



# Inclusive®

*Restorative Driven Implant Solutions*

Vol. 1, Issue 3

*A Multimedia Publication of Glidewell Laboratories*



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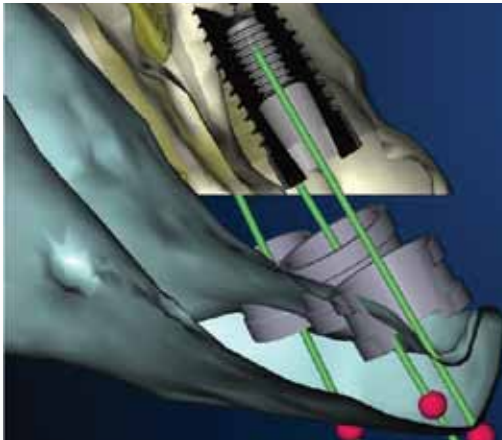
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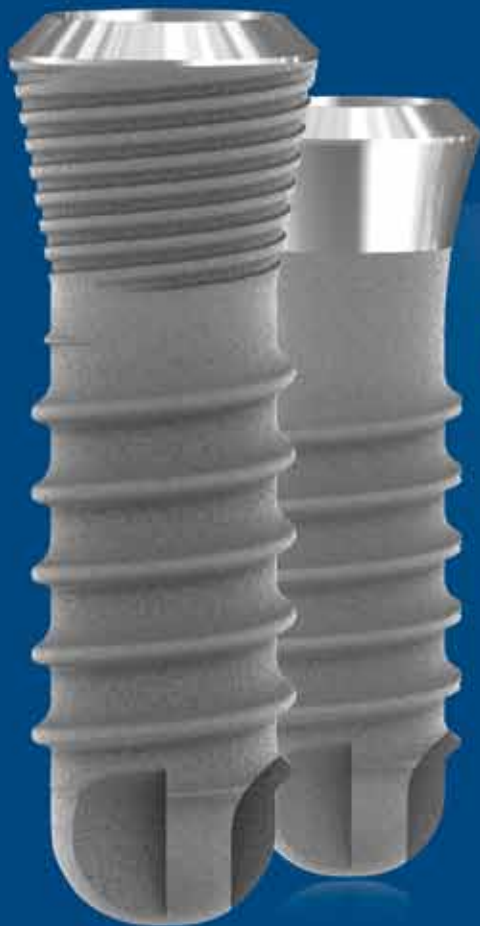
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<sup>1</sup>Surgical and Mechanical Techniques to Increase Stability of Dental Implants. Khourif, Jemke, Shi, Hwang, Chien, Sato, Hens, Cardozo, Guiguet, Bru, Michail, Chai, Sang-Choon, Thuan, Stuart, Sennow, Dennis. Sybron (Department of Periodontology and Implant Dentistry, New York University, New York) presented at the AO Boston 2008.

<sup>2</sup>Implant Design and Its Effect on Preservation of Crestal Bone Levels. Jang, Song, Jang, Park, Moon, Lee, Kim, Moon, Kim, Sennow, Robert, Elan, Hwang, Chai, Sang-Choon, Thuan, Stuart, Sennow, Dennis. Sybron (Department of Periodontology and Implant Dentistry, New York University, New York) presented at the AO Boston 2008.

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# Letter from the Editor

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Welcome to the third issue of Inclusive. By now, I hope you have had a chance to view the expanded articles and videos, as well as take advantage of the CE opportunities at [inclusivemagazine.com](http://inclusivemagazine.com) and [glidewelldental.com](http://glidewelldental.com).

In our continued effort to provide you with milestone clinical articles, we are proud to include Dr. Lyndon Cooper's article on guiding and evaluating implant esthetics. After reading this classic article, you will understand the importance of the "3:2 rule" and the gingival zenith when planning implants in the esthetic zone.

Another vital aspect of treatment planning implant cases is the amount of prosthetic vertical space available. The patient may have adequate bone to accommodate an implant, but because of collapse of the bite or supra-eruption of the opposing dentition there may be limited restorative space. We present an overview that provides the average crown heights, lists diagnostic tools to determine the amount of space and illustrates the prosthetic height limitations from a laboratory standpoint.

We'll also introduce you to [whatimplantisthat.com](http://whatimplantisthat.com). Today, it is all too common for a patient to show up at your office with implants that already have been placed, and identifying these implants can be a challenge. Drs. Kent Howell and Nate Farley of The Ohio State University created this site to aid in the identification of implants based on common characteristics.

On the material science side, we'll also explain the unique properties of zirconia, which has become a very popular restorative material over the last several years. Glidewell Laboratories recently introduced BruxZir® Solid Zirconia, a unique full-contoured all-zirconia restoration. Senior Director of R&D Robin Carden provides an overview of how this material can benefit you and your patients.

You'll also find a photo essay in which Dr. Tim Kosinski walks through the decision process and procedure to replace missing maxillary first molars, as well as a practice management article on pricing psychology when presenting treatment options from Dr. David Schwab.

The Global Institute for Dental Education ([gIDEdental.com](http://gIDEdental.com)) provides a tremendous amount of on-line educational opportunities. To introduce you to this site, we have a short online presentation by Dr. Joseph Kan of Loma Linda University School of Dentistry on immediate versus delayed implant placement.

Also online is expanded coverage on the topics in the magazine, including a video that shows the utilization of BioTemps® and the IOS FastScan™ Digital Impression System.

As always, we welcome your feedback. Share your thoughts at [inclusivemagazine@glidewelldental.com](mailto:inclusivemagazine@glidewelldental.com).



Regards,

*Bradley C. Bockhorst, DMD*

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# Master of Esthetic Dentistry

## Objective Criteria: Guiding and Evaluating Dental Implant Esthetics



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by Lyndon F. Cooper, DDS, Ph.D

The evolution of dental implant therapies is fully apparent. From the introductory concepts of tissue-integrated prostheses with remarkable functional advantages, innovations have resulted in dental implant solutions spanning the spectrum of dental needs. Current discussions concerning the relative merit of an implant versus a 3-unit fixed partial denture fully illustrate the possibility that single implants represent a bona fide choice for tooth replacement.<sup>1</sup> Interestingly, when delving into the detailed comparisons between the outcomes of single-tooth implant versus fixed partial dentures or the intentional replacement of a failing tooth with an implant instead of restoration involving root canal therapy, little emphasis has been placed on the relative esthetic merits of one or another therapeutic approach to tooth replacement therapy.<sup>2</sup> An ideal prosthesis should fully recapitulate or enhance the esthetic features of the tooth or teeth it replaces. Although it is clearly beyond the scope of this article to compare the various methods of esthetic tooth replacement, there is, perhaps, sufficient space to share some insights regarding an objective approach to planning, executing and evaluating the esthetic merit of single-tooth implant restorations.

Therapeutic success for dental implants has largely been described in terms of implant survival. Anterior single-tooth implant survival is high.<sup>3</sup> Further documentation provides implant success criteria, defined by the reporting of marginal bone level data.<sup>4</sup> Occasionally, prosthetic or restorative outcomes have been reported. Here, marginally less favorable data are reported for abutment complications of loosening or screw fracture.<sup>3</sup> Less often, biologic data concerning the peri-implant mucosal responses are provided. A biologic width develops around implant crowns, and the associated peri-implant connective tissue inflammatory cell infiltrate reacts to plaque accumulation.<sup>5</sup>

The incidence of peri-implantitis and its effect on implant esthetics may not be fully appreciated. Recently, two esthetic scoring systems have been described.<sup>6,7</sup> These or possibly other esthetic evaluations have not been widely deployed. Although Chang and colleagues<sup>8</sup> examined patient-based outcomes for anterior single-tooth implants, there remain many unanswered questions regarding the esthetic requirements and related patient satisfaction concerning anterior single-tooth implants. In 2008, esthetic concerns dominated the discourse surrounding dental implants. An objective approach to planning, executing and evaluating therapy is warranted.

Meeting the goal of providing a single-tooth implant crown that equals or exceeds the esthetic value of the tooth it replaces requires identifying and addressing easily recognized anatomic constraints. The hypothesis underscoring an objective approach to single-tooth dental implant esthetics is that the majority of unresolved esthetic problems are because of the discrepancies of implant crown dimension and orientation. Most often, these reflect improper clinical management of peri-implant and peri-coronal soft tissue architecture.<sup>9</sup> The application of time-proven and well-documented objective criteria for dental esthetics to the anterior single-tooth implant scenario can guide planning and ensure execution of implant placement, abutment design and crown formation to achieve the highest and most reproducible esthetic goals of the clinician and patient. The aim of this report is to describe how objective criteria can guide planning and execution of implant therapy and, more importantly, how a single aspect of dental implant planning and placement can negatively impact half of these objective criteria and lead to unacceptable implant-supported restorations.

## Objective Criteria for Dental Esthetics and the Implant Scenario

In a classic (now out of print) textbook titled “Esthetic Guidelines for Restorative Dentistry,”<sup>10</sup> Dr. Urs Belser describes the objective criteria for dental esthetics. More recently, an updated list and illustration of these criteria were published as a chapter in the textbook “Bonded Porcelain Restorations in the Anterior Dentition.”<sup>11</sup> These criteria (*Table 1*), together with the additional significance of identifying the midline and plane of occlusion as a prerequisite for ideal anterior dental esthetics, can provide an indelible guidance system for dental esthetics. In the process of evaluating single-tooth dental implant restorations in prospective and retrospective studies,<sup>11–14</sup> it became apparent that these criteria were equally valid to the dental implant restoration. The form of the dental implant-supported tooth requires careful consideration of these objective criteria (*Fig. 1*).

