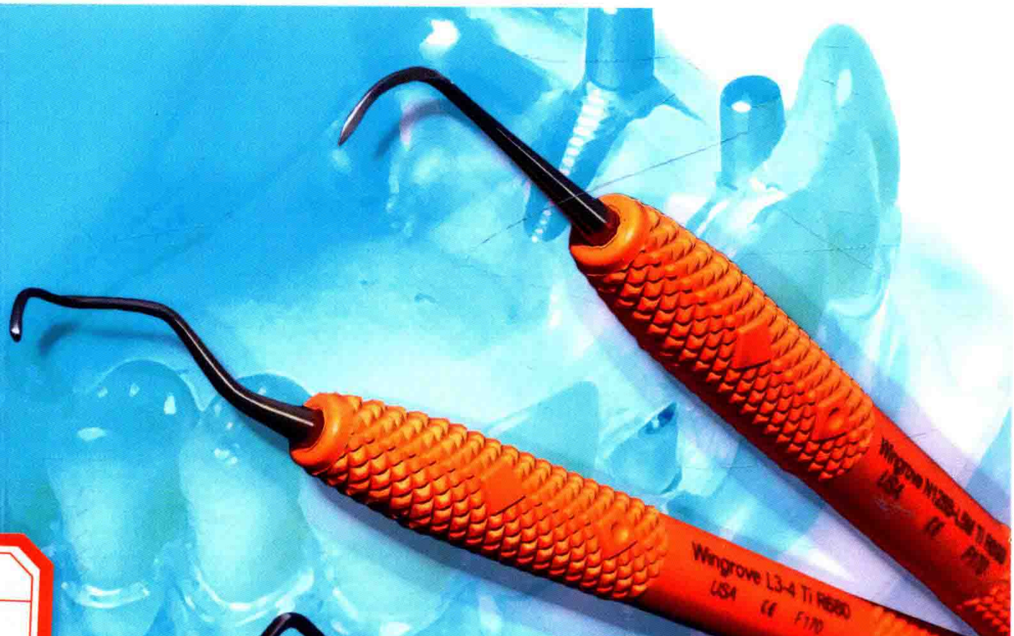
Peri-Implant Therapy for the Dental Hygienist

Clinical Guide to Maintenance and Disease Complications

Susan S. Wingrove

With contributions by Drs. Robert Horowitz, Alfonso Pineyro, and Robert Schneider



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Clinical Guide to Maintenance and Disease Complications

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Peri-Implant Therapy for the Dental Hygienist

To my late husband Dr. Frank Wingrove, who opened my mind and my passion for implant and regeneration dentistry.

To my late father Dr. Richard Strand, who passed along the importance of building relationships with your patients.

They both taught me lessons to last a lifetime.

Life is a journey

That continues around every corner.

Embrace it, treasure it, and live it to the fullest!

Go, see, do

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Go, see, do!

S.S.W.

Foreword

Osseointegration and implant dentistry use and research are at a previously unthought-of pinnacle. Dental implants are no longer "experimental" but are mainstream dentistry. The placement of dental implants is not limited to surgical specialists such as periodontists and oral and maxillofacial surgeons, many general dentists are also placing dental implants. Dental hygienists will see many more patients who have been restored with implants as their use increases even further. More than one million dentists worldwide are eager to learn about implants and offer implants treatment to their patients. Many types of dental implants are in use, and many more are in development.

Success for dental implants is based on many factors from the basic diagnostic procedures, proper planning, surgical technique, restorative techniques, dental technology, and materials knowledge, and, of course, periodontal maintenance, perhaps the most important in maintaining long-term osseointegration of the root form implants. Continued observation and maintenance of the implant-retained and -supported prostheses is critical, especially with the plethora of prosthesis designs being utilized today from conventional crown and bridge, removable prostheses, and hybrid designs that are very difficult for the patient to clean and maintain.

Dental implants are utilized for everything from single-tooth replacement to full arch tooth replacement, and each restoration comes with unique challenges for appropriate hygiene access and maintenance. For single teeth, proper emergence profile and proper cement margin placement is critical in the maintenance of a healthy periodontium. With full arch fixed restorations, access to the abutments and the pontic/gingival areas, which should follow a convex contour as desired in routine pontic design, are very important for patient access and proper oral hygiene technique and procedures.

