Computer-Generated Abutments Using A Coded Healing Abutment: A Two-Year Preliminary Report

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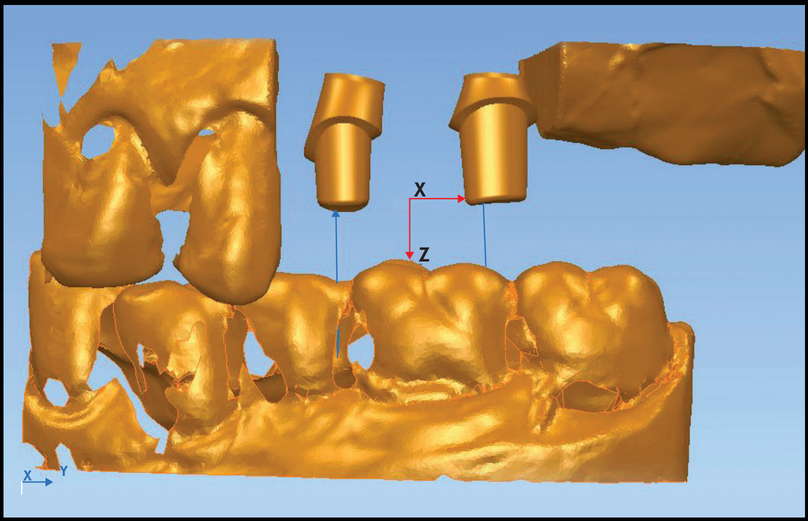

This article presents a preliminary clinical evaluation following the placement of 107 dental implants covered with computer-coded healing abutments. The healing abutment system evaluated herein provided information to specific computer software that facilitated the delivery of an anatomical definitive abutment. This system also assisted in the development of a titanium abutment whose characteristics mimicked the natural contours of the teeth being replaced. A two-year postoperative evaluation was performed to evaluate occlusion, gingival integrity, contact areas, inflammation, food impaction, porcelain integrity, radiographic condition and overall patient satisfaction. Improved tissue response and resultant aesthetics were observed.

Learning Objectives:

This article describes the clinical procedure associated with the placement of CAD/CAM-fabricated, implant-supported restorations. Upon reading this article, the reader should:

- Understand the long-term clinical implications of the use of a CAD/CAM implant system.
- Be aware of the advantages and considerations associated with the placement and success of implant-supported restorations.

Key Words: implants, CAD/CAM, soft tissue, aesthetics

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Clinical success and implant retention are dependent upon a variety of critical factors. Once an endosseous implant is positioned via an immediate or delayed restorative approach, some type of impression index of the implant head must be captured to relate the surrounding variables to the fixture position. The primary factors that influence this prosthetic restoration include the following:

- Width of the implant fixture;
- Distance of the gingival tissue circumferentially;
- Angulation of placement with respect to the occlusal plane; and
- Distance of the opposing arch from the cusp or incisal tip to the implant platform (WDAD).

Each of these factors, in conjunction with other restorative variables such as shade, occlusal anatomy, and the amount of hard tissue to be restored, are necessary to relate the optimal anatomical and natural features of the prosthetic implant abutment and restoration. Inevitably, this will allow the gingival tissues to heal around the restoration and to replicate the natural emergence profile, thereby providing an aesthetically pleasing prosthetic tooth replacement.[1-3]

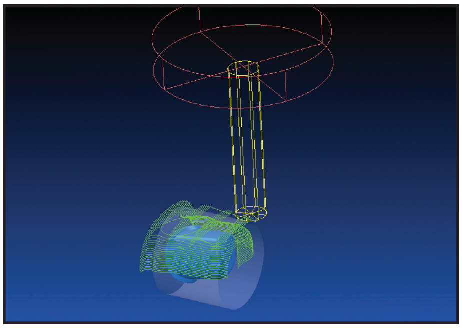

Figure 2. The CAD/CAM system allows precise, computerized development in the manufacturing of implant abutments.

