CHAPTER 14

Dental Implants

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LEARNING OUTCOMES

After reading this chapter, the student will be able to achieve the following objectives:

- Describe the common types of dental implants.
- Discuss the indications and contraindications for dental implant therapy.
- Explain why titanium is the best biomaterial available for use in dental implants.
- Define the concept of osseointegration.
- Compare and contrast the bone and soft tissue interfaces of implants and natural dentition.
- List the criteria for success used in implant therapy.
- Describe the maintenance protocol for implant patients.
- Define the elements of appropriate home care regimens for patients with implants.

KEY TERMS

Abutment screw
Biocompatibility
Biomaterials
Cover screw
Endosseous implant
Failing implant
Immediate loading
Implant abutment
Implant biologic width
Implant fixture
Jumping distance
Loading
Nonsubmerged protocol
Osseointegration
Peri-implant disease
Peri-implant mucositis
Peri-implantitis
Subperiosteal implant
Submerged protocol
Suprastructure
Titanium
Transosteal implant

Since their inception, dental implants have revolutionized the way dentistry is practiced. In fact, many teeth that needed heroic treatment in efforts to preserve them are now extracted and replaced with implants. Dental implants have undoubtedly been the most significant scientific breakthrough in dentistry over the past 40 years and they have become an integrated part of both dental and periodontal practice.

A multitude of dental implant systems are currently used in the rehabilitation of edentulous and partially dentate patients. The majority of the implants used in clinical dentistry are the root-form type **endosseous implant** that is based on the principle of **osseointegration.** The term osseointegration was coined by Professor P. I. Brånemark, describing an intimate lattice that is formed between titanium implant surfaces and bone. Until the late 1960s to mid 1970s, dental implant systems did not have this property and were not viewed favorably by the community because they were considered unpredictable. The observation and findings of Brånemark, Albrektsson and colleagues, and others, together with the long-term survival data of osseointegrated dental implants has changed this perception so that the procedure has become a highly predictable and valuable option in the management of missing teeth.[1-6]

Today, in excess of 50 implant systems are available with innovations being proposed and instituted by different manufacturers through intense competition. However, many of these newer systems lack the longitudinal research necessary before patient application. Ideally, longitudinal trials of 5 years or more are required to adequately forecast the validity of emerging treatment concepts.[7] The American Dental Association provides an acceptance program for endosseous implants through its Council on Dental Materials, Instruments, and Devices.[8] Accepted implants have shown success for a minimum of 5 years in clinical trials of 50 or more patients.

Types of Implants

The most commonly used variety of dental implant is the osseointegrated root-form dental implant. Subperiosteal and transosteal types are also still seen, but much less frequently. All are described because these treatment modalities are still seen in clinical practice. However, this chapter focuses on the most common and successful implant, the endosseous osseointegrated root-form dental implant.

SUBPERIOSTEAL IMPLANTS

The **subperiosteal implant** is a custom-made cast framework that is placed beneath the periosteum over the alveolar bone. It can be used in either the maxilla or mandible. The frame rests on the jawbone with no evidence of direct union with bone in most cases. Posts of varying number, based on the prosthetic design, protrude through the overlying soft tissues to provide anchorage for the denture or fixed bridgework. A radiograph of a subperiosteal implant is presented in Figure 14-1.

TRANSOSTEAL IMPLANTS

Transosteal implants traverse the mandible in an apicocoronal direction. They protrude through the gingival tissues into the mouth for prosthesis anchorage. A stabilization plate is placed along the inferior border of the mandible. Posts are in turn attached to this plate and traverse the mandible to provide anchorage for prosthesis. Their use is limited to the mandible, where it is commonly referred to as a staple implant.

The interfacial adaptation between the subperiosteal and transosteal implants and bone resembles that of scar tissue with no direct bone anchorage. This creates a compromised arrangement under occlusal and physiologic load. An example of a transosteal implant is presented in Figure 14-2.

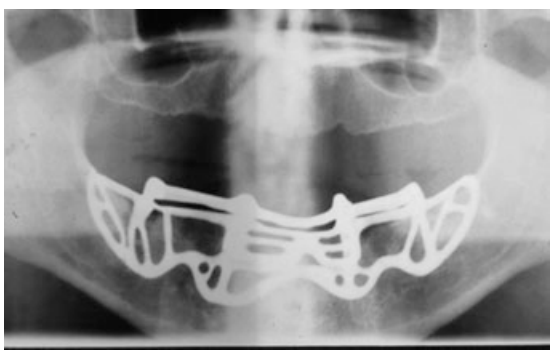


FIGURE 14-1 Example of a subperiosteal implant as it appears in a panographic radiograph.

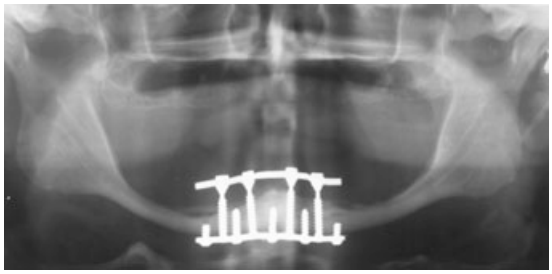


FIGURE 14-2 Example of a transosteal implant as it appears in a panographic radiograph. (Courtesy of Frederick C. Finzen, DDS.)

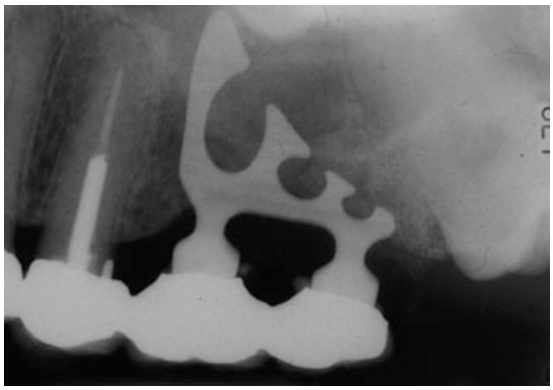


FIGURE 14-3 Example of a blade implant.

ENDOSSEOUS IMPLANTS

Endosseous implants, which come in a variety of different shapes, are placed within bone. They are broadly divided into blade and root-form types. The root-form variety is either screw or cylindrically shaped with different lengths, diameters, and manufacturer-specific design characteristics. The blade implant is rarely used today; it has a high incidence of complications and failures. An example is shown in Figure 14-3.

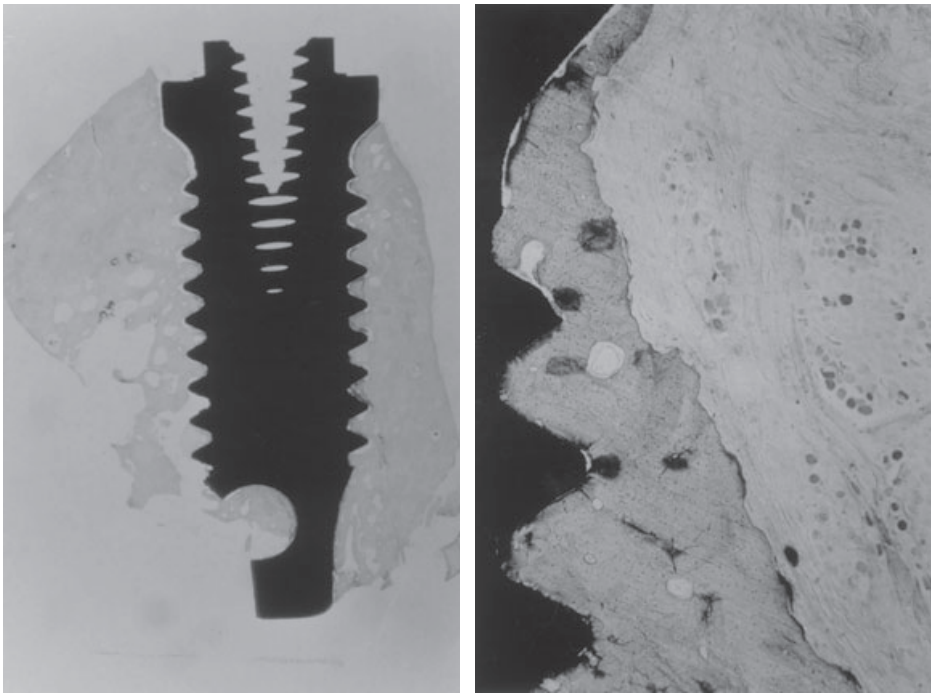
Root-form endosseous implants provide direct osseous anchorage through formation of an intimate lattice between the titanium surface and bone. They comprise the most predictable and acceptable implant type used in clinical practice. These implants are used extensively for replacing missing teeth in partially and totally edentulous patients. Examples of several root-form endosseous implants are presented in Figure 14-4.

FIGURE 14-4 A selection of titanium root-form endosseous implants. The two on the right are shown with abutments.

OSSEOINTEGRATION

The definition of osseointegration has evolved through the development of more refined methods to study the interface between the implant and the surrounding bone. The precise nature of this integration is not fully understood. Originally, because of limitations in histologic techniques at the light microscope level, the term was defined as a direct implant-to-bone union without any intervening soft connective tissue,[4,5] a condition that resembles that of "functional ankylosis."[9] A light microscopic view of osseointegration is presented in Figure 14-5. With the advent of scanning electron microscopy, more direct analysis of the interface is possible and osseointegration is more clearly understood. Scanning electrom microscopy of the interface revealed a narrow nonmineralized zone, approximately 20 nm to 40 nm, between the bone and the implant, containing chondroitin sulfate glycosaminoglycans.[10,11]

The definition of osseointegration, as exemplified by Bränemark, is characterized as a "direct structural and functional connection between ordered, living bone and the surface of a load-bearing implant."[12] This definition is based on clinical and radiographic implant stability rather than true interfacial arrangement, as observed histologically. Because implant integration involves soft and hard tissues, the term "stably integrated" implant has been suggested to better describe implant integration.[13]



A **B**

FIGURE 14-5 Peri-implant supporting tissues seen at the light microscopic level. A, View of the root-form with bone growth surrounding the titanium. **B,** Higher magnification showing bone apposition directly next to the titanium surface. (Used with permission from Bernard G, Carranza FA, Jovanovic S. Biologic aspects of dental implants. In Clinical Periodontology, 9th ed. WB Saunders, Philadelphia; 2002.)

Longitudinal observation of the bone-implant interface has also demonstrated that, because of the dynamic nature of bone, 100% integration never develops, and the bone-to-implant contact is both time dependent and influenced by implant surface characteristics. The amount of bone-to-implant contact varies between different implant systems (because of surface characteristics) and ranges from 30% to 70%.[14] However, the exact amount of bone-to-implant contact required for success has not been determined.

Other than its application in the dental field for tooth replacement, the concept of osseointegration has been applied in maxillofacial prosthodontics for correction of deformities and in orthopedics for joint and limb replacement.

The biologic processes involved in attainment and maintenance of implant integration depend on factors that include biomaterials and biocompatibility, implant design (length, diameter, shape, surface, etc), bone factors, and surgical and loading considerations.[2]

BIOCOMPATIBILITY

Biocompatibility of a material is defined as allowing "close contact of living cells at its surface, which does not contain leachables (molecules that separate off the surface) that produce inflammation and which does not prevent growth and division of cells in culture."[15] Biocompatible materials are called **biomaterials.** Many different types of materials are considered biomaterials, including gold, stainless steel, cobalt-chromium alloys, bioactive glasses, niobium, hydroxyapatite, tricalcium phosphate, polymers, zirconium, and titanium. However, not all are compatible as implant material.

Any implanted material is considered a foreign body. Unlike living tissue, the body recognizes all implanted metals as unnatural (nonself). Metals in contact with tissue fluid are prone to degradation and dissolution by corrosion. Exchange of protons with biologic molecules leads to antigen formation and cellular uptake. This reaction can

prove toxic to tissue cells and may inhibit growth and function. For example, fibroblast and osteoblast cells show growth inhibition with most metals other than titanium and zirconium. Thus commercially pure titanium has become the standard in osseointegration.

Titanium is a highly reactive yet biocompatible metal. It is the material of choice in osseointegration because it rapidly forms a layer of surface oxides, 3- to 5-mm thick, most notably of titanium oxide, when exposed to air or fluid (including tissue fluid). Unique to the mode of oxide formation on titanium is that no metal ion reaches the surface to be released. The oxide layer prevents corrosion on the surface so that tissue integration can occur. The tissue ground substance in the vicinity of the implant contains proteoglycans and other adhesion proteins that adhere to specific receptors in the oxide layer. Other advantages of titanium are that it is lightweight and possesses enough strength to withstand occlusal forces and moments.

IMPLANT DESIGN AND SURFACE CONDITIONS

Length

The range of implant lengths varies among manufacturers. Most conventionally used implants are between 7 and 16 mm long, which conforms to natural root lengths. Selection is based on the available bone height at the implant site and proximity to vital structures such as nerve trunks and blood vessels.

Diameter

Implant diameter ranges from 3.25 to 6 mm. The selection of a particular diameter is based on the volume of available bone at the implant site. There is less bone in the lateral incisor region, so narrower implants are used there, whereas wider implants can be used in the posterior molar region. The wider implants provide a larger surface area, which increases the implant stability in areas with limited bone height.

Shape

The most dominant form of endosseous implants used today is cylindric. Implants are solid and most of them exhibit a threaded surface design. The thread pitch varies among implant systems and can influence the initial stability and force distribution to the surrounding bone. There are also hollow implants available with no threads.