In addition to basic prosthesis design for optimal hygiene access, the hygienist will also see biomechanical issues leading to gingival/alveolar challenges such as fractured or loose prosthetic- and abutment-retaining screws, which can manifest as a loose prosthesis, gingival hypertrophy, peri-impalantitis, alveolar bone loss, and so on. Cement-retained implant restorations have become very prevalent. A significant periodontal concern is inadequate removal of the residual cement in the subgingival areas. Incomplete cement removal can result in serious peri-implantitis and alveolar bone loss. These issues need to be identified by the hygienist and an appropriate treatment rendered to help ensure the longevity of the implant and prosthesis along with continued gingival health.

Ailing or failing dental implants, due to poor oral hygiene or lack of appropriate follow-up, may lead to possible health issues due to the unaddressed peri-implantitis. Infection and/or alveolar bone loss can be an issue in many patients, especially with the aging population and the "graying" of the baby boomers. Quality oral health care may be a challenge for many of our patients as they transition into assisted living or supervised care facilities for the aged. Dental hygienists will play a critical role in maintaining the general dental and medical health of these patients and the role will expand even more as an increased number of dental implants are placed and restored and the population ages.

This excellent text will provide much-needed information for the dental hygienist and therapist to facilitate monitoring and maintaining dental implant patients in an optimal state of dental health and general well-being.

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Contents

1 Implants 101: History, Implant Design, Parts, and Pieces

Understand as hygienists a tidal wave of ailing or failing implants may be imminent. It is imperative that hygienists are trained in identifying and treating peri-implant mucosal inflammation that could affect overall body health. (1)

—G. Nogueira-Filho, DDS, MDent, PhD

Dental hygienists must be ready and be prepared to take on this next, very important challenge in our profession! The 21st century is an important and critical time to be a hygienist. During this exciting time in dentistry, we as hygienists have a critical role in implant therapy. As a hygienist, your role will be to access patients for healthy periodontium prior to placement of implants, to monitor the tissue surrounding the implants, and to maintain the implants through safe, effective implant maintenance. Current studies reveal that infections in the periodontium occur in more than 50% of implants placed (2). Therefore we as dental professionals will be faced with different dynamics, challenges, and complications.

As a hygienist the history of implant dentistry makes you aware that implants are not new, but have been evolving for decades. Patients may have concerns that implants are so new that not enough research or development has been done for them to feel comfortable with the procedure. With your knowledge of the history, design, and research done on implants you will be better able to talk with your patients and answer these concerns. A fundamental understanding of key terms and statistics associated with implant dentistry will also be a valuable tool to add to your verbal skills when talking with patients about tooth replacement.

History

Believe it or not, the history of dental implants dates back to 600 AD with the ancient Mayans. Dr. and Mrs. Wilson Popenoe found the lower mandible of a young Mayan woman in Honduras in 1931 (Figure 1.1). She was missing some of her lower teeth and they had been replaced with the earliest example of the first dental implants, made from pieces of shell shaped to resemble teeth. Scientists believe

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Figure 1.1 Discovery by Dr. and Mrs. Wilson Popenoe, Honduras, 1931. Reprinted with permission from Malvin E. Ring, Dentistry: An Illustrated History, 1st ed., Mosby.

Figure 1.2 George Washington's lower denture. Courtesy of Rick Blanchette.

that these shells may have actually worked. Slots were made into the bone and the shells were pounded in like little wedges, without anesthesia!

Similar discoveries were made in Egypt, artifacts that date back to the 1700s. Ivory and the bones of animals were also sometimes used to replace missing teeth. It would be decades after these archaeological discoveries before the modern world caught up with the Mayans' and Egyptians' dental technology.

In the late 18th and 19th centuries, the level of dental care went through many changes. Through the letters, journals, and accounts left by our first president, George Washington, we have a well-documented case history of his lifelong dental problems and the level of dental care available at that time. George Washington started losing his teeth at age 24 and by 1789, the year that Washington took his oath of office, he had only one of his original teeth left (Figure 1.2).

Dr. John Greenwood made a set of dentures for Washington made of hippopotamus ivory and eight real human teeth attached by brass screws. The denture, which was anchored on the one remaining tooth in Washington's mouth, has a hole that fit snugly around the one tooth. Dr. Greenwood was noted to be quite ahead of his time in his dental practice, extracting teeth and utilizing them in the manufacture of dentures, but he also experimented with implantation.