Dental implant placement is neither fully intuited from the anatomy of the residual alveolar ridge nor can it be divined from the existing volume of bone. Desired tooth position dictates implant placement and informs the clinician

**TABLE 1 — Objective Criteria for Dental Esthetics**

- |                                |  |
|--------------------------------|--|
| ■ Gingival health              | ■ Tooth characterization                 |
| ■ Balance of gingival levels   | ■ Surface texture                        |
| ■ Gingival zenith              | ■ Color                                  |
| ■ Interdental closure          | ■ Incisal edge configuration             |
| ■ Interdental contact location | ■ Lower lip line                         |
| ■ Tooth axis                   | ■ Smile symmetry                         |
| ■ Basic features of tooth form | ■ Midline and occlusal plane orientation |
| ■ Relative tooth dimensions    |  |



**Figure 1:** Tooth form is objectively defined. The objective criteria for dental esthetics (*Table 1*) help guide decisions concerning ideal tooth form. The clinical photo of this implant crown replacing central incisor #8 reveals the significance of the many soft tissue items present as criteria defining dental esthetics. Note that much of the crown form is defined by the peri-implant mucosa. The lack of symmetry between the central incisors is due to the incorrect depth of implant placement and the 1 mm apical location of the gingival zenith. The incorrect soft tissue contour is represented by a more oval or triangular tooth form and a longer clinical crown when compared with the left central incisor. The more mesial location of the zenith has been compensated by the enhancement of the line angles and tooth character to correct the appearance of the tooth's long axis. The loss of attachment at tooth #7 results in the absence of gingival closure and cannot be accommodated by modifications of the implant procedure or crown #8. These objective limitations reduce the overall esthetic value of this tooth display.

regarding potential requirements for tissue augmentation. In considering the role of the objective criteria in planning for dental implant placement and recognizing that the depth of implant placement can dramatically affect one-half of these criteria, a potential objective strategy to esthetic planning for dental implant placement emerges. That strategy requires evaluation of the edentulous alveolar ridge and adjacent teeth in the context of the objective criteria for dental esthetics. Simply stated, dental implant placement can be guided by the location of the gingival zenith.

## The Gingival Zenith as a Guide for Dental Implant Placement

The gingival zenith represents the most apical part of the clinical crown. It also represents both the faciolingual and the mesiodistal location of the crown in relationship to the edentulous ridge. As such, it has a remarkable influence on the morphology of the planned restoration. The gingival zenith affects other objective criteria, including the balance of gingival levels (too inferior or superior), the tooth axis (too distal or mesial), the tooth dimension (too inferior or superior), and the tooth form (triangular becomes ovoid if too inferior). Without the control of the gingival zenith, the clinician's ability to define dental implant esthetics is vastly diminished (*Fig. 2*).



**Figure 2:** In the left and right views, the retained "c" and "i" teeth reflect the absence of permanent cuspid teeth. The retained deciduous teeth have aided in the preservation of alveolar bone, but the location of the gingival contours are not correct and are unattractive. Using the present bone and gingival locations to guide implant placement would result in short clinical crowns. Redefining the gingival zenith of the permanent cuspid teeth is required.

## Dental Implant Control at the Zenith

At least four factors affect the gingival zenith. First is the relative location of the tissues to the planned gingival zenith. Second is the depth of the dental implant placement. Third is the response of the buccal bone and mucosa to the implant procedure and components. Fourth is the prosthodontic management of the gingival zenith architecture.

## The Relative Locations of Tissues and the Planned Gingival Zenith

Ideally, the planned gingival zenith is symmetric with the contralateral tooth and harmonious with the gingival levels of adjacent teeth. Unfortunately, most residual alveolar ridges are significantly resorbed.<sup>15</sup> Important objective classification<sup>16</sup> is useful and a Diagnostic Wax-Up permits the exact determination of the extent of resorption and permits planning to the key esthetic parameters. Interproximal tissue contours (papillae) appear to be supported by adjacent teeth connective tissue contacts, but peri-implant facial tissue contours are dependent on facial bone and co-dependent soft tissue morphology.

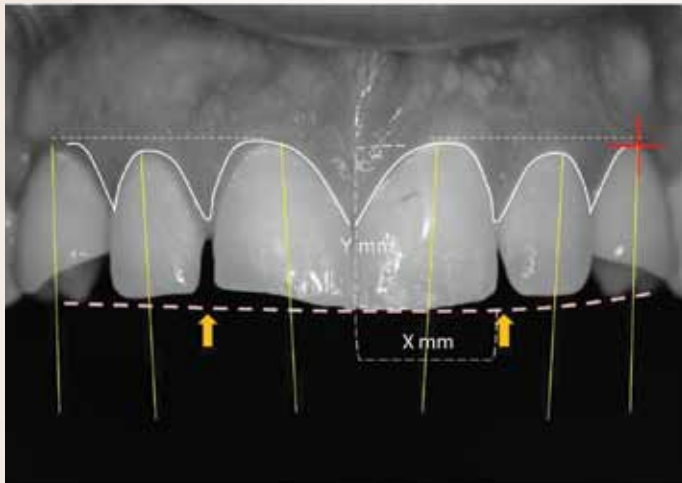
## Controlling the Depth of Implant Placement

Decisions concerning the depth of implant placement should be based on the biologic understanding of the tissue responses to the implanted device. Assuming a steady state peri-implant bone level, it is well known that a biologic width forms at the dental implant<sup>17</sup> and that the buccal dimension of the biologic width formed at an abutment is approximately 3 mm.<sup>18</sup> The ideal depth of the implant placement is suggested to be 3 mm apical to the planned gingival zenith. The implant/abutment interface should also reside 2 mm palatal to the zenith to ensure adequate thickness of bone and mucosa to support tissue form.<sup>19</sup> This “3:2 rule” further suggests to the clinician when bone grafting or soft tissue augmentation should be performed. If bone is not present at approximately this position from the gingival zenith, bone grafting procedures should be considered in preparation for ideal esthetics (*Fig. 3*).

Without apology for the following circular logic, controlling the depth of placement is achieved by defining the gingival zenith. Managing the gingival zenith at the time of implant placement sets the stage for ideal anterior single-tooth esthetics. Whether William’s theory of tooth form has merit,<sup>20</sup> the characterization of teeth as square, ovoid or triangular is based on the peri-coronal architecture. An often unrecognized truth about dental implant esthetics is that tooth form is largely defined by the peri-implant mucosal architecture.



**Figure 3:** The location of the gingival zenith should be symmetrical with the contralateral tooth and in harmony with the adjacent teeth. As shown in this illustration, the gingival zenith should be located approximately 3 mm from the implant/abutment interface. This permits a subgingival crown margin at the facial aspect of the implant and provides at least 2.5 mm for the development of the biologic width in a supercrestal position. Placement of the implant/abutment interface in a deeper location will result in loss of bone and facial peri-implant mucosal recession.



**Figure 4:** A simple photograph (representing the situation illustrated in *Fig. 2*) can be used to objectively evaluate the clinical situation to make a complete esthetic diagnosis. Note that the mirror image of the right and left gingival contours do not match. Note also that the orthodontist has provided good spacing for the central and lateral incisors; it is clear that relative to tooth #10, tooth #7 is distal in its location. The gingival zenith on tooth #11 has been marked to indicate how its position guides overall esthetic value of the implant restoration, presently represented by provisional crowns without occlusion.

## Controlling Peri-Implant Mucosal Architecture

A reproducible procedure should be imposed onto the artistic philosophy of each clinical exercise. For the single-tooth dental implant, this process begins with an esthetic diagnosis. The diagnosis is nothing more than the assessment of the objective criteria as displayed by the preoperative condition of the patient. Suggested is the use of clinical digital photographs upon which simple evaluations can be superimposed (*Fig. 4*).

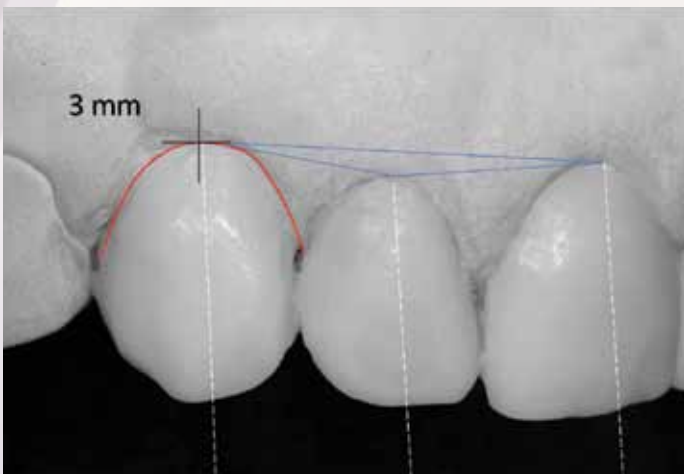
Perhaps the most prognostic indicator of eventual esthetic success through symmetry is gained by evaluation of the connective tissue attachment at the adjacent teeth. Careful assessment using a periodontal probe and diagnostic periapical radiograph are needed. Loss of attachment of greater than 1 mm is clinically discernible and difficult to regenerate. This step is essential because interproximal peri-implant mucosal contours (papillae) are



**Figure 5:** Study casts of the interim situation and the diagnostically waxed cast. The location of the gingival zenith is directed by the process of diagnostic waxing. This is confirmed by the evaluation of the intraoperative study cast.

greatly dependent on adjacent tooth contours. Together with study casts indicating the extent of alveolar ridge resorption, a thorough prognosis and treatment plan can be provided to the patient.

For the situation of the single anterior missing tooth, it is not possible to fully appreciate these criteria unless a fully contoured crown is waxed in the edentulous space (*Fig. 5*). Following the diagnostic waxing, it is possible to understand the relationship between the proposed gingival zenith location and the existing mucosa. The relationship of the gingival zenith to the underlying bone can only be determined by bone sounding with a diagnostic template in place or, preferably, by use of volumetric imaging (e.g., Cone Beam Computed Tomography) with a radiopaque image of the gingival zenith in place (*Fig. 6*). This assessment is critical. Without underlying bone to support the buccal contour in full dimension, the esthetic volume of the edentulous space ultimately will be deficient (*Fig. 7*). Based on the location of the planned gingival zenith, therefore, decisions regarding the need for bone augmentation, socket preservation and/or soft tissue augmentation procedures can be prudently accessed.



**Figure 6:** On the left, detailed evaluation of the diagnostically waxed cast shows that the concepts revealed by the objective esthetic evaluation have been translated to the cast. This includes the harmonious arrangement of the gingival zenith and the proper location of the cuspid zenith in the buccolingual as well as the apicoincisal direction. Bone should be present 3 mm apical to the gingival zenith. At right, an unrelated Cone Beam Computed Tomography image of a canine site exemplifies the examination of the required gingival zenith/bone relationship. In this example, insufficient bone for an esthetic restoration exists. The planned restoration's zenith is 8 mm from the alveolar crest. The resulting crown would be approximately 14 to 15 mm in length (versus the average of 10 to 11 mm). Bone augmentation would be indicated.