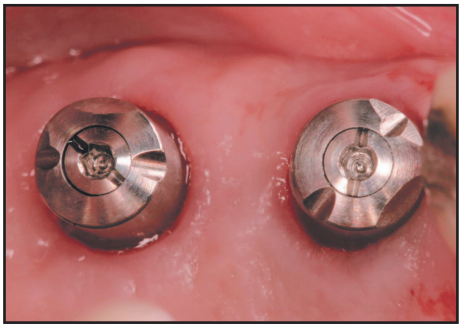

Figure 3. Preoperative appearance of the maxillary left quadrant. Periodontal therapy provided by Dr. Neil Karnofsky, New York, NY.

Historical Background

The UCLA abutment was traditionally used to create an emergence profile that began at the fixture level and continued through the gingival tissue to create a natural contour for the prosthetic restoration.[4] Unfortunately, the retaining titanium screws would invariably fracture, or the unsupported porcelain would fail.[5] The amount of laboratory time required for these restorations was often prohibitive, and the cost was so great that many clinicians could not afford to provide this service to their patients.[6]

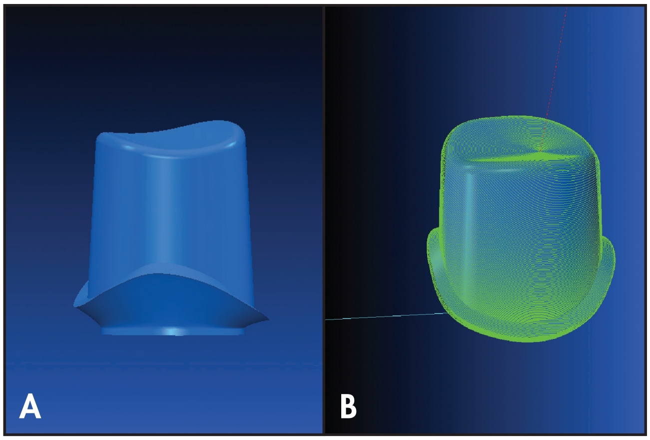

Figure 1A. A computerized abutment can be created using CAD/CAM technology to facilitate fabrication of the definitive restoration. 1B. The dimensions of the abutment can be customized to address each patient's needs.

As the technology advanced, many clinicians found it more cost-effective and efficient to use prefabricated abutments that facilitated the subsequent cementation of a porcelain restoration.[5] This technique was far less costly, which increased the overall acceptance of implant restorations as a viable solution for edentulism. The emergence profile was, however, sacrificed following the use of this technique as a result of the rounded abutment design.[3] Radiographic evaluation of these restorations also showed the presence of open margins, inadequate tissue support, overextended abutments, inflamed tissues, and potential gingival recession.

Computer-generated abutments are designed to conform to specific gingival biotypes for each specific implant on a three-dimensional scale. Once the design is approved, the information is transferred to a high-powered milling machine that then fabricates the titanium abutment from a machined block that corresponds to the specific implant fixture head. It is then cleaned, polished, and sterilized prior to insertion. The development of the ideal anatomical implant has been reported to reduce laboratory time

Figure 4. A model was poured and pin-indexed prior to scanning.

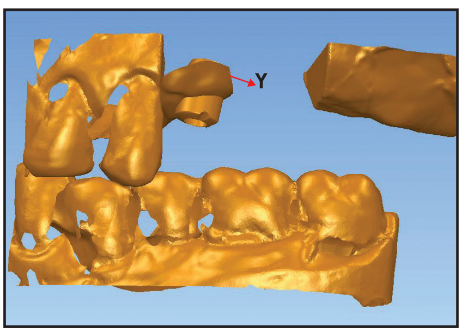

Figure 5. CAD/CAM technology was used to estimate the necessary positioning for the restoration. Note the simulated edentulism that assisted in proper abutment fabrication.

and cost (Figure 1). Preliminary results have demonstrated success using a contoured abutment for any tooth in the oral cavity that can allow the tissues to heal and ensure self maintenance.[7] The aesthetic results and the predictability of the restoration have allowed clinicians to restore missing teeth without having to speculate on the appearance of the final restoration or how the gingival region will respond. In addition, the use of ceramic abutments and restorations now provides a whole new meaning to "natural implant restorations."

