# Chapter 2: Implants and Implant Restorative Components

## INTRODUCTION

Dental implant treatment requires a different, precise terminology that is unique to implant dentistry. Clinicians must learn the proper terms for implants and implant restorative components to facilitate communication among the members of the implant team: surgeons, restorative dentists, dental laboratory technicians, third-party payers, patients, and implant manufacturers.

All of the implants illustrated in this textbook have been manufactured by Implant Innovations, Inc.®, Palm Beach Gardens, Florida. The internal connection implants are trademarked as OSSEOTITE® Certain® Implants. The external connection implants have been trademarked as OSSEOTITE® Implants.

## IMPLANTS

Implants are the components that are placed into patients' bone with the intent of achieving osseointegration. Osseointegration was originally defined by Brånemark as ". . . the direct structural and functional connection between ordered, living bone and the surface of a load carrying implant" (Brånemark 1985). The surgical placement of endosseous implants initiates a complex series of biologic events associated with wound healing: inflammation, proliferation and maturation (Zoldos and Kent 1995).

Healing of bone and soft tissue around endosseous implants is a dynamic process and is the result of numerous factors, among them: surgical, atraumatic technique; design of the osteotomy; host immune system; macroscopic and microscopic design of dental implants; fit of the implant into the osteotomy; wound dehiscence; and loading protocol. For optimal performance, dental implants should have appropriate mechanical strength, biocompatibility, and biostability in humans (Cook and Kay 1987). Further discussion of the biology of osseointegration is beyond the scope of this textbook. The reader is referred to other sources for further discussion.

Clinicians may choose implants from any number of manufacturers. Implants may be made from various materials, but commercially pure titanium or titanium alloy have enjoyed extraordinary clinical results. Dental implants come in various sized diameters and lengths, with various macroscopic thread designs, surface treatments, and implant/abutment connections. This textbook features the implants manufactured by ***3i***®, Implant Innovations, Inc.®, Palm Beach Gardens, Florida. All the catalogue numbers and implant and restorative components refer to products made by ***3i***®.

**Figure 2.1.** Profile view of threaded ***3i***®, 4.0 mm X 11.5 mm OSSEOTITE® Certain® implant (IOSS411).

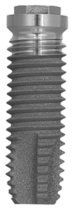

**Figure 2.2.** Profile view of threaded ***3i***®, 4.0 X 11.5 mm OSSEOTITE external hex implant (OSS411).

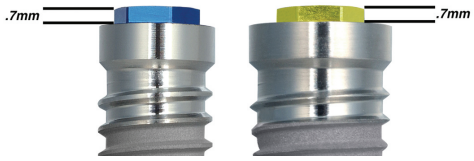


**Figure 2.3.** Profile view of OSSEOTITE® external hex implant. Vertical measurement of external hex measures 0.7 mm. (4.1 mm restorative platform left; 5.0 mm restorative platform right).

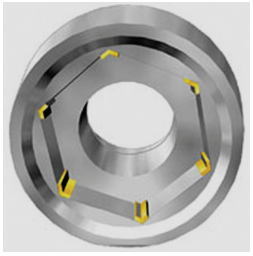

**Figure 2.4.** Apical view of pre-machined abutment with a 4.1 mm restorative platform. Flat surface to flat surface of the hex measures 2.7 mm. Microstops (Gold Standard ZR®) have been machined into the corners of the hex in UCLA Abutments and GingiHue® Posts.

Dental implants manufactured by ***3i***® have threaded external surfaces for both the tapered and cylindrical implant designs (Figures 2.1, 2.2) The original external hex implant design consisted of a six-sided hex .7 mm tall; a flat-to-flat surface measurement of 2.7 mm; and a restorative platform that measured 4.1 mm (Figures 2.3, 2.4). Dental

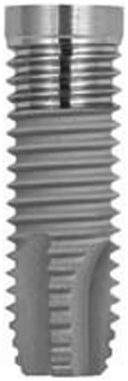

**Figure 2.5.** Profile view of 3.25 mm diameter internal connection implant. This implant expands to a 3.4 mm restorative platform (IOSM311).

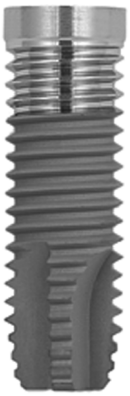

**Figure 2.6.** Profile view of 4.0 mm diameter internal connection implant. This implant expands to a 4.1 mm restorative platform (IOSS411).

**Figure 2.7.** Profile view of 5.0 mm diameter internal connection implant (INT511).

**Figure 2.8.** Profile view of 6.0 mm diameter internal connection implant (INT611).

**TABLE 2.1.** Implant Lengths and Catalogue Numbers (4 mm Diameter) for OSSEOTITE® Certain® Implants

| Length (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Certain® NT Implants |
|---|---|---|
| 8.5 | IOSS485 | INT485 |
| 10.0 | IOSS410 | INT410 |
| 11.5 | IOSS411 | INT411 |
| 13.0 | IOSS413 | INT413 |
| 15.0 | IOSS415 | INT415 |
| 18.0 | IOSS418 | N/A |
| 20.0 | IOSS420 | N/A |

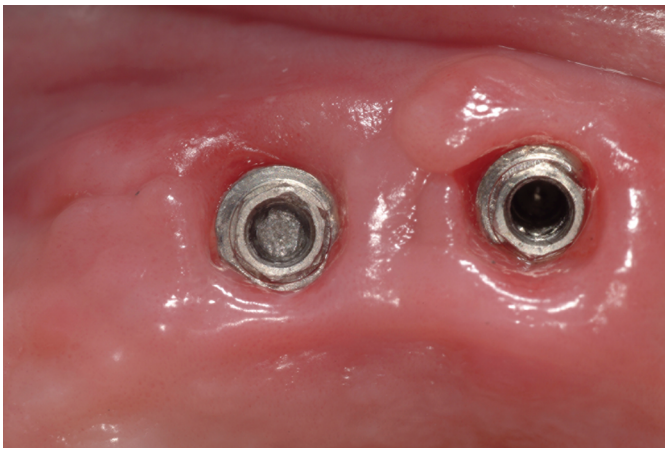

**Figure 2.9.** Clinical photograph of a broken abutment screw inside an external hexed implant.

implants are available in multiple diameters: 3.4, 4.0, 5.0, and 6.0 mm (Figures 2.5, 2.6, 2.7, 2.8).

Increasing the length of dental implants will also increase the amount of bone in contact with dental implants. Dental implants are generally made in increments of approximately 2 mm (Table 2.1).

## IMPLANT/ABUTMENT CONNECTIONS

Osseointegration of dental implants has proven to be predictable in clinical practice (Adell and Lekholm 1981; Davarpanah 2001). The original design for implant restora-

tions per the Brånemark protocol called for screw-retained prostheses. It was not unusual for these restorations to become loose secondary to screw loosening or screw fracture (McGlumphy and Huseyin 1995; Jemt and Lacey 1991). However, there have been more recent reports that have demonstrated a decreased number of screw failures for implant-retained restorations (Zarb and Schmitt 1990; Levine and Clem 1999).

Mollersten and others reported on the effect of implant/abutment joints on the strength and failure modes of implants from several different implant manufacturers (Mollersten and Lockowandt 1997). They found that the strength of the implant/abutment connections varied significantly depending on the length or depth of the connections. Low joint depths or lengths (<2.3 mm) were correlated with failures at lower forces; large/thicker joint depths (>5 mm) were correlated ($r = 0.959$) with failures at higher levels. The lowest failure was measured at 138 N for a connection that was 0.8 mm long. The highest failure was recorded at 693 N for a connection that measured 6.0 mm in length.

## EXTERNAL IMPLANT/ABUTMENT CONNECTIONS

The original Brånemark protocol called for the placement of several external hexed implants for restoration of edentulous jaws. The implants were rigidly splinted together with metal castings attached to the implant abutments with retaining screws. The external hex of the original implants was designed to drive implants into their respective osteotomies (Beaty 1994). It was not designed as an antirotation component for single-unit implant restorations. The external hex measured 0.7 mm in height and was not designed to withstand masticatory forces on single, screw-retained crowns (Binon 1995; Jemt 1993).

Implant manufacturers compensated for this design by changing the type of screw used for attaching abutments to implants—geometry, height, and surface area; improved machining between implants and implant restorative components; and application of appropriate torque to the screws (Finger and Castellon 2003). The goals of any modification in the original external hex designs were to improve the stability of the implant/abutment connection on a long-term basis. According to Finger and Castellon, there are at least 20 different implant/abutment connection designs that have been approved by the Food and Drug Administration for sale in the United States (Finger and Castellon 2003).

Clinical success with external hexed implants is dependent on precise machining between implants and implant restorative components and the stability of screw joints. Screw joints are found wherever two implant components are tightened or held in place by screws. The screw joint will fail (the screw will loosen) if outside forces are greater than the ability of the screw to keep the units tight. Forces attempting to disengage the screw joint are called joint separating forces. Those forces attempting to keep the joint together are called clamping forces. There are two primary factors involved in maintaining screw joints: maximum clamping forces and minimal separation forces.

In any external hex implant system, the screw joint includes the abutment, abutment screw, and implant. As the abutment screw is tightened or torqued, a compressive clamping force is generated between the abutment and implant. An equal, but opposite, tensile force is generated between the abutment screw and abutment. This force is referred to as the joint preload, or simply preload (Sakaguchi and Sun 1994). Schulte (1994) measured the external hex dimensions of six implant systems and obtained the ranges and coefficients of variance. Smaller ranges and variances suggested more accurate machining and better quality control. The ranges for the widths of the external hexes for all companies were 0.00030 for ***3i®*** to 0.00140 for Nobelpharma. Schulte concluded that there were differences in quality control among the various implant systems as determined by the external hex measurements, but that larger sample sizes and different batches may make a difference in the results.

Torque may be defined as a measurable means of developing tension in a screw joint. Tightening involves the application of torque. Every screw design has a specific preload/torque relationship depending on the material used in the screw and the design of the screw head.

Preload is induced into the abutment screw when the screw is torqued during tightening. Preload keeps the abutment and implant together by producing a clamping force between the screw head and its seat inside the abutment. As torque is applied to the abutment screw, the abutment screw actually elongates, which places the screw shank and screw threads in tension. The elastic recovery of the screw actually creates the clamping force between the abutment and implant. This concept is of great clinical significance because the resistance of the abutment to displacement or screw joint failure is a function of preload or the clamping forces between the abutment and implant (Figure 2.9).

Within the last several years, implant manufacturers have introduced prefabricated or machined abutments that were designed for use with cement-retained crowns (Keith and Miller 1999). Cement-retained crowns have several advantages over screw-retained crowns. The most important is that there is no longer a need to develop a screw access opening in the occlusal or facial surface of the

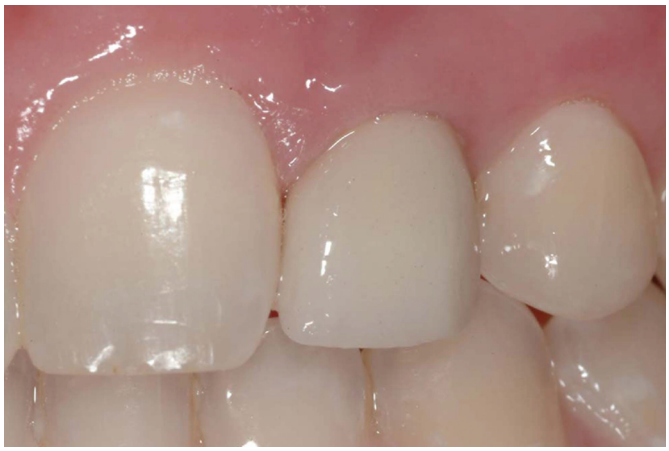

**Figure 2.10.** Facial view of an implant cement-retained crown replacing the maxillary left lateral incisor.

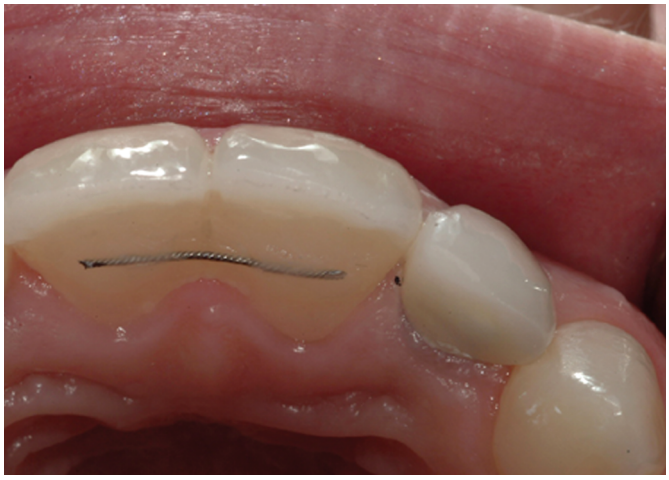

**Figure 2.11.** Occlusal view of the implant cement-retained crown in Figure 2.10. Note the lack of a screw access opening on the palatal surface.

implant crown restoration (Figures 2.10, 2.11). However, cement-retained crowns are not as retrievable as screw-retained crowns in the event that the abutment and/or crown have to be repaired (Figures 2.12, 2.13). One survey of commercial dental laboratories suggested that the number of screw-retained restorations was decreasing (Marinbach 1996).

One of the keys to successful long-term implant restorations is the stability of the implant/abutment connection. Rodkey (1977) pointed out that the type of finish on screws could have a significant effect on the tension induced by a given torque. Implant manufacturers have altered the materials in the screws as well as the surface of abutment screws in an attempt to prevent or minimize screw loosening (Robb and Porter 1998; Porter and Robb 1998; Steri-Oss 1968). Martin and Woody (2001) tested the rotational angles in implant/abutment connections with various abut-

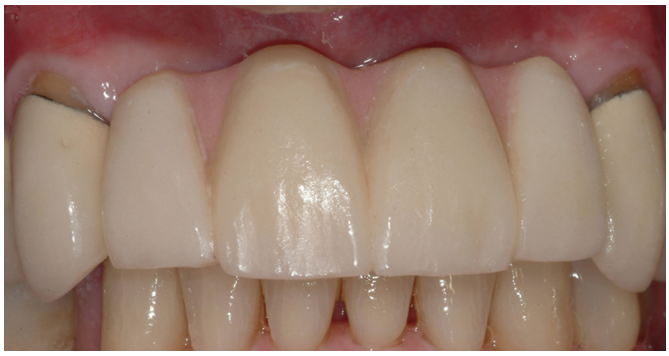

**Figure 2.12.** Facial view of an implant screw-retained fixed partial denture (inserted 1992) replacing the maxillary incisors.

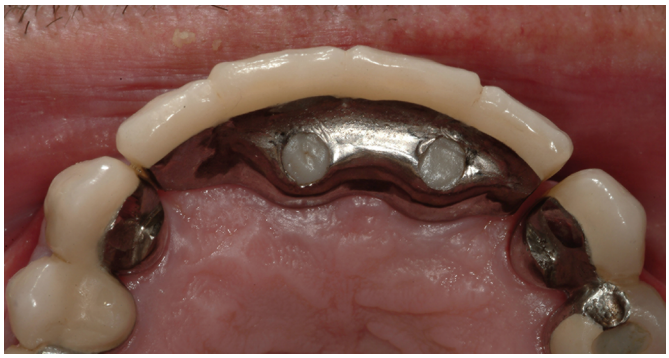

**Figure 2.13.** Occlusal view of the implant screw-retained fixed partial denture in Figure 2.12. Note that the screw access openings provide access to the abutment screws without interfering with the facial aesthetics of the prosthesis.

ment screws and preloads. They found that the abutment screws with enhanced surfaces reduced the coefficient of friction and produced greater rotational angles and preload values than screws made from conventional gold and titanium alloys.

In review, external implant/abutment connections have proven to be successful in clinical use (Drago 2003; Eckert and Wollan 1998). This connection has a long, successful history in clinical implant dentistry and is still a viable choice for clinicians. This textbook features implant restorations utilizing the external hex implant/abutment connection of the OSSEOTITE® Implant System and the internal implant/abutment connection of the OSSEOTITE® Certain® implant system.

## INTERNAL IMPLANT/ABUTMENT CONNECTIONS

One of the first internal implant/abutment connections was designed with a 1.7 mm internal hex below a 0.5 mm wide 45° bevel (Niznick 1983). This system was designed to distribute masticatory forces deeper within the implant, which would protect the abutment screw from excess occlusal

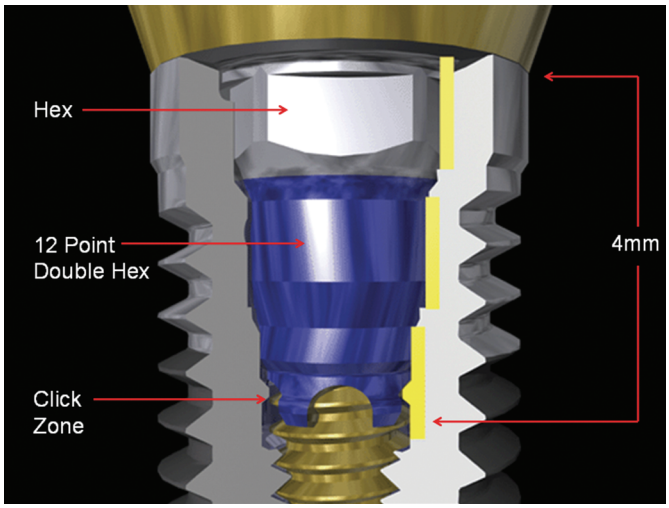


**Figure 2.14.** Cross section diagram of OSSEOTITE® Certain® implant illustrating 4 mm length of internal connection.

loading. This internal implant/abutment connection provided greater strength to the implant/abutment joint (Niznick 1991) when compared to the strengths of external hex implant/abutment connections.

The OSSEOTITE® Certain® implant internal connection is 4 mm long (Figure 2.14). These connections also feature intimate contact along a significant length of the connection that provides increased lateral stability to the implant/abutment connection (Niznick 1991; Mollersten and Lockowandt 1997).

Laboratory testing has demonstrated that the internal connection implant/abutment connection is stronger than the external hex implant/abutment connection (Implant Innovations 2003). The testing was conducted by placing 30° static loads to abutments connected to their respective implants with abutment screws torqued to a known level of preload. The internal connection implant/abutment connections failed at 767 Ncm of force. The external hex implant/abutment connections failed at 648 Ncm. It is important to note that the abutment screw for the internal connection was a hexed abutment screw tightened to 20 Ncm of preload. The external implant/abutment connection was maintained with square abutment screws torqued to 35 Ncm of preload (Table 2.2).

The OSSEOTITE® Certain® implant system features several design changes that should facilitate predictable restorable treatment. The hexed abutment screw measures 1.95 mm from the occlusal aspect of the screw to the screw seating surface (Figure 2.15). This allows clinicians and laboratory technicians great flexibility in abutment preparation, decreasing the risk of abutment wall fracture or fenestration (Figure 2.16). The long implant/abutment connection

**TABLE 2.2.** Force Required to Break Implant/Abutment Connections

| Implant/Abutment Connection | Force (Ncm) to Break Implant/Abutment Connection |
|---|---|
| Internal connection-abutment screw torqued to 35 Ncm | 774.7 Ncm |
| Internal connection-abutment screw torqued to 20 Ncm | 767.1 Ncm |
| External connection-abutment screw torqued to 35 Ncm | 648.4 Ncm |
| Internal connection-no screw | 519.9 Ncm |

**Figure 2.15.** Cross-section of an abutment screw (IUNIHG) for the OSSEOTITE® Certain® implant illustrating height of hex abutment screw.

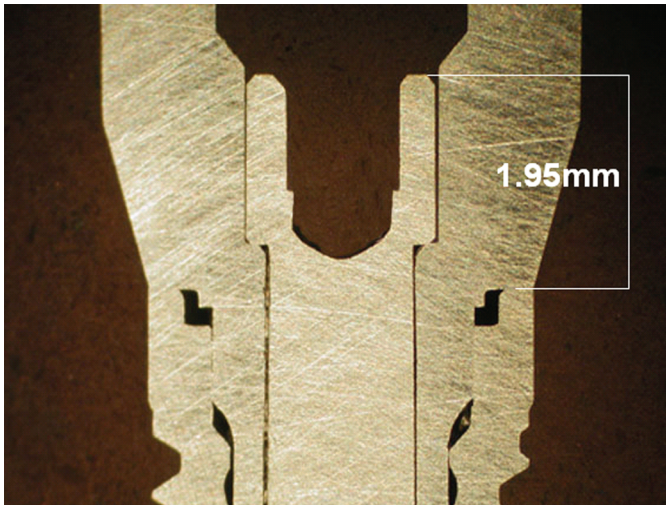


**Figure 2.16.** Cross-section of GingiHue® Post (OSSEOTITE® Certain® Implant System) demonstrating sufficient axial wall thickness for preparation.

**Figure 2.17.** Pick-up implant impression coping (OSSEOTITE® Certain® Implant System, IIIC12). This impression coping features a 4 mm connection that allows clinicians to positively seat the coping into the implant with little risk of inaccurate seating.

allows clinicians to positively seat impression copings and abutments into their appropriate positions (Figure 2.17). This internal connection also features audible and tactile feedback (QuickSeat™ Connection) during abutment and impression coping insertion by way of a "click" associated with flexure of fingers at the apical ends of the restorative components (Figure 2.18). The connection also features a 6/12 internal connection that has a hex and 12-point double hex. The hex serves two functions: It engages the driver tip for mountless delivery during implant placement and it provides anti-rotation for all straight abutments. The 12-point double hex provides rotational positioning every 30° for the 15° Pre-angled GingiHue® Post (Figure 2.19).

Several impression techniques have been described that provide accurate casts for development of implant frameworks (Sutherland and Hallam 1990; Loos 1986; Taylor 1990). Vigolo and Fonzi (2004) studied the accuracy of implant impression techniques with the OSSEOTITE® Certain® implant system. They found that improved accuracy of the master cast was achieved when the square, pick-up implant impression copings were joined together with autopolymerizing acrylic resin for multiple, splinted implant restorations.

## HEALING ABUTMENTS

### *EP® Healing Abutments*

Originally, abutments and gold cylinders were designed for use in edentulous patients. Clinicians were frustrated with the limitations of the components to provide aesthetic, natural-looking implant restorations (Jansen, 1995). Most implant components were 4–5 mm in diameter; many teeth were larger than the components. A maxillary central incisor generally has a CEJ diameter between 6 and 8 mm (Linek 1949). With the original components there were several millimeters difference in size between the implant components and maxillary central incisors. Laboratory technicians were asked to make implant restorations with natural contours and in many cases had to add ridge laps

**Figure 2.18.** Pick-up implant impression coping (OSSEOTITE® Certain® Implant System, IIIC12) with four fingers at the apical end of the coping that provide an audible click when seated into an implant or implant analog.

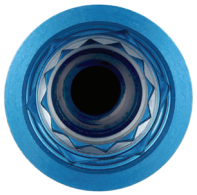

**Figure 2.19.** Occlusal view of OSSEOTITE® Certain® Implant System internal connection. The 12-point double hex is apical to the hex at the occlusal portion of the implant.

to the restorations to mimic the contours of the adjacent natural teeth.

An implant abutment emergence profile similar to that of a natural tooth is required to support and contour the peri-implant soft tissues (Saadoun 1995). The cylindrical shapes of the implants must be changed to more anatomically correct cross sections by the time the implant restorations reach the gingival margins, reflecting the root structure of the teeth being replaced (Weisgold and Arnoux 1997). Lazzara considered dimensions and contours of implant-retained crown restorations and the stability of the gingival margins surrounding implant restorations to be the two primary concerns in assuring durable aesthetics in implant restorations (Lazzara 1993).

EP® Healing Abutments were designed as part of The Emergence Profile System® to guide soft tissue healing after implant placement in single-stage surgical protocols or after implants had been uncovered in two-stage surgical protocols (Implant Innovations 1993) (Figures 2.20, 2.21, 2.22). They are available for all implant restorative platforms. EP® Healing Abutments were designed with collar heights between 2 and 8 mm and 3.4, 4.1, 5, 6, and 7.5 mm diameters (Figure 2.23) (Table 2.3 through 2.6).

**Figure 2.20.** Five mm EP® Healing Abutment (ITHA54) for 4.1 mm diameter internal connection implant. The apical portion of the healing abutment has been color coded blue for 4.1 mm diameter implants

**Figure 2.21.** Five mm EP® Healing Abutment (IWTH54) for 5.0 mm diameter internal connection implant. The apical portion of the healing abutment has been color coded gold for 5.0 mm diameter implants

**Figure 2.22.** Six mm EP® Healing Abutment (IWTH64) for 6.0 mm diameter internal connection implant. The apical portion of the healing abutment has been color coded green for 6.0 mm diameter implants

**TABLE 2.3.** Catalogue Numbers for EP® Healing Abutments for 3.4 mm Diameter OSSEOTITE® Certain® Implants

| Emergence Profile | Collar Height | Catalogue Numbers |
|---|---|---|
| 3.8 mm | 2.0 mm | IMHA32 |
| 3.8 mm | 3.0 mm | IMHA33 |
| 3.8 mm | 4.0 mm | IMHA34 |
| 3.8 mm | 6.0 mm | IMHA36 |

**TABLE 2.4.** Catalogue Numbers for EP® Healing Abutments for 4.1 mm Diameter OSSEOTITE® Certain® Implants

| Emergence Profile | Collar Height | Catalogue Numbers |
|---|---|---|
| 4.1 mm | 2.0 mm | ITHA42 |
| 4.1 mm | 3.0 mm | ITHA43 |
| 4.1 mm | 4.0 mm | ITHA44 |
| 4.1 mm | 6.0 mm | ITHA46 |
| 4.1 mm | 8.0 mm | ITHA48 |
| 5.0 mm | 2.0 mm | ITHA52 |
| 5.0 mm | 3.0 mm | ITHA53 |
| 5.0 mm | 4.0 mm | ITHA54 |
| 5.0 mm | 6.0 mm | ITHA56 |
| 5.0 mm | 8.0 mm | ITHA58 |
| 6.0 mm | 3.0 mm | ITHA63 |
| 6.0 mm | 4.0 mm | ITHA64 |
| 6.0 mm | 6.0 mm | ITHA66 |
| 6.0 mm | 8.0 mm | ITHA68 |
| 7.5 mm | 3.0 mm | ITHA73 |
| 7.5 mm | 4.0 mm | ITHA74 |
| 7.5 mm | 6.0 mm | ITHA76 |
| 7.5 mm | 8.0 mm | ITHA78 |

**Figure 2.23.** Profile view of EP® Healing Abutments for OSSEOTITE® Certain® 5.0 mm implants: 5, 6 and 7.5 mm diameters (left to right). Similar healing abutments are also available for the other implant diameters.

