# The Integrated Abutment Crown<sup>TM</sup>, a Screwless and Cementless Restoration for Single-Tooth Implants: A Report on a New Technique

Rainier A. Urdaneta, DMD<sup>1</sup> and Mauro Marincola, DDS, MSD<sup>2</sup>

A technique is presented for the restoration of single-tooth, implant-supported crowns where the abutment and the crown material are chemomechanically bonded; therefore, there is no need for cement, and the implant and implant-abutment are connected with a screwless locking-taper. The clinical and laboratory procedures involved in the fabrication and insertion of the restoration are described in detail. This restoration offers the restorative dentist some advantages: excellent marginal adaptation with a cementless interface, a bacterially sealed implant-abutment connection, a crown material with a similar wear rate and hardness values of human enamel, a simple laboratory technique, and a reduced number of prosthetic components. Due to the light-cured nature of the crown material, chairside modifications can be accomplished. The major drawbacks are: studies are necessary to assess the long-term performance of the Integrated Abutment Crown<sup>TM</sup> (IAC)'s in both anterior and posterior areas of the mouth. Resin materials have higher roughness values, accumulate plaque at a higher rate, and are more likely to stain than tooth structure and all-ceramic restorations.

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INDEX WORDS: single-tooth implants, dental crown, composite resins, Bicon implants, lockingtaper implants

THE BICON Dental Implant<sup>TM</sup> system (Bicon, LLC, Boston, MA) is a screwless implant system. The implant and implant-abutment unit connect by means of a 3.0° locking taper. Assembly is achieved by tapping the abutment into the matching socket in the implant. A high clamping force between abutment and implant is generated through elastic deformation of both parts. Dur-

<sup>2</sup>University of Cartagena, Implant Dentistry Centre, Cartagena, Colombia; Private Practice, Rome, Italy.

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Copyright © 2007 by The American College of Prosthodontists 1059-941X/07 doi: 10.1111/j.1532-849X.2007.00194.x ing engagement, the high friction force resulting from the relative slip between the friction surfaces yields high contact forces. This interaction results in the surface oxide layers breaking down and the asperities fusing, commonly referred to as cold welding<sup>1</sup> (Fig 1). The locking-taper connection provides a frictional bacterial seal with excellent clinical reliability.<sup>2,3</sup>

The Integrated Abutment Crown<sup>TM</sup> (IAC) (Bicon, LLC.) is a cementless restoration for singletooth implants where the implant abutment and the crown material are one unit (Fig 2). A lightcured highly filled composite resin material such as Diamond Crown<sup>TM</sup> (DRM Research Laboratories, Branford, CT) is chemomechanically bonded to the coronal part of a titanium alloy abutment. The objective of this technique is to provide the restorative dentist with a screwless and cementless alternative to conventional single implant restorations. The IAC provides an alternative restorative option to metal-ceramic and allceramic crowns.

The clinical and laboratory procedures involved in the restoration of a maxillary left central incisor (Fig 3) with a locking-taper implant and an IAC<sup>TM</sup> are presented.

<sup>&</sup>lt;sup>1</sup>Clinical Instructor, Harvard School of Dental Medicine, Restorative Dentistry and Biomaterial Sciences and Concord Dental Associates, Faulkner Hospital, Implant Centre, Boston, MA.

Correspondence to: Dr. Rainier A. Urdaneta, Implant Dentistry Centre, 501 Arborway, Jamaica Plain, MA 02130. E-mail: rainieru@yahoo.com

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Figure 1. Cross-section of a Locking taper (screwless) implant and abutment. There is no space between them (picture courtesy: Dr. Thomas G. H. Diekwisch).

# **Impression Technique**

Remove the temporary or healing abutment (Fig 4A). If necessary, use a guide pin and an impression reamer to widen the sulcus (Fig 4B) to accommodate the impression post. Make an implant-level impression by tapping a plastic im-



**Figure 2.** An Integrated Abutment Crown<sup>TM</sup> ready for insertion (picture courtesy: Bicon Dental Implants).

pression post (Fig 4C) into the well of an implant prior to using a poly(vinyl siloxane) impression material (Fig 4D). After removing the impression, the impression post remains attached to the implant.

