

OVERVIEW OF THE SWISSPLUS IMPLANT SYSTEM

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KEY WORDS

SwissPlus
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Although many improvements have been made to implant dentistry during the last quarter of a century, clinical challenges still remain. For the surgeon, achieving implant stability in low-density bone can be difficult. For the restorative dentist, incompatibility between implant systems and the increasing complexity of esthetic restorative options frequently require special training in the selection and use of prosthetic components. This article presents an overview of a 1-stage implant system with a textured surface and osteocompressive surgical protocol designed to achieve stability in soft bone. Self-tapping, double lead threads and a separate surgical protocol also enable the implant to be placed in high-density bone. The implant is packaged on a fixture mount that also functions as a transfer and transitional or definitive abutment for cemented restorations. This implant is designed to help simplify restorative procedures by eliminating many ancillary restorative components. For multiple-unit, screw-retained restorations, the prosthesis can be splinted directly to the top of the implant without an intermediate abutment. Overdenture attachments and straight, angled, screw-receiving, and custom-cast abutments complete the restorative system.

INTRODUCTION

In the intervening decades since the developmental period of osseointegration,¹⁻³ clinical research has documented many new factors that may positively influence the long-term predictability of dental implants.⁴ Improvements in implant designs⁵ and surfaces,⁶⁻⁸ use of prophylactic antibiotics,^{9,10} and even clinician experience¹¹ are some of the many variables that have been reported to affect

implant anchorage in bone. Despite the improvements in implant predictability ostensibly afforded by these findings, studies of machined, titanium implants during the past 2 decades have shown a 10% higher failure rate in low-density maxillary bone compared with higher-density mandibular bone.^{4,12-17} Successful implant treatment in poor-quality bone thus remains one of the most pervasive clinical challenges to implant dentistry.^{4,18,19}

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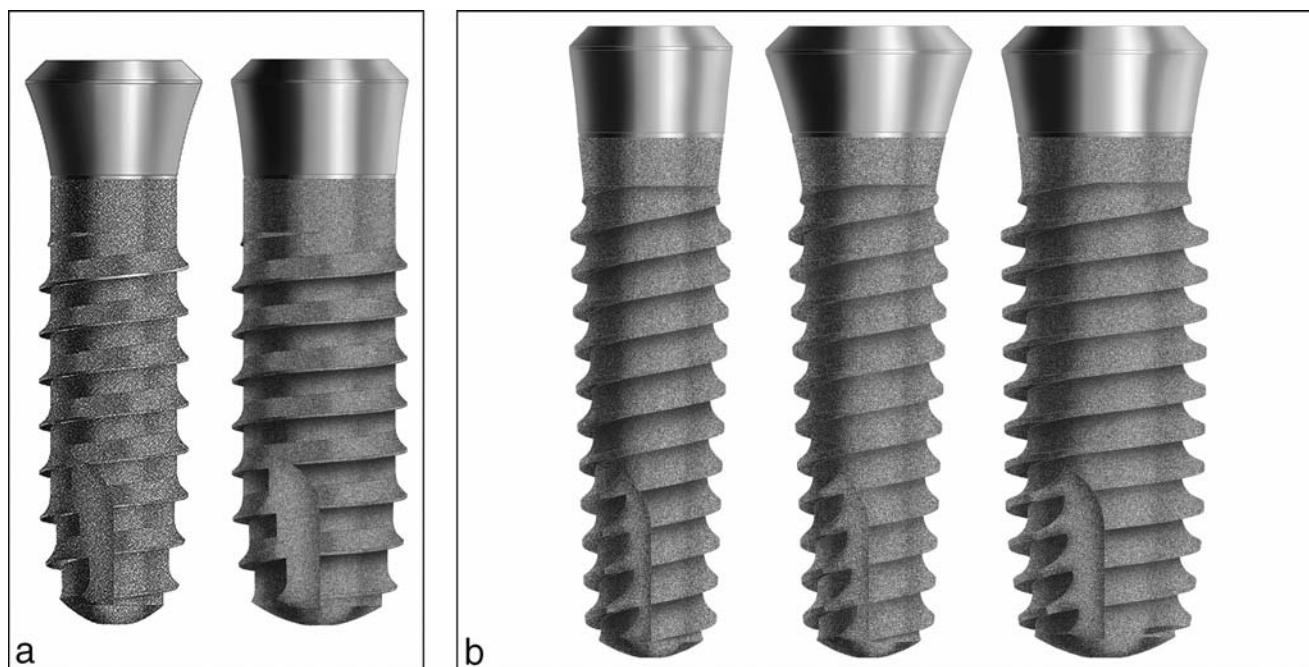