**TABLE 2.5.** Catalogue Numbers for EP® Healing Abutments for 5.0 mm Diameter OSSEOTITE® Certain® Implants

| Emergence Profile | Collar Height | Catalogue Numbers |
|---|---|---|
| 5.0 mm | 2.0 mm | IWTH52 |
| 5.0 mm | 3.0 mm | IWTH53 |
| 5.0 mm | 4.0 mm | IWTH54 |
| 5.0 mm | 6.0 mm | IWTH56 |
| 5.0 mm | 8.0 mm | IWTH58 |
| 6.0 mm | 2.0 mm | IWTH562 |
| 6.0 mm | 3.0 mm | IWTH563 |
| 6.0 mm | 4.0 mm | IWTH564 |
| 6.0 mm | 6.0 mm | IWTH566 |
| 6.0 mm | 8.0 mm | IWTH568 |
| 7.5 mm | 2.0 mm | IWTH572 |
| 7.5 mm | 3.0 mm | IWTH573 |
| 7.5 mm | 4.0 mm | IWTH574 |
| 7.5 mm | 6.0 mm | IWTH576 |
| 7.5 mm | 8.0 mm | IWTH578 |

**TABLE 2.6.** Catalogue Numbers for EP® Healing Abutments for 6.0 mm Diameter OSSEOTITE® Certain® Implants

| Emergence Profile | Collar Height | Catalogue Numbers |
|---|---|---|
| 6.0 mm | 2.0 mm | IWTH62 |
| 6.0 mm | 3.0 mm | IWTH63 |
| 6.0 mm | 4.0 mm | IWTH64 |
| 6.0 mm | 6.0 mm | IWTH66 |
| 6.0 mm | 8.0 mm | IWTH68 |
| 7.5 mm | 2.0 mm | IWTH672 |
| 7.5 mm | 3.0 mm | IWTH673 |
| 7.5 mm | 4.0 mm | IWTH674 |
| 7.5 mm | 6.0 mm | IWTH676 |
| 7.5 mm | 8.0 mm | IWTH678 |

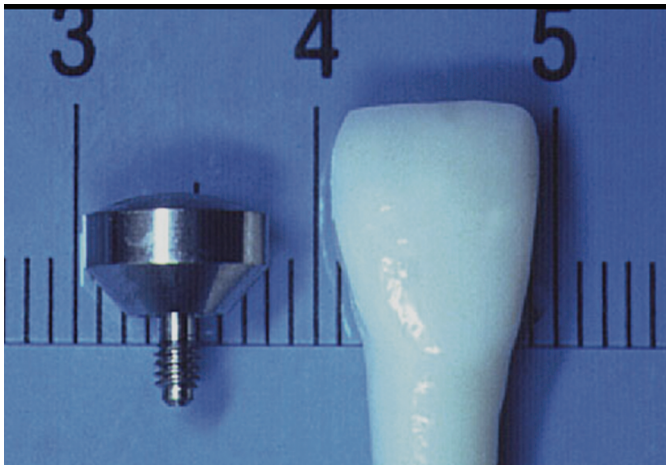


**Figure 2.24.** 7.5 mm EP® diameter healing abutment (THA74) adjacent to a maxillary central incisor. Note the similarities in the diameters of the abutment and tooth at the CEJ.

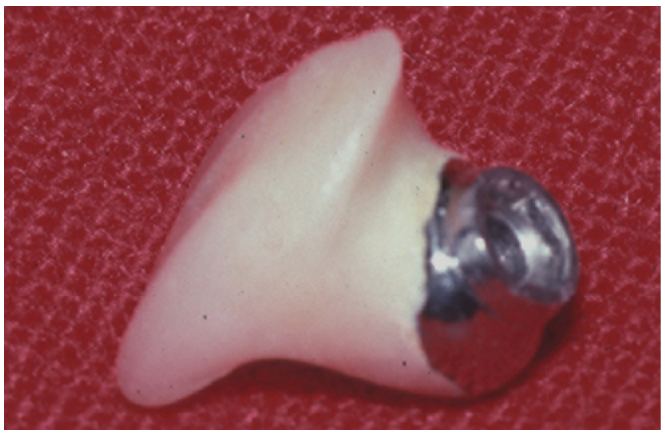

**Figure 2.25.** Laboratory view of a screw-retained crown that was fabricated to replace a maxillary right cuspid. Note the ridge lap that was developed in the porcelain to simulate the gingival margin of the missing natural tooth.

EP® Healing Abutments are one part of the EP® Emergence Profile System that was developed by ***3i®*** to optimize the gingival contours of implant restorations with stock restorative components (Figure 2.24). In the past, the sub-gingival contours of implant restorations were left to dental laboratory technicians working on stone casts (Figure 2.25). Clinicians and patients both expect optimal aesthetics and in some cases prior to development of the EP® System, implant restorations were made with ridge lap contours to simulate the gingival margins of natural teeth (Figure 2.26).

In other instances, implant-retained restorations were made from cylindrical abutments and gold cylinders that had straight emergence profiles (Figure 2.27, 2.28). The sub-gingival contours for this implant-retained restoration were improved by removing the standard abutment and placing the appropriate healing abutment (THA464, 4.1 mm implant restorative platform, 6 mm EP® diameter, 4 mm height) for soft tissue healing. The definitive crown was cemented to a prefabricated titanium abutment (GingiHue® Post, APP464G) that was prepared in the laboratory (Figures 2.29, 2.30, 2.31).

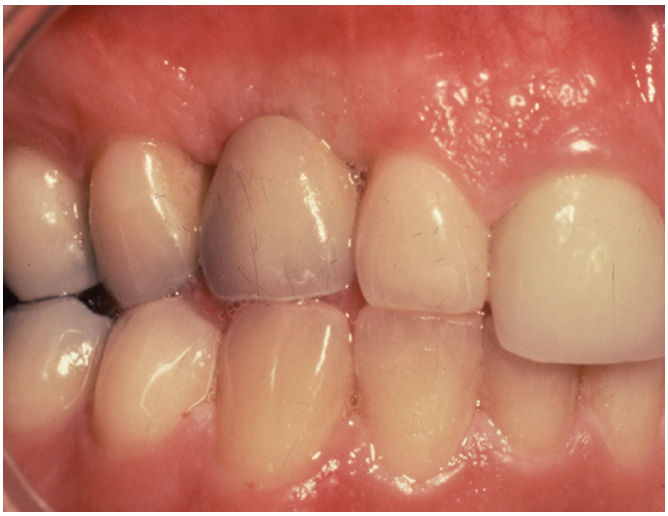

**Figure 2.26.** Clinical view of the screw-retained crown in place featured in Figure 2.25. Due to the ridge lap design, the gingival contours of the implant restoration mimic the clinical crown heights of the adjacent natural teeth.

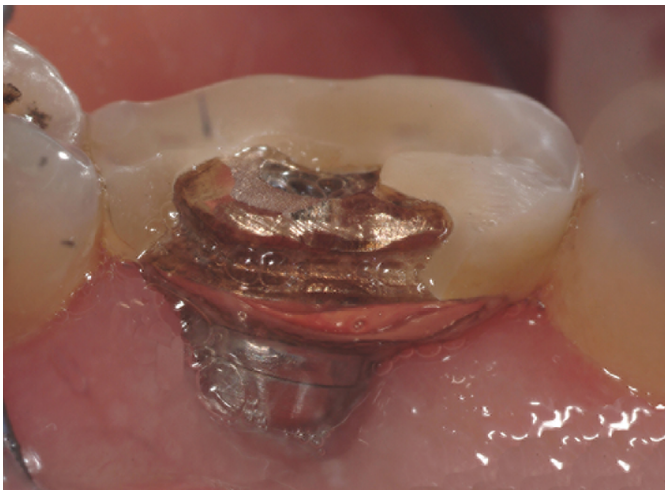

**Figure 2.27.** Clinical view of a screw-retained crown replacing the mandibular left first molar. The metal coping was cast to a machined gold cylinder that was screwed into a standard abutment.

**Figure 2.28.** Laboratory view of the crown in Figure 2.27. The subgingival contours were established by the contours of the standard abutment.

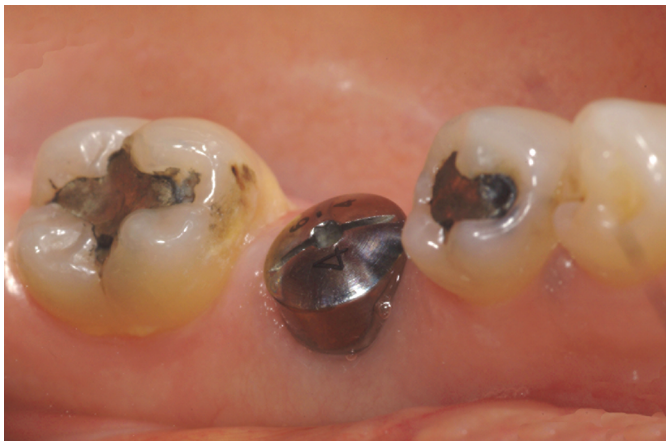

**Figure 2.29.** Lingual occlusal view with healing abutment (THA46) in place. Optimal sub-gingival contours were established by placing the appropriate size healing abutment consistent with the size of the missing tooth.

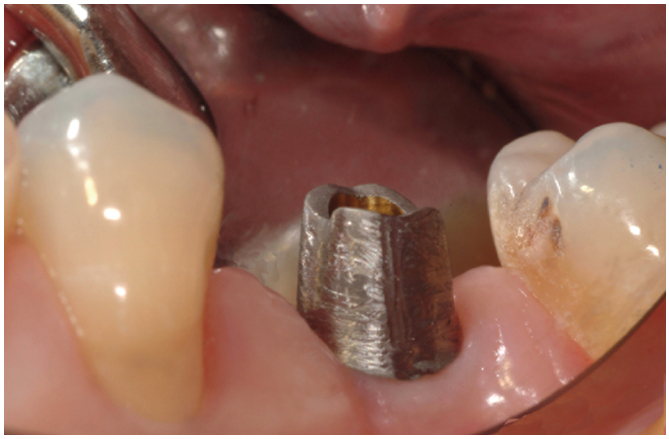

**Figure 2.30.** Buccal view of pre-machined titanium abutment (APP464G) in place. Emergence profiles were established by the healing abutment.

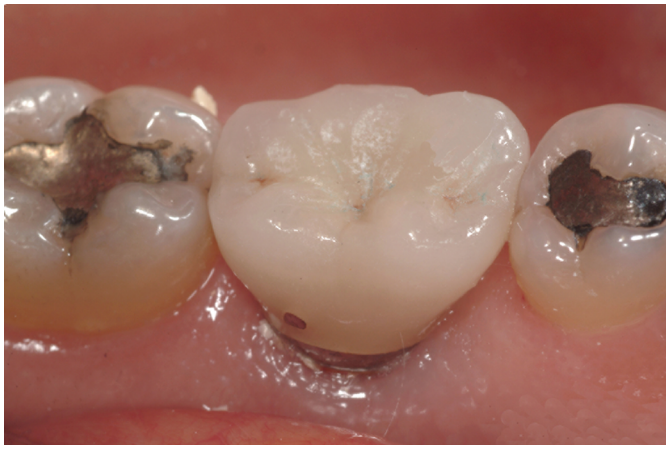

**Figure 2.31.** Lingual view of definitive crown in place.

### *Encode™ Healing Abutments*

The Encode™ Restorative System has recently been introduced by ***3i®*** (2004). Encode™ Healing Abutments were designed as two-piece components: abutment screws and healing abutments. They are available for both OSSEOTITE® and OSSEOTITE® Certain® implant systems in sizes consistent with the EP® System (Tables 2.7, 2.8, 2.9, 2.10)(Figures 2.32, 2.33). Encode Healing Abutments have codes embedded into the occlusal surfaces that allow development of patient specific abutments through CAD/CAM technology. The codes provide information to a computer relative to the hex position, implant restorative platform, and diameter and collar heights of the Encode Healing Abutments. Encode Healing Abutments will be selected for use by clinicians based on the same criteria already in use with conventional healing abutments (Figures 2.34 and 2.35).

**TABLE 2.7.** Catalogue Numbers for Encode Healing Abutments for 3.4 mm Diameter Seating Surfaces OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Emergence Profile (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|---|
| 3.8 | 3 | IEHA343 | EHA343 |
| 3.8 | 4 | IEHA344 | EHA344 |
| 3.8 | 6 | IEHA346 | EHA346 |
| 3.8 | 8 | IEHA348 | EHA348 |
| 3.8 | 3 | IEHA353 | EHA353 |
| 3.8 | 4 | IEHA354 | EHA354 |
| 3.8 | 6 | IEHA356 | EHA356 |
| 3.8 | 8 | IEHA358 | EHA358 |

**TABLE 2.8.** Catalogue Numbers for Encode Healing Abutments for 4.1 mm Diameter Seating Surfaces OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Emergence Profile (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|---|
| 4.1 | 3.0 | IEHA443 | EHA443 |
| 4.1 | 4.0 | IEHA444 | EHA444 |
| 4.1 | 6.0 | IEHA446 | EHA446 |
| 4.1 | 8.0 | IEHA448 | EHA448 |
| 5.0 | 3.0 | IEHA453 | EHA453 |
| 5.0 | 4.0 | IEHA454 | EHA454 |
| 5.0 | 6.0 | IEHA456 | EHA456 |
| 5.0 | 8.0 | IEHA458 | EHA458 |
| 6.0 | 3.0 | IEHA463 | EHA463 |
| 6.0 | 4.0 | IEHA464 | EHA464 |
| 6.0 | 6.0 | IEHA466 | EHA466 |
| 6.0 | 8.0 | IEHA468 | EHA468 |
| 7.5 | 3.0 | IEHA473 | EHA473 |
| 7.5 | 4.0 | IEHA474 | EHA474 |
| 7.5 | 6.0 | IEHA476 | EHA476 |
| 7.5 | 8.0 | IEHA478 | EHA478 |

**TABLE 2.9.** Catalogue Numbers for Encode Healing Abutments for 5.0 mm Diameter Seating Surfaces OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Emergence Profile (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|---|
| 5.0 | 3.0 | IEHA553 | EHA553 |
| 5.0 | 4.0 | IEHA554 | EHA554 |
| 5.0 | 6.0 | IEHA556 | EHA556 |
| 5.0 | 8.0 | IEHA558 | EHA558 |
| 6.0 | 3.0 | IEHA563 | EHA563 |
| 6.0 | 4.0 | IEHA564 | EHA564 |
| 6.0 | 6.0 | IEHA566 | EHA566 |
| 6.0 | 8.0 | IEHA568 | EHA568 |
| 7.5 | 3.0 | IEHA573 | EHA573 |
| 7.5 | 4.0 | IEHA574 | EHA574 |
| 7.5 | 6.0 | IEHA476 | EHA576 |
| 7.5 | 8.0 | IEHA578 | EHA578 |

**TABLE 2.10.** Catalogue Numbers for Encode Healing Abutments for 6.0 mm Diameter Seating Surfaces OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Emergence Profile (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|---|
| 6.0 | 3.0 | IEHA663 | EHA663 |
| 6.0 | 4.0 | IEHA664 | EHA664 |
| 6.0 | 6.0 | IEHA666 | EHA666 |
| 6.0 | 8.0 | IEHA668 | EHA668 |
| 7.5 | 3.0 | IEHA673 | EHA673 |
| 7.5 | 4.0 | IEHA674 | EHA674 |
| 7.5 | 6.0 | IEHA676 | EHA676 |
| 7.5 | 8.0 | IEHA678 | EHA678 |

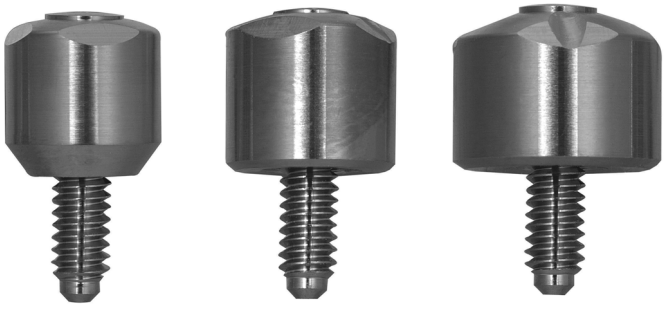

**Figure 2.32.** Profile views of Encode™ Healing Abutments: 5, 6, and 7.5 mm diameters, 4 mm collar heights for the OSSEOTITE® Implant System (4.1 mm diameter; THA54, THA64, THA74, respectively).

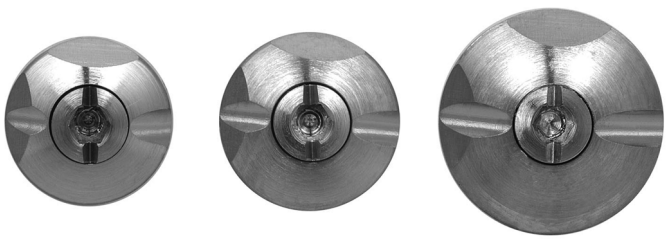

**Figure 2.33.** Occlusal view of Encode™ Healing Abutments for the OSSEOTITE® Certain® Implant System (4.1 mm diameter): 5, 6, and 7.5 mm diameters (IEHA454, IEHA464, IEHA474, respectively).

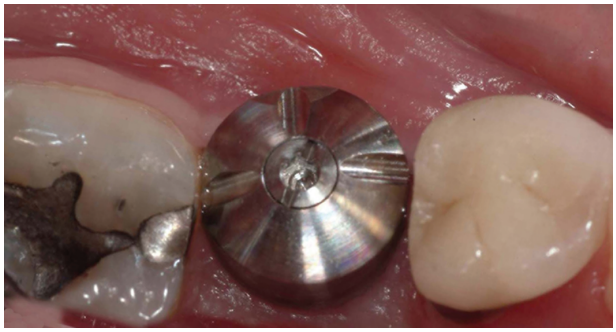

**Figure 2.34.** Occlusal view of Encode™ Healing Abutment (IEHA464) in place 12 weeks post implant placement for a missing mandibular left second premolar. An optical scanner will read the codes embedded into the occlusal surface of a die of the healing abutment.

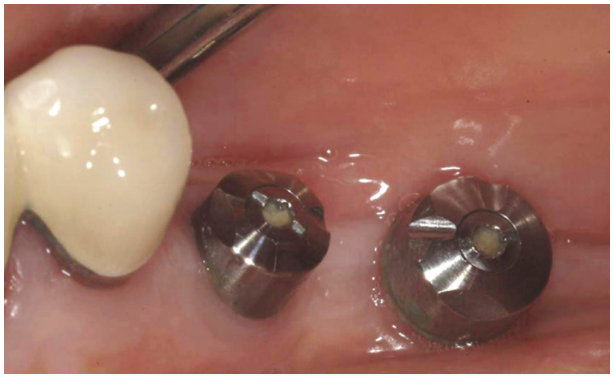

**Figure 2.35.** Occlusal view of Encode™ Healing Abutments in place 12 weeks post implant placement for missing right mandibular molar and second premolar (IEHA454 anterior, IEHA564 posterior).

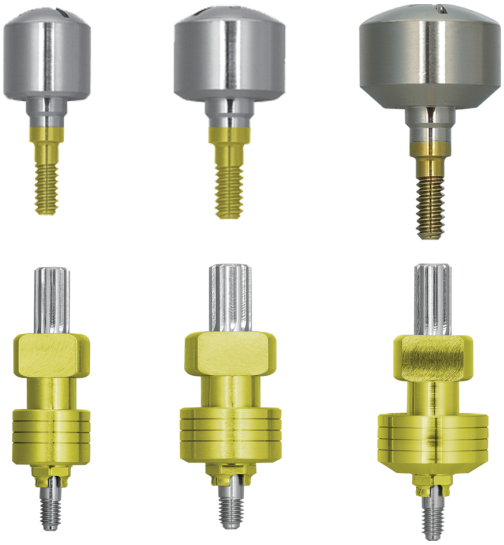

**Figure 2.36.** Top: Lateral view of EP® Healing Abutments for 5.0 mm diameter OSSEOTITE® Certain® implants (5.6 and 7.5 mm diameters, 4 mm collar heights, IWTH54, IWTH564, IWTH574, left to right, respectively). Bottom: Lateral view of pick-up implant impression copings for 5.0 mm diameter OSSEOTITE® Certain® implants (5, 6, and 7.5 mm diameters; IWIP55, IWIP56, IWIP57, left to right, respectively).

The Encode™ Restorative System has multiple advantages for both clinicians and dental laboratory technicians. Further discussion is featured in Chapters 6 and 9.

## IMPRESSION COPINGS

### *Implant Impression Copings*

Definitive implant restorations are best made with indirect techniques using fixed prosthodontic impression materials and techniques. EP® impression copings that correspond to the EP® Healing Abutments described above are available for implants and abutments (Figure 2.36). Impressions can be made that exactly duplicate the clinical soft tissue dimensions in the laboratory and result in crown restorations with optimal emergence profiles made from stock implant restorative components (Figure 2.37, 2.38).

Implant impression copings are placed directly onto the implant restorative platforms; abutment impression copings are placed directly onto standard abutments that have been placed onto implants (Tables 2.11, 2.12). With this system, laboratory technicians do not have to arbitrarily grind or remove material from the master cast to make properly contoured restorations (Figures 2.39, 2.40).

The impression copings that were illustrated in this case were pick-up implant impression copings. Pick-up impression copings require windows or openings in impression trays in order for clinicians to access the screws that retain the copings to the implants (Figures 2.41, 2.42). Twist Lock™ implant impression copings are proprietary for Implant Innovations, Inc.®'s trade name for transfer impression copings. Transfer impression copings remain in the mouth after the impression has set and the impression tray has been removed. Twist Lock™ implant impression copings are available for all implant restorative platforms except for 3.4 mm diameters. They have also been designed per the EP® System (Figure 2.43).

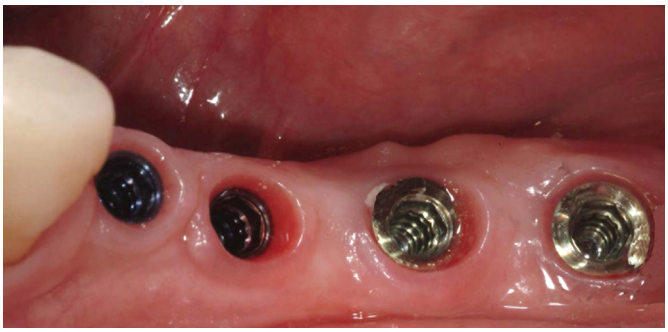

**Figure 2.37.** Occlusal view of two 4.1 mm and two 5.0 mm OSSEOTITE® Certain® implants in place in the mandibular right posterior quadrant. The emergence profiles were created by the appropriate EP® Healing Abutments.

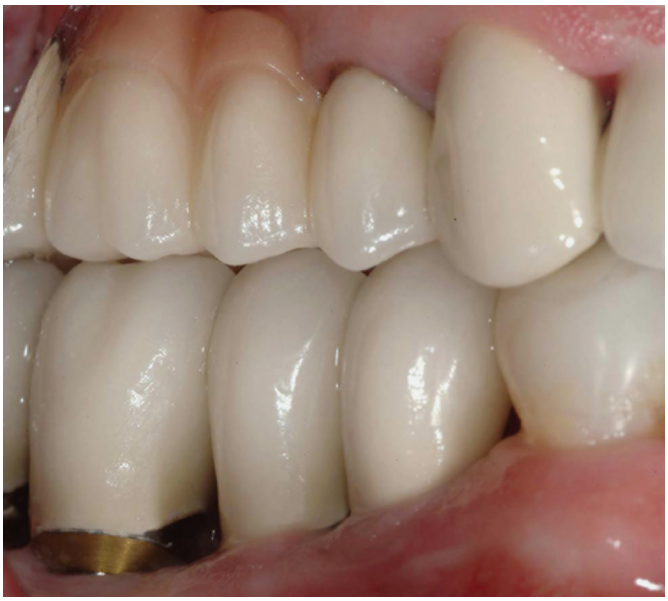

**Figure 2.38.** Buccal view of crown restorations for the implants in Figure 2.37.

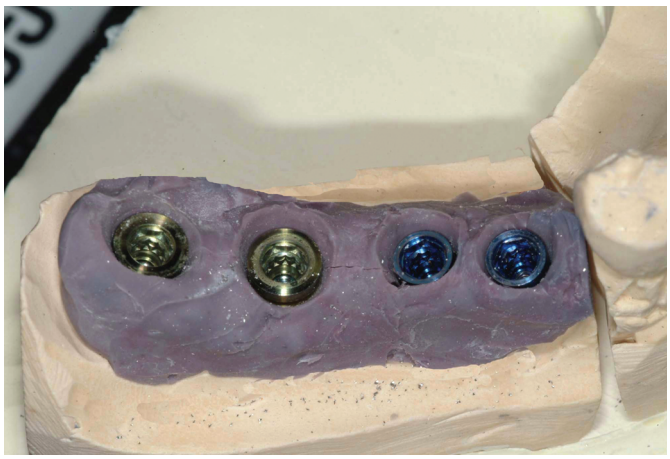

**Figure 2.39.** Occlusal view of master cast with four implant lab analogs (IILA20, IILAW5) in the mandibular right posterior quadrant. The healing abutments placed at the time of implant placement generated the emergence profiles.

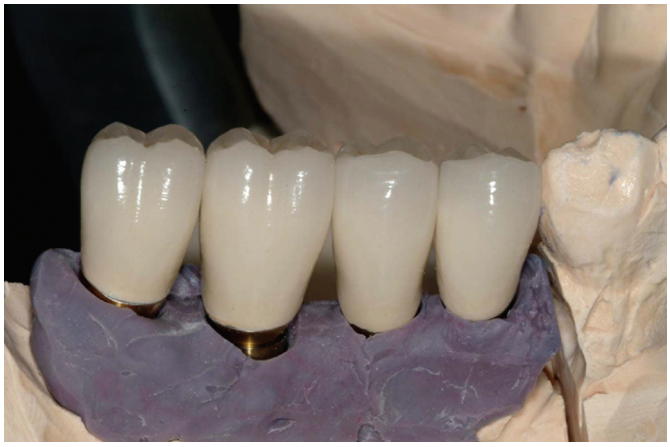

**Figure 2.40.** Laboratory facial view of four implant-retained crowns from Figure 2.39. Note that the surgeon generated the emergence profiles at the time of implant placement by placing the appropriate healing abutments. The laboratory technician had only to follow those contours to create the crowns.

**TABLE 2.11.** Implant Impression Copings for 3.4 and 4.1 mm Diameter OSSEOTITE® Certain® Implants

| | | | | | |
|---|---|---|---|---|---|
| Implant Restorative Platforms (mm) | 3.4 | 4.1 | 4.1 | 4.1 | 4.1 |
| Emergence Profile (mm) | 3.8 | 4.1 | 5.0 | 6.0 | 7.5 |
| Pick Up Impression Copings | IMIC33 | IIIC41 | IIIC12 | IIIC60 | IIIC75 |
| Twist Lock™ Impression Coping | N/A | IIIC44 | IIIC45 | IIIC46 | IIIC47 |

**TABLE 2.12.** Implant Impression Copings for 5 mm and 6 mm Diameter OSSEOTITE® Certain® Implants

| | | | | | |
|---|---|---|---|---|---|
| Implant Restorative Platforms (mm) | 5.0 | 5.0 | 5.0 | 6.0 | 6.0 |
| Emergence Profile (mm) | 5.0 | 6.0 | 7.5 | 6.0 | 7.5 |
| Pick Up Impression Copings | IWIP55 | IWIP56 | IWIP57 | IWIP66 | IWIP67 |
| Twist Lock™ Impression Coping | IWIT55 | IWIT56 | IWIT57 | IWIT66 | IWIT67 |

**Figure 2.41.** Laboratory example of open face tray for implant impression of maxillary right cuspid, maxillary left lateral incisor, and maxillary left cuspid.

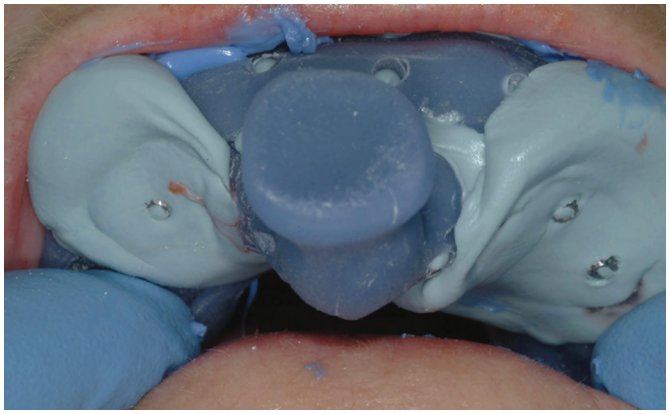

**Figure 2.42.** Clinical view of impression tray from Figure 2.41 in place. The windows provided the clinician with access to the impression coping screws for loosening prior to removing the impression from the mouth. The implant impression copings remained inside the impression.

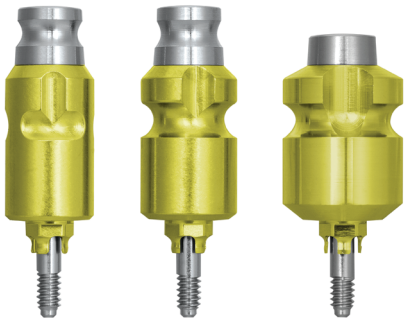

**Figure 2.43.** Profile view of Twist Lock™ Implant Impression Copings for 5.0 mm diameter OSSEOTITE® Certain® implants: (5, 6, and 7.5 mm emergence profile diameters, IWIT55, IWIT56, IWIT57 left to right).

**Figure 2.44.** Profile view of Pick-Up Standard Abutment Impression Coping for 4.1 and 5.0 implant restorative platforms (SQIC7).

