jCD
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Journal of Cosmetic Dentistry

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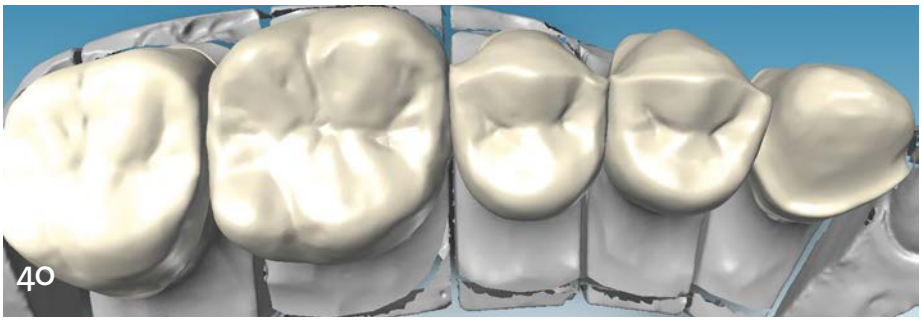

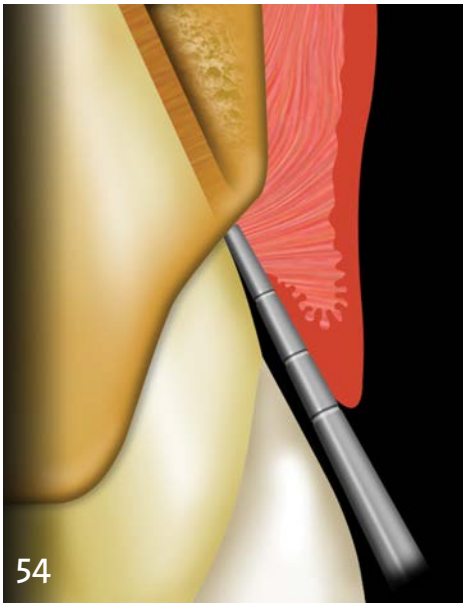

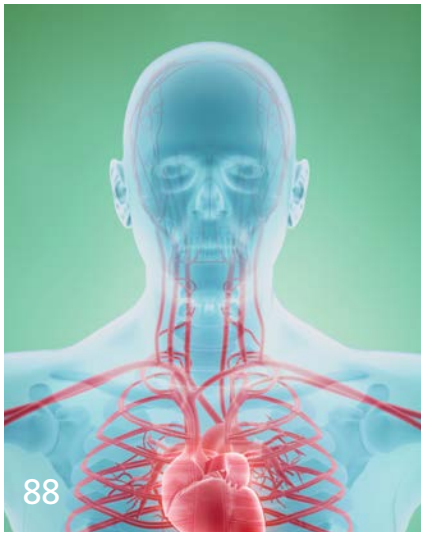

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***jCD* Wins Two Awards! See page 9!**

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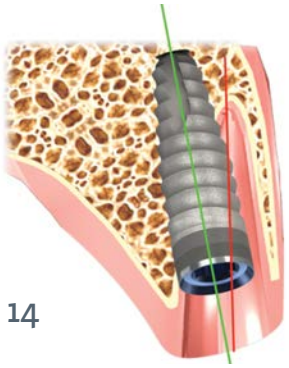

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The *Journal of Cosmetic Dentistry* (ISSN 1532-8910), USPS (10452), published quarterly. $200 per year (U.S. & Canada) or $240 per year (All other countries), single issues available upon request, by the American Academy of Cosmetic Dentistry®, 402 West Wilson Street, Madison, WI 53703. 800.543.9220 OR 608.222.8583. Periodicals postage paid in Madison, WI, and additional offices.

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The "Tissue Issue"

> **"The gingival tissues are the "yin" to the teeth's "yang."**

This "tissue issue" of *jCD* has a focus on the critical importance of the gingival tissues in the health and attractiveness of a smile. When we first look at a person's face, there are three features we notice immediately: the eyes, the nose, and the smile. The eyes and the smile are generally considered to be among the first measures of physical attraction; *"He has soulful eyes"* or *"She has a beautiful smile"* are two phrases we typically utter after meeting someone for the first time.

When we look at a smile, we see the teeth (which, hopefully, are pretty and white). But how attractive would those "pearly whites" be if they were surrounded by inflamed and bleeding gums? What if the gum tissue was receded and emitted the distinctive odor of periodontal disease?

This is the reality we as appearance-related dentists work with daily. The gingival tissues are the "yin" to the teeth's "yang." The two must intertwine synergistically to produce a smile that is attractive not only to the smile's possessor, but also to the beholder.

The gingival tissues and periodontal structures determine the teeth's fate. In a healthy periodontium, the gingivae look robust, pink, and stippled. The mucosal tissues are red and vascular.

As oral health specialists, we strive to educate our patients about caring for their teeth and gums. Unfortunately, many patients believe that brushing their teeth once a day is enough to maintain their dentition for a lifetime. How often has a patient said they brush every day but do not floss, use mouthwash, or scrape their tongue? How many patients in your practice think that coming in for a hygiene appointment twice a year is a daunting task?

Many patients do not take dental hygiene seriously. As long as their teeth are not painful, these patients believe their mouth is healthy. The sad reality is that, in many cases, the teeth are endangered because the periodontal tissues are suffering from lack of attention. Unfortunately, we all have seen many patients who truly do not understand why their teeth are loose.

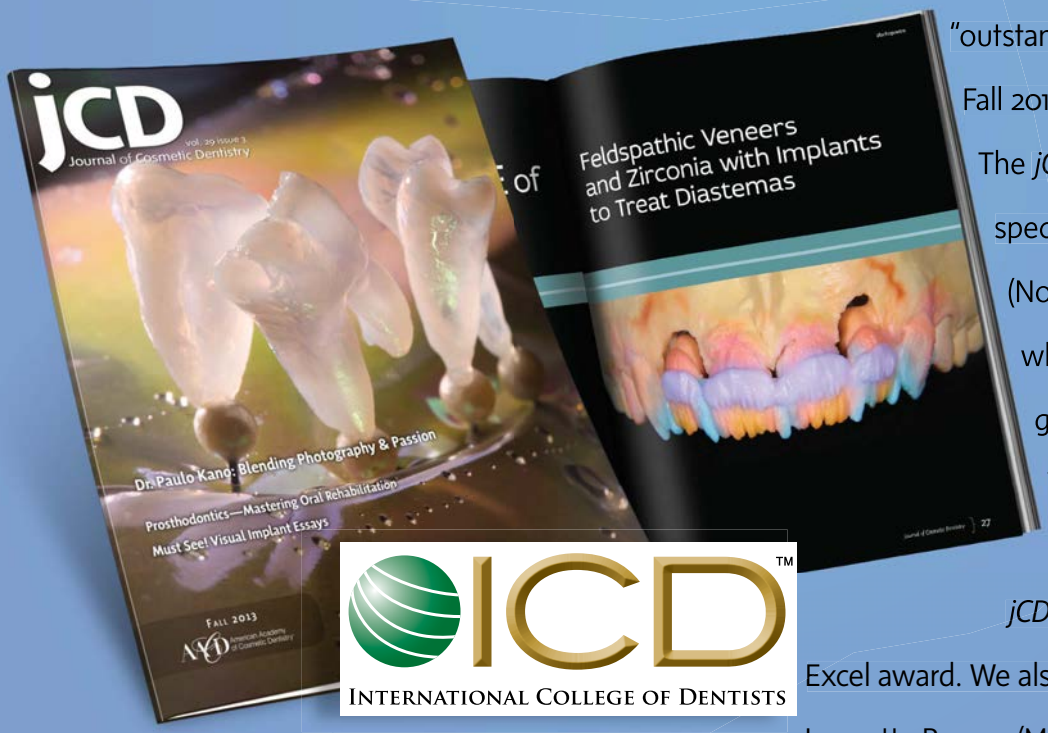
We are fortunate to have the opportunity to improve the lives of our patients and help them to attain oral health. Let's all agree to take action and refuse to accept periodontal neglect. Which reminds me…I must take my own advice and see my hygienist this week!

Edward Lowe, DMD, AAACD
Editor-in-Chief

jCD Spring and Fall 2013 are Award Winners!

Association Media & Publishing (AMP) and the International College of Dentists (ICD) have announced their 2014 journalism award winners. The *jCD* is proud to have received the Excel Bronze award for best journal cover design from AMP and the Platinum Pencil, Division 1 award from the ICD!

AMP praised the *jCD* for "superior quality and innovation" for the Spring 2013 front cover design and ICD commended the *jCD* for "outstanding use of graphics" in the Fall 2013 issue.



The *jCD* team would like to give a special thanks to Dr. Irfan Ahmad (North Harrow, Middlesex, UK), whose vivid, exciting imagery graced the Spring 2013 cover. Without his artistic eye and photography skills, the *jCD* would not have won the Excel award. We also applaud our Art Director, Lynnette Rogers (Madison, WI), for her creative leadership and skills, which can be seen in her eye-catching designs throughout the *jCD*.

Periodontology, Yesterday and Today

Myron Nevins, DDS
Marc L. Nevins, DMD, MMSc

Dr. Myron Nevins is an associate professor of periodontology, Harvard School of Dental Medicine; and clinical professor of periodontology, University of Pennsylvania. He maintains a private practice limited to periodontology and implant dentistry in Swampscott, Massachusetts.

Dr. Marc Nevins is a diplomate of the American Board of Periodontology and clinical assistant professor at Harvard School of Dental Medicine in the Department of Oral Medicine, Infection and Immunity. He maintains a private practice in Boston, Massachusetts.

Disclosures: The authors did not report any disclosures.

The authors are Editors-in Chief of *The International Journal of Periodontics and Restorative Dentistry.*

Periodontology is the study of the periodontium, with a focus on chronic inflammatory diseases including gingivitis and periodontitis. Therefore, all treatment regimens recognize an endpoint goal of creating an environment that can be maintained by the patient and the dental hygienist.[1] Debridement therapy is the first step in helping the patient reduce inflammation and maintain hygiene.[1] Classical treatments resulting in pocket reduction, gingival enhancement, and non-surgical procedures have proven to be successful for untold numbers of patients and continue to be effective.[2,3] The interdisciplinary team approach has optimized the health and longevity of patients with advanced diseases via cooperative strategic treatment planning, with the healthy periodontium serving as a stable foundation for sophisticated restorative dentistry. Advances in technical and technological approaches have increased benefits to our patients both surgically and restoratively. One example is the transformation in gingival grafting as an effective procedure to enhance the zone of keratinized gingiva in contemporary periodontal cosmetic surgery. This routinely provides excellent esthetic corrections of gingival recession. All treatment planning must consider the harmony of the esthetic approach to achieve the desired gingival architecture.

Two significant steps forward in the past 25 years are the introduction of predictable periodontal regeneration, and tooth replacement with osseointegrated implants. Perhaps the most important decisions to be made for the patient involve the ability to determine the regenerative prognosis with accurate diagnostics. This is necessary for both infrabony defects and furcation invasions of multirooted teeth. Many patients require periodontal intervention to prepare the dentition for restorative dentistry.

A restorative diagnostic wax-up allows for crown lengthening in concert with gingival grafting to achieve an optimal esthetic prosthetic display. This is especially important for the individual with precise esthetic demands. Many patients present with severely compromised teeth that need to be replaced, but require hard and soft tissue grafting to achieve the desired esthetic and phonetic results. Once again, the benefit of a competent team approach with a coherent treatment plan is beneficial to the patient.

The ability to utilize exciting newer approaches along with proven clinical procedures has greatly enhanced the periodontal armamentarium. The bottom line: Select the treatment that we would provide if *we* were the patient.

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2. Nevins M, Kim DM. Classical versus contemporary treatment planning for aggressive periodontal disease. J Periodontol. 2010 May;81(5):767-75.
3. Nevins M, Dornbush J, Koo S, Depaoli M, Kim DM. A 42-year observation of traditional periodontal therapy supplemented by dental implants. Clin Adv Periodontics. 2013 May;3(2):72-6. **jCD**

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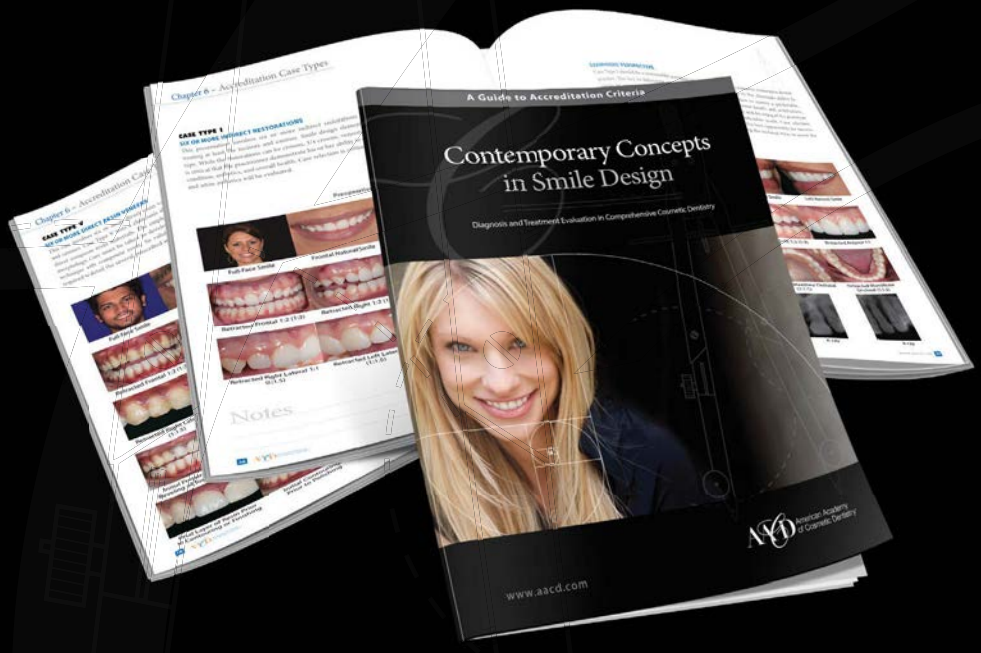

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A Lifelong Dream and a **Carefully Designed Plan**

By Sascha A. Jovanovic, DDS, MS

The patient, a 67-year-old woman, ran a small supermarket in an Italian village for most of her life. She had met the referring dentist, Dr. Francesco Mintrone, many years ago when he was still in high school. As the years passed and he went through dental school and postgraduate education, she confided to him more and more about her dental situation. When she retired from her business, she took the big step of visiting Dr. Mintrone in his office and having him evaluate her dental status in detail. She had seen another dentist for many years, but he had done only what was necessary to keep her pain-free.

The patient complained about an ill-fitting upper full denture and an uncomfortable lower removable partial denture. She had dreamed for many years of having a beautiful smile, with no removable appliance, and a natural-looking and healthy fixed dentition. She had heard about implants, but was always afraid to move forward with them. After an initial examination, Dr. Mintrone determined that she was an excellent candidate for implants and a fixed natural prosthesis. She overcame her fear and chose to move forward with implants because she had known Dr. Mintrone since his childhood.

Dr. Mintrone contacted me soon thereafter because we had worked together on other complex implant cases, and he familiarized me with the patient's condition and her wishes.

This case illustrates how a patient with a fundamentally challenging condition and a denture for many years can be brought back to full dental esthetics when the case is carefully analyzed and planned and treatment is executed to the best of our surgical and prosthetic abilities. It also demonstrates how the dental esthetic team can collaborate even in the smallest details before the surgery takes place, including giving the patient comprehensive insight into what to prepare for and what to expect.

At the end of the treatment, this patient achieved her dream—fixed implants in the upper and lower jaws, providing her with a wonderful and natural smile that enhanced her beautiful, warm personality.

For more information on the clinical aspects of this case, please turn to page 64.

Cover dentistry and clinical images: Sascha A. Jovanovic, DDS, MS (Los Angeles, CA) and Francesco Mintrone, DDS (Modena, Italy). The cover images were photographed with a Nikon D90 and D200 camera (Tokyo, Japan).

“She had dreamed for many years of having a beautiful smile, with no removable appliance, and a natural-looking and healthy fixed dentition.”

Preoperative

Postoperative

Esthetic Implant Dentistry

Current Surgical and Restorative Trends

Sonia S. Leziy, DDS, Dipl Perio, FRCD(C)
Brahm A. Miller, DDS, Dipl Pros, FRCD(C)

See *jCD's* digital edition to access Drs. Leziy and Miller's CE video offered by AACD's Virtual Campus.

Drs. Leziy and Miller spoke at the 30th Annual AACD Scientific Session in Orlando, Florida, on May 2, 2014. The title of their lecture was "*An Architectural Plan for Creating Ideal Implant Esthetics: A Vision for Success and Change*." In this lecture, upon which the following article is based, Drs. Leziy and Miller taught strategies to idealize the esthetic outcome of treatment from surgery to case completion.

Key Words: immediate implant placement, biologics, bone allograft, immediate provisionalization

Figure 1a: Mineralized allograft (MinerOss, BioHorizons, Birmingham, AL).

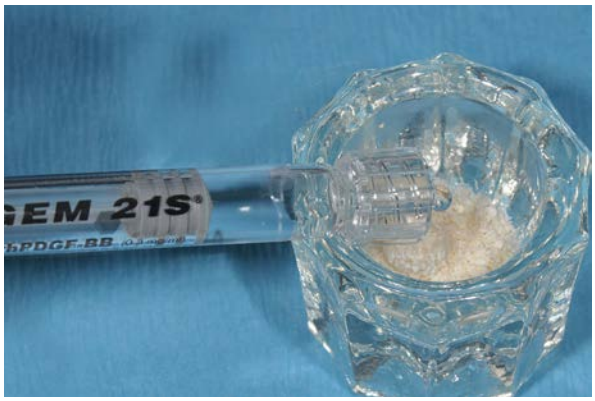


Figure 1b: Allograft hydrated with PDGF-bb.

Introduction

Since the introduction of implant dentistry to North America in the early 1980s, striking advances in our knowledge, skills, products, and instruments have substantially enhanced clinical outcomes in implant dentistry. Today, it is a commonly recommended solution for tooth replacement, so every clinician involved in planning and treatment with implants needs to keep informed about the recent developments and required procedures reported in the literature and of the constantly evolving materials and products. This article's subject matter is designed to enhance participants' understanding of the demanding process of implant therapy in the anterior maxilla. The tools necessary to bring about the highest predictable esthetic results are discussed.

The Foundation

Bone and Options to Manage It

From a treatment-planning perspective, restoratively driven implant placement is the goal of treatment, which requires that the ridge architecture be maintained after tooth extraction or that bone be reconstructed if the ridge is deficient. It is not always possible to rebuild lost tissue to a natural form, so prosthetic means, such as the use of ceramics or composites are regularly needed to compensate for deficiencies that cannot be surgically corrected.[1,2] Most importantly, the patient must be informed of this situation in the planning stages to avoid disappointment. Although autogenous bone is still recognized as the "gold standard" material for ridge rebuilding, biologics **(Figs 1a & 1b)** or bone graft substitutes, sometimes coupled with growth factors of autogenous origin, or made by means of recombinant technology such as PDGF-bb (Gem 21S, Osteohealth; Shirley, NY) or BMP2 (Infuse, Medtronic; Minneapolis, MN), are increasingly penetrating clinical practice in ridge preservation procedures and in augmentation of deficient ridges **(Figs 2a-2c)**.[3-5] Biologics offer some advantages over autogenous bone. For example, biologics are an unlimited resource, eliminating the need for a donor site and the associated morbidity of these procedures and importantly, equivocal outcomes to autogenous bone-grafting procedures in many applications.[6]

Titanium meshes and non-resorbable membranes are often used to confine bone graft materials. Alternatives to these types of materials include resorbable membranes that break down at varying rates depending upon their composition and treatment, as well as resorbable fixation systems. Materials that do not have to be retrieved simplify surgery and eliminate the need for reentry flaps, and they potentially reduce the complications resulting from exposure or contamination of non-resorbable materials **(Figs 3a-3c)**.

Implant Placement Protocols

Influence on Grafting Decisions

Numerous implant placement and restoration protocols are used routinely today. Immediate implant placement plays an important role in the esthetic area of treatment, with numerous studies confirming the long-term predictability of this treatment.[1-7] This currently popular procedure is often coupled with bone or soft tissue grafting to reduce post-restoration remodeling.

The initial thickness of the buccal crestal bone can affect the extent of the buccal bone resorption.[8,9] Revised requirements for facial bone/soft tissue volume (4 mm rather than 2 mm) have recently been suggested to reduce post-restoration resorption in the case of immediate implant placement **(Figs 4a & 4b)**.[10,11] The effect of different bone products on long-term hard and soft tissue stability must also be considered. In the case of immediate implant placement, stable and slowly resorbed graft products such as the xenograft Bio-Oss (Geistlich Pharma North America; Princeton, NJ) may help compensate for subtle but important remodeling of thin facial bone.[12,13] **Figures 5a through 5d** tie in concepts such as careful extraction, ideal implant position, size, and management of the facial bone defect volume that must be considered to maintain post-restoration ridge architecture.

Although bone volume preservation or gain around implants is important, soft tissue biotype and volume also contribute to underlying ridge stability and esthetics. Recession at thin biotype sites tends to be of a greater magnitude than that at thick biotype sites.[14] As a result, tissue graft procedures are often included in the surgical protocol. However, to our knowledge there is no literature in which investigators evaluate the effect of the graft quality, or describe the effect of the technique used to adapt a graft. Our clinical findings suggest that grafts of poor quality (having fatty or low fibrous characteristics) do not produce the same benefits or outcomes that can be achieved with fibrous grafts **(Fig 6)**. Hence, in our opinion, graft quality must be considered. Coupled with the importance of graft quality, three-dimensional graft adaptation around an implant could potentially enhance the esthetic outcome by circumferentially improving tissue quality and volume. Our results suggest that proximal and palatal or lingual grafting are probably as important as facial tissue enhancement **(Figs 7a-7c)**.

Figure 2a: Ridge preservation: Mineralized cancellous MinerOss being introduced into the extraction site, the buccal bone defect sealed with slowly resorbable membrane.

Figure 2b: Collagen membrane adapted to confine the bone.

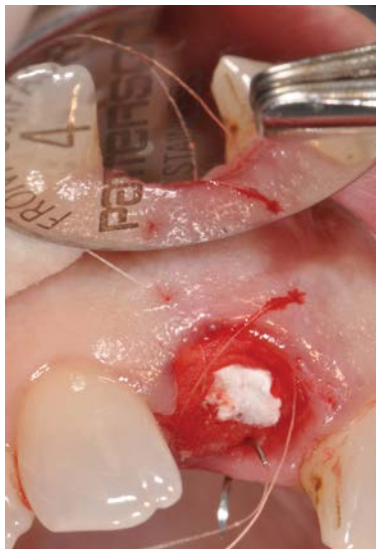


Figure 2c: CollaPlug (Zimmer Dental; Carlsbad, CA) placed on top of socket membrane and stabilized with a "Figure 8" suture.

Figure 3a: Severe ridge resorption requires augmentation to allow implant placement.

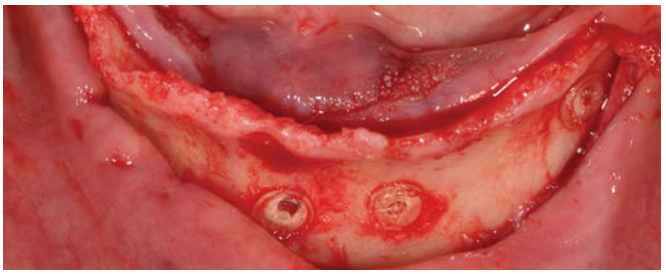


Figure 3b: View of ridge with SonicWeld resorbable pin and membrane system (KLS Martin; Jacksonville, FL).

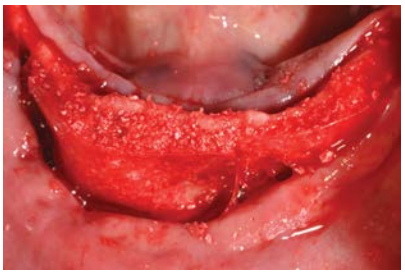


Figure 3c: Resorbable rigid membrane and pins have been fixed, creating a buccal wall to confine the biologic product(s).

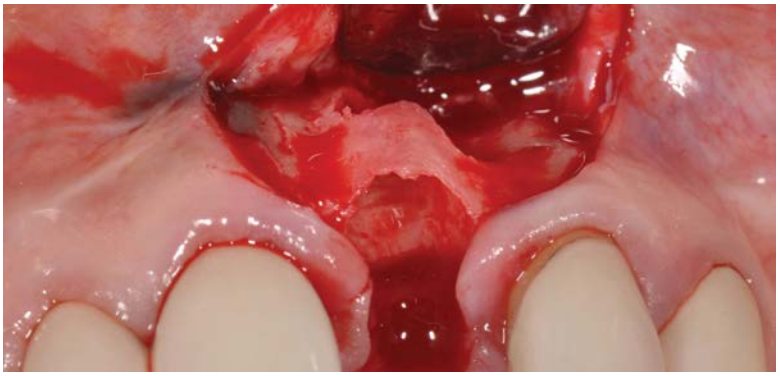


Figure 4a: Thin bone and facial dehiscences or fenestrations are characteristic of what normally is found over roots of teeth in the maxillary anterior area. Without intervention, ridge resorption will be significant.

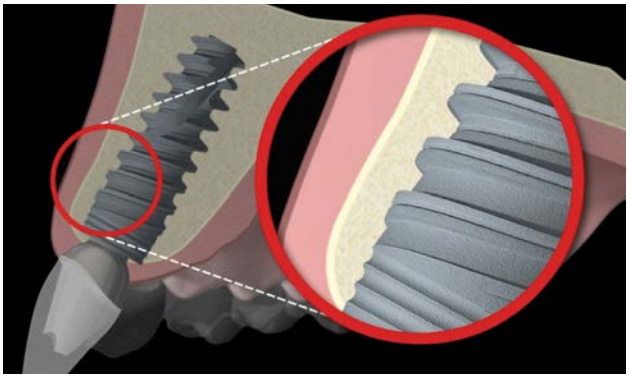


Figure 4b: In immediate implant placement, the minimum desired facial bone thickness is 4 mm (residual native bone plus the grafted residual horizontal defect).

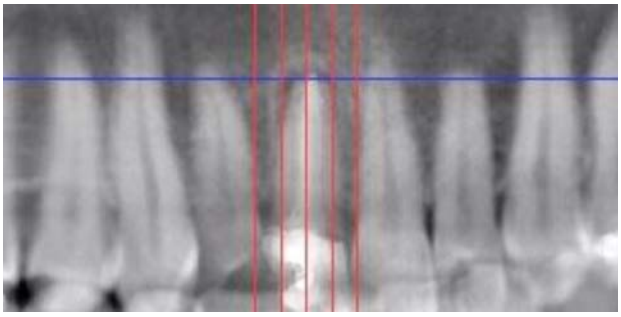


Figure 5a: Cone beam computed tomography "scout" film shows apical disease. Cross-sectional images are used to determine whether immediate implant placement can be considered.

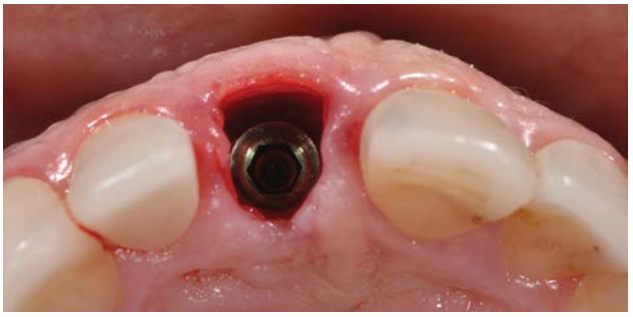


Figure 5b: Immediate implant placement (BioHorizons) with residual facial bone defect. This area will be grafted to produce 4 mm of native and grafted bone.

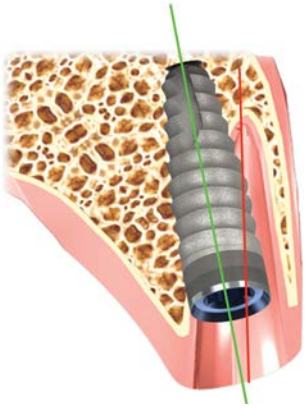


Figure 5c: Ideal implant position and size to create a facial residual bone defect that can be grafted to produce the desired facial bone volume (red line indicates socket position and green line indicates position of the implant).

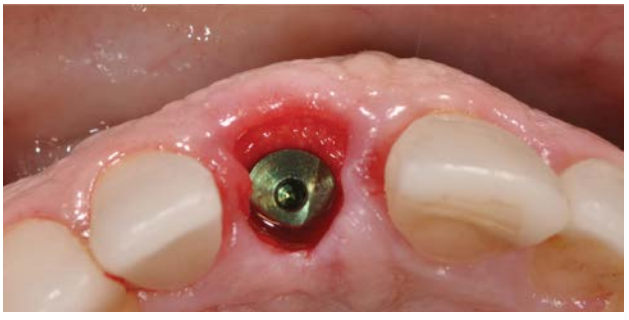


Figure 5d: Facial defect grafted with Bio-Oss. The low substitution rate may compensate for inevitable change to the thin facial bone.

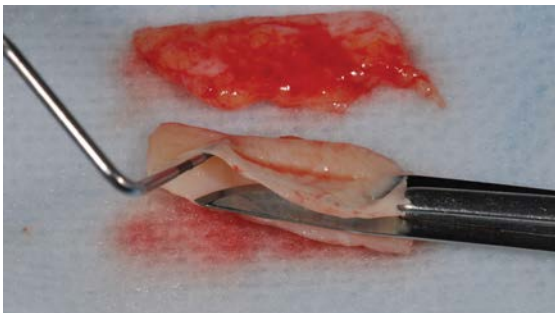


Figure 6: A "fatty" graft (upper) is not desirable for stable tissue outcomes. A more fibrous graft harvested superficially from the palate will produce a more dense graft: 0.5 mm of the superficial epithelium is being dissected bench-top.

Most importantly, the patient must be informed of this situation in the planning stages to avoid disappointment.

Figure 7a: A fibrous graft that has been punched to adapt around a healing abutment or provisional restoration.

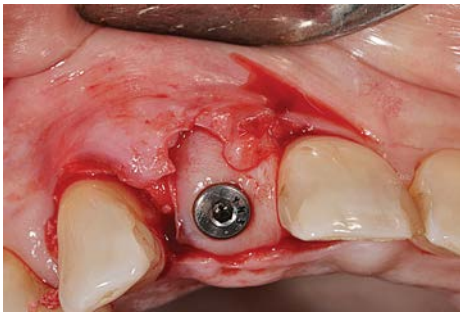


Figure 7b: Excellent graft quality adapted around a healing abutment. The flapped tissue will be sutured over the graft for blood supply.

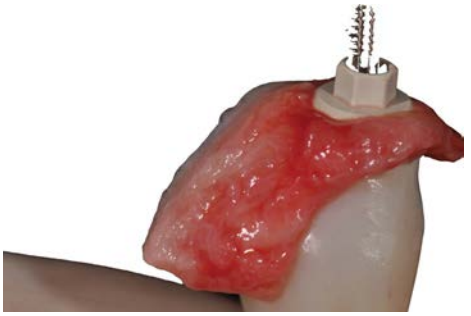


Figure 7c: Graft adapted around a provisional restoration.

Implant Selection

Primary Stability, Secondary Stability and High Bone-to-Implant Contacts, and Crestal Bone Stability

Although there are many implants available to choose from, the decision as to what implant system and design to work with is often not an easy one; different implants may need to be considered to manage unique clinical situations. The scientific literature does not support one implant type, implant design, or surface treatment as superior to another, but findings suggest that some implant surfaces may be less successfully treated when affected by peri-implant mucositis or peri-implantitis.[15,16] Several issues need to be considered when choosing an implant:

- Will today's implants be supported by their manufacturers in the future as new products are introduced and older ones are phased out?
- Does the manufacturer offer appropriate product, clinical, and technical support?
- Are the surgical and restorative product lines comprehensive?
- Is there scientific validation to support the long-term outcome or success of the products?

Although surfaces are now generally made moderately rough to increase surface area, different treatments can be used to create these complex surfaces. Increasing the surface roughness will increase the bone-to-implant contacts, which is particularly beneficial for implants being placed into bone of poor quality and in grafted ridges. The modifications that are currently incorporated at the level of the implant collar have the goal of stabilizing crestal bone. Platform switching has the goal of reducing marginal bone changes by reducing stress transfer to the bone thus better supporting the marginal soft tissues, and the unique Laser-Lok surface (BioHorizons), a laser-ablated surface microgroove pattern is thought to guide both bone-producing and soft tissue-producing cells to organize specifically through contact guidance **(Fig 8)**.[17]

Implant design also can be considered as a tool to enhance soft tissue outcomes. In the case of implants of a platform-switched design, enhanced crestal bone stability may be partly the result of a thickening of the marginal soft tissues, along with medialization of the microgap.[18-20] In the case of implants with Laser-Lok technology, the possibility of a soft-tissue attachment and functionally oriented connective tissue over a gingival cuff with parallel fiber orientation that is reported around most implant systems may provide a biologic advantage for tissue stability and tissue health.[21-24]

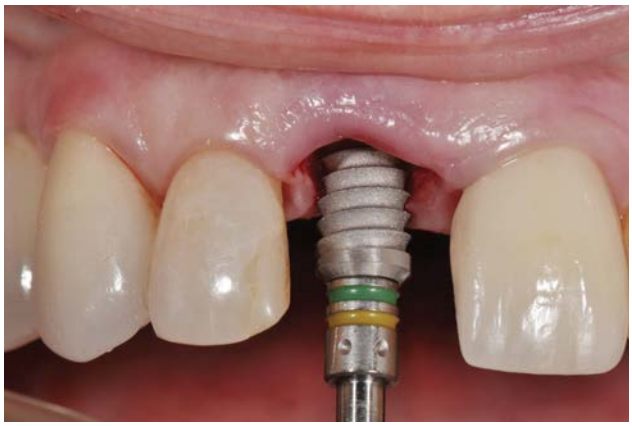


Figure 8: Immediate implant placement with platform-switched BioHorizons Tapered Plus with Laser-Lok at the implant collar and over the exposed platform designed to guide both osteoblasts and fibroblasts, reducing crestal bone changes while enhancing tissue volume and soft tissue stability.

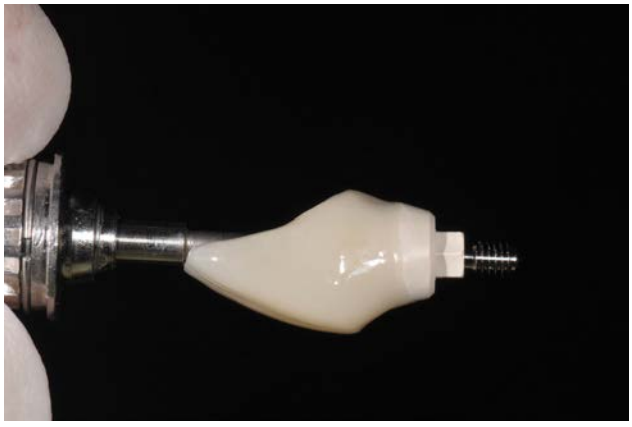


Figure 9a: Chairside-fabricated, screw-retained provisional crown.

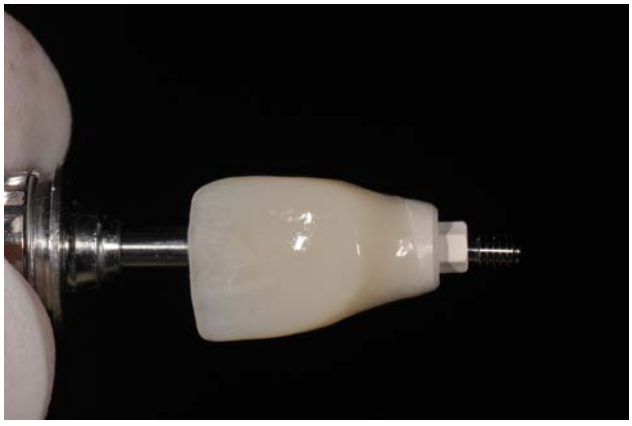


Figure 9b: Shaping and polishing of subgingival provisional crown contour.

Identifying the Need to Provisionalize

Surgical and Restorative Benefits

Provisionalization historically has been viewed as the first phase of implant restoration after integration; today this step is often coupled with implant placement, even at the time of tooth extraction. Although the benefits are clear when viewed from the patient's perspective, there are clinical reasons for considering the coordination of this treatment where possible. Immediate provisionalization at the time of implant placement may help to guide the soft tissues, avoiding or minimizing the typical changes in soft tissue architecture that accompany tooth loss. **Figures 9a through 9e** illustrate a chairside provisional crown fabricated for insertion at the time of surgery. The subgingival crown contours must be carefully established, followed by polishing and steam cleaning to support ideal healing.[25,26] Although it is possible to recapture the tissue anatomy post-integration, and sometimes post-restoration, the added time to accomplish this may be unnecessary and further complicates the treatment, particularly in terms of what the patient will have in the interim to replace the missing tooth or teeth. Ill-defined tissues do not set the tone or the framework for esthetics and potentially complicate abutment design and establishment of an ideal margin position in the case of cement-retained restorations **(Fig 10)**. In our opinion, this difficulty is often overlooked or not recognized as a pivotal step to minimize cementation challenges. **Figures 11a through 11f** highlight the tissue transformation that is possible through provisionalization (an expanded look at chairside provisional fabrication is presented on pages 22 and 23).