Surface

Since the introduction of the original machine-surface implants, a variety of surface topographies and thread designs have been introduced. The initial stability of the implant is, in part, dependent on the surface texture.[16] The rate of bone apposition and growth and the amount of bone-to-implant contact are influenced by implant surface characteristics.[17] Many studies have demonstrated that a higher bone-to-implant contact is attained around rough-surfaced implants.[18,19] Methods for producing roughened implant surfaces include grit blasting, acid etching, and additive surfaces such as hydroxyapatite coating. An increased rate and amount of interface with bone allows for better transfer of forces to bone, facilitates earlier **loading** protocols (placement of restorations on the implants), and permits better success in areas with poorer bone quality. Biomaterial research also underway is aimed at developing surface modifications to improve bone-inductive characteristics and to make these treatments even more predictable.[20] However, roughened implant surfaces are more prone to corrosion and, if exposed to the oral cavity, encourage more plaque biofilm adherence to the implant surface, which increases the risk for development of peri-implant inflammatory disease.

STATE OF HOST BED AND BONE FACTORS

The amount of bone-to-implant contact achieved at the time of implant placement is related to the quantity and quality of bone, and it determines fixture stability. There is variability in the amount of cortical and cancellous tissue within the arch and between the maxilla and mandible. The volume density in cortical bone is three to four times that of cancellous bone. Cancellous bone therefore contributes less to implant stability at placement. Resorption of the alveolus is also a natural sequelae to tooth loss. The extent of the resorptive process is partly dependent on the span of the edentulous space, history of trauma or infection, and the length of time since the loss occurred. The quality of bone is also influenced by systemic conditions and social factors such as smoking. Therefore the shape and quality of bone

must be considered when planning for implant therapy.[21]

LOADING CONSIDERATIONS

There are no fixed guidelines for length of healing time after surgery and before prosthetic loading of implants. Three months for the mandible and 6 months for the maxilla before loading was originally advised by Bränemark; the difference in healing times reflects the variation in bone characteristics.[5] Movement of the implant greater than 100 µm during the healing phase may result in fibrous tissue encapsulation of the implant rather than osseointegration, a result that does not tolerate long-term functional occlusal load. In cases where the functional load can be controlled and the implant is determined as stable at the time of placement, **immediate loading** (placement of the restoration at the time of the implant surgery) of the implant is shown to be compatible with attaining osseointegration.[22-27]

INDICATIONS AND CONTRAINDICATIONS FOR IMPLANT THERAPY

INDICATIONS

The clinical situations in which osseointegrated implant-retained prostheses are used have expanded enormously. A diverse range of case scenarios with varying degrees of complexity can be managed with the use of implants. These include the treatment of a single tooth,[28-30] partially and completely edentulous patients,[31,32] and correction of maxillofacial deformities. Single tooth replacement with an implant-supported prosthesis is considered to be a highly predictable and effective alternative to conventional prosthodontics procedures such as fixed partial dentures (bridges), which often require preparation of healthy neighboring teeth.[29] Specific indications for dental implants may include the following:

- Treatment of patients with strong gag reflex
- Long span bridges
- Free-end partial dentures
- Alternative to periodontally compromised teeth for bridge abutments
- Hopeless periodontal or endodontically involved teeth
- Orthodontic anchorage.

Examples of implant-supported prostheses are presented in Figures 14-6 through 14-9.

CONTRAINDICATIONS

It has been speculated that the presence of certain systemic, local, and social factors may affect the outcome of therapy. Age is not a contraindication for dental implants.[33] Treatment should be delayed in younger patients until growth is near completion because, unlike the natural dentition, implants remain stationary during dentoalveolar growth.[34,35] Similarly, increasing age in older persons has no adverse effect on osseointegration as long as associated medical conditions are well controlled or modified.

Conditions that increase the patient's susceptibility to infection such as uncontrolled diabetes or acquired immunodeficiency of different origins may result in a higher incidence of peri-implantitis and implant failure.

Osteoporosis, an age-related disease characterized by decreased bone mass and increased susceptibility to fractures, affects 20 million Americans, 80% of whom are older women. Hormone replacement therapy and osteoporosis do not appear to influence implant survival in this population,[36-39] although therapy with bisphosphonates have recently been attributed to an increased risk of jaw osteonecrosis.[40] Consultation with the patient's physician is recommended before implant therapy for patients receiving anticoagulant therapy because they are at risk for hemorrhage during surgical procedures; patients on long-term steroid therapy may have steroid crisis or steroid-induced osteoporosis.

The pathogens associated with periodontal disease around natural teeth are also associated with disease progression around dental implants.[41,42] Pathogenic bacteria associated with sites that exhibit active disease around teeth in partially dentate patients can colonize the peri-implant tissues.[41-45] Effective treatment and control of any periodontal disease before implant therapy is essential, and implants should only be considered in patients who demonstrate commitment to good home care and maintenance routines.

The adverse effects of smoking on osseointegration and implant survival have been shown in many studies.[46-48] Although smoking is not an absolute contraindication to implant therapy, it increases the risk of peri-implantitis

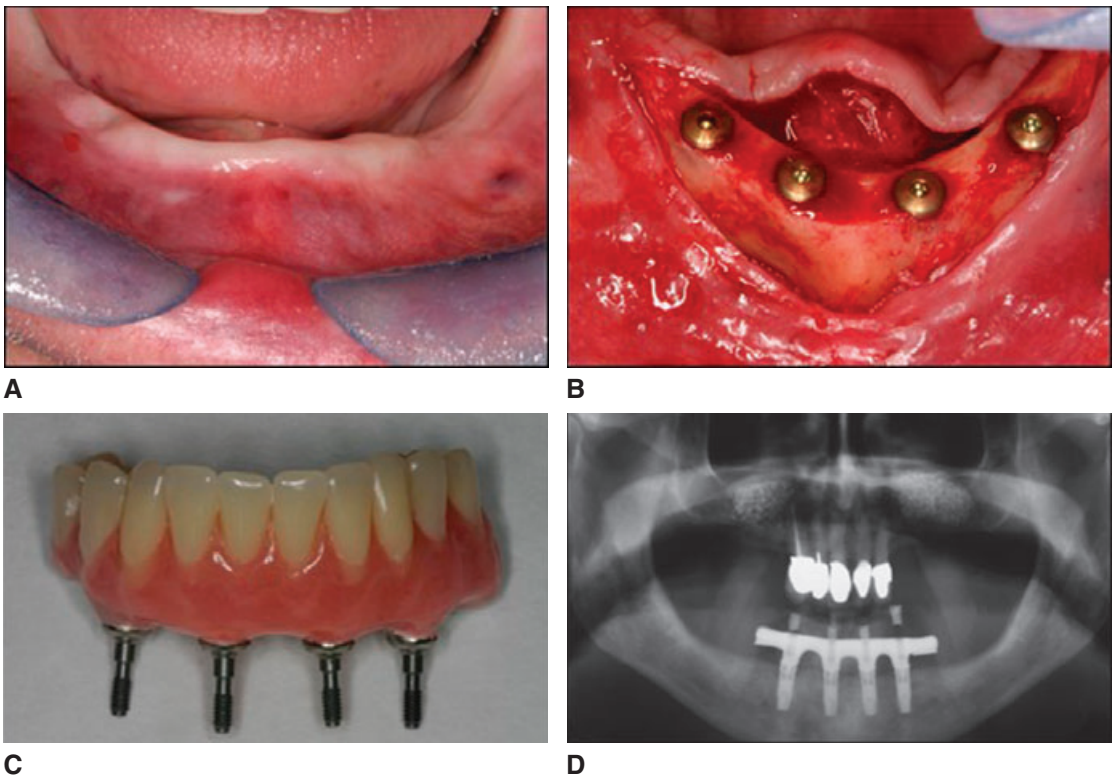


FIGURE 14-6 An example of a mandibular fixed denture supported by four endosseous implants. **A,** The mandibular ridge as it healed after implant placement. **B,** The flaps reflected to expose the implants. **C,** The denture with abutments to attach to the implants. **D,** Panographic radiograph of the denture in place, attached to the implant fixtures. Note the restored natural teeth in the maxillary arch.

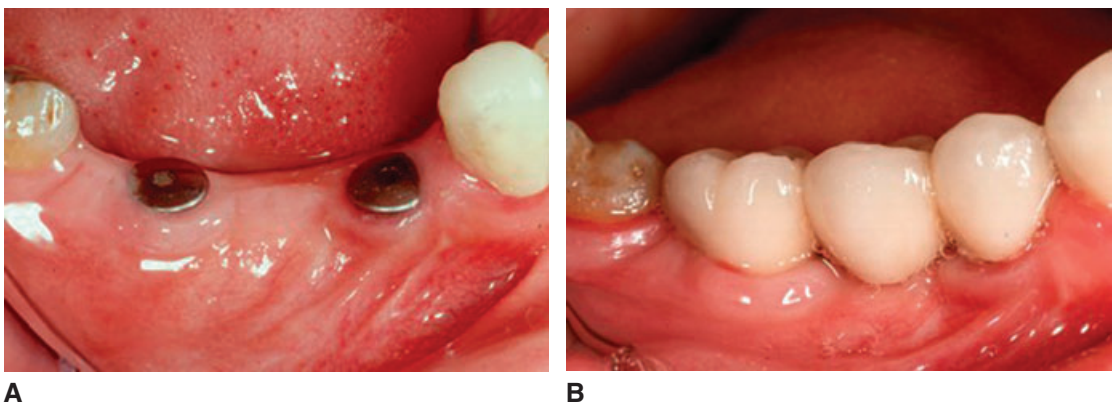


FIGURE 14-7 Example of an implant-supported fixed partial denture. **A,** The implant fixtures. **B,** The restoration in place when the implants are loaded.

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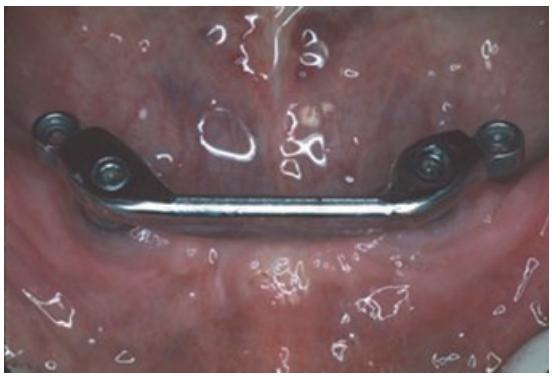

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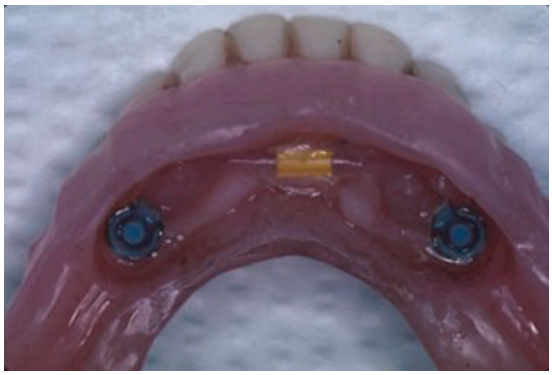


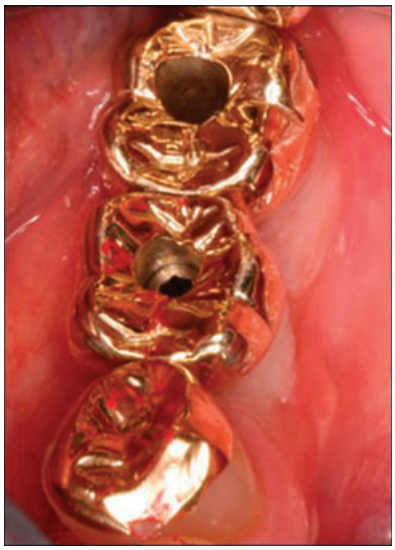
B

FIGURE 14-8 Example of a mandibular implant-supported overdenture. A, Two implants have been placed connected by a bar. **B,** The undersurface of the denture has an attachment for connecting to the bar.

and failure.[46] A smoking cessation protocol before implant surgery and during the healing period improves the treatment outcome.[49]

Teeth and Implants

The natural dentition is surrounded by the periodontium, comprising the gingiva, cementum, alveolar bone, and periodontal ligament (PDL). The gingival sulcus is 1 to 3 mm deep in health, and the base of the sulcus is formed by the coronal aspect of the junctional epithelium (JE). The JE is attached to the root surface by hemidesmosomes and a basal lamina. The cells of the JE have a high turnover rate and can migrate on the root surface to re-establish or form a new attachment. This occurs after trauma, inflammation and bone loss, restorative procedures that impinge upon the epithelial/connective tissue attachment zone (biologic width), and periodontal surgical



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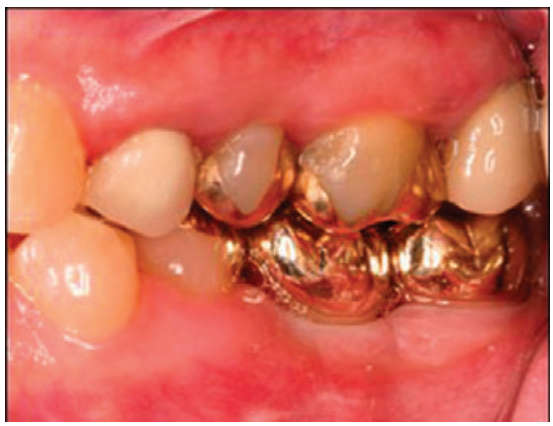

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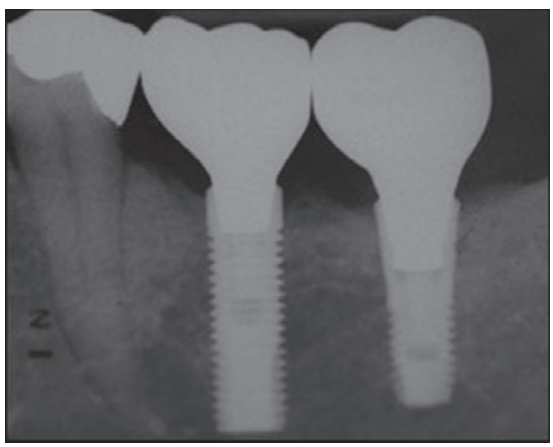


C

FIGURE 14-9 Examples of screw-retained, implant-supported crowns. A, The crowns in place on the fixtures, the holes are access for the screws that attach the restoration to the abutment. **B,** Lateral view of the crowns in place. **C,** Radiographic view of the implant-supported crowns.

procedures. The peri-implant soft tissue is shaped after abutment connection or, in case of single-stage implant systems, it forms around the transmucosal portion of the fixture (the section that extends from the bone into the oral cavity). The collagen fibers are aligned parallel to and organized in a circular arrangement around the supracrestal portion of the implant.[50] There is no cemental layer over the implant surface, so fiber insertion is not possible. The initial observations by Gould and colleagues,[51] and many subsequent studies[12,52-54] have demonstrated that the peri-implant soft tissue adheres to the titanium collar of the implant by a hemidesmosomal and basal lamina attachment mechanism, analogous to that of the JE to enamel attachment.