FIGURE 1. (a) Straight implant design (single thread). Two diameters have a common 4.8-mm-diameter platform and internal octagon connection. Apex is tapered 7°. (b) Tapered implant design (double threads). Narrow diameter (left) has a 3.8-mm-diameter platform and internal hexagon connection; standard (middle) and wide (right) diameters have a 4.8-mm-diameter platform and internal octagon connection.

For restorative dentists, incompatibility between implant systems and the increasing complexity of esthetic restorative options frequently require special training in the selection and use of prosthetic components. According to data from the American Dental Association, dental implant use increased 73% from 1986 to 1990.^{20,21} Although this upward trend continued for surgical specialists through 1998, the opposite was true for general practitioners. From 1994 to 1998, the number of general practitioners who restored dental implants decreased by 2% and the number who placed dental implants decreased by 4%.^{21,22} Standardization of implant systems and the need for more product training are 2 reported variables that may help to increase implant use.^{21,23} This article presents an overview of an implant system designed to increase initial stabil-

ity in poor-quality bone and to simplify restorative procedures by eliminating many ancillary restorative components.

IMPLANT DESIGN

The SwissPlus Implant System (Zimmer Dental Inc, Carlsbad, Calif) is composed of 1-piece straight (Figure 1a) and fully tapered (Figure 1b) implant designs with self-tapping, apical threads and a microtextured surface on the intraosseous portion of the implant body (Table). After placement, the implant's slightly fluted neck penetrates through the soft tissue for a 1-stage surgical procedure. In the esthetic zone, the clinician may elect to place 1.0 mm of the 2.0-mm smooth neck subcrestal, if needed, to lower the shoulder of the implant below the gingiva. The soft tissue opening is maintained by attaching a 2-mm-high cover screw provided with the implant.

This cover screw matches the diameter of the fixture mount to establish the desired emergence profile. Additional cover screws are available in 1.0- and 3.0-mm lengths. The implant receptor site is conventionally prepared using a series of straight drills in progressive diameters, but the final drill differs according to the density of bone in the surgical area.

Dense bone surgical protocol

In dense and moderately dense bone (types 1 to 3),¹⁸ the final drill is a step design that prepares a narrower diameter in the apical region of the osteotomy. Depending on implant length, approximately one third to half of the tapered implant body can be placed into the osteotomy before the self-tapping threads engage the walls of the receptor site. This can facilitate placement in locations with limited vertical access,

TABLE
Design features of SwissPlus and Tapered SwissPlus implants

Feature	SwissPlus	Tapered SwissPlus
Neck design	Fluted	Fluted
Neck height	3.2 mm	2.5 mm
Neck surface	Machined	Machined
Platform diameter	4.8 mm	3.8 mm (narrow diameter) 4.8 mm (standard and wide diameters)
Body design	Screw	Screw
Body diameters	4.1 mm (standard diameter) 4.8 mm (wide diameter)	3.7 mm tapering to 3.0 mm at apex (standard diameter) 4.8 mm tapering to 3.8 mm at apex (wide diameter)
Body lengths	8, 10, 12, and 14 mm	8, 10, 12, and 14 mm
Thread pattern	Single	Double
Thread depth	0.3 mm	0.3 mm (standard and narrow diameter) 0.6 mm diminishing to 0.3 mm at apex (wide diameter)
Apical threads	Self-tapping	Self-tapping
Body surface	Microtextured	Microtextured
Internal connection	Internal octagon (3.0 mm diameter)	Internal octagon, 3.0 mm diameter (standard implant) Internal hexagon, 2.5 mm diameter (narrow implant)

such as the posterior mandible. The double thread pattern on the tapered implant body also requires fewer revolutions to seat the implant, which shortens surgical time and reduces the risk of overheating the bone. After placement, intimate bone contact is well distributed over the entire length of the implant body, and the surgeon can tactilely discern the firm anchorage achieved.^{24,25} The torque applied during the last revolution can reach 100 Ncm,⁴ easily surpassing the 40 Ncm commonly recommended²⁶ for immediate or early loading.²⁴ Under these conditions, immediate loading of the implant can be considered, provided caution is used to avoid any initial occlusal overload.²⁴