Figure 9c: Finishing of the provisional restoration.

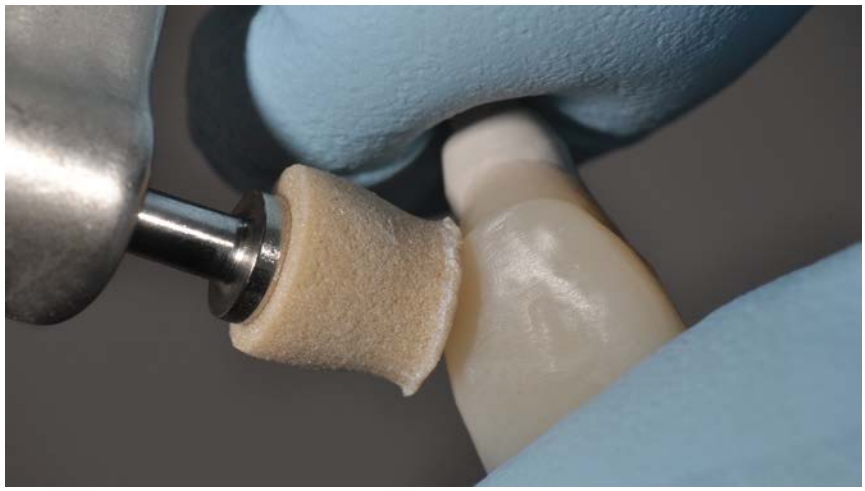


Figure 9d: Final polishing.

Figure 9e: Insertion of a provisional restoration at the time of implant placement. This step helps to support and guide soft tissue healing.

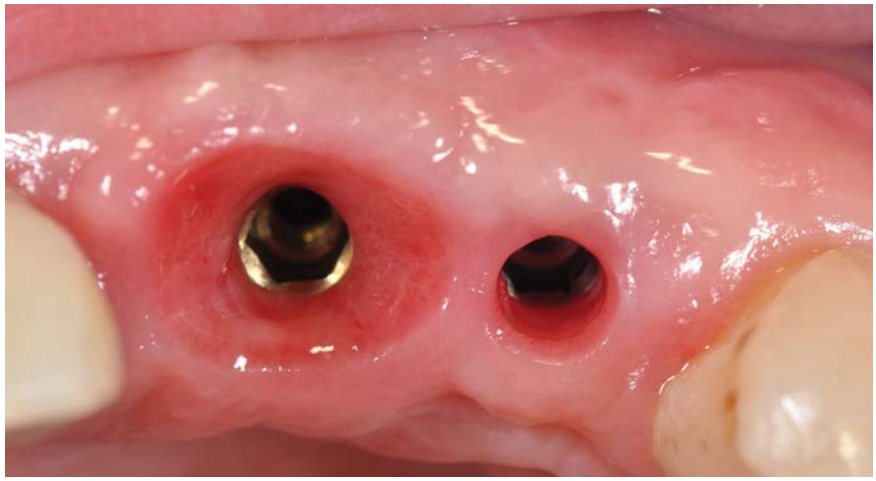


Figure 10: Gingival tissue emergence profile: comparison of a provisionalized site and a non-provisionalized site.

Figure 11a: Congenitally missing lateral incisor with flat papilla architecture and ill-defined emergence profile.

Figure 11b: Provisional restoration in place for 12 weeks, resulting in defined papilla form.

Figure 11c: Newly defined gingival scallop.

Figure 11d: Definitive restoration with tissue form that was optimized during the provisional phase of treatment.

Biologics offer some advantages over autogenous bone.

Figure 11e: Preoperative radiograph.

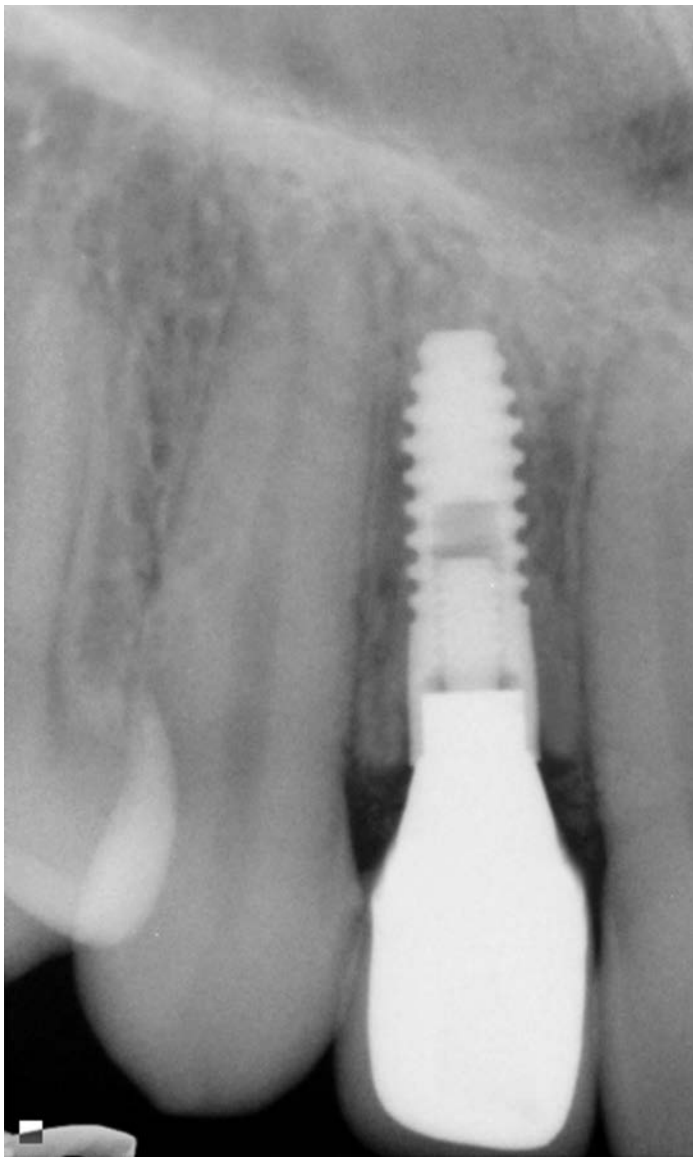
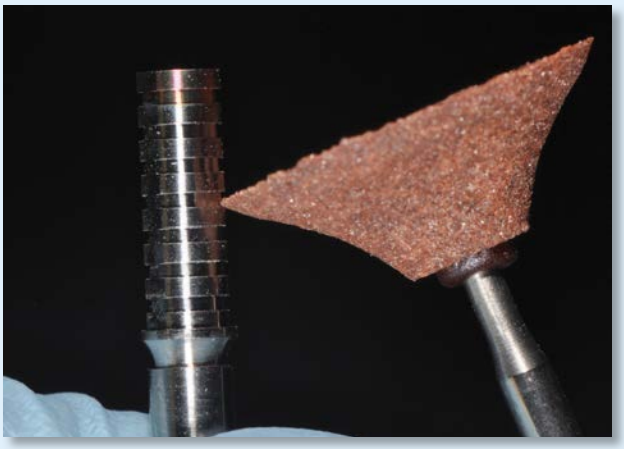


Figure 11f: Post-restoration radiograph.

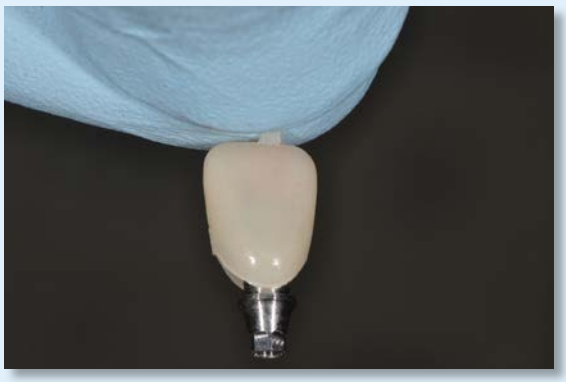
Expanded Look at a Chairside-Fabricated Screw-Retained Provisional



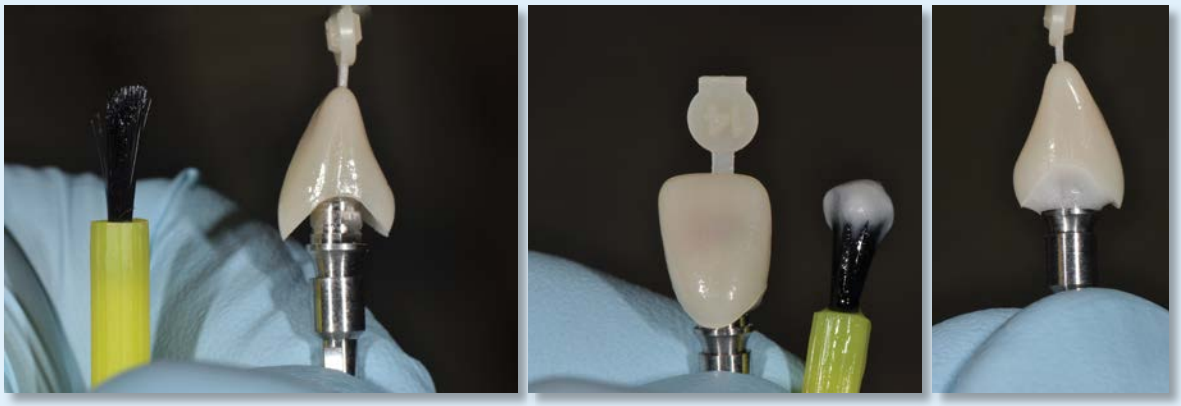
Provisional cylinder is reduced according to the patient's bite.

Red rope wax is used to block the access. Cylinder screw can be in place or removed prior to this step.

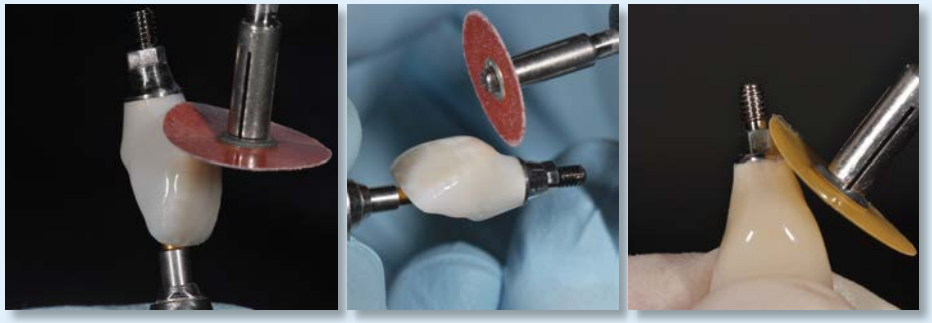
A provisional crown (a crown form, provisional shell, or a laboratory-fabricated provisional made from a wax-up or vacuform) is indexed intraorally. A small amount of acrylic or composite is introduced into the coronal third of the crown to secure it to the modified cylinder.



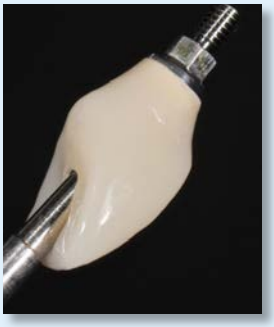
If the screw has been left out (the base of the provisional cylinder will usually be stable in the head of the implant without the need for a screw), then the assembly is removed by hand and a bur can be introduced through the cylinder to create an access hole. If the cylinder was screwed in, then the area to make the access can be identified by the red rope wax, which will be visible on the palatal surface.



The cylinder is attached to the implant replica. The subgingival areas can be added to outside the mouth with the addition of acrylic or composite.



The contours are adjusted by trying in the provisional and determining where it is overcontoured or undercontoured. The objective is to ensure that it is not overly compressive. Comparing it to the contralateral tooth to assess any overcontouring, particularly facially and in the gingival embrasure areas, is helpful. Careful attention to the most apical position of the contact area will allow the papillae to develop normally.



The final provisional is highly polished and cleaned with a steam cleaner or in an ultrasonic bath.

An example of a properly designed provisional restoration as viewed at the day of delivery, eight weeks later, and the definitive restoration at four months. The papillae and facial tissues are ideal. Note the position of the contact areas. The patient was instructed to keep these areas clean using regular hygiene techniques. The patient was followed at 10 days, 1 month, and 3 months. Additional changes to the provisional can be made at any time.

Restorative Materials

Advantages and Challenges in the All-Ceramic Era

While all-ceramic restorations are often viewed as desirable in esthetically sensitive areas, they also present unique challenges when used in implant dentistry. Material advances such as full-contour monolithic zirconia or lithium disilicate crowns **(Figs 12a & 12b)** have eliminated the risk of chipping fractures **(Figs 12c & 12d)**, and a better understanding of the handling of the feldspathic porcelains fused to zirconia substructures has reduced the chipping incidence. Coupled with these restorative materials, abutments themselves made with these same materials are generally used in the transmucosal zone when esthetic demands are high. Although the esthetic benefits of these materials are clear in terms of their color advantages, other factors often overlooked include the role that these materials play with respect to tissue biocompatibility and cellular attachment.[27,28] However, incorrect handling by the technician, such as polishing the abutment, can leave a surface impregnated with polishing paste. Inadequately cleaning the abutment in the subgingival region after handling can also adversely affect this biocompatibility.[29,30] Although zirconia is a material with substantial structural strength, abutments with zirconia stems, rather than metal stems, are at high risk for fracture, resulting in catastrophic restoration failure.[31,32] In our view, metal stems that are engaged by a screw or that are cemented to the zirconia abutment body are essential to the prosthetic survival of the abutment and restoration.

Proper abutment design and cementation technique can contribute to long-term implant success and health. Techniques to reduce the risk of cement retention in the subgingival prosthetic envelope include minimal submergence of the cement line through coronal movement of the abutment margin, techniques to limit the amount of cement introduced into the crown itself, and techniques to deflect and vent cement away from the sulcus.[33,34] **Figures 13a through 13h** illustrate some of the design and protocol steps that can limit the complication of cement trapping. Although screw retention is viewed as a clear advantage in avoiding the complications associated with the cementation process, there are circumstances in which positioning implants more palatally is not possible or will cause functional disturbances.

Figure 12a: Full-contour zirconia hybrid implant crown.

Figure 12b: Monolithic lithium disilicate first and second premolars and first molar, and monolithic zirconia second molar.

Figure 12c: Porcelain chipping of bilayered zirconia.

Figure 12d: Chipping fracture: cohesive failure of veneering porcelain.

Immediate implant placement plays an important role in the esthetic area of treatment...

Figure 13a: Zirconia abutment with anatomically ideal design features to position the cement line approximately 0.5 to 1.0 mm subgingivally.

Figure 13b: Retraction cord placed apical to the abutment margin to limit apical displacement of excess cement during the cementation process.

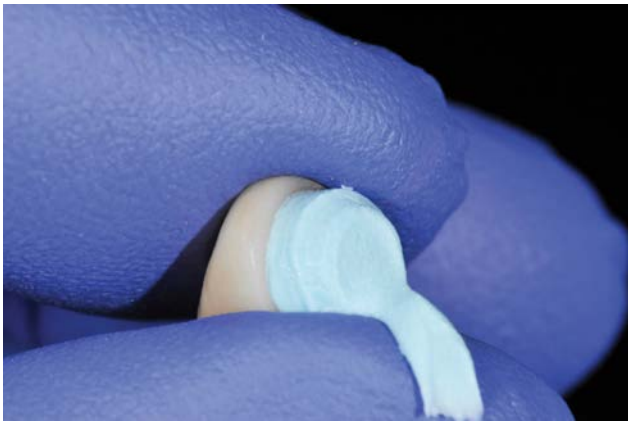


Figure 13c: Dummy abutment.

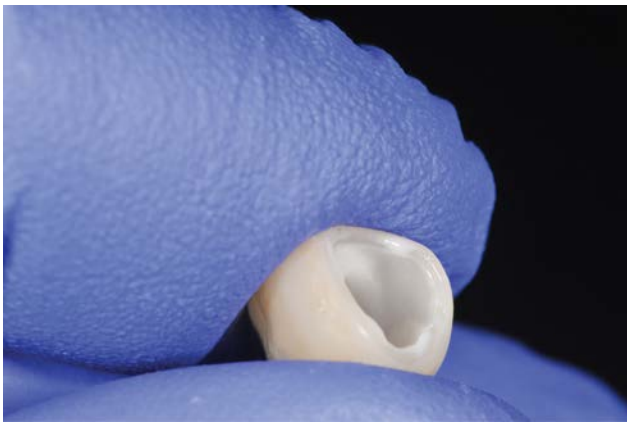


Figure 13d: Dummy abutment removed, minimizing cement in the crown.

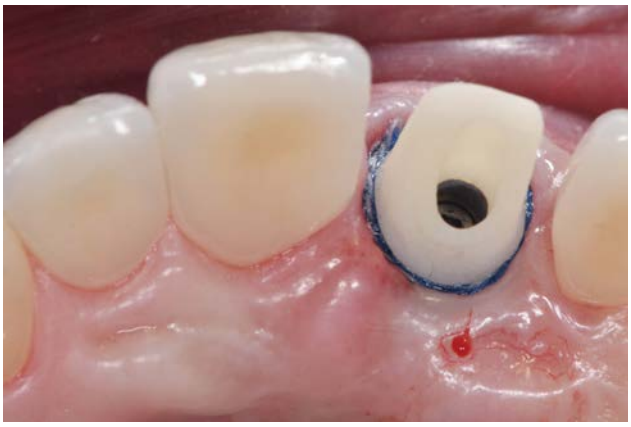


Figure 13e: Open abutment chimney, except for small amount of wax or Teflon tape, which will be placed over the screw head to protect it.

Figure 13f: After seating of the crown, excess cement fills the abutment chimney vent.

Figure 13g: Removal of deflective cord.

Figure 13h: Definitive crown post-cementation showing ideal tissue contours and health.

Summary

Although the outcomes addressed here are scientifically based, idealizing outcomes in implant dentistry demands comprehensive planning, artistry, and thinking "outside the box." Practitioners can reach new heights with a thirst for knowledge and a willingness to adapt and evolve.

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Proper abutment design and cementation technique can contribute to long-term implant success and health.

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Disclosure: Dr. Leziy and Dr. Miller receive grants, research support, and honoraria from BioHorizons, for which they are consultants.

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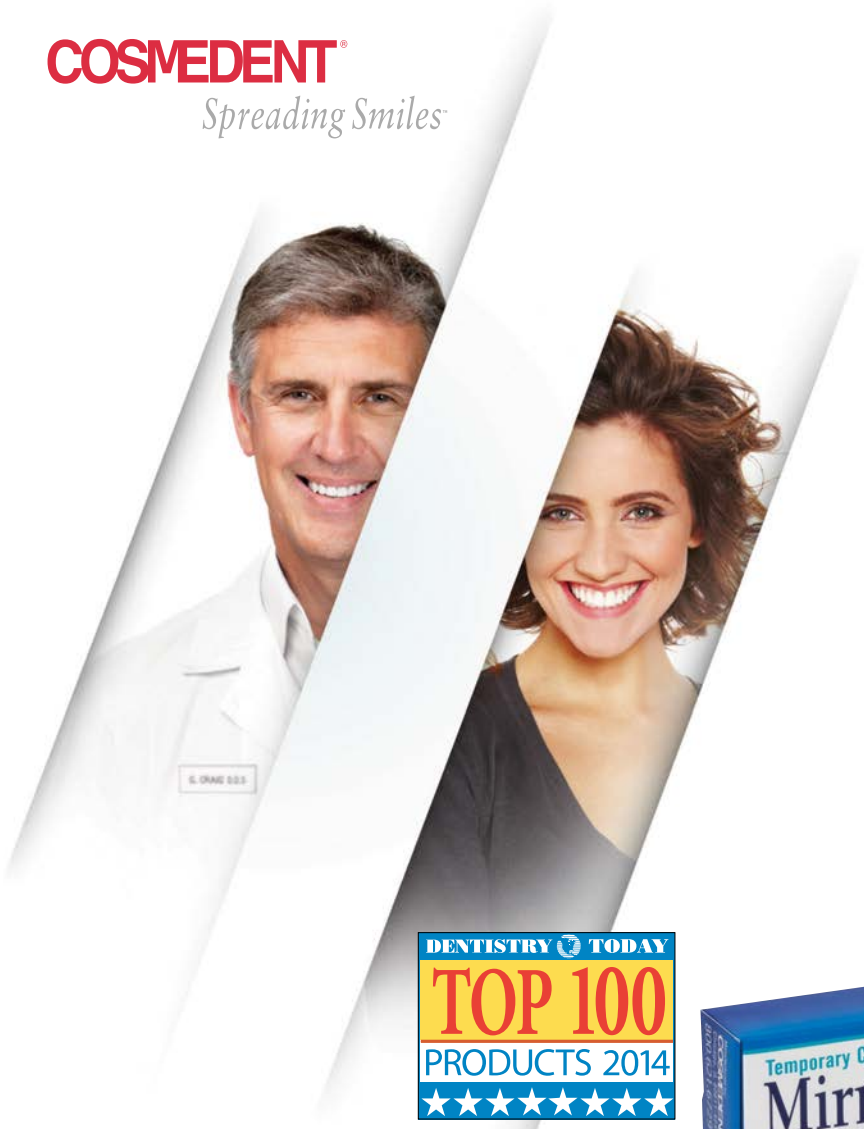

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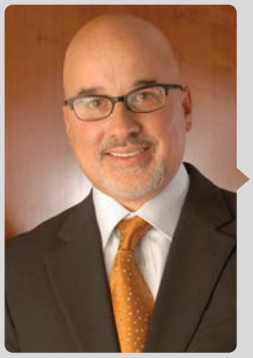

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Tooth Replacement in the Esthetic Zone

Synergy and Success for Accreditation Case Type III

Mohan Bhuvaneswaran, MDS, AAACD

Key Words: implant esthetics, soft tissue grafting, anterior implant restoration, abutment solutions, subgingival contouring, Accreditation Case Type III

Figure 1: Preoperative; full-face smile view.

Introduction

The field of cosmetic dentistry has gained new dimensions from numerous advances in the fields of materials science and soft tissue techniques. Undetectable replacement of a missing anterior tooth has become more predictable; however, such procedures remain a challenge in day-to-day dental practice.

One of the clinical options for the replacement of a missing tooth involves the use of a dental implant. With the expanded knowledge we have gained about bone and soft tissue reactions to tooth extraction and implant placement, we can now fabricate implant-retained restorations with an outcome that is beautiful and natural in appearance. A successful outcome depends upon a number of factors, including implant position, gingival biotype, restoration emergence, and communication with the ceramist and specialists.

"A successful outcome depends upon a number of factors, including implant position, gingival biotype, restoration emergence, and communication with the ceramist and specialists."

Figure 2: Preoperative frontal 1:2 view, showing the unesthetic acrylic bridge.

Figure 3: Preoperative 1:1 view, clearly showing that the acrylic bridge has impinged on the gingival tissues, resulting in an unhealthy site in relation to #8 and #9.

Patient History

A 20-year-old female was referred to us by her general dentist due to a missing upper anterior tooth. Her history revealed trauma to her maxillary central incisors 10 years earlier during a school sporting event. Both #8 and #9 had been treated with a light-cured composite to restore the significant fractures, after endodontic treatment. Five years later, because there were frequent failures with composite, temporary acrylic crowns were placed. Subsequently, the patient experienced moderate discomfort in this area. Tooth #8 was deemed non-restorable and was extracted, while #9 was retreated endodontically. An acrylic cantilever bridge was then placed by her general dentist.

She was in excellent health, with an unremarkable medical history and good preventive dental care. Her oral hygiene was good and the soft tissue was in good shape. Clinical and radiographic examinations were within normal limits and there were no temporomandibular joint (TMJ) abnormalities. For many years, the patient had been unhappy about her appearance; her dream was to have a beautiful smile **(Fig 1)**.

Diagnosis and Treatment Planning

A thorough clinical examination including study models, photographs, and radiographs was completed. For precise implant planning, a CT scan was also done to evaluate the bone morphology of the edentulous area. The examination revealed a poor acrylic temporary cantilever bridge replacing tooth #8 **(Fig 2)**. The bridge was totally out of contour, impinging on the tissues, and was highly unesthetic. The soft tissue surrounding the bridge was highly inflamed **(Fig 3)**. There was an obvious extraction site defect in the region of #8 and radiographic examination revealed that the endodontic treatment of #9 was without any periapical pathology **(Fig 4)**. The patient's other teeth were all in good condition.

Figure 4: Preoperative radiograph shows the extracted site and the satisfactory endodontic treatment in #9.

Treatment options for this patient included a traditional fixed bridge or an implant crown for replacement of #8. Considering the age and overall status of the patient, it was decided to place an implant. Implants are a conservative treatment modality for a missing anterior tooth and the level of esthetics achieved can be exceptionally good.[1]

Biological Considerations

Clinical and radiographic examinations and a scan report revealed acceptable bone quality for implant placement. The site required only soft tissue augmentation **(Fig 5)**. It was also noted that there was loss of keratinized attached gingiva in the region of #8.

Esthetic Considerations

The challenge was to achieve a symmetrical smile with reference to hard and soft tissues. All-ceramic crowns would be sufficient, but the main issue was to mirror #8 with #9 both anatomically and at the gingival interface. This required careful implant placement, provisionalization, abutment selection, customizing of the abutment, and final crown placement.

Functional Considerations

The patient did not have any occlusal discrepancy or TMJ problems. Hence, a carefully designed restoration in harmony with the existing dentition was enough to address functional considerations. A good diagnostic wax-up was done on a semi-adjustable articulator, and a provisional template and surgical stent were fabricated. The same wax-up also served as a guide for the permanent restorations.

After correlating the data, a precise treatment plan was formulated with the help of additional key team members, including the oral surgeon, periodontist, and ceramist. The esthetic importance of achieving a correct emergence profile was discussed with the surgeon and the periodontist. The surgeon's plan ensured that the implant was placed correctly, bearing in mind the incisal edge position of the final restoration and the bone morphology.[2] Correct placement and angulation of the implant are important in achieving good soft tissue architecture.[3] The grafting procedure was planned after the implant placement to take into consideration the final soft tissue morphology after wound contraction.[4] The tissue was harvested from the palatal mucosa instead of using Alloderm, since the former generally yields predictable results.[5] Considering the esthetic requirements of the case, the technician preferred a glass ceramic instead of oxide ceramic. Glass ceramic can provide a better esthetic outcome.[6]

Figure 5: Note defect and loss of attached keratinized tissue.

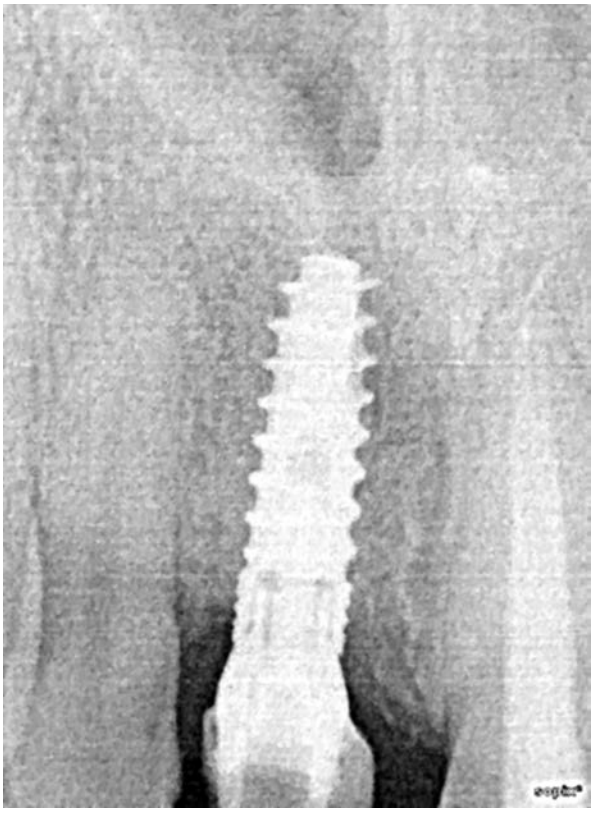

Figure 6: Radiograph three months after implant placement.

The treatment time required to achieve an excellent result was discussed, as soft tissue management can require significant time.[7,8]

Treatment Plan Sequence

The treatment plan sequence was as follows:

1. placement of temporary crown in #9
2. placement of a two-stage implant for #8
3. placement of temporary abutment and provisional crown for #8
4. connective tissue grafting for soft tissue augmentation in the region of #8
5. provisionalization of #8 and #9
6. functional and esthetic evaluation of provisionals
7. fabrication of customized abutments and permanent crowns using lithium disilicate glass ceramic (IPS e.max, Ivoclar Vivadent; Amherst, NY)
8. observation and follow up.

Description of Treatment

Surgical Procedure

The temporary acrylic bridge was removed, a new temporary crown was placed in #9, and the tissue was allowed to heal in the region of #8. Our surgical treatment was simple, predictable, and respected the biology of hard and soft tissues. The surgeon's goal was to create an ideal prosthodontic environment,[9] allowing the dental technician to create an implant restoration with ideal soft tissue support and long-term stability. The surgeon used the template from the diagnostic wax-up as a surgical stent for the placement of a 3.7 mm x 14 mm implant (Hexacone, IHDE Dental; Uetliberg, Switzerland). After achieving complete local anesthesia, the implant was placed, an esthetic healing cap was placed, and the soft tissue was sutured. The surgical guide helped the surgeon to determine the angulation of the implant.[10] Instructions for home care were given and the patient was discharged after postoperative radiographs were taken. The primary stability of the implant was satisfactory and the radiograph revealed correct placement.

Tissue Grafting

The patient was recalled one week later for suture removal and the healing was found to be acceptable. A temporary partial denture was fabricated without impinging on the soft tissue and the patient was examined monthly for three months.

Clinical and radiographic examinations during the follow-up appointments verified satisfactory healing. After three months, laser gingivectomy was done to expose the implant, and a temporary abutment and provisional were placed for #8 **(Fig 6)**. After two weeks, soft tissue grafting was completed using the connective tissue from the palate, which served as the donor site **(Figs 7 & 8)**. Vicryl 5-0 suture (Ethicon; Blue Ash, OH) was placed to secure the graft in position. Care was taken to maximize soft tissue thickness around the implant **(Fig 9)**; this allowed ideal gingival contour, to achieve the required emergence profile.[11]

Ten days later, sutures were removed and the bone levels of the teeth adjacent to the implant were evaluated **(Fig 10)**. The bony crest was sounded using a periodontal probe to ensure that the proximal contacts of the provisional were within 4 to 5 mm of the interdental bone of the adjacent natural tooth (this will minimize the occurrence of black triangles). The provisional crown of #8 was removed and reshaped using flowable composite in order to train the peri-implant soft tissue for a proper emergence profile. The gingival third of the crown was well polished to avoid any irritation to the soft tissue. In subsequent appointments, small amounts of composite were added in the gingival third to establish the required emergence profile **(Figs 11a & 11b)**. This tissue training was repeated every two weeks to achieve the desired contours.[12,13] During the entire procedure of soft tissue grafting, it was always kept in mind to match #8 and #9 with regard to the symmetry of hard and soft tissues. Once the ideal contours were developed with provisional crowns, the tissue was allowed to mature for six weeks. During the healing phase, the soft tissue responded very well to treatment and a good keratinized mucosa formed in the region of #8 **(Fig 12)**.

> **"Implants are a conservative treatment modality for a missing anterior tooth and the level of esthetics achieved can be exceptionally good."**

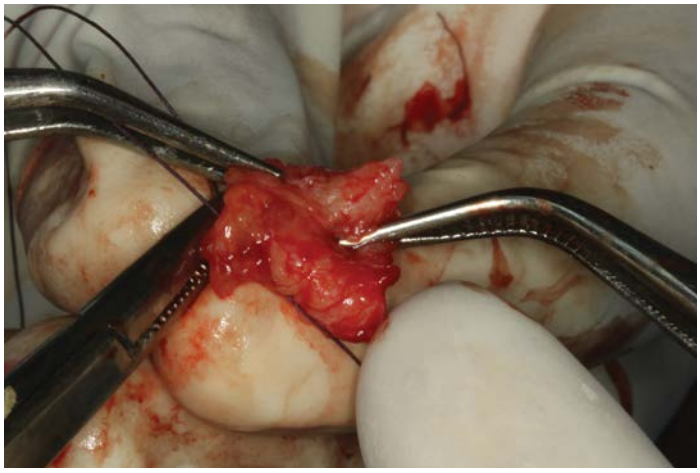

Figure 7: The connective tissue graft was taken from the palatal region.

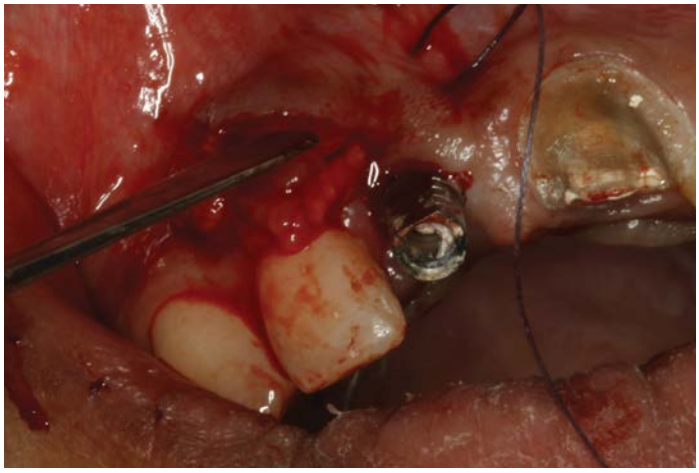

Figure 8: The connective tissue graft was tucked into an envelope, to preserve the papilla and any related wound contraction.

Figure 9: Note the significant bulk of soft tissue that was gained after the initial grafting procedure.

Figure 10: The postoperative period was uneventful. This image shows the maturation of the tissues.

Figure 11a: Labial view of the provisional was contoured to obtain the emergence profile.

Figure 11b: Mesial view of the provisional.

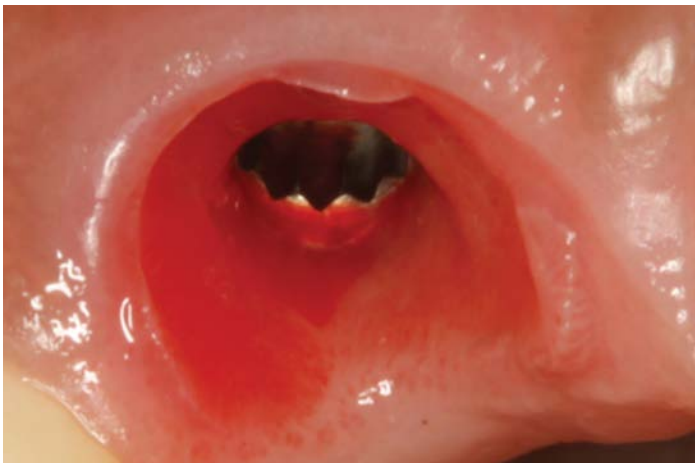

Figure 12: An ideal soft tissue profile was obtained. Note the soft tissue bulk and the healthy site for prosthetic rehabilitation.

Figure 13: Custom abutment during the try-in stage.

Prosthetic Management and Crown Fabrication

After complete evaluation and discussion with the technician, it was decided that the NiTi abutment would be milled and used as a base for the final abutment. Lithium disilicate glass (IPS e.max) was selected to customize the abutment to the tissue contours using computer-aided design/computer-aided manufacturing (CAD/CAM) technology, making it easy to replicate the tissue contours that were achieved.[14] The provisionals were removed, the temporary abutment of #8 was replaced with the custom titanium abutment, and #9 was carefully prepared for an all-ceramic crown. An open tray impression was made using an addition silicone impression material (Virtual, Ivoclar Vivadent). The opposing arch impression and bite registration were made. An impression of the gingival third of the provisional of #8 was also sent to the laboratory to transfer the exact replica of the soft tissue contour that was achieved. The abutment was milled to achieve the required contour and then customized using lithium disilicate (IPS e. max), which was cemented onto the titanium abutment using Mutilink Hybrid Abutment (Ivoclar Vivadent) **(Fig 13)**.

