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The mission of the Journal of Cosmetic Dentistry is to educate AACD members, as well as other professionals in the field, on the art and science of cosmetic dentistry. We will endeavor to do this by publishing well-researched, peer-reviewed articles accompanied by high-quality, comprehensive clinical imagery. The objective is to enhance readers’ knowledge and skills while showcasing the latest cosmetic techniques and procedures. The Journal of Cosmetic Dentistry will strive to help readers become better clinicians, so they can offer their patients the best—and most responsible—treatment possible.

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Features

42 Clinical Cover Case
Severe Malocclusion:
The Importance of Appropriately Timed Treatment
David M. Sarver, DMD, MS

54 Laminate Veneers & Flapless Crown Lengthening
Cristiano Soares, CDT
Luciana Mara Soares, DDS, MSc
Guilherme Ferreira Duarte, DDS, MSc

70 Different Materials for Different Situations (CE article)
Alexandre dos Santos, CDT
Milko Villarroel, DDS, MS, PhD
Andrea Sousa Villarroel DDS, MS, PhD
Diana Garrigós Portales, DDS

82 AACD Self-Instruction
Continuing Education

Column

8 Editor’s Message
Time Well Spent...
Edward Lowe, DMD, AAACD

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Departments

10 Behind the Cover Smile
Worth the Wait! ✶
David M. Sarver, DMD, MS

14 Scientific Session—Toronto 2016
Orthodontics & Esthetic Dentistry:
Mission Possible! ✶
David M. Sarver, DMD, MS

28 Accreditation Essentials
Don’t Gamble in the Anterior Zone ✶
Paul E. VreNon, DDS, MAGD

38 Examiners’ Commentary ✶
Replicating Nature with a Dental Implant
James H. Peyton, DDS, FAACD

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When I became editor of the *Journal of Cosmetic Dentistry (jCD)* five years ago, I was excited yet a bit apprehensive about how to fit this new opportunity into my already bursting schedule. While writing my first *jCD* editorial, I thought, “Why am I doing this?” The answer might surprise you.

I have been fortunate to have had many mentors who generously shared their time and expertise with me. We all have been influenced by an educator who has made a significant impact on our careers and our lives.

My first article in the dental literature was published 18 years ago. I was a novice at using photography to document a case. The use of retractors to hold the lips and unveil the teeth, framing and cropping the shot through the camera viewfinder, and utilizing mirrors to capture full arches all were foreign to me. My assistant and I felt like awkward dance partners as we “waltzed” around the patient’s mouth. (Remember, we did not then have the benefit of the many great technological features of today’s digital cameras.) After discarding the slides in which the tongue was in the way of the teeth, the mirror was fogged up, or the patient’s eyes were closed, I pieced together the few good images that came out of the photo shoot. Then came the daunting task of writing the article.

Writing about a technique you have done is easy. Making the manuscript flow in a logical and readable manner is not. Eventually, I had my first draft. Even though it was just one page, I was proud to have produced something to share with my colleagues.

What I got out of writing that article was an education and new skills to provide my patients with better care. I knew the topic inside out. I had read the reference articles used in my bibliography and absorbed their information. I gained experience in dental photography. It was, in my opinion, time well spent.

With your help, I hope to see the *jCD* develop into an even finer publication than it already is, with significant contributions from authors worldwide. Some of you have great ideas and want to have an article published in the journal but don’t know where to begin or whom to turn to for guidance.

With the help of a mentor, I learned the importance of documentation in helping to educate others. There is no better way for me to “pay it forward” than to help *jCD* readers to become *jCD* authors. Whether it is your first or your fiftieth article, the journal’s editorial team and I are here to help you bring it to life for the professional enrichment of your colleagues.

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Edward Lowe, DMD, AAACD
Editor-in-Chief
"Being able to provide my patients with amazing results, meeting their specific requirements for health and esthetics is what I love about dentistry. And as a dentist, we all know we can’t do it alone - we need a great team and I’m proud to say I know the people at LK Dental Studio quite well. They feel the same way about my patients as I do, and I appreciate their talent, expertise, and dedication."

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"I didn’t know it was possible at the time to change my life with a smile makeover, but three years later I am more confident and outgoing, I reach out more to people, laugh bigger and smile brighter than I ever had before. I used to hide my smile, feeling my teeth were too small and dark. Deciding to move forward and improve my smile was one of the best, life enhancing decision I have ever made! I consider myself a positive, healthy person and now I feel like my smile really says it all! Thank you Dr. Miller and LK Dental Studio!"

TRACY, actual patient of Dr. Stephen Miller
By the time I met Jason he had already learned how to minimize the skeletal issues that were making him a source of ridicule (turn to page 42). He was in elementary school and just beginning to experience the verbal abuse to which children with facial deformities are all too often subjected. When I presented my treatment plan there was no question in his mind (or his parents’) that it was the right course of action. He almost ripped the arm off the chair in my office when he heard the necessary orthognathic surgery would have to wait until he was finished growing, because it felt as if I had just taken away the thing he wanted most in life.

Jason is from a close-knit family and his brothers would often come to his defense when kids taunted him about the way he looked. But no matter how careful he was to disguise his jaw in photos and when interacting with others, the problems were obvious. For example, when he bit down to swallow or while eating, one kid would call him “bitter beer face.” For Jason, surgery couldn’t come soon enough, but he would have to get through high school before the procedure could take place.

His family was gathered around when the bandages came off, and everyone was astounded by the transformation. They all felt they were finally seeing the “real” version of Jason, where what they saw on the outside matched the amazing young man on the inside. He began a new chapter in his life at college, running for student government and engaging in life in ways he had never considered before his treatment was complete.

Jason’s father, reflecting back on life before and after his son’s surgery, said, “He became a stronger individual as a result of all he went through and that is an interesting life lesson.” Today, Jason is a successful young professional. He is very confident, comfortable in his own skin, and recently took a job in Sydney, Australia. We keep in touch and I’m very proud—not only of his case, but also of all that he has done to seize life’s opportunities.

To learn more about this patient’s treatment, turn to the Clinical Cover Case on page 42. To read about other clinical cases completed by Dr. Sarver, turn to page 14.

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"Before" retracted smile.

"After" retracted smile.
His family was gathered around when the bandages came off, and everyone was astounded by the transformation.
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Abstract
For decades, dentistry has been evolving into a profession that is extremely multifaceted and varied in its approach to both smile and facial esthetics. The coordination of macro esthetics (the face), mini esthetics (the smile), and micro esthetics (the dental esthetic component) offers a complete approach to esthetic planning. This article presents an expanded vision of esthetic treatment designed to take readers to another level of facial, smile, and dental esthetic planning that can elevate patient outcomes.

Key Words: macro esthetics, mini esthetics, micro esthetics, orthodontics, smile design
Figure 1: In both multidisciplinary and orthodontic diagnosis, three esthetic divisions are advocated: macro esthetics (the face), mini esthetics (the smile), and micro esthetics (the teeth).

...there are principles of cosmetic dentistry that orthodontists can use to enhance their work to provide a superior esthetic outcome.
Introduction
Patients seeking esthetic treatment today wish to enhance their appearance for improved self-esteem and quality of life. I advocate use of the term appearance in conjunction with the term esthetics because it involves a broader assessment of the patient than just the smile (the esthetics of the smile is important, but the patient’s appearance is how they look to others).

Interdisciplinary treatment has become a very important part of the practice of dentistry, and the possibilities for a more inclusive approach to diagnosis and treatment have expanded at an exponential rate. What we can offer our patients now is so much more than just smile design. While patients may seek to correct their bite or other functional issues, the fact is that a great majority of patients are coming to our offices to enhance the appearance of their dentition, smile, and face.

Dental and orthodontic diagnosis and treatment planning have merged much more closely over the past decade. This article and my presentation in Toronto will describe how, in orthodontic diagnosis and treatment planning, I have created an approach to evaluation divided into three categories (Fig 1). The descriptive process was arrived at by borrowing a set of terms from Morley and Eubank in which they described the macro esthetics of smile design.1 I have expanded it to include a broader approach to esthetic treatment.2 The three major divisions are as follows:

- **macro esthetics** (the profile and vertical facial dimensions, i.e., the face)
- **mini esthetics** (the smile’s attributes, e.g., buccal corridors, smile arc, incisor display)
- **micro esthetics** (the teeth and their many attributes, e.g., contacts and connectors, embrasures, gingival shape and contour).

The key in this fundamental approach to esthetic analysis is the systematic analysis of all the facial and smile components, both anatomically static and functionally dynamic. This leads to a greater appreciation of the subtle interactions of each of the facial elements and how each can be appropriately managed through a unified treatment approach.

In cosmetic dentistry, orthodontics, and orthognathic surgery, if the esthetic outcome is not satisfactory to the patient they consider our work a failure. Orthodontists do not perform cosmetic dental procedures such as composite bonding, veneers, and crowns. However, we all recognize that in some instances when orthodontic treatment is completed, not all smiles look “right.” Not all patients want or can afford veneers, and certainly not all need them. But there are principles of cosmetic dentistry that orthodontists can follow to enhance their work to provide a superior esthetic outcome.3

This article’s goal is to illustrate how orthodontics has incorporated the principles of smile design from esthetic dentistry into how we treat our orthodontic patients. Of greater interest to the esthetic dental audience, however, is how a well-planned, well-coordinated multidisciplinary treatment plan can yield results that are exponentially greater than what one individual can achieve. It is important for all members of the interdisciplinary team to understand what the other members bring to the table in terms of enhancing the overall outcome. This mutual understanding of each other’s capabilities and responsibilities facilitates synchronization of the overall treatment plan to deliver the best outcome with a minimal amount of time and burden for the patient. I believe that this works best if the team has a “quarterback.” The football quarterback knows what routes the receivers are going to run, where the left guard is going, what the right guard’s duties are, and what the other team’s defense is presenting to them. That adds up to a winning team, and the selected interdisciplinary team “quarterback” should have that depth of understanding to be able to effectively solve problems.

**What we can offer our patients now is so much more than just smile design.**
Case 1: Proclined Anterior Teeth

Imagine a patient who has undergone routine orthodontic treatment. Class I occlusion is obtained, and the teeth are nice and straight. Despite this, however, the smile simply does not look “right.” Is the only answer cosmetic enhancement via veneers? Or are there things that we as orthodontists can do as part of our treatment, first learning then utilizing the principles of cosmetic dental smile design to deliver a better result? The 22-year-old patient shown in Figure 2 had received orthodontic treatment as an adolescent, and was not pleased with her smile outcome. A mini esthetic analysis identified the smile elements that fell short of ideal: an incomplete incisor display and a flat smile arc4-6 (Fig 3). She had also noticed that her anterior teeth were proclined, or flared anteriorly (Fig 4).