Soft bone surgical protocol

In low-density bone (type 4),¹⁸ sequential preparation of the osteotomy culminates with a final straight spade drill that is 0.2 or 0.3 mm smaller in diameter than the tapered apical end of the implant, depending on the im-

plant's diameter. During placement, the self-tapping apical threads of the implant fully engage the lateral walls of the receptor site and gradually condense the bone to a maximum of 0.6 or 0.7 mm of compression at the crest of the ridge, depending on the implant diameter.²⁴ Research has shown that, when a receptor site is prepared slightly smaller (minimum, 100 μ m) in diameter than the implant, the force-fitting stresses generated during placement will increase insertion torque and implant stability.^{24,27,28} In ridges with adequate width, this technique is designed to produce axial and lateral densification of the soft bone and achieve maximum thread engagement along the entire implant body for immediate stability.²⁴ In narrow ridges, bone densification and lateral deformation may be performed simultaneously during implant placement, but care must be taken to avoid tearing the crest of the ridge.²⁴ It is sometimes advisable to first expand the ridge with a tapered osteotome before placing the implant.²⁴

Although the amount of bone that comes into direct apposition with screw-type implants gradually increases with follow-up time, removal torque for screw-type implants depends on the amount of compact bone, rather than the total amount of bone, between the implant threads.²⁴ The low-density bone surgical technique is designed to compress the lateral walls of the receptor site during insertion to achieve immediate, intimate contact along the entire length of the implant body, which may reduce the need for remodeling at the hard tissue interface.^{4,24} For bone of higher density, these features can provide excellent mechanical resistance to facilitate immediate loading.^{24,29,30} In comparison, placement of conventional, straight screw-type implants often results in slight play between the implant and bone at the level of the first few coronal threads, whereas the most stable interface is limited to the apical region of the implant.²⁴

In addition to thread engagement and body design, surface roughness may help to provide