The crowns for both #8 and #9 were fabricated using IPS e.max pressable glass ceramic, replicating the diagnostic wax-up in the permanent restorations. The laboratory sent the custom abutment and crowns in the pre-glaze stage for clinical evaluation. The custom abutment was placed and required no further adjustment, as the expected soft tissue contour was achieved. The crowns were placed using the try-in cement and evaluated esthetically and functionally. The shade match to the natural dentition was excellent, as were all contours and contacts. Radiographs were used for seating verification. When the patient and all the team members were happy with the results, the crowns were returned to the laboratory for final finishing.

Delivery

On delivery day, the provisionals were removed, the implant was rinsed with chlorhexidine gluconate (0.2%), and the custom abutment was torqued into place (20 Ncm). Radiographs were taken to verify seating of the abutment. The screw access hole of abutment was then sealed and the abutment and tooth were cleaned thoroughly before cementing the crowns with Multilink Speed (Ivoclar Vivadent). The crowns were held firmly in place and light-curing (Bluephase G2, Ivoclar Vivadent) was done using a quarter-cure technique. This facilitated the easy removal of the cement. The restorations were then carefully examined under magnification and radiographed to ensure there was no excess cement. Finally, the occlusion of crowns was verified and was found to be in proper alignment with rest of the dentition. The patient was examined after one week, at which time the restorations had completely blended with the existing dentition **(Figs 14 & 15)**. Postoperative photographs and radiographs were taken during this visit **(Fig 16)**. The emergence profile proved to be in the zone of excellence **(Fig 17)**.

Summary

Replacement of missing teeth in the esthetic zone with an implant-supported restoration provides patients with a conservative treatment modality. In this case, an interdisciplinary approach to treatment was the key to success. Needless to say, an excellent treatment plan is essential for a predictable outcome. Improving the perio-prosthetic interface with connective tissue grafting is one of the most efficient surgical treatments for obtaining long-term stability, as seen in this type of esthetic case.

This case was managed via a multidisciplinary team effort that proved to be successful for the patient and all who were clinically involved **(Fig 18)**.[15] The patient was extremely satisfied with the treatment outcome **(Figs 18-20)**.

Figure 14: Note the blending of the ceramics with the existing dentition.

Figure 15: The ideal soft tissue contour and the beautiful restorations that were achieved through a multidisciplinary team effort.

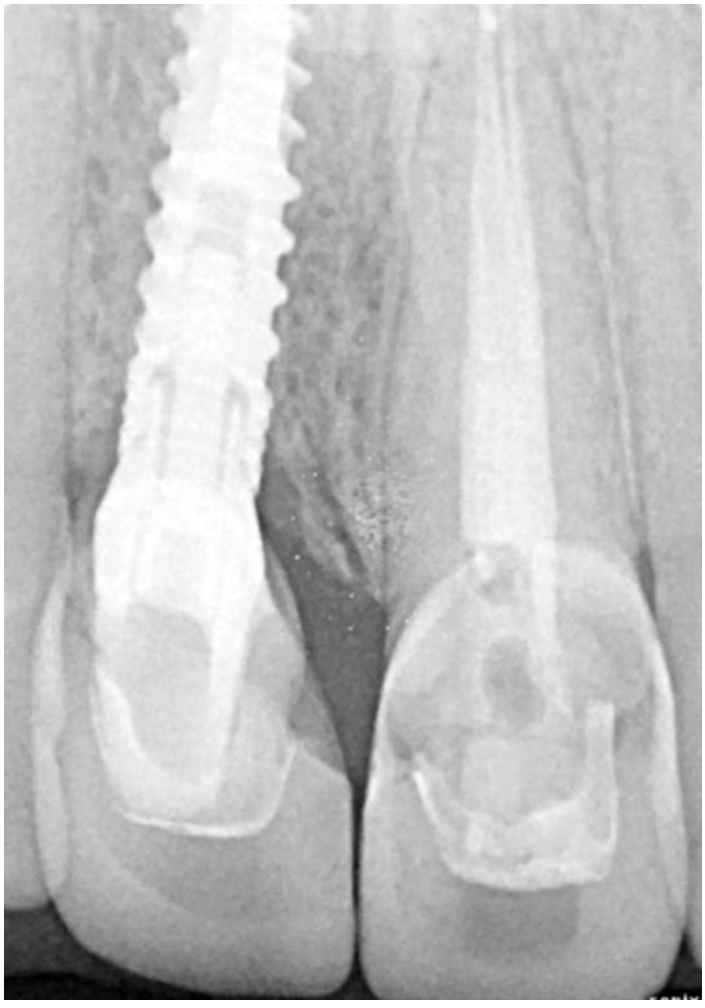

Figure 16: Postoperative radiograph showing perfect fit of the restorations with no excess cement.

Figure 17: The right lateral view showing good emergence profile.

Figure 18: Postoperative full smile.

Figures 19 & 20: The happy patient.

Acknowledgments

The author thanks his team members: oral and maxillofacial surgeon P. Suresh Kumar, periodontist P.M. Archana, and N. Dhanasekar, CDT, all of Tamil Nadu, India, for their tireless efforts leading to the success of this case. The author also extends his gratitude to his mentor, Rebecca Pitts, DMD, FAACD, for her continuous support and encouragement to pursue Accreditation.

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Disclosure: The author did not report any disclosures.

Synergy and Success

Clinical Case Type III: Tooth Replacement (Implant)

James H. Peyton, DDS, FAACD

> **"Careful attention to the gingival profile and soft tissue contours are of the utmost importance."**

The examiners' main comments were as follows:

- Criterion #53: *Is the color (hue, value, chroma) selection appropriate/natural, not monochromatic?* The restored teeth #8 and #9 were lower in value.
- Criteria #64/#84/#87: These criteria are related to a wide contact area. The incisal embrasure was underdeveloped and the distal line angle was underdeveloped.

Accreditation Case Type III can be very difficult to blend seamlessly with the surrounding dentition. Careful attention to the gingival profile and soft tissue contours is of the utmost importance. The restoration needs to be made to mimic the adjacent teeth. This all calls for a tremendous team effort! The cosmetic dentist must properly treatment plan the case in conjunction with the implant surgeon/periodontist, laboratory technician, and the patient. A result such as that obtained by Dr. Bhuvaneswaran could have been achieved only by selecting a first-rate team.

There was a significant esthetic improvement in this case. The soft tissue was healthy and the extraction site was handled very well. However, even though all five examiners passed the case, it was not perfect. The examiners' comments were almost the same, and the scores they awarded were identical.

It is important to note that sometimes a fault can be categorized as belonging to several different criteria. However, in each instance here, the examiners did not "double dip" and just deducted for one fault that related to the similar issue. Overall, Dr. Bhuvaneswaran obtained an excellent result and his case was deemed worthy of Accreditation. **jCD**

Dr. Peyton is an AACD Accredited Fellow and has been an AACD Accreditation Examiner since 2000. A part-time instructor at the UCLA School of Dentistry, he practices in Bakersfield, California.

Disclosure: The author did not report any disclosures.

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Managing Prosthetic Challenges with a CAD/CAM Zirconia Restoration

From Bilayered to Monolithic

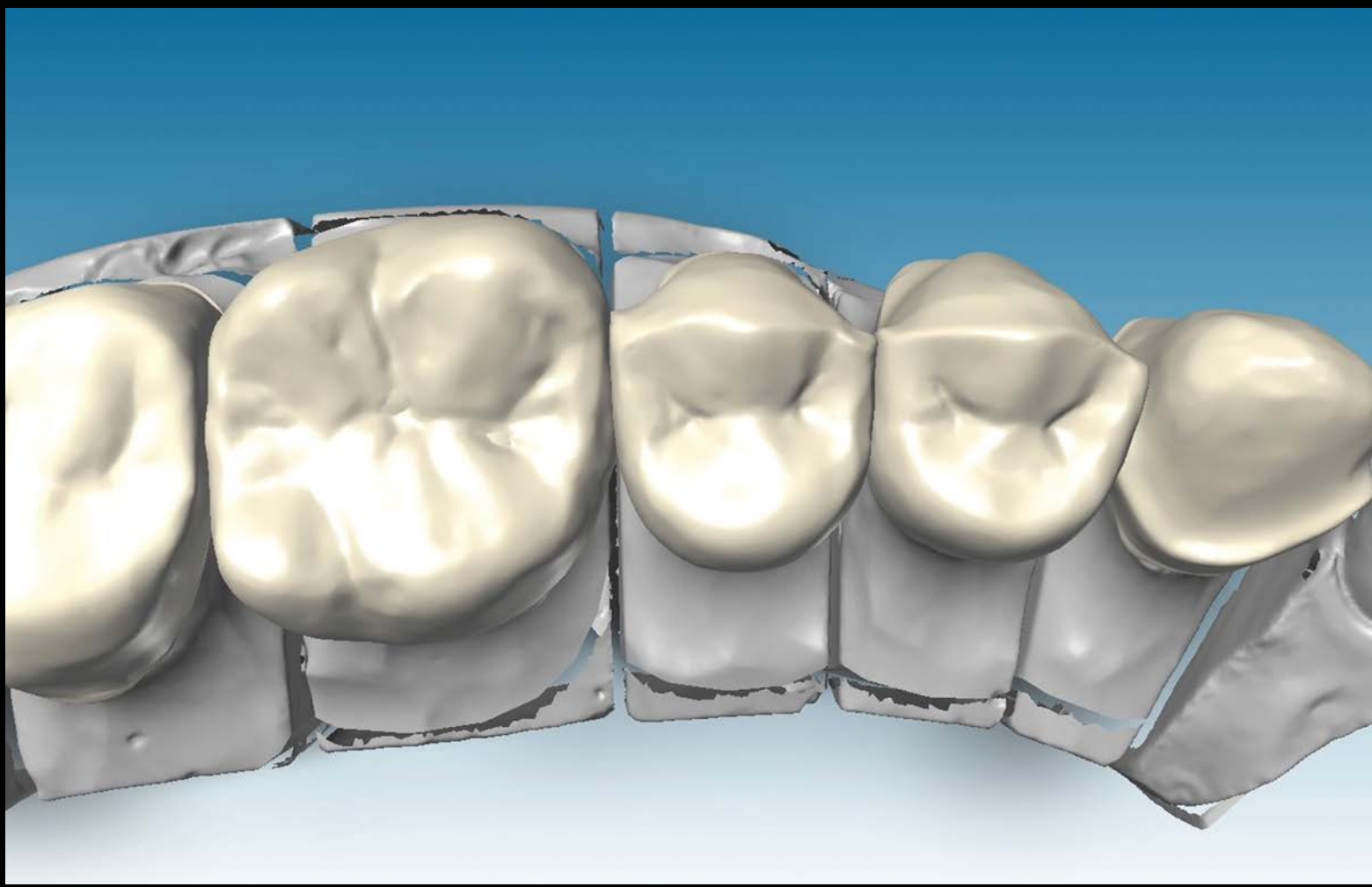
Ariel J. Raigrodski, DMD, MS, FACP

Abstract

The integration of an esthetic restoration with the soft tissue is paramount for a comprehensive esthetic, functional, and healthy restorative outcome. Zirconia may facilitate such an outcome due to its optical properties, which enhance the esthetic integration of the restoration at the soft tissue/restorative interface, while also enhancing soft tissue health due to its unique biocompatibility. This article will demonstrate concepts and procedures for soft tissue management in the case of a full-mouth rehabilitation using CAD/CAM technology and zirconia as a catalyst for an improved soft tissue/restorative integration with crowns and ovate pontic contours.

Key Words: all-ceramic, monolithic restoration, bilayered restoration, hybrid restoration, ovate pontic, CAD/CAM, soft tissue/restorative interface

Zirconia-based restorations are designed and processed via computer-aided design/ computer-aided manufacturing technology.



Introduction

The success of all-ceramic crowns and fixed dental prostheses (FDPs) is measured not only by achieving adequate function and esthetics in terms of color match with the adjacent and opposing dentition; it is also measured by their integration with the adjacent hard and soft tissues in terms of function, health, and esthetics. Certainly, the optical properties and multiple tooth-colored shades and translucencies presented by all-ceramic materials enhance such integration at the soft tissue/restorative interface.[1]

CAD/CAM Technology

Zirconia-based restorations are designed and processed via computer-aided design/computer-aided manufacturing (CAD/CAM) technology.[1] Clinical studies have shown that these restorations can be used predictably for anterior and posterior crowns and for anterior and posterior FDPs.[2-4] With the advent of CAD/CAM technology, the primary design option for such restorations is the fabrication of a framework/coping that adequately supports the weaker veneering porcelain to minimize the risk for veneering porcelain cohesive failure.[5-7] Recent studies demonstrated similar flexural strength values (70 to 130 MPa) and similar values for fracture toughness (1.2 to 1.7 K1c) for different brands of veneering porcelains for zirconia-based restorations and for high noble alloy-based metal ceramic restorations.[8,9] Such a design is mostly desirable in the anterior segment, where occlusal forces are lower compared to the posterior segments, and esthetics is often the primary consideration. Coping thickness for such restorations is recommended to be a minimum of 0.6 mm in the posterior segments with a thickness of at least 1.5 to 2.0 mm of veneering porcelain, whereas in the anterior segment coping thickness can be reduced to 0.3 mm.[3,10] In addition, developments in CAD/CAM technology have facilitated restoration design flexibility, including the design and processing of monolithic zirconia crowns and FDPs.[11] Although concern has been expressed regarding the effects of aging on zirconia and of the wear properties of zirconia, recent studies have demonstrated that such concerns may be over-emphasized.[12-15] Such restorations may be used in the posterior segments where esthetics is less of a concern; and resistance to fracture, possible lack of interocclusal space, and control of occlusal contacts are of greater concern mainly due to higher occlusal forces compared to the anterior segment. Although clinical evidence is still limited with regard to the minimal thickness of such restorations, an in vitro study demonstrated that monolithic zirconia crowns of 0.6 mm thickness resulted in relatively high magnitude fracture loads.[16] A more recent in vitro study demonstrated that the fracture resistance of monolithic zirconia crowns with 1.0-mm thickness is equal to that of metal-ceramic crowns.[17] Consequently, and since the clinical reality is that minor occlusal adjustments may be needed after the restorations' cementation, it is advisable to use 1.0 mm of occlusal thickness as the guideline for minimal occlusal reduction.

However, in the premolar areas, where esthetics may still be of concern and occlusal forces are increased compared to the anterior segment, a different design can be considered. Termed the "hybrid" design,[18] with such restorations the lingual and occlusal surfaces are still designed for monolithic contours, whereas the buccal aspects can be virtually cut back to the ideal coping thickness and subsequently veneered with the corresponding veneering ceramics to facilitate the esthetic outcome.[18] Such a design can be used in the anterior segments as well, and can be easily achieved via CAD/CAM technology as long as clinicians communicate in detail with the dental laboratory regarding the restoration's design **(Table I)**.

Zirconia Characteristics

In addition, zirconia is presented with multiple tooth-colored shades and different levels of translucency as related to the brand used and to the thickness of the material.[19,20] This may promote favorable integration in terms of color and translucency at the soft tissue/restorative interface, a critical area in terms of soft tissue health and esthetics. These optical characteristics of zirconia are accompanied by excellent biocompatibility and several studies have demonstrated that, compared to titanium, zirconia presents with less bacterial accumulation, less bacterial adhesion, and less inflammatory reaction.[21-23] Thus, zirconia may facilitate adequate soft tissue integration in terms of esthetics and gingival health.

Soft Tissue Integration

Patients restored with FDPs and crowns in areas where esthetics is of paramount significance present with the challenge of having the restorations' contours blend adequately with the free gingival margins and the interproximal papillae. If the patient is missing a tooth that is planned to be restored with an FDP, the goal is to ensure that the pontic blends with the edentulous space and matches the contralateral and opposing soft tissues in terms of emergence profile (including facial and interproximal contours), texture, color, and health.[24,25] Various types of hard and/or soft tissue augmentation procedures, in conjunction with the use of an interim prosthesis to mold the tissue, are utilized to create a healthy concave pontic site at the residual alveolar ridge to facilitate the creation of an adequately matching convex ovate pontic.[26-28] The creation of an ideal convex ovate pontic enhances the pontic's blend with the pontic site, promoting an illusion of the pontic erupting out of the ridge. Moreover, the convex surface of the pontic facilitates the patient's ability to adequately clean the pontic site, while minimizing gingival inflammation.[24,25,29]

This visual essay addresses the use of CAD/CAM technology and zirconia in conjunction with proper clinical procedures, to facilitate not only the restorations' durability and "white component" of esthetics in terms of translucency and shade matching, but also the "pink component" in terms of soft tissue esthetics and health.

Table 1. Advantages and Limitations of Different Designs of Contemporary Complete-Coverage, All-Ceramic Restorations.

Restoration Design	Advantages	Limitations
bilayered	most esthetic potential	least functional potential due to weaker veneering porcelain (risk of cohesive chipping), and due to an interface between the veneering porcelain and the core material (risk of adhesive delamination)
monolithic	most durability and functional potential	least esthetic potential (relatively monochromatic)
hybrid	most esthetic potential in low-function areas while maintaining durability in high-function areas	requires detailed communication with the ceramist

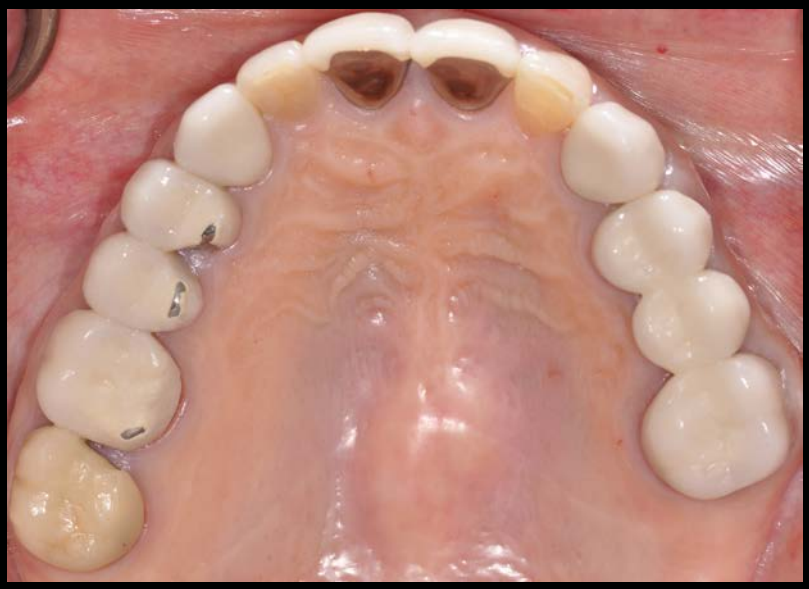


Figure 1a: Preoperative maxillary occlusal view of a patient with a failing full-mouth rehabilitation. The patient had been experiencing symptoms of malocclusion, which were translated to wear and fracture of some of her restorations. Note the wear and the fractures of the porcelain on ##2-5, and missing #15.

Figure 1b: Preoperative mandibular occlusal view of the patient. Note the wear on the occlusal aspect of the restorations and the anterior teeth, and missing #31.

Figure 2: Preoperative frontal retracted view of the patient in maximal intercuspal position. Note the color match discrepancies of the restorations with the remaining dentition. The patient presented with 4. 0-mm overbite, 3.0-mm overjet, gingival recessions, and opaque restorations. She expressed her satisfaction with the shade of her maxillary lateral incisors (which were relatively intact, excluding a mesial and distal direct composite resin restorations on #7). Therefore, a joint decision was made with the patient to use the maxillary lateral incisors as a guide for shade matching along with the mandibular anterior teeth. This decision increased the challenge the dental ceramist faced while fabricating the definitive restorations.

Figure 3a: Right lateral view of the patient in maximal intercuspal position. She presented with an Angle Class II dental relationship and demonstrated initial group function transitioning to right canine guidance in right lateral movement.

Figure 3b: Left lateral view of the patient in maximal intercuspal position. She demonstrated initial group function transitioning to left canine guidance in left lateral movement.

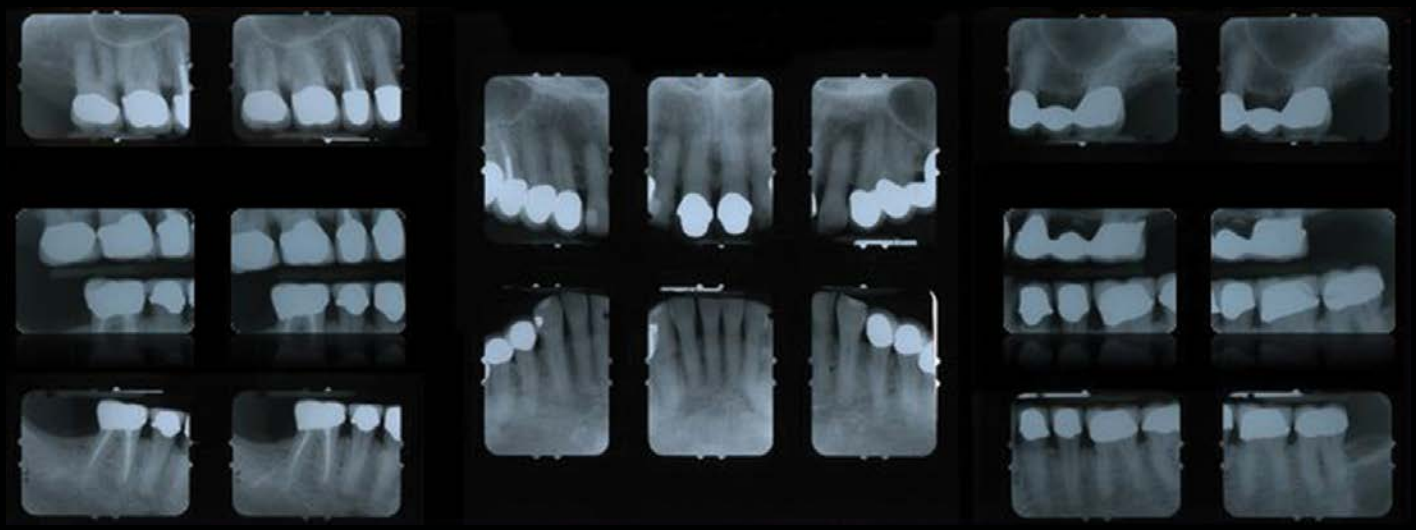


Figure 4: A full-mouth periapical radiograph showed adequate crown-to-root ratio, and mild bone loss around the anterior mandibular dentition. The patient was diagnosed with the following: mild localized periodontitis, acquired horizontal and vertical ridge deficiencies, partial edentulism, bilateral Angle Class II malocclusion with fractured restorations, and bruxism and clenching (by report). Treatment objectives were to resolve the patient's chief complaints; this included addressing her malocclusion while also improving her chewing ability as well as esthetics. Therefore, she was given an anterior deprogrammer to eliminate any posterior teeth contact and interferences that might cause muscle disharmony and preclude adequately recording centric relation (CR) position (which was to be used as a reference for designing the definitive occlusal scheme). It was decided to provide the patient with long-term provisional restorations, which would be used as trial prostheses to ensure adequate function and esthetics. In addition, it was decided to use monolithic zirconia full-coverage restorations on the molars to address the patient's complaint of porcelain chipping and zirconia-based restorations elsewhere. Such an approach will facilitate the esthetic result, in particular at the soft tissue/restorative interface, while providing the patient with restorations that can be predictably conventionally luted since her gingival health was questionable.

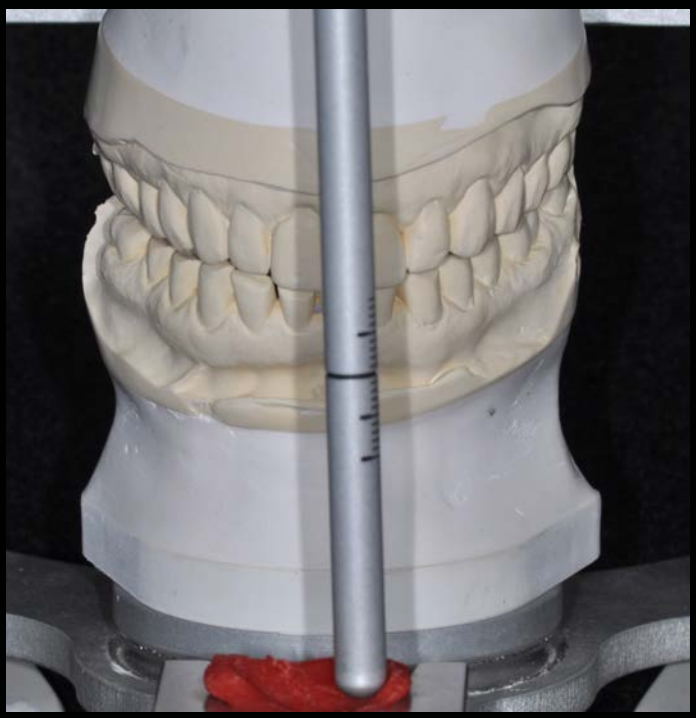
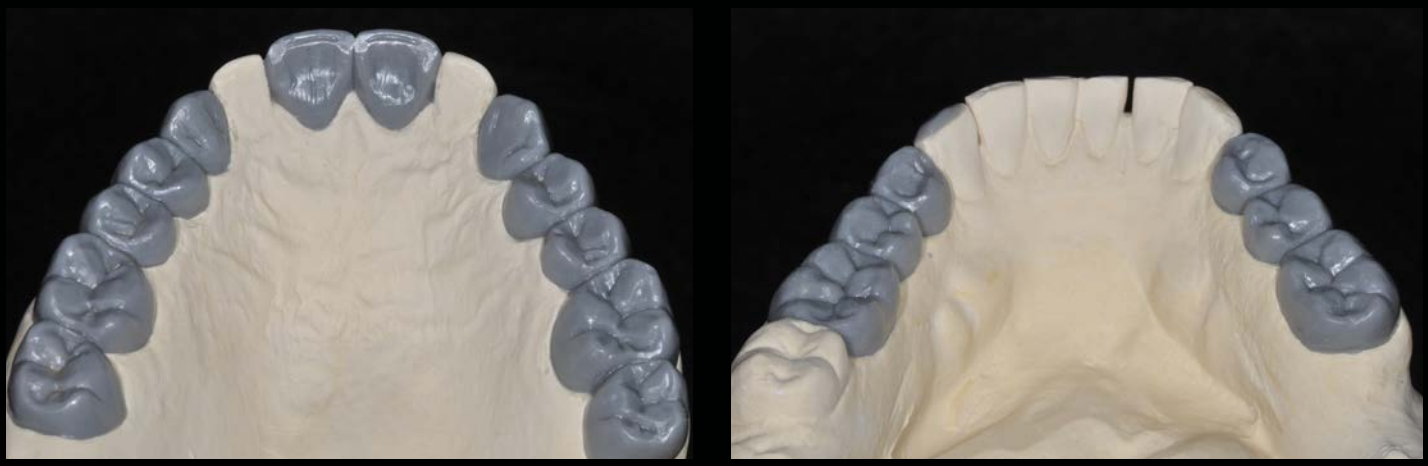
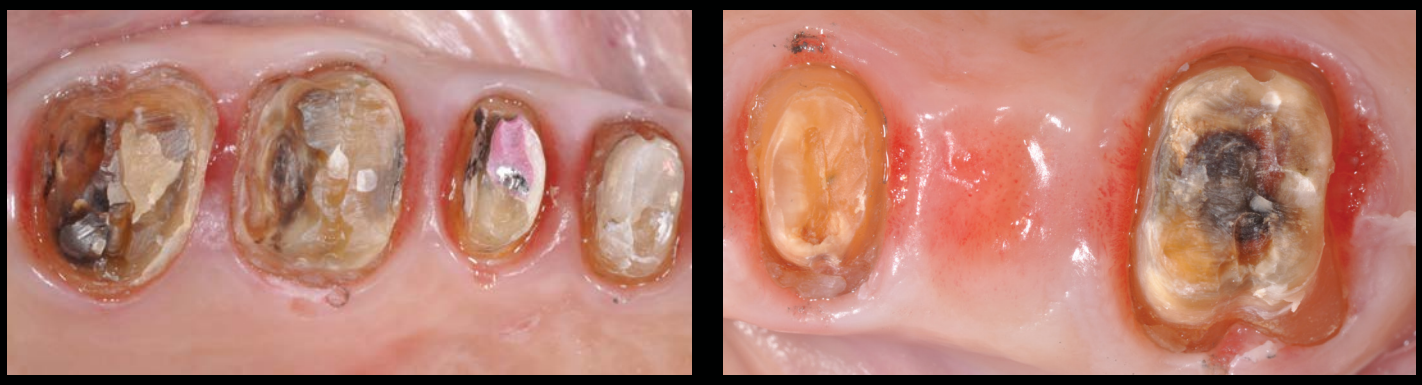


Figure 5: Diagnostic impressions were made and the patient was provided with an anterior deprogrammer for three months. Once centric relation was confirmed, a facebow record was made and the maxillary cast was mounted on a semi-adjustable articulator. A CR record was made and the mandibular cast was mounted while opening the vertical dimension of occlusion by 2.0 mm at the incisal area. A custom incisal guide table was made and was used in fabricating the diagnostic wax-up while providing the patient with mutually protected occlusion.

Termed the "hybrid" design, with such restorations the lingual and occlusal surfaces are still designed for monolithic contours, whereas the buccal aspects can be virtually cut back to the ideal coping thickness and subsequently veneered with the corresponding veneering ceramics to facilitate the esthetic outcome.



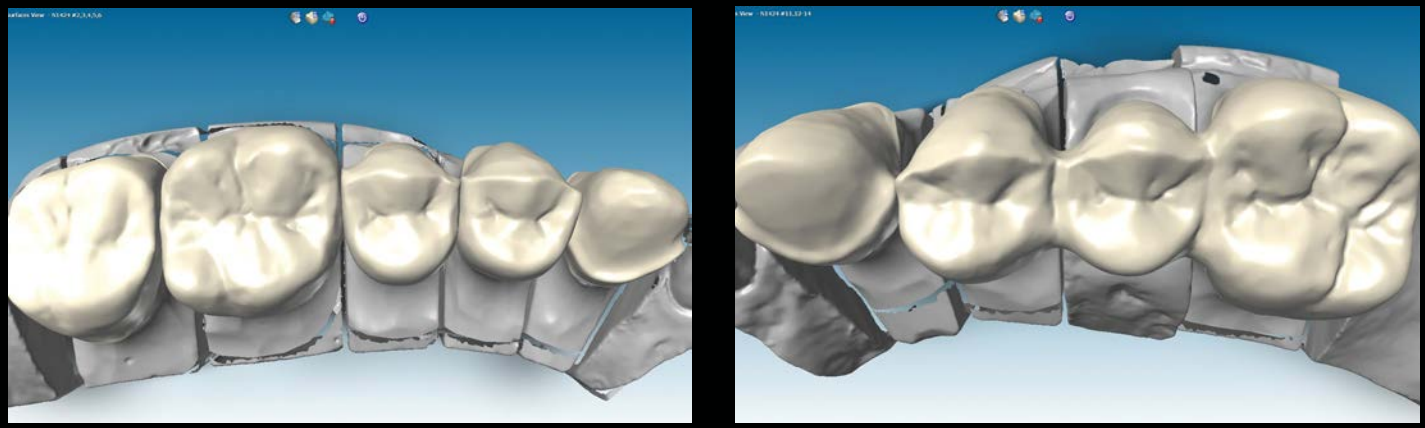
Figures 6a & 6b: Occlusal views of both the maxillary and mandibular wax-ups showing the palatal aspects of the maxillary central incisors and the maxillary canines, as well as the incisal aspects of the mandibular canines. All were designed to ensure that the anterior and canine guidance would immediately disocclude the posterior dentition in excursions.



Figures 7a & 7b: All maxillary full-coverage restorations were removed. In the occlusal view of the maxillary posterior dentition immediately after removal of the preexisting restorations, note a relatively healthy gingiva traumatized by the procedure. Also, note the pontic area, which will be manipulated for an ovate pontic site with the provisional restorations. The mandibular preexisting restorations were removed as well. Foundation restorations were replaced and the tooth preparations were refined. The patient declined any new metal or metal-ceramic restorations. Since her gingival health was questionable (which might compromise bonding procedures of bondable all-ceramic restorations), a posterior FDP was part of the rehabilitation, and matching of all the restorations was of primary importance to the patient, it was decided to select zirconia-based restorations with various restoration designs.

Figures 8a & 8b: Maxillary and mandibular views of the provisional restorations. The diagnostic wax-ups were duplicated in dental stone, impressions of these new casts were made, and shells with contours of the diagnostic wax-up were made of bis-acryl material (Protemp Plus, 3M ESPE; St. Paul, MN). Maxillary and mandibular provisional restorations were placed following the occlusal scheme developed on the articulator using the shells, which were relined with autopolymerized acrylic-resin (Jet, Lang; Wheeling, IL) in the patient's mouth. The pontic site was trimmed with a high-speed, super-coarse, football-shaped bur and direct composite resin was added to the cervical part of the pontic to mold the tissue at the pontic site to an ovate pontic shape.
The patient functioned with the provisional restoration for more than three months and did not report any sensitivity, discomfort, or pain. During that period the provisional restoration on #19 cracked once. However, there was no additional loss of retention, cement wash, or fracture.

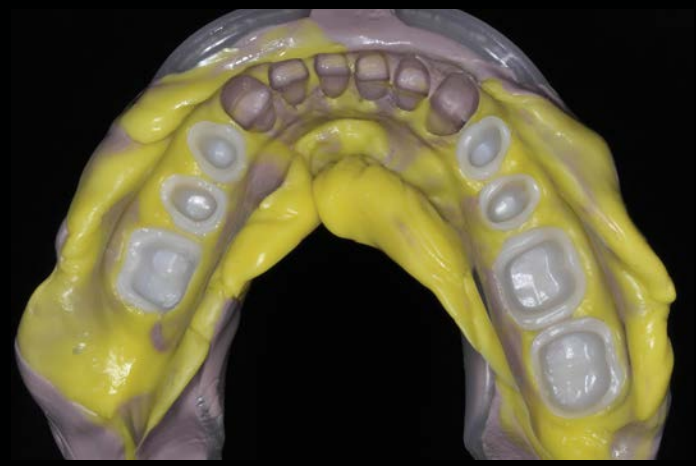
Figures 9a & 9b: Occlusal views of the maxillary and mandibular teeth preparations. Subsequently, master impressions of the prepared teeth on both arches were made with polyvinyl siloxane (PVS) (Imprint 3, 3M ESPE); impressions of the provisional restorations were made as well. Interocclusal records were made to allow for cross mounting of the definitive casts to the provisional restorations. Care was taken not to compromise the soft tissue and to avoid prospective recessions.



Figures 10a & 10b: The definitive casts, the casts of the provisional restorations, and interocclusal records were scanned with the Lava scanner (3M ESPE). Zirconia-based restorations (Lava Plus, 3M ESPE) were designed to allow for adequate support of the veneering porcelain at areas where esthetics is critical. Monolithic zirconia restorations were designed for the molars, where the likelihood of heavy occlusal forces is higher and to reduce the incidence of mechanical complications.

Figures 11a & 11b: Lateral views of the framework try in. The proximal contacts and internal fit were assessed using a silicone disclosing agent (Fit Checker, GC America; Alsip, IL). Afterwards, the occlusal contacts were evaluated and the occlusal surfaces of the posterior teeth were slightly adjusted with a high-speed fine diamond bur and ample water. In addition, the intaglio surface of the FDP framework pontic was coated with autopolymerized acrylic resin (GC Pattern Resin, GC America) to record the ovate pontic contours to facilitate the fabrication of a natural-looking ovate pontic for #13.

Figures 12a & 12b: Intraoral occlusal views of the maxillary and mandibular zirconia copings and FDP framework secured on the prepared abutment teeth. Note the monolithic design of the molar restorations, the coping design for the bilayered maxillary canines and central incisors crowns, and the hybrid design for the premolar restorations.



Figures 13a & 13b: Maxillary and **mandibular pick-up impressions were made with Imprint 3 PVS to ensure an accurate transfer of the soft tissue contours around the abutment teeth, in particular at the pontic site. This facilitated the creation of adequate blending of the restorations in terms of contours at the soft tissue/restorative interface.**

Figure 14: The zirconia copings and frameworks were layered, and stained and glazed as needed. A monolithic approach was used for the design and fabrication of the functional occlusal aspects of the posterior crowns and FDP; this helped to ensure optimization of the mechanical properties of the restorations' occlusal contacting areas. The facial and incisal aspects of the crowns that were visible at smile were conventionally layered to facilitate internal characterization, translucency, and esthetics using corresponding layering ceramics (Noritake CZR, Kuraray Noritake; Tokyo, Japan). The intaglio surface of the pontic was layered as well, to match the contours of the pontic site.

Figures 15a & 15b: The restorations were tried in the patient's mouth to assess color match and esthetics, proximal, internal, and marginal fit, and to assess occlusal contacts. Functional and esthetic integration with the adjacent and opposing dentition as well as integration at the soft tissue/restorative interface were noted. Once verified, the restorations were conventionally cemented with self-etching, self-adhesive, dual-cured composite-resin cement (RelyX Unicem 2, 3M ESPE).