**Figure 2.45.** Profile view of Twist Lock™ Standard Abutment Impression Coping for 4.1 and 5.0 implant restorative platforms (SIC70).

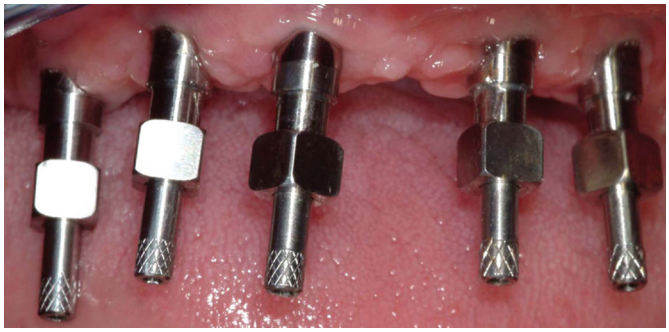

**Figure 2.46.** Standard Abutment Pick-Up Impression Copings (SQIC7) in place for a maxillary impression.

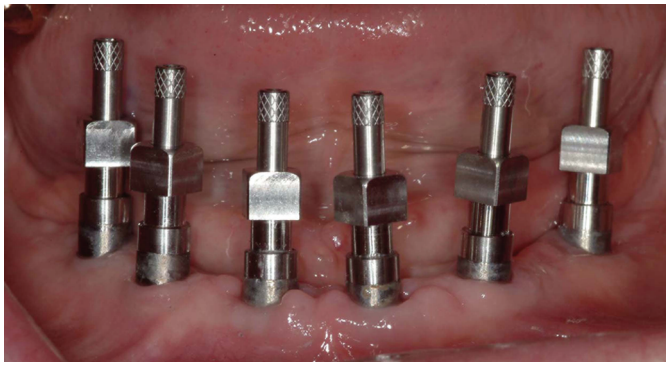

**Figure 2.47.** IOL® Pick-Up Impression Copings (IOLPIC) in place for a mandibular impression.

**TABLE 2.13.** Standard Abutment Impression Copings for 4.1 mm and 5 mm Diameter ***3i***® Implants

| | | |
|---|---|---|
| Implant Restorative Platform (mm) | 4.1 | 5.0 |
| Emergence Profile (mm) | 4.5 | 4.5 |
| Pick-Up Impression Coping | SQIC7 | SQIC7 |
| Twist Lock™ Impression Coping | SIC70 | SIC70 |

**TABLE 2.14.** IOL® Abutment Impression Copings for 4.1 mm Diameter ***3i***® Implants

| | |
|---|---|
| Implant Restorative Platform (mm) | 4.1 |
| Emergence Profile (mm) | 4.5 |
| Pick-Up Impression Coping | IOLPIC |
| Twist Lock™ Impression Coping | IOLTIC |

### *Abutment Impression Copings*

Impression copings are made for standard abutments. Standard Abutments (AB200, AB300, AB400, AB550, AB700) are the implant restorative components that attach directly to implants with abutment screws. Standard Abutments may be used for single- and multi-unit porcelain restorations, implant-retained bars, and within castings for hybrid prostheses. Abutment impression copings (Tables 2.13, 2.14) are available in both pick-up and transfer designs (Figures 2.44, 2.45, 2.46, 2.47).

### *Abutments*

***3i***® manufactures multiple abutments for use in edentulous and partially edentulous patients. The following abutments are discussed in this textbook:

1. Standard Abutments
2. LOCATOR® Abutments
3. Immediate Occlusal Loading® (IOL®) Abutments
4. GingiHue® Posts
5. ZiReal™ Posts
6. Provide™ Abutments
7. UCLA Abutments
8. Final Encode™ Abutments

### *Standard Abutments*

Standard Abutments are generally used in edentulous patients in which a traditional cast metal framework is used to splint multiple implants together. These abutments require a minimum inter-occlusal clearance of 6.5 mm and a maximum divergence of 30°. Standard abutments have been machined for 4.1 and 5.0 mm implant restorative platforms for OSSEOTITE® Certain® and OSSEOTITE® implant systems (Figure 2.48) (Table 2.15).

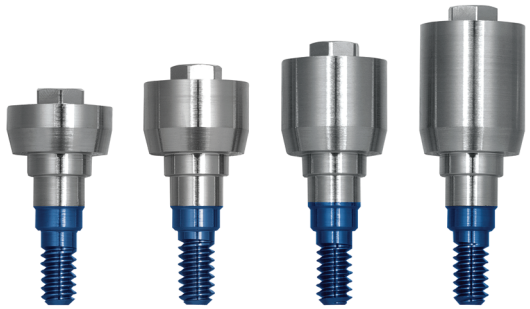

**Figure 2.48.** Profile view of 4.1 mm diameter OSSEOTITE® Certain® Standard Abutments: IAB200, IAB300, IAB400, IAB550 (2, 3, 4, and 5.5 mm collar heights, left to right).

**TABLE 2.15.** Standard Abutment Catalogue Numbers for OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|
| **4.1 mm Implant Restorative Platforms** | | |
| 2.0 | IAB200 | AB200 |
| 3.0 | IAB300 | AB300 |
| 4.0 | IAB400 | AB400 |
| 5.5 | IAB550 | AB550 |
| 7.0 | IAB700 | AB700 |
| **5.0 mm Implant Restorative Platforms** | | |
| 2.0 | N/A | WAB200 |
| 3.0 | N/A | WAB300 |
| 4.0 | N/A | WAB400 |
| 5.5 | N/A | WAB550 |

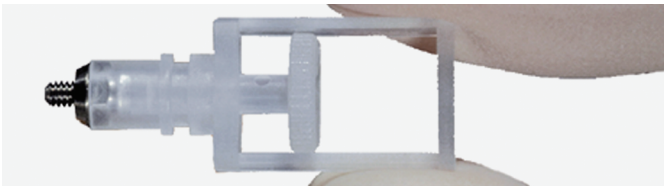

**Figure 2.49.** Standard Abutments are sold in sterile packages with the ASYST® placement system.

Standard Abutments are manufactured from commercially pure titanium, packaged in sterile containers in a convenient delivery system called ASYST® (Figure 2.49). In clinical use, the abutment screws are generally torqued to 20 Ncm.

### *LOCATOR® Overdenture Abutments*

The LOCATOR® Abutment is ideal for mandibular tissue supported overdentures on two to four implants. These abutments are manufactured from titanium alloy with a gold titanium nitride coating. The housings contained

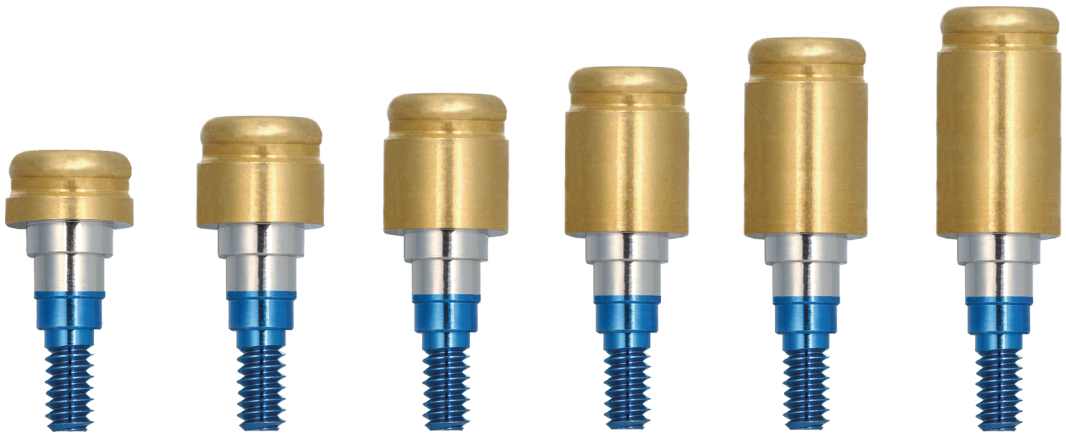

**Figure 2.50.** Profile view of LOCATOR® Abutments for OSSEOTITE® Certain® implants: ILOA001, ILOA002, ILOA003, ILOA004, ILOA005, ILOA006 (1, 2, 3, 4, 5, and 6 mm collar heights, left to right).

**TABLE 2.16.** LOCATOR® Abutment Catalogue Numbers for OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Implant Restorative Platform (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|---|
| 4.1 | 1.0 | ILOA001 | LOA001 |
| 4.1 | 2.0 | ILOA002 | LOA002 |
| 4.1 | 3.0 | ILOA003 | LOA003 |
| 4.1 | 4.0 | ILOA004 | LOA004 |
| 4.1 | 5.0 | ILOA005 | LOA005 |
| 4.1 | 6.0 | ILOA006 | LOA006 |

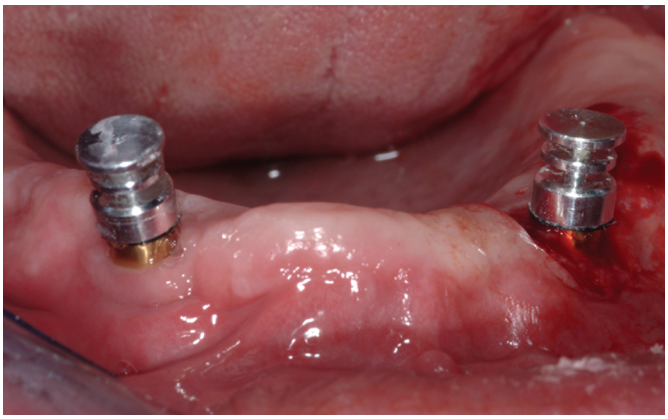

**Figure 2.51.** Clinical view of two implants with LOCATOR® Abutment Impression Copings (LAIC1) in place. The implants diverge from each other by approximately 25° but were viable for use as overdenture abutments.

within the denture base are made from stainless steel. They are available in multiple collar heights (Figure 2.50), and the smallest LOCATOR® Abutment (ILOA001) is only 3.17 mm in total height (Figure 2.50) (Table 2.16).

It has been the author's experience that patients have demonstrated that they are better able to seat LOCATOR® Abutments than other overdenture abutments even with divergent implant placement. These abutments can be used with nonparallel implant placement of up to 40° (Figure 2.51).

### *Immediate Occlusal Loading® (IOL®) Abutments*

IOL® Abutments are available for 4.1 mm diameter OSSEOTITE® Certain® (one-piece non-hexed) and OSSEOTITE® (two-piece non-hexed) implant systems (Table 2.17). They are manufactured from titanium alloy

**TABLE 2.17.** Catalogue Numbers for IOL® Abutments for OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Implant Restorative Platform (mm) | Emergence Profile (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|---|---|
| 4.1 | 4.5 | 2.0 | IIOL20S | IOL20T |
| 4.1 | 4.5 | 3.0 | IIOL30S | IOL30T |
| 4.1 | 4.5 | 4.0 | IIOL40S | IOL40T |
| 4.1 | 4.5 | 5.5 | IIOL55S | IOL55T |
| 4.1 | 4.5 | 7.0 | IIOL70S | IOL70T |

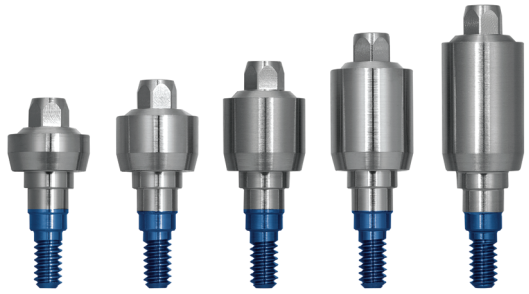

**Figure 2.52.** IOL® Abutments for OSSEOTITE® Certain® implants: 2, 3, 4, 5.5, and 7 mm collar heights (left to right).

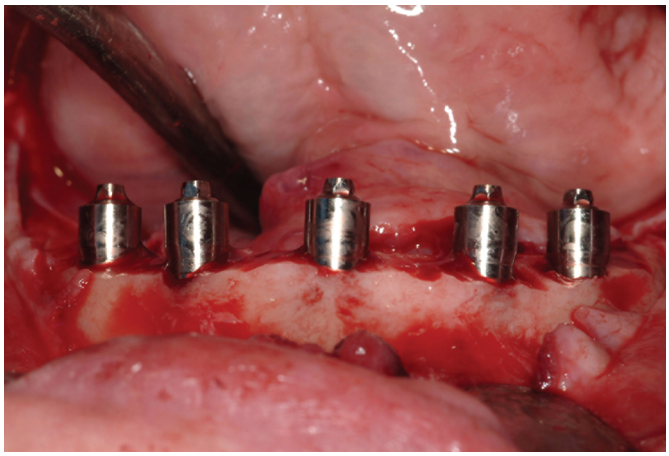

**Figure 2.53.** Clinical view of 5 IOL® Abutments (IIOL30) in place at the time of implant surgery.

(Figures 2.52, 2.53). Although these components have been specifically designed for use in Immediate Occlusal Loading®, they may also be used as abutments in the traditional, two-stage, unloaded healing protocol.

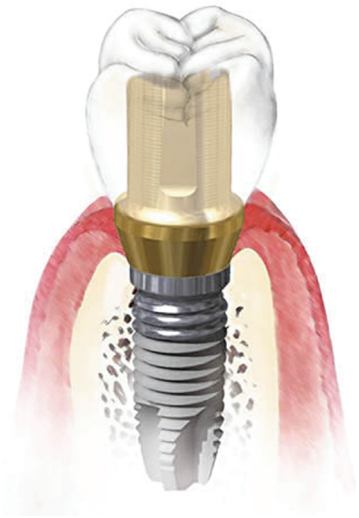

**Figure 2.54.** Simulation of a GingiHue® Post in place with transparent cement-retained crown for a natural looking, functional restoration.

### *GingiHue® Posts*

***3i®***'s pre-machined titanium abutments (GingiHue® Posts) have proven to be a versatile, cost-effective addition to the implant restorative dentistry armamentarium. In many cases, they may be used in lieu of custom abutments (Figure 2.54). They have been designed in accordance with the EP® System for natural emergence through the peri-implant soft tissues (5, 6, and 7.5 mm diameters, 2 and 4

**TABLE 2.18.** Catalogue Numbers for GingiHue® Posts for OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Seating Surface (mm) | Emergence Profile (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants-Straight | OSSEOTITE® Certain® Implants-15° Pre-Angled |
|---|---|---|---|---|
| 3.4 | 3.8 | 2.0 | IMAP32G | IMPAP32G |
| 3.4 | 3.8 | 4.0 | IMAP34G | IMPAP34G |
| 4.1 | 5.0 | 2.0 | IAPP452G | IPAP452G |
| 4.1 | 5.0 | 4.0 | IAPP454G | IPAP454G |
| 4.1 | 6.0 | 2.0 | IAPP462G | IPAP462G |
| 4.1 | 6.0 | 4.0 | IAPP464G | IPAP464G |
| 4.1 | 7.5 | 2.0 | IAPP472G | IPAP472G |
| 4.1 | 7.5 | 4.0 | IAPP474G | IPAP474G |
| 5.0 | 5.0 | 2.0 | IWPP552G | IPAP552G |
| 5.0 | 5.0 | 4.0 | IWPP554G | IPAP554G |
| 5.0 | 6.0 | 2.0 | IWPP562G | IPAP562G |
| 5.0 | 6.0 | 4.0 | IWPP564G | IPAP564G |
| 5.0 | 7.5 | 2.0 | IWPP572G | IPAP572G |
| 5.0 | 7.5 | 4.0 | IWPP574G | IPAP574G |
| 6.0 | 6.0 | 2.0 | IWPP662G | IPAP662G |
| 6.0 | 6.0 | 4.0 | IWPP664G | IPAP664G |
| 6.0 | 7.5 | 2.0 | IWPP672G | IPAP672G |
| 6.0 | 7.5 | 4.0 | IWPP674G | IPAP674G |
| 3.4 | 3.8 | 2.0 | MAP32G | MPAP32G |
| 3.4 | 3.8 | 4.0 | MAP34G | MPAP34G |
| 4.1 | 5.0 | 2.0 | APP452G | PAP452G |
| 4.1 | 5.0 | 4.0 | APP454G | PAP454G |
| 4.1 | 6.0 | 2.0 | APP462G | PAP462G |
| 4.1 | 6.0 | 4.0 | APP464G | PAP464G |
| 4.1 | 7.5 | 2.0 | APP472G | PAP472G |
| 4.1 | 7.5 | 4.0 | APP474G | PAP474G |
| 5.0 | 5.0 | 2.0 | WPP552G | PAP552G |
| 5.0 | 5.0 | 4.0 | WPP554G | PAP554G |
| 5.0 | 6.0 | 2.0 | WPP562G | PAP562G |
| 5.0 | 6.0 | 4.0 | WPP564G | PAP564G |
| 5.0 | 7.5 | 2.0 | WPP572G | PAP572G |
| 5.0 | 7.5 | 4.0 | WPP574G | PAP574G |
| 6.0 | 6.0 | 2.0 | WPP662G | PAP662G |
| 6.0 | 6.0 | 4.0 | WPP664G | PAP664G |
| 6.0 | 7.5 | 2.0 | WPP672G | PAP672G |
| 6.0 | 7.5 | 4.0 | WPP674G | PAP674G |

mm collar heights) (Table 2.18) (Figure 2.55). They can be prepared intra-orally or in the laboratory on a master cast (Drago 2002) (Figures 2.56, 2.57, 2.58).

### *ZiReal™ Posts*

***3i®***'s ceramic abutments (ZiReal™ Posts) are indicated in areas where aesthetics is of paramount importance. Metal abutments may cause a gray hue to show through thin, translucent peri-implant soft tissues (Figure 2.59). This coloration may have a negative impact on the overall aesthetic outcome of the implant restoration.

ZiReal™ Posts are manufactured from tetragonal zirconia polycrystals (TZP) that have been extensively used in artificial hip replacements. This material is a combination of zirconia dioxide ($ZrO_2$) and yttrium-stabilized zirconium oxide (95% and 5%, respectively). These abutments have a flexural strength of more than 900 Mpa. Aluminum oxide ($Al_2O_3$), used in other commercially available ceramic

**Figure 2.55.** GingiHue® Posts (left to right, IAPP454G, IPAP454G, APP454G, PAP454G) for 4.1mm OSSEOTITE® Certain® implants (left) and OSSEOTITE® implants (right).

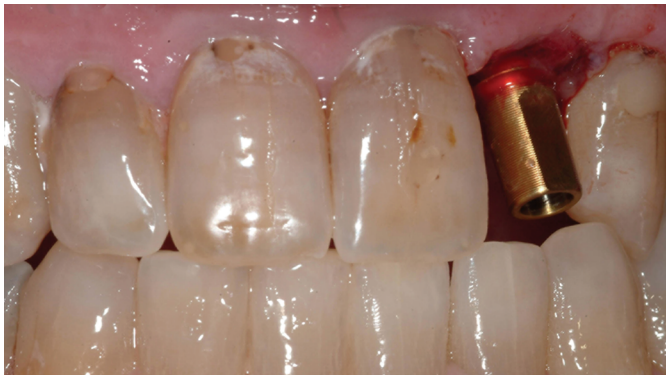

**Figure 2.56.** Clinical view of GingiHue® Post (IAPP454G) in place at the time an implant was uncovered in the maxillary left lateral incisor location. The flat surface of the abutment was placed on the facial surface.

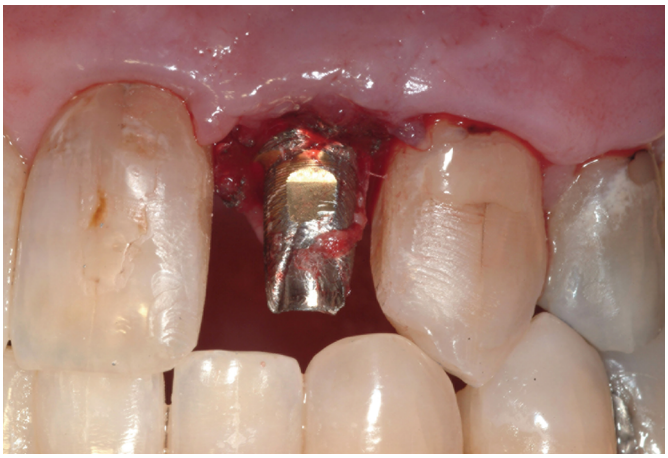

**Figure 2.57.** Clinical view of GingiHue® Post in Figure 2.56 after it was prepared, prior to fabrication of the provisional crown. It was screwed into the implant with an abutment screw (IUNIHG) torqued to 20 Ncm.

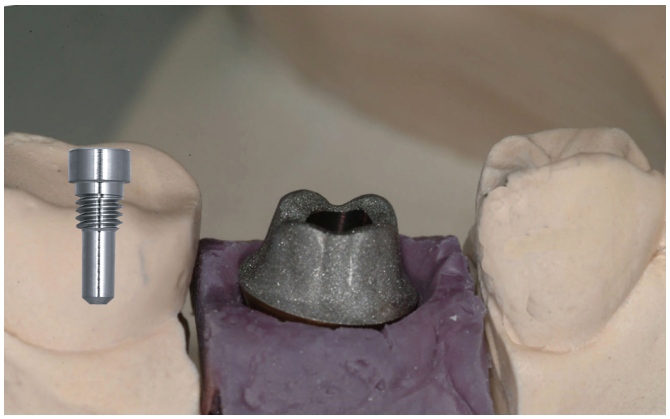

**Figure 2.58.** Laboratory view of GingiHue® Post (IWPP574G) in place on a master cast in the area of a mandibular right first molar. A dental laboratory technician prepared the abutment on the master cast. The porcelain fused to metal crown was fabricated directly on the abutment. A laboratory try-in screw (IUNIHT) was used during these procedures (inset).

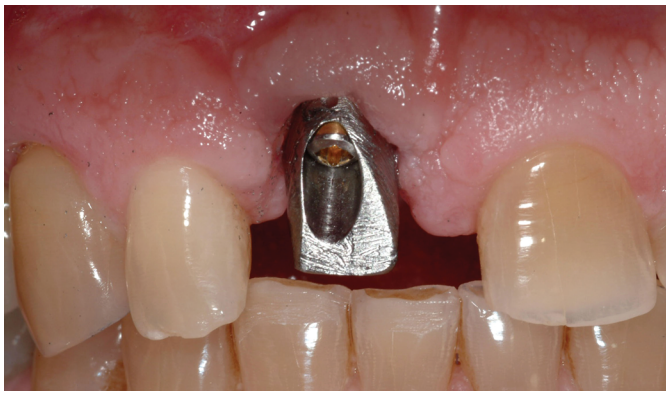

**Figure 2.59.** Clinical view of titanium abutment in place in maxillary right central incisor site. Note the gray metallic appearance of the distal facial gingival margin.

**Figure 2.60.** ZiReal™ Post demonstrating the titanium cylinder and the zirconia abutment. The height of the cylinder inside the abutment is 1.25 mm. The height of the exposed collar is 0.25 mm.

**Figure 2.61.** ZiReal™ Posts (ICAP454, ICAP464) for 4.1mm OSSEOTITE® Certain® implants (5 and 6 mm EP® diameters).

abutments, has a flexural strength of 500 Mpa (Seghi and Sorenson 1995).

ZiReal™ Posts are unique in that the TZP has been fused with a titanium cylinder (1.25 mm height) that permits a precise metal-to-metal interface between these ceramic abutments and implant restorative platforms. The height of the clinical metal collar is 0.25 mm (Figure 2.60). All-ceramic abutment/implant connections do not have the same high degree of precision that has been reported for metal abutments (Brodbeck 2003).

ZiReal™ Posts have been manufactured for internal and external implant/abutment connections for 4.1 and 5.0 mm implant restorative platforms using the parameters of the EP® System (5, 6, and 7.5 mm EP® diameters) (Figure 2.61) (Table 2.19). They can be used for both single- and multi-unit ceramic restorations with a minimum inter arch space of 6 mm. The maximum angle correction that can be obtained with these abutments is 10°. The axial wall minimum thickness after abutment preparation is 0.3 mm. ZiReal™ Posts may be prepared intra-orally or they may be prepared in the laboratory on a master cast (Bonilla and Sullivan 2003; Drago 2003) (Figures 2.62, 2.63).

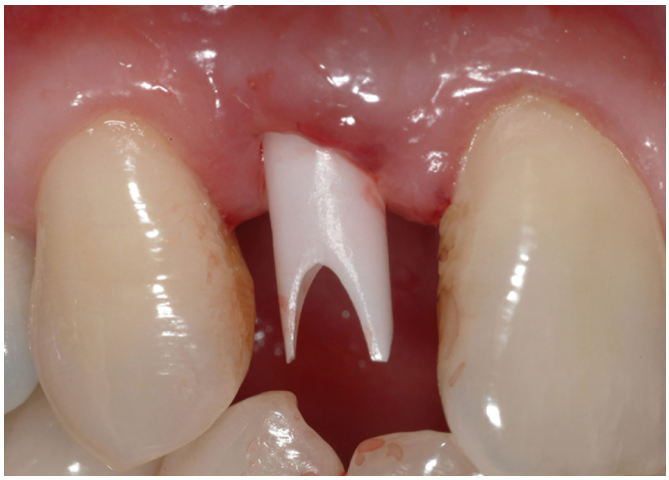

**Figure 2.62.** Clinical view of ZiReal™ Post (ICAP454) that was prepared intra-orally in the maxillary right lateral incisor site.

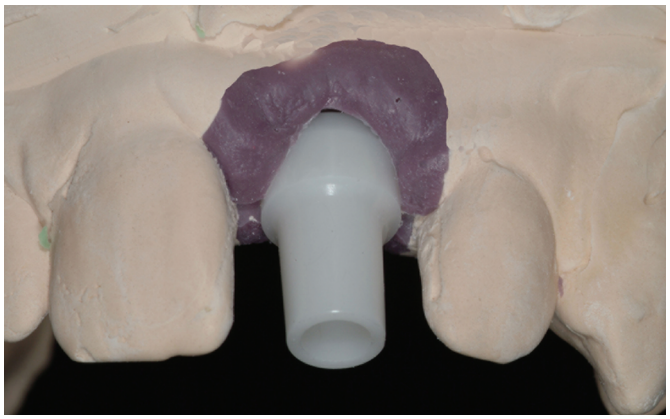

**Figure 2.63.** Laboratory view of ZiReal™ Post as received from the manufacturer in place for a maxillary left central incisor (IWCAP564). Note the flat side of the abutment (for anti-rotation of the cemented crown) has been placed on the palatal surface and is not visible in this view.

### *Provide™ Abutments*

***3i®*** recently introduced a new abutment: The Provide™ Abutment (Figure 2.64). This abutment provides the implant team with more options and therefore greater flexibility in meeting aesthetic and functional demands of patients with stock, noncustom implant restorative components. Provide™ Abutments give restorative dentists and implant surgeons four different collar heights (1-4 mm) and two different post heights (4.0 and 5.5 mm).

**TABLE 2.19.** Catalogue Numbers for ZiReal™ Posts for OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Implant Restorative Platform (mm) | Emergence Profile (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|---|---|
| 4.1 | 5.0 | 4.0 | ICAP454 | CAP454 |
| 4.1 | 6.0 | 4.0 | ICAP464 | CAP464 |
| 5.0 | 6.0 | 4.0 | IWCAP564 | WCAP564 |
| 5.0 | 7.5 | 4.0 | IWCAP574 | WCAP574 |

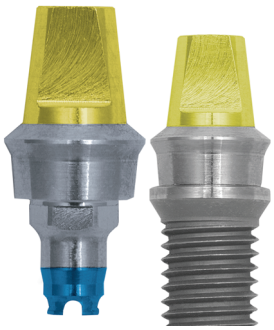

**Figure 2.64.** Product view of two Provide™ Abutments (IPA4155, IPA4140, left to right).

**Figure 2.65.** Provide™ Abutments 1–4 mm collar height, left to right (IPA4140, IPA4240, IPA4340, IPA4440, left to right).

