment surfaces [52]. However, while plastic-coated scalers may cause minimal damage and may also have a polishing action, they can leave residual plastic deposits on the implant surface [52]. Moreover, some of these instruments are too thick to gain access to areas requiring debridement. If the roughened surface of the implant becomes exposed, it must be debrided. The difficulty is when peri-implantitis is established as studies have demonstrated that even specially designed instruments with a nonsurgical approach may be of little value in establishing health [53]. In these scenarios, a regenerative surgical approach is often required which involves surface debridement with air-powder abrasion and citric acid conditioning [12, 54]. Where lesion morphology may not be amenable to such care, implantoplasty [44–46] may be considered to establish a smooth surface, as calculus oral biofilm on the implant surface can be very tenacious and difficult to remove due to the microstructure and macrostructure. The degree to which implantoplasty is performed will depend upon the diameter of the implant as it is important to avoid weakening the implant and causing it to fracture.

Treatment

Treatments aimed at controlling inflammation and infection and limiting biologic complications for peri-implant
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Their use can help evaluate for plaque control efficiency around the prosthesis, determine if any cosmetic and functional compromises exist, along with developing a desirable emergence profile. Any modifications made on the provisional are significantly easier and less costly than those on the final prosthesis (Fig. 27.15a, b). If the final prosthesis cannot be made totally cleansable due to implant position, esthetics, phonetics, or function, then its screw retention should be planned to facilitate removal at maintenance visits, which must be far more frequent. Additional devices to disrupt developing plaque biofilm need be considered for use by the patient.

As the implant-supported provisional is refined, the restorative dentist and the patient can evaluate the cosmetics, function, and hygienic access. When a desirable outcome has been reached, the restorative dentist can duplicate the subgingival emergence profile and supragingival prosthetic contours by creating a customized impression coping (Fig. 27.16a–f).

The above methods have been reported to be far less effective once the condition has progressed to peri-implantitis [57]. Moreover, even flap access surgical approaches, with or without targeted antimicrobial treatment, have met with limited success [58, 59]. Surface decontamination must completely eliminate the biofilm, debris, and excess cement. Recent evidence suggests that a dual antibiotic approach may be more appropriate than a single medication [60]. Nonetheless, aggressive surface management with air–powder abrasion combined with citric acid [12, 54] or the use of implantoplasty may be necessary.

When it comes to the final prosthetic outcome, prevention/recognition of problems are best ascertained through the fabrication of a provisional restoration.

Mucositis and peri-implantitis are usually identical to those found effective for gingivitis and periodontitis, respectively. First, it is always best to prevent a problem than to have to treat it. Identifying patients and dental implants at risk requires more frequent professional care and is the first step in prevention of complications. This includes tighter maintenance intervals, added effort in patient plaque control and very stringent monitoring. If patients are unable to perform acceptable maintenance due to implant positioning or prosthesis design, modification of the soft tissue or prosthesis in the affected area may be indicated. If that fails, remake of the prosthesis may be necessary.

Similar to gingivitis, peri-implant mucositis, when detected early, may be successfully treated with effective nonsurgical efforts aimed at elimination of the biofilm from the implant surface [55, 56]. No one instrument will most effectively debride the implant and an optimal outcome may require a combination of items. Furthermore, in situations where there are adjacent implants versus an implant adjacent to a tooth, it may require a different approach if the implants are placed too close to one another. Subgingival air–powder abrasion might be considered on a low intensity level. Efforts to treat peri-implant mucositis with conventional mechanical therapy or combined with adjunctive subgingival irrigation, local delivery agents, photodynamic therapy, laser treatment, and systemic antibiotics is, however, at best, only effective in approximately 40% of cases [57]. This may be due to the inability to thoroughly decontaminate any exposed microthreads at the flange area or any exposure of the roughened surface from physiologic bone loss associated with the implant’s placement or to remove residual cement if embedded into the roughened surface. For this reason, a surgical approach may be necessary [57]. This is especially true in an area where there is an absence of keratinized tissue around the implant (Fig. 27.14a, b) [41, 42]. These sites often require soft tissue grafting and possibly implantoplasty of the implant surface [47–49].

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Treating occlusal disharmonies can be quite challenging. Clinicians should be familiar with the opposing dentition and what parts are interfacing with the dental
Fig. 27.15 (a) An implant-supported provisional crown with a full ridge lap profile. (b) The profile has been modified to a partial ridge lap for improved hygienic access.

Fig. 27.16 Fabrication of a customized impression coping. (a) An implant-supported provisional is attached to an implant analog. (b) This complex is seated into a fast-setting bite registration material. (c) The implant-supported provisional is removed, leaving behind the replica and an impression of the desired prosthetic contours. (d) The impression coping is attached to the analog. (e) A fast-setting acrylic is flowed into the void between the impression coping and the impression of the desired prosthetic contours. (f) The completed customized impression coping.
implant. The restorative clinician must insist that original abutments made by the implant manufacturer be used, as aftermarket parts differ in design of the connecting surfaces and materials and demonstrate higher rotational misfit [25]. These differences may result in micromotion that can lead to crestal bone loss or implant fractures. The latter can be quite difficult and may necessitate removal of the implant and its subsequent replacement. If problems develop due to ongoing growth and development of the jaws [34] (i.e., the opening of contacts due to mesial tooth movement relative to the relatively static dental implant or development of infra-occlusion of the implant with concomitant food impaction), there may be the need for revision or remake of the prosthesis.

Because of the dynamic nature of the occlusion, excessive contact may occur on the implant crown in centric or excursive movements [61]. These may best be addressed through occlusal adjustment and the use of nightguard appliances for parafunction.

### Take-home hints

- Identify risk factors associated with developing peri-implant diseases.
- Establish radiographic baseline at the time of implant placement.
- Establish clinical and radiographic baseline at final prosthesis insertion.
- Employ methods that monitor implant health and determine inflammatory complications as part of an ongoing periodontal maintenance program.
- Determine, through provisional restorations, potential problem areas for oral hygiene and correct them prior to final restoration seating.
- In those situations where hygiene may be compromised, increase the maintenance frequency, use screw retention for retrievability, and consider adjunctive aids beyond standard brushing and flossing.
- Establish an early diagnosis and intervention, which will contribute to more effective management of peri-implant diseases. If the advancement of disease threatens keeping the dental implant, every reasonable effort should be made to save it before replacement is considered. The time and cost for replacement treatment can be prohibitive and this therapy can be quite complex, requiring significant experience to achieve a successful outcome. Although techniques have advanced to provide greater predictability for saving diseased implants with regenerative therapy, it is certainly easier, less costly, and less painful to avoid these treatments with early diagnosis and appropriate maintenance of the implant restoration.

### References