Figures 16a-16c: The patient was provided with a mutually protected occlusion with canine guidance in right lateral excursion, anterior guidance in protrusive movement, and canine guidance in left lateral excursion.

Figure 17: Excellent marginal integrity and excess cement removal were confirmed. The ceramist layered the facial and incisal aspects of the anterior restorations to provide characterizations and translucency to the patient's satisfaction.

Figure 18: Postoperative full-mouth radiographs. Note the excellent marginal integrity of the definitive restorations.

Figure 19: A hard occlusal guard with a mutually protected occlusion was provided for the patient to wear while sleeping and when feeling the urge to clench while awake. This left lateral view taken several months after delivery demonstrates esthetic and functional integration with the soft tissue around the teeth, in particular at the ovate pontic restoring #13.

Acknowledgments

The author thanks master ceramists Nori Kajita, RDT, CDT, and Masayuki Saito, RDT (Cusp Dental Research; Malden, MA), for fabricating the restoration presented in this article.

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Patients restored with FDPs and crowns in areas where esthetics is of paramount significance present with the challenge of having the restorations' contours blend adequately with the free gingival margins and the interproximal papillae.

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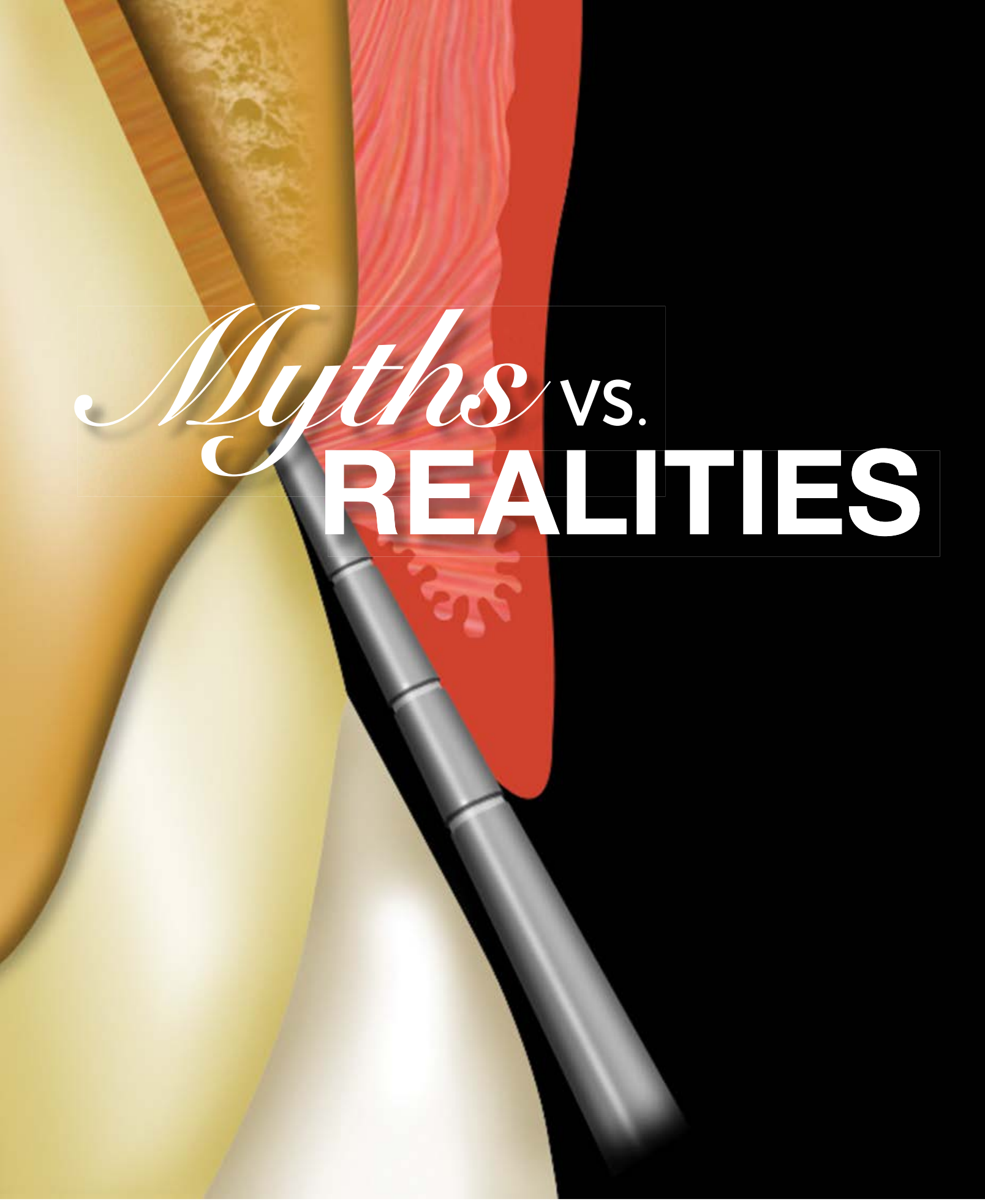

Myths vs.
REALITIES

> There is a misconception that sulcular depth can be precisely measured clinically and varies greatly from one individual to the next.

Considerations in Esthetic Crown Lengthening

Elizabeth M. Bakeman, DDS
John C. Kois, DMD, MSD

Illustrations by Harriet McCullough

Key Words: esthetic crown lengthening, sulcular depth, dentogingival complex, biologic width, transulcular approach

Introduction

Crown lengthening for esthetic purposes is a valuable procedure that can be incorporated into treatment plans to increase coronal tooth length in an apical direction, enhance symmetry, alter emergence profile, or balance length-to-width ratios. With scientifically based knowledge, crown lengthening can lead to predictable and stable outcomes. If we rely upon clinical references that are imprecise, we will have imprecise and unpredictable outcomes. The key elements to success come from making decisions based upon the use of reliable clinical references and understanding and respecting the biology of wound healing.

Myth

Knowledge of sulcular depth helps determine the need for a simple gingivectomy versus osseous crown lengthening.

Reality

A commonly held myth is that sulcular depth provides all the information necessary to decide when and if there is a need for osseous resection when altering gingival contours, but this is not the case.

There is a misconception that sulcular depth can be precisely measured clinically and varies greatly from one individual to the next. The reality is that probing depth is not representative of sulcular depth. The dentogingival complex comprises the sulcus, junctional epithelium, and the connective tissue attachment **(Fig 1)**. Histologically, there is little individual variability in the depth of the sulcus (.5 mm), yet clinically we find significant differences in probing depths and perceived sulcus depths.[1] While the distinction between the components of the dentogingival complex can be identified and measured histologically, it is unlikely that this can be done with precise clinical accuracy.[1-3] When attempting to measure the sulcus intraorally, the periodontal probe easily passes through the sulcus and penetrates the junctional epithelium **(Figs 2a & 2b)**, thereby measuring the sulcus and the zone of junctional epithelium. The degree to which the probe penetrates the junctional epithelium depends upon the force being applied to the probe, the degree of inflammation present in the tissue (more inflammation leads to increased penetration), and the probing location.[4,5] The point is that probing depth is highly variable and a histologically inaccurate measure of sulcus depth.

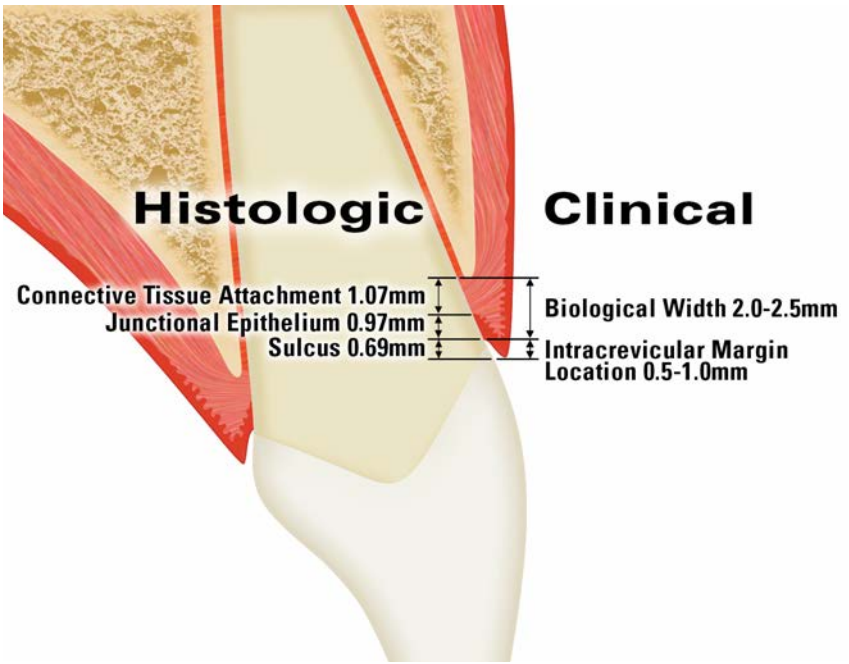


Figure 1: The dentogingival complex comprises the sulcus, junctional epithelium, and connective tissue attachment.

Myth

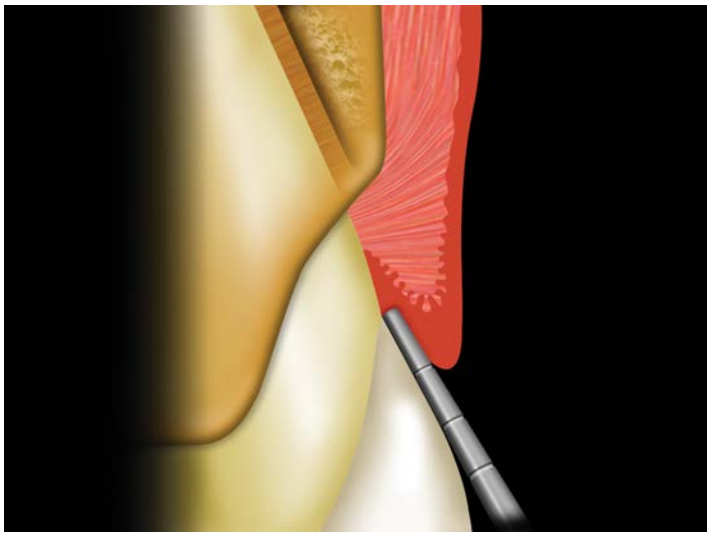
If the sulcus probes greater than .5 mm, dimensions greater than .5 mm can be predictably removed with a laser or electrosurgery, without the need for alteration of the osseous contours.

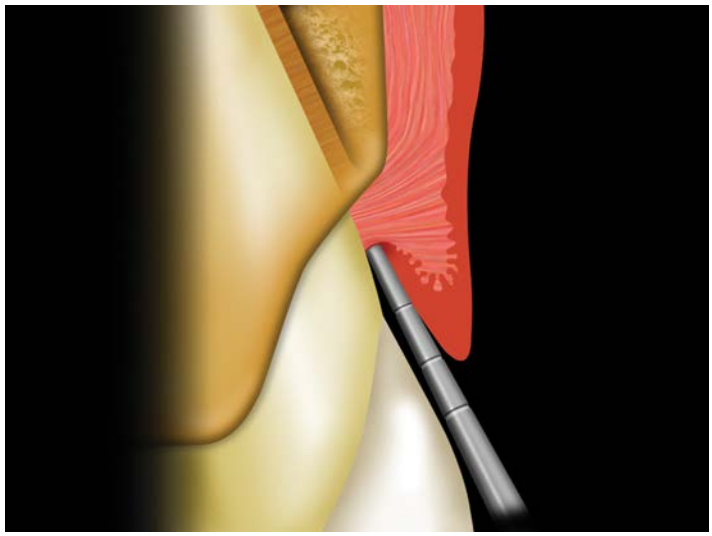
Reality

As previously discussed, probing depth is a poor determinant for sulcular depth. In addition, the process of a gingivectomy resects the coronal portion of the dentogingival complex—the sulcular and most likely portions of the junctional epithelium. These components are not dispensable elements of the dentogingival complex. They will regenerate through normal wound healing and establish dimensions similar to the presurgical situation. In fact, the entire dentogingival complex, if resected, is capable of regeneration.[6] Differences in dimensions of the dentogingival complex from one situation to the next can be attributed to variations in the dimensions of the fiber attachment, as opposed to variations in sulcular dimensions **(Fig 3)**.[7,8] The length of the connective tissue and junctional epithelial attachment may be alterable (in instances where it is greater than normal) but requires severance of the supracrestal fibers to the osseous crest. If this is not accomplished, the dimensions within the zone of attachment will regenerate. At best, as the elements of the dentogingival complex regenerate, the original gingival contours reestablish themselves and the surgical benefits are negated. At worst, the teeth in the area of surgery have been restored and restorative margins have unintentionally been placed within the zone of the supracrestal fiber attachment, in effect creating a violation of biologic width characterized by chronic and unesthetic erythema and inflammation **(Fig 4)**.[9]

Using the clinical measurement of the sulcus to make determinations about the need for osseous resection during crown lengthening can lead to less-than-predictable outcomes. The most reliable way to make decisions about the need to remove bone when removing tissue during crown-lengthening procedures is to use the dimensions of the entire dentogingival complex ("sounding to bone"—the measurement for the free gingival margin [FGM] to the osseous crest) **(Fig 5)**.[9,10] Most situations will require alteration of both the gingival tissue and bone to effect stable outcomes.[9,10]

> “The closer the tissue is positioned at the conclusion of surgery to a normal crest relationship…the sooner the architecture will be representative of the final outcome.”





Figures 2a & 2b: When attempting to measure the sulcus intraorally, the periodontal probe easily passes through the sulcus and penetrates the junctional epithelium, leading to inaccurate interpretations of sulcus dimensions.

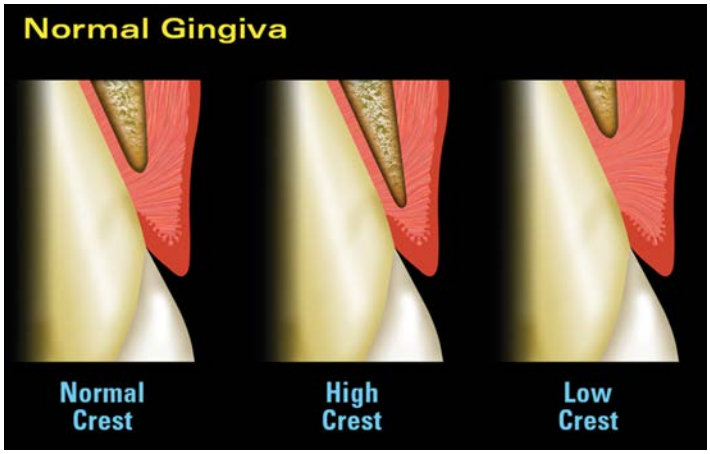


Figure 3: Dimensional differences of the dentogingival complex from one situation to the next can be attributed to variations in the histologic dimensions of the fiber attachment, as opposed to variations in the histologic dimensions of the sulcus.

Figure 4: Signs of biologic width violation (unesthetic erythema and inflammation) developed 18 months after crown-lengthening surgery in this patient as a result of restorative margins inadvertently placed within the zone of supracrestal fiber attachment.

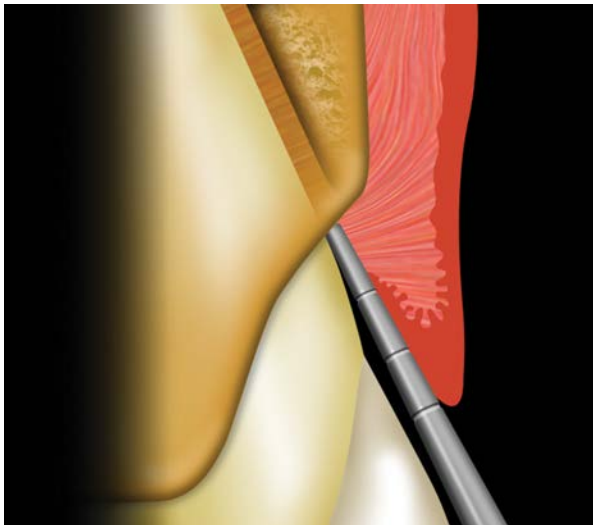


Figure 5: The most reliable reference for making decisions about the need to remove bone when removing tissue during crown-lengthening procedures is to use the dimensions of the entire dentogingival complex.

Myth

It is important to know the dimensions of the dentogingival complex (connective tissue attachment, junctional epithelium, and sulcus) for an individual patient before proceeding with osseous crown lengthening, so the same dimensions can be reestablished.

Reality

The dentogingival complex can vary within a patient from one location to another.[10,11] In most situations, tissue alteration involving severance of the supracrestal fibers will effect wound healing that moves the dimensions of the dentogingival complex to a normal relationship (3 mm from the FGM to the osseous crest), regardless of the initial presentation.[12,13] Exceptions are more likely to occur when the osseous crest exceeds 1 mm of thickness. It is important to know the height of the dentogingival complex in all areas considered for osseous crown lengthening, not in an effort to reestablish like dimensions, but rather to have a sound reference position upon which to make decisions regarding surgical approaches and the need for osseous resection.

Tissue alteration in situations with a normal or high crest relationship (less than 3 mm from the FGM to the osseous crest) will require osseous resection in order to achieve predictable post-surgical results. Tissue alteration in situations with a low crest relationship (more than 3 mm from the FGM to the osseous crest) may necessitate only a gingivectomy with concurrent fiberotomy. Knowledge of the dimensions of the interproximal dentogingival complex directs surgical approaches and flap design (i.e., whether it is safe to reflect papillae or if papillae-sparing approaches should be utilized).

Myth

Waiting three months after esthetic crown lengthening (osseous resective surgery), it is safe to place the margins .5 to 1 mm subgingival without risk of biologic width violation.

Reality

While recommendations have been made for waiting three to six months after crown-lengthening procedures prior to placing margins for indirect restorations,[14-16] it should not be considered a fail-safe way to prevent biologic width violation. The three-month waiting period is based upon the biologic principles of wound healing, as opposed to the reliability of complete evolution of the dentogingival complex, which can take as long as three years following surgical intervention to fully mature.[6] The closer the tissue is positioned at the conclusion of surgery to a normal crest relationship (3 mm from the facial FGM to the osseous crest), the sooner the architecture will be representative of the final outcome **(Figs 6a-6d)**.

Tissue response can appear favorable in the provisional and early post-insertion restorative phases. Some aspects of the restorative procedure itself (packing retraction cord, the use of acidic hemostatic agents, the removal of cements) can disrupt the connective tissue attachment and further delay tissue maturation. It is only as the supracrestal fibers reestablish their predestined histology that clinical indications of biologic width violation begin to become evident.

It is true that margins that stay within the sulcus will not violate biologic width.[10] The challenge clinically, as previously discussed, centers on our inability to precisely measure sulcular depth. The only predictable way to avoid biologic width violation following surgical intervention is to measure the entire dentogingival complex by sounding to bone at the time of tooth preparation.[10] Ideally, a normal crest relationship of 3 mm facially exists and margins can be placed slightly intracrevicular without concern of impingement on biologic width.[17] In areas of high crest (less than 3 mm from the facial FGM to the osseous crest), extreme care must be used to avoid biologic width violation. Intracrevicular margin placement should be avoided. In these instances, even a supracrevicular margin could inadvertently lead to biologic width violation.

The most important concern is that three-month post-surgical tissue contours may not reflect the underlying osseous contours. Apical limitations of margin placement are best defined by knowing the relationship of the free gingival margin to the bone at the time of preparation rather than by relying on tissue contours that have healed but have not matured.

Myth

The only effective and predictable way to perform osseous crown lengthening is to reflect and reposition a mucoperiosteal flap.

Reality

Reflecting a flap to have visual and instrumentation access to the osseous crest is a predictable and proven approach for esthetic crown lengthening. It is the method of choice when multiple teeth are involved or the osseous architecture is greater than 1 mm in thickness. However, in circumstances that call for crown lengthening on one to three teeth and

Figure 6a: Initial presentation of a patient with short clinical crowns, excessive gingival display, and excessive erosion, necessitating full-coverage indirect restorations.

Figure 6b: One-month presentation following first molar to first molar crown lengthening. The tissue was positioned 3 mm coronal to the newly positioned osseous scallop at the time of surgery to more quickly represent the mature gingival scallop following healing and maturation.

Figure 6c: Three months after surgery, the gingival tissues have healed but are not fully mature. Osseous references are used to establish apical limits of margin placement for full-coverage restorations to avoid biologic width violation.

Figure 6d: The addition of cervical length to the final outcome places the teeth in a pleasing vertical position within the framework of the smile.

where the bone is equal to or less than 1 mm in thickness, a transulcular approach to esthetic crown lengthening can be predictably employed **(Figs 7a & 7b)**. A transulcular approach involves a gingivectomy to scribe the FGM at the desired level, as well as a transulcular transection of the connective tissue attachment, followed by the use of hand instruments (chisels/curettes) passed through the transulcular incision to remove bone **(Figs 7c-7e)**. Rotary or laser instrumentation to remove bone with a closed approach is not recommended due to the inherent risk of damaging root surfaces.[18] Because facial bone is often equal to or less than 1 mm in thickness,[19-21] a transulcular method of crown lengthening can be an effective approach **(Figs 7f & 7g)**. Additionally, less tissue disruption allows crown lengthening in this manner to be predictably combined with indirect restorative procedures, providing an efficiency of service for the patient **(Figs 8a-8e)**.

Conclusion

Since the majority of patients display gingival tissue in maximum reveal, considerations of symmetry and scallop should be routine when establishing a diagnosis and developing a treatment plan.[22] Crown lengthening for esthetic purposes is a valuable technique that can be incorporated into treatment plans to increase coronal tooth length in an apical direction, enhance symmetry, alter emergence profile, and/or balance length-to-width ratios. A thorough understanding of the dentogingival complex as well as the surgical and restorative considerations is paramount in achieving optimized results. Dentists wishing to excel in the area of esthetic dentistry owe it to themselves and their patients to master knowledge in these critical areas.

Figure 7a: A patient presents with excessive gingival display on the right lateral incisor.

Figure 7b: The gingival components (health and architecture) are addressed prior to initiating restorative procedures.

Figure 7c: The tissue is scribed to the desired position in relationship to the contralateral side.

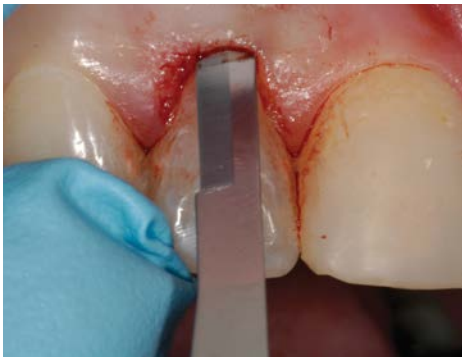


Figure 7d: A microsurgical blade is inserted through the sulcus to the osseous crest to sever the supracrestal fiber attachment.

Figure 7e: A Wedelstaedt chisel passed transulcularly is used to scallop the osseous crest 3 mm in distance from the newly established free gingival margin.

Figure 7f: The final result reveals a more uniform tissue architecture and appropriate length-to-width ratio of the restored lateral incisor.

Figure 7g: Tissue levels remain stable eight years after surgical and restorative procedures.

Figure 8a: The patient presented with congenitally defective central incisors in need of restoration.

Figure 8b: The patient was primarily concerned with the appearance of the teeth themselves and was previously unaware of the tissue asymmetry between the central incisors.

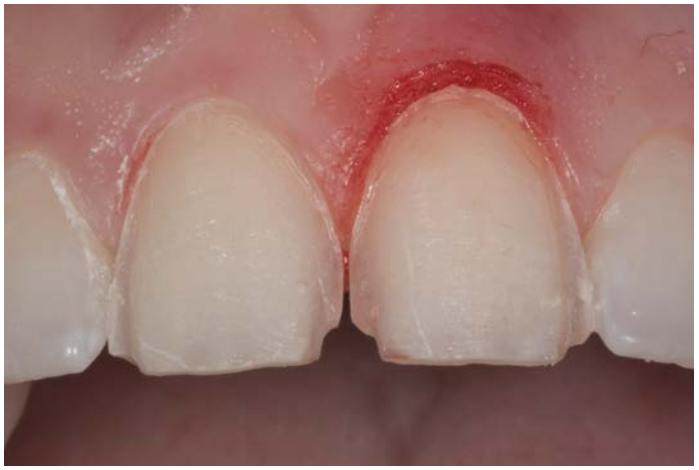


Figure 8c: The preparation appointment was combined with transulcular osseous crown lengthening on the left central incisor to level the gingival architecture and mirror the scallop of the contralateral incisor.

Figure 8d: The definitive veneers created uniformity in the tooth shapes. The transulcular crown lengthening created uniformity and symmetry of the gingival scallop.

Figure 8e: Osseous references are more reliable than tissue references when it comes to creating stable long-term results.

> “Since the majority of patients display gingival tissue in maximum reveal, considerations of symmetry and scallop should be routine when establishing a diagnosis and developing a treatment plan.”

Acknowledgments

The authors recognize the fine contributions of Harriet McCullough (HarrietDesigns; Norfolk, VA) for the illustrations; and Lee Culp, CDT (MicroDental; Dublin, CA), and Sandra Stassen, CDT (North Kent Dental Arts; Belmont, MI), for the ceramic restorations shown in this case.

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Disclosure: The authors did not report any disclosures.

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Understanding the Biological Potential of Hard and Soft Tissues

Treatment Evolution: From Bone Resorption to Planned Implant Therapy to Predictable Gingival Esthetics

Sascha A. Jovanovic, DDS, MS
Francesco Mintrone, DDS

> "Based upon her initial examination and radiographs, it was determined that she was a possible candidate for implants and a fixed esthetic prosthesis..."

Key Words: vertical ridge augmentation, bone graft, soft tissue graft, 3-D planing, implants, gingival esthetics, zirconia

Case Presentation

The patient was a healthy 67-year-old female with an unesthetic and ill-fitting upper full denture and an uncomfortable lower removable partial denture with moderately compromised lower anterior dentition.

Her wish was to have a beautiful and healthy smile with no removable appliances, and natural-looking fixed teeth with no pink prosthetic replacement. Based upon her initial examination and radiographs, it was determined that she was a possible candidate for implants and a fixed esthetic prosthesis with normal tooth dimensions if tissues were augmented and implants guided in the right position.[1-3] Her jawbone and soft tissues were healthy though resorbed and thin, her function and vertical dimension were compromised, and her esthetic status needed much improvement. On the positive side, she did not smoke, had no medical or economic restrictions, and was a very compliant patient.

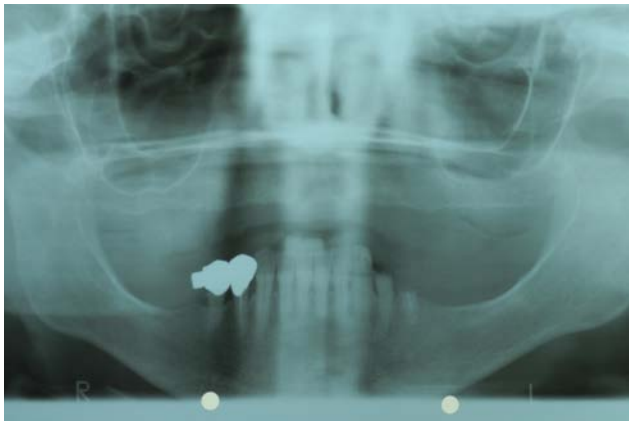
After her smile analysis was completed with an upper and lower full-mouth wax-up/mock-up[4] and was matched with her cone beam computed tomography (CBCT) scan in a software program (NobelClinician, Nobel Biocare; Yorba Linda, CA), it was concluded that the patient needed an anterior vertical ridge augmentation with a guided bone regeneration graft and a connective tissue graft, as well as meticulous implant placement. She also needed sinus lift bone grafts, reduction of the ridge in the premolar region, and an immediate implant temporary with careful tissue management during the implant-uncovering procedure and the prosthetic steps. Eight implants were placed in the optimal tooth positions using a guided surgery template and a full-contour surgical guide with simultaneous vertical bone and soft tissue augmentation in the anterior ridge,[5-9] bone reduction in the premolar region, and bilateral sinus lifts in the molar sites.[10] Her wax-up/mock-up was also used to create a precise temporary duplicate of the teeth as a full-arch acrylic bridge. The implants with more than 45 Ncm stability and no vertical bone grafting were planed for an immediate fixation of the temporary on the day of implant placement.

After nine months of bone and soft tissue maturation, the remaining implants were uncovered, the membrane removed, a connective tissue placed, and the temporary and emergence profiles adjusted for final soft tissue guidance.[11] The soft tissues were allowed to heal and mature for 12 months, after which time a final prosthesis was fabricated out of four bridges with lithium disilicate restorations on full-contour zirconia frameworks.[12,13] During the temporary phase in the upper jaw, the lower teeth were addressed and periodontal and implant treatment completed. The patient's esthetic wishes were met after an active treatment period of a little less than two years with a fixed implant temporary throughout the entire treatment time. Now two years after implant placement, she has follow-ups every four months, and has stable gingival margins and a stable crestal bone with excellent function and esthetics.

The patient's relaxed smile shows her malaligned upper full denture with esthetic limitations.

The upper jaw showed significant vertical ridge resorption in the anterior, and a surplus of bone and soft tissues in the posterior. The lower showed periodontal concerns and moderate ridge resorption in the posterior.

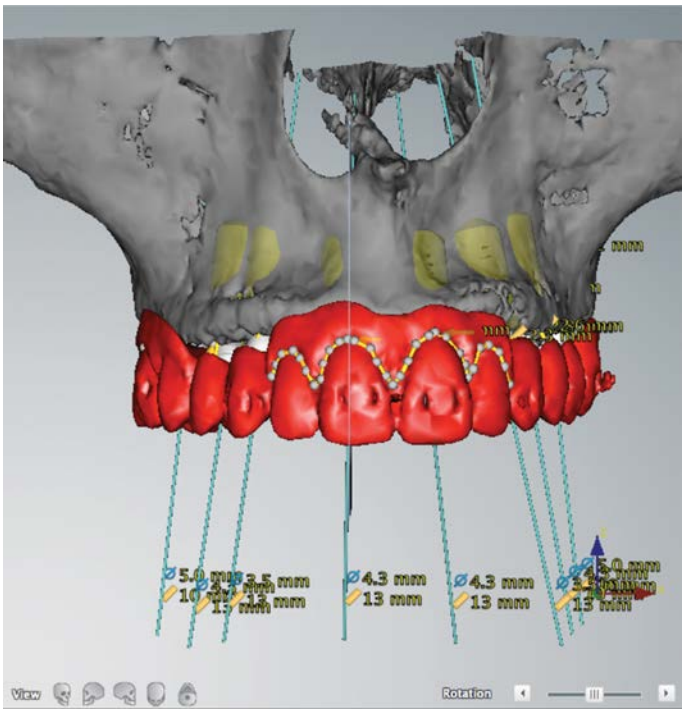
The clinical examination of the upper jaw showed sufficient healthy, attached, and keratinized soft tissues, although thin on the facial.



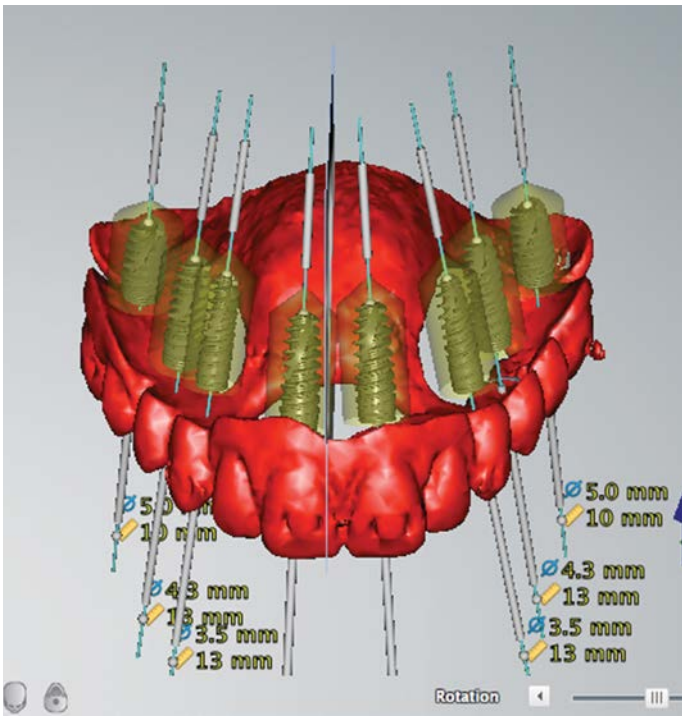
The two-dimensional radiographs showed no pathology, with sufficient maxillary and mandibular bone, moderate sinus enlargement, and periodontal concerns in the anterior teeth.

A full-mouth mock-up was prepared with proper incisal edge position, gingival margin position, and tooth proportions.

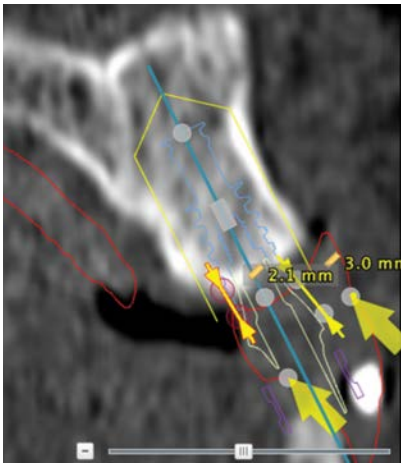
A radiographic guide of transparent acrylic with full-contour tooth dimensions was made from the mock-up and used in the CT scan evaluation.



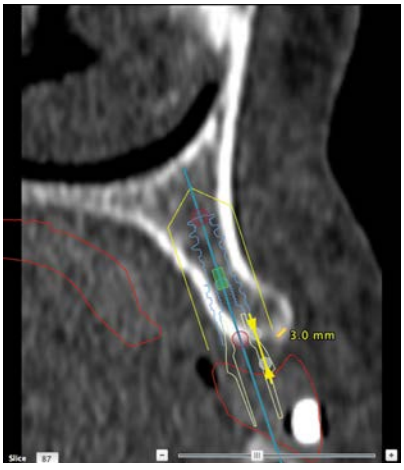
A software program was used to import the CT data, consisting of the bony structures and the acrylic mock-up. This allowed for a precise analysis of the implant positions and the relationship to the gingival proportions and bone dimensions. Please note the anterior gingival margins visualized with a dotted line.



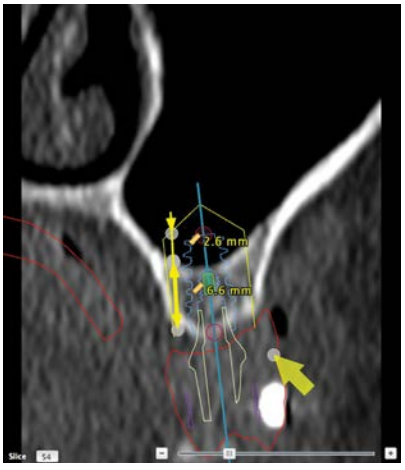
Eight tapered RP and NP implants (NobelActive) were planned for the central, canine, first premolar, and first molar positions for a fixed prosthesis with four bridges.



Optimal implant placement in the central incisor position showed a vertical bone deficiency of 3 mm. This required a vertical ridge augmentation procedure with hard and soft tissue to create the foundation for optimal soft tissue esthetics.



Optimal implant placement in the first premolar position showed a bone surplus of 2 mm, which required bone reduction for the proper crown length and contour.

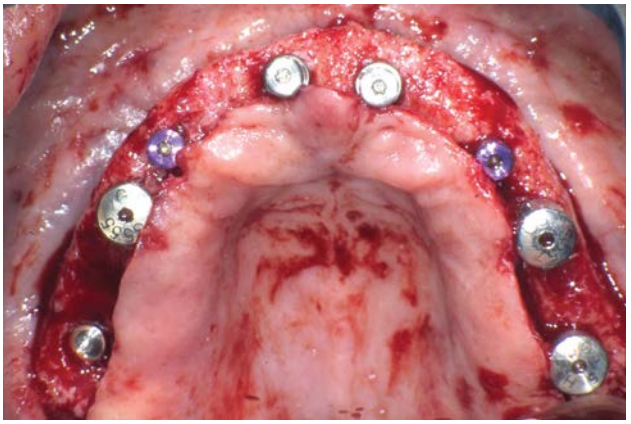


The implants in the first molar positions showed a sinus bone deficiency of 3 mm, which required a bone graft with a closed sinus osteotome technique.