**TABLE 2.20.** Catalogue Numbers for the Provide™ Abutment for the OSSEOTITE® Certain® Implant System

| Implant Restorative Platform (mm) | Collar Height (mm) | Post Height (mm) | Emergence Profile (mm) | Catalogue Number |
|---|---|---|---|---|
| 4.1 | 1.0 | 4.0 | 4.8 | IPA4140 |
| 4.1 | 2.0 | 4.0 | 4.8 | IPA4240 |
| 4.1 | 3.0 | 4.0 | 4.8 | IPA4340 |
| 4.1 | 4.0 | 4.0 | 4.8 | IPA4440 |
| 4.1 | 1.0 | 5.5 | 4.8 | IPA4155 |
| 4.1 | 2.0 | 5.5 | 4.8 | IPA4255 |
| 4.1 | 3.0 | 5.5 | 4.8 | IPA4355 |
| 4.1 | 4.0 | 5.5 | 4.8 | IPA4455 |
| 5.0 | 1.0 | 4.0 | 6.5 | IPA5140 |
| 5.0 | 2.0 | 4.0 | 6.5 | IPA5240 |
| 5.0 | 3.0 | 4.0 | 6.5 | IPA5340 |
| 5.0 | 4.0 | 4.0 | 6.5 | IPA5440 |
| 5.0 | 1.0 | 5.5 | 6.5 | IPA5155 |
| 5.0 | 2.0 | 5.5 | 6.5 | IPA5255 |
| 5.0 | 3.0 | 5.5 | 6.5 | IPA5355 |
| 5.0 | 4.0 | 5.5 | 6.5 | IPA5455 |
| 6.0 | 1.0 | 4.0 | 6.5 | IPA6140 |
| 6.0 | 2.0 | 4.0 | 6.5 | IPA6240 |
| 6.0 | 3.0 | 4.0 | 6.5 | IPA6340 |
| 6.0 | 4.0 | 4.0 | 6.5 | IPA6440 |
| 6.0 | 1.0 | 5.5 | 6.5 | IPA6155 |
| 6.0 | 2.0 | 5.5 | 6.5 | IPA6255 |
| 6.0 | 3.0 | 5.5 | 6.5 | IPA6355 |
| 6.0 | 4.0 | 5.5 | 6.5 | IPA6455 |

Implant surgeons will not need to determine the height of stock abutments at the time of implant placement because this abutment is available in 1, 2, 3, and 4 mm heights (Figure 2.65). OSSEOTITE® Certain® implants can be placed with either single- or two-stage surgical protocols. Abutment selection can be deferred until the tissues have matured, or it can be made at the time of implant placement with the potential of changing the abutment collar height relative to the height of the gingival margins (Table 2.20).

The Provide™ Restorative System provides clinicians with color-coded restorative components within the OSSEOTITE® Certain® Implant System. These abutments are not available in the external hex OSSEOTITE® implant system. These abutments may be used with implant level impressions and prepared in the laboratory. The abutments may also be used with a direct technique and prepared intra-orally. The latter protocol will simplify the restorative procedures by eliminating implant level impressions.

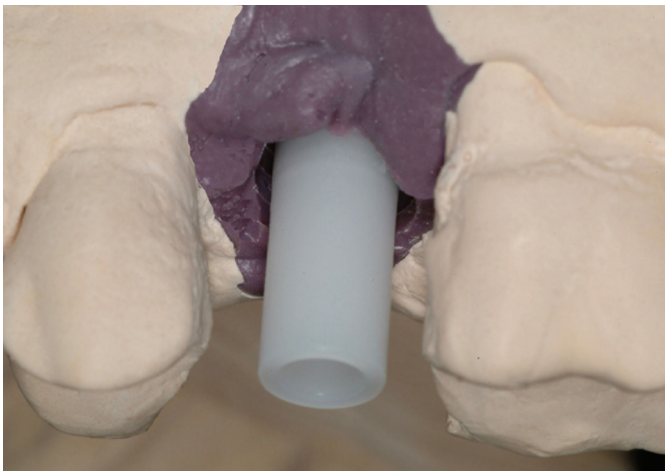

**Figure 2.66.** Laboratory facial view of UCLA Abutment (IGUCA1C) in place as received from the manufacturer. The titanium cylinder has a precise metal-to-metal fit at the implant/abutment interface.

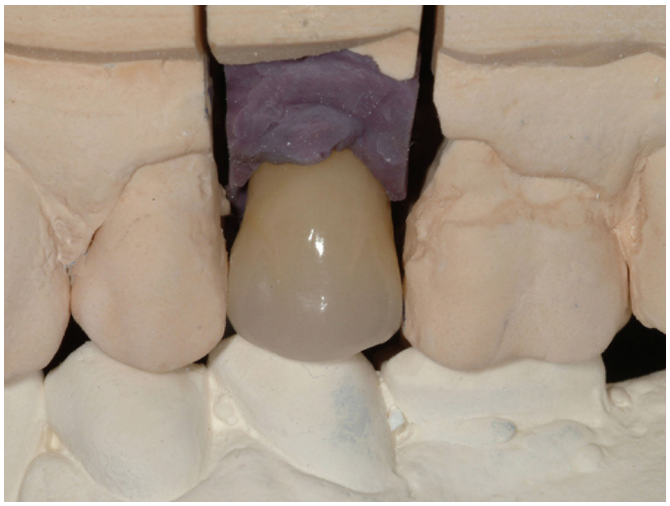

**Figure 2.68.** Porcelain fused to metal crown and custom UCLA Abutment in place on master cast.

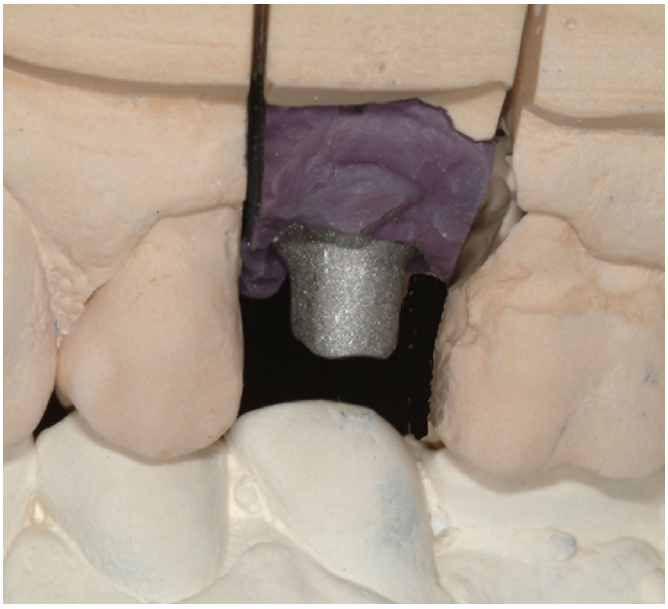

**Figure 2.67.** This UCLA Abutment was adjusted, waxed, and cast with a noble alloy into the shape of an abutment for a cement-retained crown.

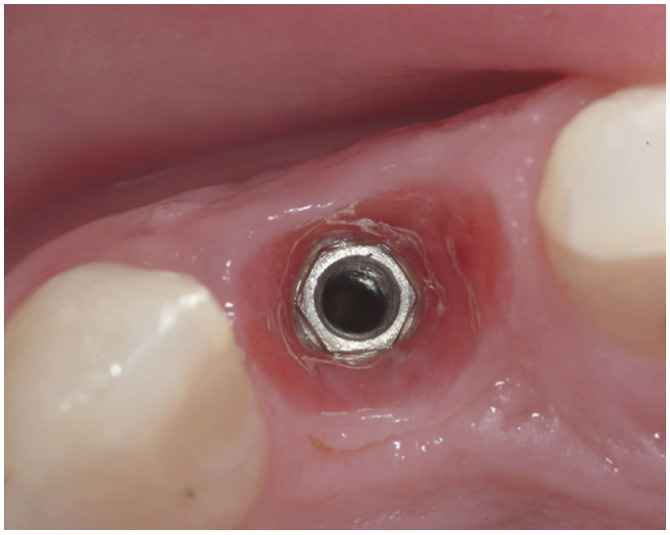

**Figure 2.69.** Clinical occlusal view of external hex implant 10 years after UCLA Abutment (GUCA1C) was cast as a single-unit, screw-retained implant restoration. The original abutment screw was loose for several months prior to this photograph. Note the redness of the peri-implant sulcular tissues.

### *UCLA Abutments*

The UCLA Abutment was developed to allow a direct connection between the implant and the implant restoration. These abutments can be used for single- and multiple-unit restorations with a minimum inter-occlusal clearance of 4 mm. They can be used as abutments for cement-retained crowns (Figures 2.66, 2.67, 2.68), as well as one-piece implant restorations screwed directly into implants (Figures 2.69, 2.70, 2.71, 2.72) (Table 2.21).

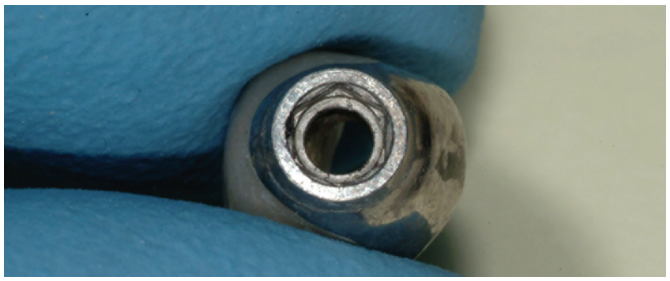

**Figure 2.70.** Laboratory view of abutment hex from the screw-retained crown in Figure 2.69.

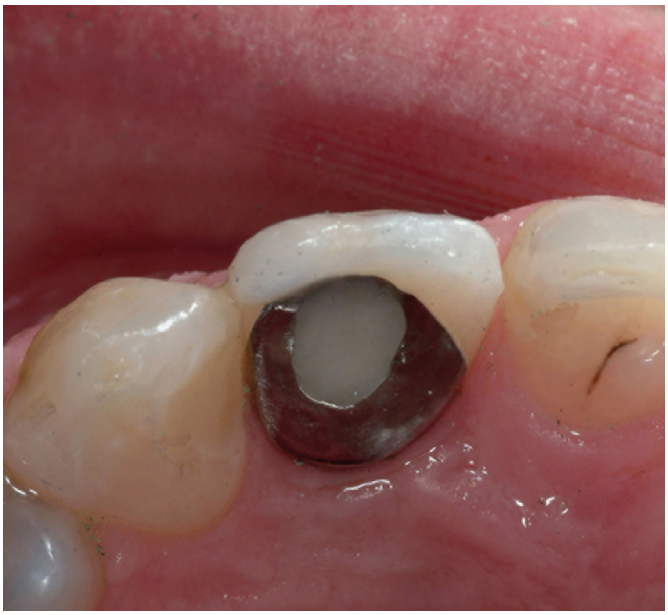

**Figure 2.71.** Clinical occlusal view of screw access opening on the palatal surface of the implant crown restoration in Figures 2.69 and 2.70. Note the size of the opening that was required to accommodate the head of the abutment screw. The access opening was restored with composite resin.

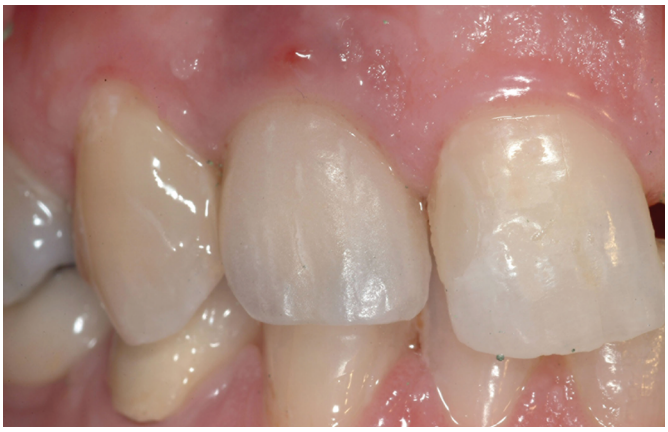

**Figure 2.72.** Clinical facial view of screw-retained crown replacing the maxillary right lateral incisor. Screw-retained crowns in the aesthetic zone require implant placement that have screw access openings within the palatal surfaces of maxillary restorations.

**TABLE 2.21.** Catalogue for UCLA Abutments for OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Implant Restorative Platform (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|
| **3.4** | | |
| Gold (Hexed) | IMUCG1C | MUCG1C |
| Gold (Non-Hexed) | NA | NA |
| **4.1** | | |
| Gold (Hexed) | IGUCA1C | GUCA1C |
| Gold (Non-Hexed) | IGUCA2C (includes large diameter Gold-Tite™ Screw) | GUCA2C |
| Gold (Non-hexed) | IGUCA2T (includes large diameter Ti Screw) | NA |
| Gold Standard ZR™ (Hexed) | NA | SGUCA1C |
| **5.0** | | |
| Gold (Hexed) | IWGA51C | NA |
| Gold (Non-Hexed) | IWGA52C (includes large diameter Gold-Tite™ Screw) | WGA52C |
| Gold (Non-Hexed) | IWGA52T (includes large diameter Ti Screw) | NA |
| Gold Standard ZR™ (Hexed) | NA | SWGA51C |
| **6.0** | | |
| Gold (Hexed) | IWGA61C | WGA61C |
| Gold (Non-Hexed) | IWGA62C (includes large diameter Gold-Tite™ Screw) | WGA62C |
| Gold (Non-Hexed) | IWGA62T (includes large diameter Ti Screw) | NA |
| Gold Standard ZR™ (Hexed) | NA | SWGA61C |

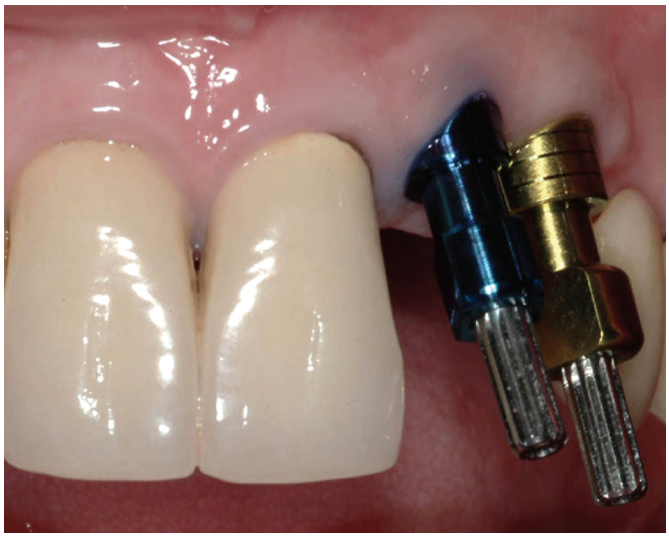

**Figure 2.73.** Clinical view of implants with impression copings in place replacing the maxillary left lateral incisor and cuspid. Note the facial angulation of the implant impression copings. If the restorations were to be screw-retained, the screw access openings would be in the middle portions of the facial surfaces of the restorations.

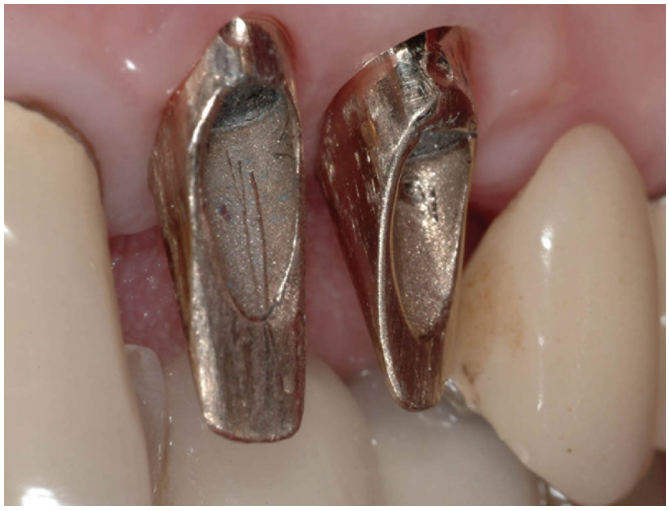

**Figure 2.74.** Clinical view of custom UCLA Abutments featured in Figure 2.73 in place. Due to amount of inter-occlusal clearance and the 6° axial taper, the nonfacial axial walls provided adequate surface area for satisfactory retention and resistance form for the individual cement-retained restorations.

UCLA Abutments have been manufactured with machined gold palladium cylinders and plastic unitubes. These abutments may be waxed and cast as custom abutments. The heights of the unitubes may be modified depending upon the available inter-occlusal clearance. This allows dental laboratory technicians to correct misaligned implants with up to 30° divergence (Figures 2.73, 2.74). UCLA Abutments are available in hexed and non-hexed configurations (Figure 2.75).

**Figure 2.75.** Hexed and nonhexed UCLA Abutments (IGUCA1C, IGUCA2C, respectively) for 4.1 mm diameter OSSEOTITE® Certain® Implant System.

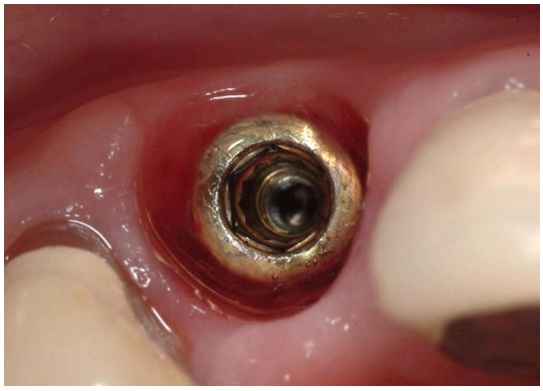

**Figure 2.76.** Clinical occlusal view of 5.0 mm implant restorative platform in maxillary right cuspid site. The emergence profile of the peri-implant soft tissues was created with a custom provisional implant restoration.

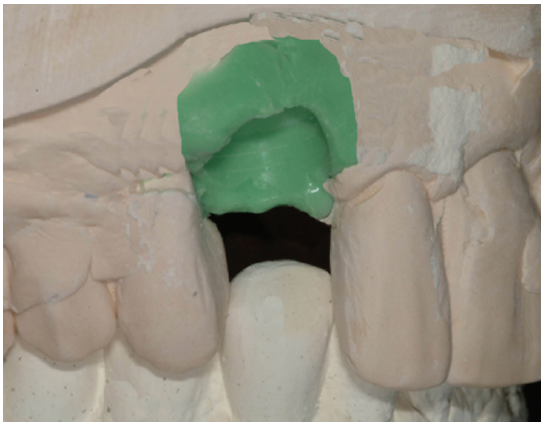

**Figure 2.77.** Master cast from the impression in Figure 2.76 was mounted against a mandibular cast. The emergence profile was captured in the definitive implant level impression and replicated in poly vinylsiloxane impression material.

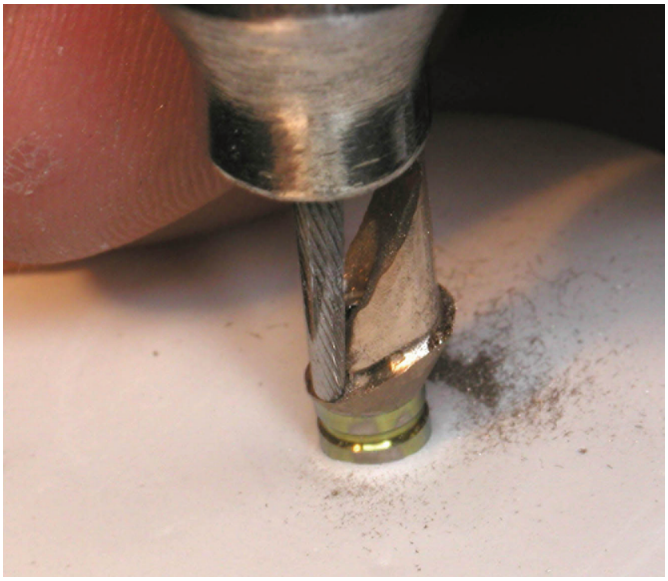

**Figure 2.78.** A custom UCLA Abutment was developed in wax and cast in a noble alloy. It was milled on a surveyor for minimal axial wall taper. The sub-gingival portions were waxed to fit into the peri-implant space around the implant analog.

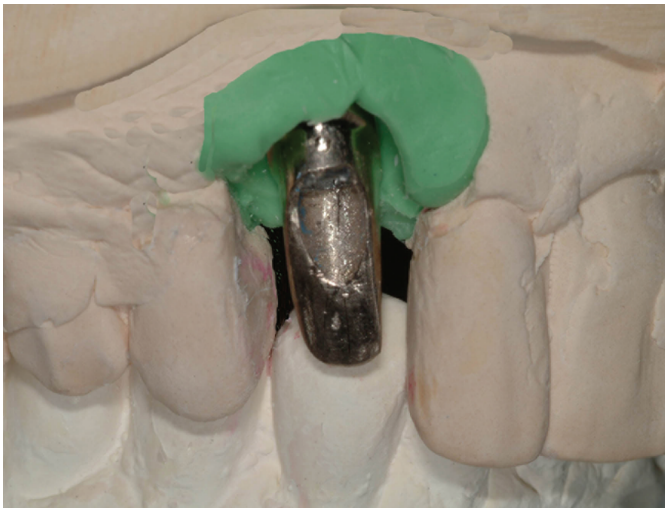

**Figure 2.79.** Custom cast UCLA abutment in place on master cast. The emergence profiles were originally developed clinically with the provisional restoration. The dental laboratory technician followed these contours to establish optimal anatomic form in the custom abutment.

UCLA Abutments are ideal for use in situations when space is limited and stock, pre-machined abutments will not satisfy aesthetic or functional demands (Lazzara, 1993). These abutments require implant level impressions to develop master casts with implant analogs (Figure 2.76, 2.77). Custom abutments may be fabricated by casting to the UCLA Abutments as received from the manufacturer and milling procedures performed as required by the clinical situations (Figures 2.78, 2.79). Definitive implant crown restorations can be made directly on the custom abutments. The emergence profiles have already been established clinically and this information transferred to the master cast with the implant level impression. The net result is an implant-retained crown with anatomic contours that replicate the contours established by the provisional restoration (Figure 2.80).

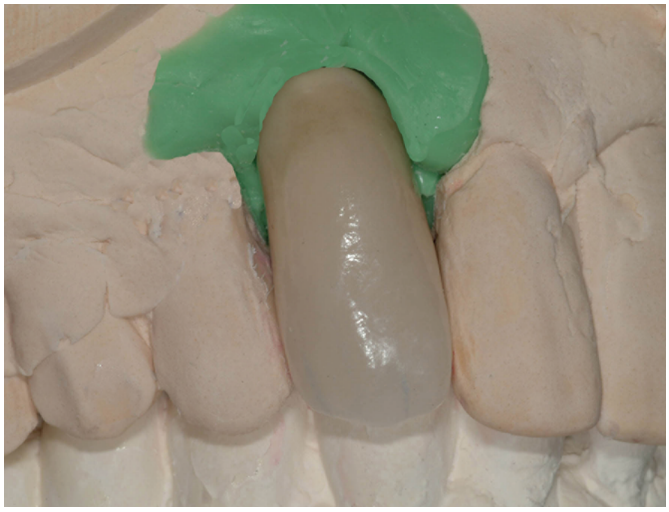

**Figure 2.80.** A porcelain fused to metal crown was fabricated that replicated the emergence profile of the peri-implant tissues developed with the provisional restoration. The dental laboratory technician was able to follow the contours that were in the master cast to fabricate a crown whose contours had already been determined clinically.

**Figure 2.81.** Occlusal view of Encode™ Healing abutment (EHA554). Codes have been embedded into the occlusal surfaces that identify the size and location of the implant restorative platform, implant/abutment connection, emergence profile, and height of the healing abutment.

### *CAD/CAM Abutments (Encode™ Abutments)*

Encode™ Healing Abutments have been manufactured with codes embedded into their occlusal surfaces (Figure 2.81). These codes provide the required information for optical scanning and construction of definitive abutments produced with computer-assisted design and computer-assisted milling.

Protocols have been established for fabrication of Encode™ Abutments. In principle, an implant level impression of some type is needed to transfer the position of the implant restorative platform to a cast for fabrication of the

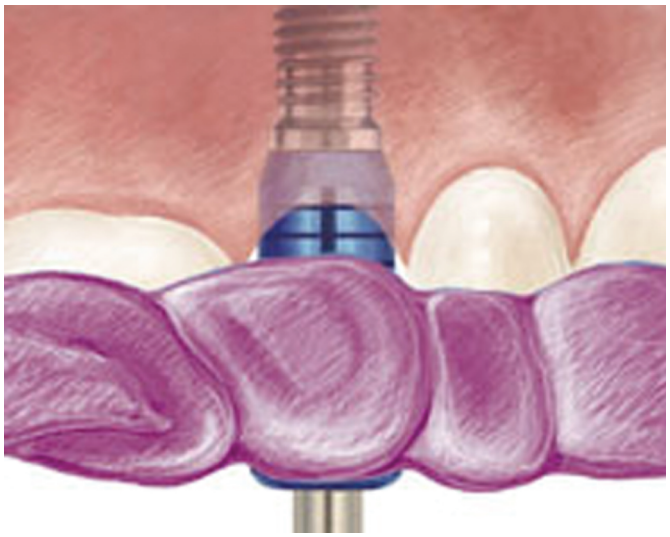

**Figure 2.82.** Illustration of surgical index: the surgeon, prior to closure of the wound, placed a pick-up implant level impression coping. An index was made that oriented the impression coping to the anatomical contours of the adjacent teeth.

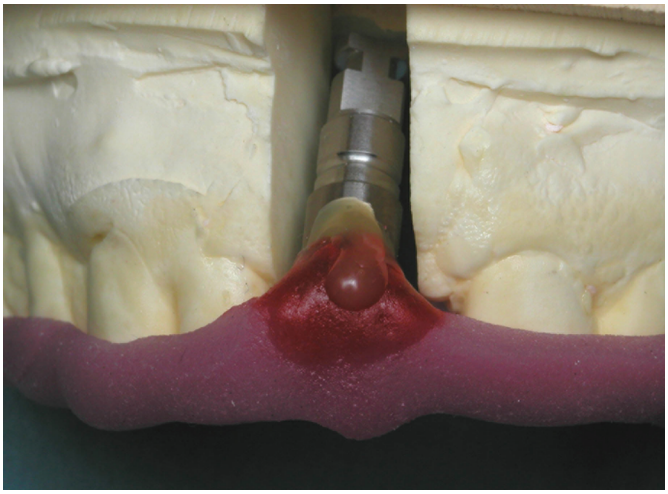

**Figure 2.83.** Stone was removed from the area corresponding to the implant. An implant analog (ILAW5) was attached to the implant impression coping (WIP55) and the index was refitted to the occlusal surfaces of the adjacent teeth.

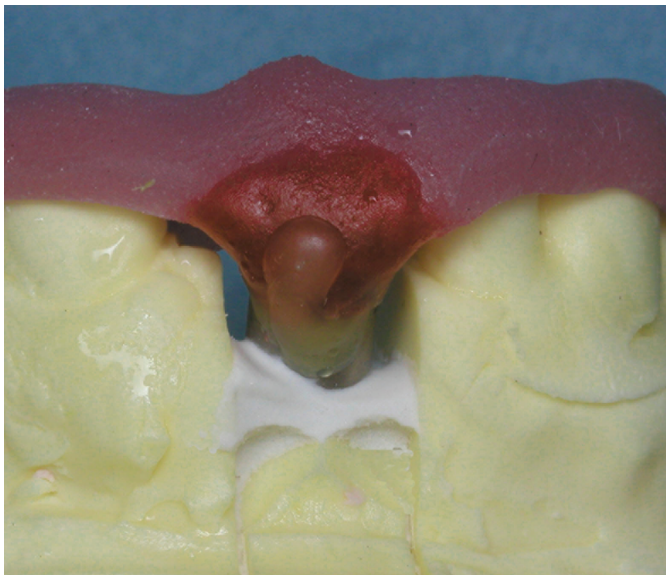

**Figure 2.84.** The implant analog transferred the precise location of the implant to the diagnostic cast via the surgical index. The gingival margins were not recorded because the wound was not closed at the time the index was made.

crown restoration. This impression may be a surgical index at the time of implant placement (Figure 2.82). Dental stone will then be removed from the cast in the area of the implant; an implant analog will be attached to the impression coping in the index (Figure 2.83) and the analog will be retrofitted to the cast by injecting dental stone into the void around the analog (Figure 2.84).