The PDL provides anchorage in the alveolus for natural teeth and imparts physiologic mobility and proprioceptive sensation to the dentition. The connective tissue fibers of the PDL attach to the alveolar bone and cementum perpendicularly and adapt to variations in occlusal load. The PDL space is highly vascular and a major source of undifferentiated mesenchymal cells, which play a pivotal role in regenerative and adaptive processes. Resorption and apposition of the surrounding bone and widening of the PDL space under different physiologic conditions, such as that seen in orthodontic tooth movement and occlusal trauma, are also functions of the PDL.

Implants acquire their stability and anchorage through direct contact with the surrounding bone, osseointegration. There is no PDL so that proprioceptive feedback is minimal, although proprioceptive mechanisms in the surrounding hard and soft tissues exist. Once osseointegrated, orthodontic movement of the implant is not possible and the forces applied to implants are important to control in maintenance of the integrated interface. Unfavorable loading of implants is one etiologic factor for bone loss around implants.[14,55-57]

The biologic width around teeth, the dimension of the epithelial and connective tissue attachments, is approximately 2 mm. A similar **implant biologic width** has also been described for the peri-implant mucosa, which comprises a 2-mm long JE and a 1-mm zone of connective tissue.[58] The connective tissue zone is poorly organized and exists between the JE, which is typically attached to the prosthetic component, called the **implant abutment,** and the bone. It is the implant abutment that extends from the implant through the soft tissues (transmucosally), which can be temporary, to allow soft tissue healing, or permanent. The implant abutment is connected to the **implant fixture** (the root analog device in the bone) by an **abutment screw.**

The osseous crest around natural teeth in health follows the outline of the cementoenamel junction at a distance of 1 to 2 mm apically on the root surface. The location of the crestal bone around implants depends on the implant design and may vary from 0.5 mm to 3 mm from the top of the implant fixture. These characteristics are compared in Table 14-1 and demonstrated diagrammatically in Figure 14-10.

TABLE 14-1 Comparison of Teeth and Implants in Health

	TEETH	IMPLANTS
Gingival sulcus depth	Shallow	Depth dependent on implant type and prosthetic component length
Gingival fibers	Inserted into supracrestal root cementum	Fibers arranged parallel to implant
Location of crestal bone	1-2 mm from cementoenamel junction	Dependent on implant design; ranges 0.5-2.5 mm from implant shoulder or to first thread
Connective tissue attachment	Sharpey's collagen fibers inserted into alveolar bone and cementum	Bone-implant interface has no fiber insertions; filled with chondroitin sulfate glycosaminoglycans
Mobility	Physiologic as a function of PDL	No PDL; rigid fixation similar to that of functional ankylosis
Proprioception	Receptors within PDL	No receptors within interface

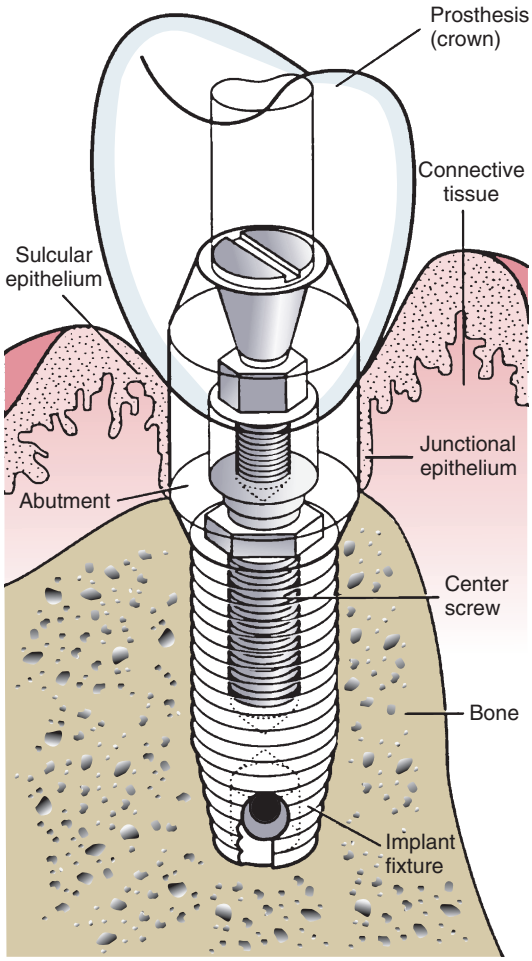


FIGURE 14-10 Diagrammatic representation of the implant fixture, abutment, and crown as they relate to the surrounding tissues.

BOX 14-1 Criteria for Implant Success[7,59-61]

1. No peri-implant radiolucency
2. Absence of mobility
3. Bone loss not greater than one third of implant
4. Provide functional service for 5 years in 85% of cases in the anterior maxilla and 90% in the anterior mandible; after 10 years, 80% success in the maxilla and 85% in the mandible.
5. Absence of persistent or irreversible signs or symptoms such as pain, infection, neuropathies, paresthesia, violation of mandibular canal
6. Bone loss less than 0.2 mm annually after first year of service
7. Implant design allows restoration satisfactory to patient and dentist
8. Absence of continuous marginal bone loss
9. Absence of persistent soft tissue complications
10. Probing depth less than 4-5 mm, bone loss less than 4 mm
11. No mechanical failure

Success Criteria

The clinical success of implant therapy is assessed by radiographic imaging, evaluation of implant mobility, and observing the surrounding soft tissue. Refinements to these conventional techniques include the use of digital and subtraction radiography, computed tomography, and devices that record the implant interface contact. Although evaluation of implants includes assessment of soft tissue parameters such as probing depths, this criterion is considered to be of limited value around implants and remains controversial.[7,59,60] Criteria commonly used to determine success of the implant are outlined in Box 14-1.

Most of the implant systems available for clinical application demonstrate high success rates. The reliability of this procedure has made it a common treatment modality in dental practice, and dental hygienists routinely provide maintenance care for implants.

Surgical Procedures

There are guidelines for the placement of osseointegrated endosseous implants to ensure high success rates and predictability of this treatment modality. Knowledge of the basics of implant surgery will help the dental hygienist communicate effectively with patients. The following is a brief outline of contemporary surgical issues and protocols.

Implant surgery is highly technique sensitive, and many factors are instrumental in achieving predictable, long-term results. Trauma to bone during implant recipient site preparation through overheating or use of excessive forces must be avoided to ensure treatment success.[61,62] Bone cells are irreversibly damaged if heated above 47°C for

1 minute, so copious irrigation with a coolant is required during surgery to create the recipient site in the bone for the implant. There is no recommended aseptic protocol for implant surgery[63] because the outcome of therapy is similar when implant placement is performed under "aseptic" and "clean" conditions.

Implant immobility throughout its healing period, ranging from 3 to 6 months, encourages successful osseointegration rather than a fibrous union at the implant-bone interface.[64] For this reason, a two-stage surgical approach was initially recommended to minimize the potential for functional load on the implant during the healing phase. With the introduction of a single-stage implant surgical protocol, and further research into the application of two-stage implant systems with use of a single-stage surgical protocol, similar results and implant success rates for soft tissue and bone healing have been shown.[65,66]

After a thorough examination and planning process that includes appropriate radiographs, study casts and fabrication of surgical guides (stent), implants are placed with use of a submerged or nonsubmerged protocol. The ideal location and angulation of the implant should be consistent with planned prosthetic **suprastructure** (restorations).

SUBMERGED (TWO-STAGE) PROTOCOL

As the name suggests, the **submerged protocol** requires two surgical procedures before the restorations that will be placed on the implants are fabricated. The first surgery places the implant fixture within bone, followed by a second surgery 3 to 6 months later to uncover the implant so it can be accessed through the mucosa.

First Surgical Procedure

After anesthesia is administered, a crestal incision is made within the soft tissue along the crest of the alveolar ridge and a flap is reflected in the location where the implant is to be placed. With the aid of a surgical stent, drills specific for the implant system of choice are used under copious saline solution irrigation to prepare the endosseous implant recipient site or sites to the predetermined length and diameter. Guide pins are used to verify the angulations and distances between implants or implant and tooth. Implants are either slowly threaded into place, in the case of screw design implants, or gently tapped in place in the case of nonthreaded cylindric designs. The implants are inserted into the prepared sites until they are completely submerged and encased in bone. The internal aspect of the implant is protected from ingrowth of tissue by placing a device called a cover **screw** on top of the implant. The flap is then replaced and sutured to obtain closure over the implant so that it is submerged under the gingiva. The two-stage submerged protocol is illustrated in Figure 14-11.

Postoperative Procedures

The patient should not wear dentures over the implant site for 2 to 3 weeks to avoid pressure on the implant. The area should be cleansed with a chlorhexidine 0.2% mouthwash twice daily, and the use of systemic antibiotics should be considered to minimize the chance of infection.

Second Surgical Procedure

After a healing period of 3 months for implants placed in the mandible and 6 months for those placed in the maxilla, submerged implants are exposed by either making small incisions or using circular punches over the implants to gain access to the cover screws and exchange them for healing abutments. Healing abutments are transmucosal posts that allow healing and adaptation of the peri-implant soft tissues to take place. An example of a healing implant in place after second-stage surgery is seen in Figure 14-12.

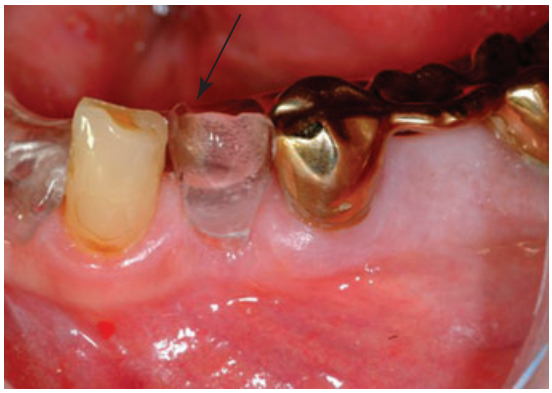
Restorative Procedure

The restorative procedures can usually begin after 3 to 4 weeks of soft tissue healing.

NONSUBMERGED (SINGLE-STAGE) PROTOCOL

Surgical Procedure

The surgical approach for the **nonsubmerged protocol** for implant placement is similar to that described for the two-stage submerged procedure except that after implant placement the tissues are closed either around the specially designed transmucosal portion of the implant or around the healing abutment. This eliminates the need for a second surgery to uncover the implant, which may reduce both treatment time and patient discomfort. Figure 14-13 presents an example of the single-stage protocol.