Our office’s routine records include the oblique view in our photographic images because it reflects the way patients are seen by others, in contrast to the usual imagery in orthodontic and esthetic dental practices, which depicts the frontal smile only. In orthodontics, the most common way to address the issue of upright or proclined incisors is through premolar extraction to create space to retract the incisors and upright them. Due to profile considerations, however, this was not an acceptable option for this patient, so we recommended tooth size reduction through enameloplasty to create the space needed to upright the incisors sufficiently. This is an excellent option in selected cases where the teeth are of appropriate size and shape to benefit from the reshaping.7

The first step was to orthodontically align the teeth and eliminate all rotations, because they made it difficult to accurately judge the true width of the anterior teeth. Once initial alignment was achieved, we assessed the height-to-width ratio, incisal and gingival embrasures, connector lengths, and general shape and contour of the incisors. Then, using an air-rotor stripping bur, we performed interproximal reduction to create space and to esthetically reshape the teeth. Because the patient had previously undergone orthodontic treatment and had no overjet, the mandibular incisors were also reduced in width (Fig 5). The teeth were reshaped using the air-rotor stripping bur and the resulting space was orthodontically closed. The teeth can be reshaped by the esthetic dentist but I prefer to manage this myself because, prior to treatment, I have already visualized where I will be moving the tooth, and the esthetic dentist would have to guess as to what my plan was. In addition, enameloplasty is performed incrementally, because once enamel is removed it cannot be put back. For example, we may remove some of

Figure 2: Having undergone orthodontic treatment during adolescence, this 22-year-old patient had grown displeased with her smile.

Figure 3: Her mini esthetic analysis demonstrated incomplete incisor display and a flat smile arc. The smile arc is defined as the curvature of the maxillary occlusal plane and anterior teeth (yellow line) relative to the curvature of the lower lip (white line). In the ideal smile arc the two are consonant, or parallel.

Figure 4: This 45-degree angle, or “social” view, shows clearly that the maxillary incisors were proclined, or flared anteriorly. This is considered unesthetic by most people.
the width of the tooth, close the space, and then reassess for further enamelplasty. Also, it is important for orthodontists to note that in this particular case the space closure was done on round wire so that the incisors rotated palatally around the rotation point in such a way as to upright the teeth, which also increased the incisor display (Fig 6). The final outcome was a dramatic improvement in smile esthetics (Figs 7a-7c).

**Synchronization Plan**

Synchronization with the dental office in this case was fairly minimal because there were no veneers or any other type of cosmetic dentistry planned. The anterior teeth can be reshaped by the orthodontist or by the dentist. If either of them is reluctant to reshape teeth, we recommend that a “set-up” be performed first. This is similar to a wax-up, but a set-up is performed by creating plaster models of the patient’s existing teeth and segmenting each tooth so that they can be reshaped, reset, and waxed to the proper position. This serves as a “virtual walk-through” of the procedure before any enamel is permanently altered. The important point is that the teeth be completely aligned so that visualization of tooth proportionality is accurate before any reshaping is done. Once orthodontic treatment is complete, a normal retention pattern is implemented with a Hawley retainer or Essex-type retainer.

**Take-Home Message**

Rather than just “straightening teeth,” the principles of esthetics were applied in an orthodontic case with the goal of taking the outcome from good to great. Orthodontic treatment was utilized versus veneers, leaving the patient with an intact tooth structure, the option that most of us would want for our children.

**Figure 5:** Enamelplasty of the maxillary incisors was planned to improve the height-to-width ratio and lengthen the connectors, thus reducing the large incisal embrasures. Because the patient had no overjet, reshaping was extended to the lower incisors as well as the maxillary incisors to accommodate retraction of the latter.

**Figure 6:** This illustration demonstrates how subsequent space closure after enamelplasty results in retraction of the maxillary incisors. The incisors rotate palatally on round wire in such a way as to increase incisor display and improve the smile arc.

**Figure 7a:** The patient’s dramatically improved smile esthetics.

**Figure 7b:** The close-up smile image demonstrates the increased incisor display, improved proportionality, and improved smile arc.

**Figure 7c:** From the oblique view, the maxillary incisors were uprighted, and her concern about the flare of her anterior teeth was addressed successfully.
Case 2: Severely Worn Incisor and Short Lateral Incisors

The adult female patient shown in Figure 8 was referred by her dentist for preparation and placement of porcelain veneers. The severely worn upper left central incisor needed to be intruded, and the lateral incisors were disproportionately short (Fig 9). Her maxillary incisor alignment also fell short of an ideal smile arc. The dentist may utilize a mock-up and temporary try-in so the patient can get a feel for the esthetics and the functional aspects of the restoration. We often perform a computer mock-up on the initial visit to begin to model the patient’s idea of what might be accomplished, and also so we can visualize where to make recommendations and alterations. Computer imaging is also helpful in modeling the patient’s expectations. In this visual mock-up (Fig 10), we normalized gingival levels and lengthened the incisors to hit the ideal target, the smile arc. We initiated orthodontic alignment and, to facilitate visualization of where the patient was in treatment, we took a page from cosmetic dentistry and used crown formers and composite to add length to the four maxillary incisors. While her smile was greatly improved (Fig 11), we believed that by using some of the principles presented in the previous case, an even more outstanding result could be achieved. Therefore, we reduced the width of the maxillary incisors through enameloplasty (Fig 12) and closed space on a round wire to increase incisor display and the curvature of the anterior maxillary occlusal plane. In the final result, the incisor shape was excellent in all proportions (Fig 13) and the patient’s smile was enhanced dramatically (Figs 14a & 14b).

Synchronization Plan

To facilitate treatment with the dental office, we find it very useful to forward digital images of our temporary restorations to the dentist so they can see what was underneath the composite I placed and what tooth structure was underneath. In this way, they can exchange the temporary composite for more esthetic and durable materials.
Take-Home Message
Visualization is an exercise and skill that all esthetic dentists must possess. This case illustrates the use of digital imaging for visualization and serves as a powerful tool in communicating treatment goals to the patient. The wax-up process in dentistry is very common, as is the use of temporaries to assess speech, esthetics, and function before the final product is delivered. In our practice, the use of composite is called the “orthodontic mock-up” and is no different from mock-ups for veneers; it is simply transferred to the orthodontic arena. In the end, this patient’s dentist planned to replace the composite with much more esthetic materials and the patient is currently considering porcelain veneers. The prerestorative orthodontic phase accomplished two things of great benefit to the dentist: increased incisor display to work with and appropriate anterior tooth proportionality.

Figure 11: Composite was bonded to the incisal edges to allow evaluation of the incisal edges on smile, and to assess tooth size proportion. After orthodontic alignment, the gingival margins were placed vertically in the proper position, but the smile arc was still flat.

Figure 12: To improve the smile arc, interproximal enamelplasty was performed, resulting not only in the desired space to create space for retraction of the incisors, but also improved height-to-width relationships.

Figure 13: Final retracted image.

Figure 14a: Final full-face smile, with consonant smile arc and full incisor display.

Figure 14b: Final close-up smile, with ideal smile esthetics and tooth proportion.
Case 3: Diminished Incisor Display

This adult female patient wanted a more youthful smile, which we identified as necessitating more tooth display on smile (Figs 15a & 15b). In the initial evaluation, we offered her several options:

- orthodontics and orthognathic surgery to downgraft the anterior maxilla to provide greater incisor display
- porcelain veneers to add some length to the maxillary teeth
- a combination of orthodontics to extrude the maxillary anterior teeth, followed by veneers.

The patient did not wish to pursue the orthognathic option, and instead agreed to the use of orthodontic fixed appliances to extrude the maxillary incisors as much as possible (while simultaneously intruding the lower incisors). Midway through treatment, we evaluated the height-to-width ratio of her central incisors, noting that the maxillary central incisors were disproportionately wide with an excessive gingival embrasure (Fig 16). Adding length to the maxillary central incisors could improve the height-to-width ratio, but in looking at the shape of the teeth we recognized the sizable gingival embrasure. We added composite to the incisal edges (as in the orthodontic mock-up) and removed enamel on both the mesial and distal of the centrals (Fig 17). This yielded better tooth form, as well as space with which we could upright the maxillary incisors and increase incisor display (as in Case 1). When we believed the limit of maxillary anterior extrusion had been reached (Fig 18), we referred her to her dentist for wax-up and finalization of treatment. The dentist approved removal of the appliances and finished with maxillary porcelain veneers (Figs 19a & 19b).

Figure 15a: This patient presented desiring an improved smile, but could not be specific about what she did not like. We observed that upon smile, she had very limited incisor display.

Figure 15b: Upon clinical examination, she showed only 3 mm of incisor on smile, while her crown height was 9.5 mm.

Figure 16: The maxillary incisors had short connectors and large gingival embrasures because of the greater width of the central incisors.
Synchronization Plan
Once the maximum extrusion allowable in this patient’s alveolar bone had been reached, it was retained for three months before referring her to her dentist’s office for a final evaluation and wax-up if needed. The preparations were done and the temporaries fabricated as a single unit. Once the individual veneers were situated, we placed an Essix-type retainer that extended over the height of contour to maintain the vertical position of the incisors. Another option to ensure maintenance of extrusion is to, prior to impressions for an Essex retainer, place bonded attachments (much as in aligner-type cases) before the retainer impression is taken. Then, when the Essex retainer is fabricated, it engages these attachments when fully seated to maintain their vertical position.

Take-Home Message
When evaluating smiles, esthetic dentists might not often consider orthodontic extrusion or intrusion of incisors. Orthodontists routinely use these dentoalveolar movements in adolescents, but not very often in adult patients. However, alveolar bone is modifiable to a degree even in the adult, and may be considered an option in the multidisciplinary treatment plan.

Figure 17: In an orthodontic mock-up, composite was added temporarily to the incisal edge while enamelplasty was performed to reduce the width of the incisors.

Figure 18: When the limit of maxillary anterior extrusion had been reached, we referred the patient to her dentist for finalization and wax-up.

Figure 19a: Porcelain veneers were placed, with outstanding smile esthetics.

Figure 19b: The patient’s close-up smile demonstrates greatly increased incisor display and enhanced smile attributes.
Case 4: Congenitally Missing Maxillary Lateral Incisors

This adult female patient (Fig 20a) consulted a cosmetic dentist about the possibility of a smile makeover with veneers. She was referred to our office to see what we could do to improve the potential outcome. The patient was congenitally missing her maxillary lateral incisors. When she was an adolescent, an orthodontist had placed the canines in the lateral position and her dentist added composite to the mesial and the distal incisal edges to camouflage the canine tip, rendering an approximate incisor shape (Fig 20b). However, the width of the laterals was now greater than that of the centrals and the shade of these teeth was also darker, as happens in many canine substitution cases (Fig 21).