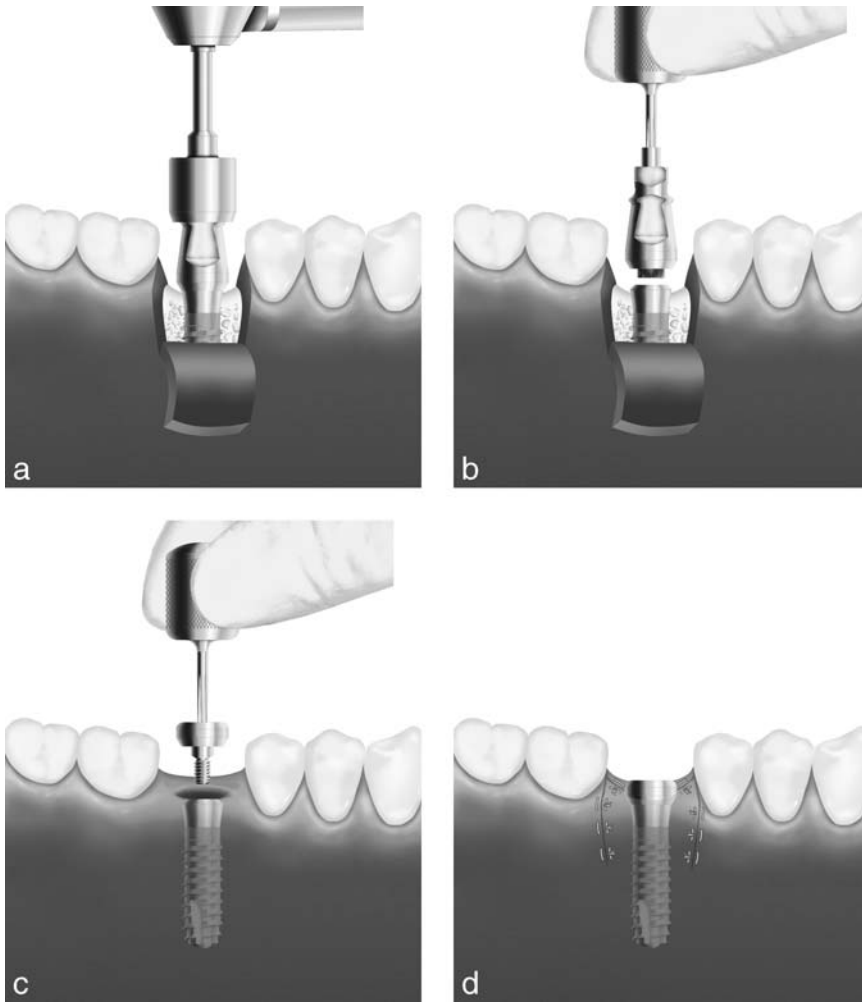


FIGURE 2. Multifunctional post initially serves as a (a) fixture mount to place the implant. It is then (b) removed and (c) a healing cap is attached for (d) 1-stage healing.

a frictional interface with the receptor site and assist in mechanical retention by allowing bone ingrowth during osseointegration.^{24,31} Numerous researchers have reported that surface roughness can positively influence cellular and tissue responses to implants and that a positive correlation exists between implant surface roughness and the degree of initial and long-term mechanical fixation.^{4,31} Although the surface finish of screw-type implants can range from relatively smooth (eg, machined) to relatively rough (eg, titanium plasma spray), the implants have a fairly uniform,

moderately microtextured surface, which has been found to significantly increase bone apposition compared with machined surfaces³² and to osseointegrate even under immediate, full occlusal loading conditions in partially edentulous patients.^{29,30,33}

MULTIFUNCTIONAL PROSTHODONTICS

The implant is packaged on a fixture mount that overlaps the beveled edge of the implant's prosthetic platform and interlocks with its internal octagon or

hexagon connection.³⁴ This component is designed to seat the implant into the osteotomy (Figure 2a through d) and function as an impression post and transfer (Figure 3a through d) to fabricate a working cast either at the time of implant placement or after osseointegration has been clinically confirmed.³⁴ To restore the implant with a cemented single tooth or fixed partial denture restoration, the fixture mount can be removed from the implant and shortened for use as a transitional or definitive straight abutment (Figure 4a through d). After modifications on a working cast, the abutment is resterilized, is attached to the implant at 30 Ncm of torque, and can be further prepared intraorally using an intermittent cutting technique with diamond or carbide burs under copious irrigation to avoid excessive heat generation.³⁵ Conventional impression procedures are then implemented to fabricate the provisional and definitive restorations (Figure 5a and b). Alternatively, the fixture mount can be used as a transfer to fabricate a working cast and then be prepared on the working cast in the dental laboratory for use as the removable die and as the definitive abutment.

For a multiple-unit, screw-retained tissue bar or denture, a castable coping may be used to fabricate a prosthesis that attaches directly to the top of the implant without an intermediate abutment. The component consists of either a plastic sheath or a gold base and plastic sheath assembly and a fixation screw. Instead of attaching the coping to an abutment, it rests passively on the implant's prosthetic platform, and the abutment fixation screw holds the coping in place. The copings are splinted on the working cast and waxed directly into

the bar or framework pattern before casting. When additional vertical height is needed for multiple-unit, screw-retained restorations, a tapered, screw-receiving abutment is threaded into the top of the implant and provides 1.6 or 3.0 mm of vertical height above the top of the implant platform. A variety of "cast-to" copings are available to facilitate fabrication of the prosthesis.

The system also features a number of conventional implant restorative products. In the anterior maxillary jaw, for example, implants must often be placed at a labial inclination to access available bone. To correct for implant angulation problems, 20° angled abutments that use the beveled shoulder of the implant as the restorative margin are indicated. For optimum orientation of the angled head to minimize preparations, the implant's internal octagon or hexagon must be indexed at the time of implant placement. Margins conforming to the soft tissue contour can be defined in the abutments with diamond or carbide burs under copious irrigation to prevent excessive heat generation.³⁵ After preparations, this nonrotational abutment can be restored with a cemented crown or bridge. The 20° angled abutments may thus eliminate the additional time and expense required with cast abutments.