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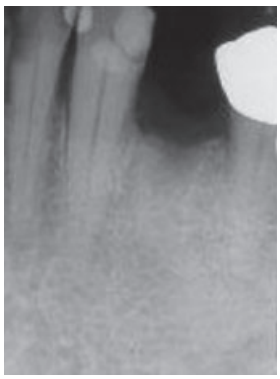

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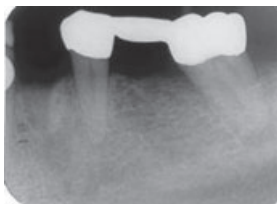

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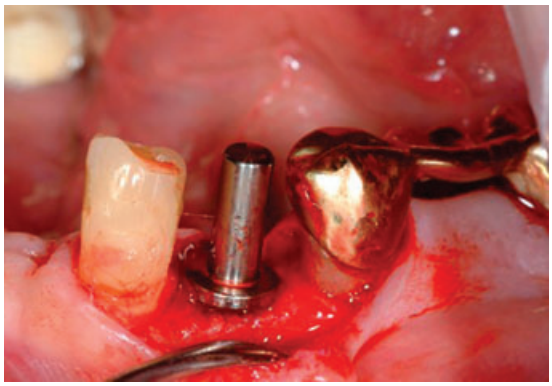

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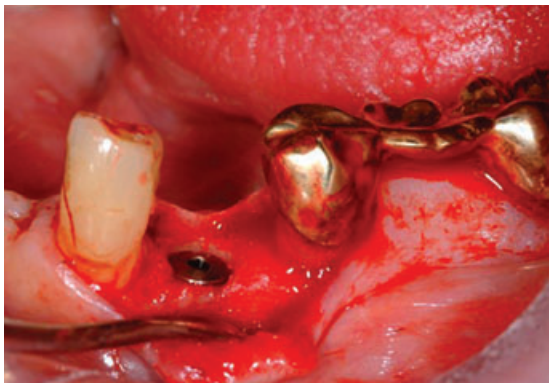

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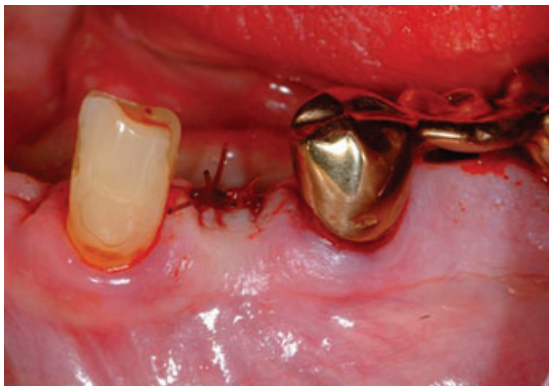

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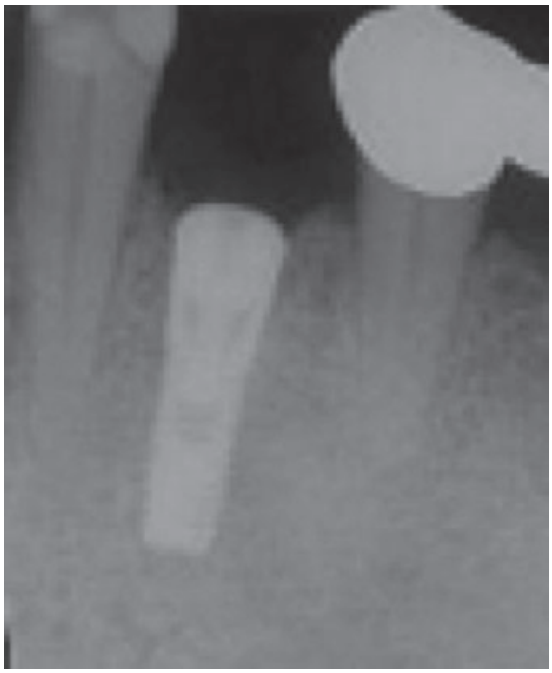


F

FIGURE 14-11 Implant placement surgery, submerged technique. **A,** Preoperative view of tooth #21. A surgical stent *(arrow)* is used to guide the implant placement. **B,** Preoperative radiographs *(1* and *2)* show adequate volume and quality of bone. **C,** Flaps reflected and guide in place to verify correct implant position after initial osteotomy preparation. **D,** Flaps reflected to show implant placed within the bone. **E,** Flaps repositioned and sutured in place to submerge the implant. **F,** Postoperative radiograph confirming good positioning of the implant fixture.

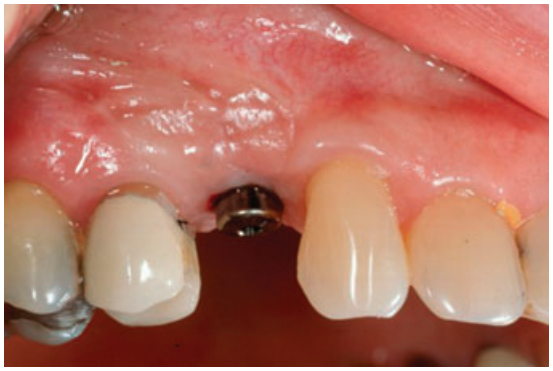


FIGURE 14-12 Example of a healing abutment in place after the second stage surgery to uncover the implant fixture.

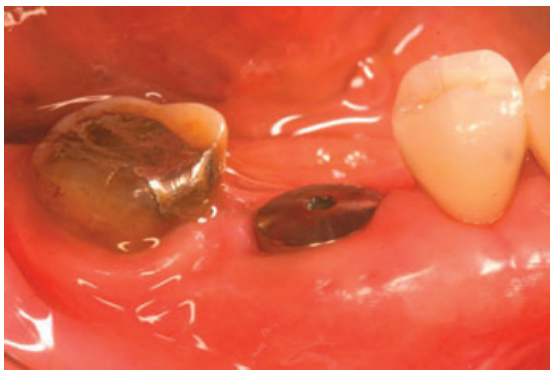


FIGURE 14-13 A non-submerged, single-stage implant 2 weeks after placement. The cover screw is not submerged and the tissues heal around the transmucosal portion of the implant.

Additional Procedures

Often intraoral soft and hard tissue deformities prevent implants from being placed in the desired location for the best restorative results. These deformities can occur from trauma, congenital abnormalities, cystic and neoplastic lesions, infections, or periodontal disease. Additional regenerative treatment to restore both soft and hard tissues may be necessary before or concurrent with implant placement. These procedures may include soft tissue augmentation to increase the thickness or amount of keratinized tissue, bone grafting, guided tissue regeneration, or combinations of procedures. To satisfy the goals of implant dentistry, hard and soft tissues need to be present in adequate volumes and quality.

TABLE 14-2 Classification of Timing of Implant Placement

	TIMING OF IMPLANT PLACEMENT
Immediate	At the time of extraction
Delayed	6-10 weeks after extraction
Late	6 months or more after extraction

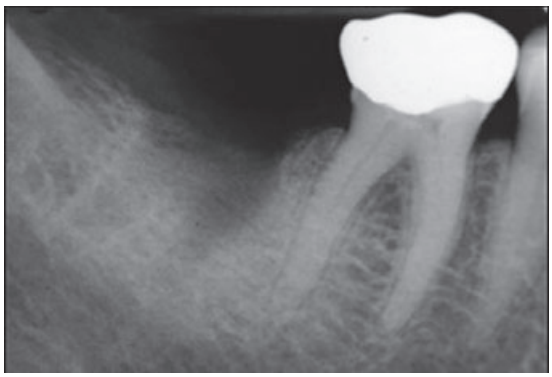
OTHER IMPLANT PLACEMENT PROTOCOLS

IMMEDIATE IMPLANT PLACEMENT AFTER TOOTH EXTRACTION

Generally, there is a lack of uniformity in the interpretation of the terms "immediate," "delayed," and "late" with regard to timing of implant placement. These terms are defined in Table 14-2.

The surgical procedures described thus far are in reference to delayed or late implant placements. These terms imply that the implant surgery is performed after an adequate healing period of the extraction socket has taken place. Immediate placement of implants is performed at the time of tooth extraction. The reason for extraction of a tooth determines whether immediate implant placement should be considered. The presence of infection and lack of bone to achieve primary stability of the implant contraindicates immediate placement. However, immediate placement after extraction of teeth for periodontal reasons, which constitutes an infected site, show results similar to those of healthy sites.[67,68]

It is important to note that the shape of a single-rooted tooth, and therefore the socket of that extracted tooth, is not the same as that of a cylindric endosseous implant. Immediate placement of implants into extraction sockets, therefore, leaves a gap between the nonengaged implant surface and the inner aspect of the socket wall. This distance is referred to as the **jumping distance.** It is not known how wide a space can be tolerated and still permit normal healing. Studies suggest that gaps of 1.0 to 2.0 mm can fill with bone without the use of adjunctive grafting materials.[69-71] The degree of fill and the rate of bone apposition are influenced by the surface characteristics of the implant. An example of immediate placement is presented in Figure 14-14.



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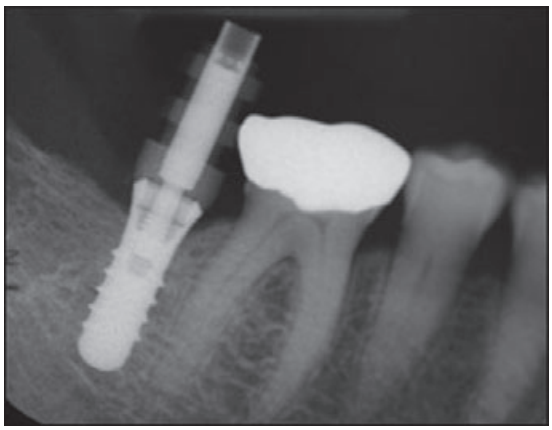

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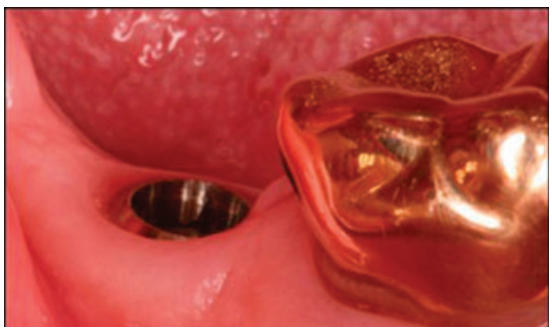

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FIGURE 14-14 **Implant placement surgery, nonsubmerged technique. A,** Radiographic view of fresh extraction site. **B,** Radiographic view of implant fixture after several months of healing; note the adequate healing of bone in the extraction site. **C,** Implant fixture in healed site ready for loading.

IMMEDIATE LOADING OF IMPLANTS

The issue of the prolonged healing period required for osseointegration, and thus the need for patient compliance to wear removable temporary prosthesis, has been overcome by immediately providing a fixed provisional implant-supported crown after implant placement. This is termed **immediate loading** and it has been applied to edentulous mandibles, partially edentulous cases, or single implants. If multiple implants are placed, the temporary restorations are typically splinted together to minimize movement and provide even load distribution. Single implant provisional restorations are restored out of occlusion to limit the functional load that may be transmitted to the implant fixture. Immediate loading of an implant placed in an extraction site is illustrated in Figure 14-15.

PROSTHETIC CONSIDERATIONS

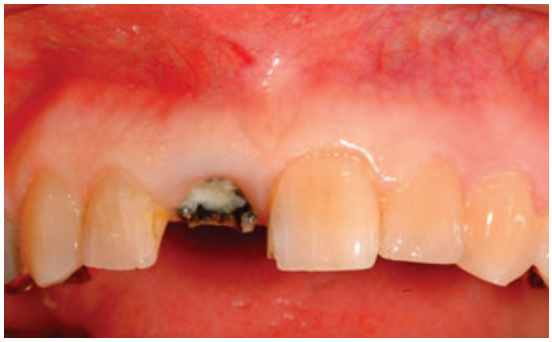
The direction and magnitude of forces distributed along the long axis of the implant, which in turn are transmitted to the surrounding bone, are critical in both attainment and maintenance of osseointegration. Prosthetic restorations must be designed to avoid an excessive load on implants to protect them from bone loss and prosthetic component failure. Treatment of patients exhibiting parafunctional habits such as clenching and bruxism should be undertaken with caution. An occlusal guard should be considered to help protect the implants after delivery of the prosthesis.

Restorations are either cemented in place or screw retained. Screw-retained restorations have the advantage of being retrieved by the dentist if required to permit treatment of the implant or address prosthetic complications. However, both implant location and esthetic demand may favor the use of the cement-retained restorations. The abutment is attached to the implant with a conventional screw system, but the crown is cemented on to the abutment, typically with temporary cement so that it can be removed if necessary.

MAINTENANCE

PARAMETERS OF EVALUATION FOR PATIENTS WITH IMPLANTS

The purpose of regular periodic clinical evaluation of patients is to detect early disease activity and to provide individualized maintenance protocols. Many of the parameters used for the evaluation of natural teeth may be used in patients with



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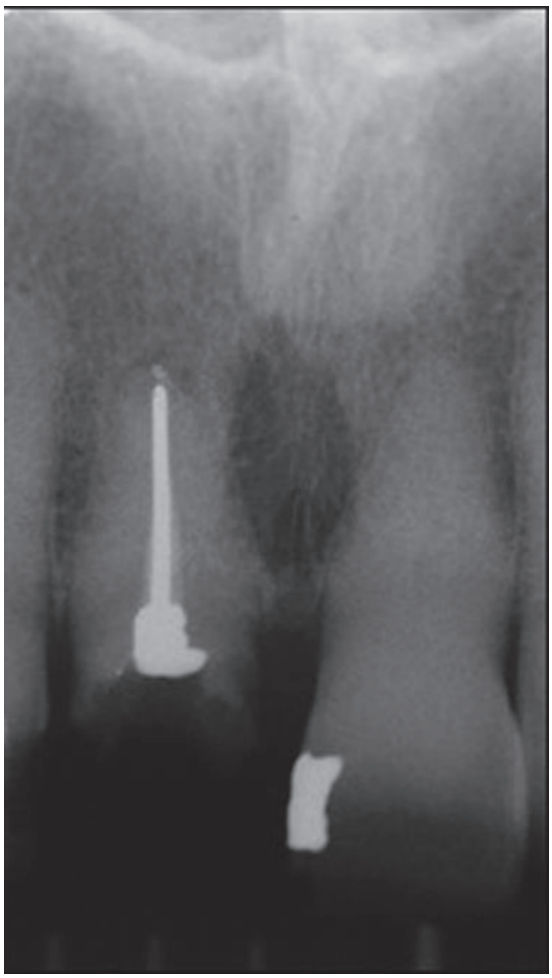

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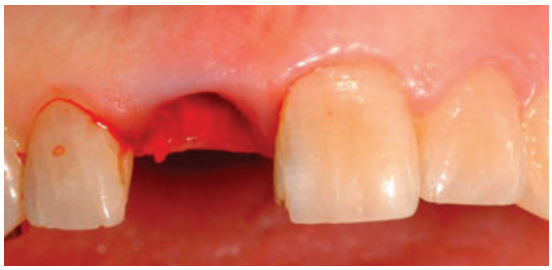

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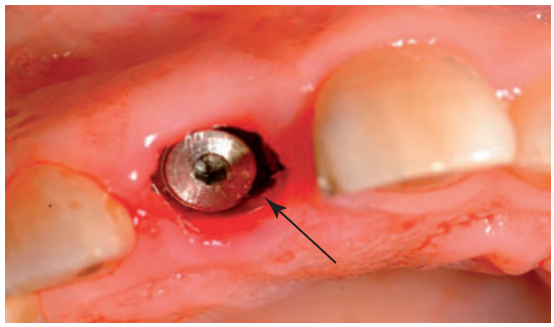

