An endosteal implant is an alloplastic material surgically inserted into a residual bony ridge primarily as a prosthodontic foundation. The prefix *endo* means “within,” and *osteal* means “bone.” The major subcategory of endosteal implants covered in this text are root form implants. The term *osseous* also is used in the literature. Because the term *osseous* also indicates bone, either term is acceptable. However, *endosteal*, *periosteal*, and *transosteal* are preferred.

Root form implants are the design most often used in restoration of the partial or completely edentulous patient. The desire has always been to replace missing teeth with something similar to a tooth. Root form implant history dates back thousands of years and includes civilizations such as the ancient Chinese, who 4000 years ago carved bamboo sticks the shape of pegs and drove them into the bone for fixed tooth replacement. The Egyptians, 2000 years ago, used precious metals in a similar method, and a skull was found in Europe with a ferrous metal tooth inserted into a skull in similar fashion. Incas from Central America took pieces of sea shells and tapped them into the bone, such as this jaw with three incisors implanted. Calculus formation on these three implants indicate this was not a burial ceremony, but a fixed, functional, and esthetic tooth replacement.

Surgical cobalt chromium molybdenum alloy was introduced to oral implantology in 1938 by Strock when he replaced a maxillary left incisor single tooth, an implant that lasted more than 15 years. In 1946 Strock designed a two-stage screw implant that was inserted without a per-mucosal post. The abutment post and individual crown were added after complete healing. The desired implant interface at this time was described as *ankylosis*, which may be equated to the clinical term *rigid fixation*. The first submerged implant placed by Strock was still functioning 40 years later (Fig. 3-2).

Bone fusing to titanium was first reported in 1940 by Bothe et al. Brånemark began extensive experimental studies in 1952 on the microscopic circulation of bone marrow healing. These studies led to dental implant application in early 1960; 10-year implant integration was established in...
Many practitioners are taught the use of a specific manufacturer's implant system rather than the theory and comprehensive practice of implant dentistry. The increasing number of manufacturers entering the field use trade names for their implant components (often unique to a particular system), and such names have proliferated to the point of creating confusion. Several different terms or abbreviations now exist that describe similar basic components.\textsuperscript{20-23}

To make conditions worse, in the team approach to implant treatment the widening referral base often requires that the restoring practitioner be knowledgeable regarding many implant systems. With the required knowledge of multiple systems and the lack of uniformity in component names, communication is hampered among manufacturers, dentists, staff, laboratory technicians, students, and researchers. In addition, the incorporation of implant dentistry into the curriculum of most predental and postdoctoral programs further emphasizes the need for standardization of terms and components in implant dentistry.\textsuperscript{24} This chapter proposes a generic terminology, first introduced by Misch for endosteal implants, that attempts to blend the continuity and familiarity of many implant systems with established definitions from the \textit{Illustrated Dictionary of Dentistry} and the glossaries of the Academy of Prosthodontics and the American Academy of Implant Dentistry.\textsuperscript{1,2,25,26}

\section*{GENERIC IMPLANT BODY TERMINOLOGY}

\textbf{Root form implants} are a category of endosteal implants that are designed to use a vertical column of bone, similar to the root of a natural tooth. Although many names have been applied, the 1988 National Institutes of Health consensus statement on dental implants and the American Academy of Implant Dentistry recognize the term \textit{root form}\textsuperscript{1,19} (Fig. 3-3). The exponential growth of implant use over the last 20 years has been paralleled by an explosion of the implant manufacturing field. Currently, more than 90 designs are available, offering countless combinations of implant body design, platform shapes, diameter, length, prosthetic connections, surface conditions, and interfaces.\textsuperscript{26-47}

The most common root form design combines a separate implant body and prosthetic abutment to permit the implant placement under the soft tissue during initial bone healing. A second surgical procedure is required to uncover the implant as a two-stage surgical approach, separated by the hard tissue healing process. The design philosophy is to achieve clinical rigid fixation that corresponds to a microscopic direct bone-to-implant interface without intervening fibrous tissue occurring over any significant portion of the implant body.