Unfortunately for Dr. Greenwood, the 18th century's lack of antibiotics and any understanding of germ theory or antisepsis doomed any such experiments to failure. He did make President George Washington several sets of dentures, none made out of wood as often referred to. They were made from gold, ivory, lead, and human and animal teeth (horse and donkey teeth were common components), with springs to help them open and bolts to hold them together.

In the 18th century, researchers experimented with gold and other metal alloys including lead as implants. Dr. Maggiolo fabricated gold implants that were placed in sockets where teeth had recently been extracted and after a healing period attached a "donor" tooth. Dr. Harris, a physician, attempted the same procedure with a platinum post, both had poor results.

Dr. Edmunds in 1886 was the first in the United States to implant a porcelain crown mounted on a platinum disc and presented at the First District Dental Society of New York. Other metal alloys with porcelain crowns were experimented with, but these implants did not have a long-term success rate.

Dr. E.J. Greenfield, pioneer of the endosseous implant, provided many of basic concepts of nascent field of implantology. He was known for his patented hollow-cylinder implants made of wire soldered with 24 karat gold. This hollow-basket design was a similar design that Straumann Implant Company from Switzerland adopted many years later. He presented his research and surgical technique in 1913, and although histological proof of bone-to-implant contact was not available at that time, he understood the clinical importance to what he called "primary stability" or osseointegration. His surgical techniques, stepwise use of drill diameters starting with round bur, were presented in 1913 and are still practiced today (3).

It wasn't until 1937 before the first relatively long-term implant success was noted. Dr. A.E. Strock used the metal alloy Vitallium®, placing a series of implants at Harvard University in animals and humans. He published a paper on the physiological effects of Vitallium in bone, with no post-operative complications or reactions noted, total toleration. These were the first relatively successful dental implants and certain types of implants are still cast in Vitallium today.

The turning point of implant dental history happened in the 1950s, when Professor Per-Ingvar Brånemark, an orthopedic surgeon, discovered that titanium components can bond irreversibly with living bone tissue. His team designed many studies on the healing effects of bone with one specific study on rabbits in which a titanium metal cylinder was screwed in a rabbit's thighbone. A several-month healing period and other experiments of the blood circulation in animals using a hollow titanium cylinder demonstrated that the titanium cylinder fused to the bone. Brånemark named this discovery osseointegration (the firm, direct, and lasting biological attachment of a metallic implant to vital bone with no intervening connective tissue) (Figure 1.3).

Figure 1.3 Professor Per-Ingvar Brånemark, an orthopedic surgeon. Courtesy of Nobel Biocare.

Brånemark's research and other colleagues from other disciplines evolved this theory of osseointegration along with the design of the "Brånemark titanium screw" device with a number of specific surface treatments to enhance bioacceptance with bone. One of the key reasons that titanium was chosen by Brånemark is his relationship to Hans Emneus, an orthopedic surgeon, who studied different metals used for hip joint prostheses. His research indicated that a new metal, titanium, from Russia and used in nuclear industry, might be optimal. Brånemark used a sample from Russia and from there on the best metal for implants has been pure titanium.

In 1964, commercial-grade pure titanium was accepted as the material of choice for dental implants. Other bodies of medicine (e.g., joint replacements) had recognized the fact that the body does not recognize titanium as a foreign material, which results in higher success rate and fewer rejections. Eventually the use of commercial pure titanium evolved into the use of titanium alloys ($TiAl_6V_4$ being the most commonly used) due to experimentation and improved durability.

In 1981, Dr. Per-Ingvar Brånemark published his findings covering all the data on the animal and human clinical trials: success rate, concept, and the design of endosteal root-form titanium implants most commonly placed today. In an effort to gain international support and collaboration, based on patient care with sound biological and clinical principles Brånemark founded the Association of Brånemark Osseointegration Centers (ABOC).

Brånemark identified the edentulous patient as an amputee, an oral invalid, to whom we should pay total respect and rehabilitation ambitions. He was also instrumental in identifying the mouth as a much more important part of the human body than medicine and controlling agencies had previously recognized. He coined the term *osseoperception*, "the dentate mouth communicates with the brain, possibly improving not only daily function, but also being an important factor in restitution after intra-cranial vascular events" (P-I Brånemark, September 2005).