The impression post is inserted into an implant analog (Fig 4E), and the assembled unit is placed into the impression (Fig 4F) prior to its being poured with a soft tissue material and dental stone.

#### **Crown Material**

The build-up of the crown is done using Diamond Crown<sup>TM</sup> (DRM Research Laboratories; DC) light-cured composite resin system. The veneer material is composed of organically bridged glass-ceramic nanofillers embedded in a microcrystalline matrix of PEX resin. DC has the following properties: same wear rate and hardness as human enamel, low water sorption and shrinkage rates, and high diametral tensile strength.<sup>4</sup> The DC resin system comes with a metal coupler (primer), metal opaquer powder/liquid of different shades (self-cured), a ceramo-coupler, modeling liquid (adhesive), dentin chroma intensifiers/modifiers, and 16 Vita shades, plus various incisal effects and characterization stains.<sup>4</sup> The material has dentin opaque, dentin, enamel, and incisal colors.



**Figure 3.** Clinical and radiographic views. Maxillary left central incisor with external root resorption was extracted *(A, B)*, and a Bicon implant placed *(C)*. Notice the intracrestal placement of the locking-taper implant. Implant surgery done by Dr. Shadi Daher (Implant Dentistry Center, Boston, MA).

#### Laboratory Steps

- 1. Choose a nonshouldered or shouldered lockingtaper abutment that will allow for a minimum of 2- and a maximum of 5-mm thickness of crown material. Reduce the abutment using carbide burs to provide for smooth surface contours and subgingival margins (Fig 5A).
- 2. Air-abrade the prepared abutment with 50  $\mu$ m of aluminum oxide (50 PSI) (Fig 5B); place in an ultrasonic cleaner for 5 minutes in a solution of 95% ethyl alcohol and allow to air dry thoroughly.
- 3. Apply 4 to 6 thin coats of the metal coupler (Fig 5C) with a disposable brush and place in an oven for 5 minutes at 250°F (120°C) without vacuum.
- 4. Mix equal portions of the metal opaque powder and liquid of the appropriate shade. Apply one coat of the metal opaque mix with a disposable brush (Fig 5D), place abutment in the oven at 250°F (120°C), and hold under vacuum for 5 minutes (Fig 5E). Apply ceramic-coupler and a second opaque layer until the desired effect is achieved.

- 5. Apply modeling liquid (bonding agent) and light cure for 2 minutes using the DiamondLite VL Halogen Light Cure Booth<sup>TM</sup> (DRM Research Laboratories). Dentin opaque, dentin, enamel, and incisal layers of the appropriate shades are added incrementally. Light-cure the material for 2 to 4 minutes in 2- to 3-mm thick increments (Fig 6A-C).
- 6. Finish with fine cut and superfine grade carbide burs. Polish using silicone polishing discs and a nylon bristle brush (Fig 6D, E).

## **Insertion Technique**

- 1. At the insertion appointment, remove the transitional crown and abutment, clean the IAC with alcohol, and place it into the well of the implant (Fig 7).
- 2. Use an incisal orientation jig or vacuum-formed template to ensure proper anatomical alignment (Fig 7), as the well of a Bicon implant does not contain any antirotational features and allows for 360° of rotation prior to tapping.



**Figure 4.** An implant-level impression is necessary for the restoration of a Bicon implant with an IAC (A). A sulcus reamer (B) is used when there is a need to remove excess tissue around the implant shoulder. The impression post is tapped into the implant well (C). After the impression is obtained (D), the impression post is inserted into the implant analog (E), and the assembled unit is placed into the impression (F).



**Figure 5.** The locking-taper titanium abutment is seated unto an abutment holder and is prepared for the application of the crown material. Carbide burs are used (A). The prepared abutment is air-abraded (B), and a metal coupler is applied (C), then the abutment is placed in an oven for 5 minutes. The opaquer is applied (D), and the opaqued abutment is placed in an oven for 5 minutes (E) (pictures courtesy: Bicon Dental Implants).