More recently, implant body designs with a permucosal section have been developed to allow a one-stage (unsubmerged) approach. Also, the immediate load techniques are reported more widely on two-piece and one-piece implant designs.

The macroscopic body design can be a cylinder, thread, plate, perforated, solid, hollow, or vented; the surface can be smooth, machined, coated, or textured. The designs are available in submersible and nonsubmersible forms in a variety of biocompatible materials. Three primary types of root form endosteal implants are available based on design.\textsuperscript{26}

**Figure 3-2** Al Strock, from Boston, Mass., invented a series of two-stage endosteal implants in 1948. This patient received one of these implants to replace a maxillary lateral incisor. The patient presented in 1986 with the implant still in function 38 years later.
Cylinder (press fit) root form implants depend on a coating or surface condition to provide microscopic retention and bonding to the bone and usually are pushed or tapped into a prepared bone site. They can be straight, tapered, or conical. Screw root forms are threaded into a bone site and have macroscopic retentive elements for initial bone fixation. These root forms may be machined, textured, or coated. Three basic screw-thread geometries are V-thread, buttress thread, and power (square) thread designs that are combined with different geometric shapes. Threaded implants are now available in straight, tapered, conical tapered, ovoid, and expanding designs. Combination root forms have macroscopic features of the cylinder and screw root forms.

Micro or macro thread features, alternating thread pitch, depth, and self-tapping features can be combined to create a myriad of implant designs from which to choose. The screw or combination root form designs also may benefit from microscopic retention to bone through varied surface treatment (machined, textured, etched, resorbable blast medium [RBM]) and the addition of coatings or macroscopic features such as baskets, vents, grooves, ledges, plateaux, and fins. Root forms also have been described by their means of insertion, healing, surgical requirements, surface characteristics, and interface.

**IMPLANT BODY REGIONS**

The implant body may be divided into a crest module (cervical geometry), a body, and an apex (Fig. 3-4).
Implant Body

A solid screw implant body design with a blunt apex offers significant advantages to the practitioner with limited experience or limited availability of different implant systems. A solid screw is defined as an implant of a circular cross section without any vents or holes penetrating the implant body. A number of manufacturers provide this design. The V-shaped threaded screw has a long history of clinical use; the most common thread outer diameter is 3.75 mm, with a 0.4 mm depth of thread and a crest module about 2 mm in height and crestal diameter of 4.1 mm. The various lengths range from 7 to 20 mm; lengths from 10 to 16 mm are the most widely used. This design now is offered in a variety of diameters (narrow, standard, wide) to better answer the mechanical, esthetic, and anatomical requirements in different areas of the mouth.

A solid screw permits the preparation and placement of the implant in dense cortical bone and in fine trabecular bone. The surgery may be modified easily to accommodate both extremes of bone density. The solid screw permits the implant to be removed at the time of surgery if placement is not ideal. A solid implant may perforate the inferior border of the mandible, nares, or maxillary sinus without inherent complication if the apex is smooth or blunted. The solid screw may be plasma spray-coated with titanium or hydroxyapatite to marginally increase the functional surface area, microlock the bone, and take advantage of biochemical properties related to the surface coating (e.g., bone bonding or bone growth factors).

Manufacturers also may provide slightly smaller or larger implant diameters for use in limited anatomical situations or surgical complications. A solid screw also permits the implant to be removed at the Stage II surgery if angulation or crestal bony contours are not adequate for long-term prosthesis success.

The functional surface area of a threaded implant is greater than a cylinder implant by a minimum of 30% and may exceed 500%, depending on the thread geometry. This increase in functional implant surface area decreases the stress imposed on the implant bone interface and also depends on thread geometry.

A cylinder implant design system offers the advantage of ease of placement, even in difficult access locations. For example, in the very soft D4 bone of the posterior regions of the maxilla, a 70:1 handpiece, rather than a hand wrench, is needed to insert a threaded implant design. Very soft bone otherwise may be displaced during the hand ratchet procedure, and the implant will not be rigid. A cylinder implant may be pressed into the bone by hand in hard or soft bone. The cylinder system also has some benefits for the single-tooth implant application, especially if the crown height of the adjacent teeth is large. Extenders are needed for the screw implant placement in these situations, as well as additional armamentarium to insert the cover screw of the implant. Cylinder systems also are easier and faster to place because bone tapping is not required. The speed of implant rotation during insertion and the amount of apical force in implant insertion are also less relevant.