Both 1- and 2-piece narrow, straight abutments are also available for crown and bridge restorations. These components also use the beveled shoulder of the implant platform as the restorative margin and include a castable plastic coping that can also function as a transfer. For multi-unit restorations, 1-piece narrow abutments that do not engage the implant's internal octagon

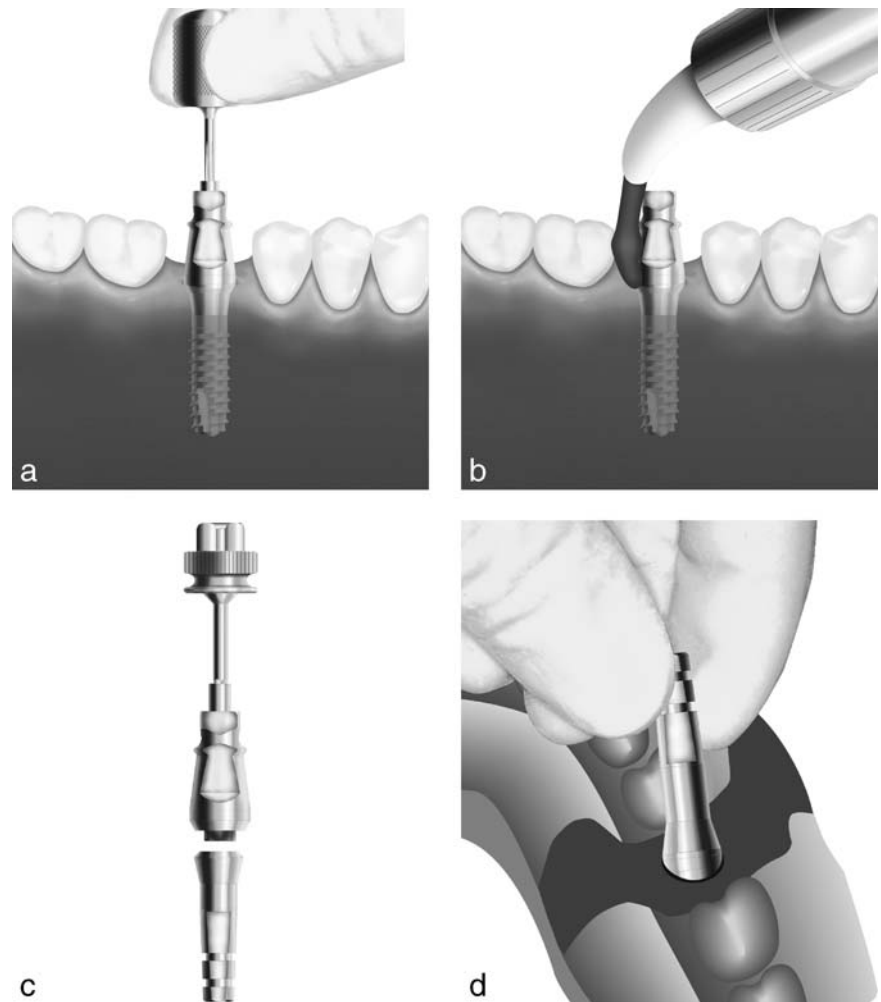


FIGURE 3. After healing, (a) the fixture mount is reattached to the implant and (b) used as an impression post and (c-d) transferred to fabricate a working cast.

are indicated. After tightening the 1-piece abutments into the implants using 30 Nc/m of torque, plastic copings are placed on the abutments and picked up in an impression. Shoulder abutment replicas are then inserted into the plastic copings and the impression is poured in dental stone. After separating the working cast, the copings are incorporated into the framework pattern for the restoration.

The 2-piece narrow abutments engage the implant's internal octagon for antirotational stability and are used for single-unit or multi-unit restorations. They can

be used in the same manner as the 1-piece narrow abutments, namely, attached intraorally followed by a transfer impression of the abutment-implant shoulder relationship. Alternatively, because this component can be precisely repositioned on the implant, a transfer can be made of the location of the implant platform (implant-level transfer) using the implant's fixture mount and an implant replica. The 2-piece narrow abutment can then be attached to the implant replica, shortened on the working cast, if necessary, and used as a die to fabricate the prosthesis with the plastic