Our first step was to place fixed appliances and align the teeth prior to reshaping the canines. In reshaping the canines,9,10 we removed the composite material and visualized the shape of a lateral incisor and its height-to-width ratio compared to the canine. Figure 22 illustrates the areas in which enamel needed to be removed on the mesial, distal, and incisal aspects of the canine to get the proper height-to-width ratio, as well as the tooth's shape and form. When removing the enamel, it was important to flatten the facial convexity of the canine and aggressively remove the canine fossa. This was necessary for the facial of the lateralized canine to reflect light properly and so it would not have the facial prominence of a cuspid. Also, the lateral incisor is normally tucked in against the incisal edge of the lower incisors and the cuspid cingulum would interfere, so we aggressively reshaped the palatal aspect of the canine to have an actual fossa (Fig 23). The orthodontic brackets were then reset to intrude the maxillary first premolars, to place the gingival margins in the appropriate vertical position relative to the lateral and central incisor. The space created by reshaping was closed orthodontically and the patient was sent back to her referring dentist for gingival recontouring and porcelain veneers. The final smile was exceptionally esthetic (Figs 24a & 24b) and the anterior tooth proportions ideal (Fig 25).
Synchronization Plan
Near the end of the orthodontic treatment, the patient needed to decide whether we should intrude the maxillary first premolars. This was easy, as she had already decided on veneers. Working with the dental office, we coordinated a day for removal of the braces and preparation of the veneers, sequentially. The temporaries were fabricated as a single unit to retain orthodontic tooth movement. It was important that retention be placed quickly as it was likely the intruded maxillary first premolars would erupt rapidly after appliance removal. To achieve this, we ensured that the first premolars (which were becoming canines) were included in the fabrication of a single-unit temporary restoration from canine to canine, consolidated into a six-tooth unit. Once the final veneers were placed, the patient returned for final images and documentation, and placement of a clear retainer. We checked for teeth that were prone to relapse and where retention in the full arch was desirable.

Take-Home Message
The restorative dentist could have obtained a nice result for this case simply by providing veneers. However, the dentist’s willingness to consider a more comprehensive approach was critical in elevating a good result to an impressive one. It also is important to note that if canines are to be reshaped, it should be done deliberately and with a clear vision of what the final outcome should be.

Figure 22: This illustration depicts the ideal outline of a lateral incisor superimposed on a canine. This allows the dentist or the orthodontist to visualize where enamelplasty needs to be performed to adequately lateralize the canine. In simpler terms, we suggest, “Just carve away everything that does not look like a lateral.”

Figure 23: Image reflecting the more aggressive reshaping required to convert a canine to a lateral. The incisal tip was flattened, the mesiodistal width reduced, the facial convexity flattened, and the cingulum of the canine converted to a fossa.

Figure 24a: Once tooth movement was complete, the patient was referred back to the dentist for placement of veneers, resulting in an outstanding smile.

Figure 24b: The close-up smile image reflects the proportionality of the teeth and great improvement of the patient’s smile.

Figure 25: The first premolars were intruded, and reshaping the laterals to resemble canines led to ideal gingival margin placement and tooth proportion, enabling the dentist to achieve an excellent restorative result.
Case 5: Class II Malocclusion

This 62-year-old female patient was referred by her dentist about her Class II malocclusion, reflected in her profile (Fig 26). We recommended correction of the malocclusion through combined orthodontic/surgical treatment with mandibular advancement. She had never been happy with her smile (Figs 27a & 27b) and while orthodontics would achieve straighter teeth, we recommended she finish with porcelain veneers once her malocclusion was corrected. Her dentist had also advised her that there were a number of esthetic options she might consider as an adjunct to her mandibular advancement. As a result, she was willing to discuss more than just the dental concerns, and we suggested she consider overall facial rejuvenation through rhytidectomy (facelift), lip augmentation, and blepharoplasty (rejuvenation of upper and lower eyelids). She wished to pursue all these options, so after the orthodontic and surgical plan was completed with her malocclusion corrected and teeth aligned (Fig 28) she went directly for preparation and delivery of her porcelain veneers. The facial procedures were performed one week later. The final outcome (Figs 29a-29c) was impressive from an esthetic standpoint and the advancement of her mandible and chin greatly increased her airway size, with significant health benefits.

Synchronization Plan

This case obviously required careful attention between multiple specialties. A consolidated treatment plan was formulated in our office, utilizing digital imaging software to demonstrate choices the patient could make and to provide realistic parameters for the team or indicate those that needed to be adjusted in case any of the specialties had constraints. Orthodontic treatment was designed to carry the patient through mandibular advancement and to place the dentition in a favorable position for esthetic dental finishing. In many cases, as discussed above, esthetic soft tissue procedures can be performed simultaneously with the orthognathic surgery. However, with this case we staged the procedures to be done sequentially. We find it best not to perform rhytidectomy concurrently with orthognathic surgery, so that procedure was delayed until the skeletal components were in place. Veneer preparations were performed first and temporaries were placed. This established final incisor position as well as anterior posterior position and lip support. The facial procedures were then completed and the final veneers were placed a few weeks later.

Editor's Note: This patient's story can be seen at www.thesmileinside.com
Take-Home Message
This case illustrates the expansion of the term multidisciplinary to include our medical colleagues, specifically the facial plastic surgeon. The surgeon working with us on this case has been a member of our team for 20 years and understands the soft tissue reaction to the dental and skeletal changes we effect; he therefore is able to develop the facial design in such a way as to produce these types of results. Another important point is that the patient’s referring dentist was well versed in this multidisciplinary approach to treatment, was comfortable discussing it with the patient, and did a nice job of preparing her to hear what we had to say.

Summary
This article presented five cases ranging from fairly simple to very complex. The goals were to demonstrate the greater vision we all should offer our patients, and to demonstrate how orthodontic diagnosis and treatment planning has incorporated smile design principles into our overall functional and esthetic treatment goals.

References

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Executing Successful Peri-Implant Esthetics

Bone resorption following maxillary anterior tooth extraction is common and often compromises gingival tissue levels for implant restoration.

Paul E. VreNon, DDS, MAGD

Abstract
Executing a successful esthetic implant-supported restoration for an anterior tooth is one of the most challenging procedures in cosmetic dentistry, requiring an interdisciplinary approach between the surgeon, restorative dentist, and laboratory technician. To achieve the optimal predictable clinical outcome, an understanding of risk factors is essential, from periodontal surgical procedures to the reproduction of natural tooth characteristics on the implant. The goal of this article is to enhance the clinician’s knowledge of the risks and techniques that will affect the restoration’s success.

Key Words: implant-supported restoration, implant placement, custom abutment, implant crown, esthetic zone, Accreditation Case Type III
Introduction
During the last decade, implants have become a predictable treatment modality for replacing missing or nonrestorable teeth with a high clinical success and survival rate.\textsuperscript{1,2} In the esthetic zone, there are several fundamental components that dictate the definitive outcome; these include the establishment of periodontal soft and hard tissue that will thoroughly support the implant crown and the reproduction of natural tooth characteristics on the implant abutment. Bone resorption following maxillary anterior tooth extraction is common and often compromises gingival tissue levels for implant restoration.\textsuperscript{3,4} An implant that is osseointegrated does not always translate into esthetic success. Understanding the five diagnostic keys of peri-implant esthetics—relative tooth position, form of the periodontium, biotype of the periodontium, tooth shape, and position of osseous crest height—will enable the clinician to develop treatment options and clinical procedures to more predictably achieve the desired therapeutic outcome.\textsuperscript{3}

Case Presentation
A 31-year-old female presented desiring to definitively replace her missing left maxillary central incisor. Her dental history revealed that she had lost tooth #9 two years previously due to a traumatic accident. She reported that she was in excellent health, and her medical history was unremarkable. Clinical findings in the maxillary anterior edentulous area included localized moderate horizontal bone loss, localized moderate vertical bone defects, moderate loss of gingival attachment, and moderate loss of labial bone. Moderate horizontal bone loss was observed in the radiographic examination on the edentulous area (Figs 1a-1c). A treatment option was presented that included a three-unit fixed restoration. Because this would require tooth preparation on the adjacent teeth, the patient declined this option. Instead, she accepted a plan to have a single tooth implant that involved a surgically staged treatment approach with soft tissue augmentation to maximize an esthetic and functional treatment outcome.

Figures 1a-1c: Clinical images, all at initial presentation: (a) Facial view. (b) Occlusal view. (c) Radiograph of anterior maxillary area.
Treatment

A comprehensive oral examination was completed to establish predictability in the periodontal soft tissue and determine the best mode of action (Figs 2a & 2b). When determining the need for surgical augmentation, the patient’s smile is an important factor to consider. The transition from the restorative margin to the mucosa or the artificial papillae is visible in patients with high or average smile lines, so attempts to augment the height of the tissues can be beneficial. Thin biotypes and sites with no keratinized tissue have demonstrated more recession than thick biotypes, and the addition of a soft tissue graft may be beneficial in providing improved esthetic outcomes. Several studies have utilized a freeze-dried acellular dermal matrix allograft as an alternative to autogenous-free gingival grafts to achieve increased attachment of keratinized gingiva around natural teeth or implants, root coverage, and for ridge preservation procedures.

Preliminary impressions were made with an irreversible hydrocolloid impression material (Jeltrate Chroma, Dentsply Int.; York, PA). Diagnostic casts for both the maxillary and mandibular arches were fabricated with Type III dental stone (Microstone Golden Stone, Heraeus Kulzer; South Bend, IN) and were mounted in maximal intercuspal position on a semi-adjustable articulator (Panadent; Panadent Corp.; Colton, CA) after a Kois Dento-Facial Analyzer (Panadent) was used. A diagnostic analysis of the occlusal plane and a diagnostic wax-up were completed. A surgical template was then fabricated with clear autopolymerizing polymethyl methacrylate resin (Teets Cold Cure Denture Material, Co-Oral-Ite Dental Mfg Co.; Diamond Springs, CA). A surgical guide, created by the restorative dentist in collaboration with the surgeon, was used to place the 4.6 x 12 mm implant with a 3.5-mm platform (Tapered Plus, BioHorizons; Birmingham, AL) in proper position with cover screws and submerged. To compensate for the horizontal and vertical ridge resorption, a freeze-dried acellular dermal matrix (AlloDerm GBR, BioHorizons) was placed to enhance the soft tissue to create an ideal gingival contour and emergence profile. The implant remained in place for three months to allow osseointegration. During this period, the patient wore an interim partial removable dental prosthesis relieved in the ridge area to avoid any tissue contact at the surgical site. Several options of interim partial removable dental prostheses are available (Figs 3a-3h) that allow enhanced patient esthetics and functionality throughout treatment.

“A healing period of three months is adequate if the implant was placed in a good-quality bone.”
website confidence

[web-sahyt] [kon-fi-duh ns]  (noun) The feeling or belief that one's website clearly and beautifully represents his or her work ethic, philosophy, and passion as a dentist.  • After my redesign project launched, my website confidence increased ten-fold. I now feel that my online image is perfectly in tune with my practice.

synonyms: digital trust, online credence
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Figures 3a-3h: During implant uncovering, several types of interim partial removable dental prostheses are available for the patient: (a,b) Essix retainer. (c,d) Hawley retainer. (e,f) Stay plate. (g,h) Smile transition.
Reproduction of Natural Tooth Characteristics

After three months of healing, the horizontal and vertical dimensions of the ridge showed significant improvement (Fig 4). A healing period of three months is adequate if the implant was placed in a good-quality bone.11 A periapical radiograph was evaluated for any bone loss (Fig 5a). The healing abutment was then removed and an impression coping was inserted on the implant (Fig 5b). The definitive polyether impression (Impregum, 3M ESPE; St. Paul, MN) was made on the impression analog with a closed-tray impression technique before determining the shade color for the definitive restoration (Figs 6a & 6b). Next, the gingival contour was poured with elastomeric material (Softissue Moulage, Kerr Dental Laboratory; Orange, CA) around the implant analog, and a definitive cast with a Type IV dental stone (GC Fujirock EP, GC America; Alsip, IL) was fabricated.