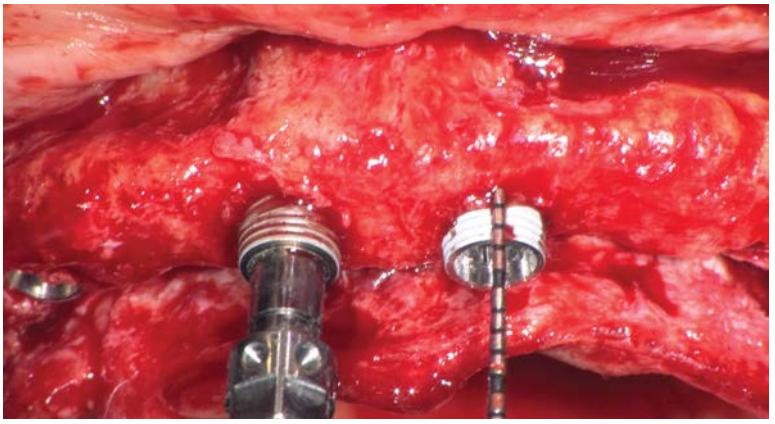
A guided surgery template was created from the CT scan implant planning. This ensured the positions of the eight implants in the exact buccolingual and mesiodistal dimensions following the treatment mock-up.

A full-contour surgical guide was made showing the precise gingival margins and locations of all teeth. This allowed confirmation of ideal implant placement and the 3-mm biological vertical distance of the implant neck to the planned crown margin.

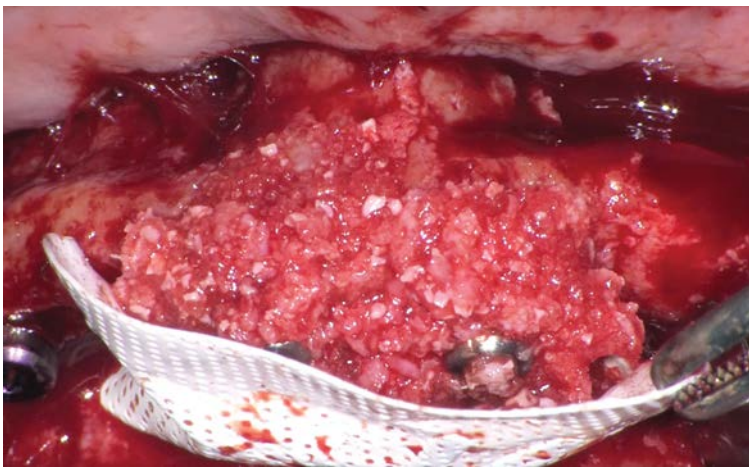
A full-arch temporary was created out of acrylic with the same tooth contours, to allow immediate fixation to the implants using titanium temporary abutments.



The surgical step confirmed the accuracy of the CT scan planning. Using the guided surgery template and the surgical full-contour guide, eight implants were placed in the exact position of the mock-up and in the optimal vertical position to ensure a 3-mm distance between the implant neck and the planned crown margins.

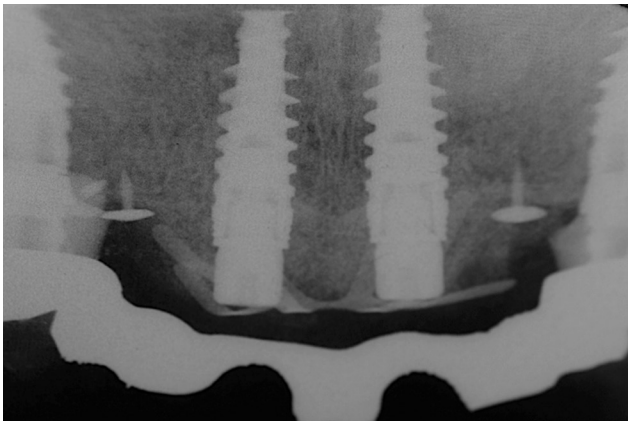


The two anterior implants were placed 3 mm above the bone crest, following the surgical guide's gingival margin contour.



A vertical bone graft consisting of a 1:1 mixture of autogenous particulate and mineralized xenograft (Bio-Oss, Geistlich Pharma North America; Princeton, NJ) was placed around the anterior implants and short healing abutments. A titanium-reinforced non-resorbable PTFE membrane (Cytoplast, Osteogenics Biomedical; Lubbock, TX) was trimmed and secured with titanium tacks. The site was submerged with primary flap closure.

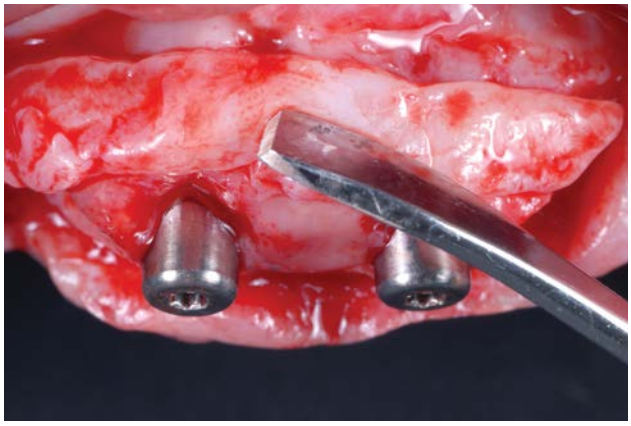
The full-arch temporary was screw-retained to five out of the eight implants immediately after the surgical phase with titanium abutments and properly dimensioned emergence profile for soft tissue guidance. The temporary was adjusted to prevent any contact on the grafted site.



The radiograph of the two anterior implants shows a titanium-reinforced membrane for vertical bone regeneration around the implant necks, and abutments to support the gingival margin and the interproximal papilla.

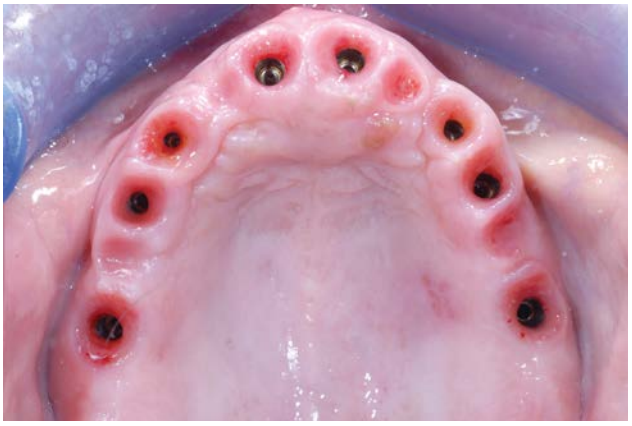
After an uneventful nine-month healing period, the clinical condition appeared healthy and augmented in a horizontal and vertical dimension.

Surgical removal of the membrane, showing complete vertical and horizontal bone regeneration around the implant necks and the healing abutments.



Longer healing abutments were secured and a subepithelial connective tissue graft was harvested from the palate and placed on the buccal regenerated bone to thicken the gingival biotype.

The implant provisional was adjusted and connected to the remaining three implants. All subgingival portions of the acrylic and the abutments were undercontoured to allow for soft tissue guidance. Note the normal tooth length and shape of the provisional mimicking the mock-up.



Occlusal view, showing the maturation and shaping of all soft tissues around the pontics and eight implant sites.

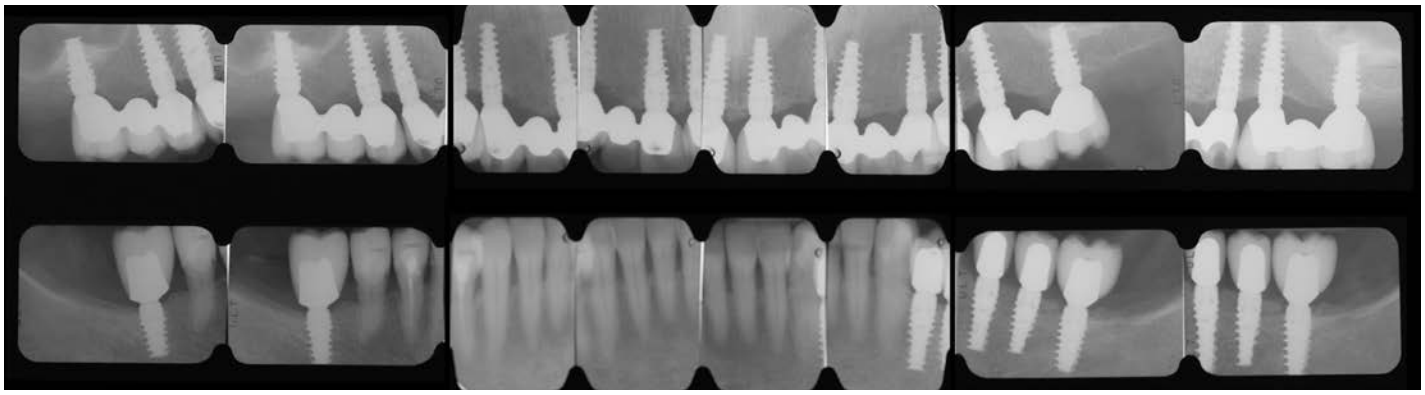
Open-tray impression of all eight implants, capturing the matured soft tissue emergence.

The laboratory phase captured the exact emergence of the soft tissue contour and gingival margins. Four screw-retained bridges of full monolithic zirconia frameworks with cemented lithium disilicate restorations were fabricated for the upper jaw.

Frontal view of the final ceramic restoration in place, and the established harmony with the soft tissues and the developed soft tissue profile. Note the excellent soft tissue integration and the positive biologic response.

Occlusal view of the final restoration of the upper jaw. The four three-unit zirconia/lithium disilicate bridges were screw-retained with sealed occlusal openings.

Occlusal view of the restored lower jaw, with anterior veneers from canine to canine, single crowns on two teeth, and single cemented crowns on four implants with zirconia abutments.



Radiographs two years after implant placement show stable bone level and precisely fitting abutments and restorations. Note the increased vertical bone around and between the upper front implants, allowing the proper gingival margin and papilla creation.

The patient's smile line, showing harmony and support of the lips and proper tooth display.

> "The keys to this optimal result were an understanding of the biologic potential of tissue guidance and the planning of the restorative needs and steps."

Full-face photograph of the upper and lower restorations in harmony with the patient's face and overall appearance

Summary

The patient's condition was a challenge to restore to a full esthetic gingival profile because she had had a full maxillary denture for decades and a resorbed anterior ridge. However, the two-year radiographic and clinical follow-up demonstrated a functional and esthetic full-arch rehabilitation on implants and teeth with excellent bone and soft tissue stability and natural tooth length and contour. The wishes of the patient and the plan for therapy were satisfied with no need for pink prosthetic replacement. Gaining full control of the case by developing a mock-up and a CT digital evaluation allowed implants to be placed optimally and bone to be regenerated/resected as needed. The vertical bone and soft tissue graft around the two anterior implants allowed for sufficient bone and soft tissue foundation to guide the tissues around the emergence profile of the temporary and final restoration.[1]

The keys to this optimal result were an understanding of the biologic potential of tissue guidance and the planning of the restorative needs and steps. These two critical factors led to the treatment's clinical success and longevity.

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> "After nine months of bone and soft tissue regeneration, the temporary and emergence profiles were adjusted and the remaining implants were activated for final soft tissue guidance."

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Disclosures: Dr. Jovanovic is a consultant for Nobel Biocare. Dr. Mintrone did not report any disclosures.

"Many different technological advances have combined to make implant dentistry much more predictable, especially when restoring teeth in the esthetic zone."

The Art & Science of Tissue-Colored Porcelain

A Useful Esthetic Alternative

Sang K. Jun, CDT
Heinz J. Klein, DMD
Lois Lagier, DDS

Abstract
Tissue-colored porcelain can be used to create esthetic implant-supported restorations when bone and gingival tissues are deficient and surgical replacement of such tissues is not possible. Important considerations when designing such prosthetics include hygiene and maintenance. It is essential to create smooth and cleansable gingival contacts that will promote long-term hard and soft tissue health.

Key Words: implants, CAD/CAM, soft tissue, cleansing, low-fusing porcelain

Introduction

The use of dental implants to restore partially edentulous dentitions[1] has become standard practice in most modern dental practices today. Many different technological advances have combined to make implant dentistry much more predictable, especially when restoring teeth in the esthetic zone.

Cone beam computerized tomography (CBCT) facilitates digital surgical treatment planning, which allows an accurate preview of implant placement.[2] The use of this same digital imaging information by the restorative team (restorative dentist and laboratory technician) and surgical team (periodontist and oral surgeon) provides a valuable resource to assess and identify specific details that must be considered prior to starting treatment.

Current esthetic dental materials and techniques—including computer-aided design/computer-aided manufacturing (CAD/CAM)-milled single tooth zirconia, full round fixed dentures with artificial gingiva, and pressed or milled lithium disilicate—can be utilized to create final restorations.

Scanned and designed on computers, zirconia blocks are milled by machine, dipped into liquid and stained as needed (e.g., pink for artificial gingiva and gray or blush for incisal translucent) on the green stage of milled zirconia prior to sintering.

Many porcelain shades, including those that mimic gingival tissue, are available. These can be used to effectively and esthetically replace gingival soft tissue that cannot be restored surgically.[3] Whether the restorations are handcrafted by a ceramist, or created using CAD/CAM technology in combination with milling, the final result must be hygienic and allow the patient to properly maintain the prosthesis at home.

Case One

Patient History and Chief Complaints

A 63-year-old female presented with missing maxillary central incisors. The edentulous space had been present for more than 10 years and had been restored with a maxillary acrylic partial denture **(Figs 1 & 2)**. The patient's chief complaints were the inconvenience of wearing the removable appliance and the compromised esthetic appearance. She had lost self-confidence and self-esteem due to the ill-fitting removable partial denture (RPD), which often fell out during conversations with friends and clients and occasionally during meals. The patient had had to develop certain ways of smiling and talking to prevent embarrassing situations. She also had changed her diet because she could not bite into or chew hard foods.

Figure 1: Removable partial denture for #8 and #9. Note the short incisal edge position of #8 and #9 relative to the adjacent lateral incisors. It can be speculated that the gradual loss of alveolar support under the appliance contributed over time to the reverse smile line appearance.

Figure 2: The edentulous space of #8 and #9. Different mesial heights on both lateral incisors, and the concave aspect of the alveolar ridge on the #8 and #9 sites are factors that must be considered during the initial treatment plan discussion with team and patient.

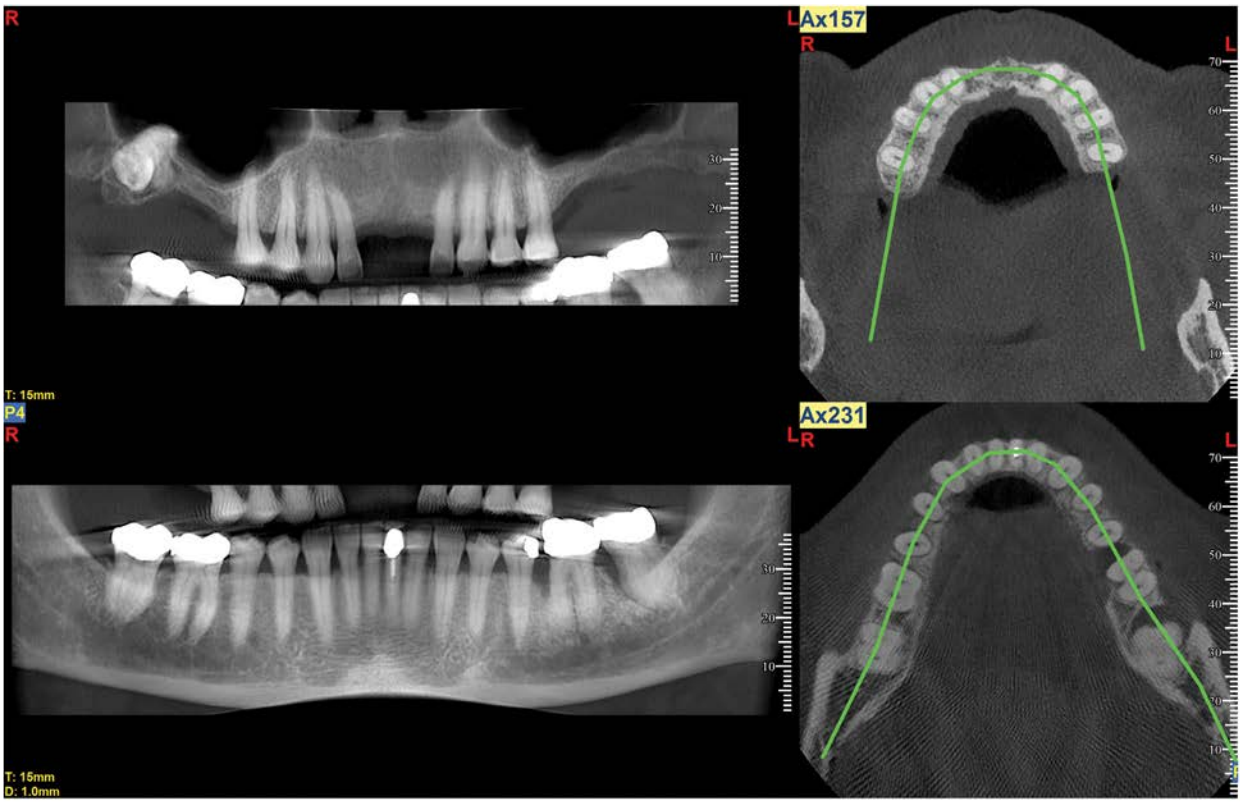

Figure 3: CBCT images of the patient, confirming advanced ridge resorption of the facial plate at the proposed implant sites, and dictating the need for ridge augmentation prior to implant placement.

Treatment

A treatment plan for dental implants to restore missing teeth #8 and #9 was developed and presented. The patient was referred to a periodontist for further evaluation of the proposed surgical sites. A CBCT was done to evaluate more accurately the available bone and simulated virtual implant placement on the proposed sites **(Fig 3)**.

The remaining alveolar ridge showed significant loss of facial bone and lack of soft tissue to reproduce the appearance of an interdental papilla between the implants. An alveolar ridge augmentation[4] was performed to improve the site for proper implant placement and improve the quality and quantity of attached fibrous soft tissue where the implants would emerge.

After a four-month healing period, the periodontist placed two implants (Bone Level NC 3.3 x 14 mm Roxolid SLActive [Straumann; Andover, MA]), using a guided surgical stent (Cybermed; Seoul, South Korea) based on a three-dimensional virtual treatment plan. Healing abutments were positioned at tissue height at the time of surgery.

The existing RPD was adjusted to prevent any soft tissue contact with the healing sites. An additional four months of healing was allowed for the integration of dental implants and maturing of the soft tissues surrounding them.

Two NC temporary abutments made with PEEK (Straumann) were placed intraorally after removal of the healing abutments. Black ink marks were placed on the facial of the abutments for reference in case the abutments had to be removed and placed back at the same position.

The abutments were prepared intraorally for occlusal clearance **(Fig 4)**. Reduction was done mostly on the lingual and incisal length due to prior digital planning for screw-retained crowns. The customized prepared temporary abutments would serve as transfer impression posts for the final fixture level impression.

The temporary abutments were further customized by adding composite to their subgingival portion to create a proper emergence profile.[5] This was done by removing them from the mouth, preparing the PEEK surface for bonding by sandblasting the surface (using 50-µ aluminum oxide), and applying an adhesive resin (Optibond FL, Kerr; Orange, CA), and light-curing.

Figure 4: Customized PEEK abutments in place for fixture level impression for temporary restorations.

Figure 5: Screw-retained temporary restorations with pink acrylic.

Small increments of composite resin (Filtek Supreme Ultra, 3M ESPE; St. Paul, MN) were then added to mimic the cross section of root anatomy as the abutments emerge through the gingival tissue.

The abutments were tried in the mouth to verify proper soft tissue remodeling and desired tissue contour. Only then was the final impression (Panasil, Kettenbach; Huntington Beach, CA) closed tray technique performed, using the temporary customized abutments as a transfer post for the position of the implant analogs.

A laboratory prescription was written to use the temporary abutments to fabricate screw-retained provisional crowns, adding pink composite resin as necessary to close the open interproximal spaces **(Fig 5)**.[6] The screw-retained provisional crowns were inserted and adjustments were made.

The patient was very excited about the provisional restorations and was able to discard her old RPD. Slight modifications in shape were made over the following week to allow for flossing under the splinted provisional crowns.

The provisional crowns allowed for easier communication with the laboratory for the fabrication of the permanent restorations. An amount of pink gingival porcelain was necessary to close spaces and at the same time allow for proper patient hygiene around the peri-implant tissues.

One month after provisional crown insertion, the patient returned for a final fixture level impression for the fabrication of the final restorations. A diagnostic impression of the provisional crowns in place was made.

The patient was very comfortable with the length and position of incisal edges on the provisional crowns. The laboratory technician received invaluable information to fabricate a precise, functional, phonetically correct permanent restoration that the patient would be able to properly maintain at home.

The maxillary impression was poured with and without a soft tissue cast **(Figs 6 & 7)**. The restorative team elected to utilize the solid stone model. The temporary restorations had created well-sculpted soft tissue architecture. The soft tissue restorative goal was to prevent compression of the gingival tissue[7] and avoid potential recession or pathology.

The laboratory technician created a framework designed to support the veneering porcelain **(Fig 8)**.[8] Gold coat (Gramm Technology; Woodbridge, VA) was applied after the first layer of opaque and fired framework **(Fig 9)**. The second layer of opaque masking porcelain was then applied and fired **(Fig 10)**.

A bright opacious dentin porcelain (Creation, Jensen Dental; North Haven, CT) layer was applied to the height of the contours to slightly increase the value; this would later be offset and lowered by applying layers of enamel and translucent porcelain **(Fig 11)**.

Appropriate opaque dentin porcelain was applied in the incisal one-half of the restoration, and mostly vertical depressions or grooves were created for the internal reflection of light **(Fig 12)**.[9] A thin layer of clear (translucent) porcelain was applied between grooves in the stacked porcelain to trap the light **(Fig 13)**.

Slightly darker dentin porcelain was applied in the gingival area and the porcelain was built to full contour **(Fig 14)**. Pink gingival-colored porcelain was then applied to the interproximal areas to create the missing soft tissue **(Fig 15)**.

Porcelain was cut back to create internal characterizations[10] and space for the enamel and translucent porcelain layer **(Fig 16)**. Select internal stain and characterizing porcelains were placed, and different colors of enamel porcelain were applied to create the illusion of depth **(Figs 17 & 18)**.

The first body firing was accomplished **(Fig 19)** and additional stains and colored porcelain were added to further enhance the natural appearance. White enamel porcelain was added to create a "high value" zone often found in natural dentitions. Pink gingival porcelain was added where required **(Fig 20)**.

A translucent enamel layer was created by alternating different colors of translucent porcelain to mimic the blending and contrast found in nature **(Fig 21)**.

Figure 6: A model of the final impression with soft tissue cast.

Figure 7: A stone model of the final impression.

Figure 8: Metal substructure for veneering porcelain.

Figure 9: Gold coats were applied after first opaque.

Figure 10: Second layer of opaque was applied and fired.

Figure 11: Bright opaque dentin was applied on the height of the contours to prevent low value on the final restoration.

Figure 12: Appropriate opaque dentin was applied incisally, then indentations were created to reflect light.

Figure 13: Clear translucent was filled in between indentations to capture light.

Figure 14: Dentin was built to full contour.

Figure 15: Pink porcelain was built where needed.

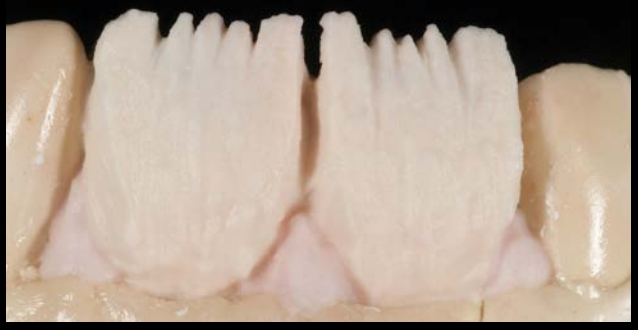

Figure 16: Cutback was done to create space for internal characterization, and enamel and translucent layers.

Figure 17: Internal characterization and staining was accomplished, and different optical densities of enamel were filled and layered.

Figure 18: The enamel layer was completed.

Figure 19: First firing of restorations.

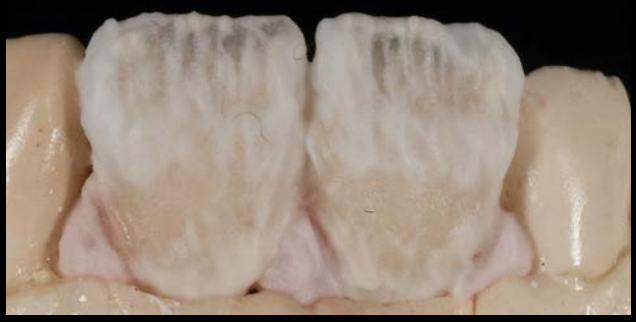

Figure 20: Internal stain and characterizations were added and whitish enamel was applied to the middle part of the restorations for a high value zone.

Figure 21: The translucent layer was completed and pink porcelain was added.

The second body firing was completed, and all necessary contour adjustments were done prior to bisque bake try in **(Fig 22)**.

The splinted restoration was temporarily attached to the supporting implants, and the shape, contours, color, and cleansability were evaluated **(Figs 23 & 24)**.

After final contour adjustments were made, low-fusing porcelain powder was applied to the gingival tissue contact areas and fired at the normal glazing temperature, creating a very smooth, overglazed surface **(Figs 25-27)**. The purpose of overglazing the gingival surface layer was to minimize plaque retention and tissue irritation.[11]

Restoration longevity and gingival health are expected due to utilizing correct design principles, understanding the materials involved, establishing proper communication, facilitating good patient hygiene, and following through with routine dental evaluation visits. **(Figs 28-34)**.

Figure 22: The second firing was done and ready for bisque bake try in.

Figure 23: Bisque bake try in.

Figure 24: Confirming access for cleansing.

Figure 25: Facial view of final restorations.

Figure 26: Low-fusing porcelain was applied and fired on a regular porcelain glazing cycle.

Figure 27: Final restorations on stone model.

Figure 28: Insertion of final restorations.

Figure 29: The screw-retained, implant-supported restoration was shade-matched to the adjacent teeth, and the pink porcelain color blended well with the surrounding soft tissue.

Figure 30: Postoperative right lateral view at six months. Matching the shade and translucency of the natural teeth required the use of many different porcelain build-up techniques, and porcelain powders with different optical densities. When fired, these porcelains utilized light diffusion and reflection to mimic the appropriate translucency and provide the illusion of depth.

Figure 31: Postoperative left lateral view. Internal characteristics of incisal edges are well-defined and blend very well with the aged adjacent teeth.

Figure 32: Postoperative frontal view at six months. The restoration was designed with the patient's daily hygiene in mind. The pink porcelain gingival contours allow for easy access. Equally important is that the large area of intaglio porcelain contacting the patient's gingiva was created using low-fusing porcelain on the last, or glazing, bake, which was overfired. This created an exceptionally smooth surface that is easily cleansable. No tissue inflammation was observed clinically.

> "Whether the restorations are handcrafted by a ceramist, or created using CAD/CAM technology with milling, the final result must be hygienic and allow the patient to properly maintain the prosthesis at home."

Results

Even though the treatment time was lengthy due to bone and tissue augmentation and implant healing, the patient was very happy with the result. Not only was it esthetically pleasing, but she also regained her self-confidence, her speech returned to normal, and she was once again able to enjoy eating.

Figure 33: Preoperative full-face view.

Figure 34: Postoperative full-face view.

> "The demand and need for implant-supported restorations is greater than ever."

Case Two

A 63-year-old female patient presented with bone loss and soft tissue recession due to prolonged periodontal disease. A maxillofacial surgeon performed surgical bone grafting with limited success due to the patient's health. Dental implants were placed in the compromised site **(Fig 35)**.

When compared to the contralateral tissue and dentition, it was observed that the deficient tissue contours would significantly compromise esthetics **(Fig 36)**.

The same techniques and materials as in the previous case were utilized to create gingival soft tissues in the porcelain **(Fig 37)**. Proper design for cleansability, combined with an overglazed low-fusing porcelain contact area, created the best possible conditions for soft tissue health **(Figs 38 & 39)**. The patient was very happy with the result **(Fig 40)**.

Summary

The demand and need for implant-supported restorations is greater than ever. Constantly evolving technologies such as CBCT continue to help clinicians to treatment plan and place implants accurately. However, even currently available technology cannot replace bone and soft tissue contours when they are inadequate. Tissue-colored porcelain, using designs and techniques that are hygienic and cleansable, offer a useful esthetic alternative. Effective communication between clinicians and laboratory technicians is essential to design and plan such cases.

Figure 35: Positions of implants and customized cast metal abutments.

Figure 36: Custom abutments in place.

Figure 37: Insertion of final restorations.

Figure 38: Facial view of final restorations at time of cementation.

Figure 39: One-year postoperative view.

Figure 40: Very satisfied patient.

Acknowledgments

The authors thank Norm Rosene, DDS (Chico, CA), for his help in the preparation of this article; and Jochen Pechak, DDS, MSD (Monterey and Palo Alto, CA), for his excellent surgical procedures in the bone and tissue augmentation and placement of the implants in the first case.

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> "Even current technology cannot replace bone and soft tissue contours when they are inadequate."

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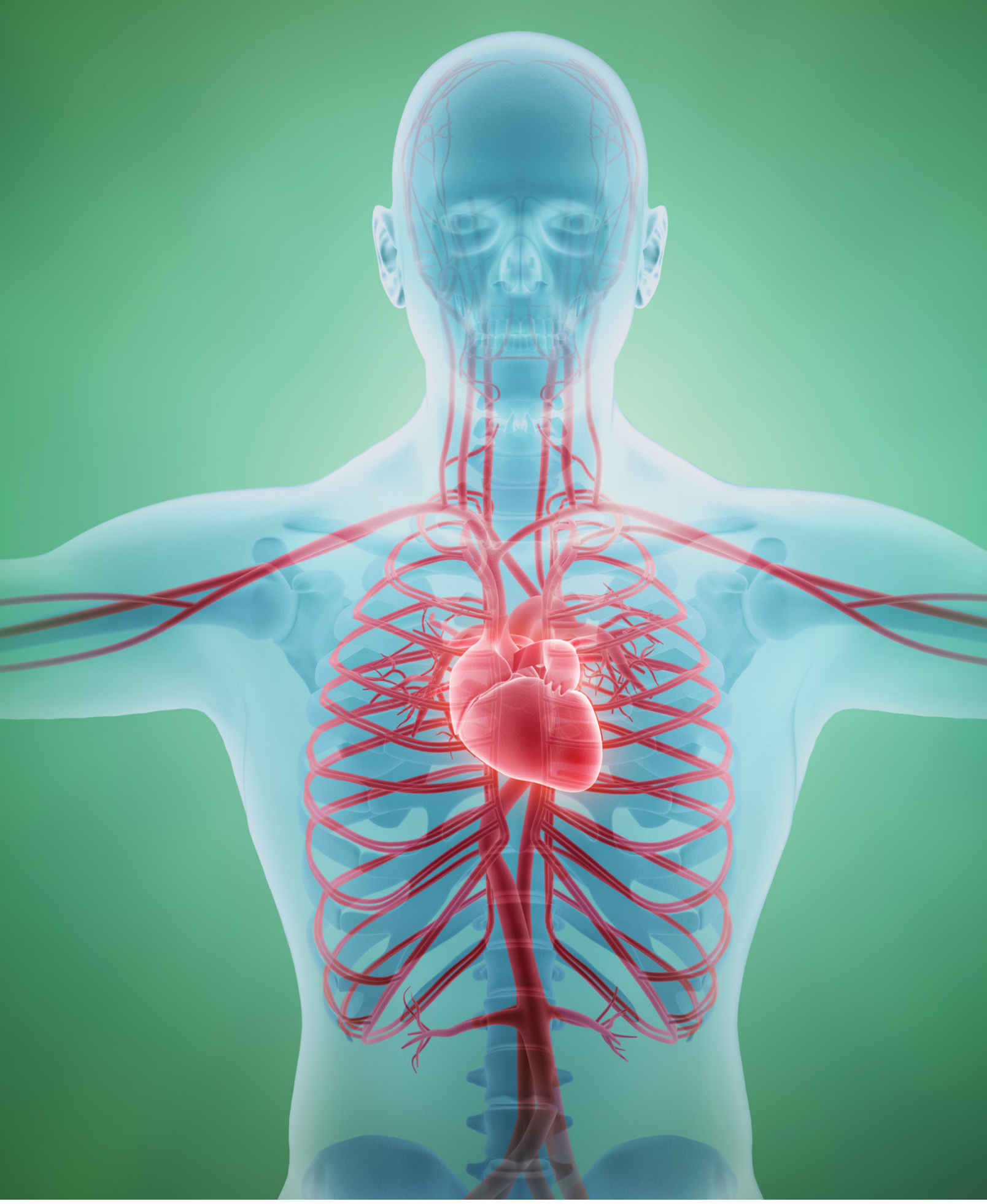

It is Time to Bridge the Cosmetic-Systemic Gap

Physicians and Dentists Working Together to Set a New Standard in Care

Charles Whitney, MD

Introduction

When I was invited by Dr. Edward Lowe to submit an article for this issue of the *Journal of Cosmetic Dentistry* (*jCD*), which focuses on periodontal issues, I was very excited. Not only because *jCD* is a well-regarded dental journal, but also because the success of my practice and the well-being of my patients requires the effective diagnosis and treatment of periodontal disease.

I am a physician, not a dentist. However, I work closely with dentists and their teams to bridge the oral-systemic gap and to provide my patients with an optimal level of care.

Do not ever underestimate the critical role you and your team play in the overall health of your patients, even in saving their lives. In all of my lectures and articles, I emphasize that periodontal inflammation and infection is a medical disease of the mouth that physicians cannot treat.

I must confess that I was not always such a strong advocate of working closely with my dentist and hygienist colleagues. That is because after seven years of medical training, my oral cavity education consisted of exactly one lecture. This is why so many physicians still "don't get it."

So why do *I* get it? I had my oral-systemic "epiphany" in 2010, when I completed the training program for the Bale/Doneen method of heart attack and stroke prevention. I learned that potentially dangerous bacteria from the oral cavity are a root cause of inflaming and rupturing vulnerable soft plaque that invades arterial walls. I was not taught this in medical school. Subsequently, I observed countless medical profiles improve through eradicating oral infection and inflammation.

As an advocate of the "third era of medicine," which focuses on the prevention of disease rather than managing illness, this was great news! If I could reduce the causative bacterial load in my patients' mouths, and prevent the passage of bacteria into the bloodstream, I could significantly lower their risk of heart attack, stroke, and several other medical diseases.

Up to 85% of heart attacks and strokes occur in completely asymptomatic inflamed small plaques that rupture like a volcano **(Fig 1)**.[1] This is why television journalist Tim Russert died of a sudden heart attack just six weeks after having a "normal" stress test.

Most cardiac risk factors are like pouring gasoline in the wall of an artery. There are just a few "matches" that ignite the gasoline and trigger an event. It is becoming more and more clear that oral bacteremia is one of those matches.

After completing my Bale/Doneen preceptorship, I completely overhauled my family practice to focus on heart attack and stroke prevention. At that time, I forged alliances with the dental professionals in my community, because treating this medical condition of the mouth that I was not qualified nor licensed to treat was a critical component in the guarantee I make to my patients: "If you suffer a heart attack or stroke while under my care, I will refund the fees you've paid in the past year."

Please note that this promise comes with significant financial risk, because I have a direct primary care practice that charges a monthly fee in return for a highly personalized level of care.

Unchecked periodontal disease compromises the health of the patients I am currently treating for arthritis, diabetes, hypertension, and many other chronic illnesses. I also know that my female patients may significantly reduce their risk of miscarriage and preterm labor by simply creating a healthy oral cavity.

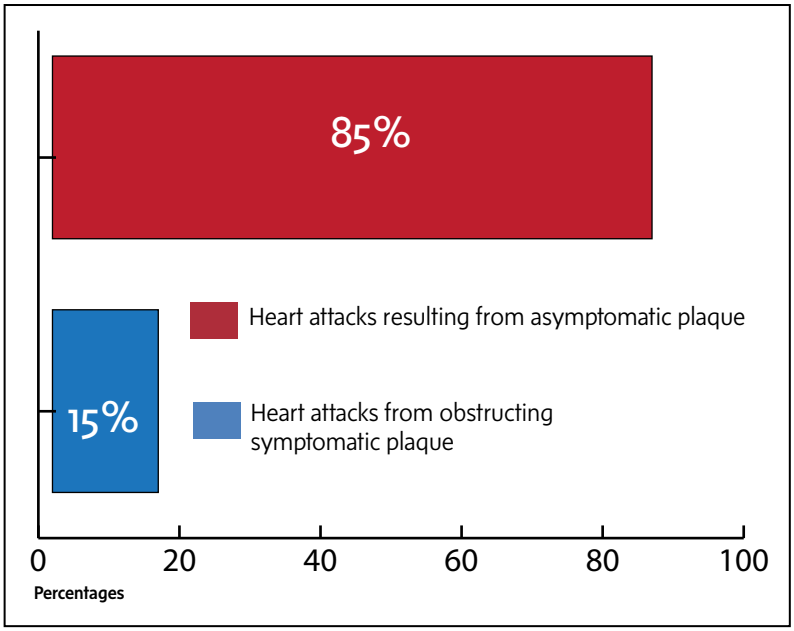

Figure 1: Up to 85% of heart attacks and strokes occur in completely asymptomatic inflamed small plaques.