**Figure 7:** (A) Intervening veneer preparations for teeth #7-10 were performed in the enamel only. The provisional crowns are removed and impression copings are placed for fixture-level impressions of the Astra Tech dental implants. (B) ZirDesign™ abutment delivery in the well-formed residual alveolar mucosa. The provisional crown should aid in the creation of the gingival contours. The form of the provisional crown should reflect both the clinical crown marginal contours as well as provide ideal submucosal transition contour. In most cases, the interproximal surfaces of the abutment and crown should be concave or flat, whereas the buccal contours are slightly convex in support of the buccal architecture. The interproximal contours must accommodate sufficient interproximal tissue mass to support contours. (C) Provisional crowns reflect the contours of the diagnostic waxing and have been used to direct soft tissue changes at the implants as well as the mesial aspects of teeth #7 and #9.

## Prosthodontic Management of Peri-Implant Mucosal Architecture

With an implant positioned properly in the alveolus, the control of peri-implant tissues is enhanced morphologically by enforcing the remodeling of tissues using properly contoured abutments and provisional crowns (Table 2). To ensure proper healing and to limit inflammation, properly polished abutments of titanium or zirconia should be sculpted to support the soft tissue form, and thus, the cervical contour of the crown. Typically, the abutment will possess concave features, with the possible exception being a convexity of the buccal surface. This is particularly important in developing the contours of any provisional restoration for a dental implant. Morphologic refinement is established using the provisional crown and, again, the submucosal contours should be refined to be more root-like (concave interproximally) to support ideal tissue form. No particulate materials should be introduced into the sulcus, and all debris should be

**TABLE 2 — Factors Controlling Buccal Peri-Implant Tissues**

- Initial presentation (Seibert classification)
- Implant position capability (relative to planned gingival zenith)
- Bone formation and resorption at the implant
- Peri-implant mucosa integration
- Character of the implant abutment interface
- Inflammation
- Local factors (plaque, etc.)
- Patient factors (biotype)
- Abutment form
- Submucosal contour of the provisional crown
- Bone modeling/remodeling
- Potential adjacent tooth eruption



**Figure 8:** (A) Facial view of final restorations on implants #6 and #11, and teeth #7-10. All-ceramic crowns were bonded to ZirDesign™ implant abutments and veneers were bonded to #7-10. The photograph was made three months after delivery of the definitive prostheses. (B) One-year evaluation of the restoration/tissue relationships of #6-8 and (C) #9-11. The form and color of the peri-implant mucosa is in part due to the choice of the zirconia abutments and modification of the tissues during the immediate provisionalization period. The thick biotype contributes to the predictability of tissue responses illustrated here. The restorations were produced by Lee Culp, CDT.

carefully washed from the implant and sulcus prior to the delivery of the abutment and crown. The provisional crown should be highly polished, well adapted to the abutment margin and free of extruded cement (*Fig. 7*).

### Assessment at the Provisional Phase of Implant Restoration

Excellent esthetics frequently involves iterative processes. For implant crowns, attempts to provide highly esthetic crowns to properly contoured peri-implant mucosa directly from a fixture-level impression is not likely to achieve great expectations. It is important to provisionalize implants with provisional or definitive abutments and achieve the planned tissue architecture described earlier. After a period of tissue healing (6 to 8 weeks) or adaptation (3 to 4 weeks), objective assessment should be performed. Only after reviewing potential opportunities for refinement should the final impression of the implant or abutment be made. Several suggestions for capturing the form of the peri-implant mucosa include the placement of rigid materials into the sulcus. This is not recommended if the peri-implant tissues display little inflammation and tissue prolapse (*Fig. 8*). Regardless of the method chosen, the sulcus should be carefully examined and debrided after the impression is made. The provisional restoration should be replaced with little or no displacement or disruption of the peri-implant mucosa.

### Delivery and Assessment of the Final Prosthesis

The goal of the laboratory procedures includes the preservation and possible directed enhancement of the peri-implant mucosal form created by the clinician, maintenance of the designated incisal edge position and incisal embrasures, and the creation of the designated abutment and crown. The prepared abutment and crown may be delivered to complete the restorative procedure.

With a major goal being to preserve the peri-implant mucosal architecture with the gingival zenith as a reference point, it is important to evaluate possible tissue displacement when a final abutment is placed. Only modest, if any, blanching should be evident using this protocol following a careful provisionalization process. If tissues are displaced apically, it suggests that the abutment is improperly contoured and is most likely convex in form. The abutment can be modified and the tissue contours can be evaluated again. Abutment delivery is, therefore, a critical step in the control of the peri-implant mucosal form.

Finally, the crown can be evaluated in the usual and customary manner. Included is a very useful checklist for this procedure that applies the objective criteria for dental esthetics.<sup>6,7</sup> It will focus attention beyond the issues of delivering an implant crown, and it reaffirms the maintenance of peri-implant mucosal architecture (*Table 3*).

## A Procedural Review

Integration of the concepts discussed earlier indicates that for all anterior implants, there is a set of procedures that can ensure esthetic success (*Table 3*). The process begins with an esthetic diagnosis to reveal the limitations present and to suggest steps to overcome esthetic limitations before initiating implant therapy. The key features to observe include adjacent tooth connective tissue attachments. Further evaluation requires that a diagnostic waxing be performed to suggest the ideal restorative form. The designated gingival zenith can then be used to identify the critical crown-to-bone relationship, today using volumetric radiographic imaging techniques. If the ideal gingival zenith is greater than 3 mm incisal and 2 mm buccal from the existing bone crest, bone augmentation procedures may be considered. The gingival zenith, therefore, becomes the therapeutic reference point. A positive esthetic result is suggested when the adjacent tooth attachment levels are intact and there is adequate bone relative to the reference point. Using a surgical guide, the implant can be accurately positioned to the zenith reference point. At the appropriate time (after immediate placement, one-stage surgery or two-stage surgery), an abutment can be placed to permit the formation of biologic width along the abutment and to begin to properly contour the peri-implant tissues. The provisional crown should be used to direct proper morphologic development of the peri-implant mucosa and control the crown's ultimate form. Finally, the definitive restoration should impart color, translucency, contour and surface texture that embellish or match the adjacent and contralateral anterior teeth.

## Conclusion

An objective approach to dental implant therapy is warranted. Recent application of objective criteria suggests that further control of the anterior dental esthetics might be achieved. For example, the level of the peri-implant soft-tissue margin came to lie within 1 or 2 mm of the reference tooth in no more than 64 percent of the implant-supported replacements. The color of the peri-implant soft tissue matched that of the reference tooth in no more than just over one-third of cases.<sup>6</sup> More recently, Meijndert and colleagues<sup>9</sup> reported that only 66 percent of single-implant crowns in 99 patients were rated acceptable by a prosthodontist, despite high patient satisfaction.

**TABLE 3 — Procedural Control of Peri-Implant Mucosal Architecture**

- *Esthetic diagnosis using objective criteria*
- *Determination of the adjacent connective tissue attachment*
- *Diagnostic Wax-Up with emphasis on peri-implant mucosal architecture (evaluation of the residual alveolar ridge)*
- *Assessment of bone-to-prosthesis relationship (CBCT/bone sounding)*
- *Possible bone and/or soft tissue augmentation to support objectively defined crown form*
- *Ideal placement of the implant relative to the planned gingival zenith*
- *Creating the ideal peri-implant mucosal architecture using well-formed provisional crowns and abutments*
- *Selection of abutment and crown materials to support peri-implant mucosal health*
- *Removal of cement from the sulcus*

This may be the result of soft tissue changes. For example, the measured mean apical displacement of facial soft tissue was 0.6 mm one year after crown placement on abutments at flat-to-flat dental implants (Cardaropoli and colleagues).<sup>21</sup> In contrast, Cooper and colleagues<sup>13</sup> reported the stability of the facial soft tissue contour at conus design implant/abutment interfaces throughout a three-year period after dental implant placement and provisionalization.

It may be possible to exert clinical control over the facial soft tissue contours that control single-implant esthetics. Recognizing the initial limitations and guiding treatment planning by the use of the objective criteria for dental esthetics are essential to this process. Targeting the clinical and biologic factors affecting these criteria, particularly the buccal tissue contour, may improve single-dental implant esthetics. The influence of component selection is suggested but remains unproven. Nonetheless, the controlling depth of implant placement, managing peri-implant mucosal biology by limiting inflammation, and managing peri-implant mucosal morphology through ideal abutment selection and provisionalization extend the clinical control of single-tooth dental implant esthetics.

*ZirDesign is a trademark of Astra Tech Inc.*

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Reprinted with permission of Blackwell Publishing Ltd. Cooper L. Master of Esthetic Dentistry Objective Criteria: Guiding and Evaluating Dental Implant Esthetics. *Journal of Esthetic and Restorative Dentistry* 2008;20(3):195-205.

# Clinical Tip

## whatimplantisthat.com



The popularity of implant treatment has grown rapidly over the last 30 years. With today's mobile society, it seems that every week a patient walks into the office with an implant that needs to be restored, repaired or redone. Many times, the patient's implant case was done by another dentist. As experts, we want to do the best job possible for that patient, but all too often we lack the knowledge needed about the details of the implant. This presents many challenges in helping the patient attain his or her desired final result. With the hundreds of dental implants available, it can seem almost impossible to identify what you're dealing with.

That's where whatimplantisthat.com comes in. This innovative website hosts a database of radiographs for quick identification of implants. The database is categorized by common characteristics, including whether the implant has a tapered or nontapered design and whether there are holes in the apex. This system allows you to quickly filter the radiographs, making it easier to find what you're looking for and proceed with treatment.

Created by Drs. Nate Farley and Kent Howell, the site evokes a community environment of camaraderie, relying on clinicians to upload images from their completed implant cases. Currently, the system has more than 150 images, and that number grows every day.

Other information you can find on the site includes: the implant company's name, website and contact information; links to the company's catalog; and driver size and torque values.



- Your resource for quick implant identification
- Never again wonder: What implant is that?
- Practical aid for GPs and implantologists

# The Role of the Scan/Radiographic Index



by **Bradley C. Bockhorst, DMD**

A critical step in the Digital Treatment Planning process is ensuring the scan appliance remains completely seated and the upper and lower teeth are separated during the CT/CBCT scan. This can be accomplished with a scan index (also known as a Radiographic Index). It is basically a bite registration of the Scan Appliance related to the opposing dentition.