Figures 5a & 5b: Radiographs of: (a) Implant after three months of placement with cover screw and submerged. (b) Impression coping on implant to verify that it is completely seated before impression for custom abutment and implant crown.

Figures 6a & 6b: Shade communication: (a) Hue and chroma (color). (b) Value (black and white).
To develop definitive soft tissue architecture around the implant with a correct anatomical emergence profile, it is essential to understand the esthetic gingival components. These components include gingival horizontal symmetry from canine to canine and a scallop form that follows the interproximal embrasures. Generally, the facial level of the gingival tissue mimics the architecture of the underlying osseous crest. Predicting the level of facial tissue dimension can be accomplished with 3.0 mm referenced from the osseous crest and with 4.0 mm measured from the free gingival margin to the osseous crest at the interproximal osseous scallop.12 A definitive crown with a relatively narrow anatomical emergence profile may result in soft tissue complications due to unsupported soft tissue components. As a result, it may trap plaque and can be difficult for the patient to maintain hygienically (Figs 7a-7h).

In this case, when placing the anatomically correct abutment, the tissue was impeding the seat of the abutment on the platform. To preserve the facial tissue, a lingual releasing incision was placed clinically to allow seating.

Subsequently, an all-ceramic zirconia custom abutment (Atlantis, Dentsply Int.) was fabricated and a lithium disilicate crown (IPS e.max, Ivoclar Vivadent; Amherst, NY) was heat-pressed to fit with the abutment, using a cut-back layering technique. The abutment screw was torqued and tightened to 35 Ncm and the hole was filled with warm gutta percha (Obtura Spartan Endodontics; Algonquin, IL). The crown was cemented with elastomeric resin cement (Premier Implant Cement, Premier Dental; Plymouth Meeting, PA) and excess cement was removed with a #12 blade. The occlusion was then refined using 200-µ articulating paper (Bausch Dental; Nashua, NH) before the crown was polished with polishing paste (DiaShine, VH Technologies; Lynnwood, WA). The patient expressed her satisfaction with the esthetic and functional outcomes. There were no mechanical complications at the two-month follow-up appointment (Figs 8a-8c).

**Figures 7a-7h:** Definitive implant abutment: (a-d) Inadequate—displays narrow anatomical emergence profile. (e-h) Adequate—displays normal anatomical emergence profile that supports soft tissue architecture. Note that the occlusal view shows the lingual releasing incision.
Figures 8a-8c: Definitive implant-supported restoration for the anterior tooth at the two-month follow-up appointment.
Summary
This case report described the correction of a difficult clinical situation presenting a loss of horizontal and vertical ridge volume. By evaluating and establishing the periodontal soft tissue from both a surgical and a restorative perspective, a satisfactory and enhanced predictable clinical outcome was achieved.

Acknowledgment
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References


"To develop definitive soft tissue architecture around the implant with a correct anatomical emergence profile, it is essential to understand the esthetic gingival components."

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Case selection is very important; it is essential to have sufficient soft tissue and bone available in the edentulous space.

Case Type III consists of restoring a maxillary anterior tooth with either a fixed bridge or a dental implant. For the implant case, the preoperative x-rays and photographic views must show the edentulous space or the failing tooth prior to implant placement. Case selection is very important; it is essential to have sufficient soft tissue and bone available in the edentulous space. When there is a deficiency in the edentulous ridge, augmentation must be done (connective tissue or bone graft). This may take a long time to heal and add significant cost to the case. It is also important to have a good mentor, preferably an Accredited AACD member who is an Accreditation Examiner. That way the member in the process (MIP) will know whether they have a case that is appropriate for Accreditation. It is important to have excellent communication with the laboratory technician, periodontist (implant surgeon), orthodontist (if necessary), and the patient. The MIP should be prepared by taking study models, doing a diagnostic wax-up, creating the necessary surgical stent, making a temporary implant (to create the ideal tissue contour), and any other steps needed to ensure the best possible result.

When selecting the fixed bridge option, it is very difficult to create a pontic site that appears to emerge from the gingiva naturally. It is helpful to fabricate temporaries that are shaped in the same contour that is planned for the final restoration (i.e., ovate pontic). The second major concern is the size of the connectors and how well the laboratory technician can make this area appear as if it were a natural tooth space interproximally. It is important not to make the connectors too long. Choosing an implant restoration for Case Type III minimizes these concerns.
Dr. Paul VreNon did an excellent job of restoring missing tooth #9 with a dental implant (Figs 1 & 2). The main focus of the Accreditation Examiners on Case Type III is to evaluate how the MIP handled the soft tissue in the edentulous site. Dr. VreNon did a very nice job with the soft tissue around the implant crown. There is a good emergence profile around the restoration and the gingival crest of #8 matches the implant crown in the #9 site.

As with almost all restorative cases, this case was not perfect and the Accreditation Examiners noted faults (see sidebar). These were judged to be minor faults (-2 deduction). Two of the examiners commented that the distal of #9 had a blunted/constricted embrasure.

The Accreditation process provides a framework to achieve excellence in cosmetic and restorative dentistry. Once this level of excellence is achieved, the dentist has this skill and knowledge for the rest of their career. This will be a tremendous benefit not only to the dentist, but also to all their patients.

References


The examiners found the following faults:

- Criterion #53: *Is the color (hue, value, chroma) selection appropriate/natural, not monochromatic?* All five examiners stated that the value of #9 was slightly lower than the adjacent teeth.

- Criterion #89: *Are the cervical embrasures proper? No dark triangles?* All five examiners stated that there was a dark triangle between #8 and #9.

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Severe Malocclusion: The Importance of Appropriately Timed Treatment

A Synchronized and Simultaneous Interdisciplinary Plan Using Cosmetic Dentistry Principles

David M. Sarver, DMD, MS

Abstract

This article discusses challenging issues clinicians face when treating malocclusions and illustrates a solution in a severe Class III malocclusion case. Interestingly, and the motivation for this article, principles of cosmetic dentistry and timing determined the treatment plan. Orthodontics and a three-dimensional visualization and spatial diagnosis were required, along with carefully orchestrated orthognathic surgery with simultaneous rhinoplasty. The final result showed dramatic improvements in the facial profile and smile.

Key Words: Class III malocclusion, orthodontics, craniofacial growth, vertical maxillary deficiency, orthognathic surgery, rhinoplasty
Is the answer contained only in the sometimes perplexing cephalometric radiograph?
Even at age six, the patient’s skeletal deformity was obvious.

Introduction

Treatment of Class III malocclusions can comprise a number of options, depending upon who is undertaking the diagnostic and treatment-planning responsibilities. This can cause some challenging issues for the dentist, such as when the best time to treat the malocclusion is and what the best approach is. Is the answer contained only in the sometimes perplexing cephalometric radiograph? Surprisingly, in today’s orthodontics the cephalometric radiograph is not the main determinant of the treatment plan.1 Rather, a critical piece of the answer lies in principles commonly used in cosmetic dentistry. The case described here is an excellent example of how the relationship of the soft tissues to the hard tissues (the “soft tissue paradigm”) is the major factor in determining treatment.

Initial Patient Presentation and Findings

This patient first came to our office with his parents when he was six years old. He had a short lower facial height and an overclosed appearance at rest (Fig 1). His underbite was immediately evident and vertical maxillary deficiency was diagnosed because of the characteristic short lower face and little to no maxillary incisor display in his smile (Fig 2). Even at his young age, the patient’s skeletal deformity was obvious (Fig 3). His primary dentition had negative overjet with no anterior slide (Fig 4). An important clinical finding is that if the incisors are edge to edge in CR, the mandible has to slide forward for the posterior teeth to articulate. This type of CR-CO discrepancy has a greater likelihood of successful early treatment. However, when there is no anterior slide, then the position of the mandible relative to the maxilla is less successfully treated with early intervention. At this point, however, it was hard to determine the etiology of the Class III malocclusion.

As with most young patients, an attempt was made to protract the maxilla, but it soon became clear that any treatment at that time would be futile given the severity of the skeletal deformity. Therefore, it was decided to follow the patient for a number of years until he reported he had stopped growing toward the end of high school.

Treatment

Timing

When is the right time to proceed to orthodontics and surgical correction? Particularly in Class III malocclusion cases, the patient should be finished growing in terms of statural height. Long-term data, however, support the idea that our dentoalveolar and craniofacial growth never completely stops.2 But in this type of surgical/orthodontic treatment, the critical gold standard for the orthodontist is to follow craniofacial growth with a series of cephalometric radiographs taken six months apart. When three consecutive films can be superimposed on the stable cranial base with no changes evident, the patient’s treatment may be initiated. By age 20, this patient had met all the criteria for beginning his treatment (Fig 5). His incomplete incisor display on smile and deep nasolabial folds had a great influence on our treatment planning (Fig 6). It remained obvious that his facial and dental malformations were quite severe (Figs 7 & 8). A complicating factor in our decision-making process was that there was an extreme excess of space in the lower arch. An attempt to close all that space would not only be difficult, but also would be contrary to the principles of proper orthodontic preparation for an ideal surgical outcome. The position of the lower incisors was excellent, and to retract them would tilt them lingually, which would adversely affect how much the maxilla could be advanced. We decided to leave the space, and planned implant placement to restore the integrity of the mandibular arch (Fig 9). Due to vertical maxillary deficiency (lack of vertical growth of the maxilla), incomplete incisor display was evident on both the facial smile and the close-up smile. This had a significant impact on the surgical placement of the maxilla, since the position of the maxillary incisor drives the treatment plan (Fig 10).

Orthodontics

Orthodontic treatment was begun to decompensate the dentition in preparation for the patient’s jaw surgery. Once the teeth were properly positioned for surgery, it became critical to determine the cause of the malocclusion. In Class III malocclusion, the procedure itself sometimes drives what is perceived as the problem. For example, many would correct this malocclusion by surgically moving the mandible back. While this might correct malocclusion, facially it results in a more obtuse chin-neck contour (i.e., a fatter-looking neck). Commonly, the maxilla is moved forward to avoid that problem. But rather than limiting our thinking only to the anteroposterior plane of space, a more three-dimensional spatial diagnosis was required. This type of malocclusion may be the result of mandibular prognathism, maxillary deficiency (insufficient anterior growth of the maxilla), or vertical maxillary deficiency (vertical undergrowth of the maxilla resulting in a clockwise rotation of the mandible).
Figure 1: The patient first presented at age six with short lower facial height and an overclosed appearance at rest. The short lower facial height is a visual cue for vertical maxillary deficiency, one of the possible etiologic agents in a Class III malocclusion.

Figure 2: The patient’s underbite was evident and Class III malocclusion was diagnosed.

Figure 3: Although the patient’s skeletal deformity was obvious even at this young age, it was hard to determine the potential multifactorial etiologies of the Class III malocclusion.

Figure 4: This intraoral image shows negative overjet with no anterior slide.

When is the right time to proceed to orthodontics and surgical correction?
Figure 5: At age 20, the patient’s prominent mandible and flat midface remained obvious.

Figure 6: The patient’s incomplete incisor display on smile and deep nasolabial folds had a significant impact on our treatment decisions.

Figure 7: The severity of the patient’s facial deformity clearly remained, as demonstrated in this profile image.