Bridging the Cosmetic-Systemic Gap

Based upon what I know about cosmetic dentistry, its practitioners need to be on the forefront of bridging the oral-systemic gap (or perhaps in the case of AACD members, the cosmetic-systemic gap).

There is no doubt that cosmetic dentists are changing lives every day by helping their patients recover from disfiguring trauma, regain self-esteem, and advance their careers. But they can also collaborate with physicians to save lives.

I am told that the most successful cosmetic dentists pay very close attention to the oral health of their patients because unhealthy gum tissue is not an acceptable foundation for the cosmetic and restorative work they require.

What else can AACD members do to bridge the cosmetic-systemic gap?

What Dentists Can Do

I believe that every dental patient record should include contact information for the patient's primary care physician. For those who do not have a regular physician, be prepared to provide a list of physicians, and if possible, ones who understand the oral-systemic link.

When a patient presents with even Grade I periodontal disease, check his or her records for a personal or family history of the many linked conditions. Ask female patients if they have had problems with infertility or a history of preterm labor.

Someone on your team should also explain to the patient the connection between the periodontal disease you have diagnosed and the medical illnesses in their personal or family history. Explain that periodontal disease can contribute to the development of systemic diseases, and make many existing conditions more difficult for their physician to adequately treat. Tell them that you will notify their

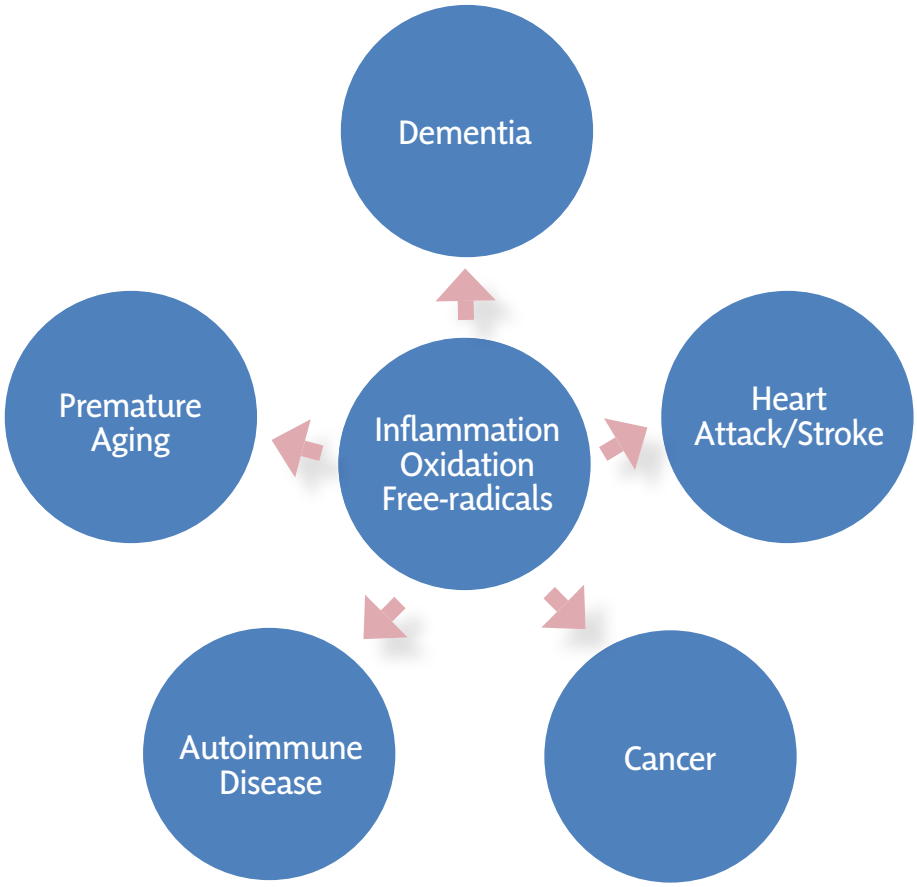

Figure 2: Representation of the causative relationship between oral bacteria and adverse medical events and conditions.

physician of your findings, recommend a course of treatment, and update them as treatment progresses.

It also is worth noting that if you contact their physician regarding your periodontal disease diagnosis, patients may be much more accepting of your treatment recommendations and more compliant with your hygienist's home hygiene instructions.

Also encourage your physician colleagues to ask patients whether they have followed up for treatment of their periodontal disease.

What Physicians Can Do

If the answer to the question posed above is "no," physicians should let patients know that periodontal disease is an infection that can spread to other parts of the body and possibly cause inflammation-driven disease. It makes it harder to treat conditions including diabetes, high blood pressure, cardiovascular disease, and arthritis; and will increase the risk of heart attack, cancer, and Alzheimer's disease **(Fig 2)**. The physician should request that the patient make an appointment with his or her dentist right away.

I also urge my medical colleagues to update their patient history questionnaires to include the question,

> "Someone on your team should also explain to the patient the connection between the periodontal disease you have diagnosed and the medical illnesses in their personal or family history."

"Do you see blood in the sink when you brush or floss your teeth, or when you receive cleanings from your hygienist?"

If the answer is "Yes, I see blood in the sink," the physician should strongly suggest that the patient have the problem addressed by his or her dentist. If the patient does not have a regular dentist, the physician should refer to dentists who thoroughly understand the mouth-body connection and have experience in treating periodontal disease, including both mechanical disruption of the biofilm and protocols to eradicate the infection. I believe that periodontal disease is significantly undertreated because many dentists do not understand its impact upon the rest of the body.

If the patient has a history of heart disease, the dentist referral is much more urgent because of the negative impact untreated periodontal and endodontal disease can have on this potentially devastating condition.

In my practice, we go a step further. We don't wait for our patients to see blood in the sink. If a patient has no systemic symptoms, but has a personal or family history of cardiovascular disease, diabetes, preterm birth, or even Alzheimer's disease, we consider diagnostic salivary testing from OralDNA Labs, especially if the patient has elevated inflammatory markers.

Causative oral bacteria that can be identified with this saliva testing are often associated with elevated blood inflammatory markers. By the way, I frequently see these blood markers plummet when the patient receives adequate periodontal treatment and homecare!

As always, patient education and communication is key; this is why I hired a hygienist to work in my practice. She serves as my liaison to the local and national dental and medical community.

> "Collaboration between physicians and dentists is critical for patient health."

Summary

We are all health professionals and should be treating the whole patient, not just the body part or parts related to our specific expertise. Collaboration between physicians and dentists is critical for patient health. I for one would not be able to provide my patients optimal care without my local network of trusted dental professionals. Together, we can maximize the prevention-oriented tenets of the third era of medicine, the era of empowering an intrinsically motivated individual to create health!

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Disclosure: The author did not report any disclosures.

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Partnering for Success

A Team Effort Restores a Smile

Sandra Hulac, DDS, AAACD
Edward C.L. Tam, BDS, MFGDP, MGDS, MGD

Abstract

This article describes how a dentophobic patient was able to overcome her anxieties and obtain an overdue smile restoration, thanks to the successful collaboration of an implant surgeon and a restorative dentist. The pleasing outcome was facilitated by the fact that the two practitioners work in the same office and could see the patient in fewer separate appointments, thus easing her dread of trips to the dentist. The surgeon and the restorative dentist worked side by side with optimal communication on the case design and execution.

Key Words: communication, cosmetic dentistry, implant dentistry, surgical and prosthetic components, porcelain anterior esthetics, shade matching

Introduction

Achieving excellent esthetics after extraction and implant placement in the anterior zone continues to be a challenge. Although implants have proven to be a successful treatment modality in terms of surgical outcomes, esthetic results in the smile zone are less certain.[1] Accurate diagnosis and treatment planning; meticulous implant site development;[2] and close communication between the restorative dentist, surgeon, and laboratory technician are key to success.

Patient History

The patient, a 40-year-old female, had no medical problems, but suffered from severe dentophobia due to poor childhood dental experiences and repeated episodes of dental treatment that had been performed without local anesthetic. She had come to the office a year earlier as an emergency patient after her infant son accidentally "headbutted" her during play and fractured the root of tooth #8, which had an existing post-crown. The tooth had originally been treated with a root canal and restored after a sporting accident in her youth. Brief examination and radiographs confirmed a horizontal root fracture of #8 with a dislodged post-crown. The hopeless prognosis was explained to the patient. It was decided to re-cement the existing post-crown and remove any static and dynamic occlusal contacts on #8 as a temporary measure and schedule the patient for record taking and in-depth treatment discussion. Unfortunately, due to her dentophobia, the patient did not return; she was not seen again until nearly one year after the emergency appointment, when the temporarily re-cemented #8 had become severely mobile.

Clinical Examination and Findings

The surgeon and the restorative dentist examined the patient together. A panoramic radiograph, bitewings, a new periapical radiograph of #8, and preoperative images were taken **(Figs 1-3)**. The patient's oral hygiene was fair and she presented with very slight tissue inflammation. Minimal bone loss was observed on the radiographs and she was classified as an AAP Type II patient.[3]

Tooth #8 was found to be extremely mobile, with its incisal edge and tissue profile extruded. The periapical radiograph showed that some bone loss had occurred on the mesial. This was confirmed by sounding to bone, with an 8-mm reading on the mesio-palatal aspect of #8. Caries was detected on #13. A questionable restoration was found on #14 and structural compromises were observed on #18 and #19. A questionable root canal treatment was present in #19, but the tooth was symptom-free. Tooth #4 had been lost due to biomechanical failure. Her regular dentist had removed #20 and #29 in her youth to "create space," but no subsequent orthodontic treatment had been performed to close the spaces.

There were no signs or symptoms of functional problems; examination of muscles and bite revealed no abnormal findings. No joint sounds were noted, joint range of motion was normal, and joint load and immobilization tests were negative. [3] Her bite was in an Angle Class I molar relationship with a Class II Division I incisor relationship and retroclined lower incisors. A lower midline shift to the right was noted.

The patient had high esthetic expectations. Dentofacial examination noted medium-to-high lip dynamics and normal-to-flat gingival scallop around the anterior teeth.[3] The tissue profile of #8 was positioned coronal to #9 due to extrusion of the fractured root fragment and loose post-crown. A small dent or bur mark was noted on the mesial of #9 **(Fig 4)**.

Treatment Plan

Periodontal

Periodontal therapy would consist of scaling and polishing, with a focus on increased home care and six monthly recare visits.

Biomechanical

Direct composite restorations were planned to replace the questionable restorations and treat decay. Implant placement was planned for the missing #4 and the hopeless #8, rather than replacing these teeth with resin-bonded or fixed bridges, based upon long-term treatment success[4-7] and the increased biomechanical risk bridges could pose to the abutment teeth.[8,9]

Functional

As the patient was determined to be in acceptable function, no treatment in this area was considered necessary.

Dentofacial/Esthetics

To accurately predict peri-implant esthetics, the restorative dentist and the surgeon jointly must assess relative tooth position, form and biotype of the periodontium, tooth shape, and position of the osseous crest.[10] Gingival margin placement and excess tissue, normal to thick biotype, and square tooth shape were favorable. Some bone loss had occurred on the mesio-palatal aspect of #8 with an 8-mm bone sounding reading, which might have increased the risk for postoperative loss of the mesial papilla.[11] Bone sounding readings on the distal #8 were 4 mm, which is considered normal crest. On the facial of #8, readings were 4 mm owing to the extrusion of the coronal part of the fractured #8. This was an artificial high crest situation and would lead to recession, which was desired. Readings on the mesial of the adjacent #9 were 4 mm to the crestal bone; therefore, an overall good tissue outcome could be predicted, provided the remaining bone was kept intact.[2] The patient expressed that she wanted an overall brighter shade for her teeth and it was decided to achieve this with home whitening. She also disliked the worn appearance of #11, which would be solved by additive composite bonding.

Treatment

Periodontal and Whitening

Basic periodontal therapy was carried out. The patient was fitted with bleaching trays and provided with 15% bleaching gel (Opalescence, Ultradent Products; South Jordan, UT) for nighttime use. The bleaching result was assessed after a three-week period and it was determined that the desired outcome had been achieved. In the experience of this case's restorative dentist, bleaching adjacent teeth simplifies shade matching, particularly in single anterior implant cases. Bleaching renders natural teeth more opaque, similar to the opacity that results from an all-ceramic crown placed on a zirconium abutment.

Although implants have proven to be a successful treatment modality in terms of surgical outcomes, esthetic results in the smile zone are less certain.

Figure 1: Preoperative radiograph of #8. Multiple root fractures are present and the prognosis of the tooth is hopeless.

Figure 2: Preoperative full-face smile. The patient's smile is slightly guarded, as she is embarrassed to smile fully.

Figure 3: Preoperative full close-up EEEE smile showing full lip movement and tissue display.

Figure 4: Close-up preoperative photograph of the fractured and extruded #8.

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Biomechanical

Direct composite restorations were placed in #13 and #14.

Implants

The surgical procedures were performed under intravenous sedation using midazolam. Tooth #8 was extracted atraumatically using the Easy X-TRAC system (A. Titan Instruments; Hamburg, NY)[2] after cutting along the sulcus with a fine 15C surgical blade (Henry Schein; Melville, NY) to separate the periodontium. The aim was to preserve as much of the gingival architecture as possible and to not damage the surrounding bone **(Figs 5 & 6)**.

The extraction socket was cleaned and the labial bone was checked again with a periodontal probe to ensure that the labial bone was intact and favorable for immediate implant placement **(Fig 7)**. A regular platform (4.3-mm diameter) NobelActive 13-mm long implant (Nobel Biocare; Yorba Linda, CA) was placed 4 mm below the predetermined gingival margin to facilitate adequate postoperative prosthetic emergence.[2] It was placed to engage the harder palatal socket wall with access angled toward the cingulum area and torqued to 50 Ncm. A small cover screw was then placed on top. The gap between the labial bone and the dental implant was filled with allograft filler particle (Puros, Zimmer Dental; Carlsbad, CA)[12] mixed with platelet-rich fibrin.[13] A de-epithelialized connective tissue graft harvested from the maxillary tuberosity was added to cover the filler particles and increase tissue availability. The wound was closed with 4/0 and 5/0 Vicryl sutures (Ethicon; Blue Ash, OH).

The patient was fitted with an immediate temporary partial denture. This was adjusted so as not to exert any pressure onto the implant site. A regular platform Nobel Speedy Groovy 13-mm im-

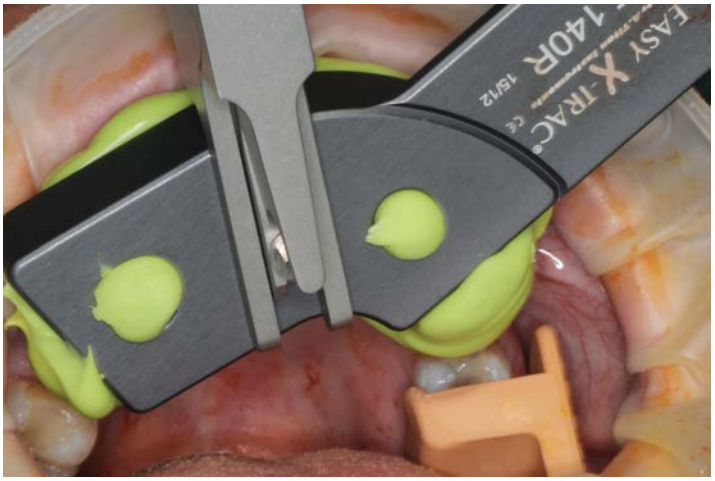

Figure 5: Atraumatic extraction of #8 to ensure bone is not damaged.

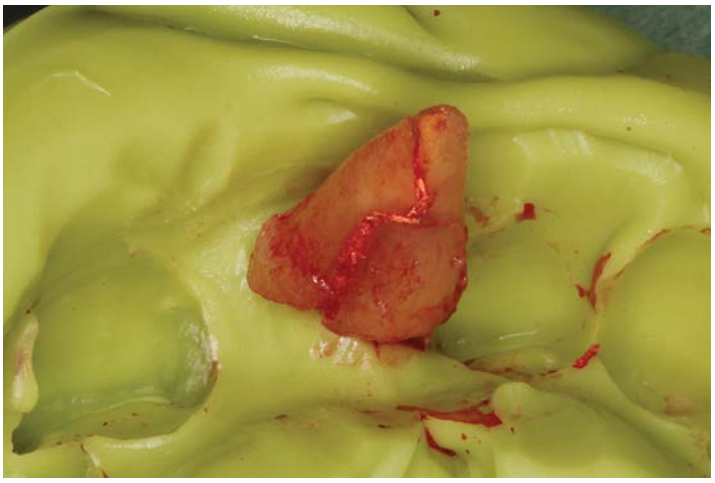

Figure 6: Extracted #8 root showing multiple horizontal and vertical fractures.

Figure 7: Bone sounding of extraction socket to ensure that labial bone is intact.

plant was placed in the #4 space at the same appointment. The patient was seen several times over the following four weeks before a resin-bonded bridge was fitted to replace #8 and to aid in shaping the tissue **(Fig 8)**.

Both the restorative dentist and the surgeon evaluated the patient regularly during a six-month healing period. Prior to performing the second-stage surgery on #8 they decided that, although the soft tissue profile was acceptable, a little more thickening of the buccal gingiva was desirable **(Figs 8 & 9)**. Therefore, a "roll flap" procedure was done by first de-epithelizing the crestal epithelium with a large diamond round bur and size 15C scalpel and cutting a small rectangular flap to expose the cover screw. An intrasulcular partial-thickness incision was then made to create a pouch so that the flap could be tucked under the buccal gingiva to thicken it. It was secured with a 5/0 Vicryl suture going through the buccal gingival about 2 mm below the new gingival margin and through the tucked-in flap in the pouch.

The implant was then connected to a suitable temporary abutment. A putty index (Sil-Tech, Ivoclar Vivadent; Amherst, NY) made from a study model was loaded with a Bis-GMA temporary material (Luxatemp, DMG America; Englewood, NJ) and placed in the patient's mouth until fully set and connected to the temporary abutment. The assembly was unscrewed and the subgingival emergence profile was modified by adding flowable composite (StarFlow, Danville Materials; San Ramon, CA) carefully so as not to overcontour the subgingival area, to avoid recession of the soft tissues **(Fig 10)**. The patient was brought back for several appointments to groom the tissues into the desired shape by modifying the subgingi-

Figure 8: Resin-bonded bridge provisional.

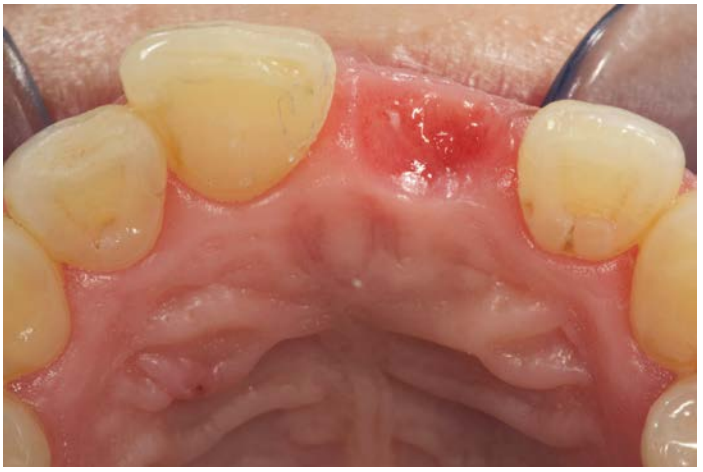

Figure 9: Ridge volume has been maintained during healing.

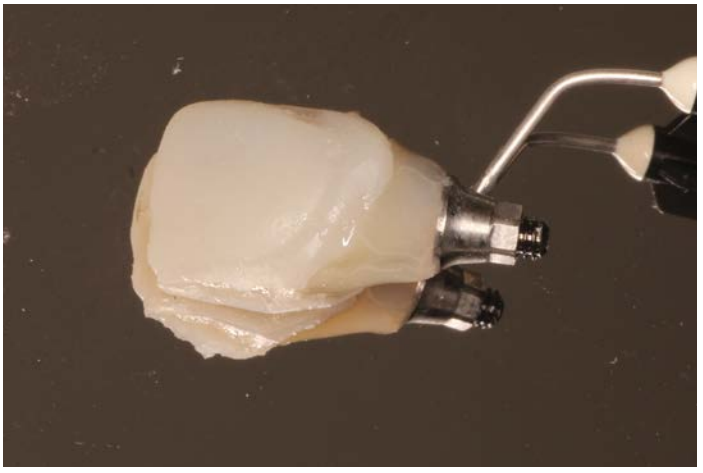

Figure 10: Subgingival emergence profile is modified with flowable composite to guide tissue maturation.

val emergence profile and changing contours and contact points of the provisional crown.[14] Color and shape of the provisional were also altered to match #9 as closely as possible **(Fig 11)**.

Final Restorations

After the ideal tissue contours had been developed and matured by modifying the provisional, a fixture level impression with a custom impression coping was taken with a polyether impression material (Impregum, 3M ESPE; St. Paul, MN). To create the custom coping, the provisional crown was removed and then connected to a fixture replica and impressed into a plastic cylinder filled with putty. The provisional was then unscrewed, an impression coping was connected to the replica, and the space was filled with Luxatemp. The obtained custom coping was marked on the buccal surface to aid orientation and unscrewed from the putty cylinder. It was then connected to the implant fixture and used in an open-tray technique for the impression **(Figs 12-16)**. This method would replicate the true soft tissue contour into the working cast and give the ceramist detailed information to copy the established emergence profile.[15] Custom zirconium abutments (Nobel Procera) **(Fig 17)** were fabricated for #8 and #4 and fitted in a subsequent appointment and torqued to 35 Ncm. New provisional restorations were fitted on #4 and #8 and left for one week to ensure that no undesirable tissue changes occurred. At the impression appointment, shade photographs were taken with various flash settings and the aid of a cross-polarizing filter (polar_eyes, Photomed; Van Nuys, CA) and communicated to the dental technician **(Figs 18 & 19)**. A 00 retraction cord (Ultradent) was packed

Figure 11: The provisional abutment crown after tissue grooming. Tissue height and contour match #9.

Figure 12: Fully developed subgingival contours of provisional.

Figure 13: The custom impression coping is fabricated with the aid of a putty impression of the provisional crown.

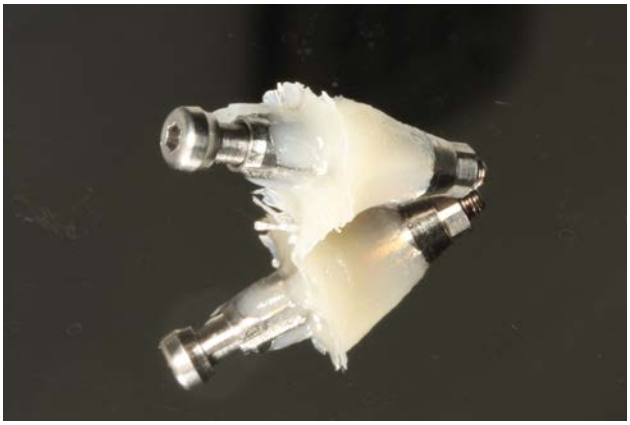

Figure 14: Custom impression coping.

Figure 15: The custom impression coping is connected to the implant fixture.

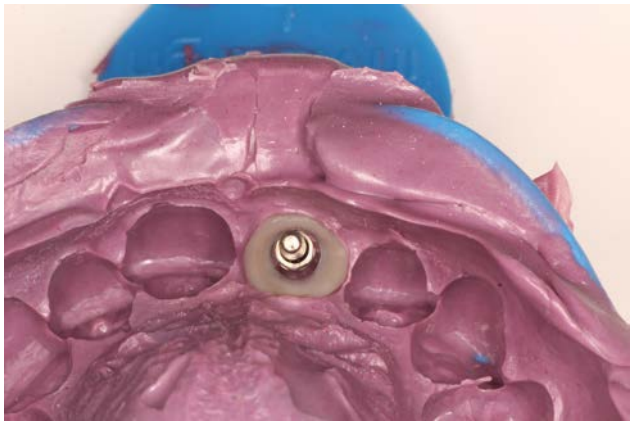

Figure 16: The impression obtained with the custom impression coping exactly replicates true tissue contours. No tissue collapse occurred, as sometimes happens with stock impression copings.

Figure 17: The custom zirconium abutment has the identical subgingival contours of the previous provisional, ensuring that no changes in tissue height or shape will take place.

Figure 18: Shade taking with normal flash setting shows color hue, but flash reflection obscures internal color detail and incisal characterization.

Figure 19: Shade taking with polarizing filter mounted on lens and flash removes spectral flash from the teeth and helps identify color value and characterization.

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around #4 and #8 and removed after four minutes and a vinylpolysiloxane impression (Take 1, Kerr; Orange, CA) was taken.

At the try-in appointment, the Lava zirconia (3M ESPE) crowns veneered with Zi-F porcelain (Jensen Dental; North Haven, CT) were tried in and photographs were taken and analyzed. The patient approved the #4 crown for final cementation and it was fitted with the aid of a cementation coping as described below. The #8 crown was deemed to require various improvements and, as is often the case with single anterior units, the first crown was used as a custom shade guide for the final restoration. The bur mark present on #9 showed very clearly in the close-up photographs and was filled in with a microfill composite (Renamel, Cosmedent; Chicago, IL). Numerous photographs and comments on form and color were communicated to the ceramist **(Figs 20a-21)**. At the second try-in appointment both the patient and the restorative dentist were happy with the esthetics of the #8 crown.

As the crown margin on the abutments was placed subgingivally, removal of excess cement after final cementation can be difficult and the risk of peri-implantitis due to residual cement left in the implant gingival sulcus is high.[16] It is beneficial to prepare a duplicate cementing die replica that will remove excess cement before the crown is seated. The intaglio surfaces of the crown were brushed with glycerin jelly for isolation. Next, Luxatemp was injected into the crown and a micro brush was inserted prior to setting of the material. The die replica was removed from the crown after full set of the bis-acryl material and the internal surfaces of the crowns were thoroughly cleaned **(Fig 22)**. The crown was then loaded with RelyX Unicem cement in shade translu-

Figure 20a: The restoration value of #8 is too low when compared to #9 and there is a noticeable width difference due to different shapes of the distal line angles of #8 and #9. The distal cervical indentation present on #9 also has not been matched in #8.

Figure 20b: By comparison, the provisional crown has more symmetrical line angles and length.

Figure 20c: This close-up and slightly underexposed photograph highlights differences in value and in incisal translucency detail. The mesial line angle of #8 is highlighted by the flash and different when compared to #9. The bur mark on the mesial of #9 is quite noticeable.

Figure 20d: The distal cervical embrasure is too closed, which might lead to a "squeezed" papilla appearance.

Figure 20e: Close-up photograph after the bur mark previously present on the mesial of #8 has been filled with a small amount of microfill composite. Differences in height of contour length and value are apparent.

Figure 21: The first version of the #8 crown. Polarizing filter highlights issues with value and incisal translucency.

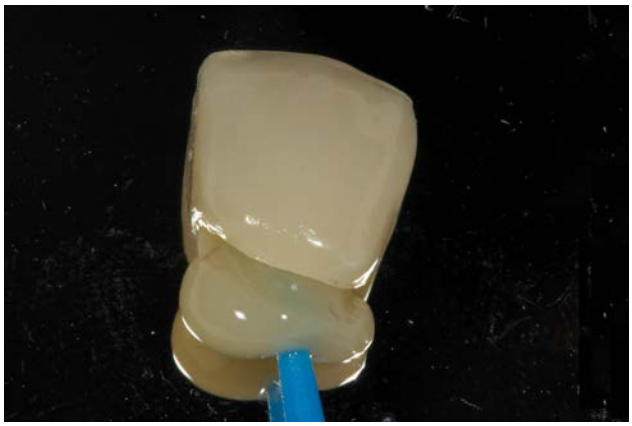

Figure 22: A cementation coping ensures that no excess cement is pressed into the implant sulcus.

cent (3M ESPE) and seated on the die replica prior to intraoral seating. Various authors have described this as the "plunger technique."[17] Static and dynamic occlusion were checked and the required adjustments were carried out.

The patient returned for a review appointment one week later, during which composite was added to the worn tip of #11 in an incremental layering technique utilizing a nanohybrid (Empress Direct, Ivoclar Vivadent) in the load-bearing areas[18] and Renamel microfill on the facial for optimum polish.[19] The patient came back for final photographs and a periapical radiograph in a subsequent appointment **(Figs 23-26)**.

Conclusion

Replacement of a single tooth in the esthetic zone is challenging but rewarding. This case demonstrates how meticulous treatment planning, careful management of hard and soft tissues, optimized implant positioning, detailed

Direct composite restorations were planned to replace the questionable restorations and treat decay.

step-by-step prosthetic procedures and, most importantly, good teamwork between the surgeon and the dentist, in conjunction with excellent laboratory support, can produce a beautiful white and pink result. Although the entire treatment was lengthy, taking 10 months to complete, the patient was extremely pleased with the outcome and the overall positive experience, which has helped her to overcome her dental phobia **(Fig 27)**.

Acknowledgment

The authors thank Mr. Jörn Lübbers, ZTM (Jörn Lübbers Zahntechnik GmbH; Hamburg, Germany) for the anterior ceramics fabrication in this case.

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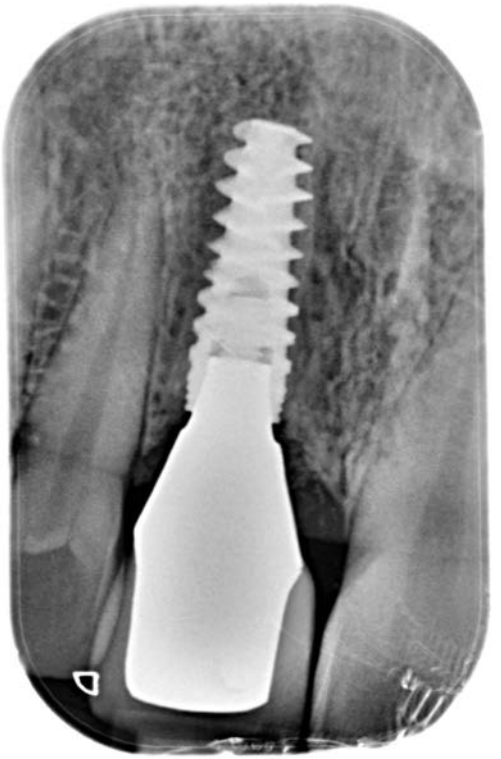

Figure 23: Postoperative periapical radiograph.

Figure 24: Postoperative full-face smile. There is a noticeable difference to the patient's guarded preoperative smile.

Figure 25: Postoperative close-up smile.

Figure 26: Postoperative close-up of centrals documenting a harmonious tissue and prosthetic result.

Figure 27: The happy patient, whose uninhibited smile now fully reflects her sparkling personality.

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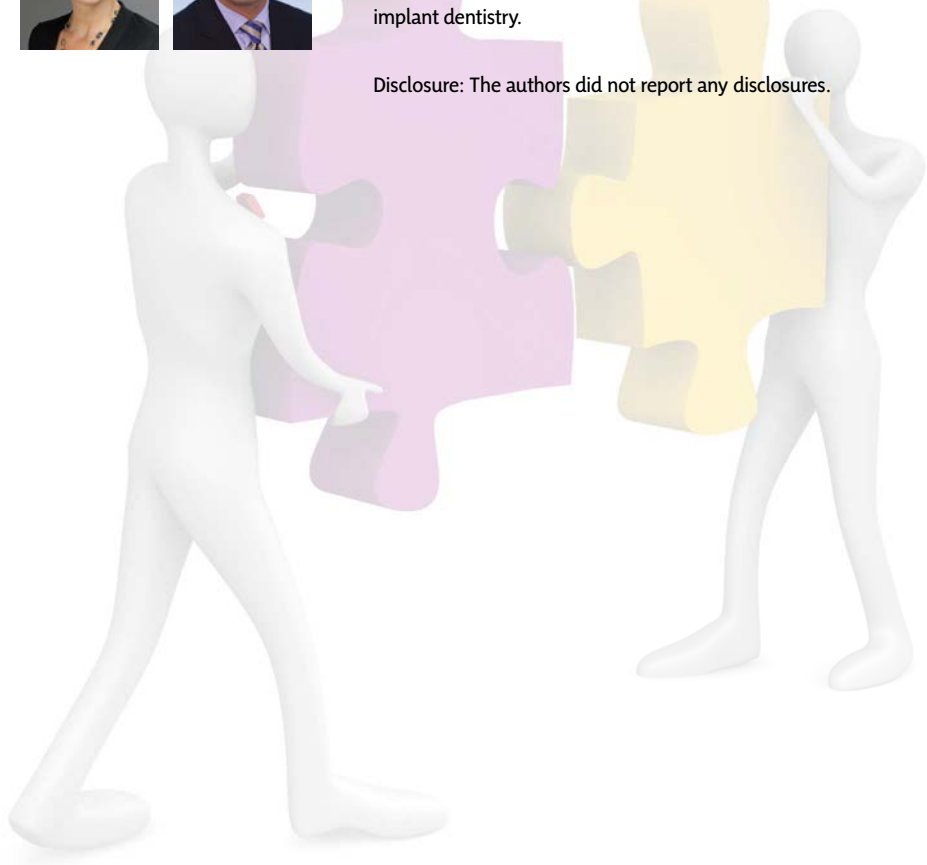
To accurately predict peri-implant esthetics, the restorative dentist and the surgeon jointly must assess relative tooth position, form and biotype of the periodontium, tooth shape, and position of the osseous crest.

Dr. Hulac and Dr. Tam are joint owners and directors of Tam, Hulac and Partners Dental, a multidisciplinary private practice in Hong Kong. Dr. Hulac, who focuses on cosmetic and restorative dentistry, is also a mentor at the Kois Center in Seattle, Washington. Dr. Tam focuses on implant dentistry.

Disclosure: The authors did not report any disclosures.



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> The myriad causes of a gummy smile are rarely if ever confined exclusively to the maxillary anterior region.

Perceptions of a *Gummy Smile*

Myths and Realities of Esthetic Crown Lengthening

Michael Sonick, DMD
Debby Hwang, DMD

Key Words: esthetic crown lengthening, gingivectomy, ostectomy, periodontal surgery, biphasic approach, lasers, bone contouring

Introduction

Within the first few seconds of meeting someone, we make up to 11 subjective judgments—on everything from credibility to professional desirability to sophistication to trustworthiness—about that person based chiefly upon nonverbal cues, among which smiling is paramount.[1] What do we think of a gummy smile? More important, how does the person with the gummy smile feel about it? Excessive gingival display, defined clinically as the display of any mucosa above the tooth margin when smiling (but not perceived as unattractive by laypeople until 3 to 6 mm shows), draws attention to the mouth.[2-4] The gummy appearance may upset facial harmony and distort dental proportions, engendering anxiety and embarrassment in the affected person while smiling or laughing. As a result he or she may suppress those expressions, which in turn affects an onlooker's perception of the person. Correction of a gummy smile returns the facial, periodontal, and dental contours to physiologic norms and hopefully restores psychological equanimity. Esthetic crown lengthening helps to rectify many cases of excessive gingival display; the following discussion addresses a few of the fallacies surrounding this treatment modality.

Myth

A gummy smile is caused predominantly by excess gingival tissue.

Reality

If a clinician observes a gummy smile, he or she must then ask two questions: *Why does it exist?* and, *What else exists*? A number of conditions affect the perception of excessive gingival display; these can be categorized as skeletal, alveolar, muscular, dental, and periodontal in origin.[5,6]

Skeletal: Vertical maxillary excess, a state in which there is an elongated middle third of the face.

Alveolar: Supraeruption of the anterior maxilla and/or possibly enlarged alveolar processes, accentuates gingival display.[7,8] Nasal protrusion and mandibular retrognathia further highlight this visual.

Muscular: Sometimes the upper lip is able to compensate for osseous prominence, but in the case of muscular hypertonicity resulting in strong labial retraction or a naturally short lip, masking skeletal issues is not viable.[9] Indeed, these muscular features in a person with regular osseous anatomy may generate a gummy smile.