We have found Capture® Clear Bite from Glidewell Direct to be an excellent material for the fabrication of a scan index. It is a clear, radiolucent, medium-viscosity vinyl polysiloxane material (*Fig. 1*).



**Figure 1:** Capture Clear Bite from Glidewell Direct

## LAB FABRICATION

The Scan Appliance is seated on the articulated model. The pin is opened 4 mm to 5 mm to separate the teeth. Capture Clear Bite is injected onto the occlusal surfaces of the entire arch and the articulator is closed (*Fig. 2*). Once the material has set, the Scan Appliance, scan index and models are shipped to your office.

## CHAIRSIDE FABRICATION

If the lab does not have articulated models, the scan index can easily be fabricated chairside. First, ensure the Scan Appliance is fully seated in the patient's mouth. For partially edentulous cases, inspection windows provide a means to verify seating (*Fig. 3*). Next, inject an ample amount of Clear Bite around the entire mandibular arch, as if you are making a standard bite registration. Guide patient into closure so the occlusal surfaces of the Scan Appliance and the opposing dentition are slightly separated.

If you are sending the patient to a radiology lab for his or her scan, ensure the patient and the radiology technician are familiar with the procedure for proper seating of the Scan Appliance and scan index.

If a dual-scan protocol is being performed, the patient is scanned with the Scan Appliance and scan index (*Fig. 4a*). A second scan is done of the Scan Appliance alone (*Fig. 4b*). Don't forget to remove the scan index!

## CONCLUSION

Proper understanding and use of the Scan Appliance/Radiographic Index will ensure complete seating of the Scan Appliance and help your Digital Treatment Planning and guided surgery cases go smoothly.



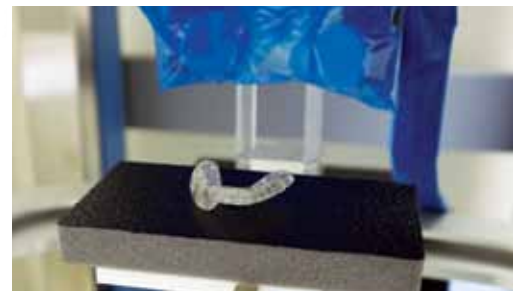
**Figure 2:** Lab-fabricated Scan Appliance or Radiographic Index



**Figure 3:** The cusp tip can be seen through the inspection window.



**Figure 4a:** The patient wears a Scan Appliance and scan index during a CT/CBCT scan.



**Figure 4b:** A second scan is done of the Scan Appliance alone.



# Priced to Sell

## Dental Fee Psychology



by **David Schwab, Ph.D**

When presenting fees to patients, case acceptance often hinges on how many options are presented, and the manner in which those options are presented.

### Consider the following scenarios:

**1.** The patient is offered one fee — \$5,000, for example. The patient has two choices: accept or decline the treatment. Even if this is a very reasonable fee for the proposed treatment, the presentation comes down to a “take it or leave it” offer.

**2.** The patient is offered two options: \$5,000 for the recommended treatment plan and \$3,500 as another option, which, while not ideal, will still provide the patient with benefits. When presented with two options, most (but not all) patients will opt for the lower of the two fees. Hence, offering two options actually creates three choices: accept the ideal treatment plan, accept lesser but still salutary treatment or decline all treatment. The number of patients who choose to do nothing will decrease because some people who do not elect the \$5,000 treatment plan will accept the \$3,500 option. When it is clinically impractical to offer two options, consider phasing treatment. The patient is given the option of doing everything now for a fee of \$5,000, or doing just Phase One now for a fee of \$3,500. Phase Two can be completed later for about \$1,500.

*It is not always the amount of the fee that makes the critical difference, but how the fee is presented in relation to other options.*

**3.** The patient is offered three options: good, better, best. The fees might look something like this: good (\$3,000), better (\$5,000) and best (\$7,000). When offered three treatment options, many patients will talk themselves into the middle option. This strategy is what I call “Goldilocks” pricing. The patient might decide that the best option is too expensive, the least costly option might not totally solve the problem, but the middle option is “just right.” Keep in mind that because doing nothing is always an option for the patient, three options are actually four, and the more choices presented, the less likely it is that the null option will be chosen.

*The patient is offered three options: good, better, best.*

To further improve the odds that the patient will choose one of the treatment options presented (instead of the unspoken fourth option of declining treatment), take a page from author Dan Ariely, whose influential book “Predictably Irrational” offers many good insights. Ariely discusses hard and soft anchor prices. He states that consumers view prices ending in zero as soft anchors; people want to move off them. Prices that end in other numbers, however, are hard anchors, because, while everyone wants a deal, people are more accepting of odd-looking prices. For example, retailers know that an item priced at \$19.95 is more likely to sell than the same item priced at \$20. Consumers do not care about the nickel, but that very round number of \$20 becomes an unacceptable price point to some. Ariely makes the point that because consumers are more likely to purchase an item priced at \$19.95 than an identical one priced at \$20, their behavior is at once predictable and irrational because consumers report in surveys that a five-cent price difference is insignificant. The lesson for dentistry is that fees need to be quoted using hard anchor prices. Using this model, the three options might be presented this way: good (\$3,185), better (\$5,273) and best (\$7,183).



*An extra service  
should not be treated as  
though it were an afterthought, but  
instead made an integral part of  
the overall pricing strategy.*

This example contains a double dose of psychology: three options, which inherently increase the chances that the patient will accept some form of treatment (often the mid-priced choice); and odd-ball, hard anchor pricing to make all the fees seem more palatable than large, round numbers ending in zero.

A real-life example illustrates the point. There was a doctor who presented a number of patients with the option of implant-retained overdentures. Many patients simply declined treatment, which is not surprising because they were given an all-or-nothing choice. This doctor then started offering his patients three options: good (conventional dentures), better (overdentures) and best (full fixed implant case). He used odd-ball pricing for each of the three options and explained to patients the limitations of conventional dentures, the benefits of overdentures, and the benefits but admittedly high cost of a full fixed implant case. He asked patients to make their own decision and said he would not be disappointed if the patient did not take the best option, as the overdenture option would provide a very satisfactory result. Patients were naturally drawn to the middle option, and when the doctor in effect gave the patient permission to choose overdentures, barriers dropped away and case acceptance soared.

4. Another strategy also takes a page from Ariely's book. Instead of offering three distinct options, present three choices where the third possibility is a value-added version of the second. For example, the patient is offered the following restorative choices: upper teeth only (\$3,715); upper and lower teeth (\$7,727); upper and lower teeth and free in-office whitening (\$7,727). Note that the fee for the second and third options are exactly the same; the important difference is that the "free in-office whitening" is now a value add. Ariely argues persuasively that when consumers are presented with three options and the third is a value-added version of the second, a significant number of people choose the third option. In this example, I have used whitening as the value add because many restorative doctors have told me that when they do a fairly large restorative case, they "throw in" the whitening. It is fine to throw in the whitening; however, this extra service should not be treated as though it were an afterthought, but instead made an integral part of the overall pricing

*While everyone wants a deal,  
people are more accepting  
of odd-looking prices.*

strategy. By offering whitening (or some other service) as a third option in the form of a value add, the practice will end up closing larger cases.

Doctors should analyze their case acceptance patterns and endeavor to use these templates. It is not always the amount of the fee that makes the critical difference, but how the fee is presented in relation to other options. By being aware of price psychology, doctors can create value in the patient's mind for proposed treatment.

# BruxZir®: Virtually Bulletproof What Is It? Why Does it Work?



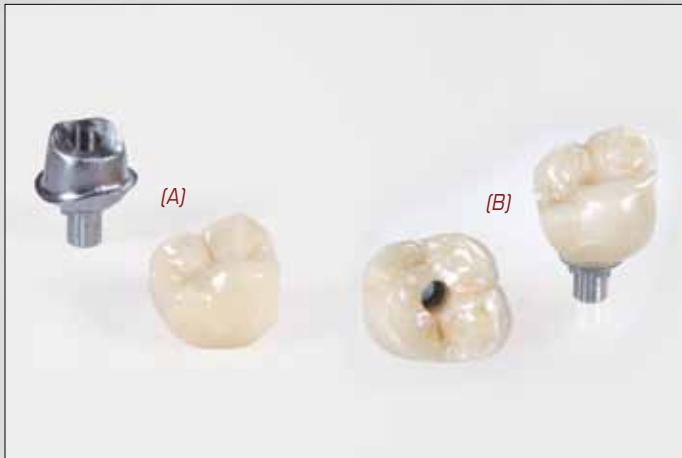
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by [Robin A. Carden](#)

Zirconia has been a popular dental material for the last several years for many reasons. It is used to create copings for crowns, frameworks for bridges and custom implant abutments for implant cases. Glidewell Laboratories has recently introduced BruxZir® Solid Zirconia, a full-contour zirconia restoration with no porcelain overlay. Made from zirconium oxide powder, this advanced material has been refined to produce the strongest and most reliable all-ceramic to date. This article provides a material science overview of zirconium dioxide ( $ZrO_2$ ), one of the most studied ceramic materials in the world.

Also known as zirconium oxide or zirconia, it is commercially available in two basic forms: naturally, as the mineral Baddeleyite, and synthetically, as derived from zircon sand ( $ZrSiO_4$ ). Zirconia powder (zirconium oxide,  $ZrO_2$ ) is synthesized from zircon sand ( $ZrO_2 \cdot SiO_2$ ) using a solid-state reaction process. Several oxides are added to zirconia to stabilize the tetragonal and/or cubic phases: magnesium oxide (MgO), yttrium oxide ( $Y_2O_3$ ), calcium oxide (CaO) and cerium (III) oxide ( $CE_2O_3$ ), among others. Zirconia is a unique advanced ceramic, a chemical compound having the formula  $ZrO_2$ . BruxZir is manufactured from yttria-stabilized



(A) Inclusive Titanium Abutment and BruxZir crown. (B) One piece screw-retained BruxZir with titanium insert.

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*The fracture toughness, or K1C value, for partially stabilized zirconia is high because of a unique event called phase transformation toughening.*

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zirconia (YSZ) powder, which exhibits superior mechanical properties such as high strength and flexibility. A technological breakthrough, YSZ surpasses the strength limitations of traditional fine ceramics. The yttria-stabilized zirconia has potential for use in a wide variety of applications—everything from telecommunications to the new energy of the future to environmentally friendly products.