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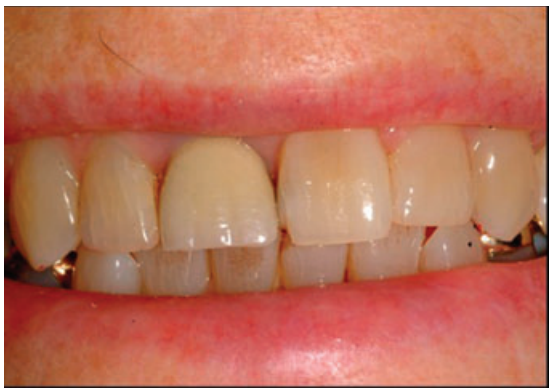
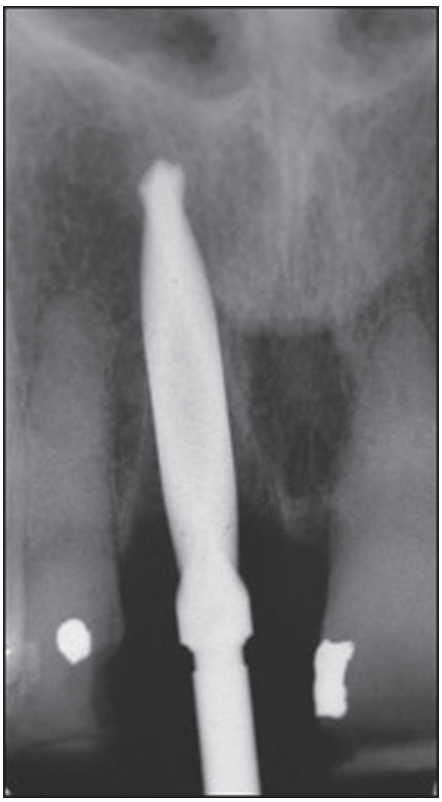


E

FIGURE 14-15 Example of immediate placement surgery and loading after loss of a tooth crown. **A,** The patient presented having lost the crown of tooth #8 as a result of recurrent caries after endodontic therapy. **B,** Preoperative radiograph shows no signs of infection and adequate bone beyond the apex of the root for implant stabilization. **C,** Atraumatic extraction of the root was performed. **D,** Implant fixture is immediately placed inside the extraction socket. Note the "jumping distance" *(arrow)* between the implant and the inner socket wall. **E,** Immediate loading was done on the implant the day of surgery.

Q



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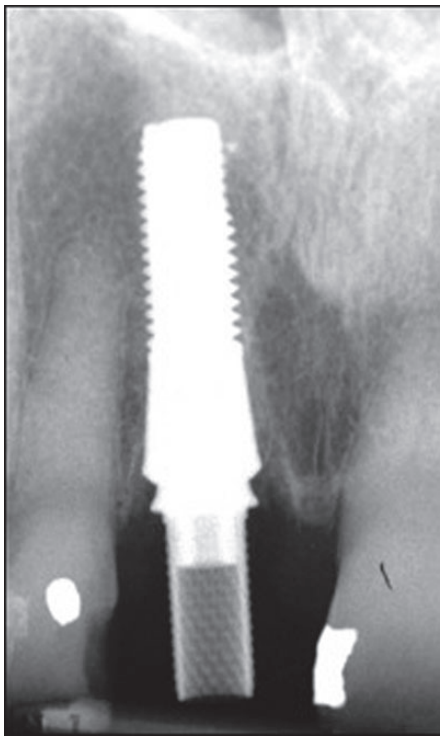

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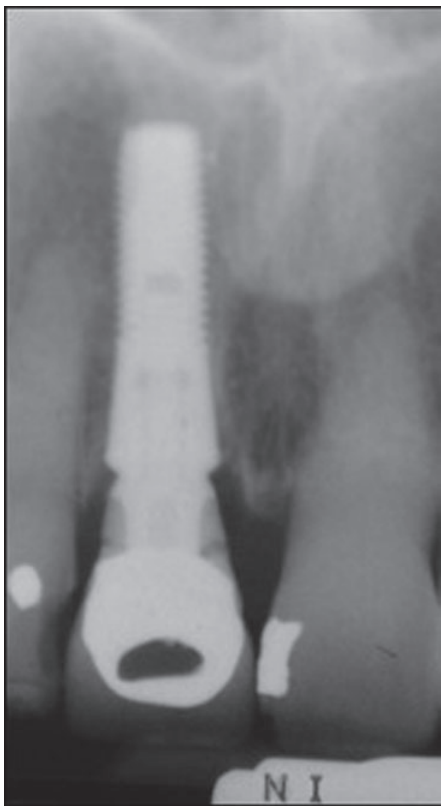

H

FIGURE 14-15, cont'd **F,** Radiographic view of the guide in place verifying implant position during surgery. **G,** Radiographic view of implant in place. **H,** Radiographic view of completed restoration.

implants; however, some of these data are of little value.

Mobility

Healthy implants are osseointegrated and do not exhibit clinical signs of mobility. The absence of PDL around implants creates a rigid bone-implant interface, maintenance of which is key in long-term success of implants. The presence of clinical mobility, as detected by conventional methods, is an indication of loss of integration and implant failure. Mobility of the prosthetic components are usually a result of loosening or fracture of screws at the implant-abutment or abutment-crown (if screw retained) interface.

Probing

A periodontal probe is used to measure probing pocket depths and clinical attachment levels around natural teeth, which provides important information regarding progression of disease or success of periodontal therapy. Increasing probing depth and loss of clinical attachment are pathognomonic for periodontal disease.[72] Probing depths are easy to measure around implants, but their interpretation is limited. Probing force, examiner variability,[73,74] probe design, gingival health,[74,75]and obstructing factors such as crown contours and calculus influence the extent of probe penetration. Also, inherent differences in the arrangement of the tissues around implants and natural teeth make interpretation of the collected data difficult. Probing pocket depth measurements do not reflect the histologic levels of attachment because probes invariably penetrate the JE and, in inflammation, penetrate into the connective tissue.[72,76,77] Perhaps because of the lack of connective tissue attachment into the implant surface, as seen in the cementum of natural teeth, probes penetrate the attachment with more ease around implants. Studies have indicated that the probe tip penetrates closer to bone in inflamed peri-implant tissues than in healthy sites[78] and that there is a tendency toward deeper probe depths around implants.[79,80] Probing values representative of health have not been defined but depths of approximately 3 mm[81,82] or less than 4 to 5 mm[13,83] are considered as consistent with health.

Another complicating factor is that probing depths are dependent on individual implant design such as abutment height and depth of fixture within bone and they are therefore system specific.[84] Most important, it is reported that clinical probing depths around implants do not correlate with the loss of osseointegration and bone loss caused by occlusal overload.[85] For these reasons, many do not regard probing as a valuable diagnostic tool when implants are evaluated.[60]

The use of plastic periodontal probes around implants has been advocated by many to reduce the chances of inadvertently scratching the implant surface.[86] There is no evidence in support of damage caused by probing to the peri-implant tissues. However, not probing during the first 3 months after loading is advised so that healing is not disturbed.[87] Probing around implants is illustrated in Figures 14-16 and 14-17.

Indices

Probing around implants provides an assessment of inflammatory parameters such as bleeding and suppuration. In the natural dentition, the absence of bleeding on probing is considered a good indicator of periodontal health.[88,89] Conflicting reports have appeared in the literature with regard to bleeding on probing around implants as an indicator of disease activity. One study found no correlation between bleeding on probing and histologic, microbiologic, or radiographic changes around implants,[90,91] whereas others have reported that healthy sites were characterized by complete absence of bleeding on probing.[80] However, healthy implant sites have been shown to exhibit a greater tendency to bleed during probing than do well-maintained teeth.[74]

Other indices that can be applied to implants include gingival[92] and plaque[93] indices to evaluate the patient's oral hygiene status. Modification of these indices has also been proposed for implant application.[45]

Radiographs

Periapical radiographs and panoramic images are used in conjunction with standard clinical examination to assess bone levels available for implant sites. Unfortunately these images provide only a two-dimensional view of the alveolar bone. After implants are placed, radiographs are used to assess the height of proximal bone, the presence of anatomic structures such as the maxillary sinus, anomalies, or pathologic lesions. Correct seating of the restorative components can be verified radiographically after second-stage uncovering

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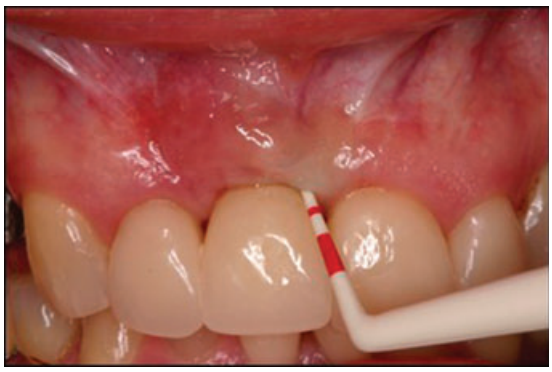

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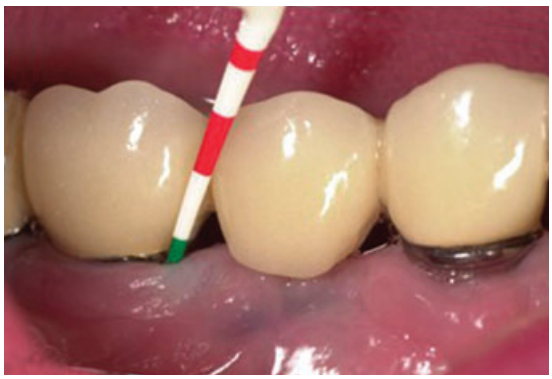

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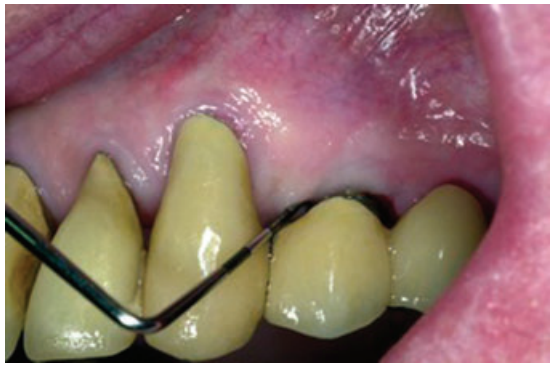
FIGURE 14-16 Use of a graduated plastic periodontal probe around implants. A, Anterior adaptation. **B,** Posterior adaptation.



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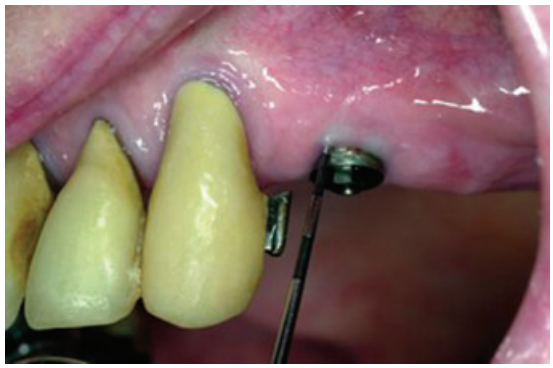


B

FIGURE 14-17 Probing may be difficult because of the superstructure design. A, The probe angulation is exaggerated to permit the tip access to the abutment with the superstructure in place. **B,** The prosthetic superstructure needs to be removed periodically to obtain more accurate probing measurements.

of the implant and after placement of the restoration. Examples of the information obtained from radiographs are presented in Figures 14-18 and 14-19.

More advanced radiographic techniques are available to give accurate measurements of bone width and bone quality, a three-dimensional view of the implant area. These cross-sectional and tomographic images can be obtained with use of computed tomography), as shown in Figure 14-20, special tomographic devices, and digital subtraction radiographic techniques, which enable quantitative and qualitative assessment of changes in bone density. The classification of bone quality and quantity is an indicator of the amount of bone available for implant placement.[21] The quality of bone, however, is better assessed at the time of surgery.

The amount of the peri-implant bone should be evaluated periodically to monitor the osseointegration status. The criteria for implant success includes bone loss not exceeding 0.2 mm annually after the first year after loading and the absence of peri-implant radiolucencies or associated conditions. Examples of radiographic information correlated with clinical findings are presented in Figures 14-21 through 14-23.

These signs are evaluated through radiographic follow-up, which is recommended for implant sites at 6, 12, and 36 months and then every 2 to 3 years thereafter unless clinical symptoms are seen. Some use continued radiographic examination every 3 months for the first year after restoration and then annually thereafter to ensure that the bone levels have become stable.

Soft Tissues

The need for keratinized tissue around implants remains controversial. Adequate health and

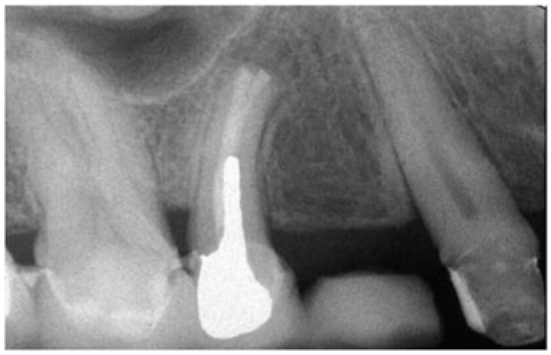


FIGURE 14-18 This periapical radiograph shows limited space between the apices of the teeth for implant restoration of the missing tooth. Note that, although the radiograph reveals this one concern regarding assessing the suitability of the site for implant restoration, the width of the bony ridge cannot be assessed with a two-dimensional radiograph.