Dental: Any situation in which there are or there appear to be shortened teeth will upset the optical mucosa-to-tooth ratio. Caries and traumatic fracture truncate tooth length. Protrusive (anterior) bruxism also diminishes the clinical crown height, and thus the observer detects more gingiva relative to tooth structure. The body attempts to offset this attrition by dentoalveolar extrusion; this entails the coronal migration of not only the teeth but also the periodontal housing, including the gingival margin, exaggerating the dominance of the soft tissue.[10] Just the illusion of less tooth structure even when none exists as seen in severe labial inclination of normal-height maxillary incisors and canines gives rise to a gummy façade, at least when the patient is perceived straight on.[11] Perhaps less obviously, aberrations of posterior teeth also contribute to a gummy smile. Premolars and molars that are missing, tipped, or otherwise in infraocclusion from attrition, abrasion, erosion or trauma lead to non-coincident anterior and posterior occlusal planes. This may introduce a deep overbite and subsequent pronounced gingival exposure.[10,12]

Periodontal: Sources of gingival overgrowth include periodontal disease (gingivitis and periodontitis); poor plaque control in the presence of orthodontic appliances; hereditary gingival fibromatosis; systemic illness; and use of specific anticonvulsant, antihypertensive, and immunosuppressive medications.[8] In a separate periodontal phenomenon, the natural apical migration of the gingiva during tooth eruption is incomplete; there is no hypertrophy or hyperplasia, yet the soft tissue margin remains coronally positioned on the tooth surface, leading to a short clinical crown height and comparative surfeit of gum tissue.[13] This altered passive eruption may involve a bone-to-cementoenamel junction (CEJ) relationship that is normal (alveolar crest lies 1.5 mm apical to the CEJ) or abnormal (alveolar crest is at the level of the CEJ).[14]

A gummy smile frequently stems from numerous simultaneously occurring factors **(Figs 1-17)**. There may or may not be superfluous (hyperplastic or hypertrophic) gingival tissue. Rather, the presence of certain traits compounds the mirage of too-small teeth engulfed by mucosa. The primary clinician consults with an orthodontist, oral surgeon, periodontist and/or prosthodontist to determine all core etiologies of excessive gingival display. Problem management eliminates or at least diminishes the impact of each contributing factor.

Myth

Limiting treatment to periodontal surgery in the anterior esthetic zone is often sufficient.

Reality

The myriad causes of a gummy smile are rarely if ever confined exclusively to the maxillary anterior region. Accordingly, definitive therapy almost always necessitates several specialties and involves a full arch or all teeth. Patient-based restrictions (e.g., financial thresholds, chairside availability, health concerns, general motivation) inevitably compromise the ideal treatment plan, but this does not render acceptable an incomplete diagnosis or preclude formulation of a multidisciplinary treatment plan. After unearthing every possible influence on the gingival display, the practitioner constructs an optimal plan, which can be pared back or reconfigured depending upon any patient constraints. Most importantly, the patient must understand that any deviation from the ideal may not fully remedy the problem. A quick fix may be a fleeting one as well, especially in the presence of ongoing ailments. Treatment begins only when the patient has realistic expectations.

The amount of excessive gingiva a patient expresses hints at the major underlying causes and suggests treatment strategies. The provider, however, must use the width range seen only as a clue to what category of deformity could be present and not as diagnostic gospel. For instance, bilateral gingival display of 8 mm or greater in a patient with a uniform anterior and posterior occlusal plane may signify a skeletal aberration (i.e., vertical maxillary excess) and merit LeFort I surgery.[8] This does not mean that other features like a short lip, tooth malposition, caries, attrition, periodontal inflammation, or altered passive eruption are not meaningful or should not be addressed. Instead, this level of gumminess warns the dentist that a skeletal component is highly probable, necessitating further, deeper orthognathic inquiry. On the other hand, a relatively mild gingival display of 2 to 4 mm in the presence of a deep overbite related to a discrepancy between the anterior and posterior occlusal planes implies a strong dentoalveolar element to the cause; therapy might incorporate intrusion of the anterior teeth and/or uprighting of the posterior teeth, though other modalities must be considered after comprehensive diagnosis.[15]

Figure 1: Patient at initial presentation. A component of vertical maxillary excess existed. The patient exposed a wide band of keratinized gingiva from molar to molar upon smiling. Orthognathic surgery was recommended but was not pursued.

> "The amount of excessive gingiva a patient expresses hints at the major underlying causes and suggests treatment strategies."

Figure 2: Relaxed smile view shows exposure of at least 1 mm to 3 mm of gingiva from #3 to #14.

Figure 3: Wide smile view shows mild asymmetry between right and left gingival contours, at least 4 mm to 6 mm of gingival display from #3 to #14, and severe generalized attrition with subsequently shorter clinical crowns from #3 to #14.

Figure 4: The maxillary midline is shifted to the patient's right compared to the frenum, and there exists a discrepancy between the maxillary and mandibular midlines.

Figure 5: Digital imaging of a more ideal smile (Dickerman Dental Prosthetics; Sharon, MA). Clinical crowns have been lengthened. Note that the maxillary midline remains offset toward the patient's right.

Figure 6: Wax-up of ideal tooth proportions based upon the digital imaging. Note the increase in the overbite and tooth height from molar to molar.

Figure 7: Compared to the untreated mouth (upper model), the idealized mouth (lower model) has more gingival symmetry, less prominence of the buccal mucosa, and longer clinical crowns.

Figure 8: Initial full-thickness reflection of the maxillary tissue. The alveolar crest is greater than 2 mm from the CEJ at the buccal aspect but less than 2 mm from the CEJ interproximally.

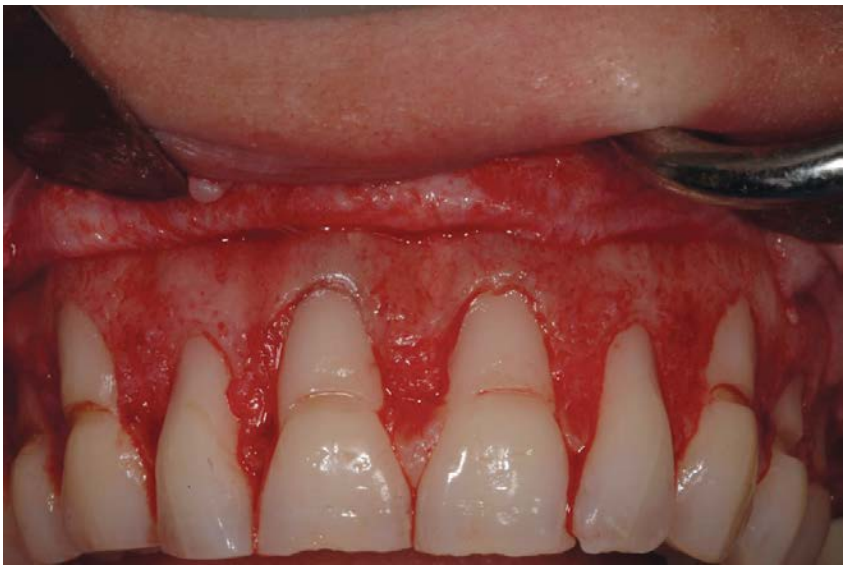

Figure 9: Esthetic and functional crown lengthening was performed via a biphasic method. An ostectomy from #3 to #14 was performed. Significant midfacial reduction was achieved to idealize the buccal heights of contour and allow for biologic width health. As the patient had long roots, copious palatal bone, and coronally oriented proximal alveolar tissue, the crown-to-root ratio was favorable. No gingival resection or repositioning occurred.

Figure 10: The flap was sutured without apical repositioning, using expanded polytetrafluoroethylene. The gingival contour closely approximates the presurgical configuration.

Figure 11: Ten days after ostectomy, the site appears to be healing well. There is no significant change in the mucosal drape.

Figure 12: Second-stage gingivectomy of #3 to #14 was completed to lift the periodontal drape coronally.

Figure 13: Ten days after the gingivectomy, the gingival contour demonstrates enhanced symmetry and remains apically positioned.

Figure 14: Relaxed smile view of final restoration four months after gingivectomy. There is no gingival display coronal to the crown margins.

Figure 15: The wide smile view reveals the final restoration of #3 to #14 four months after gingivectomy. Much-improved crown heights are seen. The patient continued to display a 2 mm to 3 mm band of gingiva upon smiling, but it was not important to her. She was very pleased with the new esthetics.

Figure 16: Frontal view three years after the final restoration. The gingiva remains healthy and positionally stable.

Resolution of a gummy smile often involves some degree of periodontal surgery in the cosmetic zone to elongate teeth. Typically, it helps to correct a 2 mm to 7 mm width of excess gingiva.[8] Esthetic crown lengthening via periodontal contouring is versatile—it can either refine results achieved by other means or be the major solution. As long as contraindications (e.g., vertical maxillary excess, malpositioned teeth, anticipated poor crown-to-root ratio, anticipated poor restorative emergence profile, active inflammation, nonrestorable teeth) do not exist, periodontal surgery is a potential monotherapy. If the case calls for prosthetic rehabilitation, crown lengthening may contribute to both beauty and function since the stability of new restorations relies on establishment of adequate coronal retention and a healthy biologic width.[16-18]

Myth

Bone contouring during esthetic crown lengthening is seldom necessary.

Reality

The periodontal anatomy dictates the exact type of contouring required.[14] Basically, redundant volumes of soft tissue or bone warrant surgical shaping, especially if the patient has an inherently thick biotype that encourages tissue rebound.[19,20] A disproportionately wide band of keratinized mucosa justifies gingivectomy. As it removes any pigmented layers of mucosa, an externally beveled gingivectomy in particular benefits the patient by removing unwanted racial, amalgam-related, or other-source coloration, though discoloration may return over time.[21,22] Excessive gingival display of mostly non-keratinized tissue, however, supports use of an apically positioned flap as opposed to resection to maintain the narrow band of attached gingiva.

The need for ostectomy depends upon three factors: the distance between the alveolar crest and the CEJ, the presence of exostoses or otherwise unsightly bony morphology, and the need for any prosthetics. If a normal or greater alveolar crest-to-CEJ distance (at least 1.5 mm) exists and no prosthetic rehabilitation is planned, gingival manipulation alone suffices. Bone contouring is required whenever the bony crest lies at the CEJ, which happens in some altered passive eruption scenarios when hard tissue protuberances occur, or crowns are proposed. Coronally located bone but-

REALITIES

- **A number of conditions affect the perception of excessive gingival display; these can be categorized as skeletal, alveolar, muscular, dental, and periodontal in origin.**
- **The myriad causes of a gummy smile are rarely, if ever, confined exclusively to the maxillary anterior region. Accordingly, definitive therapy almost always necessitates several specialties and involves a full arch or all teeth.**
- **Resolution of a gummy smile often involves some degree of periodontal surgery in the cosmetic zone to elongate teeth.**
- **The periodontal anatomy dictates the exact type of contouring required.**
- **The major advantage of laser therapy over traditional scalpel and bur treatment is its ability to induce immediate hemostasis.**
- **A variety of conditions can lead to a gummy smile. The astute clinician discerns and resolves each of the contributing factors. Commonly, esthetic crown lengthening is a meaningful part of this resolution.**
- **The judicious application of periodontal surgery results in correction of excessive mucosal display that is predictable and long lasting. Normalized dentogingival and orofacial proportions may restore the patient's emotional harmony and confidence.**

Figure 17: The patient three years after final prosthetics. She remains very pleased with the esthetics.

tresses the overlying soft tissue; even if the gingiva is completely removed, it will regrow to cover the osseous aspect and reestablish the biologic width.[23] Bone resection to a position at least 2 mm away from the CEJ therefore sustains an apical mucosal position. Any tori or osseous projections should be leveled (osteoplasty) to facilitate a harmonious, less conspicuous arch form. Finally, restorative treatment compels ostectomy. A prosthetic margin that encroaches upon the epithelial and connective tissue seal around the tooth (biologic width) triggers inflammation, plaque retention, bleeding, recession, and attachment loss.[24-27] Normally, there is 1 mm of epithelium and 1 mm of connective tissue attachments coronal to the alveolar crest in addition to 1 mm of gingival sulcus at the buccal aspect of the teeth.[28] To preserve the attachment apparatus around a crown, at least 3 mm is mandated between the restorative margin and bony crest.

Crown lengthening may be performed by both soft tissue excision and bone contouring in one surgical session or by a biphasic approach in which the bone is reduced first, followed by gingival excision at least four to six weeks later.[29] With conventional single-stage crown lengthening, the gingival margin may shift coronally 1 mm to 2 mm over 6 to 12 months, usually due to inadequate hard tissue removal or improper soft tissue resection.[19,30] Allowing the soft tissue to settle into position after ostectomy or osteoplasty gives the surgeon a chance to refine the gingival drape and change the biotype as needed (from thick to thin).[31] Prosthetic completion should be delayed at least three months after gingivectomy to allow for maturation of the attachment apparatus.[32]

Myth

Laser-assisted therapy is the standard of care.

Reality

There is a dearth of controlled studies on laser-assisted crown lengthening—the literature largely consists of case reports and expert opinions that focus on its use for gingivectomy and gingivoplasty/depigmentation. The major advantage of laser therapy over traditional scalpel and bur treatment is its ability to induce immediate hemostasis.[33] With respect to esthetic crown lengthening, soft tissue lasers assist in gingivectomy-only situations (excessive keratinized mucosa with normal or apically located alveolar crest relative to the CEJ); application in any other circumstance potentially can trigger mucogingival defects or biologic width invasion.[34] Even if used when indicated, CO2 and Nd:YAG soft tissue lasers notch or irreversibly roughen tooth surfaces and biomaterials; and char, melt, and sequester bone if in contact.[35]

Hard tissue lasers based on erbium (Er:YAG and Er,Cr:YSGG) maximize bone cutting while minimizing bone necrosis.[36] Case reports detail flapless crown lengthening with erbium lasers for patients with mild gummy smiles.[37,38] Here, bone sounding rather than direct visualization is used to determine the osseous morphology. A closed flap procedure thus disallows meticulous ostectomy. Raising a flap is much preferred for the sake of accuracy and outcome predictability.

Laser-assisted crown lengthening has its advantages, but too little evidence-based data exist for it to qualify as the gold standard for esthetic crown lengthening. Conventional scalpel and rotary instrument esthetic crown lengthening remains the clinical benchmark, especially when bone contouring is required.

Summary

A variety of conditions can lead to a gummy smile. The astute clinician discerns and resolves each of the contributing factors. Commonly, esthetic crown lengthening is a meaningful part of this resolution. The judicious application of such periodontal surgery (when, where, how, and in conjunction with what else) results in correction of excessive mucosal display that is predictable and long lasting. Normalized dentogingival and orofacial proportions may restore the patient's emotional harmony and confidence; a smiling person is a self-assured one.

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> "The periodontal anatomy dictates the exact type of contouring required."

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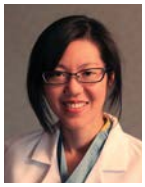

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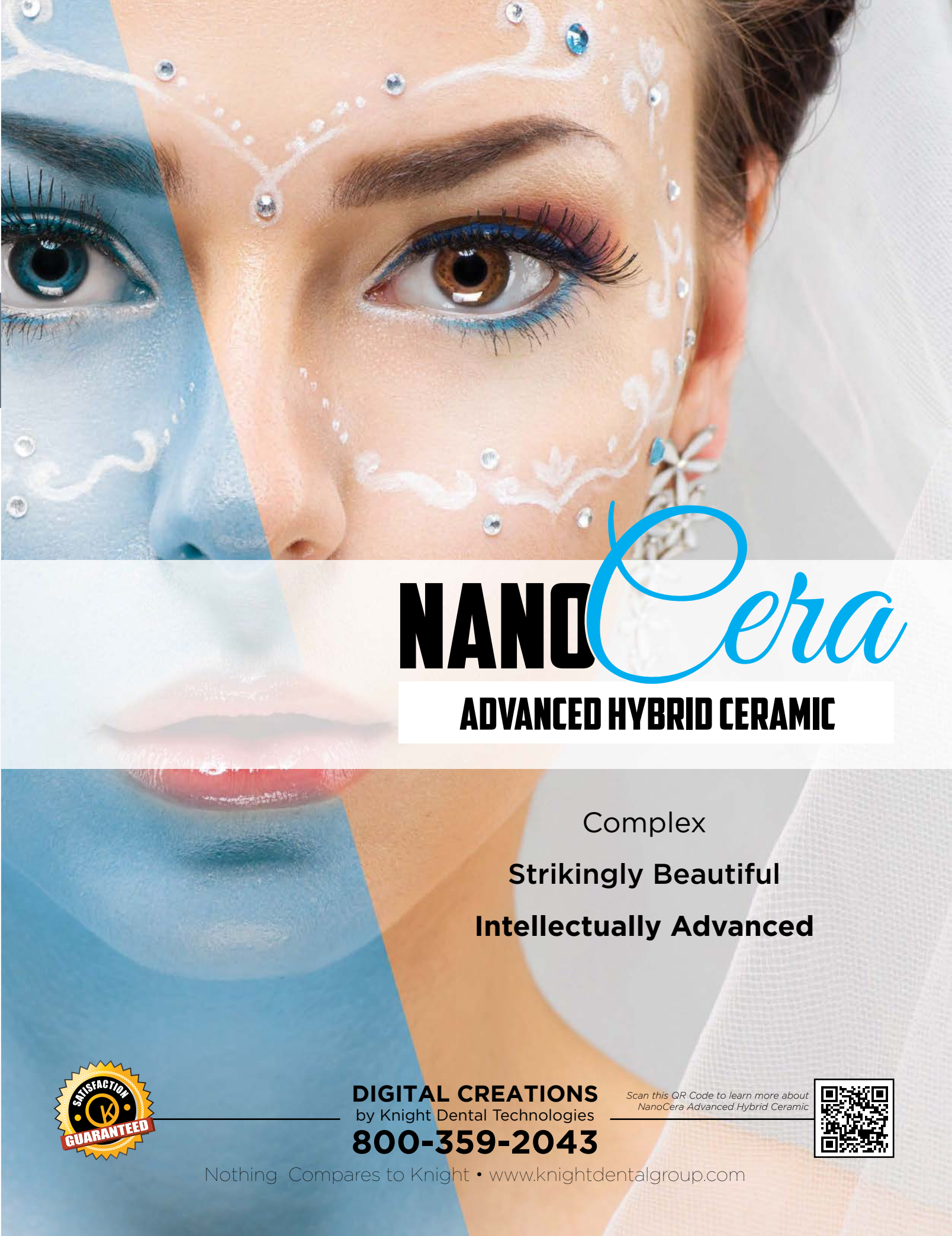
Disclosures: The authors did not report any disclosures.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After reading this article, the participant should be able to:

1. Evaluate the benefits of the full-arch All-on-4 treatment technique.
2. Assess the diagnostic elements involved in planning a full-arch dental implant prosthetic treatment.
3. Compare the costs, time, and benefits of the more traditional mix of implants, crowns, and fixed and removable prosthodontics in full-arch reconstruction with those involved in the All-on-4 technique.

Advanced Dental Implant Treatment

Functional and Esthetic Improvement in the Maxillary Arch: Case Report

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Key Words: dental implants, prosthetics, treatment planning, aging

Abstract

Although the dental literature has given substantial attention to management of intraoral hard and soft tissue profiles with single anterior dental implants, especially in cases of immediate implant placement with temporization, there is a comparative dearth of information concerning esthetic considerations with larger full-arch cases. Patients with full or partial edentulism often have significant alveolar deficiencies that create both intraoral and extraoral esthetic challenges. In addition, changes in the craniofacial skeleton related to aging alter facial esthetics and must be considered in planning dental implant prosthetic treatment. In this article, the authors examine diagnostic elements for planning full-arch dental implant cases with optimum esthetic outcomes and discuss a paradigm shift in the way many complex cases are being approached with a specific four-implant, immediate-loading technique.

Introduction

Immediate dental implant placement in the esthetic zone has received considerable attention in the dental literature as a means to maintain natural soft tissue contours and ideal emergence profiles for dental implant restorations.[1-4] Protocols for this treatment modality place significant attention upon hard and soft peri-implant tissue management to maintain or enhance optimum esthetic outcomes. When considering larger dental implant cases, such as extensive partial or full edentulism, one must address different but no less important considerations and protocols to ensure positive esthetic results. With such cases, improper diagnostic techniques and poor planning may result in dubious intraoral esthetics and, more significantly, also lead to compromised extraoral facial esthetics that cannot be hidden. In this article, we examine diagnostic considerations for extensive full-arch dental implant-supported prostheses with the All-on-4™ (Nobel Biocare; Zürich, Switzerland) dental implant treatment concept and a paradigm shift in treatment planning regarding this technique. We draw upon our experiences with more than 250 cases utilizing this treatment and provide a specific case report that required collaborative treatment planning to achieve ideal esthetics.

Initial Patient Evaluation

The initial patient evaluation appointment is one of the most important of the entire treatment process for extensive and complex implant-supported restorations. This appointment sets the tone for patient expectations and is critical for establishing rapport and understanding between the patient and the provider. Often, providers are so focused on the treatment that they do not adequately attend to the patient's concerns and desires. The initial appointment should begin with discussion of the patient's chief complaint and outcome desires. Is the patient seeking improved function, improved esthetics, or both? If the patient is seeking improved esthetics, what are the patient's expectations? Is the patient a 55-year-old who wants to look the way he or she did at age 20? Does the patient wish to look like a particular celebrity? Patient desires must be the first item of discussion so that the provider can determine whether these expectations can be met during the treatment process. To make this determination, the provider must obtain certain diagnostic information.

"The initial patient evaluation appointment is one of the most important of the entire treatment process for extensive and complex implant-supported restorations."

Intraoral Bone Considerations

When the provider is considering treatment with dental implants, the first item of consideration, apart from the patient's medical status, is the quantity and quality of the patient's existing maxillary and mandibular bone. Alveolar deficiencies develop in the presence of edentulism;[5-7] and, in severe cases, bone deficiencies may render dental implant therapy a difficult option. Definitive evaluation of alveolar profiles in these patients should be achieved with cone beam computed tomography (CBCT) because it is a more accurate diagnostic tool than are more traditional methods such as panoramic radiography.[8] CBCT allows for extensive evaluation of hard tissue profiles in all dimensions, whereas traditional evaluation techniques such as direct clinical examination and two-dimensional radiographic images often may be misleading and lead to unsuccessful treatment.[9] When evaluating native host bone on CBCT scans, the provider must determine whether residual bone is adequate for dental implant placement. If this bone is of inadequate dimensions, can the deficiency be remedied with hard tissue augmentation techniques? If so, is the patient willing to undergo the surgical procedures necessary to achieve improved hard tissue profiles and wait the necessary amount of time for the bone to heal? In addition, will these augmentation procedures result in bone that allows for optimum placement of dental implants, or will it simply get the patient to a point at which implants of less than desirable dimensions are able to be placed to support a prosthetic restoration?

In cases of extensive alveolar deficiencies that traditionally would require substantial bone augmentation procedures, a paradigm shift in treatment planning is occurring with the advent of All-on-4 full-arch treatment. With this technique, the opposite approach to conventional treatment for deficient bone is taken. Rather than augmenting the deficient bony profiles, this modality requires the bone to be reduced vertically **(Fig 1)** with high-speed surgical instruments and sometimes is referred to as a "no-bone solution" because no bone augmentation is required.[10] As the alveolar bone is reduced vertically, the horizontal profile of the bone increases as the natural contours of the maxillary[11] and mandibular[12] bone widen apically. Use of angulated dental implants compensates for the reduced vertical dimension of the bone, and the improved horizontal dimensions after alveolar reduction typically allow for the placement of standard or wide-body dental implants. This bone reduction is sometimes referred to as creating an "All-on-4 shelf."[13,14] In addition to providing improved bony contours to facilitate dental implant placement, creating a bony shelf with bone reduction also creates the prosthetic space necessary for transitional and final full-arch fixed-implant restorations. In the mandible, this dental implant placement occurs between the mental foramina, and it is rare that alveolar deficiencies preclude placement of implants in this area. In more than 100 mandibular treatments that we have performed using this technique, no

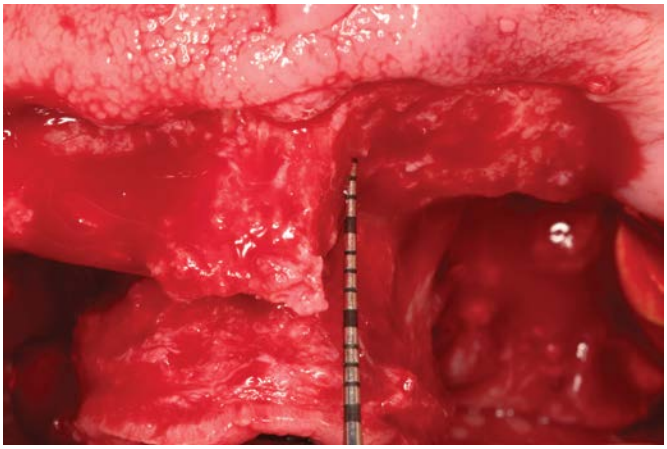

Figure 1: Bone reduction is an essential requirement for the All-on-4 treatment concept, to avoid showing prosthetic transition lines and restorations of inadequate thickness.

cases required bone augmentation to facilitate treatment. In the maxilla, this type of dental implant placement occurs in the premaxilla anterior to the maxillary sinuses. In cases of significantly pneumatized maxillary sinuses or severe atrophy of anterior maxillary bone, alternative techniques such as zygomatic dental implants[15] or subantral augmentation with subsequent implant therapy[16] must be considered. In more than 150 such treatments of the maxilla that we have performed, fewer than 3% of cases required such treatments to facilitate dental implant placement.

Smile Line Considerations

For conventional dental implant therapy in the anterior maxilla, extraoral analysis of the smile line has been documented thoroughly as an important diagnostic factor for planning implant restorations of optimum esthetic outcomes.[17-19] In addition to determining the anticipated difficulty of a maxillary anterior implant case, smile line analysis is used to determine dental implant abutment selection,[18] the need for additional soft tissue augmentation,[20] dental implant platform positioning for optimum emergence profiles,[21] and a multitude of other additional considerations. For All-on-4 treatment, smile line evaluation is of even greater importance. The final restoration for this treatment is a screw-retained, single-piece, full-arch prosthesis that has an intimate fit with the supporting gingival tissue. The location where the prosthesis meets the gingival tissue is referred to as the "transition line," and if these cases are planned improperly, the transition line may be visible when the patient smiles. A visible transition line is an esthetic disaster and may require undesirable prosthetic alterations such as an unhygienic ridge-lap flange to hide the mistake.

To avoid visible transition lines, the practitioner must measure from the existing or anticipated residual ridge to the lip **(Fig 2)**. This measurement is important presurgically because it helps to determine the likelihood of exposing the transition line and is important intrasurgically because it is used for a guide to determine bone reduction. Bone reduction using this treatment modality is influenced by both the smile line and the type of the final restoration. An important consideration for full-arch implant-supported restorations is adequate available space.[22] For hybrid acrylic restorations with a titanium bar substructure, 15 mm from the residual ridge to the lip is desired **(Fig 3)**, whereas 10 mm to 12 mm is considered adequate for zirconia restorations. All-on-4 cases with inadequate ridge reduction may result in visible transition lines, excessive tooth display, and thin restorations that have higher chances of fracture.

Facial Esthetic Considerations

Edentulous patients or patients with significant alveolar defects develop facial profile changes such as loss of lip support, deepening of the nasolabial fold, loss of the nasolabial angle, decrease in the horizontal labial angle, narrowing of the lips, increase in the columella-philtral angle, and development of a prognathic appearance.[23] Presurgical evaluation of the patient's facial esthetics will help determine the need for prosthetic alterations to support depleted facial structures. A well-designed full-arch restoration of the type discussed here can provide significant improvement to facial esthetics and restore the patient to a more youthful appearance **(Figs 4 & 5)**. Cases requiring more significant prosthetic support of collapsed facial structures require restorations that may be bulkier than typical prostheses. This additional bulk is used to support and fill out the face. Considering this situation, it is also important to examine existing or anticipated residual ridge position before placing dental implants. Because maxillary bone tends to resorb in a centripetal fashion, moving superiorly and medially,[24,25] cases of significant maxillary resorption may require prosthetic restorations of even greater added anterior bulk to provide lip support. It is important to discuss these issues with patients during the evaluation phase to set expectations and prepare the patient for what is to come. Explaining the need for a bulkier restoration after placement of the prosthesis may be upsetting to the patient and sound like an excuse from the restoring dentist.

Occlusal Considerations

Just as it is for conventional single-unit implant restorations, occlusion is of paramount consideration for this particular four-implant treatment. The maxilla is the "yin" to the mandible's "yang," and the two fit together like pieces of a puzzle. When this type of treatment is being considered, the opposing arch must be evaluated carefully. If malocclusion or situations such as combination syndrome exist, these problems must be addressed in the pre-prosthetic phase. Occlusal schemes for this treatment modality typically consist of bilateral balanced occlusion when opposing a denture or group function with light anterior guidance when opposing natural dentition or another All-on-4 restoration **(Figs 6-9)**.[26]

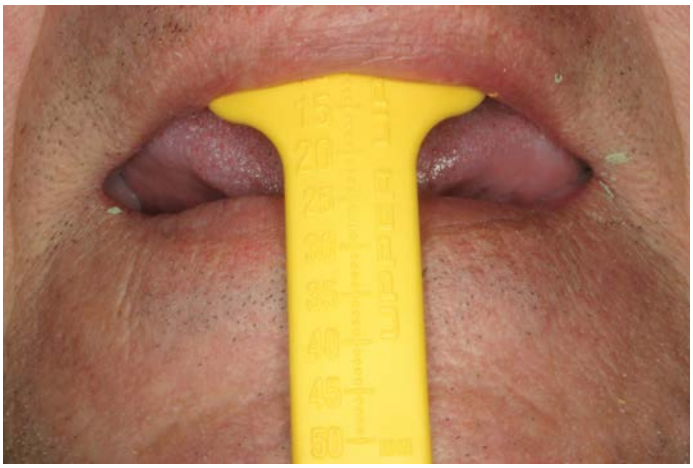

Figure 2: Lip ruler (Masaad Enterprises; Tulsa, OK), measuring only 11 mm from the residual maxillary ridge to the lip.

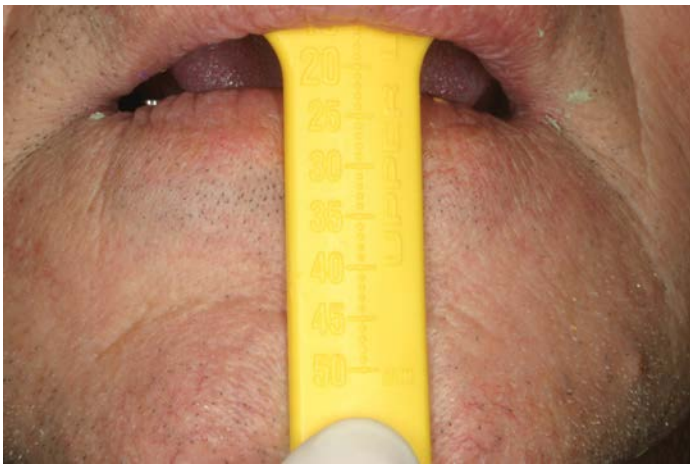

Figure 3: Lip ruler, now measuring 16 mm following reduction of maxillary bone to allow for placement of an All-on-4 transitional restoration.

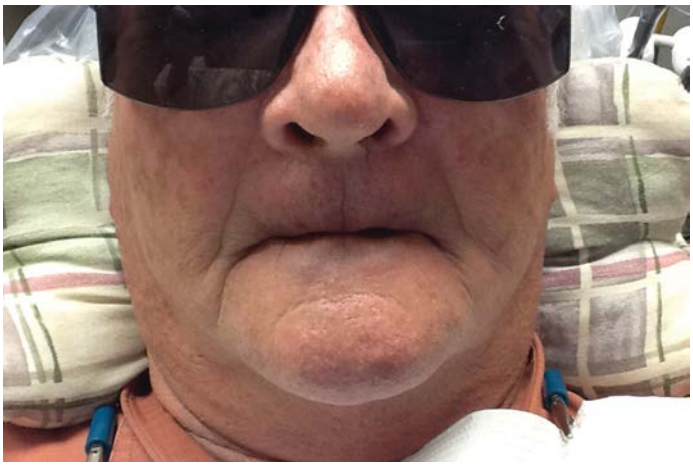

Figure 4: Edentulous patient showing significant loss of facial support.

Figure 5: The same patient as in Figure 4, showing dramatic changes in facial support after delivery of maxillary and mandibular All-on-4 restorations.

Figure 6: Mandibular patient prior to surgery.

Figure 7: Mandibular patient 48 hours after delivery of transitional prosthesis. Occlusal scheme is bilateral balanced contacts with very light anterior contact.

Figure 8: Maxillary and mandibular patient prior to surgery.

Figure 9: Maxillary and mandibular patient immediately after delivery of transitional prostheses. Occlusal scheme is bilateral balanced contacts with very light anterior contact.

Often, establishment of such occlusal schemes is challenging for patients requiring this treatment. The fact that these patients need this particular therapy typically means that there are other problems with their existing dentition. For example, patients with edentulous posterior mandibles often have supraeruption of the maxillary posterior teeth, whereas patients missing maxillary anterior teeth often have supraeruption of the mandibular anterior teeth.[27,28] Failure to address such occlusal concerns before utilizing this treatment concept results in unesthetic prostheses and precludes establishment of proper occlusal schemes.

Vertical dimension of occlusion (VDO) is another occlusal factor that must be considered during the diagnostic phase of this four-implant treatment. As it is for the construction of complete dentures, establishment of a proper VDO for these types of restorations sets the foundation for ideal facial support, dentition display, more natural-sounding speech, and pain-free temporomandibular joint function.

Paradigm Shift Considerations

Diagnostic considerations for patients with complete or near edentulism can be fairly straightforward if one uses the aforementioned established protocols. In cases of partial edentulism combined with additional factors, however, an updated examination of treatment protocols is required. During the past 30 years, dental implants have proved to be a predictable and reliable treatment option[29] that has changed the way comprehensive dental treatment planning is approached. In the past, extensive efforts and procedures were exhausted to save teeth because dental implants were considered a relatively new technology with unproven long-term results. As multiple studies consistently documented the reliability of dental implants,[29-36] a number of treatment options such as root amputations, certain endodontic procedures, and fixed partial dentures (FPDs) have declined in usage in favor of the more predictable option of dental implants.

Just as dental implants have changed the way conventional single- and multiple-unit treatments are planned, a similar paradigm shift is underway concerning complex full-arch treatments. With the use of dental implants for full-arch treatments, it is not uncommon for a variety of surgeries and other specialty treatments to be used to achieve a final prosthetic outcome. The case shown in **Figure 10** was treated by the primary author eight years ago and was the result of traditional dental implant treatment planning. This particular case required bilateral maxillary sinus lifts, multiple maxillary anterior block grafts, multiple extractions, bilateral mandibular ridge splits, multiple connective tissue grafts, 14 dental implants, extensive prosthodontic restorations, and various other smaller restorations. Total treatment time for this case was approximately 18 months and required a significant number of office visits. During the healing phase, the patient was required to wear removable prostheses that were adjusted to relieve pressure on surgical sites. Although the final result was outstanding, one must consider the fact that although the patient had invested significant time and money into his treatment, he still had a number of natural teeth remaining that may require additional treatment in the future.

Although it is impressive that the patient was able to maintain a number of his natural teeth with the treatment he received, would this type of treatment remain the best option for him today? Just as a number of dental implant studies in the 1990s demonstrated the long-term success and predictability of single-unit dental implants, multiple long-term studies now have documented the long-term success and predictability of All-on-4 dental implant treatment.[37,38] Had this patient undergone this treatment, he would not have needed any bone or soft tissue augmentation procedures, and the total number of dental implants he received would have been reduced significantly. In addition, instead of undergoing multiple dental surgeries and sedations, he would have required only a single surgery and never would have had to wear any type of removable prosthesis. Total treatment time would have been reduced by ap-

proximately one year, and the patient would not have to worry about possible future treatment for his remaining natural teeth. Esthetics with the four-implant restorations would match perfectly because all teeth in these restorations are crafted simultaneously in a laboratory setting, compared with the patient having a combination of natural and individual implant restorations. Finally, total costs for the four-implant treatment option would have been significantly lower than the total combined costs for the traditional manner in which the patient was treated. In a recent study by Babbush and colleagues, these same patient-related variables were evaluated longitudinally, comparing patients treated with the All-on-4 concept versus those treated in a traditional manner with dental implants.[39] The conclusions of this particular study noted that "when implant rehabilitation of the total jaw is sought, the All-on-4 treatment concept should be considered the least costly and least time-consuming treatment option."

Case Report

The following case report demonstrates the aforementioned paradigm shift in treatment planning regarding traditional dental implant therapy versus All-on-4 therapy. This particular case is unique due to a substantial alveolar ridge defect, which compromised the nasal floor. Not only was there a dramatic intraoral alveolar defect making dental implant therapy a challenge, but there also was a substantial extraoral deficiency that compromised facial esthetics.

Examination and Findings

A 54-year-old female presented with the chief complaint of a loose front tooth and the possibility of an infection. Upon clinical examination, #9, #11, and #12, which were components of an FPD, had Class III mobility and suppuration at probing **(Fig 11)**. Radiographically, these three teeth showed indications of severe bone loss **(Figs 12 & 13)**. The bone loss on #9 was so severe that it compromised the floor of the nasal cavity. Because of the significant bone loss in the anterior maxilla, the patient had a collapsed upper lip, which negatively affected her physical appearance **(Fig 14)**.