After osseointegration occurred, a poly vinylsiloxane impression was made of the Encode™ Healing Abutment (Figure 2.85) and the impression was poured in die stone (Fujirock® EP, GC Europe, Leuven, Belgium) (Figure 2.86). This cast was mounted on an articulator with magnetic mounting plates and shipped to ***3i***®. A laser optical scanner was used to scan this cast. A dental laboratory techni-

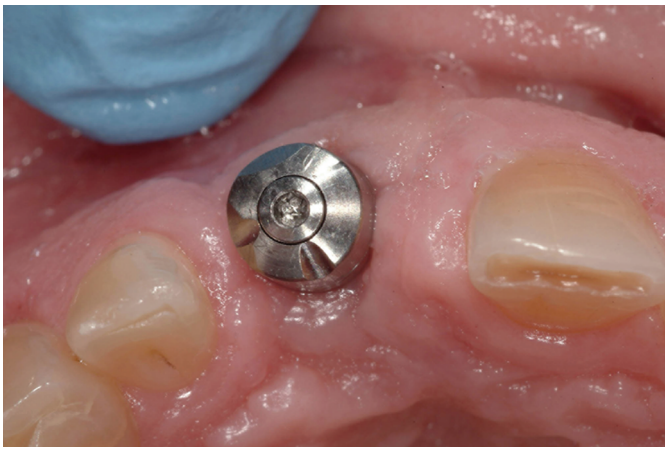

**Figure 2.85.** Clinical occlusal view of Encode™ Healing Abutment (EHA554) in place.

**Figure 2.87.** Computer-designed, patient-specific abutment in CAD software. The gingival tissues were made translucent to assist in development of the abutment margins.

**Figure 2.86.** Occlusal view of Encode™ Healing Abutment (EHA554) that was replicated in die stone in the master cast.

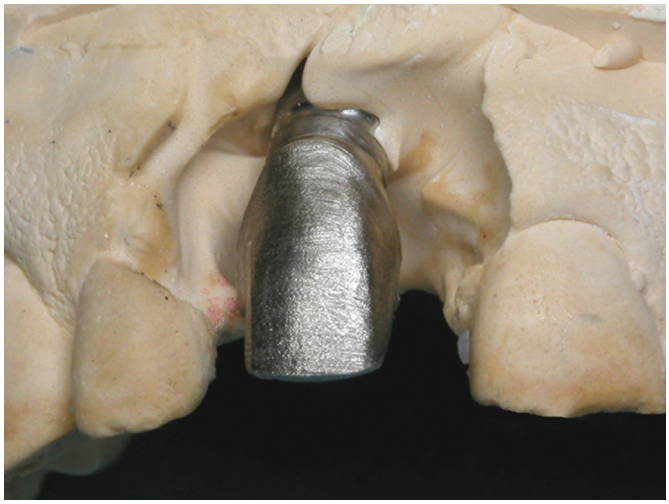

**Figure 2.88.** Facial laboratory view of cast coping on Final Encode™ Abutment in place on master cast; the soft tissue has been removed from the cast.

cian/computer designer designed the patient specific abutment using a sophisticated software program (Figure 2.87). The Final Encode™ Abutment was milled by a computerized milling machine per the specifications developed in the CAD design (Figure 2.88). The margins were fabricated from the image of the Encode™ Healing Abutment that contained the location of the peri-implant soft tissues. The definitive porcelain fused to metal crown was cemented to the abutment in conventional fashion (Figure 2.89).

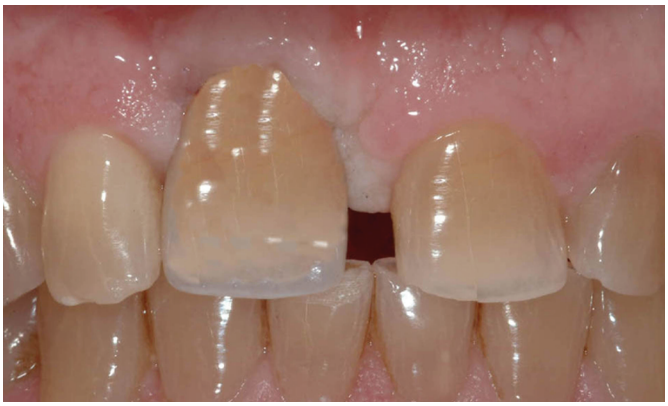

**Figure 2.89.** Facial clinical view of porcelain fused to metal crown in place on the Final Encode™ Abutment featured in Figure 2.87.

**TABLE 2.22.** Catalogue Numbers for Abutment Screws for OSSEOTITE® Certain® Implant System

| | Gold-Tite™ | Titanium | Large Gold-Tite™ | Large Titanium |
|---|---|---|---|---|
| Abutment Screws | IUNIHG | IUNIHT | ILRGHG | ILRGHT |
| Drivers | PHDO2N, PHDO3N | PHDO2N, PHDO3N | PHDO2N, PHDO3N | PHDO2N, PHDO3N |
| Driver Tips | RASH3N, RASH8N | RASH3N, RASH8N | RASH3N, RASH8N | RASH3N, RASH8N |
| Torque | 20 Ncm | 20 Ncm | 20 Ncm | 20 Ncm |
| For Use With | UCLA Abutments, GingiHue® Posts, GingiHue® Posts 15°, Hexed Temporary Cylinders | UCLA Abutments, GingiHue® Posts, GingiHue® Posts 15°, Hexed Temporary Cylinders | Non-Hexed UCLA Abutments, Non-Hexed Temporary Cylinders | Non-Hexed UCLA Abutments, Non-Hexed Temporary Cylinders |

**Figure 2.90.** Gold-Tite™ Abutment Screw for the OSSEOTITE® Certain® Implant System (IUNIHG).

**TABLE 2.23.** Catalogue Numbers for Retaining Screws for OSSEOTITE® Certain® Implant System

| | |
|---|---|
| Screws | GSH20, GSH30 |
| Drivers | PHDO2N, PHDO3N |
| Driver Tips | RASH3N, RASH8N |
| Torque | 10 Ncm |
| For Use With | GSH20-Standard Abutment<br>GSH30-Pre-Angled, Standard, conical and TG Hex Abutments |

**Figure 2.91.** Gold-Tite™ retaining screw (GSH30).

## SCREWS (CLINICAL)

Abutment screws have been defined as the screws that connect an abutment to implants (Figure 2.90). Retaining screws have been defined as the screws that retain cylinders to implants (Figure 2.91). In ***3i***®'s implant systems, abutment screws have been designed with slotted, hex, and square heads; retaining screws have been designed with slotted or hex heads. Slotted screws for clinical applications are not illustrated in this text (Tables 2.22, 2.23, 2.24).

***3i***® has patented a 24-carat-gold, ultra-thin 0.76 μm coating for its abutment and retaining screws called Gold-Tite™. This thin layer of 24-carat gold acts as a dry lubricant that reduces friction and allows approximately 62% more screw-turning during tightening with a given amount of force. This results in increased preloads in the abutment/implant connection and improves the predictability of clinical implant treatment (Figure 2.92).

**TABLE 2.24.** Catalogue Numbers for Abutment and Retaining Screws for the OSSEOTITE® Implant System

| | **Gold-Tite® Square Abutment Screw** | **Gold-Tite® Hexed Abutment Screw** | **Titanium Hexed Abutment Screw** | **Gold-Tite® Retaining Screw** |
|---|---|---|---|---|
| Abutment Screws | UNISG | UNIHG | UNIHT | GSH20, GSH30 |
| Drivers | PSQDON, PSQD1N | PHDO2N, PHDO3N | PHDO2N, PHDO3N | PHDO2N, PHDO3N |
| Driver Tips | RASQ3N, RASQ8N | RASH3N, RASH8N | RASH3N, RASH8N | RASH3N, RASH8N |
| Torque | 32-35 Ncm | 20 Ncm | 20 Ncm | 10 Ncm |
| For Use With | UCLA Abutments, GingiHue® Posts, GingiHue® Posts 15°, ZiReal™ Posts, Titanium Cylinders, Pre-Angled Abutments | UCLA Abutments, GingiHue® Posts, GingiHue® Posts 15°, ZiReal™ Posts, Titanium Cylinders, Pre-Angled Abutments | UCLA Abutments, GingiHue® Posts, GingiHue® Posts 15°, ZiReal™ Posts, Titanium Cylinders, Pre-Angled Abutments | GSH20-Standard Abutments, GSH30- Pre-Angled, Standard, Conical and TG Hex Abutments |

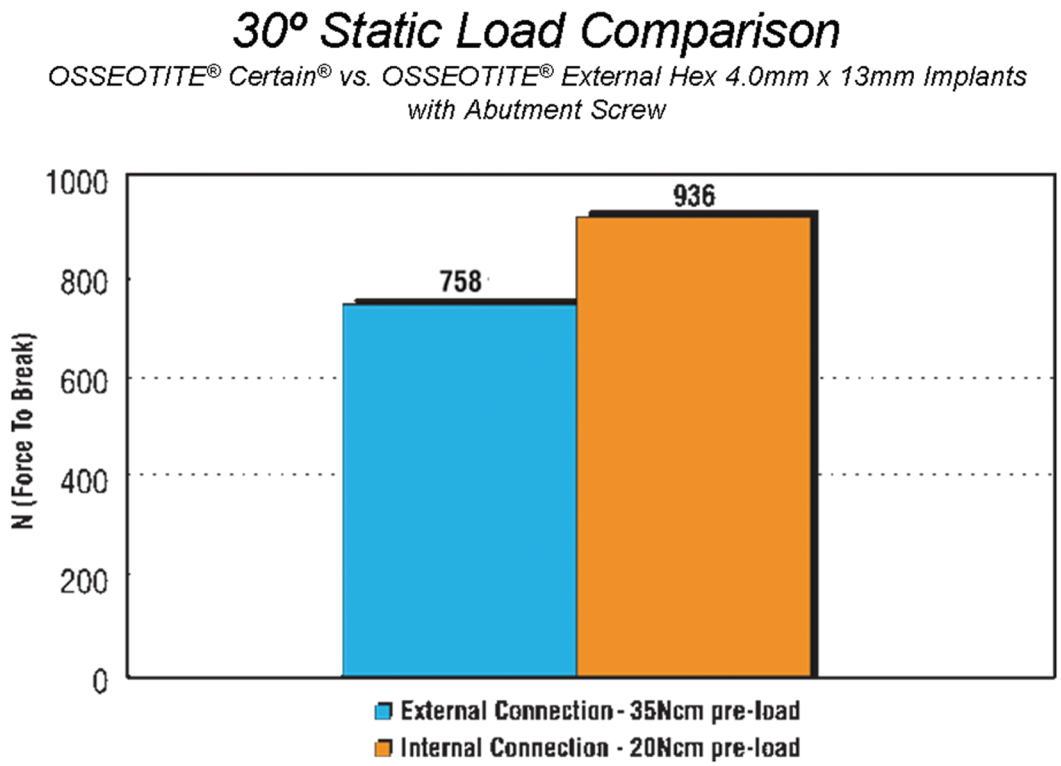


**Figure 2.92.** Graphic results demonstrating increased preload with applied torque in Gold-Tite™Abutment Screws.

**TABLE 2.25.** Catalogue Numbers for *3i*® Gold Cylinders

| Implant Restorative Component | Emergence Profile (mm) | 4.1 mm Implant Restorative Platform | 5.0 mm Implant Restorative Platform |
|---|---|---|---|
| Pick-Up Impression Coping | 4.5 | SQIC7 | SQIC7 |
| Laboratory Analog | 4.5 | SLA20 | SLA20 |
| Gold Cylinder | 4.5 | SGC30 | SGC30 |
| Healing Cap | 4.5 | TS250 | TS250 |
| Retaining Screw | 4.5 | GSH20, GSH30 | GSH20, GSH30 |

**Figure 2.93.** Standard Gold Cylinder (SGC30) machined to fit onto standard abutments.

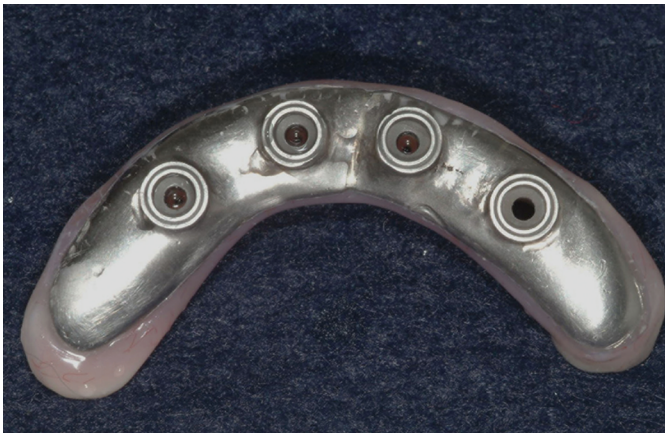

**Figure 2.94.** The intaglio surface of a cast metal framework for a hybrid prosthesis. The gold cylinders were incorporated into the wax pattern and cast as part of the metal framework. The precise machining was maintained throughout prosthesis fabrication.

**TABLE 2.26.** Catalogue Numbers for Overdenture and Fixed Hybrid Prostheses

| Implant Restorative Platform | 4.1 mm | 5.0mm |
|---|---|---|
| Emergence Profile (mm) | 4.5 mm | 4.5 mm |
| Pick-Up Impression Coping | SQIC7 | SQIC7 |
| Laboratory Analog | SLA20 | SLA20 |
| Polishing Protector | PPSA3 | PPSA3 |
| Healing Cap | TS250 | TS250 |
| Retaining Screw | GSH20, GSH30 | GSH20, GSH30 |

## CYLINDERS

### *Standard Gold Cylinders*

Cylinders (SGC30) are laboratory components that have been machined to fit onto abutments (Figure 2.93)(Table 2.25). They are waxed and cast as part of metal frameworks for implant prostheses (Figure 2.94). Gold cylinders are not generally used for single-unit restorations because optimal emergence profiles cannot be developed with standard abutments. The abutment/cylinder connections are not dependent on the implant/abutment connection type. These components may be used with both internal and external connection implant systems (Table 2.26).

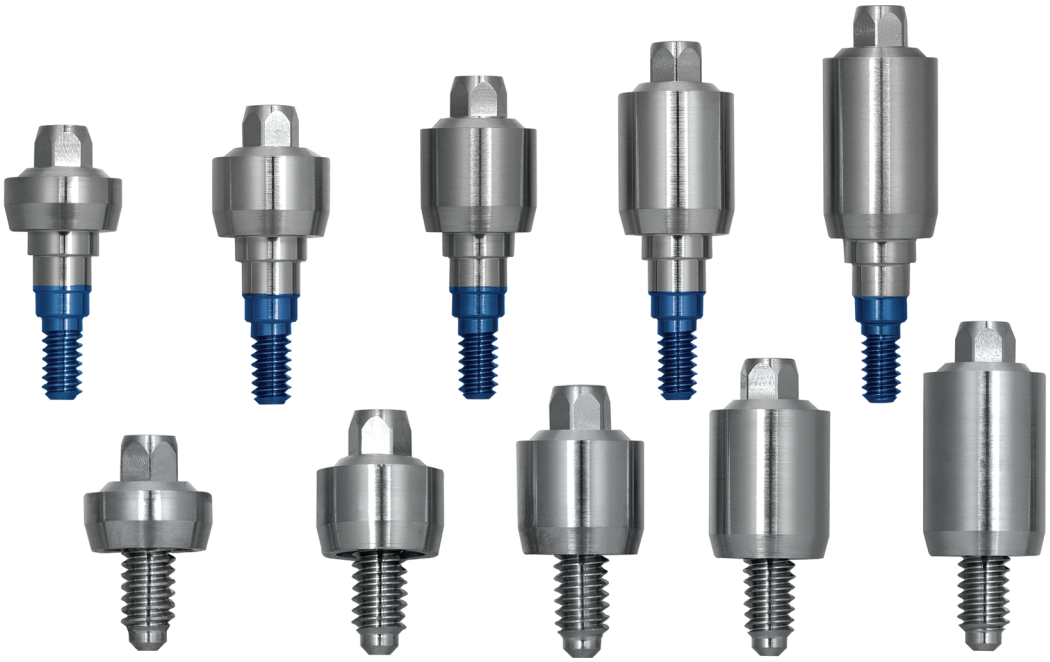

**Figure 2.95.** IOL® Abutments for the OSSEOTITE® Certain® implant system (top); OSSEOTITE® implant system (bottom): 2, 3, 4, 5.5, and 7 mm collar heights (left to right).

**Figure 2.96.** IOL® Temporary Cylinder (IOLTC).

**Figure 2.97.** IOL® Gold Cylinder (IOLGC).

**TABLE 2.27.** Catalogue Numbers for Immediate Occlusal Loading® Abutments for 4.1 Implant Restorative Platforms in the OSSEOTITE® Certain® and OSSEOTITE® Implant Systems

| Emergence Profile (mm) | Collar Height (mm) | OSSEOTITE® Certain® Implants | OSSEOTITE® Implants |
|---|---|---|---|
| 4.5 | 2.0 | IIOL20S | IOL20T |
| 4.5 | 3.0 | IIOL30S | IOL30T |
| 4.5 | 4.0 | IIOL40S | IOL40T |
| 4.5 | 5.5 | IIOL55S | IOL55T |
| 4.5 | 7.0 | IIOL70S | IOL70T |

Note: Use PADOO Abutment Driver or RASA3 Driver Tip.

### *IOL® Abutment Gold Cylinders*

IOL® Cylinders were designed specifically for use with Immediate Occlusal Loading® in the edentulous mandible (Figure 2.95). These cylinders are shorter than conical abutments but still provide a positive seating surface for IOL® temporary cylinders and IOL® gold cylinders (Figure 2.96, 2.97). They are manufactured from titanium alloy and are available for both OSSEOTITE® Certain® and OSSEOTITE® Implant Systems (Table 2.27).

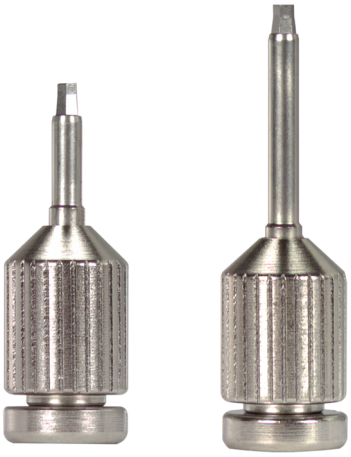

**Figure 2.98.** Large hex drivers (PHD02N, 17 mm length, left; PHD03N 24 mm length, right).

**Figure 2.99.** Contra-angle driver tips for large hex screws (RASH3N, 24 mm length, left; RASH8N, 30 mm length, right).

## DRIVERS AND PLACEMENT INSTRUMENTS

Drivers and placement instruments are the instruments that are used by surgeons, restorative dentists, and dental laboratory technicians in implant dentistry. Some of the drivers may be used with other commercial implant systems. However, this discussion is limited to drivers for ***3i***® implants.

### *Large Hex Drivers*

Large hex drivers (PHD02N, PHD03N) are used to place healing abutments and tighten hexed abutment and retaining screws (Figure 2.98). These drivers have a patented tip design that allows components to be carried safely via a frictional grip. These drivers have hexagonal tips that measure 1.2 mm (.048 inches) from flat surface to flat surface. The drivers are made from surgical stainless steel.

**Figure 2.100.** Square drivers (PSQD0N, 17 mm, left; PSQD1N, 24 mm, right).

**Figure 2.101.** Contra-angle driver tip for square screws (RASQ3N, 24 mm length).

### *Large Hex Driver Tips*

Driver tips (RASH3N, RASH8N) may be used in contra-angles and torque drivers (Figure 2.99). Driver tips were designed for use with healing abutments and abutment/retaining screws and are also manufactured from surgical stainless steel. These driver tips are used to generate 10 or 20 Ncm of torque to large hex head screws.

### *Square Drivers*

Square drivers (PSQD0N, PSQD1N) were designed for tightening square Gold-Tite™ Abutment screws and Square Try-In screws (Figure 2.100). They are made from surgical stainless steel.

### *Square Driver Tips*

Driver tips (RASQ3N, RASQ8N) may be used in contra-angle and torque drivers (Figure 2.101). These driver tips were designed for use with Gold-Tite™ Square Abutment and Try-In screws and are also manufactured from surgical stainless steel. (Table 2.28). These driver tips are used clinically to generate 32 or 35 Ncm of torque to square head screws.

**TABLE 2.28.** Catalogue Numbers for Drivers and Driver Tips (Large Hex, Square)

| Length | Large Hex Driver | Large Hex Tip | Square Driver | Square Tip |
|---|---|---|---|---|
| 17 mm | PHDO2N | N/A | PSQD0N | N/A |
| 24 mm | PHDO3N | RASH3N | PSQD1N | RASQ3N |
| 30 mm | N/A | RASH8N | N/A | RASQ8N |
| For use with | Healing abutments, Abutment Screws, Retaining Screws | Healing abutments, Abutment Screws, | Square Gold-Tite™ Abutment Screws, Try-In Screws | Square Gold-Tite™ Abutment Screws, Try-In Screws |

**TABLE 2.29.** Catalogue Numbers for Drivers and Driver Tips (Abutments, LOCATOR®)

| Length | Abutment Driver | Abutment Tip | LOCATOR® Tip Only |
|---|---|---|---|
| 17 mm | PAD00 | N/A | N/A |
| 24 mm | PAD24 | N/A | LOADT4 |
| 30 mm | N/A | N/A | LOADT9 |
| One-size | N/A | RASA3 | N/A |
| For use with | Conical, Standard and IOL® Abutments | Conical, Standard and IOL® Abutments | LOCATOR® Abutments |

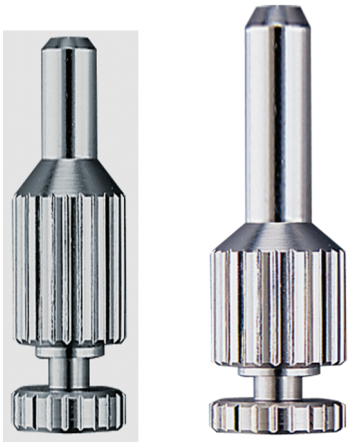

**Figure 2.102.** Abutment drivers (PAD00, 17 mm length, left; PAD24, 24 mm length, right).

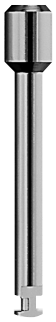

**Figure 2.103.** Contra-angle driver tip for Conical, Standard and IOL® Abutments (RASA3).

### *Abutment Drivers*

Abutment drivers (PAD00, PAD24) are used to tighten Standard and IOL® Abutments and are also made from surgical stainless steel (Figure 2.102). (Table 2.29).

### *Abutment Driver Tips*

Driver tips (RASA3) may be used in contra-angle and torque drivers (Figure 2.103). These driver tips were designed for use with Standard, Conical, and IOL® Abutment screws and are also manufactured from surgical stainless steel. These driver tips are used to generate up to 20 Ncm of torque to hexed abutment screws. (Table 2.29).

## LABORATORY COMPONENTS

Laboratory analogs are replicas of implant restorative platforms and abutments. Analogs need to be manufactured to exact tolerances, because the fit of the final restorations onto the implants is dependent upon, among other factors, the accuracy of the analogs. Binon (1995) measured the machining accuracy of 13 different implant manufacturers' products including implants, abutments, and analogs and found considerable variation in machining accuracy and

**TABLE 2.30.** Catalogue Numbers For Laboratory Components for the OSSEOTITE® Certain® Implant System

| Description | Implant Restorative Platform 3.4 mm | Implant Restorative Platform 4.1 mm | Implant Restorative Platform 5.0 mm | Implant Restorative Platform 6.0 mm |
|---|---|---|---|---|
| Laboratory Analog | IMMILA | IILA20 | IILAW5 | IILAW6 |
| Laboratory Holder | ILTAH5 | ILTAH7 | ILTAH7 | ILTAH7 |
| Try In Screws | IUNITS | IUNITS | IUNITS | IUNITS |
| QuickSeat Activator Tool | IQSA01 | IQSA01 | IQSA01 | IQSA01 |

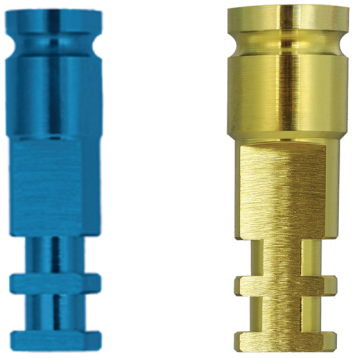

**Figure 2.104.** 4.1 mm implant analog-left (IILA20); 5.0 mm implant analog-right (IILAW5) for the OSSEOTITE® Certain® Implant System.

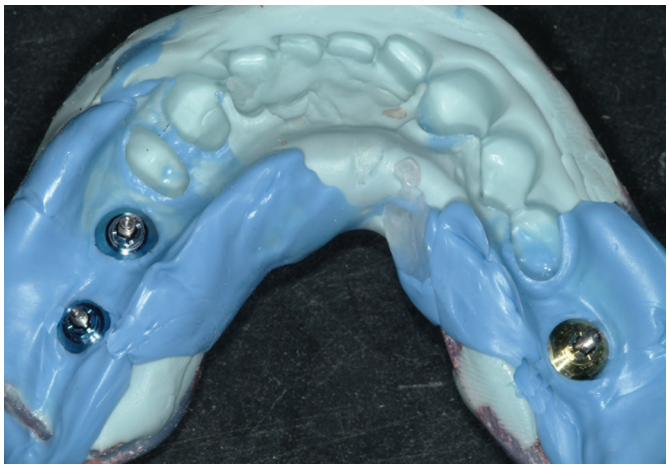

**Figure 2.105.** Mandibular impression with three internal connection implant impression copings in place. Impression copings and implant analogs are colored coded: blue for 4.1 mm restorative platforms; gold for 5.0 mm restorative platforms.

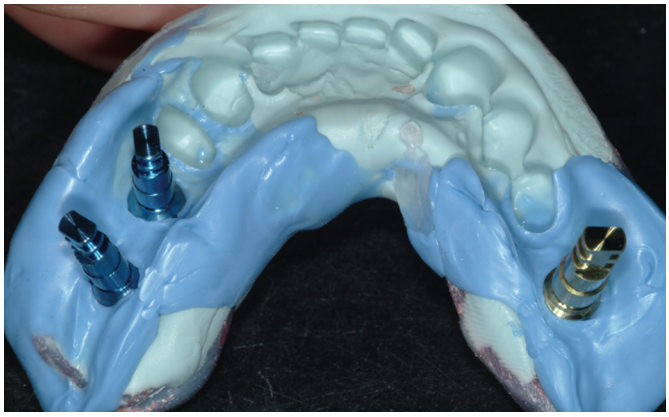

**Figure 2.106.** Blue (4.1 mm diameter, left) and gold (5.0 mm diameter, right) implant analogs in place on their respective implant impression copings in the mandibular definitive impression.

consistency in the sample implants that he studied. For instance, the mean analog hexagonal extension width (flat surface to flat surface) varied from 2.347 mm to 2.708 mm. Manufacturers had identified this dimension as being 2.7 mm. Binon was convinced that reduction or elimination of these types of discrepancies would decrease rotational movement between implants and abutments and would result in more stable and predictable screw joints. The internal connections of the ScrewVent implant system, although not included in the study with the external connection implant systems, demonstrated the least amount of rotational freedom (1.4° of all of the components and combinations that were tested in Binon's study).

### *Implant Analogs*

Implant analogs (Figure 2.104, Table 2.30) screw into the apical portions of implant impression copings (IIIC41-blue and IWIP55-gold) via the impression coping screws in the OSSEOTITE® Certain® Implant System (Figures 2.105, 2.106). A resilient impression (polyether) material was injected around the implant impression coping/implant analog junctions and the impression was poured with a Type IV die stone (Figure 2.107). There are machined concavities at the occlusal ends of internal connection implant lab analogs designed to retain the resilient soft tissue material to the implant lab analogs prior to pouring the impression.

Laboratory components are similarly available for the OSSEOTITE® Implant System (Table 2.31).