The use of healing abutments that can be scanned by a computer and recorded (eg, Encode, Implant Innovations, Inc [3i], Palm Beach Gardens, FL) at Stage I or Stage II surgery will communicate the implant position and tissue variables to allow the CAD/CAM technology to create a perfectly contoured abutment for any specific tooth (Figure 2). This healing abutment has markings and codes programmed within it that correspond to the WDAD information.

A master cast is scanned with a digital scanner. A point cloud is produced from the scan and then translated with proprietary software. The design technician designs the case according to the instructions provided by the laboratory, including margin placement and style, emergence, and polishing instructions. After the design is complete, a tool path is created. The Encode Final Abutment is milled on a five-axis industrial mill from a solid blank of titanium alloy with a premachined BIOMET 3i interface (Certain with the QuickSeat Connection are External Hex with ZR). After milling, the Encode Abutment is polished, cleaned, packaged, and returned to the laboratory.

Materials and Methods

A total of 46 patients were treated with 107 implants. In nine patients, 11 implants were immediately restored with provisional restorations made of acrylic and composite materials. The remaining patients had delayed healing prior to Stage II surgery; the duration of the healing period was approximately three to five months. Stage II uncovering was performed using a flapless approach. The implants were also indexed with a rigid impression material by the implant surgeon. Healing abutments were positioned, and the gingival area was allowed to heal for three weeks.

After initial healing, impressions were made with a polyether material (eg, Impregum and Permadyne, 3M Espe, St. Paul, MN), and models were poured (Figures 3 through 5). The models were forwarded to the laboratory technician, along with a vertical dimension of occlusion (VDO) bite registration, an opposing model, and an original diagnostic waxup of the edentulous sites. The restorations were subsequently fabricated using CAD/CAM technology (Figures 6 through 10).

Porcelain-fused-to-metal castings were fabricated on the laboratory model. Computer-generated abutments

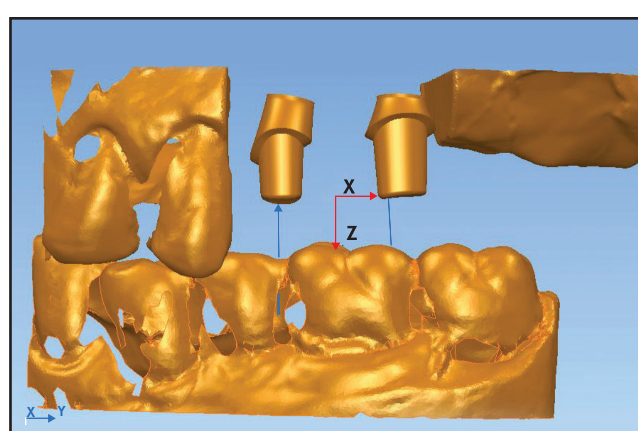

Figure 6. Proper abutment position is achieved during computerized simulation. This is critical for abutment angulation and development.

were placed in proper position three weeks following impression making. The fit of the restorations was verified, radiographs were obtained, and a final pick-up impression was made to negate any errors or shrinkage flaws up to that point. A VDO registration was made, and a revised counter model was created. This information was sent to the laboratory technicians to finalize the restorations (Figures 11 through 15).

Patients treated during this study were fitted with fixed partial dentures that spanned from one to eight units. The restorations were delivered with slight adjustments to occlusion and contact points, and cemented (eg, V-Bond, Temrex, Freeport, NY; RelyX, 3M Espe, St. Paul, MN). Although a single unit was delivered in three visits, this technique was more efficient than alternative methods. In addition, when restoring multiple units, full arches, and multiple quadrants, this third visit allowed the clinician to predictably deliver accurate restorations; chairtime and laboratory work were also minimized.