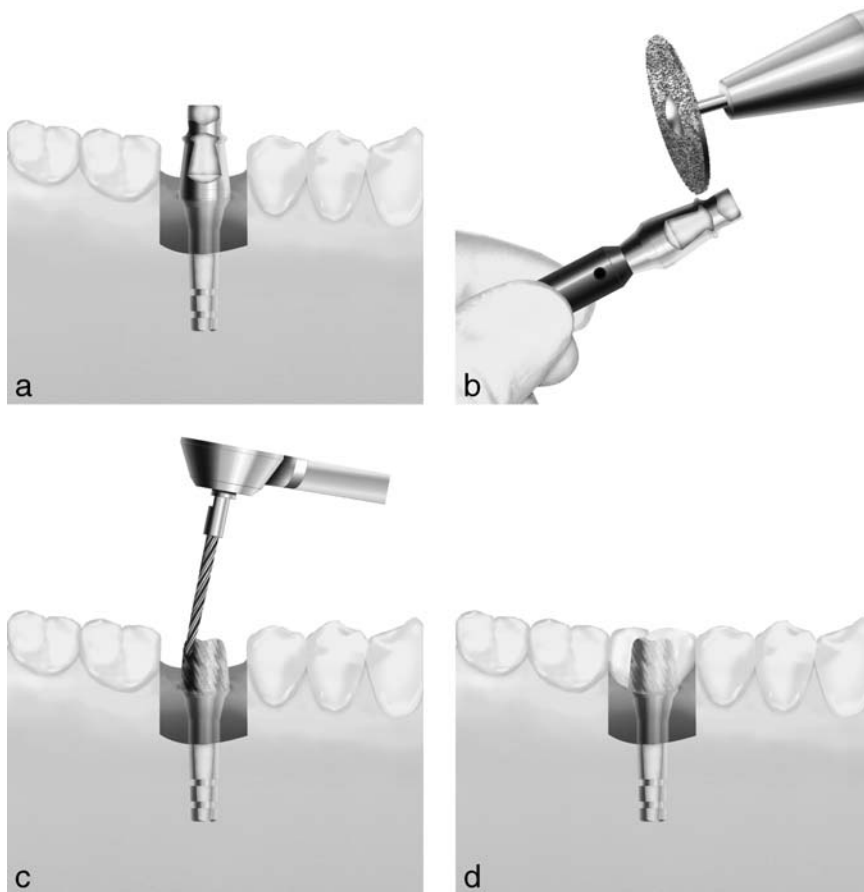


FIGURE 4. The fixture mount is (a-b) removed from the working cast, shortened, and then (c-d) reattached to the working cast and prepared as a provisional or definitive abutment.

coping. Since restorations with narrow abutments seat directly onto the implant shoulders, they

produce deep, subgingival margins. In contrast, the full-contour, preparable straight or angled

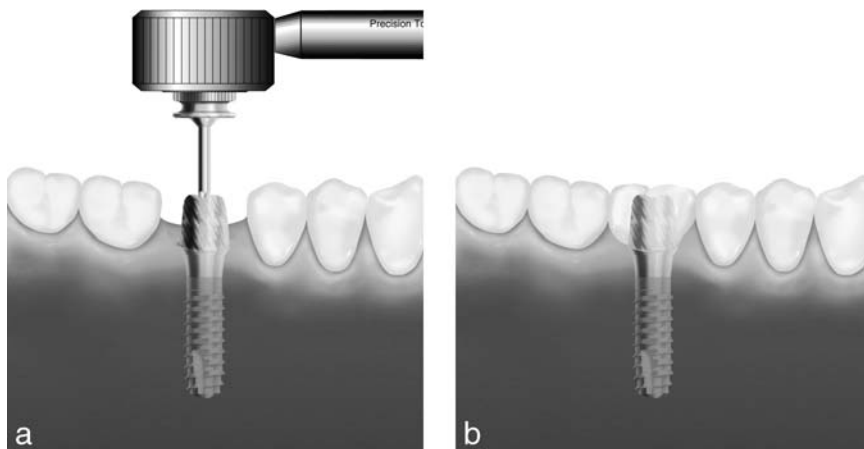


FIGURE 5. The (a) prepared abutment is sterilized, attached to the implant in the patient's mouth, and (b) restored according to conventional crown and bridge procedures.

abutments allow preparation or creation of the margins to follow the contour of the soft tissue, which makes cement removal more predictable.

When a screw-retained, combination post-and-crown restoration or a custom cast post is required, a "cast-to" gold abutment is indicated. The component consists of a gold base that interlocks with the implant's internal octagon, a plastic waxing sheath that attaches to the base, and an abutment fixation screw. A screw-retained post or framework pattern may be waxed directly over the sheath and base assembly and then cast in high noble alloy. A conventional porcelain-fused-to-metal crown can then be fabricated to cement over the cast post, or porcelain can be applied directly to the cast framework for a post-and-crown prosthesis.