**TABLE 2.31.** Catalogue Numbers for Laboratory Components for the OSSEOTITE® Implant System

| Description | Implant Restorative Platform 3.4 mm | Implant Restorative Platform 4.1 mm | Implant Restorative Platform 5.0 mm | Implant Restorative Platform 6.0 mm |
|---|---|---|---|---|
| Laboratory Analog | MMILA | ILA20 | ILAW5 | ILAW6 |
| Laboratory Holder | LTAH5 | LTAH7 | LTAH7 | LTAH7 |
| Laboratory Try In Screw | UNITS | UNITS | UNITS | UNITS |

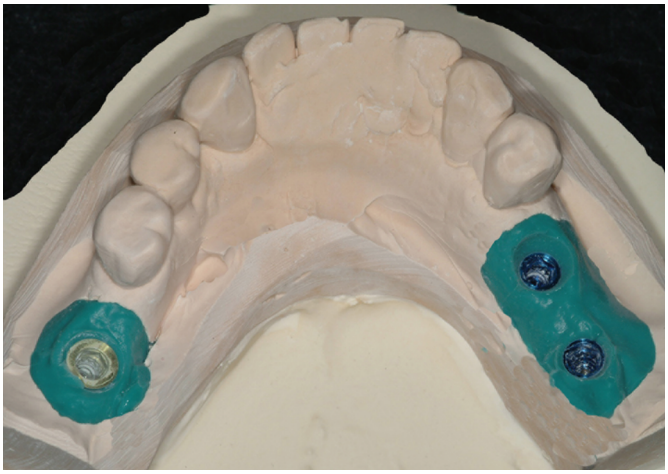

**Figure 2.107.** Laboratory occlusal view of the master cast from Figures 2.105 and 2.106. The implant analogs have been placed accurately within the master cast in preparation for fabrication of abutments and cement-retained crowns.

**Figure 2.108.** Standard Abutment Laboratory Analog (SLA20).

**Figure 2.109.** IOL® Laboratory Analog (IOLLAS).

### *Abutment Analogs*

Abutment analogs are exact replicas of implant abutments and have to be manufactured to the same high degree of accuracy as implant analogs (Figures 2.108, 2.109, 2.110). Abutment analogs are not specific for internal connection and external hex implant systems in that abutment impression copings identify the location of abutments after they have been placed into the implants. Abutment analogs are generally unique for different implant manufacturers (Table 2.32).

### *Try-In Screws*

Laboratory and clinical try-in screws are available for use by dental laboratory technicians and clinicians for implant

**Figure 2.110.** LOCATOR® Abutment Analog (LALA1).

**TABLE 2.32.** Catalogue Numbers for *3i*® Abutment Laboratory Restorative Components

| Abutment Analog | Implant Restorative Platform 4.1 mm | Implant Restorative Platform 5.0 mm | Polishing Protectors |
|---|---|---|---|
| Standard Abutment | SLA20 | SLA20 | PPSA3 |
| IOL® Abutment | IOLLAS | N/A | IOLPP |
| LOCATOR® Abutment | LALA1 | N/A | N/A |

**Figure 2.111.** Try-In Screw (IUNITS) for OSSEOTITE® Certain® Implant System.

**Figure 2.113.** Abutment Holder (ILTAH7) for the OSSEOTITE® Certain® Implant System.

**Figure 2.112.** Try-In Screw (UNITS) for OSSEOTITE® Implant System.

level laboratory and clinical procedures, respectively (Figures 2.111, 2.112). The tops of the screws are either hexed for the internal connection system or square for use with the external hex implant connection system. This feature allows clinicians to use one type of driver during the clinical appointments because the heads of the try-in screws match the heads of the definitive abutment screws.

### *Abutment Holders*

Laboratory abutment holders are instruments that provide predictable retention of abutments for extra-oral preparation and polishing procedures. They are available for both of *3i*®'s internal connection and external hex implant systems (Figure 2.113). Dental laboratory technicians and clinicians may securely attach abutments to the holders with try-in screws and be confident that the abutments will remain in place during their procedures (Figures 2.114, 2.115, 2.116). This protocol optimizes clinical chair time because the bulk of the preparation can be accomplished outside the mouth or in the laboratory. This minimizes the need for extensive clinical preparation, is less likely to result in trauma to the peri-implant soft tissue, and is more easily tolerated by patients.

**Figure 2.114.** GingiHue® Post (WPP564G), as received from the manufacturer, in place on laboratory abutment holder (LTAH7). Note that in spite of the differences between the restorative platforms (the size of the external hex is consistent within the OSSEOTITE® Implant System), a 5 mm diameter abutment fits onto the laboratory abutment holder.

**Figure 2.115.** The abutment in Figure 2.114 was prepared on the abutment holder and was now ready to be transferred to the implant.

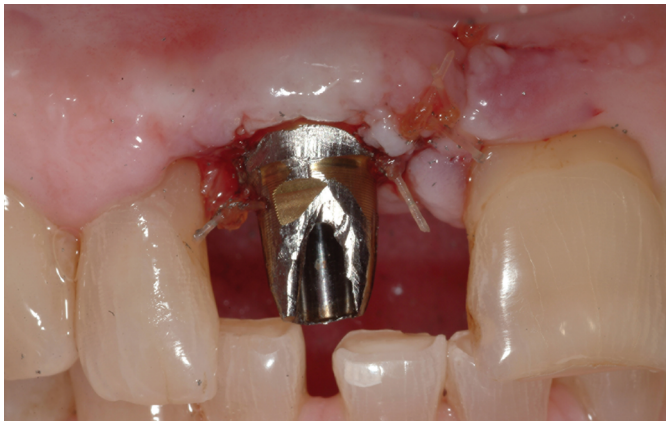

**Figure 2.116.** GingiHue® Post in place on the implant prior to fabrication of the provisional crown at the time the implant was uncovered.

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# Chapter 6: Re-Treatment of a Fractured Implant Fixed Partial Denture in the Posterior Maxilla with CAD/CAM Abutments and a New Fixed Partial Denture

## LITERATURE REVIEW

Dental implant restorations placed in the 1980s had challenges associated with the biology of osseointegration, as well as biomechanics of prosthesis survival (Adell and others 1981; Kallus and Bessing 1994). Implant prostheses were designed with screw retention to facilitate removal and repair, while sacrificing aesthetics and occlusion (Zarb and Schmitt 1990).

As the treatment modality changed from edentulous patients to include partially edentulous patients, there were reports of prosthetic complications that could have a negative impact on overall success rates in implant treatment. Zarb and Schmitt (1990) reported on 274 implants placed in 46 consecutive patients who were followed for up to nine years. The success rate for the implants was 89.05%; the success rate for the prosthetic treatment was 100%. They recorded complications and problems during the surgical, restorative, and follow-up phases of treatment. Zarb and Schmitt concluded that safe retrievable techniques would result in negligible morbidity.

Hemmings and others (1994) studied and compared the maintenance requirements for fixed prostheses and overdentures in edentulous mandibles. Post insertion adjustments were more common in the first year in the overdenture population, but thereafter, the fixed prostheses had more complications and required more maintenance. The average number of recalls for the first year was 2.27 and 1.57, respectively.

Attard and Zarb (2002) reported on the long-term success of implant-supported posterior zone prostheses in the first 35 consecutive, partially edentulous patients treated at the University of Toronto. They reported that the overall survival of the posterior implants was 94%. They concluded that Brånemark dental implants were highly effective in the rehabilitation of partially edentulous patients missing multiple posterior teeth.

The hexagonal extension on the coronal aspect of external hex implants was originally designed as a rotational torque transfer mechanism used during the surgical placement of implants. With the initiation of single unit implant restorations, the external hex was used as an anti-rotation component (Beaty 1994) (Figures 6.1 and 6.2). The precision fit between implants and abutments is one of the key elements in long-term prosthetic success of implant restorations. (Jemt 1986; Asavant and others, 1988). Binon (1995) contended that if the rotation between implants and abutments can be minimized, more stable and predictable screw joints will result and rotation of less than 5° is desirable for implant joint stability.


**Figure 6.1.** Occlusal view of 4.1 mm and 5.0 mm implant restorative platforms (left, right, respectively) that identifies the flat-to-flat surface configurations at 2.7 mm.

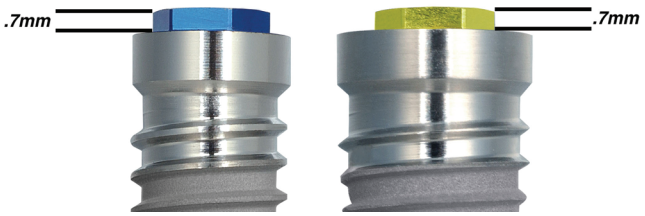


**Figure 6.2.** Profile view of 4.1 mm and 5.0 mm diameter implants that identifies the hexagonal height of 0.7 mm for both implants.

The implant/abutment interface determines joint strength, stability, and lateral/rotational stability. As implant design evolved, so did implant/abutment connections. One of the first internally hexed implant/abutment designs incorporated a 1.7 mm deep hex below a 0.5 mm wide, 45° bevel (Niznick 1983). Internal connection implants were intended to distribute masticatory forces deeper within implants, which would protect the abutment screw from excessive loading forces. For increased strength, internal connection implants were made from titanium alloy instead of commercially pure titanium, which provided superior strength to the implant/abutment connection (Norton 2000; Mollersten and others 1998).

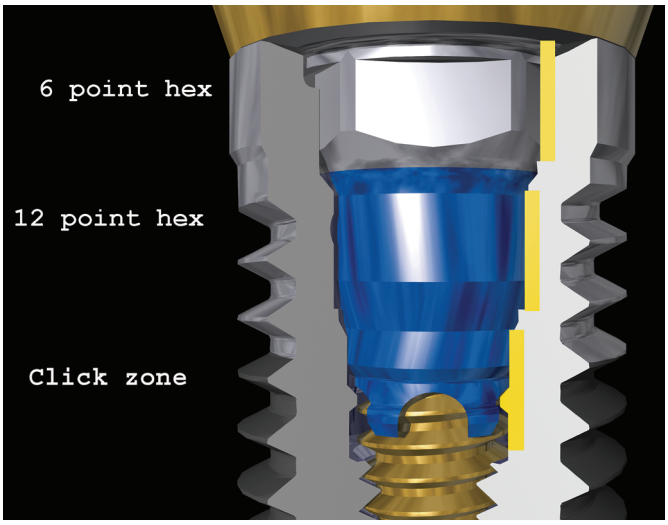


**Figure 6.3.** Cross sectional view of ***3i***®'s internal connection implant/abutment connection. There are three distinct zones within the implant/abutment connection: the occlusal most portion is specific for a 6-point hex; the middle portion for a 12-point hex; the lower portion for the audible "click" with complete insertion of the restorative component.

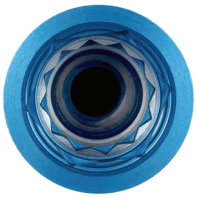

**Figure 6.4.** An occlusal view of the 6/12 point connection of ***3i***®'s internal connection implant.

There have been further design changes in attempts to improve stability and predictability of the implant/abutment interface. The design changes have included variations in joint designs, or the numbers of hexes present within the connection system (Sutter and others 1993; Perriard and others 2002).

Implant Innovations, Inc.® introduced their internal connection implant (OSSEOTITE® Certain®) in 2003 (Figures 6.3, 6.4). This internal connection provides 4 mm of internal engagement that provides lateral stability for off-axis masticatory forces (Niznick 1991; Norton 2000; Mollersten 1997). Mollersten and others (1997) performed a laboratory study in which they studied the depths of the joints in implant/abutment connections and found that the strength and failure modes varied significantly between the implant systems and deep joints, in contrast to shallow joints. They concluded that joint depth should be one of the considerations that should be taken into account in selecting predictable dental implant systems.

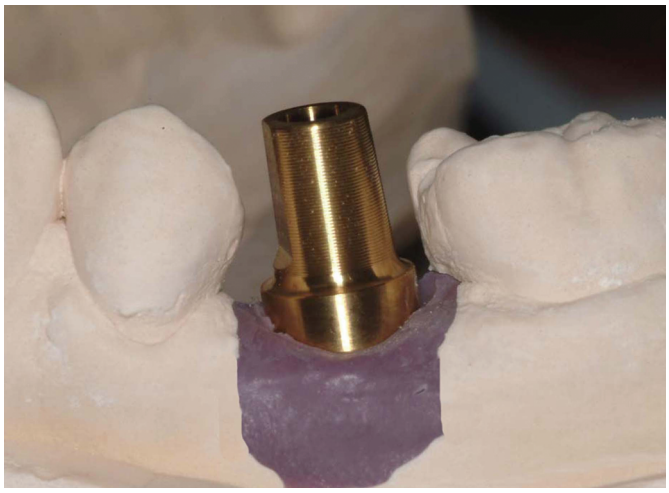

**Figure 6.5.** GingiHue® Post (IAPP454G) as received from the manufacturer in place.

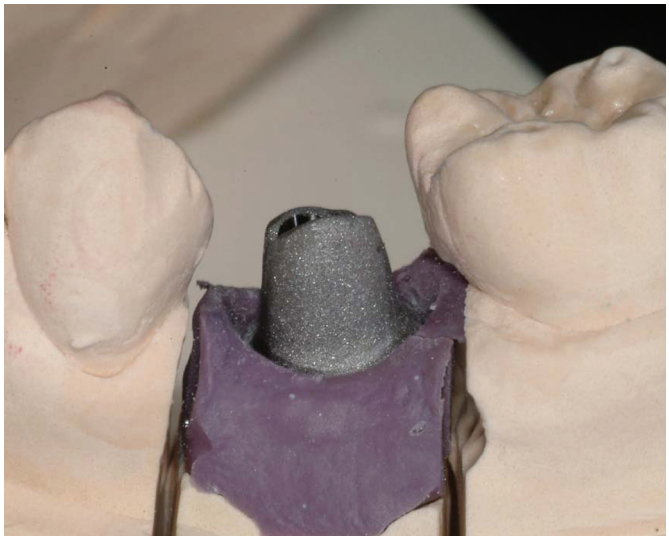

**Figure 6.6.** The above GingiHue® Post after it was prepared by a dental laboratory technician for use as an abutment for a cement-retained crown.

The height of the abutment screw is only 1.95 mm from the top of the screw to the seating surface. This allows greater flexibility in the amount of abutment preparation without risk of damaging the head of the screw (Figures 6.5, 6.6).

This internal connection system incorporates a 6-point hex design for use with straight abutments and a 12-point, double hex design for use with pre-angled abutments. Stock abutments are less expensive than custom abutments and therefore result in decreased costs for restorative dentists.

Abutment screws with ***3i***®'s internal connection have to be torqued only to 20 Ncm. Rodkey (1977) discussed that the type of finish present on abutment screws can have a considerable effect on the tension induced by a given torque.

**Figure 6.7.** Profile view of a Gold-Tite™ hexed abutment screw for *3i®*'s internal connection implant.

**Figure 6.8.** Occlusal view of an Encode™ Healing Abutment with a 5 mm emergence profile.

Sakaguchi and Borgersen (1995) reported that the actual preload developed within a screw joint system is dependent upon the finish of the interfaces, friction between the components, geometry, and properties of the materials in the system. Martin and others (2001) performed an extensive laboratory study in which they tested four commercially available abutment screws and their ability to generate preloads in dental implant (external hex)/abutment connections. The greatest preload values were calculated for Gold-Tite™ abutment screws at 20 and 32 Ncm levels. Enhanced screw surfaces were shown to generate less friction between screws and implants than non-enhanced screws (Figure 6.7).

CAD/CAM technology is an exciting new method for producing implant restorations for single, multiple, and full arch restorations. The protocol involves generating digital information relative to implant analogs, adjacent and opposing teeth, and the contours of the planned restoration in a computer. The information may be obtained with images or tactile probes. With the Encode™ Restorative System (***3i®,*** Palm Beach Gardens, FL), special healing abutments (Figure 6.8) are scanned and via a sophisticated computer software program, patient specific abutments are developed (Figure 6.9). This information is sent to a milling machine and abutments are milled from blanks of titanium alloy (Figure 6.10).

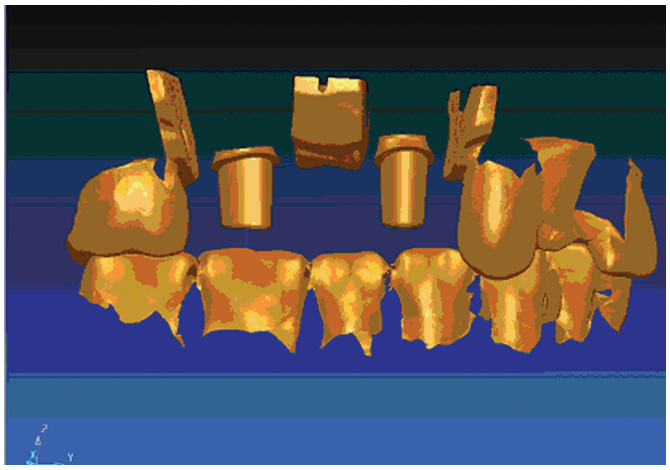

**Figure 6.9.** CAD/CAM design of two abutments for a 3-unit FPD.

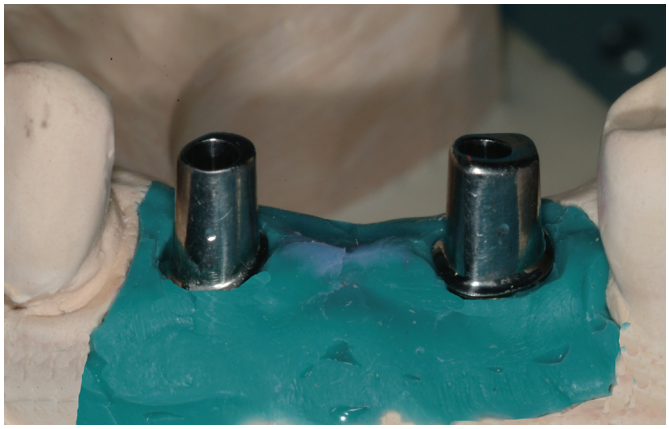

**Figure 6.10.** Facial laboratory view of two Encode Abutments on a master cast.

Milled titanium abutments fabricated with CAD/CAM technology provide clinicians and dental laboratory technicians significant advantages over custom cast abutments made with conventional casting technology. Waxing, casting, and finishing procedures associated with conventional cast abutments have been eliminated. Generally speaking, there are significant time savings with this process because the commercial dental laboratory will have to provide only the definitive porcelain fused to metal crown for implant restoration. This system actually has decreased the overall costs of implant treatment for laboratories, restorative dentists, and patients. There are clinical reports concerning this technology, but it should be noted that no laboratory studies on the precision of fit with this system have been published (Drago 2005).

The following clinical case presentation illustrates the use of CAD/CAM custom abutments and a 3-unit fixed partial denture to replace a screw-retained 3-unit FPD that failed after 10 years of function.

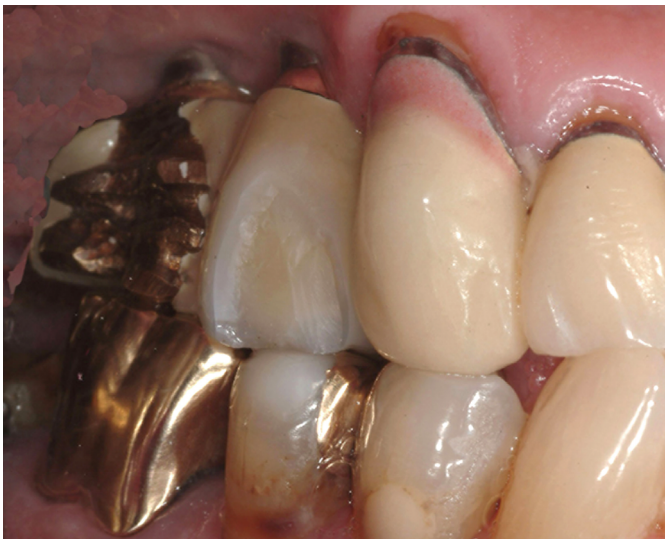

**Figure 6.11.** Pre-operative clinical appearance of the fractured implant-retained 3-unit fixed partial denture.

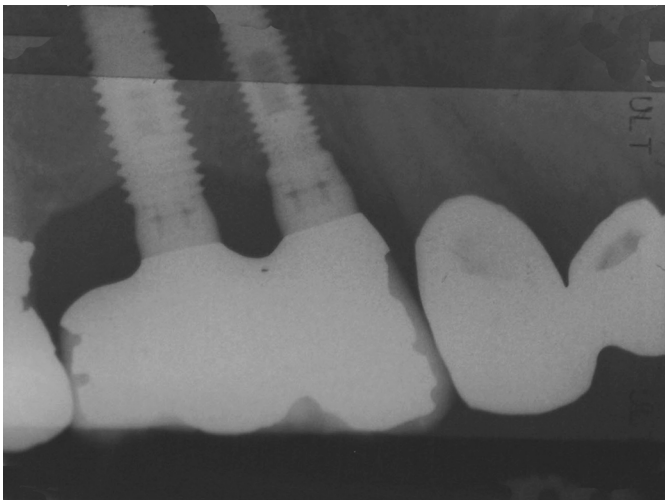

**Figure 6.12.** Pre-operative radiograph that demonstrated approximately 1–2 mm of bone loss around the osseointegrated implants in the right posterior maxilla.

## CLINICAL CASE PRESENTATION

### *Appointment 1. Initial Examination (3/4 Hour)*

A 62-year-old man presented to the author with a chief complaint: "I have a broken bridge" (Figure 6.11). His history included placement of two 4.1 mm diameter implants (external hex) approximately 10 years previous to this first visit. The implants had been placed by an oral surgeon and restored by a general dentist in Iowa. The patient had retired to LaCrosse, Wisconsin. The aesthetic veneer material had fractured. The patient was not sure which implant components had been placed (Figure 6.12).

The physical examination revealed an end-to-end occlusion, Type I gingivitis, a normal range of motion, and a dentition in good repair. The implant-retained fixed partial denture was screw-retained and appeared to be consistent with the original Brånemark implant system.

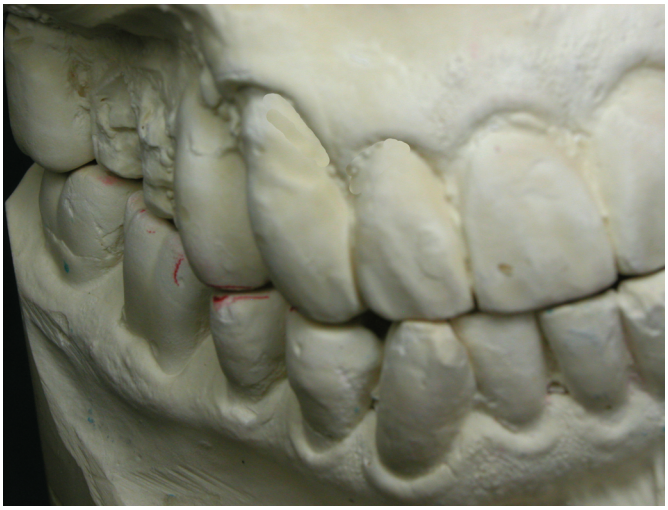

**Figure 6.13.** Diagnostic casts mounted in centric occlusion demonstrated an end-to-end occlusion. This occlusal relationship was probably implicated in the fracture of the aesthetic veneer material.

#### Diagnostic Casts

Diagnostic casts were made from alginate impressions (Figure 6.13). They were mounted in centric occlusion and the occlusal relationships were evaluated in preparation for a new fixed partial denture.

#### Diagnosis

The following diagnoses were developed:

1. Fractured aesthetic veneer, 3-unit fixed partial denture replacing teeth numbers 3–5
2. 4.1 mm diameter, external hex, osseointegrated implants, maxillary right posterior quadrant
3. Class III malocclusion with end-to-end occlusion, right posterior quadrants, minimal anterior guidance
4. Chronic, moderate gingivitis

This patient's condition was classified as patient type Class II per the American College of Prosthodontist's Classification system: moderately compromised based on the skeletal and dental malocclusion, missing three or fewer teeth in a given quadrant, and minimal periodontal involvement (McGarry and others 2002).

**TABLE 6.1.** Treatment Plan #1 (Implant Restoration)

**Diagnosis: Fractured, pre-existing implant-retained fixed partial denture**

| Restorative Services | ADA # | Fee |
|---|---|---|
| Comprehensive oral evaluation | D0150 | |
| Diagnostic casts | D0470 | |
| Panoramic radiograph | D0330 | |
| Removal of preexisting FPD and abutments<br>Assessment of implant position<br>Assessment of peri-implant contours | D9999 | |
| Implant level impression and fabrication of master cast<br>Articulator mounting | | |
| Abutment selection | | |
| If implants are in optimal positions,<br>Stock abutments | D6056 | |
| If implants are not in optimal positions<br>Custom abutments | D6057 | |
| 3-unit implant-retained FPD<br>#3 Porcelain fused to noble alloy pontic | D6240 | |
| #4 Abutment supported porcelain fused<br>To metal crown (noble metal) | D6061 | |
| #5 Abutment supported porcelain fused<br>To metal crown (noble metal) | D6061 | |
| Yearly recall appointment | D0120 | |
| Periapical radiograph | D0220 | |

**Benefits of Treatment Plan #1**

The fractured, preexisting bridge will be replaced with a fixed prosthesis that will not be removable by the patient. The patient should enjoy improved aesthetics and function on a long-term basis. The malocclusion will be made optimal.

**Limitations of Treatment Plan #1**

Cost, complexity, and length of treatment (1–2 months). The basic malocclusion will remain. The preexisting implant prosthesis will have to be remade. There is a chance that the new prosthesis may fracture due to the malocclusion and alignment of the implants. The patient will continue to need to use additional techniques (floss threader) for hygiene procedures around the implant abutments and prosthesis. The patient needs to return to this office at least once per year for follow-up, which will include radiographs (x-rays) to assess osseointegration of the implants, status of the occlusion, health of the soft tissues, and the integrity of the implant/abutment connections.

Patient signature _____

Date _____

Witness _____

Date _____

ADA #'s, CDT 2005 Current Dental Terminology, Council on Dental Benefit Programs, American Dental Association, 211 East Chicago Avenue, Chicago, IL 60611

**TABLE 6.2.** Treatment Plan #2 (No Treatment)

**Diagnosis: Fractured, preexisting implant-retained fixed partial denture**

| Restorative Services | ADA # | Fee |
|---|---|---|
| Comprehensive oral evaluation | D0150 | |
| Diagnostic casts | D0470 | |
| Panoramic radiograph | D0330 | |

**Benefits of Treatment Plan #2**
No additional expenses will be incurred for a new prosthesis.

**Limitations of Treatment Plan #2**
The preexisting prosthesis may continue to fracture with potential damage to the implant/abutment connections and/or the abutment and/or retaining screws. The aesthetic and possibly the functional results may be adversely affected, including but not limited to loosening of implant screws, uneven wear of some or all of the components, and fracture of implants or restorative components. If there are fractures of the restorative and/or implant components, the situation may not be fixable without additional surgery to remove or replace an implant(s).

Patient signature _____
Date _____
Witness _____
Date _____

ADA #'s, CDT 2005 Current Dental Terminology, Council on Dental Benefit Programs, American Dental Association, 211 East Chicago Avenue, Chicago, IL 60611

### *Appointment 2. Consultation Restorative Dentist/Patient (1/2 Hour)*

A definitive consultation appointment was scheduled as the patient left the office from the first visit. The time between the first and second appointments allowed the author to contact the oral surgeon who placed the implants and identify the type and size of the implants. It also allowed for development of the treatment options for this particular patient.

#### Treatment Options

The first treatment option involved removing the preexisting fixed partial denture and assessing the condition of the soft tissues surrounding the abutments, as well as identifying the three-dimensional location of the implants relative to the positions of the adjacent and opposing teeth (Table 6.1). The second treatment option described an option for which the patient elected not to proceed with treatment (Table 6.2).

Benefits and limitations of each treatment option were described in detail on the written treatment plans. The prosthodontic fees, or ranges of fees for each procedure, were also listed on each treatment plan. The patient was given copies of the treatment plans. The patient agreed to proceed with the first treatment plan for making a new implant-retained fixed partial denture on new abutments.

#### Laboratory Procedures

After the patient decided to proceed with treatment, several tasks had to be performed in anticipation of the prosthetic treatment.

#### Custom Impression Tray

The author prefers to use a pick-up impression technique. This warrants an impression tray with a window that provides access to the impression coping screws (Figure 6.14).