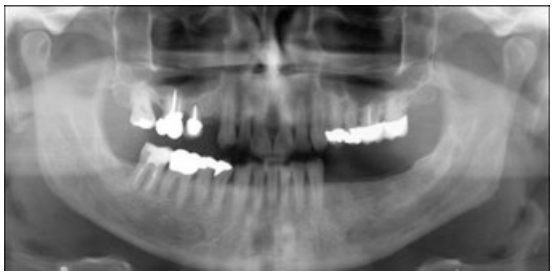


FIGURE 14-19 The panographic view of the oral cavity helps in evaluating patients for implant restoration by showing the locations of vital structures such as the nerve trunk in the mandible, the location of the mental foramen, and the maxillary sinuses.

stability of tissues around teeth can be maintained in patients with good oral hygiene practices who exhibit minimal or no keratinized tissue.[94-98] Given the differences that exist in the soft tissue structural organization around teeth and implants, the question arises about generalizing the same evidence to peri-implant tissues. Factors to consider when determining whether attached gingiva is adequate include presence of inflammation, existence of gingival recession, oral hygiene status and patient compliance, relationship between gingiva and alveolar bone, tooth position within the arch, presence of restorations, esthetic demands, and presence of tooth sensitivity.

There is no direct evidence to support the idea that keratinized peri-implant tissue is associated

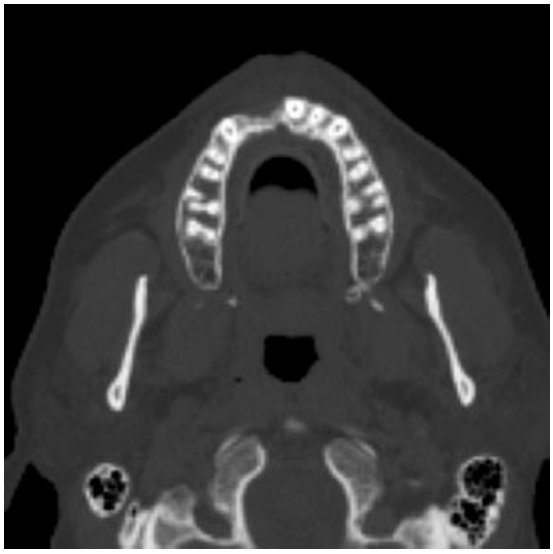


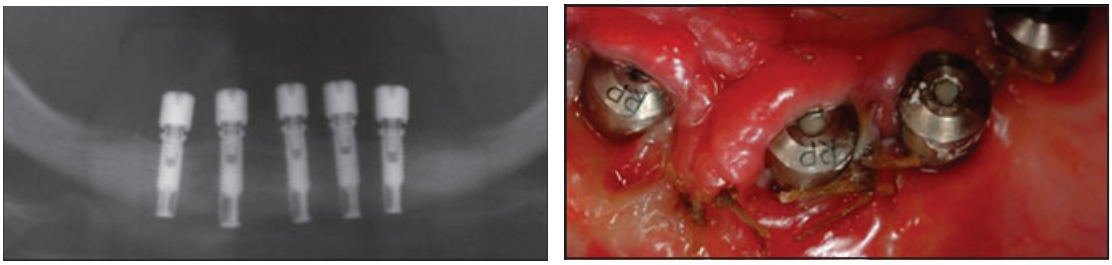
FIGURE 14-20 Computed tomography is also useful in evaluating bone for implant restoration. Cortical bone appears as a white line around the maxillary teeth. Note the deficient ridge width in the #7 to #8 area. The white lines on the side are cortical bone at the level of the scan.

with better implant success rates than nonkeratinized tissue. As the application of dental implants continue to increase, function and psychologic improvements achieved from their use continue to be important, but esthetic demand has catapulted to the forefront of the goals of therapy. Esthetic demands may dictate that keratinized tissue be present at the implant site. If needed, surgery to increase the width of attached gingiva can be performed before implant placement, at time of implant surgery, or at second-stage surgery to uncover the fixture. Attempting this surgery after the implant is in function is less predictable. The results of surgery to increase keratinized tissue are illustrated in Figure 14-24.

PERI-IMPLANT DISEASE

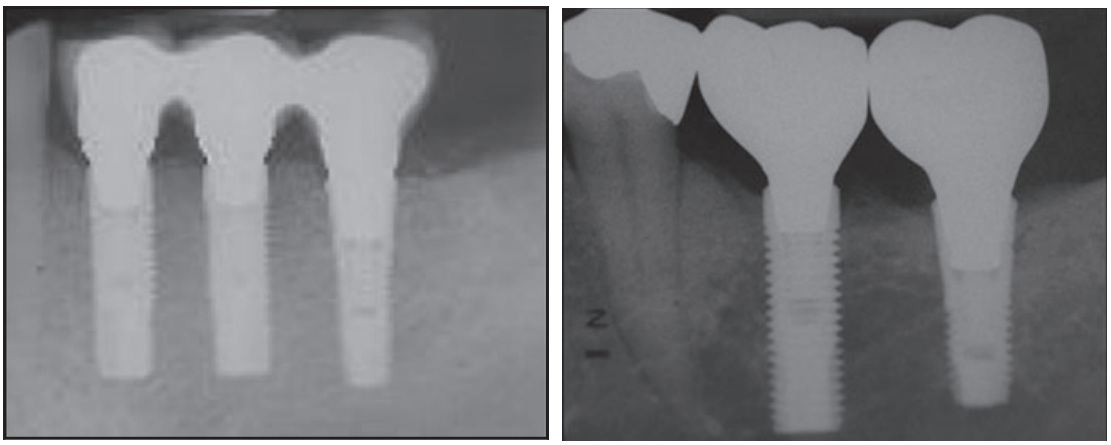
DEFINITIONS

As established by the First European Workshop of Periodontology (Switzerland, 1993), **peri-implant disease** is a collective term for inflammatory reactions in the tissues surrounding an implant. **Peri-implant mucositis** describes a reversible



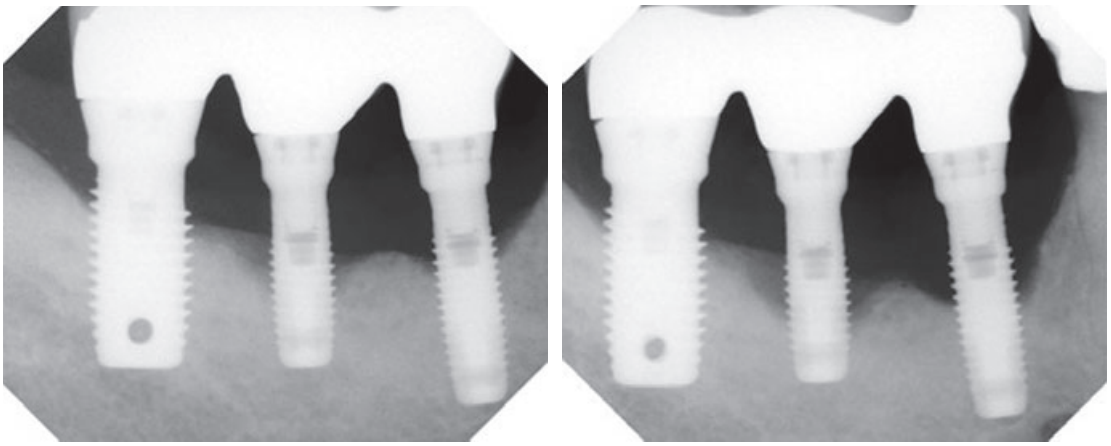
A B

FIGURE 14-21 Issues related to implant technique. A, Radiograph shows incomplete seating of the healing abutments after implant uncovering. **B,** This resulted in severe inflammation of the peri-implant tissue as a result of plaque biofilm accumulation.



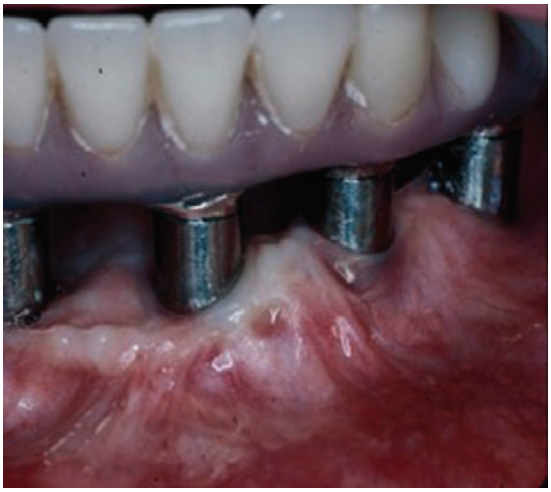
A B

FIGURE 14-22 Healing of bone after implant surgery. A, Excellent proximal bone level between implants. **B,** Another example of a satisfactory healing result.



A B

FIGURE 14-23 Follow-up radiographs can also reveal problems. **A,** This patient had significant bone loss. **B,** Six months later, more than 0.2 mm of bone loss had occurred.



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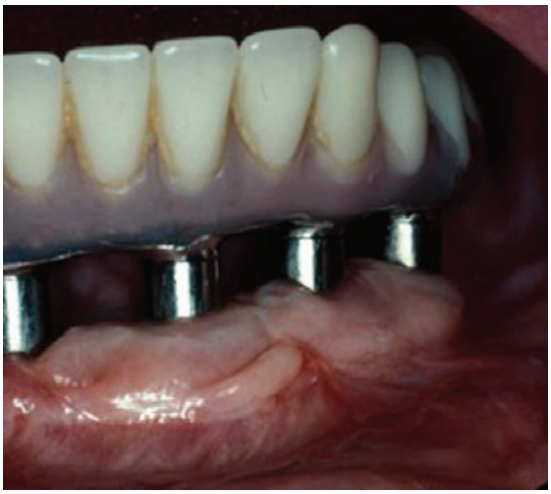

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FIGURE 14-24 The amount of keratinized tissue has been augmented by performing a gingival graft to facilitate maintenance for the peri-implant tissues. **A,** Before graft surgery. **B,** Keratinized tissue around the implants after surgery.

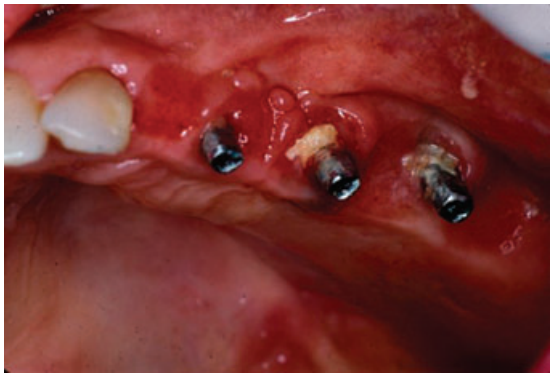


FIGURE 14-25 Peri-mucositis. Peri-mucositis is a reversible process characterized by inflammation within the peri-implant tissues. Note the calculus formation on the abutments.

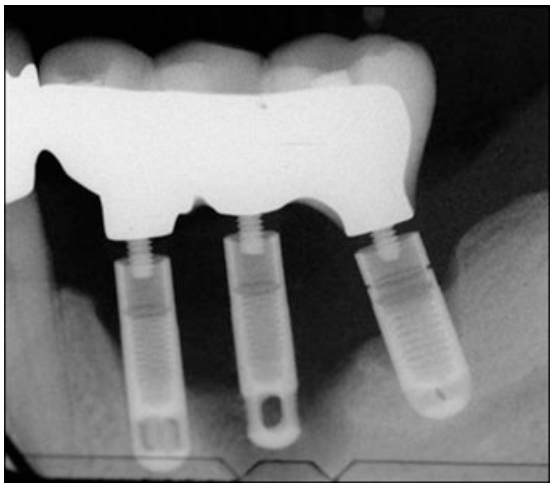


FIGURE 14-26 Peri-implantitis and failing implants. This radiograph shows three implants with advanced bone loss in a patient with uncontrolled diabetes mellitus. Clinically the implants are mobile and have increased probing depths, and the tissues bleed.

inflammatory reaction in the soft tissues surrounding a functioning implant. It has not been established that, if untreated, it will progress to peri-implantitis. **Peri-implantitis** is a term for inflammatory reactions that affect soft and hard tissues around the implant leading to deepening of probing pocket depths and loss of supporting bone on functioning implants. Despite the loss of supporting bone, mobility may not be evident clinically because osseointegration of portions of the implant surface is retained. Peri-implant mucositis and peri-implantitis are associated with bleeding on gentle probing, redness, and, rarely, pain.[99] If this condition is left untreated, it will ultimately progress to its failure.[99] Peri-implantitis occurs in about 4% to 19% of implants.[100] A **failing implant** is not synonymous with peri-implantitis and refers to an implant that has lost its osseointegration and is no longer an effective prosthetic anchor. Peri-implant mucositis and peri-implantitis are illustrated in Figures 14-25 and 14-26.

Q

MICROBIOLOGY

As with teeth, plaque biofilm is the primary microbial etiologic factor in peri-implantitis. Numerous studies have demonstrated similarities between the clinical and microbiologic features of peri-implantitis and periodontitis.[101,102]

The microflora around implants in edentulous patients forms early and appears to remain stable long term.[82,103,104] The microflora of implants differs between partially and fully edentulous patients.[103] Teeth in partially dentate patients are a source of flora that colonize implants within 2 weeks of exposure in the oral environment. Subgingival sites in healthy implants are populated by high percentages of coccoid cells and nonmotile rods with few spirochetes, whereas *Actinobacillus actinomycetemcomitans, Porphyromonas gingivalis,* and *Prevotella intermedius* have been cultured from implants in patients with minimal visible plaque biofilm but who had not had maintenance visits for 6 months or more.[44,45] Clearly the composition of the microflora before implant placement determines the flora associated with the implants. Patients with untreated periodontitis are at higher risk for development of peri-implantitis than those with treated periodontal conditions.[42] These findings emphasize the importance in regular maintenance visits for all patients with implants to help prevent the formation of mature pathogenic bacterial plaque biofilms.