Postoperative Instructions

A variety of information was provided to the patients as one method of ensuring proper maintenance of the restorations postoperatively. Following documentation, an oral rinse was supplied, eating and maintenance instructions were provided, and recall and evaluation were explained to the patients as detailed below.

Documentation

All patients were given a written report of the components that were positioned via a Dental Implant Document. This allowed the patients to permanently retain information about the fixtures, screws, abutments, crowns, and cements used. This document has been useful for patients and clinicians alike; giving patients information about their restorations makes it easier for the subsequent clinician to understand what was performed.

Oral Rinse

A natural herbal rinse (ie, Natural Dentist Rinse, The Natural Dentist, Medford, MA) was prescribed postoperatively to reduce local bacteria without staining. The rinse was used for three weeks post-implant placement and for two weeks following delivery of the prosthetic restoration.

Eating and Maintenance

All patients were instructed on mastication techniques, and different eating patterns were shown to patients

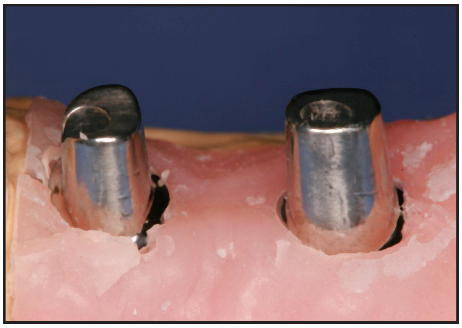

Figure 7. The CAD/CAM-fabricated implant abutments were milled by computer to ideal position, anatomy, and gingival contour.

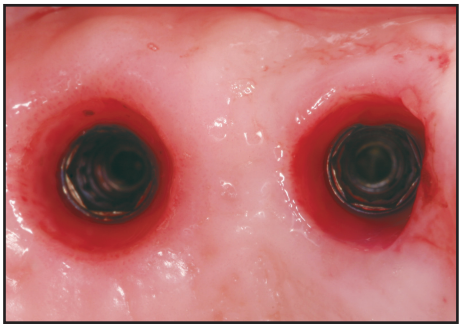

Figure 8. Note the appearance of the healed tissue architecture prior to placement of the definitive implant-supported restorations.

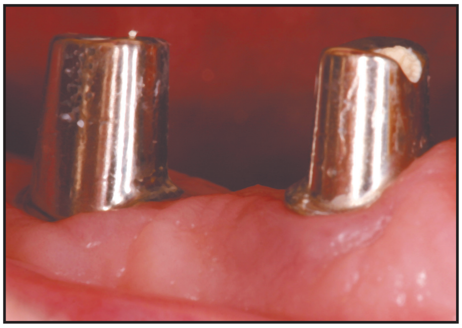

Figure 9. Case 1. Intraoral appearance of the abutments in situ after initial healing. Note the tissue architecture.

Figure 10. Postoperative appearance of the definitive implant-supported PFM restorations demonstrates aesthetic and functional integration (Peter Kouvaris, MDT, NY).

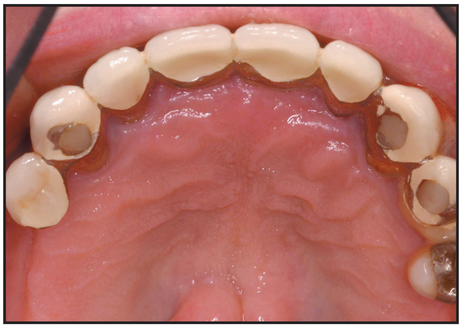

Figure 11. Case 2. Preoperative appearance prior to serial extraction. A denture was not provided.