Initial Surgery

The plan was to eliminate the source of dental infection and reconstruct the osseous defect of the anterior maxilla. After local anesthesia was achieved, a full-thickness mucogingival flap was reflected, and #9, #11, and #12 were extracted. After degranulation of the infected areas, substantial bone loss was noted in the anterior maxilla, with both vertical and horizontal deficiencies **(Fig 15)**. A pair of titanium

Figure 10: Panoramic radiograph demonstrating traditional method of full-mouth dental implant rehabilitation that required multiple surgeries and extensive healing time.

Figure 11: Initial clinical presentation of patient demonstrating severe hard and soft tissue defects in the anterior maxilla.

> **"Often, providers are so focused on the treatment that they do not adequately attend to the patient's concerns and desires."**

Figure 12: Initial radiographic presentation of patient demonstrating severe bone loss associated with tooth #9 and site 10.

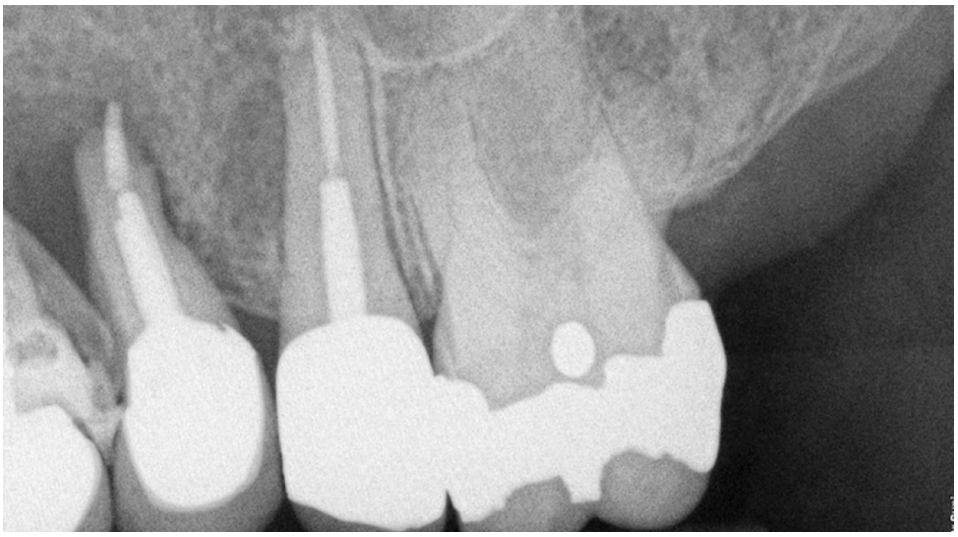

Figure 13: Initial radiographic presentation of patient demonstrating severe bone loss associated with #11 and #12.

tenting screws (Salvin Dental Specialties; Charlotte; NC) was fixed to the osseous defects **(Fig 16)** for space maintenance and support of an osseous graft. Freeze-dried bone allograft (Creos, Nobel Biocare; Yorba Linda, CA) was mixed with autogenously derived platelet-rich fibrin and packed around the tenting screws **(Fig 17)**. Dermal allograft was used to cover the osseous graft **(Fig 18)**, and the mucogingival flaps were reapproximated after a periosteal releasing incision **(Fig 19)**. Healing after the initial surgery was uneventful.

Treatment Options

After four months of healing, the maxillary anterior ridge demonstrated satisfactory clinical results, with increases in both horizontal and vertical dimensions **(Figs 20 & 21)**. Substantial bone growth was shown radiographically, with vertical fill of up to nine screw threads **(Figs 22-24)**. At this point, two treatment options were considered, representing the traditional manner of dental implant treatment versus the paradigm shift therapy. Treatment option 1 would require conserving as many remaining teeth as possible while replacing missing teeth with dental implants supported sites at #9, #11, and #12 for an implant-supported FPD. New crowns would be placed on #4, #5, #8, #13, and #14, and a connective tissue graft would be required for #7. Treatment option 2, representing All-on-4 treatment planning for the maxilla, would call for removal of all remaining natural teeth, placement of at least four dental implants, and immediate restoration with a transitional full-arch prosthesis. After four months of healing, the transitional prosthesis would be replaced with a permanent full-arch zirconia restoration.

Although treatment of the mandible was discussed with the patient, she did not desire nor could she afford it at the time. Comparing the two treatment options, the patient did not like the fact that many of her remaining natural teeth might need

Figure 14: Initial extraoral presentation of patient demonstrating unesthetic loss of facial support due to severe anterior maxillary bony defect.

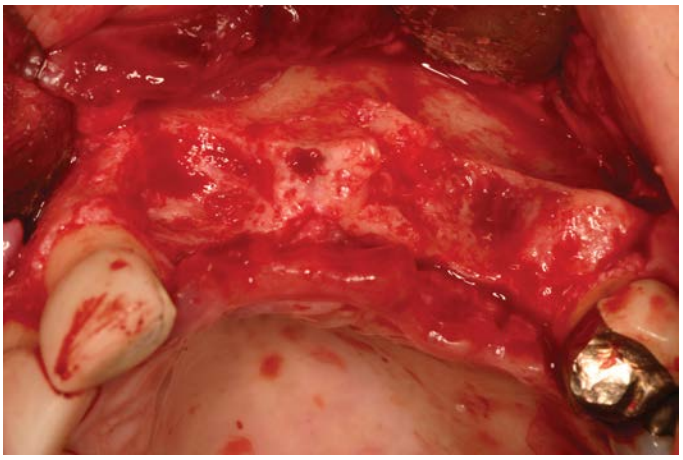

Figure 15: Severe alveolar defect in the anterior maxilla after removal of non-restorable #9, #11, and #12.

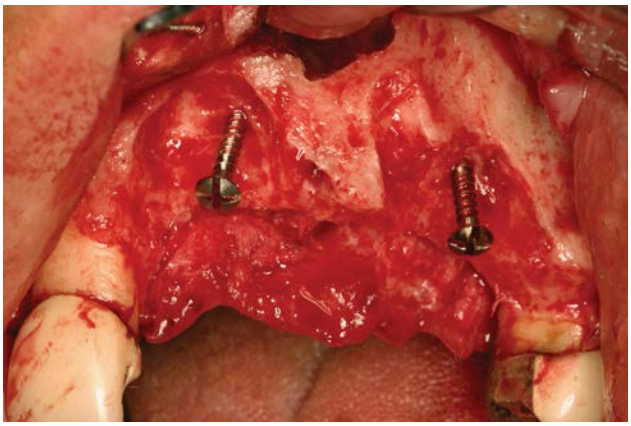

Figure 16: Placement of two tenting screws in the anterior maxillary alveolar defect to provide space maintenance support for guided bone regeneration.

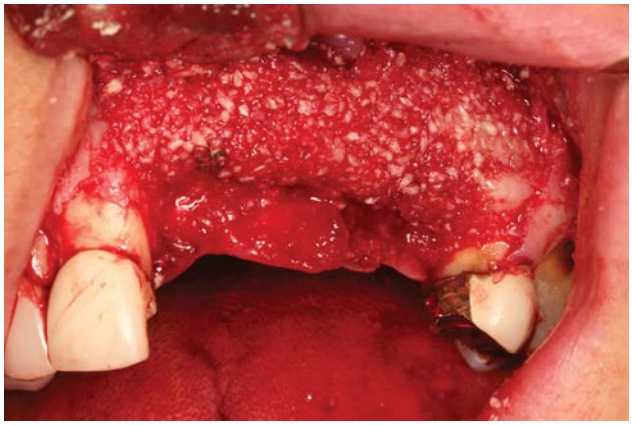

Figure 17: Placement of bone allogaft to height of tenting screws.

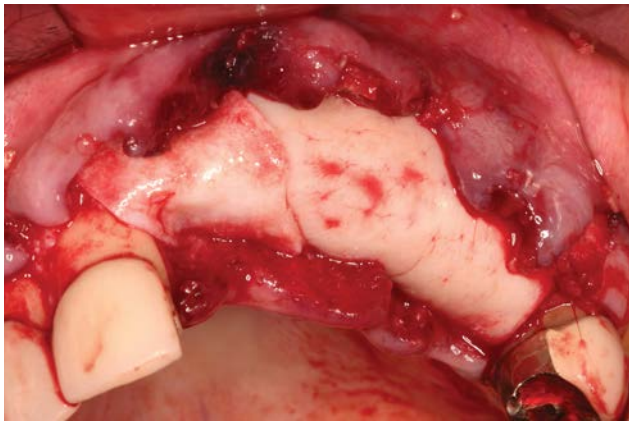

Figure 18: Placement of dermal allograft to serve as a guided bone regeneration barrier and to provide soft tissue augmentation of the surgical site.

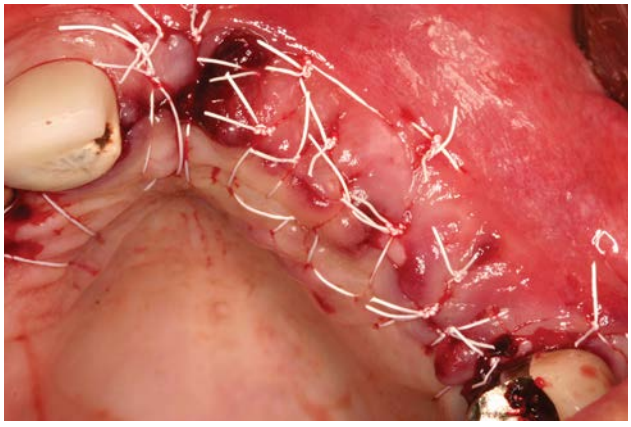

Figure 19: Primary closure of surgical site after periosteal-releasing incision.

Figure 20: Facial view of surgical site four months after guided bone regeneration surgery. Note improved vertical profile of the anterior maxilla.

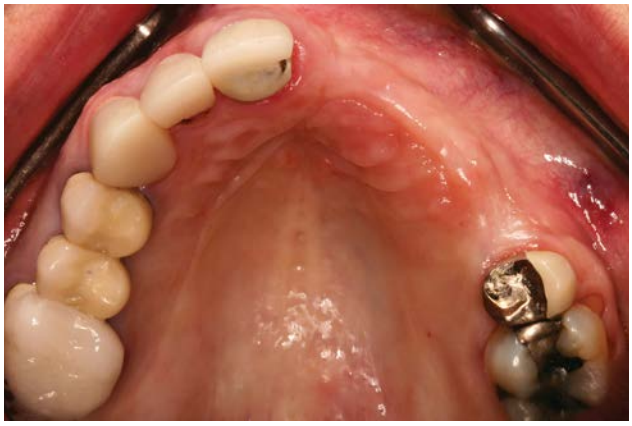

Figure 21: Occlusal view of surgical site four months after guided bone regeneration surgery. Note improved horizontal profile of the anterior maxilla.

Figure 22: Radiograph of anterior maxillary surgical site four months after guided bone regeneration surgery. New bone growth was noted up to nine threads on the anterior tenting screw.

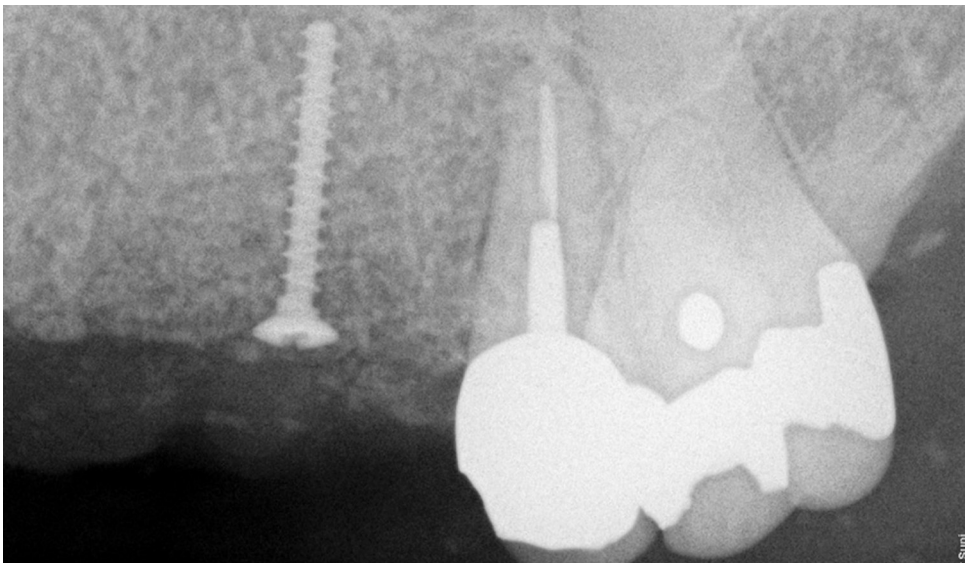

Figure 23: Radiograph of lateral maxillary surgical site four months after guided bone regeneration surgery. New bone growth was noted up to seven threads on the posterior tenting screw.

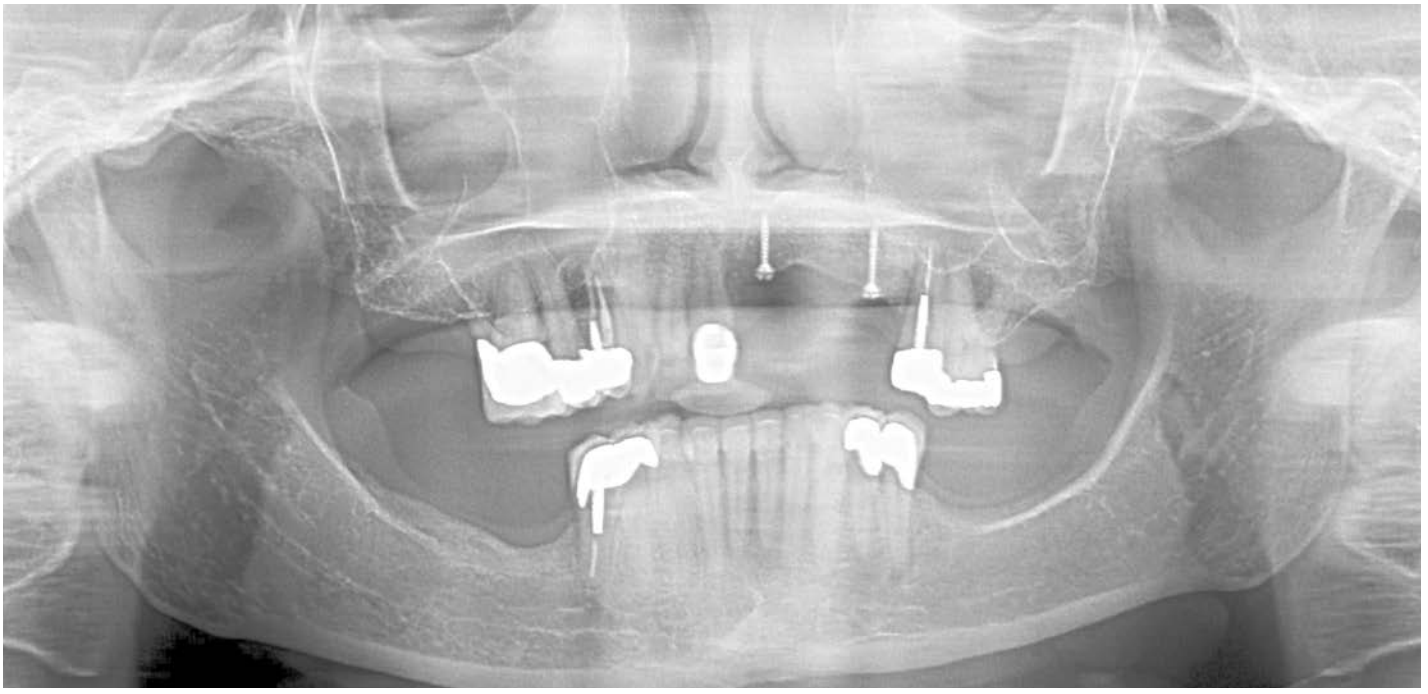

Figure 24: Panoramic radiograph four months after guided bone regeneration surgery in the anterior maxilla. Note the new bone formation to the heads of the tenting screws and the poor condition of the remaining maxillary teeth.

additional treatment in the future. Tooth #3 had moderate bone loss with distal furcation involvement, #13 had moderate bone loss, and #5 and #13 both had long-standing endodontic treatments with posts and a potential for fracture in the future. In addition, the patient did not like the fact that the implant-supported FPD was from #9 to #12 and would have significant vertical discrepancy in relation to her adjacent teeth because of the clinically significant nature of her bone loss at #9 through #12. Considering this situation, the patient elected to have the maxilla restored with the second treatment option.

Implant Planning and Placement

A CBCT scan was used to plan dental implant placement with a fixed guided stent (nSequence Center for Advanced Dentistry; Reno, NV). Because the patient had a significant amount of reconstructed bone and additional bone that appeared of questionable density on the CBCT scan, six dental implants were planned for placement. Although the All-on-4 treatment concept features the number "4," additional implants commonly are placed when dental implants achieve lower torque values during placement or if bone quality is deemed to be Type III or IV. After implant planning for guided surgery, the CBCT scan and planned surgery were used to prepare a premade transitional restoration. At the implant placement surgical procedure, local anesthesia was achieved and a full-thickness flap was reflected, revealing substantial bone regeneration around the titanium tenting screws **(Fig 25)**. After the removal of all remaining maxillary teeth **(Fig 26)**, all sockets were degranulated with hand instruments, and alveoplasty was performed with high-speed rotary burs. The CBCT-guided implant stent was fixed to the maxillary arch **(Fig 27)**, and six dental implants (NobelActive, Nobel Biocare) were delivered. Healing abutments were placed onto the dental implants, and the mucogingival flap was closed with 4-0 chromic gut sutures (Ethicon; Blue Ash, OH).

Immediately after the surgical procedure, the prosthodontist prepared the transitional prosthesis, which was prefabricated by a third-party company based on the CBCT scan (nSequence) for immediate attachment to the dental implants **(Figs 28 & 29)**. Four of the healing abutments were removed from the dental implants, and transitional copings were placed. The prefabricated transitional prosthesis was placed over the copings and luted with acrylic (Jet Denture Acrylic, Lang Dental; Wheeling, IL). Once the acrylic was set, the transitional prosthesis was unscrewed and finished in the laboratory. The transitional prosthesis was then reseated with radiographic confirmation onto the dental implants by using a torque of 15 Ncm, and

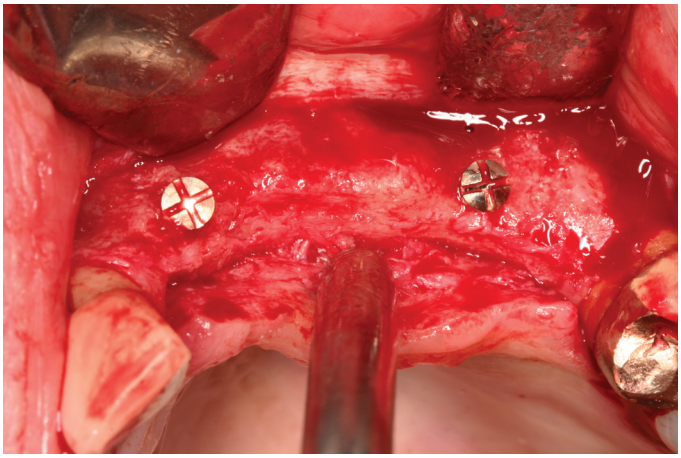

Figure 25: Clinical view of new bone formation to the head of the tenting screws after initial full-thickness flap reflection.

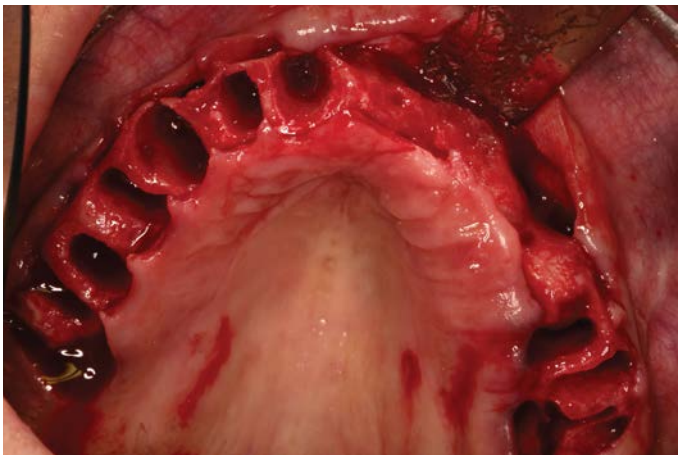

Figure 26: Clinical view of the maxillary arch after extraction of all remaining teeth and removal of tenting screws.

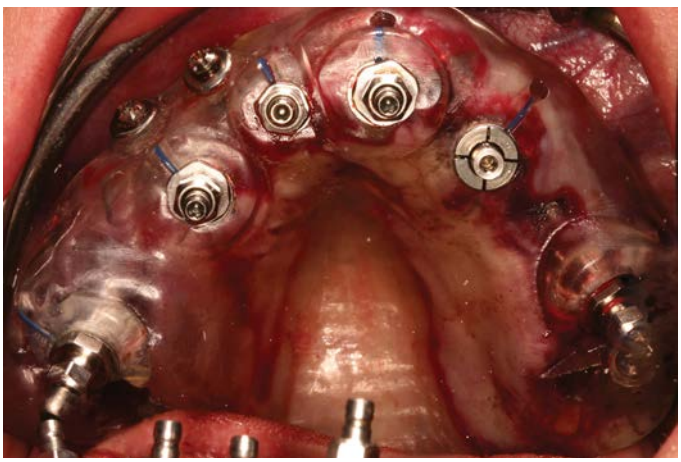

Figure 27: Guided surgery stent fixed to the maxillary arch to facilitate placement of dental implants.

Figure 28: Prefabricated transitional prosthesis (facial view) with additional pink acrylic added at site of initial maxillary ridge defect.

Figure 29: Prefabricated transitional prosthesis (occlusal view) with pre-drilled access holes for transitional coping access.

occlusion was adjusted **(Figs 30-32)**. After seating of the transitional prosthesis, the patient's appearance changed dramatically **(Figs 33 & 34)**.

The patient wore the transitional prosthesis for four months. During this time, the patient was told she could eat anything that she could cut with a fork. Oral hygiene was achieved with traditional brushing, and a Waterpik (Water Pik; Fort Collins, CO) was used for irrigation beneath the transitional prosthesis. After four months of healing, the transitional prosthesis was removed, the gingival tissue was checked for any necessary adjustments, and all abutments were retorqued. Impressions were taken for fabrication of the final prosthesis, and shades were selected for both the teeth and gingival tissues **(Fig 35)**. A milled zirconia full-arch restoration was fabricated **(Fig 36)** and attached to the dental implants **(Fig 37)**. The patient was happy with the results of the final restoration **(Fig 38)** and plans on having a similar procedure performed on her mandible in the near future.

Summary

This patient was treated with the All-on-4 treatment concept rather than traditional dental implant therapy, and a highly esthetic outcome was achieved in terms of both dentition display and improved facial support. Fewer surgeries were required, and total treatment costs were reduced. This case demonstrates the paradigm shift in thinking for full-arch dental implant treatment planning and the highly esthetic outcomes that can be achieved with this treatment concept.

Figure 30: Transitional prosthesis (occlusal view) delivered immediately after placement of dental implants.

Figure 31: Transitional prosthesis (facial view) delivered immediately after placement of dental implants.

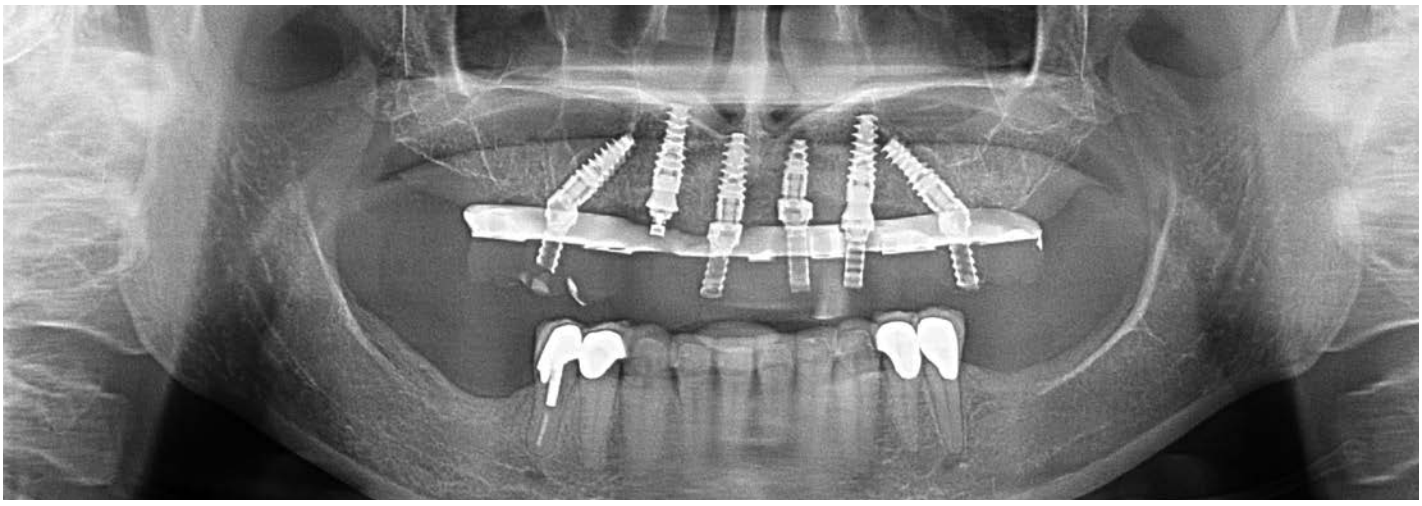

Figure 32: Radiographic confirmation of transitional prosthesis seating.

Figure 33: Patient before surgical procedure for placement of dental implants and immediate transitional prosthesis delivery.

Figure 34: Patient with transitional prosthesis in place. Note improvement of the patient's smile and extraoral soft tissue support.

Figure 35: Gingival shade selection before delivery of final zirconia prosthesis.

Figure 36: Final all-zirconia prosthesis before delivery.

Figure 37: Final all-zirconia prosthesis immediately after delivery.

Figure 38: Patient with final all-zirconia prosthesis. Note improvement of the smile and extraoral soft tissue support.

Crucial Importance of the Initial Patient Evaluation

The initial patient evaluation appointment is one of the most important of the entire treatment process for extensive and complex implant-supported restorations. This appointment sets the tone for patient expectations and is critical for establishing rapport and understanding between the patient and the provider. Often, providers are so focused on the treatment that they do not adequately attend to the patient's concerns and desires. The initial appointment should begin with discussion of the patient's chief complaint and outcome desires. Is the patient seeking improved function, improved esthetics, or both? If the patient is seeking improved esthetics, what are the patient's expectations? Is the patient a 55-year-old who wants to look the way he or she did at age 20? Does the patient wish to look like a particular celebrity? Patient desires must be the first item of discussion so that the provider can determine whether these expectations can be met during the treatment process.

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"With the use of dental implants for full-arch treatments, it is not uncommon for a variety of surgeries and other specialty treatments to be used to achieve a final prosthetic outcome."

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Disclosure: Dr. Holtzclaw receives honoraria from Nobel Biocare for lecturing on the All-on-4™ technique.

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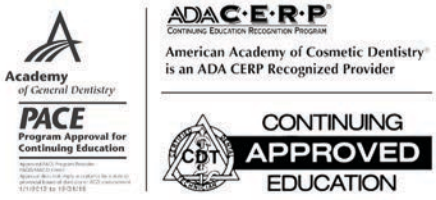

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Implant Restorative (Implants)

AGD Subject Code: 695

The 10 multiple-choice questions for this Continuing Education (CE) self-instruction exam are based on the article, *"Dental Implant Treatment for Functional and Esthetic Improvement in the Maxillary Arch: A Case Report,"* by Dan Holtzclaw, DDS, MS; Ace Jovanovski, DMD, MCDT; and Gregg Ueckert, DDS. This article appears on pages 122-137.

The examination is free of charge and available to AACD members only. AACD members must log onto www.aacd.com to take the exam. **Note that only Questions 1 through 5 appear in the printed and digital versions of the *jCD*; they are for readers' information only.** The complete, official self-instruction exam is available online only—completed exams submitted any other way will not be accepted or processed. A current web browser is necessary to complete the exam; no special software is needed. The AACD is a recognized credit provider for the Academy of General Dentistry, American Dental Association, and National Association of Dental Laboratories. For any questions regarding this self-instruction exam, call the AACD at 800.543.9220 or 608.222.8583.

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1. Diagnostic considerations for extensive full-arch reconstructive dentistry with implant-supported prosthetics should begin with:

a. upper and lower impressions and an accurate centric relation occlusal record.
b. a diagnostic wax-up to evaluate treatment options.
c. cone beam computed tomography (CBCT) scan and evaluation.
d. a review of the patient's expectations and goals.

2. CBCT scans:

a. allow evaluation of alveolar profiles.
b. are only needed when teeth are to be extracted.
c. are not useful for native host bone evaluation.
d. allow for evaluation of soft tissue profiles.

3. In cases of extensive alveolar deficiencies in the All-on-4 technique,

a. substantial bone augmentation is required.
b. substantial soft tissue augmentation is required.
c. bone is reduced horizontally with a low-speed handpiece and copious saline solution.
d. bone is reduced vertically with high-speed surgical instruments.

4. The bone shaping that is completed for the All-on-4 technique is best described as:

a. a "no-bone solution," as no bone grafting is usually required.
b. rounding of the alveolar ridge to create an improved denture base.
c. shaping to create an "All-on-4 Shelf" prior to implant placement.
d. shaping to create retentive areas following implant placement.

5. Bone reduction as part of full-arch implant reconstruction:

a. should be avoided whenever possible in the mandibular arch.
b. should only be done to remove undesirable or sharp areas.
c. will decrease the likelihood of denture sores.
d. helps create necessary prosthetic space for implant reconstruction.

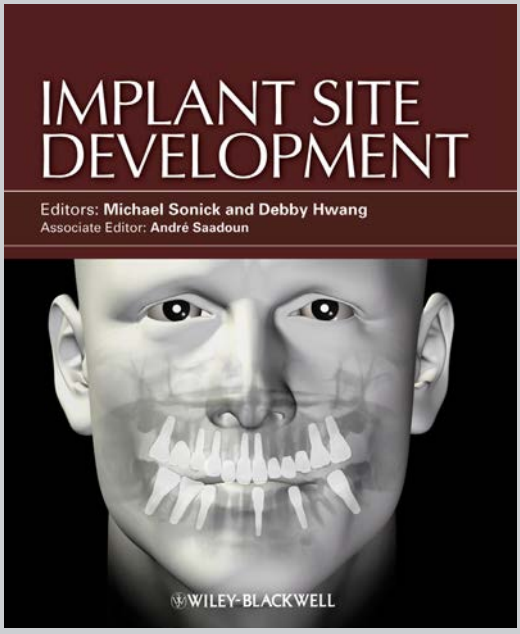
To see and take the complete exam, log onto www.aacd.com.

jCD Book Review

> **"...it is useful for all practitioners, ranging from general dentists to prosthodontists, and especially surgeons."**

The *Journal of Cosmetic Dentistry*'s Book Review is an opinion piece by *jCD* reviewers. It highlights works that are currently available from publishers in the dental industry.

Title: *Implant Site Development*
Editors: Michael Sonick & Debby Hwang
Associate Editor: André Saadoun
Publisher: Wiley-Blackwell



Implant Site Development is a comprehensive work regarding the latest innovations in implant dentistry and soft tissue/bone regeneration. Written by clinicians who are world renowned for patient care and teaching, it is useful for all practitioners, ranging from general dentists to prosthodontists, and especially surgeons.

It has been said about implant restorations that, "The tissue is the issue, but the bone sets the tone." The wonderful thing about this work is that it builds foundationally to address more complex osseous enhancements. The book is laid out logically, beginning with bone biology, anatomy, and treatment algorithms, and leads into CBCT diagnostics/treatment planning. This sets the stage for meticulously written and photographed descriptions of socket preservation; and guided bone regeneration concepts and treatments ranging from sinus elevations to very elaborate, complex vertical and horizontal defect augmentations, many using growth factor technology. There also is an excellent chapter documenting detailed step-by-step soft tissue development with provisional and definitive implant restorations. In addition, each chapter provides a thorough review of the evidence and extensive bibliography.

Given the premise of hard and soft tissue augmentation, it is fair to expect a focus on surgical intervention. However, the text would have benefited from more emphasis placed upon prosthodontic principles and treatment outcomes. Lastly, given the ever-expanding area of growth factors and bioengineering, the chapter presented deserves a more expansive level of detail.

With the use of implant therapy continuing to increase, *Implant Site Development* provides interdisciplinary knowledge and skills that are essential for every dedicated practitioner to have as a reference.

A Special Gift for *jCD* Readers:

Take advantage of a special offer from Wiley-Blackwell! As an AACD member, you can receive a preview download of *Implant Site Development* and 20% off the regular price. Simply enter promo code VBF09 at checkout. To take advantage of this discount, visit: http://www.wiley.com

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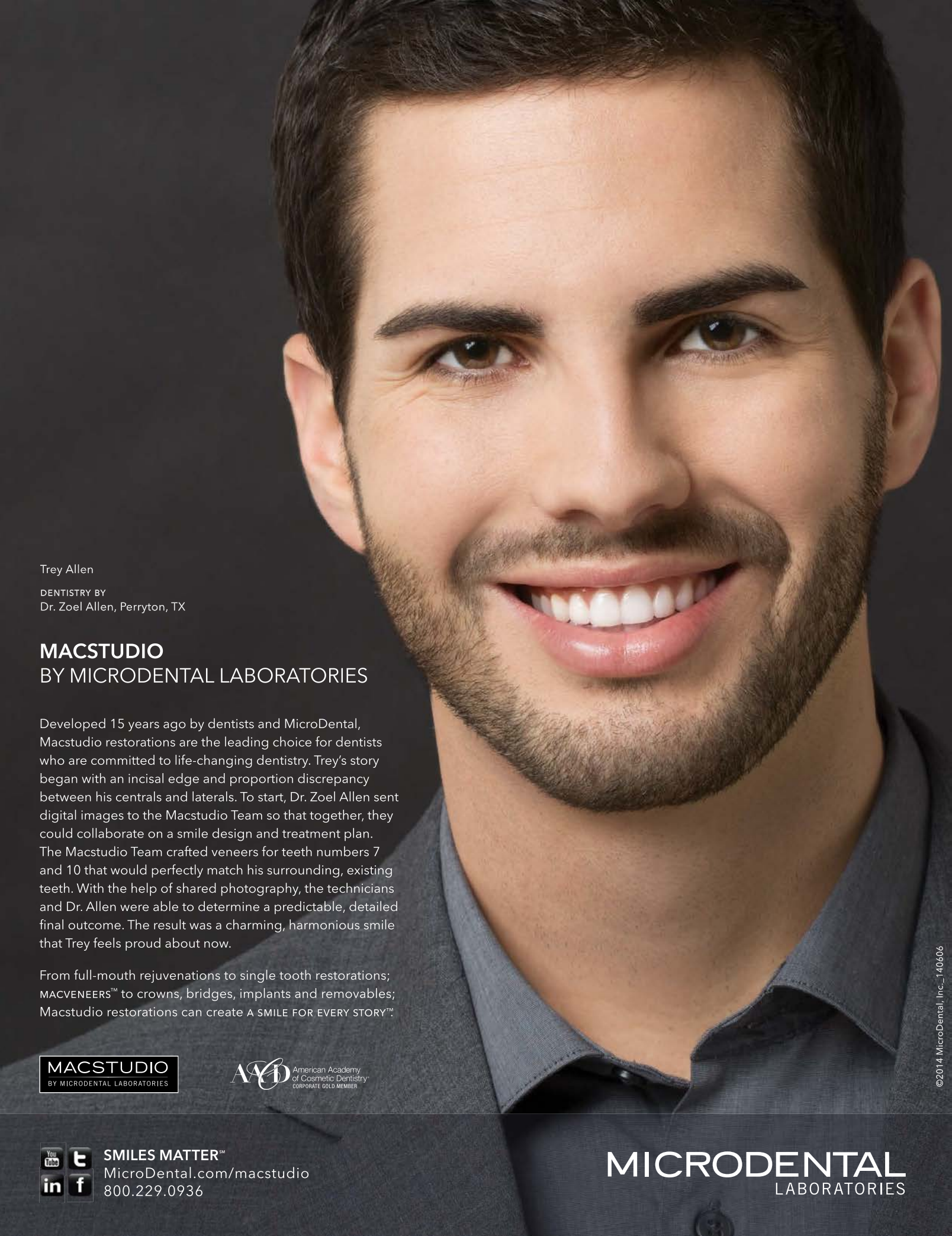

Trey Allen

DENTISTRY BY
Dr. Zoel Allen, Perryton, TX

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