PROGRESSION OF INFLAMMATION IN IMPLANTS

As a result of inherent anatomic differences between implant and teeth and despite similar etiologic factors, progression of inflammatory disease around implants appears to be more rapid than around natural teeth. Periodontal disease is a site-specific disease; pocket formation and bone loss can affect a localized site on a tooth that may lead to angular or horizontal osseous defects. In contrast, implants lack connective tissue fiber insertion so the only attachment mechanism involves the basal lamina and hemidesmosomes of the epithelium. Inflammation within the peri-implant tissues have a tendency to spread circumferentially, and progression to bone may result in angular osseous defects radiographically, whereas clinically it assumes the shape of a well-circumscribed saucer, as shown in Figure 14-27.

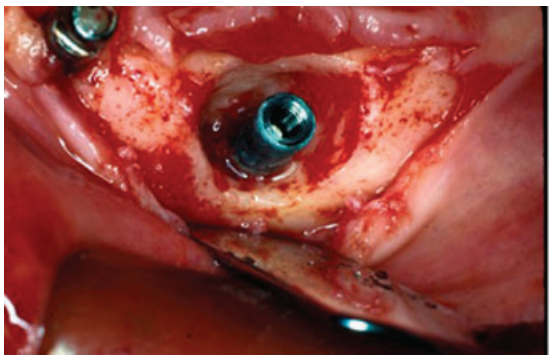


FIGURE 14-27 Peri-implant bone. This clinical view of a healthy implant with flaps reflected shows the well-circumscribed saucer shape of the bone around the fixture.

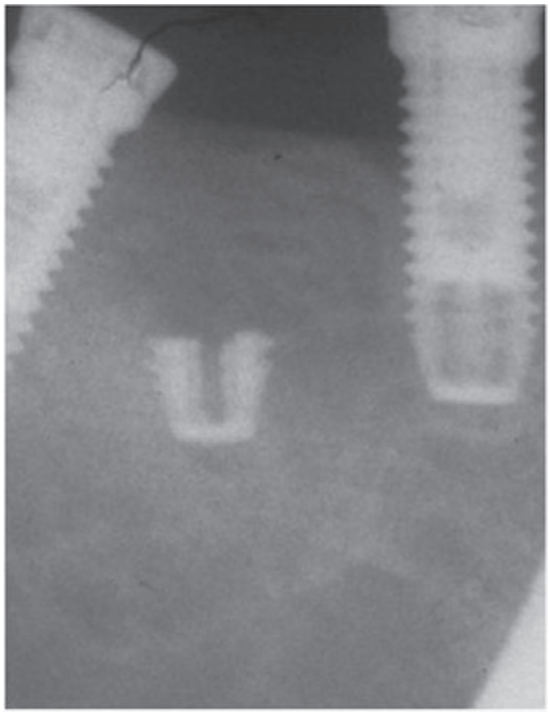
RECOGNITION AND TREATMENT

Early implant failures are typically considered to be biologic, occurring within weeks or a few months after placement. They result from failure to achieve osseointegration, possibly because of inherent host tissue factors, bacterial contamination of wounds, poor surgical technique, or instability of implant at installation. Late implant failures result from factors that cause breakdown of an osseointegrated implant. Causative factors may include mechanical overload, fatigue failure of components, and peri-implant infection. Examples of implant failure are presented in Figure 14-28.

Given the microbial association, antimicrobial therapy has been proposed as an important part of treatment for peri-implantitis. Treatment invariably includes a combination of local or systemic antimicrobial therapy, debridement that involves thorough removal of plaque biofilm and calculus, implant surface decontamination, and regeneration of defects.

Nonsurgical Therapy

As with the treatment of isolated periodontal attachment loss on natural teeth and in cases where a surgical approach is not feasible, treatment with local chemotherapeutic agents as an adjunct to plaque removal and debridement may prove beneficial. Local application of



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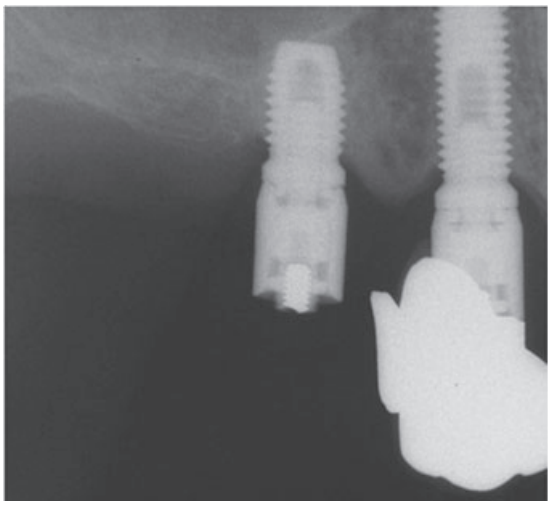


B

FIGURE 14-28 Mechanical failure of implants. **A,** Radiograph showing a fractured implant. **B,** Implant fixture with a screw fracture from overload.

antimicrobial agents such as minocycline hydrochloride can be included every 3 months with regular customized recalls, as shown in Figure 14-29. This should be performed with the understanding that any improvements will be small.

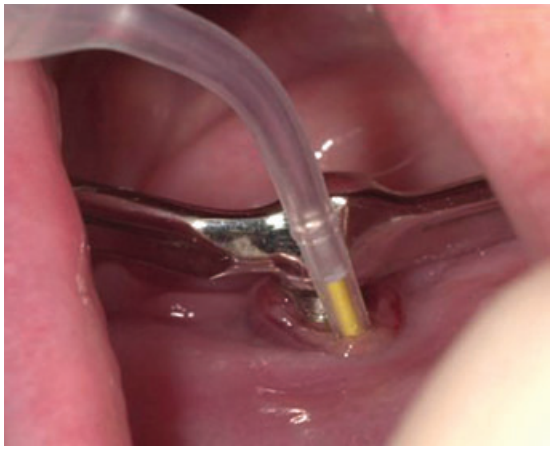


FIGURE 14-29 Locally delivered antimicrobial agents are often used as adjunct therapy to mechanical calculus and plaque biofilm removal around implants.

Surgical Therapy

If defects around implants are amenable to correction through surgical intervention, this invariably will involve bone grafting and regenerative therapy. After debridement of the site and implant surface decontamination, repair or regeneration of the osseous defect may be attempted, with the understanding that the final bone-implant interface may not be *"osseointegrated"* and may only comprise a close adaptation of grafted bone and the implant surface.

Dental Hygiene Care

Regular dental hygiene care is an important component of the long-term success of implant therapy. The dental hygienist is responsible for assessing patients with implants, providing maintenance care, and educating and reinforcing home care procedures. This can be particularly challenging because many of these patients do not have a history of compliance and have lost teeth because of neglect and periodontal disease. Implants are now a successful and commonly performed procedure, so the dental hygienist must expect to see many patients with single or multiple implants whether in general practice or specialty practices.

ASSESSMENT

Regular assessment of implants is required in addition to assessments of the remaining natural dentition. Dental hygiene care may be performed slightly less frequently in compliant patients with well-maintained implants, but recall intervals for assessment and treatment should not exceed 6 months. Table 14-3 lists the assessments recommended for the dental hygienist to perform for patients with implants. Generally, patients with implants should be seen and evaluated about every 3 months for the first year after restoration of implants.

MAINTENANCE VISITS

Plaque biofilm and calculus removal for dental implants is performed with instruments that are not abrasive to the titanium components. Conventional stainless steel instruments and ultrasonic devices scratch the softer titanium abutments, causing roughness and making them more plaque biofilm retentive. Dissimilar metals may also increase the likelihood of galvanic corrosion.[59] The use of plastic, nylon, titanium, graphite, or gold-plated curettes and air-abrasive devices can be used safely around implants.[105] Special plastic sleeves are also available for ultrasonic tips to prevent damage to implant surfaces.[106] Implants may be polished to remove plaque biofilm and stains, but coarse polishing compounds should be avoided. Tin oxide with rubber cups is a good choice for polishing around implants. The use of plastic scalers on implant surfaces is shown in Figure 14-30.

TABLE 14-3 Assessments for Implant Maintenance Care

PROCEDURE	COMMENT
Evaluate tissue for tone, color, consistency, size, and texture	Look for signs of tissue inflammation
Check for mobility	May not be possible with splinted implants
Probe and record implant sulcus depth	Use plastic probes only, four measurements per implant
Remove and clean superstructure if possible	May not occur at every visit with fixed superstructures
Assess and remove calculus	Ensure complete removal
Radiograph implant area	Done at frequent intervals to check bone levels as determined by dentist
Record assessments	Reference data for other appointments

HOME CARE

Excellent home care practices are as essential as regular professional maintenance care in the long-term success of implant therapy because there is a direct cause-and-effect association between plaque biofilm accumulation and the initiation of peri-implant disease. Home care procedures must be initiated and regularly assessed before implant treatment begins as a criterion for the suitability of patients to receive implants. The cause of tooth loss among a large number of patients with implants is periodontal disease; it has been shown that these patients are more prone to future breakdown.[107] An effective customized home care and preventive regimen for these patients is critical to achieve optimal plaque biofilm control and consequent treatment success.

The variety of available home care devices includes a host of manual and powered toothbrushes, interdental aids, and oral irrigation devices. Examples are seen in Figure 14-31 through 14-33. The choice of toothbrush is based on the individual's manual dexterity and the type of implant prosthetic suprastructure. Implant-supported overdentures can be easily removed by the patient or the hygienist to clean implant abutments and peri-implant tissues and to facilitate cleansing of the dentures.

- Patients must be instructed in thorough daily inspection and cleaning of all removable prostheses.
- Soft toothbrushes or single-tufted brushes are effective for plaque biofilm removal around implant abutments that secure removable prostheses.

Patients with implants and natural teeth must both brush the teeth and clean interproximal surfaces. Interdental aids are just as useful for interproximal plaque removal around fixed implant-retained prostheses as for around natural teeth.

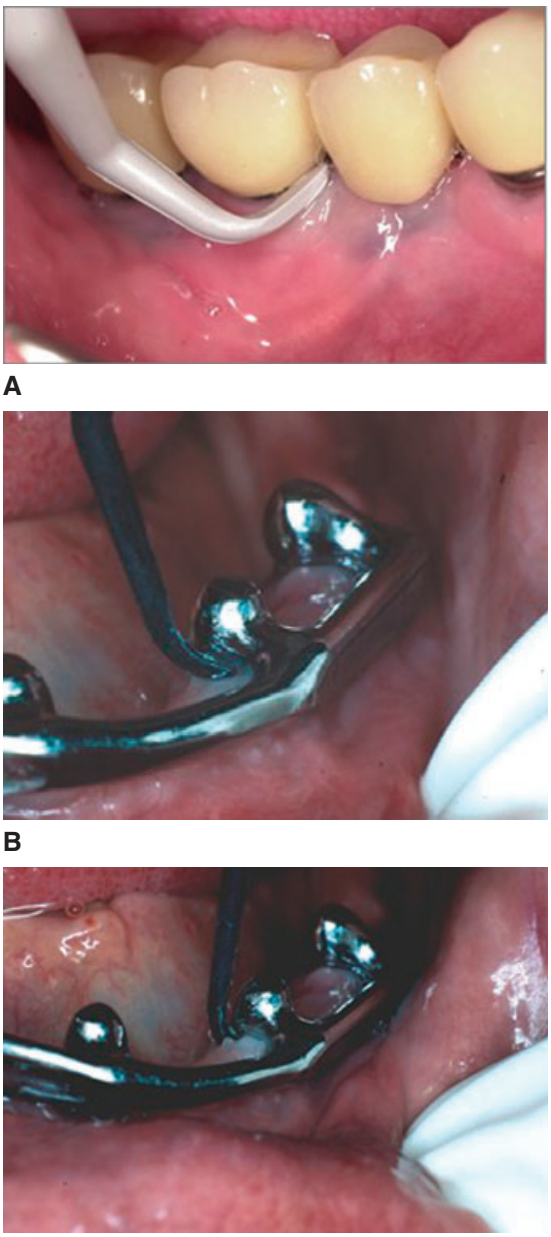


FIGURE 14-30 Plastic scalers for use around implants. **A,** Scalers must be manipulated around the superstructure to reach the abutment surface. **B,** Scaling around implant and bar fixtures is a challenge. **C,** The scaler adapted subgingivally around the abutment.