However, most cylinder implants are essentially smooth-sided and bullet-shaped implants that require a bioactive or increased surface area coating for retention in the bone. If these same materials were placed on a threaded design, the surface area of bone contact would be more than 30% higher compared with the smooth cylinder design. The greater the functional surface area of the bone implant contact, the better the support system for the prosthesis. In addition, if bone loss occurs around a coated implant, a biological smear layer attaches to the coating. The contaminated coating often must be removed for the bone to readapt to the implant. However, once the coating is removed, the cylindrical implant primarily imposes shear loading to the bone implant interface. Bone is 65% weaker in shear force compared with compression. As a result, future bone loss is even more likely. Once the surface is decontaminated and bone is regenerated next to the implant, the threaded implant still can transmit compression and tensile forces to bone. Hence surgical correction of bone loss has better prognosis with screw-type implants.

Crest Module

The crest module of an implant is that portion designed to retain the prosthetic component in a two-piece system; it also represents the transition zone from the implant body design to the transosteal region of the implant at the crest of the ridge. The crest module also may be designed to exit the soft tissue in some implant systems (e.g., the ITI implant system). The abutment connection area often has a platform on which the abutment is set; the platform offers physical resistance to axial occlusal loads. An antirotation feature often is included on the platform (external hexagon) but may extend within the implant body (internal hexagon, Morse taper, internal grooves). The implant body has a macroscopic design (e.g., threads or large spheres), whereas the crest module is often smoother to impair plaque retention if crestal bone loss occurs. The apical dimension of the crest module varies greatly from one system to another (0.5 mm to 5 mm).

The platform features a coupling that is above or below the crestal bone level. Nonrotational features are typically part of this element. The classic connection above the platform is an external hexagon of dimensions varying with manufacturers and implant diameter.

A high-precision fit of the external hexagon, flat-to-flat dimension is paramount to the stability of the implant body–abutment connection. Internal connections can be of the internal hexagon or octagon type. Other geometrics include octagonal, cone screw, cylinder hexagon, spline, cam tube, and pin slots. The connection is received by slip-fit or friction-fit with butt or bevel joint. All aim at providing a precise mating of the two components with minimal tolerance. A multitude of patents have been filed touting the merits of a particular design, and one can expect the field will see more creative versions as the field further expands.

Implant Collar

A cervical collar may be incorporated: its design varies from straight to flared neck, beveled, reverse bevel, tapered, smooth, surfaced, or microthreaded. Designs that incorporate a microscopic component into the implant bodies by coatings with hydroxyapatite or titanium often have an implant collar at the superior aspect of the crest module. Prevention of hydroxyapatite exposure above the bone may be one solution to decrease the potential bacterial liability.
From observations of a number of hydroxyapatite-coated cylinder Integral implants exhibiting morbidity, Block and Kent[67] made recommendations to reduce complications, including (1) caution in placing implants in thin bone or extraction sites without adequate bony coverage or grafting and (2) primary closure to prevent premature exposure and possible bone loss. However, the amount of bone remodeling following implant placement is difficult to predict. The inclusion of a metal collar allows functional remodeling to occur to a more consistent region on the implant.68 Studies on osseous healing around implants69,70 suggest that crestal remodeling is limited to the smooth region of the collar. As a result of this remodeling, the sulcular epithelium migrates to the base of the implant collar. However, no significant differences in the probing depths between healthy implants with and without coronal collars have been noted69 probably because of the close adaptation of circular fibers encircling the implant neck.71

Besides the possible prevention of hydroxyapatite exposure, an additional advantage of using a machined coronal portion is the potential for an improved interface at the abutment connection. Although the machined collar region may provide this advantage, the collar contributes little to the biomechanical support at the bony crest where stresses are most severe; one must consider this factor in treatment planning and prosthesis design. Therefore the machined collar limited in height to 0.5 to 1 mm provides the biological and abutment connection advantages and limits the biomechanical disadvantage.