Partially stabilized zirconia is an ideal material for dental restorations like BruxZir because of the four physical properties it exhibits.

The first is high flexural strength. Typical zirconia materials have a flexural strength of more than 1,200 MPa. However, because of post-powder processing, BruxZir Solid Zirconia dental restorations are able to exceed that strength threshold, with flexural strengths up to 1,465 MPa.

The second is high fracture toughness, or K1C value. For example, a piece of lead or steel has high fracture toughness; glass or brittle materials have a low value. The fracture toughness for partially stabilized zirconia is high because of a unique event known as phase transformation toughening that occurs in the material. The toughening mechanism comes into play when a crack is encountered. The cubic grains are constraining the tetragonal precipitates that want to expand and release associated energy. When these grains are faced with a propagating crack tip, the tetragonal phase is released and allowed to change back to the more stable monoclinic phase. This results in the associated volumetric expansion, effectively closing the advancing crack. A kind of self-healing event occurs. This also means the material has high impact resistance.

The third property is excellent resistance to thermal shock. Zirconia has relatively low thermal expansion numbers, which means it will remain very stable in the mouth.



Unsintered BruxZir Solid Zirconia crowns (intaglio surface)



Unsintered BruxZir Solid Zirconia crowns (occlusal surface)



*This patient presented with a failing amalgam restoration.*



*BruxZir Solid Zirconia crown shown on a natural abutment*



*Inclusive Custom Titanium Implant Abutment*



*BruxZir Solid Zirconia crown*



*Screw-retained BruxZir Solid Zirconia crown*



*Screw access opening sealed*

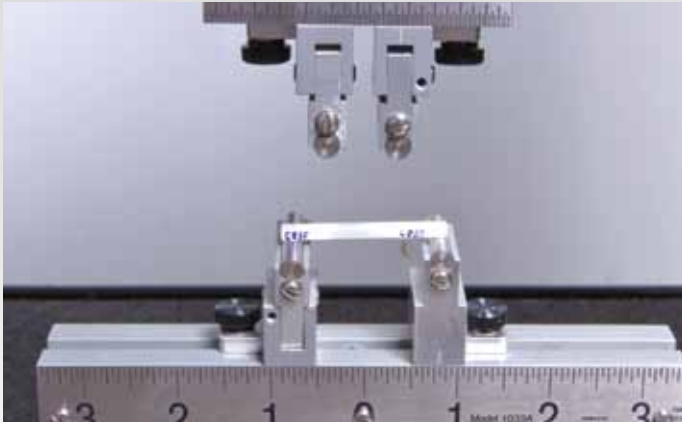
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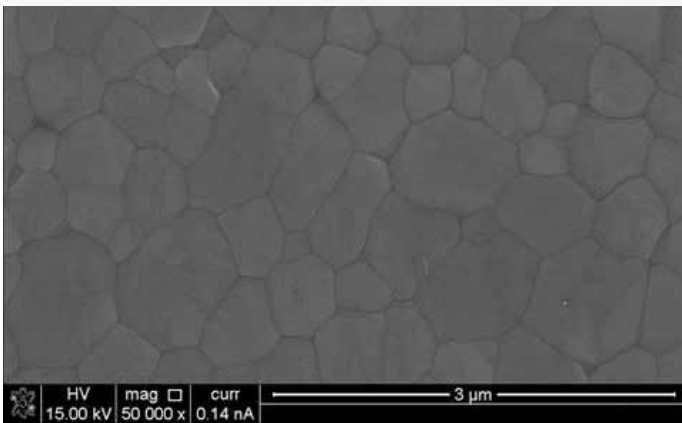
*In looking to create the strongest zirconia in the world, we found something else has happened: We created a zirconia with improved translucency.*

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*This Instron machine provides the measurement of a material's mechanical properties, including flexural, fracture and tensile strength.*



*This SEM machine photo exhibits the crystalline structure of zirconia.*

The fourth, and most innovative, is color and translucency. Zirconia has a natural opaque white hue, but Glidewell Laboratories has recorded advancements that allow zirconia to be changed into a more desirable translucent natural ivory shade. This shade is much more lifelike than typical snow-white zirconia. The lab's scientists start with the most pure powders available and create better chemistry by refining particulates via size reduction and blending.

The laboratory then creates a green pre-form with very high pre-bisque firing density by using unique consolidation processes. These processes allow the smallest particulates to be as close as possible before the machining starts. By doing this, the lab also reduces the elongation factor, which means a more accurate crown dimension. After machining, the part is sintered to full density. By using these processes and refining the starting powder, we are able to create a material that has small grain size, which improves flexural strength and fracture toughness. As a crack moves through a material's grain boundaries it is deflected by the material's grains. If a material has many grains to deflect and take energy out of the force of the crack, it becomes inherently stronger. But in looking to create the strongest zirconia in the world, we found something else has happened: We created a zirconia with improved translucency. Focusing on smaller particulates created better translucency. And BruxZir Solid Zirconia has a higher translucency than other dental zirconias.

Getting back to the workings of the material, in the field of mechanical properties, strength and toughness are related as follows. Brittle materials may exhibit significant tensile strength by supporting a static load. Toughness, however, indicates how much energy a material can absorb before mechanical failure. Fracture toughness is a property that describes the ability of a material with inherent microstructural flaws to resist fracture via crack growth and propagation. Methods have been devised to modify the yield strength, ductility and fracture toughness of both crystalline and amorphous materials. Fracture toughness is a quantitative way of expressing a brittle material's resistance to fracture when a crack is present. This is one of the most important properties of any brittle material for virtually all design applications. If a material has a high value of fracture toughness, it will probably undergo ductile fracture. Brittle fracture is very characteristic of most ceramic and glass-ceramic materials, which typically exhibit low and inconsistent fracture toughness.

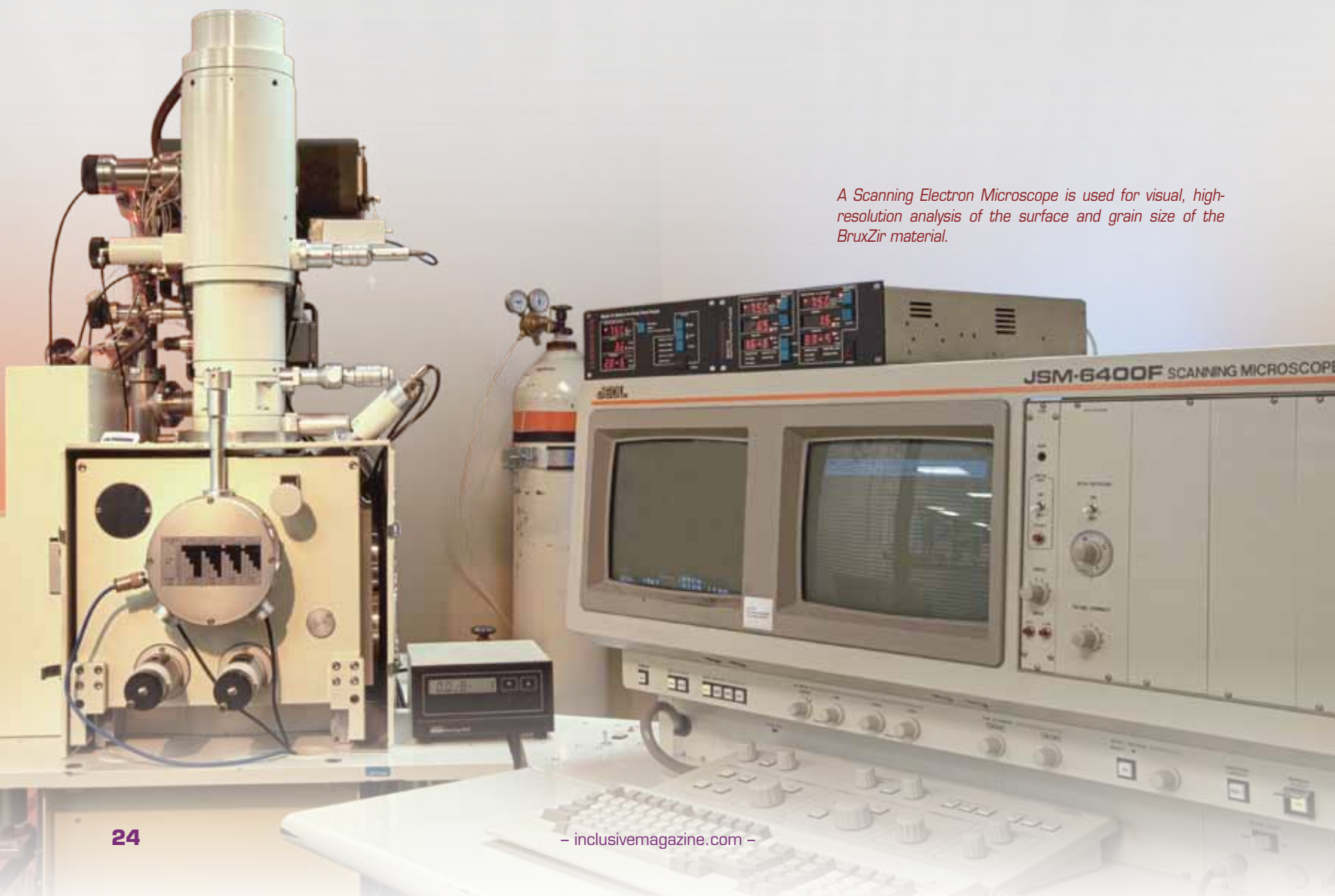
Transformation toughening was a breakthrough in achieving high-strength ceramic materials with a high value for fracture toughness. For the first time, a ceramic material was available with an internal mechanism for actually inhibiting crack propagation. A crack in a traditional ceramic travels all the way through the ceramic with little inhibition, resulting in immediate and brittle fracture and catastrophic failure. The partially stabilized zirconia

exhibits a fracture toughness that is three to six times higher than normal zirconia and most other ceramics. Partially stabilized zirconia is so tough that it can be struck with a hammer or even fabricated into a hammer for driving nails.