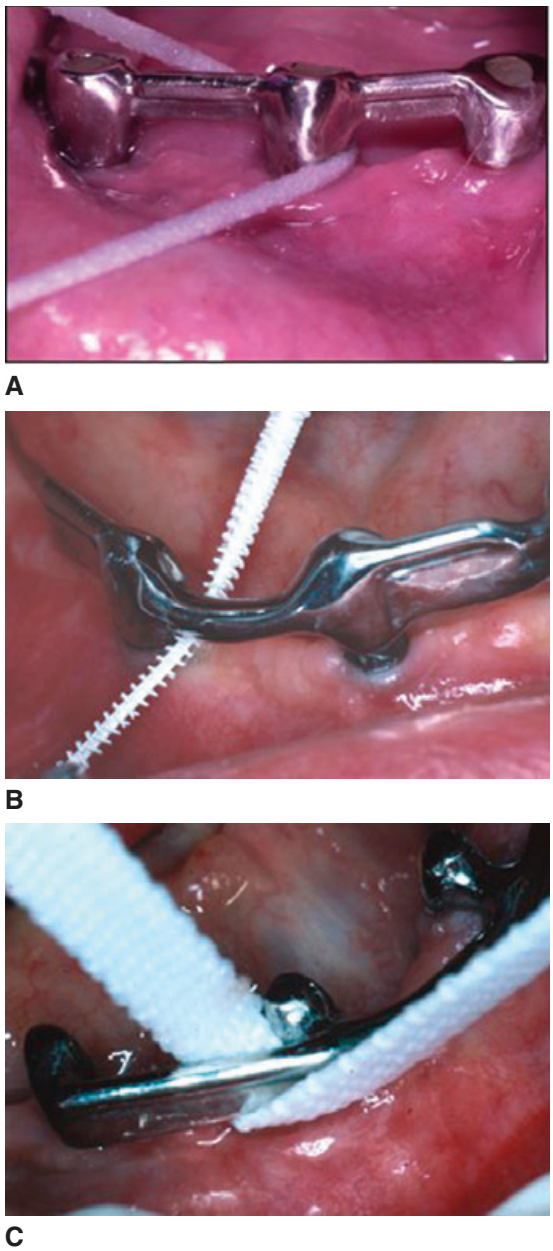
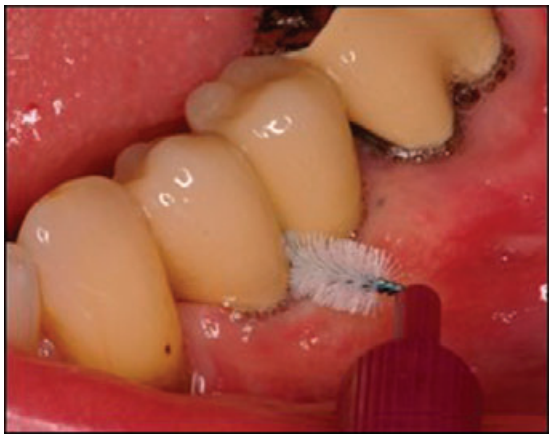


FIGURE 14-31 Home care aids: floss. **A,** Thick floss around an abutment. **B,** Plastic floss under a bar. **C,** Thick strips of floss are also efficient for cleaning.

- Rubber-tip stimulators, wooden or plastic interdental cleaners, manual and powered interproximal brushes, and a variety of flossing cords are available.
- Patients require individualized instruction in the correct application of these devices to the implants and peri-implant tissues to reduce the chances of iatrogenic damage to both the tissue and implant component surfaces.

Although there is no evidence to suggest that the use of powered devices is superior to manual devices for achieving effective plaque biofilm control, patients with limited dexterity may benefit from their use, and others simply prefer



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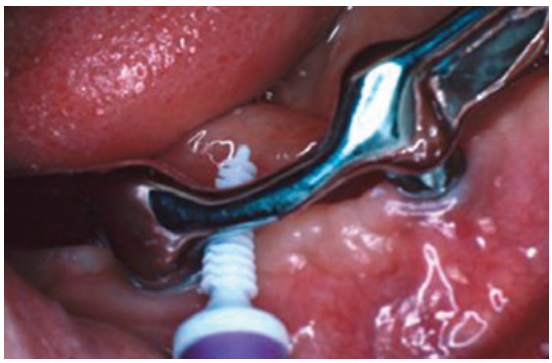

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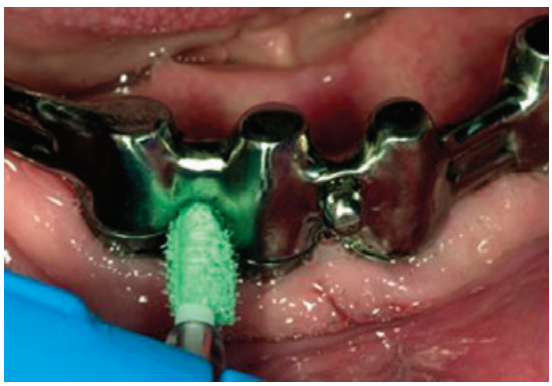

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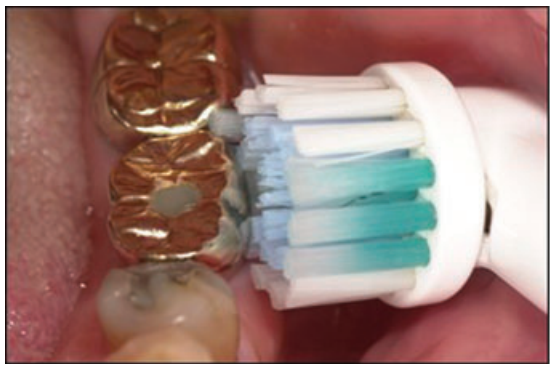
FIGURE 14-32 Home care aids: interdental brushes. **A,** Interdental brush adapted between implant restorations. **B,** These are useful under bars when space permits. **C,** Small interdental brushes can fit well between implants.



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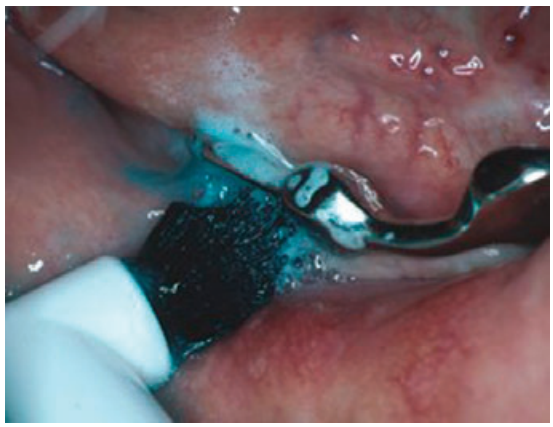

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FIGURE 14-33 Home care aids: toothbrushes. **A,** Mechanical toothbrushes can be easier for patients to use than manual brushes. **B,** Rotary interproximal brushes adapt well around implants.

powered devices. Oral antimicrobial rinses containing chlorhexidine gluconate or phenolic compounds may also be useful for individuals with physical impairments.

The use of subgingival irrigation devices as adjuncts to routine brushing should be recommended with caution so that the delicate peri-implant tissues are not damaged. The effects from subgingival irrigation do not appear to be of clinical significance around dental implants, although studies that have shown subgingival delivery of chlorhexidine to be slightly more effective in reduction of plaque biofilm and bleeding of the peri-implant tissues than is rinsing.[108]

The Role of the Dental Hygienist

Early detection of pathologic conditions improves the chances of treating and maintaining dental implants with appropriate therapy. Available evidence and clinical experience suggest that maintenance visits should occur every 3 or 4 months during the first year after implant placement. Recall intervals should not extend beyond 6 months, even for the most compliant

patients. At every recall visit thorough assessment will permit modification to the home care practices and maintenance intervals on the basis of the oral health of the patient. Even shorter recall intervals may be indicated if 3 months is too long to maintain optimal implant health. The significance of regular dental hygiene care can be seen in Figure 14-34.

Motivation and compliance are crucial elements of treatment success for the patient with an implant. The dental hygienist plays a central role in educating and motivating the patient about all aspects of implant treatment. This responsibility reduces barriers to compliance, customizes home care routines, and contributes to the success of implant therapy.

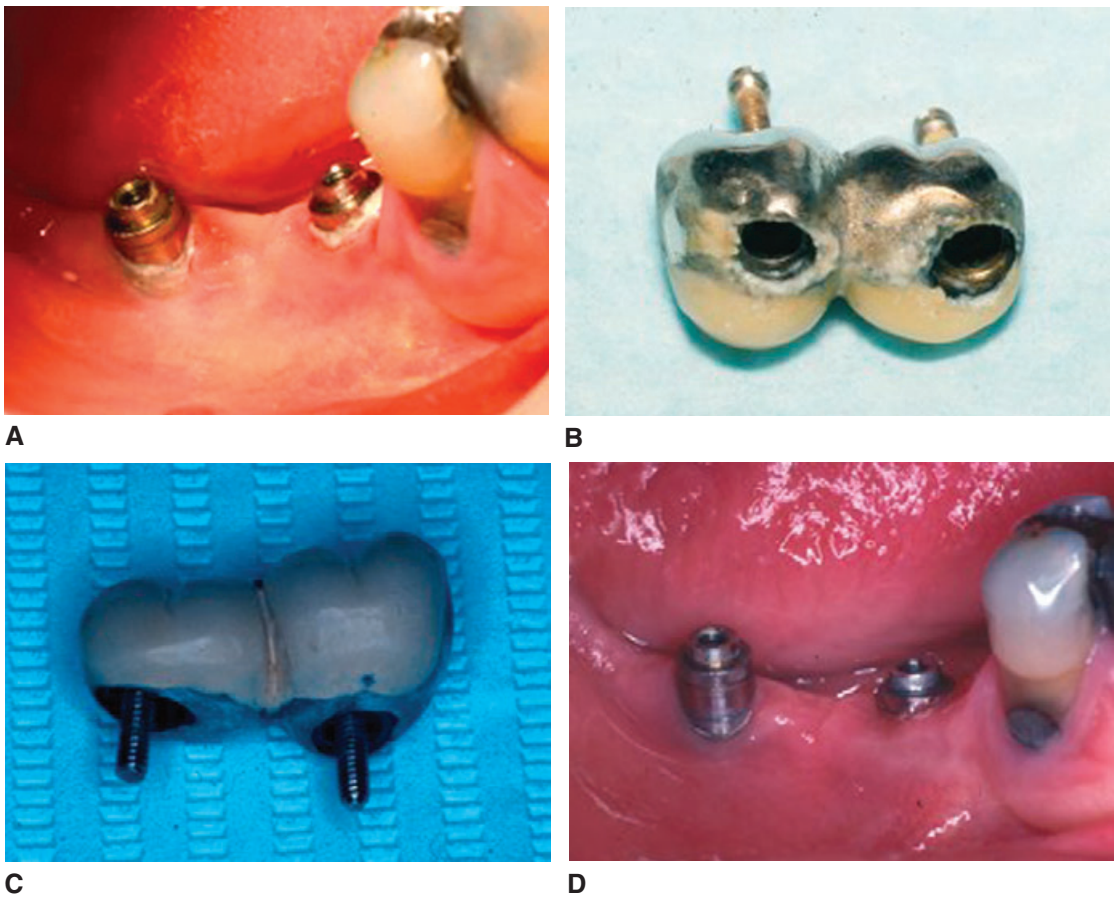

FIGURE 14-34 Removal of plaque biofilm and calculus from implants and prosthetic components is essential to eliminate peri-implant inflammation. A, Inflamed tissue surrounding two implants. Note the calculus and plaque biofilm around the abutments. **B,** The restoration is also coated with plaque biofilm and calculus. **C,** The restoration after cleaning. **D,** The tissues 1 week after cleaning and reinforcement of home care procedures for the patient.

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SUMMARY POINTS

- Dental implants are a highly successful and increasingly common treatment modality that dental hygienists will encounter often in clinical practice.
- Osseointegration is the formation of an intimate lattice between the titanium implant and bone; it creates a firm abutment for loading of prostheses.
- The most commonly placed implants are endosseous root-form implants made of the biomaterial titanium.
- The soft tissue attachment to an implant is an epithelial attachment of hemidesmosomes and basal lamina. There is no PDL and no fiber attachment.
- Implants are placed surgically by use of either a submerged (two-stage) procedure or a nonsubmerged (single-stage) procedure. They can also be placed immediately after tooth extraction. Surgical technique is critical to implant success.
- Lack of mobility is a critical factor in success of implants.
- Assessments of healed implants include mobility evaluation, probing, radiographs, and plaque biofilm and calculus evaluations. Probing is the least useful assessment tool for implants.
- Peri-implant disease includes reversible peri-implant mucositis and more serious peri-implantitis, which can result in loss of the implant.
- The microflora associated with implants is similar to normal oral flora.
- Dental hygiene care consists of regular assessments, maintenance care, and helping patients maintain excellent home care programs.
- Maintenance visits should occur at least every 3 months and may be extended slightly if the patient is extremely compliant.

STUDY QUESTIONS

Answers and rationales can be found on the Student CD-ROM.

MULTIPLE CHOICE

1. Dental implants with the highest success rates are made of:
a. Titanium.
b. Tin oxide.
c. Hydroxyapatite.
d. Aluminum oxide.

2. Which type of implant provides direct osseous anchorage through formation of a lattice between surface and bone?
a. Transosteal.
b. Endodontic.
c. Endosseous.
d. Subperiosteal.

3. According to the American Dental Association, Council on Dental Materials, accepted implants have demonstrated success in clinical trials of at least 50 patients for a minimum of:
a. 1 year.
b. 3 years.
c. 5 years.
d. 10 years.

4. The term "loading" refers to which aspect of implant therapy?
a. Size and shape of the implant.
b. Bulk of the bone at the implant site.
c. Placement of the implant into the bone.
d. Placement of abutments and restorations on implants for function.

5. Which modality is always acceptable for cleaning of implant abutments?
a. Sonic scaling.
b. Ultrasonic scaling.
c. Air-powder polishing.
d. Rubber-cup polishing.

SHORT ANSWER

6. Define osseointegration in the placement of a dental implant.

7. List the main factors on which the success of implant therapy depends.

8. What are the contraindications when removing calculus from implant abutment surfaces?

9. What are the symptoms of a failing dental implant?

10. What are the two critical elements of patient compliance for the implant patient?

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