- 3. Check and adjust interproximal contacts. Often a slight rotation of an IAC will close or open an interproximal contact. Because this restoration integrates the implant abutment and the crown into one unit, the path of insertion of the IAC is guided by both the interproximal contours and the well of the implant. Occasionally, it is necessary to make two oblique crestal relieving incisions to allow the IAC to displace the soft tissues.
- 4. Tap (essential) the IAC in the long axis of the abutment post and implant well to engage the frictional locking-taper connection (Fig 8). Using a 250-g mallet and a seating instrument, tap the crown into place with a few taps (3 to 6 are recommended). Use a crown seating tip (Bicon) and a custom-made acrylic tapping jig to achieve proper seating of the locking-taper connection in maxillary anterior IACs (Fig 8C-E).
- 5. Check and adjust occlusion. If necessary it is possible to add composite chairside or to remove the IAC for laboratory modification even after it has been seated.
- 6. To remove an IAC, grasp the crown with an abutment removal forceps (Bicon). Using

a simultaneous twisting and pulling motion, release the crown/abutment unit from the implant. Figure 9 shows a clinical and radiographic view of the IAC at the insertion appointment. The placement of opaquer/resin material at the facio-cervical area corrected the darkening of the gingival tissues observed on the temporary restoration due to abutment/metal reflection (Fig 10).

# Comparison with Alternative Techniques

#### Implant-Abutment Connection

Two common techniques to secure the abutment to the implant in single-tooth implant restorations are the use of a screw and the use of a tapered interference fit<sup>5</sup> (Morse tapers and locking tapers). For implant systems using a screw, such as Nobel Biocare (Nobel Biocare AB, Goteborg, Sweden), the connection between the implant and the abutment depends on the screw-preload, which is generated by applying a predetermined amount of torque during installation.<sup>5</sup> When both the implant-abutment and crown-abutment



**Figure 6.** Crown build-up of an IAC. Ceramic-coupler and modeling liquid (adhesive) are applied to the opaqued abutment (A) and light-cured for 2 minutes (B). The resin crown material is applied and light-cured in layers of dentin opaque, dentin, enamel, and incisal colors (C). Then the restoration is finished (D) and polished (E) (pictures courtesy: Bicon Dental Implants)



**Figure 7.** An IAC restoring a maxillary left central incisor is inserted (left). Prior to tapping, the restoration can be rotated into place; an acrylic splint is used to ensure proper anatomical alignment (right).

complexes are connected with screws, long-term follow-up studies have reported several complications, including screw loosening, fracture, and other component failures<sup>6-13</sup> that appear to be a greater problem with single-tooth restorations.<sup>14</sup> Furthermore, a screw-retained prosthesis does not seal the abutment-to-crown interface or margin, which harbors bacteria in the crevice.<sup>15-17</sup>

Implant systems such as Ankylos (Degussa Dental, Hanau-Wolfgang, Germany) and ITI (Institute Straumann AG, Waldenburg, Switzerland) use a screw with a tapered end<sup>5</sup> (Morse taper) to connect the implant to the abutment. Designs in which the screw has a large tapered end essentially work like a tapered interference fit,<sup>5</sup> and the screw threads do not appear to contribute to the connection.<sup>5,18-20</sup> The Bicon implant system uses a tapered interference fit solely (lockingtaper connection). The tapered interference fit relies on the large contact pressure and resulting frictional resistance in the mating region of the implant-abutment interface to provide a secure connection.<sup>5</sup> The use of Morse tapers has virtually eliminated screw loosening<sup>20</sup> and has shown satisfactory long-term performance.<sup>21</sup> The use locking tapers has shown a 10-year survival rate of 99.0% with single-tooth restorations,<sup>22</sup> and complications are rare.<sup>3,23</sup>

#### **Crown-Abutment Connection**

The conventional technique to retain a single crown onto an implant abutment is the use of cement. In an IAC the crown material is chemomechanically bonded to the titanium abutment.