**GENERIC PROSTHETIC COMPONENT TERMINOLOGY**

Misch and Misch26 developed a generic language for endosteal implants in 1992. This language is presented in an order following the chronology of insertion to restoration (Fig. 3-5). In formulating the terminology, five commonly used implant systems in the United States were referenced.

Ten years later, the dramatic evolution of the U.S. implant market has resulted in the complete disappearance of some and the multiplication and mutation of others through mergers and name changes. To make matters worse, even if the company remained the same, changes in the implant line and component design (dimensions or connection types) may have taken place. A 1998 article reported that in the U.S. alone the profession now has to choose from more than 1300 implants and 1500 abutments in various materials, shapes, sizes, diameters, lengths, surfaces, and connections.62 More than ever, a common language is needed. Just as in pharmacology in which the multiplicity of pharmaceutical components makes it impossible to list them all by proprietary names but by category, implant components still can be classified into broad applications/indications categories, and the practitioner should be able to recognize a certain component category and know its indications and limitations.

At the time of insertion of the implant body or Stage I surgery, a first-stage cover is placed into the top of the implant to prevent bone, soft tissue, or debris from invading the abutment connection area during healing. If the first-stage cover is screwed into place, the term cover screw may be used.

**Figure 3-5** Implant components most often have terms that are different for each company. Misch and Misch26 published a generic language that applies to any product. This language permits improved communication between referring doctors and laboratories, which often must be familiar with several different systems. (From Misch CE: Contemporary implant dentistry, ed 2, St Louis, 1999, Mosby.)

After a prescribed healing period sufficient to allow a supporting interface to develop, a second-stage procedure may be performed to expose the implant or to attach a transmucosal portion.25 This transmucosal portion is termed a permucosal extension because it extends the implant above the soft tissue and results in the development of a permucosal seal around the implant. This implant component also is called a healing abutment because Stage II uncoverery surgery often uses this device for initial soft tissue healing (Figs. 3-6 and 3-7).

In the case of a one-stage procedure, the surgeon may have placed the permucosal extension at the time of implant insertion or may have selected an implant body design with a cervical collar of sufficient height to be supragingival. In the case of immediate load, the permucosal healing abutment may not be used at all if a temporary prosthesis is delivered on the day of surgery or may be used until the suture removal appointment and the
temporarily teeth delivery. The healing abutment is available in multiple heights to accommodate soft tissue variations and also can be straight or flared or anatomical to assist in the soft tissue healing sculpture.

The abutment is the portion of the implant that supports or retains a prosthesis or implant superstructure.25 A superstructure is defined as a metal framework that fits the implant abutment(s) and provides retention for a removable prosthesis(e.g., a cast bar retaining an overdenture with attachments) or provides the framework for a fixed prosthesis.

Three main categories of implant abutment are described, according to the method by which the prosthesis or superstructure is retained to the abutment: (1) an abutment for screw retention uses a screw to retain the prosthesis or superstructure; (2) an abutment for cement retention uses dental cement to retain the prosthesis or superstructure; and (3) an abutment for attachment uses an attachment device to retain a removable prosthesis (such as O-ring attachment) (Figs. 3-8 to 3-10). Many manufacturers classify the prosthesis as fixed.

Figure 3-6 The permcosal extension (PME) attaches to the implant body and allows the soft tissue to heal and mature around the future implant abutment. The PME may be the same size as the crest module of the implant body (left) or slightly larger (right) and helps develop the emergence contour of the implant crown.

Figure 3-7 An intraoral view of eight second-stage permcosal extensions that were inserted into the implant bodies.

Figure 3-8 An abutment for screw retention is used for a screw-retained bar or fixed prosthesis. (Courtesy BioHorizons, Birmingham, Ala.)

Figure 3-9 Abutment for cement retention may be one piece (far left) or two pieces, which are retained by a separate abutment screw.