Figure 8: The severity of the Class III malocclusion is reflected in this intraoral photograph.
Figure 9: The mandibular arch had an overabundance of space and we decided not to close it because that would have retroclined the lower incisors (thus compromising the negative overjet, necessary for appropriate skeletal correction).

Figure 10: Determining the placement of the maxillary incisor was a primary factor in determining where we positioned the maxilla, since the position of the maxillary incisor drove the treatment plan.
Surgical Treatment Planning
The clinical measurements of upper lip to incisor relationships are essential to proper diagnosis. First, during our clinical examination, we noted that there was no incisor display at rest. Second, on smile, the patient’s incisor display was 5 mm while his crown height was measured at 10 mm. As is the case in cosmetic dentistry, the ultimate desired position of the maxillary central incisor determines the surgical placement of the incisal edge. Figure 11 demonstrates the overall surgical plan after orthodontic preparation. As the illustration indicates, the maxilla was planned to come forward to increase upper lip support and improve the soft tissue nasolabial folds. Anterior maxillary downgraft was also planned to increase the lower facial height (improving the overclosed appearance) and to increase the amount of incisor display and improve the smile arc. As a result, we calculated a 5-mm anterior downgraft of the maxilla, which would result in 5 mm of tooth display at rest and full incisor display on smile (Fig 12). The oral and maxillofacial surgeon performed a Z osteotomy to provide maximum stability to the maxillary downgraft, so that as the maxilla moves downward and forward, bony contact is still maintained between the maxilla and the zygomatic process (Fig 13). This allows the surgeon to place rigid fixation plates solidly in bone, providing greater stability, since maxillary downgraft is regarded as an inherently unstable procedure. All other skeletal movements were planned around the placement of the maxilla, resulting in bimaxillary surgery with clockwise occlusal plane rotation.3-6

Figure 11: The surgical plan illustrates how the maxilla needed to come forward to increase upper lip support and improve the soft tissue nasolabial folds. It also indicates an anterior maxillary downgraft to increase incisor display and improve the smile arc.

Figure 12: On smile, the patient showed 5 mm of tooth, while the total crown height was 10 mm. This dictated that the anterior maxilla should be moved inferiorly 5 mm.

Figure 13: A Z osteotomy provided maximum stability to the downgraft of the anterior maxilla, while still maintaining bone contact.

But rather than limiting our thinking only to the anteroposterior plane of space, a more three-dimensional spatial diagnosis was required.
The oblique view of the face is what I term the “social view” (i.e., the angle at which people are most often seen in social situations). While the patient presented with a rather prominent mandible, his vertical maxillary deficiency was also characterized by the overclosed look. Also on this view, the low position of the nasal tip and the broad lateral nasal cartilages without a distinct “scroll” (the curvature from the base of the nose into the lateral nasal tip cartilages) are apparent (Fig 14). The anatomy of what is considered an “ideal” nose is shown in the post-treatment (left-hand) image of Figure 15. The pretreatment (right-hand) image demonstrates a lack of scroll in this patient due to large lateral nasal cartilages. The dorsum represents the juncture of the nasal bone and the nasal cartilage—the body of the nose—and ideally it should have a general curve to it without projection. The supratip represents the junction of the septal cartilage with the nasal tip cartilages, producing a slight “supratip break.” The elevation of the nasal tip is evident compared with the pretreatment image, and the sweep from the base of the nose to the dorsum and the eyebrows is referred to as the “gull wing in flight,” which is considered esthetically desirable. The maxillary deficiency is evident in both vertical and horizontal planes of space. There is incomplete incisor display and very deep nasolabial folds on smile (Fig 16). After orthodontic preparation and during the orthognathic procedure, the implants were placed for maximum efficiency of treatment (Fig 17).

Figure 14: This image shows a prominent mandible with an overclosed appearance and a low position of the nasal tip with broad lateral nasal cartilages without a distinct “scroll.”

Figure 15: The image on the left shows the anatomy of what is considered an “ideal” nose. The image on the right demonstrates a lack of scroll due to large lateral nasal cartilages.

Figure 16: The maxillary deficiency is evident, with incomplete incisor display on smile and deep nasolabial folds.
The facial profile was further enhanced by the rhinoplasty, which significantly improved the appearance of the nose.

Rhinoplasty and Orthognathic Surgery
With an expanded team approach, a rhinoplasty was performed simultaneously with the very precise orthognathic surgery. The oblique image in Figure 18 displays the facial plastic surgeon’s superb nasal management: advancement of the maxilla improved the nasolabial folds and achieved excellent balance of the upper face and the lower face. Figure 19 demonstrates the balance of the chin projection with the upper face. The upper jaw was moved downward and forward to help support the lips and show more tooth when the patient smiled, and the lower jaw was rotated downward and forward in a clockwise fashion, resulting in dramatic improvement in the length of the lower third of the face. The facial profile was further enhanced by the rhinoplasty, which significantly improved the appearance of the nose. The final result is striking in terms of improved occlusion (Fig 20), mandibular arch (Fig 21), and incisor display (Fig 22); and an exceptionally more esthetic profile (Fig 23) and smile (Figs 24).

Synchronization Plan
This case proceeded as most orthognathic cases do in an orthodontic practice. An important part of the decision process is for the orthodontist to assess how the teeth articulate in a simulated Class I relationship. In other words, models are taken and held by hand into the desired Class I relationship and the following evaluations are made:

• Whether the angulations of the anterior teeth are sufficient to allow coupling of the anterior teeth, and simultaneously ideal posterior occlusion. For example, if the lower incisors are too retroclined, then it is virtually impossible to attain good buccal interdigitation. The orthodontist must decide how to decompensate the dentition for good occlusion.

• The transverse relationships are then evaluated. If the maxilla is too narrow and expansion is required, the orthodontist must decide whether the expansion is minor and orthodontic arch coordination is all that is needed, or if surgical expansion of the maxilla should be performed at the same time.

• The vertical relationships of the occlusal plane are evaluated. If the maxilla exhibits a differential vertical position between the anterior teeth and posterior teeth, then the maxilla may be segmented to level it and attain a flat occlusal plane in a stable manner. In other words, if there is a pronounced Curve of Spee in the maxillary arch resulting...
Figure 20: The final occlusion.

Figure 21: The mandibular arch after restoration of the implants.

Figure 22: The close-up smile demonstrates the consonance of the smile arc and improved incisor display on smile.

Figure 23: The final profile.

Figure 24: The final full-face image with complete incisor display and consonant smile arc.
in an anterior open bite, then presurgical flattening of the arch through orthodontic treatment has a high chance of instability. In this situation, the orthodontist must align the anterior and posterior teeth in separate segments so that the surgeon can perform a LeFort I osteotomy in segments to maximize stability of the final outcome.

Probably the most challenging aspect of this type of case is coordination of the orthognathic surgery and rhinoplasty. In our setting, the oral and maxillofacial surgeon previously planned with the facial plastic surgeon for the procedure to begin with nasal intubation while the jaw osteotomy was performed and stabilized with rigid fixation. Once the osteotomy was complete and the fixation securely in place, the intubation was changed from nasal to oral. This required close coordination of the surgeons and the anesthesia team: When the nasal intubation was cut at its entry to the nose, the surgeon reached in to grasp the pharyngeal tube and pull it back through the mouth to remove it, while the anesthesia team changed the nasal tube to an oral tube to be inserted immediately after removal of the nasopharyngeal tube. This procedure is neither complicated nor time-consuming, but it is essential to the success of the combined orthognathic surgery and rhinoplasty.

Summary
Orthognathic surgery used to be considered a drastic procedure. However, there have been dramatic changes in approach in the past few decades. Today, with rigid fixation, it can be performed simultaneously with other facial esthetic procedures such as rhinoplasty, with few complications and comparatively uneventful recovery. The evolution of rigid fixation has freed the interdisciplinary team from the necessity of wiring the teeth together, thus facilitating the simultaneous esthetic procedures and allowing the patient to have a much more comfortable postoperative period. In the case discussed here, interdisciplinary treatment—orthodontics followed by simultaneous orthognathic surgery and rhinoplasty—resulted in a life-transforming change for the patient.

References

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To ensure better outcomes for dental restorations, it is crucial that dentists have a full understanding of where their dental restorations are coming from and what patient contact materials are used in the process. Transparency matters! Ask your dental laboratory if they are using FDA registered materials in your patient restorations and how they ensure quality systems and good manufacturing practices.
When a comprehensive approach is necessary, communication among the disciplines is critical in achieving improved esthetic outcomes.

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Abstract

Porcelain laminate veneers are considered a conservative solution for patients requiring improvement of the shape, color, or position of their anterior teeth. Diastema closure is a frequently requested restoration procedure that can improve the esthetics of the smile and, therefore, the patient’s self-esteem. Successful application of this procedure requires a solid knowledge of tooth anatomy and proportions, as well as soft tissue morphology. To achieve these esthetic goals, an interdisciplinary approach may be necessary to ensure harmony between the final restoration and the health of surrounding soft and hard tissues. This case report describes a minimally invasive therapy for a 21-year-old woman seeking esthetic treatment, and it demonstrates the exceptional results that can be obtained with excellent material usage and teamwork integration.

Key Words: porcelain laminate veneer, diastema, flapless crown lengthening, minimally invasive dentistry, refractory die technique
Introduction
Many patients today are seeking esthetic dental treatment not only for dental caries or tooth fractures but also for diastemas, which can give the smile an unpleasant appearance. Management of diastemas in the anterior maxillary permanent dentition requires detailed evaluation and appropriate care. An accurate diagnosis and careful consideration of the contributing factors are necessary before treatment can be initiated.\(^1,2\)

In such instances, an interdisciplinary approach that combines periodontics and prosthodontics is essential to evaluate, diagnose, and resolve the esthetic problem. When a comprehensive approach is necessary, communication among the disciplines is critical in achieving improved esthetic outcomes. Ultimately, this approach should establish long-term harmony between the final restoration and the health of surrounding soft and hard tissues.

Porcelain is considered to be both an esthetic and biocompatible material, with the capacity to replicate the intrinsic characteristics and vitality of natural teeth.\(^3\) Porcelain laminate veneers are a predictable and successful treatment option to preserve a maximum amount of sound tooth structure. Over time, they have proven to be one of the most successful treatment options that modern dentistry has to offer.\(^4\) The following interdisciplinary case presentation describes conservative tooth preparation for porcelain laminate veneers combined with flapless crown lengthening as a minimally invasive periodontal procedure.

Case Presentation

Patient History and Chief Complaint
A 21-year-old female presented stating that she disliked the appearance of her smile, the discolored “fillings,” and the chipped edges of her front teeth. She also reported that she had undergone orthodontic treatment to correct the maxillary anterior teeth positions, followed by unsuccessful restorations with composite fillings to close the diastemas.

Clinical Examination and Diagnoses
A complete intraoral and extraoral examination was performed that included evaluation of hard and soft tissue, temporomandibular joints, periodontal health, occlusion, orthodontic class, and condition of existing dental restorations. The patient’s periodontal health was good and no parafunctional symptoms were diagnosed. Appropriate initial full-face and close-up photographs were taken to complete the evaluation and support the treatment plan (Figs 1-3).