In the 21st century, technology and clinical awareness will take on more importance. The science and clinical advancements have made it possible for oral and maxillofacial surgeons, periodontists, and general dentists in the United States to double the number of implants performed per dentist between 1995 and 2002.

Dental implant history timeline

Ancient history: Mayans back in AD 600 had dental implants made from pieces of shell and ancient Egyptians used shells and ivory.

1700s: Lost teeth were often replaced with teeth from human donors. The process was mostly unsuccessful due to immune system reactions to the foreign material.

1800s: Researchers fabricated gold, platinum, and other metal alloys, including lead, into posts that were placed into the sockets of extracted teeth and donor teeth were attached after a healing period.

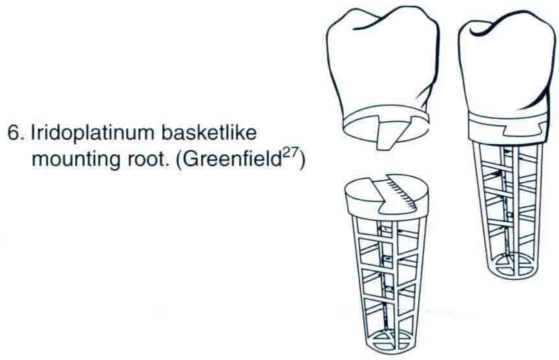

Figure 1.4 Dr. Greenfield's basket design. Source: EJ Greenfield, "Implantation of artificial crown and bridge abutments," The Dental Cosmos, 1913; 55(4):364–369.

1886: Dr. Edmunds was the first in the United States to implant a porcelain crown mounted on a platinum disc and presented at the First District Dental Society of New York.

1913: Dr. E.J. Greenfield, pioneer of endosseous implant, provided many of basic concepts of the nascent field of implantology. He was most known for his patented hollow-cylinder implants made of wire soldered with 24 karat gold and outlined surgical implant placement technique (Figure 1.4).

1939: Dr. A.E. Strock introduced the first biocompatible material, the metal alloy Vitallium, to place a series of implants at Harvard University in animals and humans. He is credited with the first relatively long-term successful dental implants.

1941: Dr. Gustav Dahl of Sweden is credited with the development of the **subperiosteal implant**, a metal framework that is surgically placed on top of the jawbone for completely edentulous patients (Figure 1.5).

1952: Professor Per-Ingvar Brånemark discovered that titanium components can bond irreversibly with living bone tissue and coined the term osseointegration.

1964: Commercial grade pure titanium, or commercial pure titanium, was accepted as material of choice for dental implants.

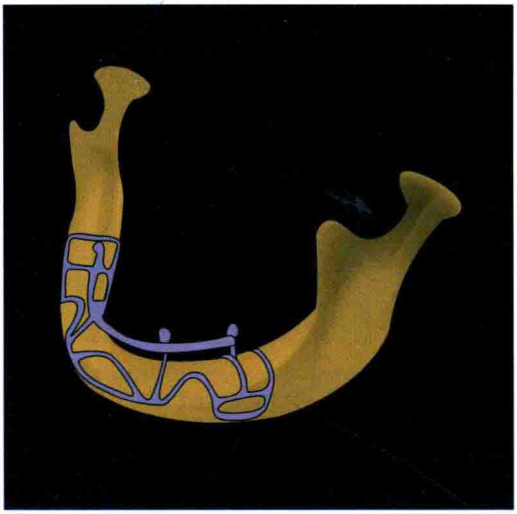

Figure 1.5 Dr. Dahl subperiosteal design.

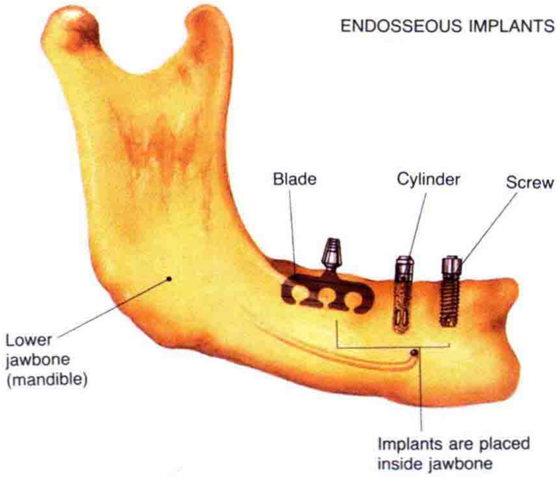

Figure 1.6 Endosteal design. Source: G Juodzbalys, HL Wang, "Guidelines for the identification of the mandibular vital structures: practical clinical applications of anatomy and radiological examination methods," J Oral Maxillofac Res 2010; 1(2):e1.