These innovations led to the development of BruxZir Solid Zirconia, which is indicated for bruxers and grinders as an esthetic posterior alternative to metal occlusal PFMs or cast-metal restorations. Designed and milled using CAD/CAM technology, BruxZir is sintered for 6.5 hours at 1,530 degrees Celsius. The final BruxZir crown or bridge emerges nearly chip-proof and is diamond polished and glazed to a smooth surface.

Another beneficial physical characteristic of BruxZir is its wear properties. The Glidewell R&D team has determined that diamond polishing the BruxZir crown provides long-term life for opposing enamel surfaces. This wear compatibility has been validated in enamel wear “in-vitro” studies, and clinical studies are currently under way as well.

*To learn more about BruxZir® Solid Zirconia or to find a lab that offers it, visit [bruxzir.com](http://bruxzir.com) or call 800-854-7256.*



*A Scanning Electron Microscope is used for visual, high-resolution analysis of the surface and grain size of the BruxZir material.*

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# Digital Implant Treatment Planning

## Restoration of Maxillary Posterior Single Teeth



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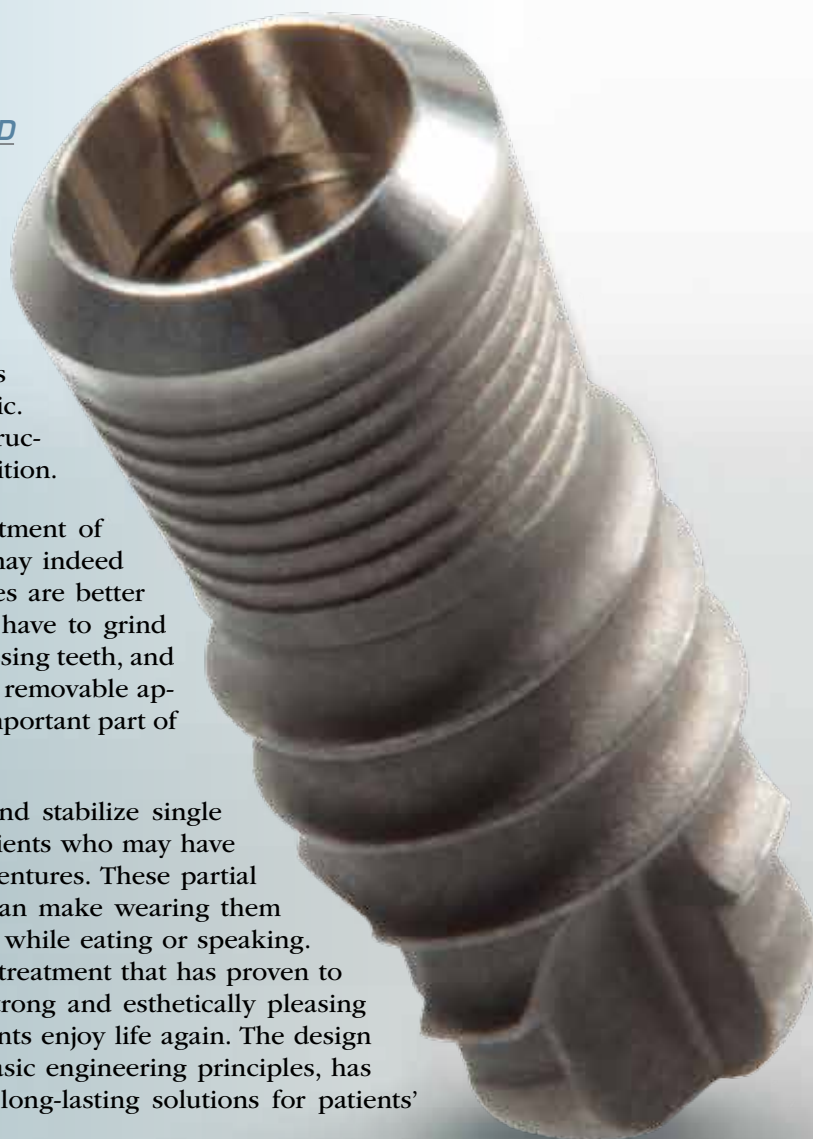


*Article and photos  
by Timothy F. Kosinski, DDS, MAGD*

Dental implants have undergone many positive advances in recent years. Our successes have dramatically increased, to the point where implant dentistry has become a constructive and simple alternative to conventional dental procedures. When a patient is missing one or more teeth, single dental implants prove functional and the final restorations esthetic. The newest materials can predictably match the structure, contour and lifelike qualities of natural dentition.

Partial dentures and bridges have been the treatment of choice in dentistry for generations. The results may indeed be acceptable, but the newest implant alternatives are better and less traumatic to the patient. We no longer have to grind down healthy tooth structure to replace single missing teeth, and patients no longer have to bear the restraints of a removable appliance. Today, dental implants are a viable and important part of tooth replacement in our practices.

The use of dental implants to support, retain and stabilize single crowns greatly improves the quality of life in patients who may have been deemed candidates for removable partial dentures. These partial appliances can be difficult to wear. Sore spots can make wearing them miserable, and they can move around the mouth while eating or speaking. It is intuitive that replacing missing teeth with a treatment that has proven to have an outstanding prognosis, is functionally strong and esthetically pleasing is a better option. Dental implants can help patients enjoy life again. The design of our modern dental implants, which follows basic engineering principles, has allowed the implant dentist to create beautiful, long-lasting solutions for patients' dental problems.



However, there are still concerns with any surgical procedure, especially in the sinus areas or in bone where nerves are located. These concerns have popularized the newest concepts in implant dentistry. We are now able to utilize CAD/CAM computer software to virtually place dental implants using CT scanning software to visualize the patient's entire oral anatomy in three dimensions, which takes only a few minutes. The reluctance to place implants in certain anatomic areas is eliminated with the virtual evaluation of anatomy and placement of the implants in question. We are now certain of ideal placement or have the ability to abort the case or consider additional procedures before touching the patient.

The information from a CT scan can be used by several scanning software programs. For this case we selected Simplant® (Materialise Dental Inc.; Glen Burnie, Md.). This system has an open architecture, which allows us to virtually choose the desired implant and position it based on the vital anatomy. Digital treatment planning is proving to be a cost-effective solution to assist the implant dentist in planning an esthetic final result and minimize any surgical challenges he or she may face. Patient acceptance is improved because concerns the individual may have can be addressed in a precise manner.

CT technology is based on planning algorithms used clinically for many years. CT scans and 3-D planning software can greatly improve our predictability and safety. This technique can be used for single-tooth edentulous spaces, like in the clinical case that follows, partially edentulous spaces, fully edentulous maxillary and mandibular overdenture cases, or fully edentulous maxillary and mandibular full-arch permanent restorations. The surgical cases are, therefore, driven by the final esthetic and functional result. It is critical to make sure that the final tooth contours are established prior to any surgical intervention. Placing the dental implants in the jaw before understanding tooth position and the final result is a big mistake.

CT planning placement systems, like Simplant, provide a high level of comfort and safety for the patient by reducing surgical and restorative time. This is done by utilizing an accurate three-dimensional plan prior to implant placement. There are obvious advantages, including: easy visual understanding for clear case presentations to the patient, reduced surgical chairtime, reduced restorative chairtime in certain cases, reduced stress for the clinician and the patient, the avoidance of surprises during surgery, implants that are placed optimally for long-term implant and prosthetic success and, most importantly, an improved esthetic result.

Typically, a scan appliance should be fabricated by the lab. This appliance shows the ideal prosthetic position of the teeth in the planning software. In a single implant case, a CT scan alone can be used to diagnose and

virtually place the implant of choice. The planning software allows you to drop virtual teeth into the edentulous area.

The surgical placement of dental implants can be done in a conventional manner using the information gathered in diagnosis using the CT image or a surgical guide created to help direct the implants in the ideal position. Based on the amount of attached gingiva, these cases can often be completed through a flapless procedure.

Our patient in the case that follows is a 44-year-old female with several dental problems. The right and left maxillary first molars had been extracted years earlier. The mandibular arch will be restored with grafting and implants in the future. The main objective was to establish a correct occlusal plane relationship and improve the esthetics.

Our choice of implants was SybronPro XRT™ dental implants (Sybron Dental Specialties; Orange, Calif.). The SybronPro XRT implant design incorporates innovative microthreads, a mount-free delivery system and self-taping threads. An internal octa or hex pattern allows for great stability of the platform-switching abutments. Here, a 4.8 mm crestal width, 4.1 mm body, 9 mm tall implant was used in the tooth #3 area. The determining factor in shape and size of the implant was based on the height and width of bone below the sinus. If less bone had been available, a sinus lift may have been necessary. The edentulous area of tooth #14 was an ideal place for a 4.1 mm by 9 mm internal hex implant. Two different implants were used in contralateral positions to describe the surgical technique and final implant restorations of each design.

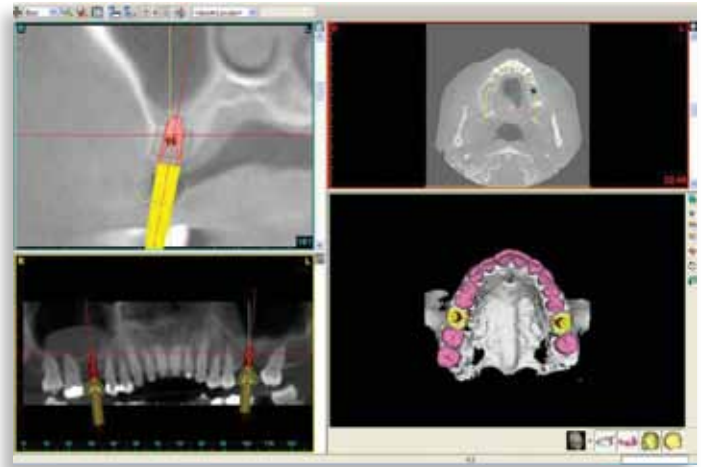
Final restoration consisted of a titanium abutment and cemented crown. Three different types of crowns were fabricated by the dental laboratory for comparison purposes, including esthetic and durable PrismaTik CZ™ (zirconia coping with porcelain veneer), conventional porcelain fused to metal and BruxZir® Solid Zirconia. It was determined that the PrismaTik CZ crown was the most esthetic and would be durable. The abutment screws were tightened to 25 Ncm, the screw access openings sealed and the crowns cemented into place.