Clinical evaluation revealed shape alterations affecting the anterior teeth, and asymmetrical gingival zenith lines (Fig 4). The patient’s composite restorations were visualized with a black light, which revealed their locations and lack of contour and fluorescence (Fig 5). Despite these suboptimal diastema closures, the incisal edge position was ideal (Figs 1 & 2). Two sets of diagnostic models of both maxillary and mandibular arches were obtained by using the double impression technique with polyvinyl siloxane (PVS) material (Virtual XD, Ivoclar Vivadent; Amherst, NY) and special Type IV die stone (Fujifrock EP; GC America; Alsip, IL).

Differential Wax-Up
Dentists and laboratory technicians must follow a proper step-by-step protocol to achieve higher rates of clinical success. Therefore, the treatment planning should begin with a diagnostic wax-up.\(^5\) Based upon the clinical evaluation in this case, the gingival zenith lines and teeth size were asymmetrical. A new gingival zenith and contour were determined for teeth #8 and #9 by using a caliper and drawing marking points with a purple pencil (Figs 6a & 6b). A diagnostic wax-up was then made with the addition of wax to the initial model in accordance with the correct gingival margin to be established (Fig 6c).\(^6\) The wax-up was ultimately used to determine the ideal position of the future margin.

Mock-Up and Treatment Plan
A mock-up can help to evaluate the patient’s esthetic desires and expectations. The mock-up also serves as an effective communication tool between the dentist, patient, and dental laboratory technician. During the mock-up, the esthetic analysis should include an evaluation of the following oral features: dental midline, facial profile, lip thickness, tooth exposure at rest, incisal curvature, tissue positions, smile width, buccal corridor, phonetics, tooth shape and texture, incisal edge position, individual tooth proportions and contours, occlusal relationship, cant of the occlusal plane, tooth axis, and tooth arrangement.\(^7-30\)

A PVS template was made of the diagnostic wax-up (Fig 7) and used to transfer the wax-up to the patient’s mouth. The template was loaded with bis-acrylic resin (Protemp Plus shade A1, 3M ESPE; St. Paul, MN) and seated in the mouth for five minutes. The template was taken out and excess material carefully removed with a #12D scalpel. Photographs were taken and videos made to guide the final treatment plan. Once the desired esthetics and functional outcome had been verified with the mock-up (Fig 8), the clinical procedures based upon the treatment plan—an interdisciplinary minimally invasive approach combining porcelain laminate veneers for teeth #5-12 and flapless crown lengthening—could begin.

...the more accurate the substrate color, the more conservative the dentist can be in achieving tooth preparations that provide effective adhesion and facilitate optimal material restoration.
Figure 1: Full-face smile at initial clinical visit.

Figure 2: Full-face resting position.

Figure 3: Close-up open smile.

Figure 4: Frontal view of maxillary anterior teeth, showing incisal edges and asymmetrical gingival zenith.

Figure 5: Black light image showing the inappropriate fillings and their locations.

Figures 6a-6c: Diagnostic wax-up procedure: (a) Establishing measurements for the ideal teeth proportions with a caliper. (b) Establishing better gingival zenith position. (c) Completed first wax-up that guided the final treatment plan and flapless crown lengthening.
Figure 7: PVS template based on the diagnostic wax-up.

Figure 8: Initial intraoral mock-up in place to check the esthetic potential of the final restorations.

Flapless Crown Lengthening
Gingival esthetics are critical for a harmonious smile. Different surgical procedures have been used to treat esthetic and functional defects of the gingiva, alveolar mucosa, and bone. This case involved one of the most widely used minimally invasive techniques for correcting asymmetrical gingival zenith lines, the “flapless” procedure.1-14

To reproduce the new gingival zenith that was previously determined, the initial mock-up based upon the diagnostic wax-up was maintained in position to facilitate the crown lengthening of #8 and #9. An internal bevel incision was made (Fig 9a), and the tissue collar removed with periodontal curettes. The next decision was whether a bone contouring procedure was required, and a bone probe was used to obtain the biologic width of each tooth. An osteotomy was then performed through the gingival sulcus with small movements, using appropriate micro chisels. After the osteotomy, probing was done again to check the final established biologic space (Fig 9b).

Second Wax-Up, Preparation, and Final Impression
Eight weeks post-surgery, a subtle zenith discrepancy between #8 and #9 was still present (Fig 10a). It was decided to extend the preparation finish line slightly deep into the sulcus of #9 (Fig 10b). Similarly, the preparation finish line was extended interproximally for #12 and #6. Thus, the final restoration slightly pushed the gingival margin to the desired position, creating a natural emergence profile. To reproduce these restorations as they would ultimately appear in their final form, a second wax-up was done (Fig 10c), being careful to maintain the shape and texture of the original teeth. The dental technician made a preparation model (Fig 10d) and guides (Fig 10e) that allowed the dentist to visualize the amount of tooth necessary to achieve the esthetic result. This preparation model and guides were then used to complete the final preparations with minimal reduction of teeth and optimal path of laminate veneer insertion. An Ultrapak #000 nonimpregnated retraction cord (Ultradent Products; Savannah, GA) was inserted to emphasize the preparation finish line (Fig 10f), and the preparations were smoothed and finished with Sof-Lex discs (3M ESPE). A second cord (Ultrapak #00), soaked in 25% aluminum chloride (ViscoStat Clear, Ultradent) was inserted for the double-mix single impression technique with PVS.

Shade Selection
The use of digital photographs for shade selection is essential to convey a correct visual presentation to the dental technician, particularly when working with translucent materials. This protocol for shade selection is quite simple and effective. Nevertheless, there are some issues, such as selecting the appropriate ceramic material, which must be addressed to ensure proper shade selection. The VITA Classical (Lumin Vacuum) Shade Guide (VITA North America; Yorba Linda, CA) was used to select the correct hue, chroma, and value. This guide also helped to identify the ceramic material with the intrinsic color characteristics and opalescence that, when used in the final restorations, can most efficiently mimic those of the patient’s natural teeth. Photographs were taken with four shade tabs that were similar to the shades of the lower teeth positioned at the incisal edge level (Fig 11a). Likewise, four shade tabs were positioned at the incisal edge of the substrate teeth to select the right ceramic material (Fig 11b).15

"Ideally, as few wear adjustments as possible should be made on the ceramic."
Figures 9a & 9b: Flapless crown lengthening procedure: (a) Internal bevel gingival incision. (b) Final probing to check the new biologic space.

Figures 10a-10f: Second wax-up procedure: (a) Pencil marking indicating the minimal asymmetrical zenith that remained between #8 and #9. (b) New contouring of #9 to determine the ideal zenith to be achieved. (c) Final wax-up. (d) Preparation model showing preparation finish line that was extended into the sulcus. (e) Silicone guide, taken from the wax-up, that was used during the preparation stage. (f) Final conservative preparation.
Laboratory Procedures

Alveolar Cast Fabrication

Appropriate restorative planning in this case was based upon the principles of using minimally invasive procedures and selecting the most appropriate material for the final restorations. Therefore, the more accurate the substrate color, the more conservative the dentist can be in achieving tooth preparations that provide effective adhesion and facilitate optimal material restoration. Based upon photographic analysis of the substrate preparations, it was decided to use the refractory die technique, which allows the fabrication of very thin and heterogeneous laminate veneers that meet the specifications of color, opacity, translucency, and transparency. Meeting these fundamental specifications is regarded as one of the greatest challenges in achieving desired esthetic outcomes.

The alveolar “Geller” cast technique was used to retain soft tissue contours while providing an adequate emergence profile for the final restorations.\(^{16}\) First, an original cast was fabricated by pouring the special Type IV stone (Fig 12a). A new cast was then created, and each die was separated and trimmed with special discs and burs to turn them in a conic shape. Afterward, a groove was cut on both sides of each alveolar die to minimize any rotational movement and thus achieve an accurate final model (Fig 12b). After creating the alveolar dies, they were duplicated by pouring the refractory material (Cosmotech Vest, GC Europe; Leuven, Belgium) and fabricating the refractory die replicas (Fig 12c).\(^{16}\)

Ceramic Layering

After hydration of the refractory dies, the ceramic layers were built up with fluorapatite-leucite glass ceramic materials (IPS d.Sign, Ivoclar Vivadent). A very thin first layer of opalescent ceramic, also known as “wash,” was built up with Opalescent Effect 1 (OE1) paste. The first firing was performed at 60 °C above normal firing temperature, producing a uniform layer and preventing formation of cracks and bubbles. This step was repeated twice for improved sealing (Figs 13a & 13b). To create the second layer, Deep Dentin (DD)A1 and Dentin Bleach (DBL)2 pastes were mixed in a 1:1 ratio. This mixture was used to close the diastemas and compensate for shrinkage at the tooth preparation margins while smoothing the transition from the ceramic layer to the remaining tooth. These regions require sufficient opacity to prevent the formation of a gray shadow and exposure of the preparation margins (Fig 14a). A 1:1 mixture of DA1 and DBL2 was applied next (Fig 14b). After achieving optimal tooth length, the incisal edges were cut for light passage, the mamelons were defined, and the spaces were built up with OE1 paste (Fig 14c). The cervical and mid-incisal thirds were subsequently built up with OE3 paste to establish the areas of highest values. Using MM salmon, some characterization spots were made between the dentin and incisal edge, and the hypomineralized areas were mimicked with Brilliant Dentin (Fig 14d). The incisal third area was covered with incisal material TS2 and the body covered with a 1:1 mixture of OE1 and OE2 (Fig 14e). Due to ceramic contraction after firing, a further correction was made with the same pastes. Finally, a 1:1 mixture of DA1 and I Edge was applied to the incisal edge and the first firing was completed (Fig 14f). In a number of instances, a third buildup was needed to correct minor incisal angles and buccal ridges (Figs 15a-15c).

Upon completion of layering, the contact points and shape were adjusted (Fig 15d). Ideally, as few wear adjustments as possible should be made on the ceramic. Therefore, a very detailed ceramic build-up technique, using condensation silicone lab putty guides, is desirable following the treatment planning. As no further firing was required, the entire ceramic surface was roughened and the angles were further adjusted to achieve a natural appearance. This finishing was guided by the patient’s original teeth before treatment. Details such as incisal embrasures, abrasions, and shape were taken into
consideration, as were occlusal adjustments, always with the aim of restoring the canine occlusal guidance (Figs 16a & 16b). Prior to glazing, a mock-up of the ceramic veneers was made in the mouth to verify esthetic details (Figs 17a & 17b) before complete removal of the refractory dies. After the final adjustments, glazing was performed with glaze paste, shades, and extrinsic pigments, while the luster was achieved using abrasive rubber points.

The veneers were removed from the refractory dies via sandblasting with a 320-µ glass sphere at 1.5 bars of pressure, followed by adjustment against the rigid cast (Fig 18). The veneers were 0.5-mm thick in the center and 0.2-mm thick at the margins, with an excellent opalescent enamel appearance resembling a natural tooth (Fig 19). Preparations performed in a controlled manner and assisted by silicone guides yielded veneers with uniform thickness such that all of them exhibited the same optical illusion when cemented.