The implant surgeon had provided the author with the size and type of implants placed (4.1 mm diameter, external hex Brånemark implants). In order to make a prosthesis with optimal emergence profiles, implant level impressions with impression copings of the proper emergence profiles needed to be selected and on hand for the impression appointment. Because the missing teeth were premolars and the preexisting prosthesis replicated the anatomy of the missing teeth, implant impression copings for 4.1 mm

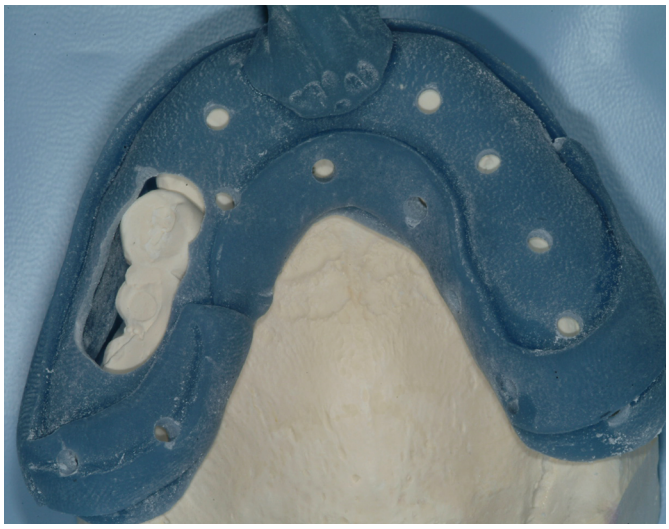

**Figure 6.14.** Laboratory occlusal view of open face custom impression tray in place on the maxillary diagnostic cast.

**Figure 6.15.** Implant impression coping with 4.1 mm restorative platform and 5 mm emergence profile (IIC12).

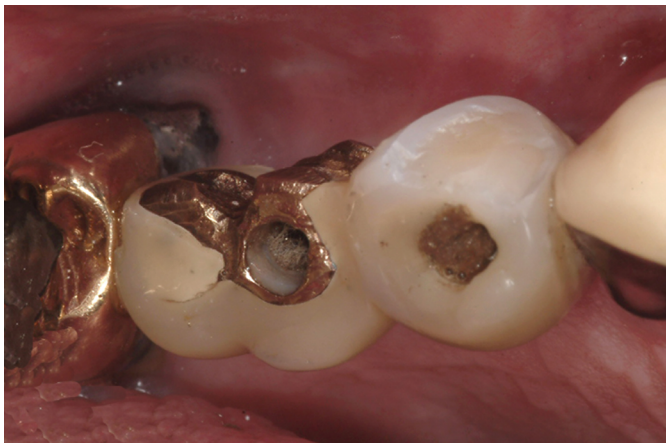

**Figure 6.16.** Occlusal view of preexisting 3-unit FPD.

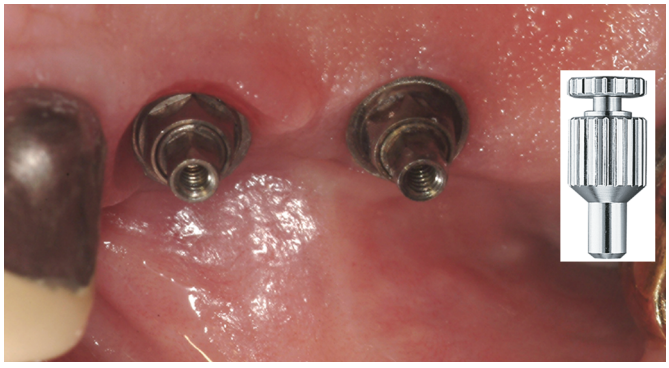

**Figure 6.17.** Palatal/occlusal view of conical abutments in place after the prosthesis in Figure 6.16 was removed. Abutment driver inset (PAD00).

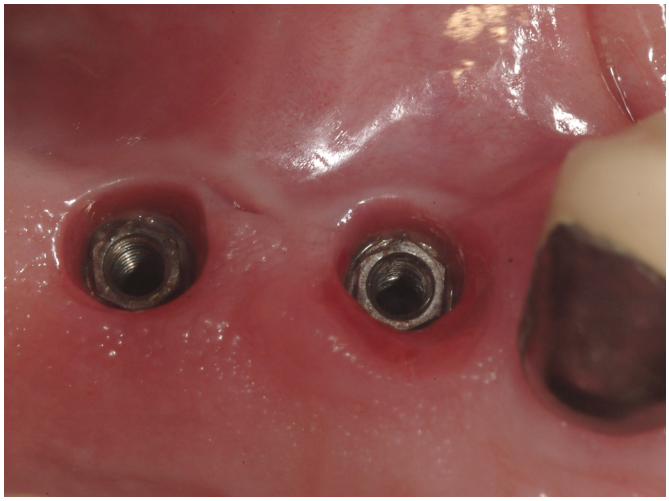

**Figure 6.18.** Implant restorative platforms (4.1 mm diameter) were completely exposed after removal of the conical abutments.

restorative platforms and 5 mm emergence profiles were preselected (IIC12) (Figure 6.15).

### *Appointment 3. Removal of Existing Prosthesis/Abutments; Implant Impression (1 Hour)*

The pre-existing FPD was removed with a slotted driver (Figure 6.16). The two conical abutments were visualized (SCA003) and were removed with a conical abutment driver (PAD00) (Figure 6.17). The 4.1 mm implant restorative platforms were completely exposed (Figure 6.18).

#### Implant Level Impression

Implant impression copings (IIC12) were placed onto the external hexes of the implants. The screws were tightened with the posterior large hex driver (PHD02N). The definitive

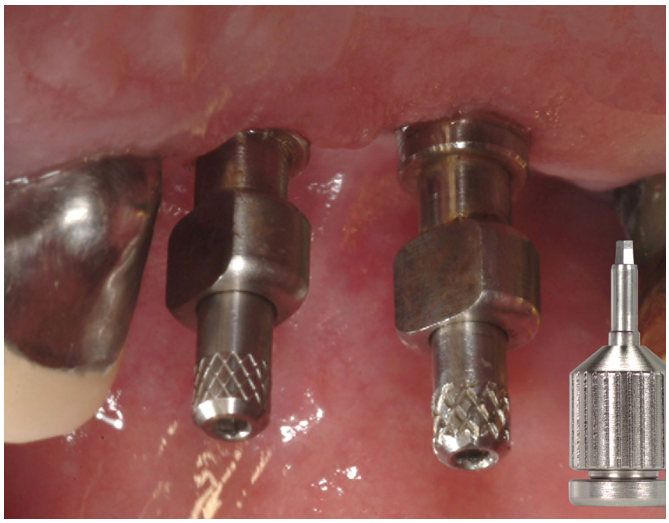

**Figure 6.19.** Palatal view of pick up implant impression copings in place. Large hex posterior driver (PHD02N) inset.

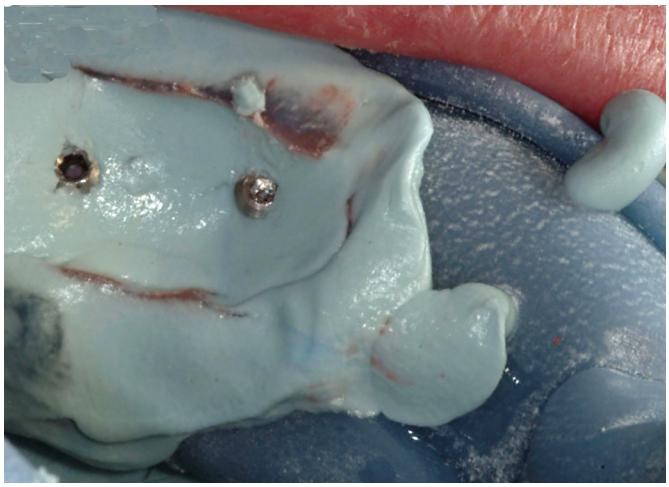

**Figure 6.20.** An open face tray was used for the pick-up impression technique. The window provided access to the impression coping screws, which had to be loosened prior to removal of the impression with PHD02N.

impression was made with injection and putty vinyl polysiloxane impression material (Figures 6.19 and 6.20).

### Laboratory Procedures/Work Orders

#### *Fabrication of Master Cast (Implant Analogs)*

After the impression material polymerized, the impression coping screws were unscrewed with the large posterior hex driver (PHDO2N) and the impression was removed. The pick up implant impression copings remained inside the impression (Figure 6.21). Implant lab analogs for 4.1 mm diameter external hex implants were selected, attached to the apical surfaces of the pick-up implant impression copings, and screwed into place from the occlusal aspect of the impression tray (Figures 6.22, 6.23).

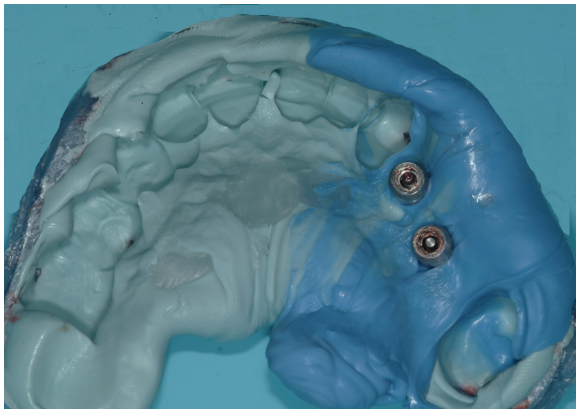

**Figure 6.21.** The pick-up implant impression copings remained inside the definitive impression after the impression was removed from the mouth.

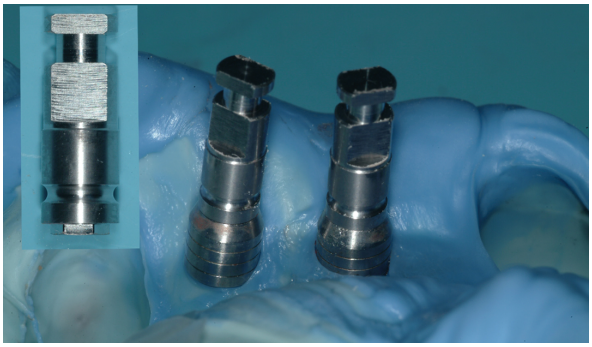

**Figure 6.22.** Implant lab analogs (ILA20), inset, were attached to the apical surfaces of the pick up implant impression copings. Metal-to-metal contact was visualized between the analogs and the impression copings.

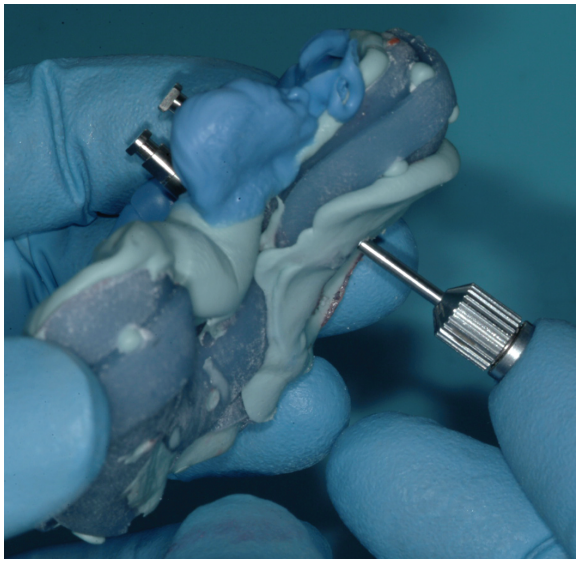

**Figure 6.23.** The PHD02N was used to screw the implant impression coping screws into the implant lab analogs. Care was taken not to over-tighten the screws because doing so may alter the positions of the impression copings within the impression.

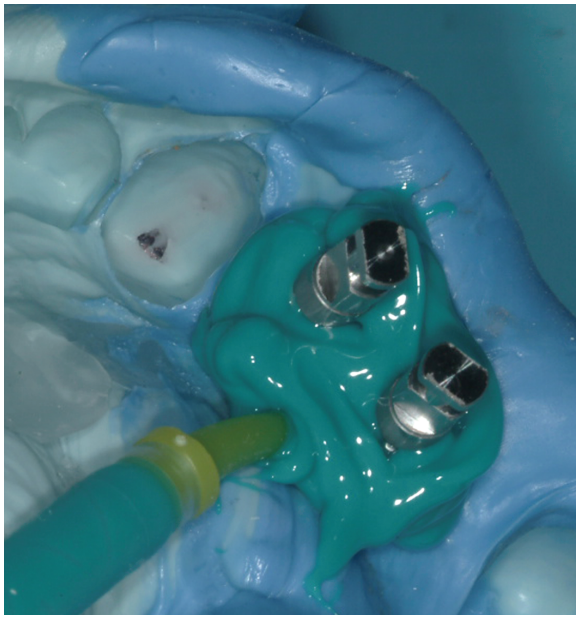

**Figure 6.24.** Poly vinylsiloxane impression material was injected in and around the impression coping/implant analog connections.

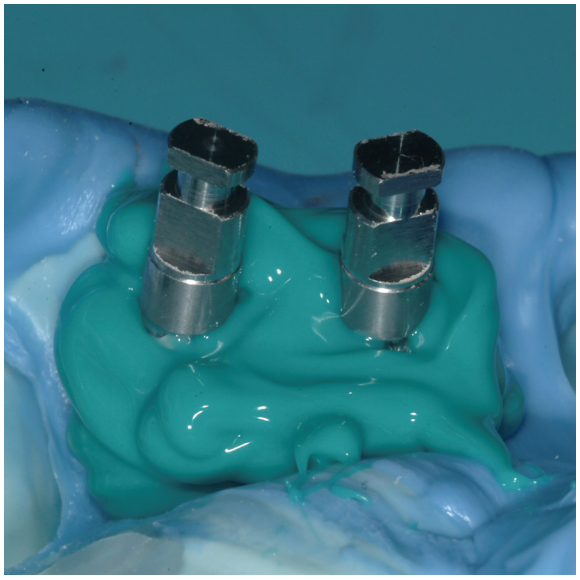

**Figure 6.25.** The impression was now ready to be poured in Type IV dental stone.

Because the implant restorative platforms were sub-gingival, the peri-implant soft tissues around the implant lab analogs in the master cast were made with a resilient material. In this case, a separator was placed around the impression copings/implant analogs prior to injecting poly vinylsiloxane impression material in and around the implant analog/impression coping connections (Figure 6.24, 6.25). Care was taken not to allow any of the impression material into the interproximal contact areas. The impression was now ready to be poured in Type IV dental stone to fabricate the master cast (Figure 6.26).

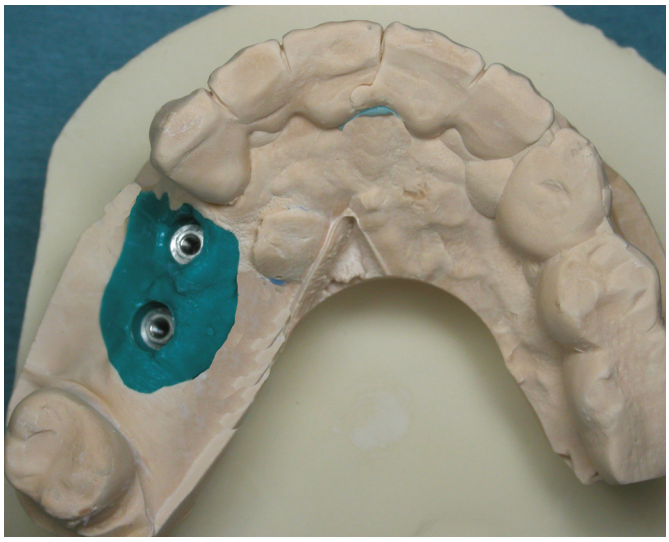

**Figure 6.26.** Occlusal view of the master cast with implant analogs in place.

**TABLE 6.3.** Laboratory Work Order for Fabrication of a Master Cast from an Implant Level Impression

Patient name _____
Doctor name _____
Doctor address _____
Phone number _____
Date _____

Treatment: Two custom abutments (Encode Abutments), 3-unit fixed partial denture (#3 is a pontic)

1. Enclosed is a poly vinylsiloxane implant impression for teeth #'s 3, 4, and 5.
2. The impression copings have 5 mm emergence profiles for 4.1 mm implant restorative platforms (external hex).
3. Place lab analogs (***3i***® ILA20) onto the impression copings.
4. Please make sure that you see metal-to-metal contact between the copings and the analogs.
5. Inject a resilient material around the impression coping/implant analog connections. Take care not to let any soft material into any interproximal contact areas.
6. Pour in Type IV die stone per the manufacturer's instructions.
7. Allow to set.
8. Pin, section as needed.
9. Mount on Stratos 100 articulator in preparation for fabrication of Encode Abutments and 3-unit FPD.

The preceding procedures describe fabrication of a master cast in the dental office. A laboratory work order for the above procedures is illustrated in Table 6.3.

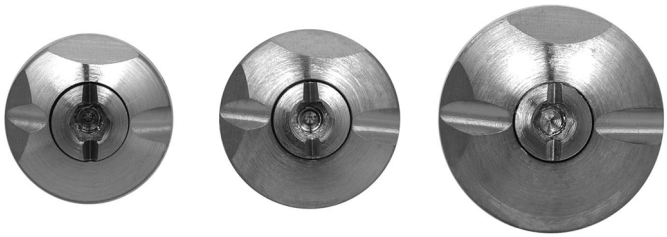

**Figure 6.28.** Encode Healing Abutments: 5 mm, 6 mm, 7.5 mm, left to right. (EHA454, EHA464, EHA474, respectively).

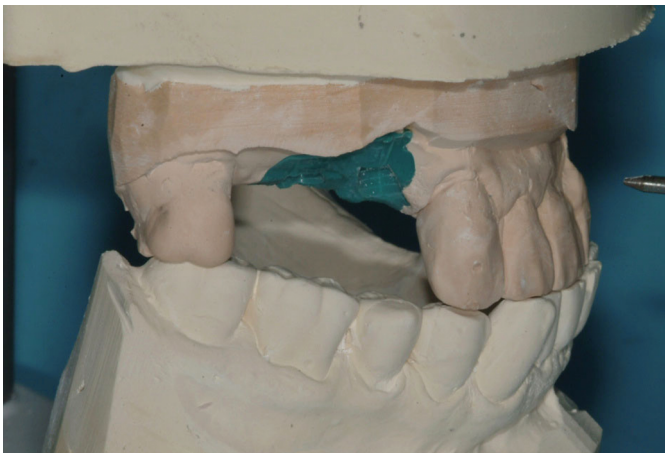

**Figure 6.27.** Maxillary master cast and mandibular cast were mounted on a semi-adjustable articulator in preparation for fabrication of the CAD/CAM abutments and definitive 3-unit FPD.

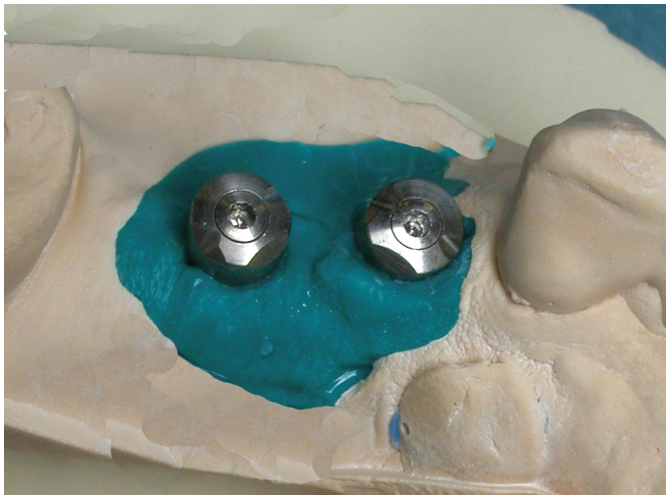

**Figure 6.29.** Encode Healing Abutments in place on master cast (EHA454).

A centric occlusal jaw relation record was made with Blu Mousse (Parkell Bio-Materials Division, Farmingdale, NY). Shades were selected and the casts were mounted on a Stratos 100 articulator (***3i***® Package, Ivoclar Vivadent, Inc., Technical Division, Amherst, NY) (Figure 6.27).

The preexisting abutments were placed back onto the implants along with the preexisting 3-unit FPD, and the patient was discharged.

### CAD/CAM Protocol

The CAD/CAM protocol for The Encode™ Restorative System is predicated on a digital scan of Encode™ Healing Abutments. These special healing abutments have codes embedded into their occlusal surfaces, and these codes provide the information required for the ideal anatomical design of final Encode Abutments (Figure 6.28).

In this case, the contours of the preexisting abutments were similar to 5 mm emergence profiles. Therefore, Encode Healing Abutments (EHA454) emergence profiles and 4 mm collar heights were placed onto the implant lab analogs in the master cast (Figure 6.29). The occlusal surfaces of Encode Healing Abutments must be supragingival to enable the scanner to accurately scan all of the codes within the occlusal surfaces.

The base of the cast was soaked in slurry water and an alginate impression was made. This cast was poured in Type IV die stone (GC FujiRock® EP Golden Brown, GC Europe, Leuven, Belgium) (Figure 6.30). This cast was pinned per conventional fixed prosthodontic protocols and sectioned. The gingival margins were not trimmed, because the scanner needs to identify the location of the gingival margins in conjunction with abutment margin design (Table 6.4).

**Figure 6.30.** Occlusal view of die stone cast of Encode Healing Abutments.

**TABLE 6.4.** Laboratory Work Order for Fabrication of a Master Cast for Encode Abutments

| | |
|---|---|
| Patient name | _____ |
| Doctor name | _____ |
| Doctor address | _____ |
| Phone number | _____ |
| Date | _____ |

Treatment: Two custom abutments (Encode Abutments), 3-unit fixed partial denture (#3 is a pontic)

1. Select 2 Encode Healing Abutments (IEHA454) and place them onto the implant lab analogs in the master cast.
2. Make sure that the occlusal surfaces of the Encode Healing Abutments are supra-gingival.
3. Make an alginate impression of the master cast.
4. Pour the alginate impression in FujiRock.
5. Mount this cast on a Stratos 100 articulator.
6. Complete the work order for two final Encode Abutments.
7. Send to ***3i***® ARCHITECH PSRY™, Palm Beach Gardens, FL.
8. Keep the master cast with the implant analogs in your laboratory for fabrication of the 3-unit FPD.

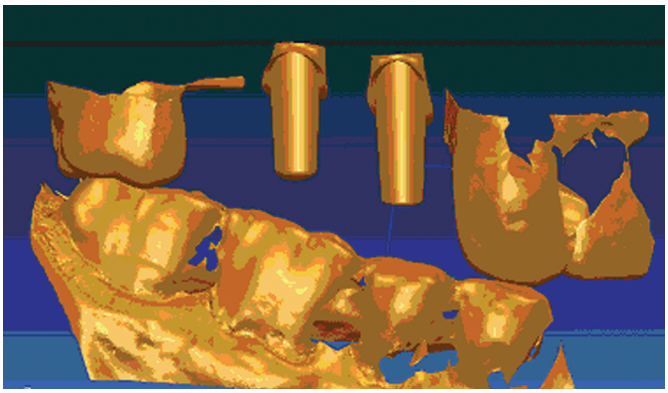

**Figure 6.31.** CAD design of abutments that will be used in conjunction with the planned 3-unit FPD.

### Articulator Mounting

This cast was mounted on the Stratos® 100 articulator in the same relationship as the original master cast (with implant analogs). A work order (Tables 6.5, 6.6) for final Encode Abutments was completed and, along with the casts, was sent to the ARCHITECH PSR™ Center in Palm Beach Gardens, FL.

### CAD Design of Abutments

Using sophisticated computer software programs, a dental laboratory technician designed the abutment contours for the 3-unit FPD. In this case, the facial margins were placed 1 mm sub-gingival, and the interproximal and palatal margins were placed at the gingival crest. The axial contours were designed with 6° taper and a common path of insertion; the occlusal surfaces were reduced for 2 mm inter-occlusal clearance. The emergence profiles were made consistent with the anatomic contours of maxillary premolars (Figure 6.31).

**TABLE 6.5.** Blank Work Order for Final Encode Abutments

ENCODE™ RESTORATIVE SYSTEM

# Work Order

## * 1. Account Information

* Lab Name: _____

***3i*** Account#: _____

* Contact: _____

* Phone: _____

Fax: _____

* Email: _____

* Patient ID: _____

* Ship To: _____

_____

Bill To: _____

_____

## * 2. Preparing Your Case For Shipment

- *Use only **yellow** die stone for the Encode Casts.*
- *Verify that all of the codes on each healing abutment are completely visible on the cast.*
- *Section and pin the Encode Die Cast **(Please do not trim the Encode Die).***
- *Mount casts on Adesso Split Plates Articulator **only** (Stratos® or Baumann) and verify the vertical pin is set at zero and meets the occlusal table.*
- *Following mounting on the designated articulator please include the following in the shipment to **3i**:*
  - ❑ Pinned & Sectioned Encode Die Cast
  - ❑ Opposing Cast
  - ❑ Copy of the Completed Work Order
- *All un-articulated or mis-articulated casts will be returned to the lab*
- *Please **do not** send the articulator*

## * 3. Case Information

| Tooth Position | Connection Type | | Gold Colored TiN** (Titanium Nitride) Yes or No |
|---|---|---|---|
| | Certain® | Ex-Hex | |
| | | | |
| | | | |
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| | | | |

** NOTE: TiN Coating will add two working days to the processing of your abutment. If a box is not checked the abutment will not be TiN coated.

## * 4. Design Guidelines

Margin Style – Select One
- ❑ Shoulder
- ❑ Chamfer (Default)

Interocclusal Distance: _____mm

***NOTE: Default on all margins = 1mm Subgingival***

Buccal Margin Location
- ❑ Subgingival _____mm
- ❑ Flush with Gingiva

Lingual Margin Location
- ❑ Subgingival _____mm
- ❑ Flush with Gingiva
- ❑ Supragingival _____mm

* REQUIRED FIELD

## 5. Contour Guidelines

*Please draw the approximate contour desired over the default images below. Note margin style. Please draw in tissue contour. (Minimum abutment height = 4mm and minimum collar height = .5mm)*

Buccal Interproximal

Anterior

Posterior

## 6. Special Instructions

❑ Polish entire abutment (Default)

❑ Only polish the subgingival collar

_____

_____

_____

❑ See back or attached page for additional instructions.

## 7. Screw Ordering

❑ I would not like to order screws at this time.

| External Hex Abutment Screws | Qty. |
|---|---|
| Gold-Tite™ Square (UNISG) | _____ |
| Gold-Tite Hexed (UNIHG) | _____ |
| Titanium Hexed (UNIHT) | _____ |
| Laboratory Square Try-in Screw - 5 pack (UNITS) | _____ |
| Microminiplant™ Square Try-in Screw - 5 pack (MUNITS) | _____ |

| Certain Abutment Screws | Qty. |
|---|---|
| Gold-Tite Hexed (IUNIHG) | _____ |
| Titanium Hexed (IUNIHT) | _____ |
| Laboratory Hexed Try-in Screw - 5 pack (IUNITS) | _____ |

## * 8. Certification — must be signed

I certify that the stated information is correct and that the submitted materials are accurate. All items that have contacted the oral environment have been disinfected. This form authorizes ***3i*** to fabricate the patient specific abutment(s) using and consistent with the information provided on this work order.

Technician Signature _____

Date _____

Internal Use Only

Job #: _____

Signature: _____

3i

Implant Innovations, Inc.
4555 Riverside Drive
Palm Beach Gardens, FL 33410
800.443.8166

ART881
REV E 10/05

**TABLE 6.6.** Work Order for Final Encode Abutments.

| Tooth Number | Connection Type | Gold Titanium Nitride |
|---|---|---|
| 4 | Ext hex | No |
| 5 | Ext hex | No |

**Figure 6.32.** External hex blank of titanium alloy prior to milling the CAD/CAM abutments.

**Figure 6.33.** The CAD/CAM abutments after milling. Square try-in screws (UNITS) were included for use during fabrication of the FPD and also for the clinical try-in appointment.