## CONCLUSION

Implants provide an excellent option for restoring missing single teeth. CT scans and planning software prove invaluable in treatment planning. This case highlights the technique to restore missing posterior maxillary teeth utilizing a minimally invasive surgical procedure leading to an esthetic, functional prosthetic result.



**Figure 1:** Periapical of edentulous maxillary right first molar area. How much vertical and height of bone do we really have?



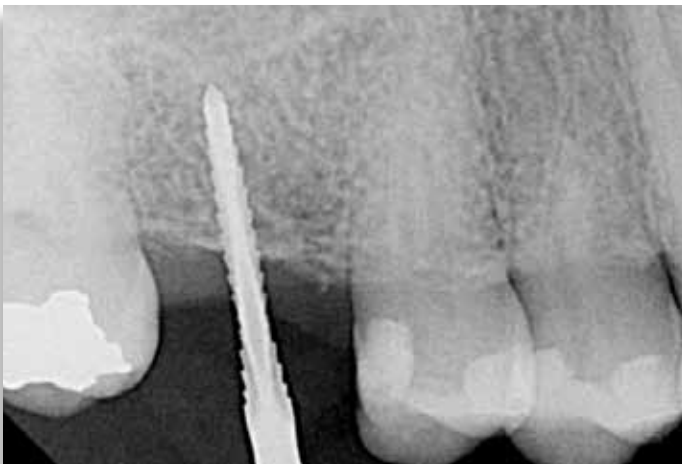
**Figure 2:** CT digital plan illustrates panoramic cross-sectional and axial views, as well as three-dimensional rendering of the patient's maxilla. Simple panoramic radiographs or periapicals do not give the 3-D image achieved with CT scanning. Note: The patient had a large polyp in the maxillary right sinus. The sinus membrane is slightly thickened on the left side.



**Figure 3:** Occlusal view of tooth #3 area. It appears clinically that we have adequate width of bone, but the CT gives us an exact interpretation of the amount of bone present.



**Figure 4:** The Sybron implant system is simple and precise. The first drill used to initially determine angulation is the Lindemann Guide. This is a very sharp drill with a point. It also allows for lateral positions, as it also cuts on its side.



**Figure 5:** A digital radiograph is taken to determine angulation of the primary drill.



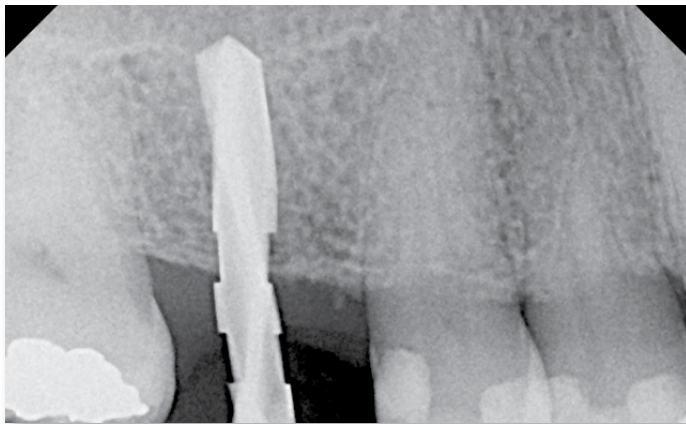
**Figure 6:** A sharp tissue punch blade removes soft tissue at the surgical site and eliminates the need for a full thickness flap. Sutures will not be required after implant placement.



**Figure 7:** The soft tissue is removed with a curette.



**Figure 8:** The 2.2 mm diameter Twist Drill is used to establish depth, followed by the 3.3 mm and 4.1 mm Twist Drills. The black lines are clearly delineated: 7 mm, 9 mm, 11 mm, 13 mm and 15 mm. Note the gingival was approximately 3 mm in height, so in determining a visual of how deep to place the implant, the 9 mm we want the implant to go into bone is added to the 3 mm of soft tissue height. Therefore, the line markings on the Twist Drill is visualized to 12 mm.



**Figure 9:** Radiograph of 3.3 mm Twist Drill in site. Note the notches of the drill itself. The first break is at 7 mm, the second at 9 mm. This is intended to be our final depth, just at the floor of the sinus.



**Figure 10:** The SybronPRO XRT Octa implant is picked up on the implant driver.



**Figure 11:** The motor is turned down to record 25 Ncm of torque. The implant is driven into the osteotomy site and stops when 25 Ncm of torque is achieved.



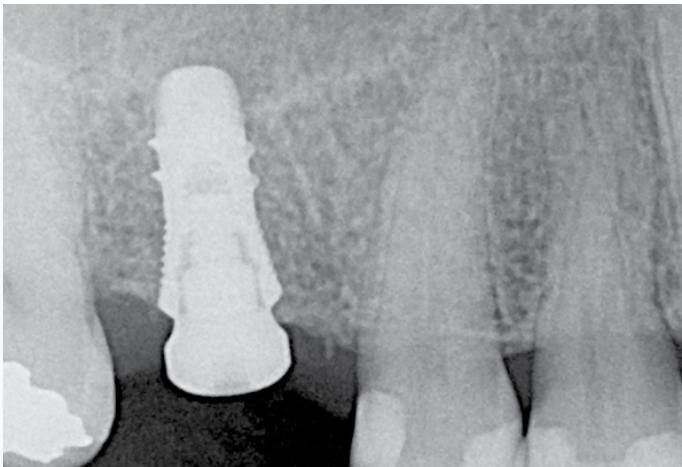
**Figure 12:** Final seating and the tightness of the implant in bone is accomplished with the torque wrench. The wrench is marked at 15, 25 and 35 Ncm. We easily achieved 25 Ncm of torque on this implant in the maxillary right first molar area.



**Figure 13:** Either a cover screw or a taller healing abutment can be safely placed into the implant to allow for tissue healing.



**Figure 14:** The healing abutment is tightened to 15 Ncm, which will prevent any loosening during the healing phase. Note there is no bleeding; no sutures were required. This is a very noninvasive therapy.



**Figure 15:** A radiograph of the Sybron Octa implant shows the position immediately after surgical placement. Note the platform-switching design of the healing abutment.



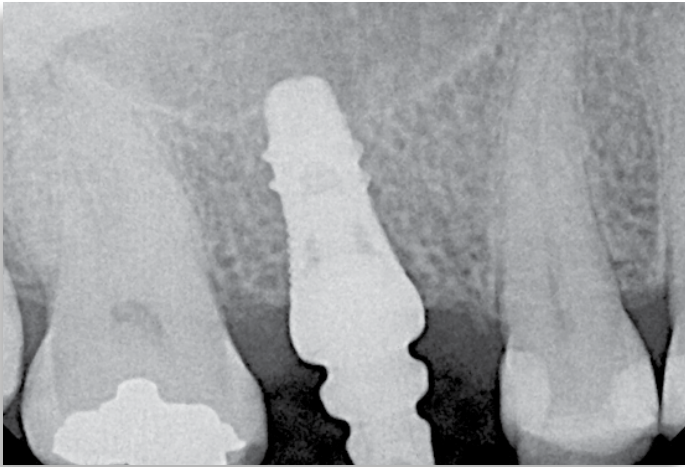
**Figure 16:** Tissue healed around the healing abutment after four months of integration. The patient had no symptoms and only took a Tylenol for discomfort the day of surgery. The healing abutment is removed from the implant. Note healthy gingival cuff created by the healing abutment.



**Figure 17:** A direct impression is planned. The impression system is a two-piece system with an octagon base that engages the internal design of the Sybron implant and a screw that threads it into position.



**Figure 18:** A hex driver is used to place the impression coping.



**Figure 19:** A radiograph is taken to ensure a complete seat of the impression coping. This is a mandatory protocol procedure to ensure the impression coping engages the implant completely.



**Figure 20:** Note the clean contours of the impression. The impression coping must be retained properly in the impression to ensure a proper abutment and crown fabrication.



**Figure 21:** The impression coping is removed from the implant and mounted onto a laboratory implant analogue.



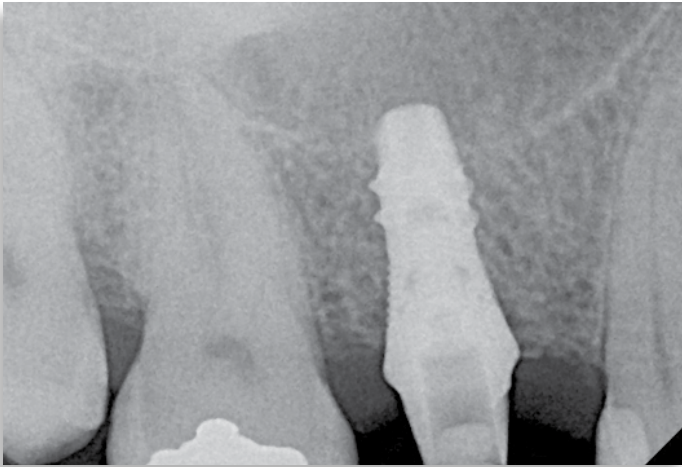
**Figure 22:** The head of the impression coping is resealed into the impression, a shade taken and the case sent to the lab.



**Figure 23:** The healing abutment is replaced in the mouth while the dental laboratory makes a master cast using the implant analogue to fabricate the proper abutment and crown.



**Figure 24:** The healing abutment is removed. The prepared abutment is seated and the abutment screw tightened to 25 Ncm.



**Figure 25:** A radiograph is taken to ensure a complete seating of the abutment into the body of the implant.



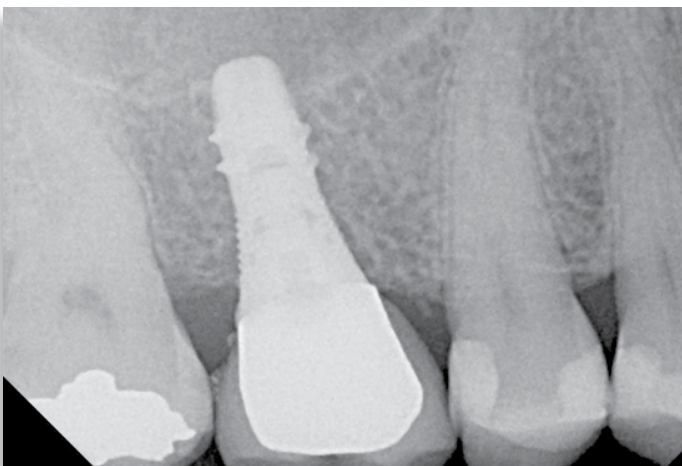
**Figure 26:** A piece of cotton or silicone is placed into the screw hole after tightening the abutment screw to the recommended torque. A little Cavit is used to cover the screw hole before crown cementation.