1967: Dr. Leonard Linkow of New York developed the blade implants and Doctors Ralph and Harold Roberts are also credited to the development of **endosteal implants** (Figure 1.6).

1968: Dr. Irwin Small developed the **transosteal dental implant** (Figure 1.7).

1969: Dr. Per-Ingvar Brånemark provided the proof of long-term success of titanium implants.

1981: Dr. Per-Ingvar Brånemark published his finding covering all the data on the animal and human clinical trials: success rate, concept, and the current design of **endosteal root-form titanium implants**.

1982: The Toronto Conference on Osseointegration in Clinical Dentistry created the first guidelines for what would be considered the standardization of successful implant dentistry.

1986: Implants received the endorsement of the American Dental Association.

1989: The Brånemark Osseointegration Center (BOC) in Gothenburg, Sweden, was founded. BOC's primary mission was to provide treatment for patients with severe oral, maxillofacial, and orthopedic impediments.

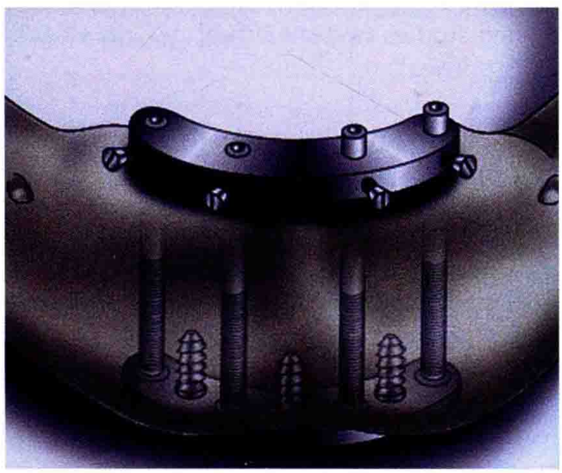

Figure 1.7 Transosteal design. Reprinted with permission from Mosby's Dental Dictionary, 2nd ed., © 2008 Elsevier, Inc. All rights reserved.

2002: An ADA survey showed that oral and maxillofacial surgeons, periodontists, and general dentists doubled the number of implants performed per dentist between 1995 and 2002.

Figure 1.8 Implants. Courtesy of BioHorizons.

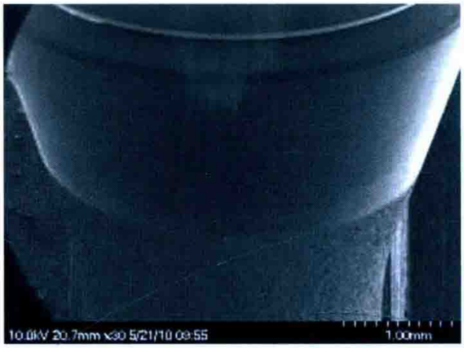

Figure 1.9 SEM titanium alloy implant macro/micro roughened surface. Courtesy of PDT.

Today: The FDA regulates the oral and dental implants being placed, requiring implant companies to furnish data and controlled studies under medical devices to gain full approval.

Implants

Over the past 30 years, research has validated the success of osseointegrated implants as a viable alternative to fixed or removable prosthetic restorations (Figure 1.8) (4). Implant placement in the premolar and molar are 95% successful and are considered the first choice in tooth-replacement options (5, 6). This is supported by the dental literature for many implant systems in every area of the mouth (7). According to Michael Tischler, et al. (8, 9), because of "the amount of edentulism currently documented, it is essential for clinicians to incorporate dental implants into everyday practice." The American Association of Oral and Maxillofacial Surgeons report that 69% of adults between ages 35 and 44 years have lost at least one permanent tooth and 43% of adults over the age of 65 years old are missing six or more teeth due to tooth decay, periodontal disease, a failed root canal, or trauma (8, 9).

As hygienists, these changes have evolved into a new phase of maintenance care for our patients. Before we can understand the new protocols for our maintenance appointments, an understanding of the basics of implants and why most implants are made from titanium alloy is necessary. The choice of which type of implant to use will be in the hands of the surgeon, but hygienist should have an understanding of the component parts. The main component parts of an implant are the fixture (design, length, shape, diameter, and surface), transmucosal abutment, and the prosthesis (Figure 1.9).