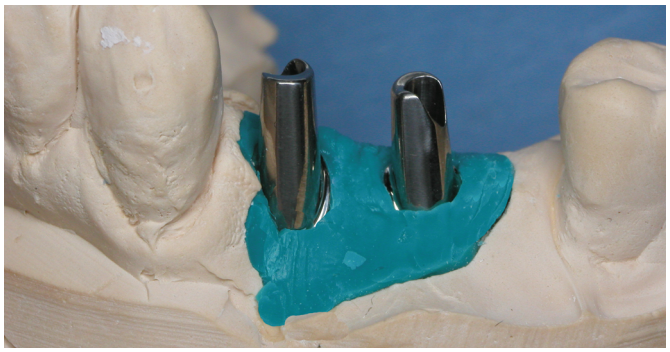

**Figure 6.34.** Laboratory facial view of the master cast with the 2 CAD/CAM abutments in place.

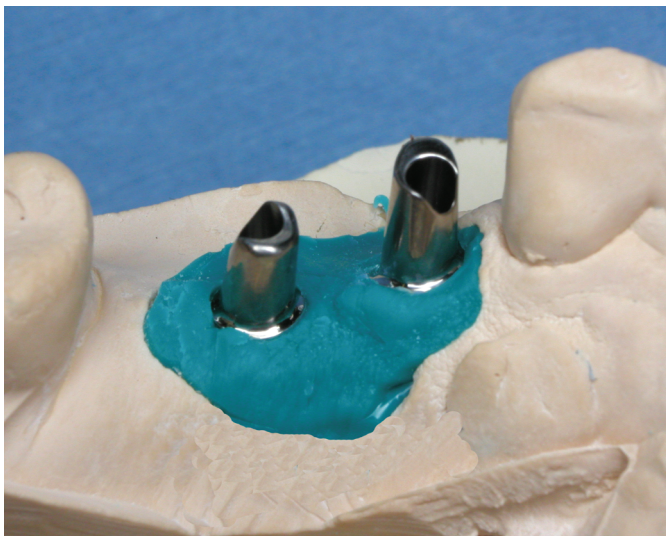

**Figure 6.35.** Laboratory palatal view of the master cast with the two CAD/CAM abutments in place.

### CAM Milling of Abutments

The abutments were milled from blanks of titanium alloy. These blanks were already pre-machined with the external hex implant/abutment connection (Gold Standard ZR™) (Figure 6.32). The abutments were milled to precise tolerances and shipped to the commercial dental laboratory for fabrication of the 3-unit FPD (Figure 6.33).

### Fabrication of 3-Unit Fixed Partial Denture

At the commercial dental laboratory, the final Encode Abutments were placed onto the implant lab analogs in the master cast (Figures 6.34 and 6.35). An abutment placement index was fabricated directly on the abutments while they were in their correct positions (Figures 6.36, 6.37, 6.38, 6.39).

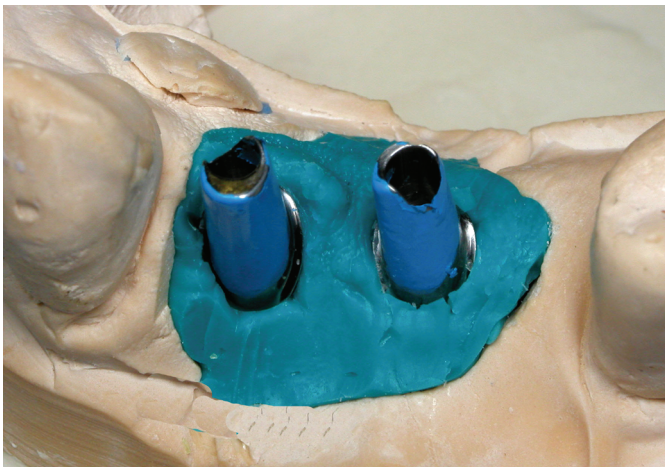

**Figure 6.36.** Two layers of die spacer were placed directly onto the abutments prior to waxing and fabricating the abutment placement index.

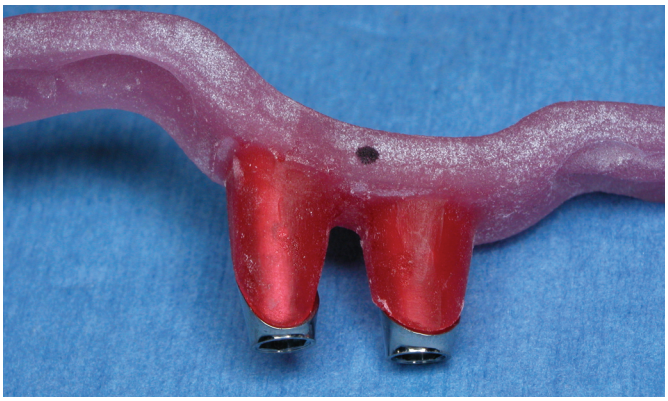

**Figure 6.39.** The abutments were contained within the abutment placement index. The index simplified insertion and removal of the abutments in the laboratory and intra-orally.

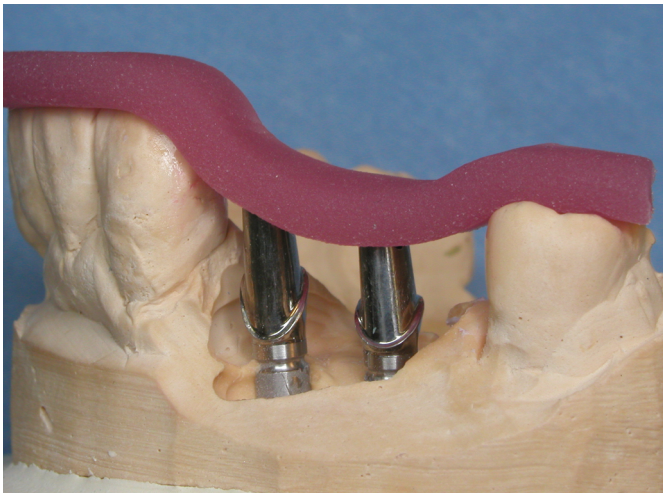

**Figure 6.37.** Light cured resin was adapted to the occlusal surfaces of the adjacent teeth, without engaging any undercuts. Autopolymerizing acrylic resin was used to make copings directly onto the abutments.

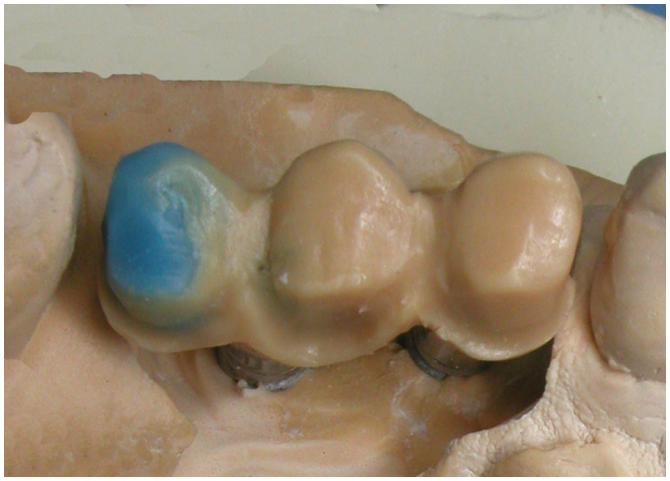

**Figure 6.40.** The wax pattern was waxed to full contour and cut back for porcelain.

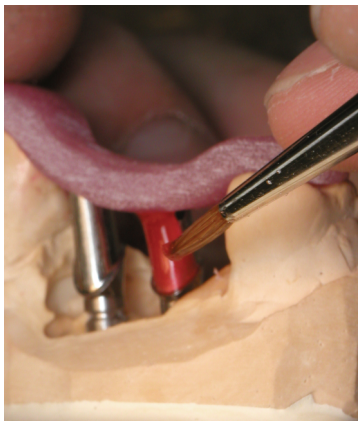

**Figure 6.38.** The resin copings were luted to the light cured resin strip for completion of the abutment placement index.

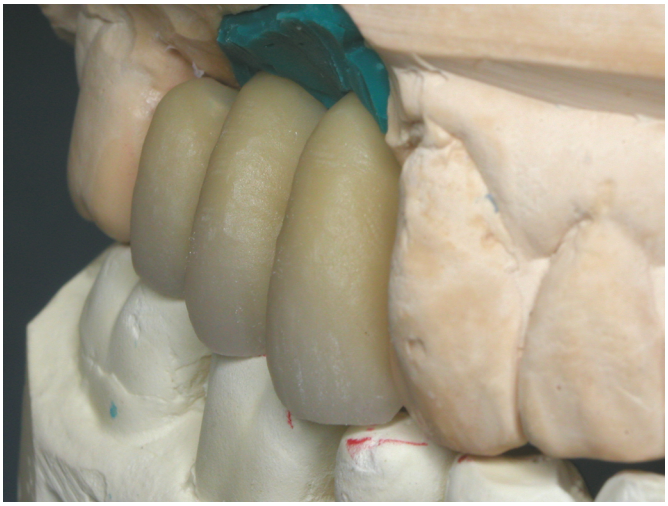

**Figure 6.41.** The 3-unit FPD was returned to the author for a clinical bisque bake try-in.

**TABLE 6.7.** Work Order for Fabrication of 3-Unit Fixed Partial Denture

Patient name _____

Doctor name _____

Doctor address _____

Phone number _____

Date _____

Treatment: Two custom abutments (Encode Abutments), 3-unit fixed partial denture (#'s 3 to 5; #3 is a pontic)

1. Master cast with implant analogs mounted on Stratos 100 articulator
2. Place Encode Abutments onto their respective analogs. Each abutment package is marked with the respective tooth number. Square try-in screws enclosed.
3. Place two layers of die spacer on each abutment within 1 mm of the abutment margins.
4. Wax the 3-unit fixed partial denture to full contour. #3 is a pontic. Diagnostic cast enclosed.
   a. Occlusion
      i. Develop a normal Class I buccal/lingual relationship between the prosthesis and the opposing mandibular teeth.
      ii. Right working occlusion to be Group Function occlusion.
      iii. Eliminate/minimize balancing interferences.
      iv. Narrow the buccal/lingual dimensions of the occlusal tables.
   b. Emergence Profiles
      i. The abutments have been contoured for optimal emergence profiles. The margins of the FPD should flow into the abutment contours without overhangs.
   c. Cut back for porcelain.
   d. Cast in gold noble alloy (IPS d.SIGN®91, Ivoclar Vivadent-Au 60%, Pd 30.6%, In 8.4%).
   e. Finish the casting
   f. Apply porcelain
   g. Return in bisque bake for try-in.

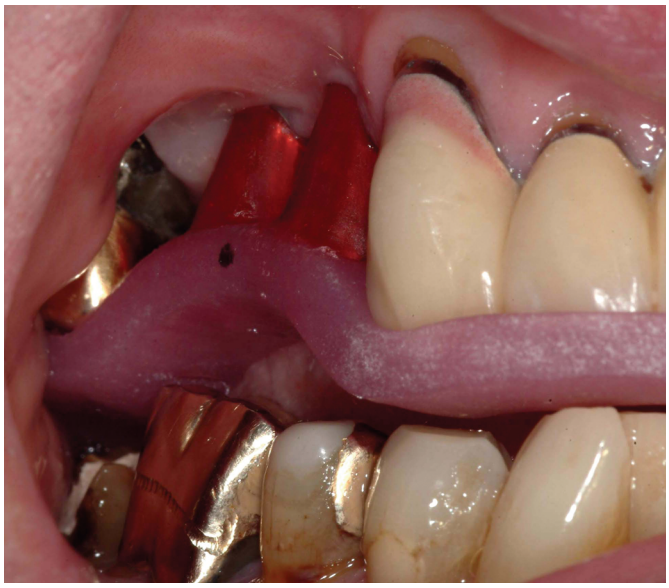

**Figure 6.42.** Abutment placement index in place. Abutments were contained within the index.

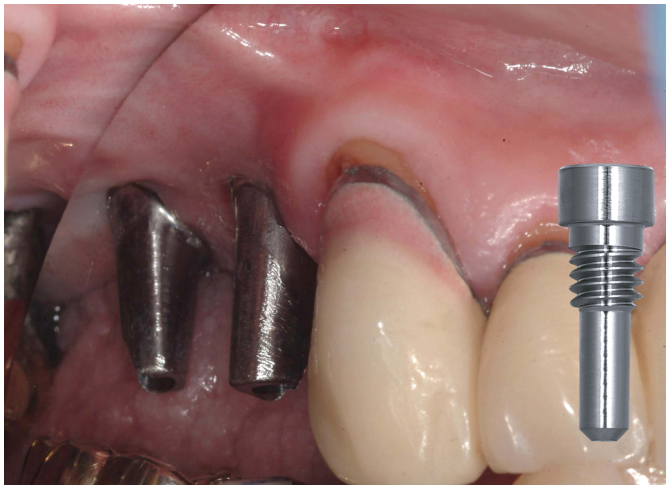

**Figure 6.43.** Square try-in screws were used to retain the abutments to the implants (UNITS, inset).

The 3-unit FPD was fabricated per the work order in Table 6.7. and was returned for a bisque bake try-in (Figures 6.40, 6.41).

## *Appointment 4. Bisque Bake Try-In (3/4 Hour)*

### Removal of Preexisting Prosthesis and Abutments

The patient returned for the fourth appointment. The preexisting FPD and abutments were removed.

### Try-In CAD/CAM Abutments

The Encode Abutments were tried in using the abutment placement index to facilitate abutment insertion (Figures 6.42, 6.43). Square try-in screws for external hex implants were used (UNITS).

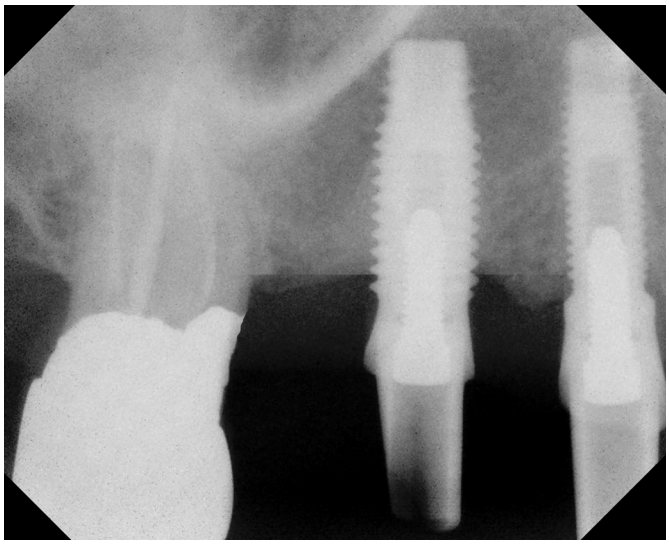

**Figure 6.44.** Periapical radiograph demonstrated an intimate metal-to-metal fit between the abutments and implants. The sub-gingival emergence profiles were fabricated by the CAD computer software program and milled by the CAM milling unit.

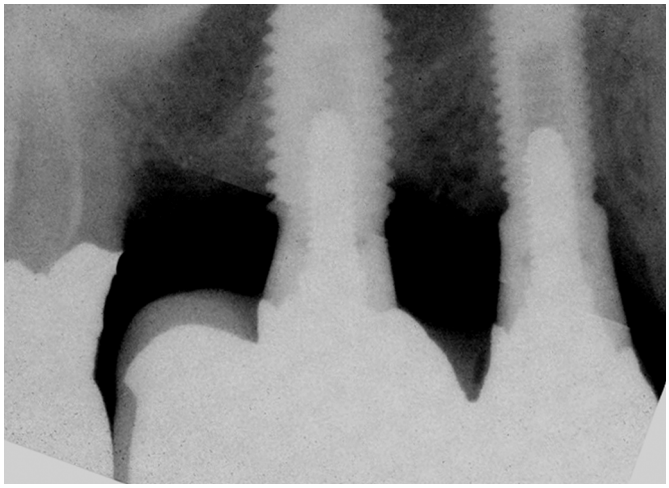

**Figure 6.45.** Periapical radiograph demonstrated metal-to-metal contact between the retainers of the FPD and the abutments.

### Verification Radiograph (Abutments)

A radiograph was taken to verify that the abutments were seated (Figure 6.44).

### Try-In Bisque Bake FPD

The 3-unit FPD was tried in by adjusting the interproximal contacts until floss could be passed between the prosthesis and the adjacent teeth easily.

### Verification Radiograph (FPD)

Another radiograph was taken to verify complete seating of the prosthesis onto the abutments (Figure 6.45).

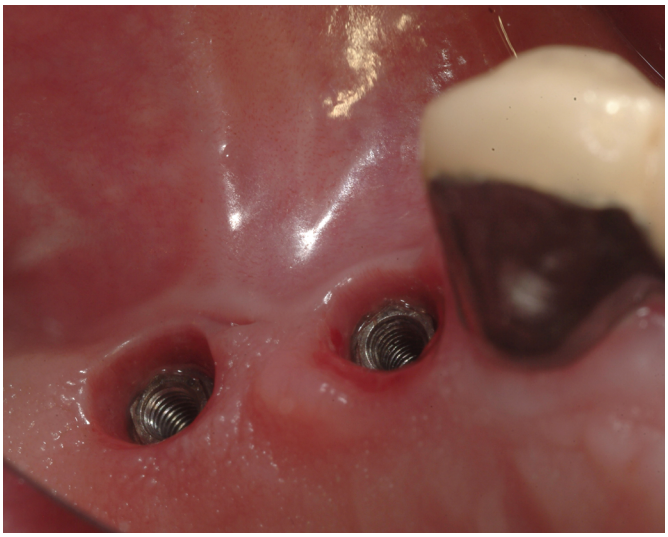

**Figure 6.46.** The implant restorative platforms for the external hex implants in the maxillary right posterior quadrant at the time of CAD/CAM abutment insertion.

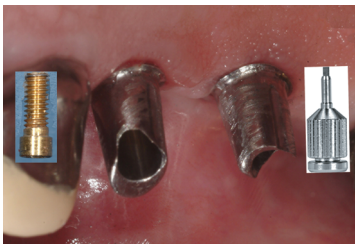

**Figure 6.47.** Final Encode Abutments were placed into the implants with definitive Gold-Tite™ abutment screws (UNISG, left inset). The abutment screw was tightened with the Posterior Square Driver (PSQD0N, right inset).

The occlusion was adjusted for stable centric contacts, right group function occlusion, and no balancing interferences. The porcelain shades were acceptable.

The prosthesis and abutments were removed and returned to the commercial dental laboratory for finishing procedures. The preexisting abutments and fixed partial denture were placed back onto the abutments, and the patient was discharged.

## *Appointment 5. Insertion Appointment (3/4 Hour)*

The patient returned for insertion of the definitive CAD/CAM abutments and fixed partial denture.

### Removal of Preexisting Abutments and Fixed Partial Denture

The preexisting prosthesis and conical abutments were removed. The peri-implant soft tissues duplicated the size and shape of the conical abutments. The implant restorative platforms were completely visualized (Figure 6.46).

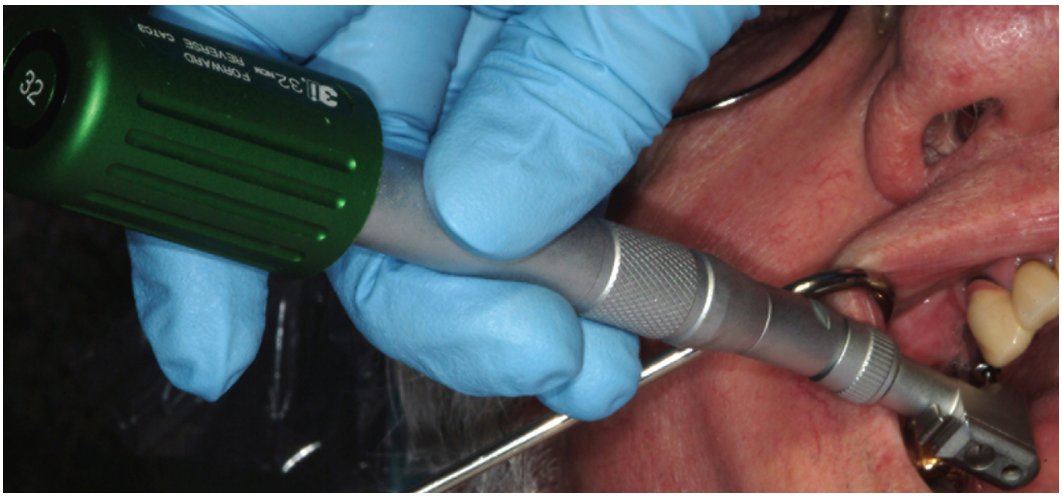

**Figure 6.48.** The Contra Angle Torque Driver Body (CADTB) and 32 Ncm torque controller (CATC3) in place.

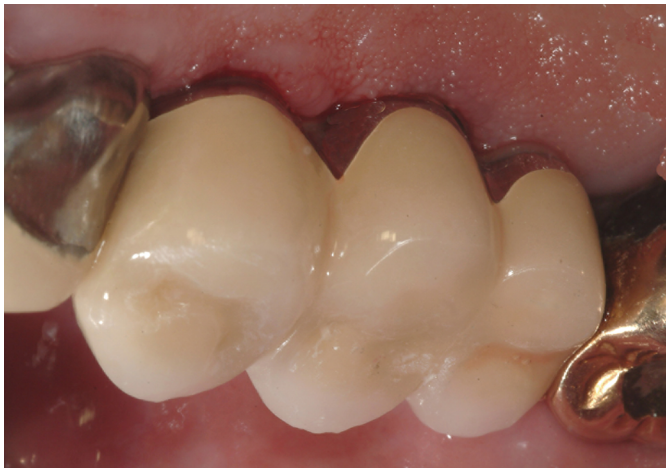

**Figure 6.49.** Palatal contours of the 3-unit fixed partial denture at the insertion appointment.

### CAD/CAM Abutment Placement

The CAD/CAM abutments were put into place with the abutment placement index as per the procedures for the bisque bake try-in (Figure 6.47). Because the author knew that the abutments and FPD fit, the definitive abutment screws were used (UNISG). The Posterior Square Driver, 17 mm (PSQDON) was used to initially tighten the abutment screws.

### Torque

The abutment screws were torqued to 32 Ncm with the Contra Angle Torque Driver (CATDB) and 32 Ncm torque controller (CATC3) (Figure 6.48). This was accomplished without pain or tenderness and generally represents a positive sign as to osseointegration of the implants.

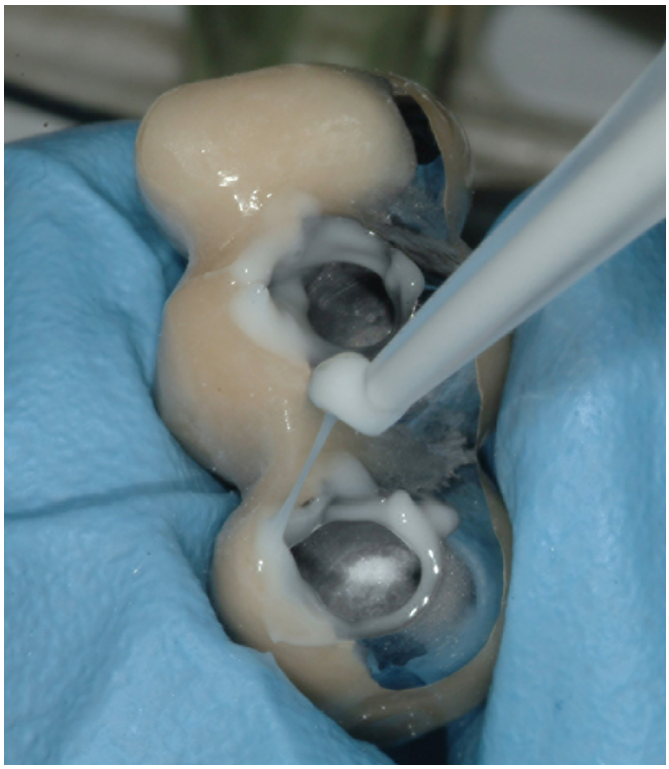

**Figure 6.50.** The margins of the retainers were rimmed with dental cement. Care should be taken to minimize the amount and placement of the cement so as to minimize changes in the fit between the retainers and the abutments.

### Fixed Partial Denture Cementation

The fixed partial denture was tried in again for interproximal and occlusal contacts; pontic/tissue adaptation, and overall aesthetics (Figure 6.49). The FPD was polished, air abraded with 50 μm aluminum oxide, and steam cleaned. The FPD was cemented with reinforced glass ionomer luting cement (GC Fuji Plus, GC America Inc., Alsip, Il) (Figure 6.50). The cement was placed in and around the apical

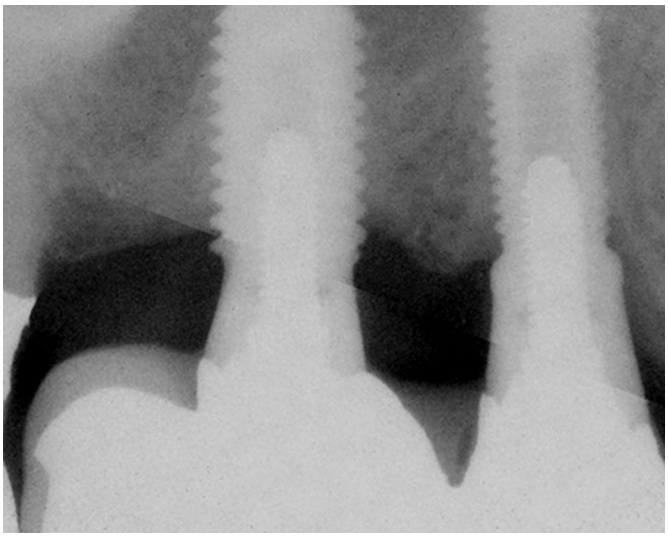

**Figure 6.51.** Periapical radiograph that was taken at the one-year post insertion recall appointment demonstrated bone levels consistent with the initial pre-operative radiograph.

2 mm of the retainers and seated into place. The cement was allowed to set for 2.5 minutes and the excess was removed.

### *Appointment 6. Follow-Up Appointments (1/2 Hour)*

#### Two Weeks/Six Months

The patient was scheduled for two-week and six-month follow-up appointments. The patient reported no adverse effects and was quite pleased with the aesthetic, functional, and phonetic results.

#### One-Year Recall Clinical and Radiographic Evaluations

One year following abutment and prosthesis insertion, the patient returned for clinical and radiographic examina-

**TABLE 6.8.** Lab Fees, Component Costs, Overhead, Fees, and Profits

| Fixed | | | |
|---|---|---|---|
| **Chair Time** | **Overhead** | **Laboratory Expenses** | |
| | | Casts | $60 |
| **Impression** | | Articulation | $50 |
| | | 3 unit FPD | $900 |
| **1 hour** | **$350/hr = $350** | **Sub Total** | **$1,010** |
| | | **Implant Components** | |
| | | Healing abutments | $120 |
| | | Impression Copings | $90 |
| | | Analogs | $42 |
| | | Encode Abutments | $500 |
| | | Lab screws | $ 25 |
| | | Abutment Screws | $110 |
| | | Encode Cast | $ 50 |
| | | **Sub Total** | **$937** |
| **Bisque Bake Try-In** | | | |
| 1 hour | $350/hr 5 $350 | | |
| **Abutment and FPD Insertion** | | | |
| 1 hour | $350/hr 5 $350 | | |
| **TOTALS** | **$1,050** | | **$1,947** |
| **Professional Fee** | | | **$5,000** |
| **Costs (fixed overhead and laboratory expenses)** | | | **$2,997** |
| **Profit (fees less costs)** | | | **$2,003** |
| **Profit per hour ($2,003/3 hr)** | | | **$ 667** |

Healing abutments, impression copings, and lab screws may be used multiple times, therefore costs will be decreased for each succeeding case and profits will be increased. Analogs should not be re-used.

tions. He again reported that there were no problems and was quite pleased with the results of treatment. Clinically, the prosthesis was evaluated for marginal discrepancies between retainers and their respective abutments, soft tissue marginal adaptation, and occlusal relationships in centric and eccentric excursions.

A periapical radiograph was taken to assess the relationship between the interproximal heights of bone and the implant/abutment interfaces (Figure 6.51). There was no additional bone loss when the initial radiographs were compared to the one-year recall radiographs.

### *Costs/Fees/Profitability*

The following discussion (Table 6.8) relative to fees is reflective of 2006 in the Midwestern United States. The costs of the implant components are retail prices from Implant Innovations, Inc., Palm Beach Gardens, Florida.

Surgeon: Ken Kempf, DDS, Iowa City, Iowa

Dental Laboratory Technicians: Tom Peterson, MDT, CDT, Northshore Dental Laboratories, Lynn, Massachusetts; Andrew Gingrasso, Gundersen Lutheran Medical Center, LaCrosse, Wisconsin

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