Figure 3-10 Abutment for attachment is used for removable prostheses that are implant retained. These may be used for complete dentures and/or partial dentures.
Whenever cement retains the prostheses, *fixed/removable* when screws retain a fixed prosthesis, and *removable* when the restoration can be removed by the patient. This description implies that only screw-retained prostheses may be removed. The description is not accurate because the dentist also may remove a fixed-cemented prosthesis. Hence the generic language in this chapter separates prostheses into fixed or removable as does traditional prosthetics. The abutment may be screwed or cemented into the implant body, but this aspect is not delineated within the generic terminology. Each of the three abutment types may be classified further as *straight* or *angled* abutments, describing the axial relationship between the implant body and the abutment. An abutment for screw retention uses a *hygiene cover screw* placed over the abutment to prevent debris and calculus from invading the internally threaded portion of the abutment during fabrication between prosthetic appointments.

The paucity of abutment design of a decade ago has been replaced by a plethora of options. The expansion of implant dentistry, its applications for esthetic dentistry, and the creativity of manufacturers in this competitive market are responsible for the explosion of implant abutment styles available today. In the abutment for cement category, the doctor may choose from one- and two-piece abutments, University of California—Los Angeles (UCLA) type (plastic castable, machined/plastic cast to cylinder, gold sleeve castable), two-piece esthetic, two-piece anatomical, two-piece shoulder, preangled (several angulations), or telescopic nullable ceramic (Figs. 3-9, 3-11, and 3-12). The abutment for screw category also has been enlarged with one- and two-piece overdenture abutments of different contours and heights.

An impression is necessary to transfer the position and design of the implant or abutment to a master cast for prosthesis fabrication. A *transfer coping* is used in traditional prosthetics to position a die in an impression [25] (Fig. 3-13). Most implant manufacturers use the terms *transfer* and *coping* to describe the component used for the final impression.

![Figure 3-12](image)

Therefore a transfer coping is used to position an analog in an impression and is defined by the portion of the implant it transfers to the master cast, either the *implant body transfer coping* or the *abutment transfer coping*.

Two basic implant restorative techniques are used to make a master impression, and each uses a different design transfer coping, based on the transfer technique performed. An *indirect transfer coping* uses an impression material requiring elastic properties. The indirect transfer coping is screwed into the abutment or implant body and remains in place when the set impression is removed from the mouth. The indirect transfer coping is parallel-sided or slightly tapered to allow ease in removal of the impression and often has flat sides or smooth undercuts to facilitate reorientation in the impression after removal. A *direct transfer coping* usually consists of a hollow transfer component, often square, and a long central screw to secure it to the abutment or implant body and may be used as a pickup impression coping. After the impression material is set, the direct transfer coping screw is unthreaded to allow removal of the impression from the mouth. Direct transfer copings take advantage of impression materials having rigid properties and eliminate the error of permanent deformation because they remain within the impression until the master model is poured and separated (Fig. 3-14).

An analog is something that is analogous or similar to something else. An *implant analog* is used in the fabrication of the master cast to replicate the retentive portion of the implant body or abutment (*implant body analog*, *implant abutment analog*). After the master impression is obtained, the corresponding analog (e.g., implant body or abutment for screw) is attached to the transfer coping and the assembly is poured in stone to fabricate the master cast (Figs. 3-15, 3-16, and 3-17).

A *prosthetic coping* is a thin covering, usually designed to fit the implant abutment for screw retention and serve as the connection between the abutment and the prosthesis or superstructure. A *prefabricated coping* usually is a metal
**Figure 3-13** An indirect transfer (far left and center) is inserted into an implant body or abutment for screw retention and a closed tray impression is made. The impression is removed and the transfers are connected to an analog and reinserted into the impression. A direct impression transfer (far right) uses an open tray to make the impression. The direct transfer coping screw must be unthreaded before the impression is removed from the mouth. (Courtesy BioHorizons, Birmingham, Ala.)

**Figure 3-14** These eight maxillary implants are connected to two-piece indirect impression transfers, which engage the hexagon of the implant platform. A closed-tray impression is made, and the indirect transfer copings are unthreaded from the implant bodies, connected to implant body analogs, and reinserted into the impression before pouring of the cast.

**Figure 3-15** Analogs may represent an abutment for screw retention, an implant body (left), and/or an abutment for attachment (right).
regardless of the implant system used; the term is descriptive of the function of the component rather than its proprietary name.

References