“Preparations performed in a controlled manner and assisted by silicone guides yielded veneers with uniform thickness such that all of them exhibited the same optical illusion when cemented.”
Figures 14a-14f: Ceramic layering, second buildup: (a) 1:1 DDA1 and DBL2 (orange). (b) 1:1 DA1 and DBL2 (pink). (c) OE1 (blue). (d) OE3 (yellow), MM salmon (red), and Brilliant Dentin (green). (e) Incisal third area covered with TS2 and body covered with 1:1 OE1 and OE2. (f) A 1:1 mixture of DA1 and I Edge was applied to the incisal edge and the first firing was completed.

“Ensuring esthetic balance between the gingival margin of soft tissues in close contact with the restorations and the adjacent natural dentition is important for establishing a harmonious smile.”
Figures 15a-15d: Ceramic layering, third buildup: (a) Correction of minor incisal angles and buccal ridges. (b) Occlusal view of the restorations. (c) 1:1 OE1 and OE2, and incisal halo made with 1:1 DA1 and I Edge (purple). (d) Final firing completed and adjustment of contact points.

Figures 16a & 16b: Final adjustments: (a) Adjustment of shape, incisal embrasures, and abrasions. (b) Smoothing of the transition angles and the flat, convex, and concave areas.
Figures 17a & 17b: Verification of esthetic details: (a) PVS template on laminate veneers to check the final shape. (b) Mock-up fabricated with bis-acrylic resin to confirm the ceramic restorations before complete removal of refractory dies and finishing.

Figure 18: Adjusted laminate veneers in the rigid cast.

Figure 19: Opalescent laminate veneers exhibiting areas of varying opacity.
Final Cementation of Veneers

Prior to bonding the veneers, the provisional restorations were removed and the teeth were cleaned with pumice and a prophylaxis brush. The veneers were first seated and eventually adjusted for ideal fit of proximal contacts. Try-in pastes (Variolink Veneer, Ivoclar Vivadent) were used to simulate the post-cementation result, and the patient was allowed to visualize, evaluate, and approve the shade and esthetics prior to bonding. The veneers were rinsed to remove the try-in paste, followed by application of 10% hydrofluoric acid etch (Dentsply; Petrópolis, Brazil) for 20 seconds (Fig 20a). After rinsing, the veneers were etched again with 37% phosphoric acid (Power Etching, BM4; Florianópolis, Brazil) for 30 seconds (Fig 20b) and rinsed to remove any residual porcelain precipitates as a result of etching. Ceramic primer (Monobond Plus, Ivoclar Vivadent) was then applied (Fig 20c), thoroughly air-dried, and treated with heat for 60 seconds, as it has been shown that application of heat to the silane-treated porcelain surface can significantly improve composite bonding strength.18 An Ultrapak #000 cord was subsequently placed around each preparation to control sulcular fluid and facilitate cement removal (Fig 21a).

The enamel surfaces were etched with 37% phosphoric acid for 30 seconds (Fig 21b), followed by a thorough 30-second rinsing with water (Fig 21c) and gentle air-drying for 15 seconds. A hydrophilic adhesive resin (Excite F, Ivoclar Vivadent) was then applied to the enamel surface (Fig 21d) and the previously-etched internal surface of the veneers, and this adhesive was air-thinned to remove residual solvent, but not cured. After adhesive thinning, light-cured luting cement (Variolink Veneer), the shade of which was distinguished by value, was loaded (Fig 22a). The veneers were gently placed on the teeth and the excess cement was carefully removed from the surfaces and interproximal spaces with artist brushes (Fig 22b) and dental floss, respectively. The veneers were then photopolymerized for five seconds at their cervical margins to tack them in place. Final removal of any residual cement was performed, followed by application of glycerin gel (Liquid Strip, Ivoclar Vivadent) at the margins to prevent formation of an oxygen-inhibited layer.

Definitive photopolymerization was performed facially and palatally (Fig 22c) for 40 seconds, followed by removal of the retraction cords (Fig 22d) and careful removal of any remaining resin cement with a #12D scalpel. Occlusion was evaluated, and interferences in lateral, lateral protrusive, and protrusive excursions were identified and removed. All finishing and polishing procedures were completed (Figs 23a-23c). An occlusal guard to provide nighttime protection for the new restorations was fabricated and delivered to the patient at a subsequent appointment. The patient returned two months later for a final check of the restorations, which met the desired esthetic and functional specifications (Figs 24a-24d).

Figures 20a-20c: Final cementation, veneer surface treatment: (a) Etching with hydrofluoric acid. (b) Application of phosphoric acid to remove residual porcelain precipitates. (c) Application of ceramic primer.
Figures 21a-21d: Final cementation, tooth surface treatment: (a) Placement of #000 cord around prepared tooth. (b) Enamel etching. (c) Rinsing of etched enamel surface. (d) Application of hydrophilic adhesive resin.

Figures 22a-22d: Final cementation, veneer bonding: (a) Application of light-cured luting cement to inner surface of veneer. (b) Removal of excess luting cement with artist brush. (c) Final light-curing. (d) Removal of #000 cord and excess luting cement at gingival margin.
Figures 23a-23c: Final result after cementation, finishing, and polishing procedures: (a) Occlusal position. (b) Anterior upper teeth, frontal view. (c) Anterior upper teeth, occlusal view.

Figures 24a-24d: Patient at two-month clinical follow-up: (a) Right-angle view. (b) Frontal view. (c) Left-angle view. (d) Full-face view.
Summary
This case report described an interdisciplinary approach to dental restoration that was based upon a diagnostic wax-up and mock-up. This approach provided a more predictable and safer minimally invasive treatment that seems to be key in successfully achieving the expected outcomes. Ensuring esthetic balance between the gingival margin of soft tissues in close contact with the restorations and the adjacent natural dentition is important for establishing a harmonious smile.

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Stefano Inglese

**Aesthetic Dental Strategies:**
**Art, Science, and Technology**

In this beautifully illustrated volume, the author encourages readers to understand natural tooth forms through simple observation of teeth and their relationship to surrounding structures in order to create dental restorations that look natural in the context of the mouth, face, personality, and age of the specific patient being treated. The text also examines the tooth surface at the micro and macro levels and how its effects on light reflection can change the appearance, size, and morphology of teeth. All the phenomena and optical properties that must be understood and recreated in restorations in order to achieve lifelike results are analyzed, and a classification based on the shape and contour of the tooth is presented. Clinical cases provide practical application of these concepts.

**Contents**
- Observation of Nature
- Natural Phenomena
- Layering Technique
- Clinical Cases
- Aesthetic Integration

**Edited by Silas Duarte, Jr**

**Quintessence of Dental Technology 2016**

A selection of the newest materials and best fabrication techniques for esthetic restorative results are elegantly presented in QDT 2016. Original articles on minimally invasive procedures, CAD/CAM, difficult cases, and the ever-challenging transition zone take center stage this year. The State of the Art article features full-mouth esthetic rehabilitation of the severely worn and compromised dentition, and the Biomaterials Update focuses on self-etching ceramic primer as an alternative to strong hydrofluoric acid porcelain etching. Rounding out the issue is a special feature on achieving excellence in portrait photography, courtesy of Naoki Aiba.

**Authors include:**

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224 pp; 900 illus (approx); ©2016; ISBN 978-0-86715-723-9 (J0627); US $132

**Aesthetic Dental Strategies:**
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273 pp; 762 illus; ©2015; ISBN 978-88-7492-026-6 (B9531); US $158
Different Materials for Different Situations

Ceramic Solutions for Specific Restorative Indications

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Abstract

The different pure ceramic systems were designed to satisfy the demands of specific restorative indications and must be selected according to the needs of each clinical case. This selection must be made very carefully, taking into consideration the mechanical properties of the material as well as a variety of clinical aspects such as the region to be restored, type of cementation, dental preparation, esthetic aspects, and laboratory technique. The dental market offers a great range of new ceramic materials for the fabrication of dental restorations, which brings new options but also generates new questions about which system to choose.

Key Words: laminate veneers, ceramic crowns, single anterior crowns, anterior esthetic restoration

Learning Objectives

After reading this article, the participant should be able to:

1. Compare different ceramic systems.
2. Evaluate the characteristics that create realism in the dental restoration.
3. Reinforce basic bonding principles.
Introduction
As dentistry continues to advance, esthetic techniques have evolved into more effective, functional, and biocompatible procedures. At the same time, esthetic dentistry has become more complex and technically challenging. With the improvement of the physical and optical properties of ceramics and the establishment of a protocol, ceramic restorations have become increasingly popular. Today, there are diverse ceramic systems that have excellent optical properties such as opalescence, fluorescence, translucency, and chromaticity, which enable clinicians to blend the restoration with the dental structure.\(^1\) All of this has led to experimentation with the use of different ceramic systems that range from conventional feldspathic ceramic to more modern versions, which are reinforced, injected, or created with the assistance of CAD/CAM.\(^3\) The selection of a ceramic system must be based upon each case’s clinical requirements, esthetic and functional needs, location of the restoration, prosthetic design, and laboratory techniques.\(^5\) Efforts have been made to improve the composition of ceramics, mainly regarding the manufacture of pure systems. The objective has been to produce monolithic structures that are more precise and resistant to fracture.\(^6\)

Translucency
The esthetic characteristics of these ceramic systems have an intimate relationship with the optical phenomena of light, which means the esthetic result of a restoration is directly related to the interaction between light and matter.\(^7\) Translucency is a property that permits the passage of light through a material or tissue. Translucency is very important because it helps to give ceramic restorations a more lifelike appearance. The presence of different degrees of translucency in the different ceramic systems is definitely an advantage when they are carefully managed. An understanding of this optical behavior is essential, as the composition of the different ceramic systems may directly influence the esthetic outcome.\(^8\)

Common Challenges
When the clinician and the technician try to emulate the characteristics of a natural tooth in creating a restoration, there can be four common fundamental challenges:

- recreating the adequate shape of a tooth where there is not enough space
- obtaining depth in the restoration when it does not have the adequate space
- masking an unfavorable dental remnant
- imparting a natural appearance when it is necessary to use opaque materials.

These situations may result in the restorations not integrating, as the reproduction of translucency and depth is essential to the creation of esthetically integrated prosthodontics.\(^11\) These natural characteristics are more difficult to achieve in metal-ceramic restorations due to the presence of the metallic structure and the need for an opaque material to conceal it. Generally, when these factors are not well controlled it results in a more opaque or very gray restoration due to an excess of translucency.\(^12\) The selection of a ceramic system must be based upon each case’s clinical requirements, esthetic and functional needs, location of the restoration, prosthetic design, and laboratory techniques.

Dental Substrates
The chromatic analysis of the dental substrate is key when selecting a restorative ceramic system. Dental substrates without color alteration or with mild alterations may be considered as “favorable” substrates due to the fact that they will not produce evident alterations in the final restoration. Chromatic alterations of dental substrates as a consequence of endodontic treatment, use of metal posts, tetracycline stains, or hypoplasia, just to name a few, deem the substrates to be considered “unfavorable” as they will cause chromatic esthetic alterations in the final restoration. Therefore, this group of substrates will need deeper analysis when selecting the restorative ceramic system.