**Figure 27:** Three different designs and types of crowns can be fabricated by the dental laboratory: esthetic Prismatik CZ™, conventional PFM or durable BruxZir® Solid Zirconia. A Prismatik CZ crown was chosen for its esthetics and strength.



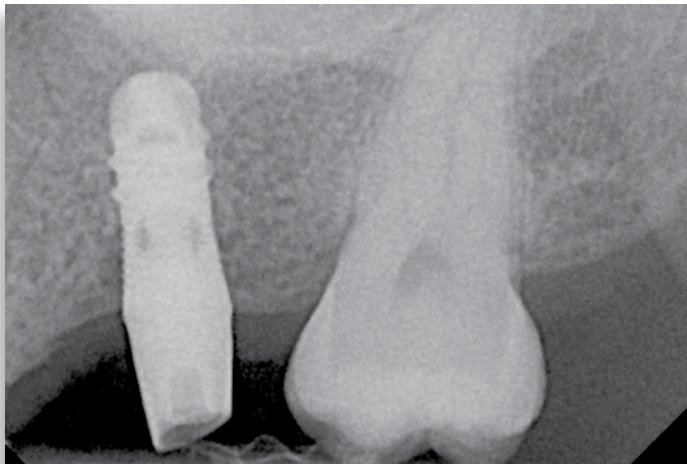
**Figure 28:** The Prismatik CZ crown is cemented into place.



**Figure 29:** Final radiograph of implant-retained maxillary first molar cemented into place.



**Figure 30:** Delivery of the final prosthesis for tooth #14: The healing abutment is removed, the hex abutment is seated and the abutment screw tightened to 25 Ncm.



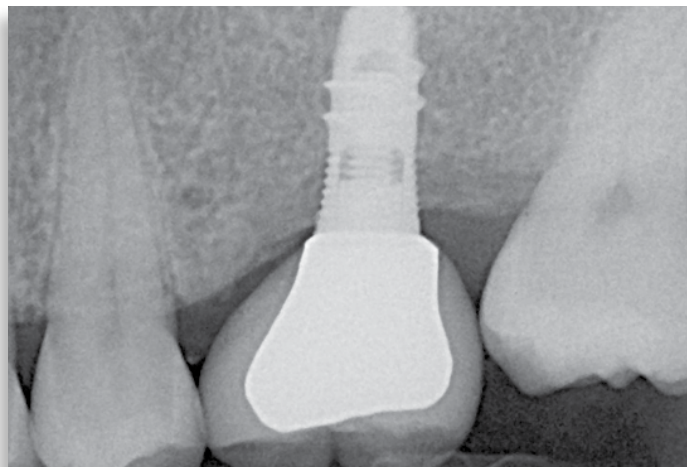
**Figure 31:** A radiograph is taken to ensure complete seating.



**Figure 32:** The abutment screw opening is covered with silicone or cotton and Cavit before crown cementation.



**Figure 33:** The PrismaTik CZ crown is cemented onto the abutment.



**Figure 34:** PA of the final restoration.

# Evaluating Limited Vertical Space When Replacing Posterior Teeth



by **Bradley C. Bockhorst, DMD**

As restorative dentists, we often are faced with cases in which the patient is missing one or more posterior teeth. If implant-supported crowns or bridges are being considered as one of the prosthetic options, the restorative space must be evaluated before the implant is placed (*Table 1*). If the bite has collapsed or the opposing teeth have supra-erupted, the vertical space may be limited. The table below lists the average crown lengths as a reference.

**Table 1: Average Length of Crown**

Tooth	Central Incisor	Lateral Incisor	Canine	First Premolar	Second Premolar	First Molar	Second Molar
Maxillary	10.5 mm	9 mm	10 mm	8.5 mm	8.5 mm	7.5 mm	7 mm
Mandibular	9 mm	9.5 mm	11 mm	8.5 mm	8 mm	7.5 mm	7 mm

*Wheeler's Dental Anatomy, Physiology and Occlusion. Ash M & Nelson S. Saunders 8th Edition. 2003.*

## □ Treatment Planning & Diagnostic Wax-Up

- Initial assessment of the edentulous space should be done during the clinical examination. This would include evaluating the vertical space when the patient is closed into centric occlusion.
- Articulated study models provide a standard diagnostic tool. The space can be easily measured and compared to the patient's remaining teeth (*Fig. 1-2*).
- A Diagnostic Wax-Up is an invaluable treatment planning tool, as well as a case-presentation and patient-education aid (*Fig. 3*). If you are utilizing digital treatment planning, the scan appliance/Radiographic

Guide is fabricated to illustrate the position and dimensions of the tooth (teeth) to be replaced (*Fig. 4*).

- Because the restoration begins at the top of the implant, the planned position of the implant becomes critical. Appropriate radiography should be taken to evaluate the quantity of bone in the proposed implant site. These images can also be used as an aid in evaluating the restorative space (*Fig. 5*). CT scans and treatment planning software are excellent diagnostic tools to plan the case from the surgical and prosthetic perspectives (*Fig. 6*).



**Figure 1:** The tooth #20 area with adequate space.



**Figure 2a, 2b:** Supra-eruption of tooth #2 and 3 limits the vertical space for #30 and 31.



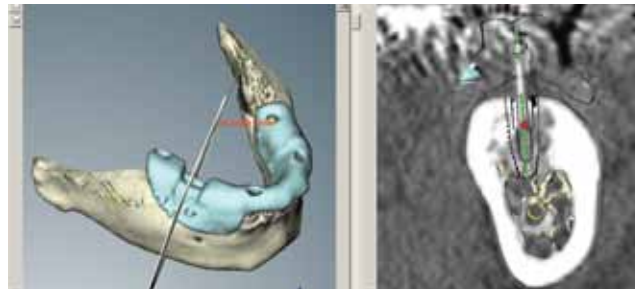
**Figure 3:** Diagnostic Wax-Up.



**Figure 4:** Radiographic Guide for replacement of tooth #19.



**Figure 5:** PA showing ridge height and restorative space.



**Figure 6:** Digital treatment planning from CBCT.

## □ Treatment Options

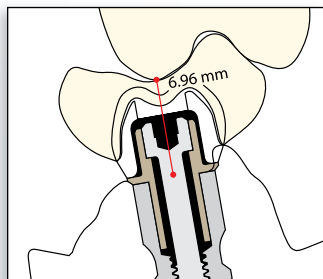
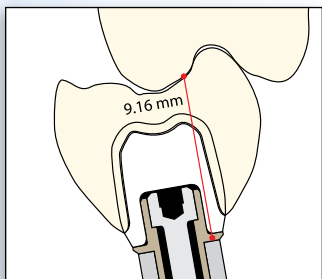
The patient should be presented with the prosthetic options as well as the consequences of not restoring the space. There are many ways the options can be presented. One is the “good, better, best” approach. As detailed in the article by Dr. David Schwab on page 18 of this issue, if the patient is missing one or more posterior teeth, a partial denture may be a good option, a fixed partial denture a better option and an implant-supported crown or bridge the best option (because prepping of adjacent teeth is unnecessary, hygiene is simpler and bone height is more easily retained, etc.).

If there is limited vertical space, the patient should be advised of the situation. Ideal treatment to create the appropriate space for the restoration should be presented. If the patient is unable or unwilling to undergo treatment, he or she should be aware of the compromise. It could eliminate the patient as a candidate for implant restoration in severe cases.

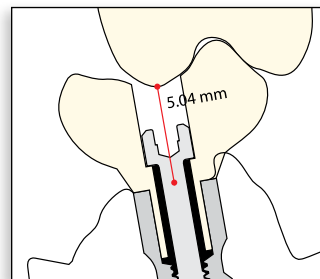
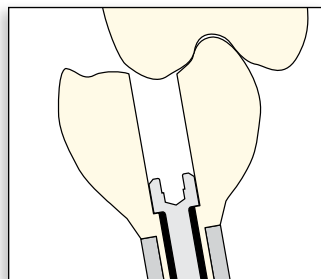
## □ Prosthetic Options

From a laboratory standpoint, there are minimal height requirements for cemented as well as screw-retained restorations\*:

- For a cemented crown or bridge over an implant, a minimum of 7 mm is needed from the top of the implant to the opposing dentition (*Fig. 7a, 7b*). This provides space for the abutment and the crown. The abutment can be shortened to the head of the abutment screw. Approximately 2 mm of occlusal space is needed for the crown.
- Because it is one piece, a screw-retained crown requires less vertical space than its cement-on counterpart. This restoration requires a minimum of 5 mm from the top of the implant to the opposing dentition (*Fig. 8a, 8b*). The head of the screw should be at least 1 mm out of occlusion so the access opening can be sealed.



**Figure 7a, 7b:** Ideal and minimum space for a cement-on crown.



**Figure 8a, 8b:** Space requirements for a screw-retained crown.

*Note: If you are going to take an impression of an abutment in the mouth, the occlusal space must be at least 2 mm. An abutment reduction guide can be fabricated and used as an aid.*

*\*These are minimum heights to allow space for the components and restorative materials. They will result in short clinical crowns. Reduced retention for cemented crowns will also result. To achieve the desired esthetics, additional vertical space may be required.*



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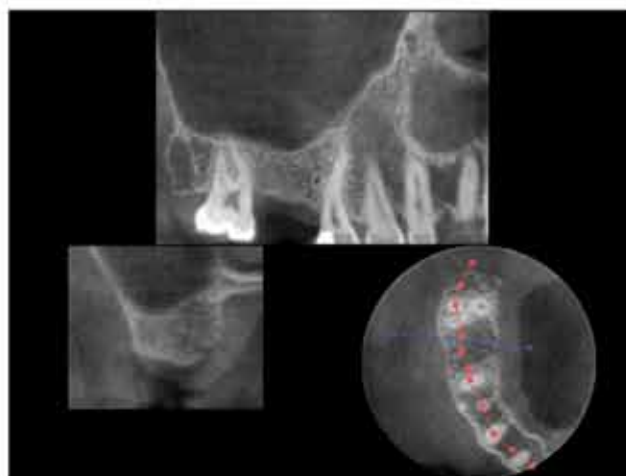
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