Ball-and-socket attachments are used for retention of tissue-supported overdentures. This type of restoration is indicated primarily for the mandible, and the overdenture is removable by the patient to facilitate hygiene. Denture movement is necessary, due to the limited number of implants, but the attachments are designed to provide secure retention during function. The denture components of the attachment assembly may be picked up chairside or processed in the working cast.

INTERSYSTEM COMPATIBILITY

In a laboratory comparison study⁴ between straight Swiss-Plus implants and ITI synOcta implants (Straumann Dental, Waltham, Mass), the 2 implant designs were found to have the same thread pitch and major diameter. The 2 implants differed in surface microtexture. Under scanning electronic microscopy mag-

nification, the SwissPlus implant thread geometry appeared to be relatively intact, whereas the ITI synOcta implant threads appeared rounded after their respective surface treatments.⁴ The final drills for the 2 implant designs had the same depth demarcations and were within 0.06604 mm of having the same diameter, which enabled them to be used interchangeably between the 2 systems.⁴ Seating performance evaluation data showed that the tapered apical ends of the straight (apex tapered 7°) and tapered SwissPlus designs helped to engage the receptor sites and stabilized the implants sooner than the ITI synOcta implants.⁴ The double lead thread on the Tapered SwissPlus enabled it to seat in fewer revolutions than either the straight SwissPlus or ITI synOcta implants.⁴

In the second part of the laboratory comparison study,²¹ prosthetic components from both systems were found to have the same dimensions at the implant-abutment interface.²¹ The interchanged implants and abutments experienced no interferences to seating and achieved a tight mating interface when assembled.²¹ Tolerance test results of static compressive or bending loading at 30°, torsional force, shear force, and minimum tensile force showed that all test samples from both systems met or exceeded minimum force requirements.²¹

To evaluate interfacial contact between the implants and abutments, the mating interfaces of straight abutments were coated with stain, tightened in the implants to the torque level designated for each system (ie, 30 or 35 Ncm), then separated.²¹ Removal of the stain material from the abutment suggested areas of tight, interfacial contact between the mated components. With the

SwissPlus System implants, a tight implant-abutment interface was achieved regardless of attachment torque.²¹ This interface was also present in a diminished form when SwissPlus System abutments were assembled and removed from ITI synOcta implants.²¹ It was found that both implant systems performed best when the abutments were seated at their designated torque levels, just as they were designed to do.²¹

When ITI System abutments were assembled and removed from the ITI synOcta implants, the patchy band of stain removal at the implant-abutment interface and on the major thread diameter of the abutment screw suggested the presence of interfacial gaps between the ITI synOcta System components, regardless of attachment torque.²¹ In one sample, there was no stain removal on one side of the implant-abutment interface and complete stain removal on the other side, suggesting the presence of a major gap at the implant-abutment interface.²¹

DISCUSSION

Replacement of lost natural teeth will continue to be an expanding area of dentistry as an increasing percentage of the population reaches 60 years and older. Additional problems associated with this population may include a reduction in the ability to masticate, which can compromise the nutritional status of the patient, and a noticeable loss in esthetics and speech, caused by unstable conventional dentures and decreasing facial support. All of these factors can also contribute to a lowering of individual self-esteem. The implant system reviewed in this article can offer these patients increased stability in low-density bone and the

opportunity for complete oral rehabilitation.

A simplified approach to implant prosthodontics means that, whenever possible, implant restorative procedures should mimic those of conventional dentistry. For single tooth restorations, for example, the surgical specialist can shorten the fixture mount for occlusal clearance and the patient can then return to the referring dentist for intraoral abutment preparation, followed by conventional impression and prosthetic procedures. This method of team cooperation reduces cost and complexity and may encourage more implant referrals to the surgeon who is cognizant of the needs and concerns of restorative dentists. It is hoped that the simplicity and predictability now possible with implant dentistry will also translate into more general dentists completing both the surgical and prosthetic implant procedures. The evolution of implant prosthodontics must be simplified and cost-effective if it is to become a part of mainstream dentistry.

CONCLUSION

The SwissPlus Implant System is designed to provide stability in all bone qualities and is surgically and prosthetically compatible with the ITI synOcta Implant System. Use of multifunctional prosthetics may help to simplify restorative procedures, inventory, and costs.

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