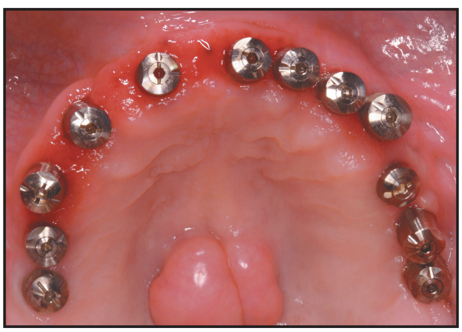

Figure 12. Occlusal view immediately following the placement of the healing abutments and caps (Periodontist: Dr. Greg Diamond, New York, NY).

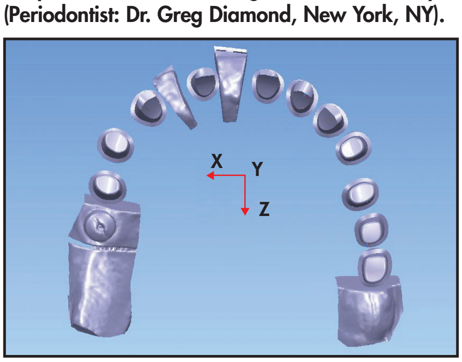

Figure 11. The CAD/CAM system (ie, Encode, 3i, Palm Beach Gardens, FL) was used to create abutments.

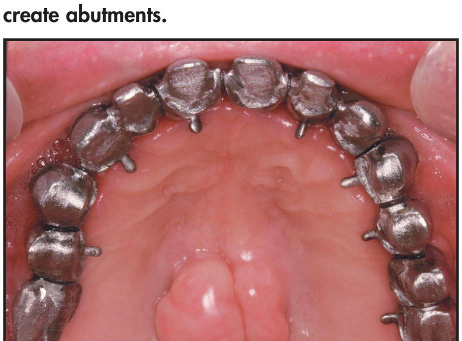

Figure 14. The definitive PFM castings were positioned, fitted, and verified prior to facebow transfer.

who received canine-protected occlusion. Instructions for interproximal brushing were provided, and a discussion about food impaction around dental implants was also initiated.

Recall Protocols and Evaluation

All patients were recalled three weeks postoperatively for occlusal adjustments. Interproximal contacts were also evaluated, and several crowns that demonstrated minimal or no contacts were removed to facilitate the placement of additional porcelain to ensure proper occlusion. After this initial three-week period, the patients were reevaluated at three months, six months, and one year. Radiographic evaluation was performed during these visits, along with a clinical examination to evaluate occlusion, gingival integrity, contact areas, inflammation, food impaction, porcelain integrity, and overall patient satisfaction.

Results

The soft tissue response was excellent and favorable in all but three of the definitive restorations. Three implant restorations showed 1 mm of recession three weeks following implant loading. Of these, two implants had surgical augmentation grafts and cortical bone grafts in the anterior maxilla prior to definitive osseointegration, which may have been a factor in the recession. The abutments were refabricated to a lower collar margin and the crown was replaced.

None of the other implant restorations—including the immediately-restored implant—exhibited any recession, inflammation, or unfavorable results. The restorations remained in function and demonstrated overall success.

Discussion

The use of custom-fabricated gold abutments has traditionally allowed the clinician to accurately re-create natural contours and aesthetic peri-implant soft tissue molding.[8-10] Prefabricated abutments have, however, allowed clinicians to deliver implant restorations at a reduced cost, with minimal laboratory time required for the fabrication process.[11] Although these abutments have been used with much success, rounded abutments cannot always cover the preexisting territory that was assumed by the root surface and the original gingival tissues.

In addition, taking multiple impressions and the repeated removal of provisional abutments often results in a radical modification to the gingival tissues. Because

Figure 15. The definitive, maxillary, full partial denture was mounted to ensure proper occlusion and function. (Laboratory: Pierre Pourchelle, MDT, NY.)