Even though cemented single implantsupported metal ceramic crowns and all ceramic crowns have a proven clinical record,<sup>3,24,25</sup> the



**Figure 8.** Tapping on the incisal edges of maxillary anterior teeth may not direct the forces in the desired direction (A, B). A crown seating tip and a custom-made acrylic tapping jig are used to ensure that the tapping forces are directed in the long axis of the implant well and achieve proper seating of the locking-taper connection (*C-E*) (pictures courtesy: Bicon Dental Implants).



**Figure 9.** Clinical and radiographic view of an IAC on the maxillary left central incisor. Gingival bleeding is observed due to the mesial and distal relieving crestal incisions done at the insertion appointment (A). The IAC 1 week after insertion (B). Radiographic View (C).

presence of prosthetic margins that are usually placed subgingivally for esthetic reasons and the use of cement have shown some limitations. A gap between the crown and the implant or abutment has been associated with greater marginal bone loss during the first year of function.<sup>26</sup> Another factor that should be considered is the possibility of excess cement flowing into the gingival sulcus.<sup>15,27,28</sup> Unlike teeth, implants do not have a connective tissue attachment zone that extends 1 mm above the bone;<sup>29</sup> the excess cement can easily go beyond the sulcus and reach closer to the bone. Incomplete cement removal from the gingival sulcus can lead to loss of peri-implant bone visualized radiographically.<sup>27,28</sup> An advantage of an IAC is the absence of cement in the gingival crevice; nevertheless, the stability of the bond between the metal abutment and the resin veneering material will need to be demonstrated in long-term studies.

#### **Crown Material**

The most common materials used for the restoration of both teeth and implants are ceramo-metal and all-ceramic crowns. A single implant-retained porcelain fused to metal (PFM) crown on a metal abutment may be considered today as the standard selection.<sup>30</sup> In an IAC, the crown material is a light-cured, highly filled composite resin. IACs have demonstrated a survival rate of 98.7%, color stability, and excellent marginal adaptation; however, their clinical performance needs to be evaluated in long-term studies.

In implant dentistry, composite resins are commonly used as temporary restorations. The use of composite resin as a definitive restorative material for tooth-supported restorations has shown some limitations. Resin materials, when polished, achieve higher roughness values compared with all-ceramic materials<sup>31</sup> and accumulate plaque at a higher rate than tooth structure and all-ceramic restorations.<sup>32-34</sup> Surface staining has been documented on composite resin restorations.<sup>35</sup>

As an implant restorative material, resins offer some advantages over porcelains. Resin materials have demonstrated "shock-absorbing properties." Composite resins have been found to reduce the impact force on implants by about 50% when compared with porcelain and gold.<sup>36</sup>

**Figure 10.** Clinical lateral views of the same maxillary left central incisor area with a temporary restoration (left) and an Integrated Abutment Crown<sup>TM</sup> (right). The application of opaquer and the ideal emergence profile allows for the correction of the metal abutment reflection (shadow) observed on the gingival tissues at the temporary stage.



Figure 11. Clinical and radiographic view of an IAC restoring a maxillary right lateral incisor. By bonding the crown material directly onto the implant abutment, it is possible to obtain an ideal emergence profile in areas with limited restorative space. (picture courtesy: Dr. Vincent Morgan, Implant Dentistry Center, Boston, MA).



Composite resins have also been shown to cause less wear on opposing enamel than porcelain.<sup>37-39</sup> One of the major disadvantages of metal-ceramic and all-ceramic restorations is their abrasiveness to opposing natural dentition.<sup>40</sup> Both in vivo and in vitro studies have consistently demonstrated that porcelain causes excessive enamel wear.<sup>40-45</sup>

Another advantage of a light-cured composite resin is that chairside modifications can be accomplished, and there is no need to send the crown back to the laboratory to add interproximal and occlusal contacts. Moreover, adding the crown material directly onto the implant abutment allows the dental technician some flexibility in obtaining a proper emergence profile, especially in areas with limited restorative space (Fig 11).

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