New Options, New Questions
The dental market today offers a great variety of pure ceramic systems for the fabrication of dental prostheses. This means new options but also generates new doubts about which system to choose. Will all ceramic systems have the same optical behavior, or will the different compositions have different outcomes? The authors believe that each case must be analyzed carefully. Evaluation of the degree of translucency and opacity of the dentin-enamel complex delivers information about which ceramic system can provide a better esthetic solution. Only after this determination is made is it possible to select the most appropriate ceramic system to deliver the desired clinical outcome.\(^15\)
Case 1: Laminate Veneers on Refractory Model

A 35-year-old male patient wanted to improve the appearance of his upper central incisors. Extensive composite resin restorations were noted during the clinical examination. The patient reported that these direct restorations had been replaced three times over a four-year period after his teeth suffered sports-related trauma. The defective restorations presented color deficiencies, evident and stained margins, and lack of gloss (Fig 1). The patient did not want a radical change so it was decided to maintain the basic dental format. Two laminate feldspathic veneers (IPS d.sign, Ivoclar Vivadent; Amherst, NY) were planned on a refractory model. After removal of the restorations and refinement of the dental preparations, favorable remnant dental tissue was observed (Fig 2). This last piece of information was very important for the ceramist due to the fact that it allowed for the planning of the ceramic stratification. Figure 3 shows the use of a silicone guide to corroborate the length and volume of the final restoration with the dental remnant. It can be observed how the dentin-colored ceramic is needed to compensate for the loss of dentin tissue.

To obtain a chromatic base and adequate opacity in the middle third and incisal region, it was necessary to apply a dentin layer with an augmented opacity to compensate the preparations and even out the substrates in opacity and color, imitating the dental tissue (Fig 4). Silicone gingiva was used to create the emergence profile. The application began with more saturated layers in the cervical region. Then the vestibular margin crests were built until the final dentin shape was obtained (Figs 5a-5c). The internal effects were achieved after an incisal reductio of the dentin for the subsequent application of layers for absorption and reflection of light. Opalescent ceramic was used as a final layer before the first bake (Figs 6a-6c). After the first bake, the incisal ceramic was used on the restoration’s entire surface. The final bake allowing the ceramic layers to be observed is shown in Figures 7a and 7b. Macro and micro texture was performed for better individualization of the veneers (Figs 8a & 8b). The esthetic potential of veneers fabricated with feldspathic ceramic on a refractory model is an excellent option to solve esthetic problems in the anterior region (Fig 9).
Figures 5a-5c: (a) The shape is sculpted to create the anatomical form. (b) Dentin layer buildup. (c) Dentin ceramic is built up in full contour according to the diagnostic wax-up.

Figures 6a-6c: (a) Dentin ceramic was cut back. (b) At the incisal edges, the mamelons were shaped to conform to the transparency. (c) Layering of feldspathic ceramic onto the refractory dies to build up the incisal wall and proximal aspect.

Figures 7a & 7b: (a) Enamel layer buildup. It is important not to overbuild ceramics when fabricating laminate veneers. (b) Completed ceramic layering.

Figures 8a & 8b: (a) Final shape. (b) Final texture of the laminate veneers.

Figure 9: Final result 30 days after placement of feldspathic laminate veneers on the central incisors.
Case 2: Anterior Crowns Over Different Substrates

A 38-year-old female patient was concerned about the appearance of her smile. She presented with a deficient porcelain-fused-to-metal restoration and metal post in the upper right incisor, darkening of the upper right lateral incisor due to a previous endodontic treatment, and extensive vestibular and palatine composite resin restorations in the upper left central and lateral incisors (Fig 10).

A situation that represents great challenge is the differences between substrates, in this particular case a metallic post (upper central incisor), an obscured dental remnant, and two favorable remnant dental tissues (Figs 11a & 11b). Selecting the correct ceramic is important to prevent the unfavorable substrates from negatively influencing the esthetics of the final result. Taking this into consideration, it was decided to fabricate ceramic crowns using a stratification technique. The copings were MO 0 (IPS e.max Press), to which a fine layer of ceramic (wash) was applied for better adhesion and control of the luminosity (Fig 12). The application of the ceramic layers started on the cervical region until the full shape was conformed. Incisal cuts were made to apply the internal effects (Fig 13). After the first bake, it was possible to evaluate the ceramic and determine whether any corrections were necessary (Fig 14a). To complete the final shape of the crowns an incisal layer was used on the entire surface.

To achieve an esthetic integration of the restorations, correct morphology and texture must be considered in addition to color. The color markings allow visualization of the areas of light reflection, making any corrections easier. The macro and micro texture will impart individualized characteristics and, therefore, a more natural appearance (Fig 14b). In the postoperative appointment, it was possible to observe how the shape, texture, and color favored the integration. Selecting the right ceramic system (IPS e.max Ceram) prevented the different substrates from negatively influencing the final outcome (Fig 15).
Figures 13a & 13b: Ceramic layering.

Figures 14a & 14b: Completed crown restorations on the solid cast before finishing: (a) Ideal positioning of the line angles for optimal light reflection. (b) Texture and final form.

Figure 15: Intraoral view of the definitive crown.
Case 3: Single Anterior Crown Over Unfavorable Substrate

One of the biggest challenges in dental rehabilitation is the restoration of a single central incisor. In these cases the shape and color are essential for integration of the restoration. It is necessary to carefully observe the homologous tooth to be able to reproduce its most evident characteristics in the ceramic. The final value of the restoration must be the closest to the natural tooth due to the fact that minor differences in color may always exist. All these considerations will result in a more natural-looking restoration.

A 35-year-old female patient presented with a provisional crown and wished to have a definitive restoration. Once the provisional was removed, an obscured dental remnant with a composite resin was found. To mask the unfavorable dental tissue it is necessary to use a material that possesses enough opacity to hide the tooth but at the same time delivers an adequate chromatic base for the stratification. Therefore, a zirconia coping was created (Amann Girrbach North America; Charlotte, NC) (Figs 16a-16c). After the first ceramic bake it is helpful to make a try-in, which will allow evaluation of the ceramic stratification (Figs 17a-17c). Small differences in color are always present; therefore, when restoring a single tooth the shape and secondary characteristics of morphology will play a very important role in the integration of the restoration. Ten days after cementation, it was possible to see that the shape, texture, and color were very close to the patient’s natural teeth, achieving a good integration (Figs 18a & 18b).

When the clinician and the technician try to emulate the characteristics of a natural tooth in creating a restoration, there can be four common fundamental challenges...
Figures 17a-17c: (a) Masking porcelain (100%) was applied to the ceramic core. No difference can be observed in color and light reflection compared to the natural right central incisor. (b) Similar translucency at the incisal edge is evident between the incisors. (c) After the first bake try-in, the ceramic crown on the left central incisor masks the dark color in the cervical area.

Figures 18a & 18b: (a) Intraoral view of the definitive crown. (b) Integrated relationship between the teeth and lips.
Discussion

Bonding
Not only is it important to select the right material for each clinical situation, but it also is important to consider the type of cementation used with each system. Appropriate bonding is a critical factor in the clinical success of all-ceramic restorations. However, the wide variety of all-ceramic systems available today may be confusing to the clinician. In terms of achieving reliable results, each system must undergo different and sometimes specific methods of surface treatment before bonding. Knowledge of proper surface treatment, based upon the composition and physical properties of the ceramic materials, is essential to achieving a long-term, durable bond.

Bonding Strength
Glass-based ceramics (i.e., feldspathic, leucite-reinforced, and lithium disilicate) have shown high bonding strength to resin cements. Bonding to feldspathic porcelain and glass ceramic can be achieved through etching. For feldspathic porcelain, 9% to 12% hydrofluoric acid gel is necessary for 60 to 80 seconds and for glass ceramic, 5% hydrofluoric acid gel is necessary for 20 seconds. The following steps are the same for both ceramic systems:

- **Cleaning.** Cleaning the etched porcelain is critical. During the etching process, dissolution of the glassy matrix ultimately leaves retentive holes, tunnels between the acid-resistant crystals, and ceramic residues and remineralized salts, leaving a typical whitish residue. Ultrasonic cleaning, which can be preceded by phosphoric acid precleaning, is essential to remove the residues, enlarging and enhancing access to the micro retentive features.

- **Bonding.** It is necessary to apply a layer of bonding material. The use of silane promotes additional chemical bonding. After these steps the ceramic surface is ready to receive the resin cement.

High-strength ceramics are not silica-based (i.e., zirconia or yttria-stabilized zirconia, alumina). The bio-inert high-crystalline and low-glass composition makes high-strength ceramics corrosion- and acid-resistant, rendering adhesion protocols applied for silica-based ceramics ineffective. Currently, no consensus exists regarding the best adhesion protocol for zirconia used in dentistry; this is important particularly for restorations where mechanical retention is deficient. Systematic reviews analyzed the adhesion potential of resin-based and glass-ionomer luting cements to zirconia and aimed to highlight the possible dominant factors affecting the bond strength results to this substrate.

Luting
Regarding luting technique, the combination of mechanical and chemical pretreatment appeared particularly crucial to obtain durable bonding to zirconia ceramics. Increased adhesion can be expected after physicochemical conditioning of zirconia. Air particle abrasion, ceramic primer (with monomer 10-methacryloyloxydecyl dihydrogen phosphate [MDP]) and MDP-based resin cements tend to present better results than those of other cement types.

Summary
The light-transmission characteristics of teeth and restorative materials must be examined to allow a fully esthetic integration. Favorable dental substrates allow better esthetic outcomes, while unfavorable dental substrates must be overcome to produce desirable results. As restorative materials continue to evolve, clinicians and technicians will be able to create improved esthetics and harmony, thus increasing patient satisfaction with the definitive result.

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References


The dental market today offers a great variety of pure ceramic systems for the fabrication of dental prostheses.

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Selecting the correct ceramic is important to prevent the unfavorable substrates from negatively influencing the esthetics of the final result.
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1. Today’s ceramic systems have excellent optical properties such as
   a. opalescence, fluorescence, translucency, and rigidity.
   b. fluorescence, translucency, flexibility, and chromaticity.
   c. translucency, rigidity, flexibility, and chromaticity.
   d. opalescence, fluorescence, translucency, and chromaticity.

2. Efforts to improve today’s ceramics have focused on
   a. producing more symbiotic pressable enamel layering.
   b. using more densely chromatic core materials.
   c. creating monolithic ceramics that are more precise and fracture-resistant.
   d. creating ceramics that exhibit polychromaticity, thus increasing the need for layering.

3. The esthetic characteristics of ceramic systems have an intimate relationship with
   a. the color of the preparation.
   b. the opacity and color of the resin cement used.
   c. the optical phenomenon of light.
   d. the thickness of the restoration.

4. In dental terms, what is translucency?
   a. The reflection of light by a material or tissue.
   b. A characteristic used to mask the color of darker preparations.
   c. A property that creates a more natural passage of light through ceramic restorations.
   d. A characteristic that is best represented in monolithic restorations.

5. When selecting a ceramic system,
   a. it is important to remember that all ceramic systems have the same optical behavior.
   b. monolithic ceramics have proved to be a universal system meeting all esthetic demands.
   c. each individual case needs to be analyzed independently.
   d. the ceramic should be chosen based solely upon the opacity required.

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