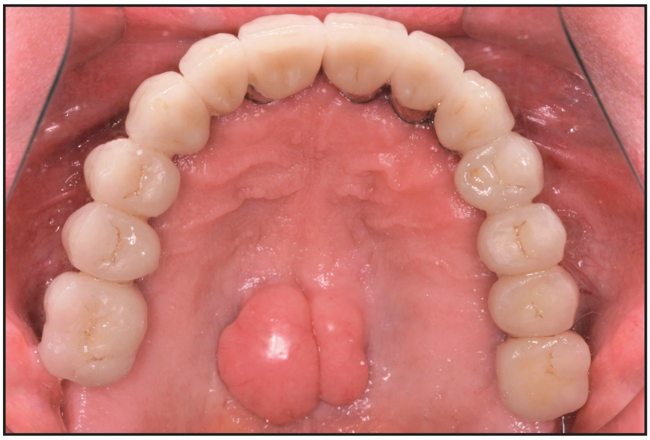

Figure 16. Postoperative occlusal appearance of the full arch following restoration using CAD/CAM.

of the number of variables that alter tissues, the rate of recession may vary from minimal to drastic amounts throughout the prosthetic phase of treatment. The use of CAD/CAM technology in the fabrication of implant abutments from the Stage II procedure allows the delivery of a properly contoured, biomimetic abutment. For the past 10 years, manufacturers have attempted to use CAD/CAM technologies to bring the clinician a predictable, cost-effective, and user-friendly technique that would address anatomical and restorative concerns. Although the results presented herein are preliminary, the future looks impressive. Patient chairtime has been reduced by approximately 50% since the advent of this technology, and the amount of laboratory time required for the fabrication of the abutment and prosthesis has also been reduced by approximately 70%. Time and expenditures can also be reduced if the system is outsourced. The advent of CAD/CAM-generated abutments may be the beginning of a new era in the prosthetic management of implant restorations, designed for timely delivery with reduced cost and an overall increase in patient satisfaction.

Conclusion

Although the results presented herein are preliminary, the use of CAD/CAM technology for the fabrication of implant abutments has demonstrated remarkable results. The computer's ability to accurately read and translate the four key characteristics of a dental restoration (WDAD) has improved the biomimetic form created by the computer-generated abutment, thereby enhancing the overall tissue response. Benefits of this approach also include a markedly reduced clinical chairtime, ease of use, and minimized laboratory time, particularly when creating multiple-unit restorations. Additional research is, however, required to confirm these preliminary results.

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References

1. Sadoun M, Perelmuter S. Alumina-zirconia machinable abutments for implant-supported single-tooth anterior crowns. Pract Periodont Aesthet Dent 1997;9(9):1047-1053.
2. Touati B. Custom guided tissue healing for improved aesthetics in implant supported restorations. Int J Dent Symp 1995;3(1):36-39.
3. Daftary F. Dentoalveolar morphology: Evaluation of natural root form versus cylindrical implant fixtures. Pract Proced Aesthet Dent 1997;9(4):469-477.
4. Dario LJ. Implant angulation and position and screw or cement retention: Clinical guidelines. Impl Dent 1996;5(2):101-104.
5. Hebel KS, Gajjar RC. Cement-retained versus screw-retained implant restorations: Achieving optimal occlusion and esthetics in implant dentistry. 1997;77(1):28-35.
6. Binon PP. Implants and components: Entering the new millennium. Int J Oral Maxillofac Impl 2000:15(1):76-94.
7. Kerstein RB, Osorio J. Utilizing computer-generated duplicate titanium custom abutments to facilitate intraoral and laboratory implant prosthesis fabrication. Pract Periodont Aesthet Dent 2003;15(4):311-314.
8. Reid PE, Burk TM. Customized implant abutments: Technical notes. Implant Dent 1994;3(4):243.
9. Papazian S, Morgano SM. A laboratory procedure to facilitate development of an emergence profile with a custom implant abutment. J Prosthet Dent 1998;79(2):232-234.
10. Osario J. Use of the Atlantis abutment in restorative practice speeds time to function and aesthetics. Dent Implantol Update 2000;11(8):57-62.
11. Byrne D, Houston F, Cleary R, Claffey N. The fit of cast and premachined implant abutments. J Prosthet Dent 1998;80(2):184-192.