Why is titanium metal used for dental implants? The reasons make quite a remarkable list: it is strong, lightweight, corrosion resistant, nontoxic, nonferromagnetic, biocompatible (not rejected by the human body), long lasting, and osseointegrative (joins to human bone), and its flexibility and elasticity are similar to that of human bone. Titanium alloy which is what dental implants are made from are mainly $TiAl_6V_4$ otherwise known as medical grade 5 and grade 23 for the greatest fracture resistance. Implants have a rough, smooth, and/or coated surface to speed up the osseointegration process. Types of treated surfaces are always evolving with the goal being

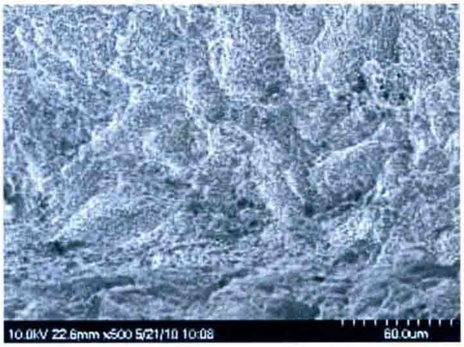

Figure 1.10 Titanium-coated implant. Courtesy of PDT.

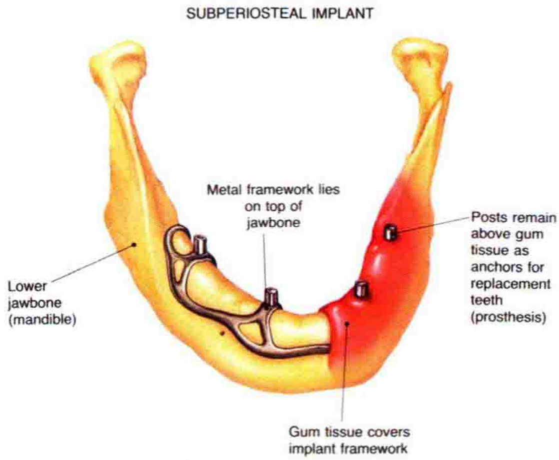

Figure 1.11 Subperiosteal Implant. Reprinted from TD Taylor and WR Laney, Dental Implants: Are They for Me? 2nd ed., Quintessence, 1993, with permission from the author.

to provide a biologically compatible surface to attract the bone to integrate to the implant. Some current examples are hydroxyapatite (HA), the crystalline phase of calcium phosphate found naturally in bone mineral that is sprayed onto the implants, and titanium plasma sprayed (TPS), which simply means a heat/spray technique used in the industry to apply metal (rough titanium) or ceramic (zirconia) coatings to implants (Figure 1.10). These coatings are sprayed on the implant body at the factory, placed in sterile container, and sealed. According to Vallecillio et al. (10), "long term success rates were outstanding for HA-coated implants and acceptable for TPS-coated implants after 5 years" (10).

Another point to call the patient's attention to about titanium implants is the nonferromagnetic quality of titanium. *The benefit of being nonferromagnetic allows for patients with titanium implants to safely be examined with MRIs and NMRIs.* One of the biggest benefits is the osseointegration of titanium and the human body, allowing for the patient's own natural bone to integrate and attach to an artificial device.

What this means for hygienists is that dental implants are biocompatible with the patient's body, not likely to be rejected. One disadvantage of titanium implants that is often listed in the literature is that they scratch easily. This will be addressed in Chapter 9; the hygienist needs to be aware of this and adjust his or her maintenance protocol to ensure safe, effective implant maintenance.

Implant design

There are multiple kinds of dental implant systems, but three main implant design types are transosteal, subperiosteal, and endosteal (endosseous) implants. They are classified according to their shape and how they interface with the bone.

Subperiosteal implants (Figure 1.11) are custom-casted framework of surgical grade metal or alloy that lies on top of the jawbone. They are surgically placed onto the ridge of an edentulous patient, similar to how a saddle is placed on a horse, and underneath the gum membrane.

This was a treatment option for patients when there was not enough bone to place an endosteal implant. Most of the implant structure, as illustrated in Figure 1.11, is covered with the original ridge tissue, so only the posts and bar are exposed above the gingiva. Sub-