JCD
Journal of Cosmetic Dentistry

Maximizing Esthetics: Combining Digital & Analog Workflows

Dr. Somkiat Aimplee, P. Sinthuprasirt, A. Acevedo, A. Blasi, A. Torosian, G. Chiche

Dental Photography—An Achievable Art

Interdisciplinary Treatment & Digital Workflow

2019 VOLUME 35 ISSUE 3
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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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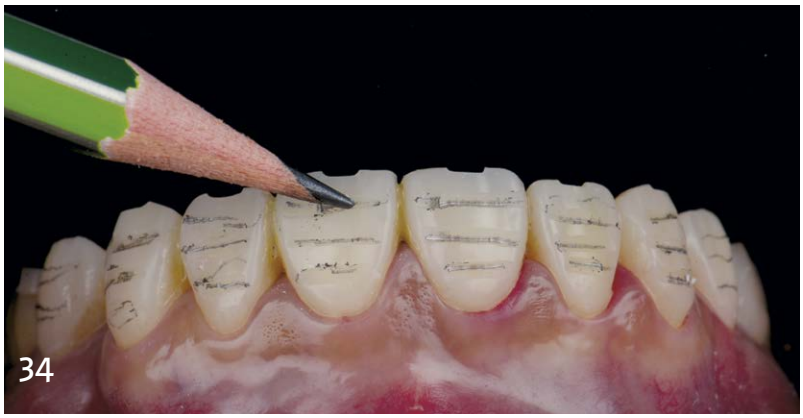

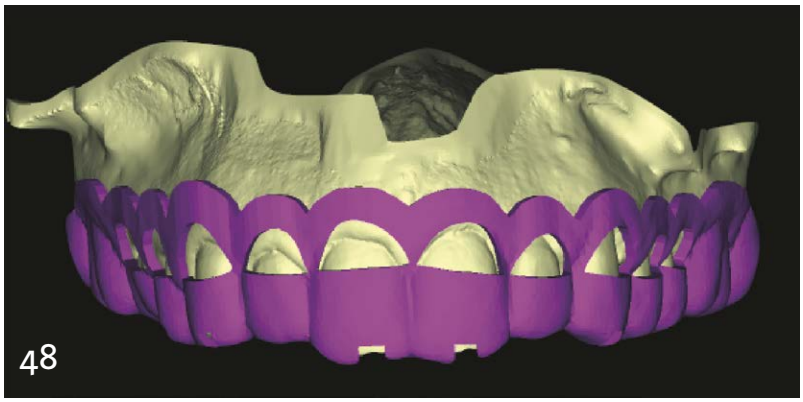

Column

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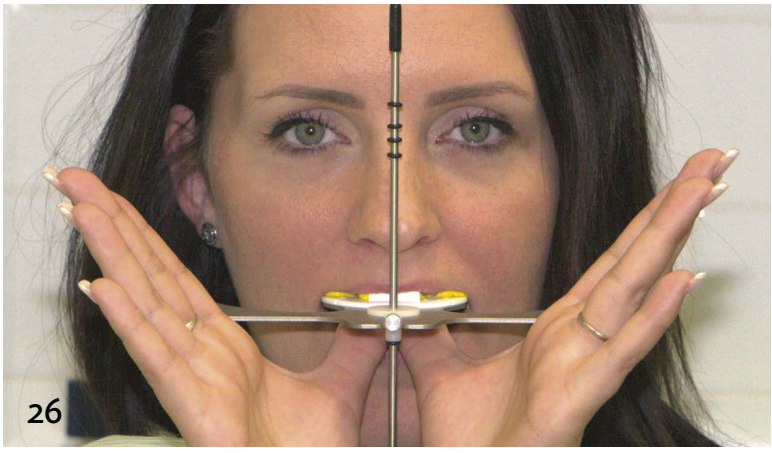

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Our Promise: Refreshing Content & Stunning Photography

> **We continue to take great pride in publishing quality, peer-reviewed educational content that reflects many different perspectives, from the clinic to the laboratory.**


THE JOURNAL
OF THE AMERICAN ACADEMY OF COSMETIC DENTISTRY
Vol.1, No.1
LIGHT-ACTIVATED POSTERIOR RESINS: THICKNESS AND SHADE
Q&A
GLASS IONOMER QUESTIONS & ANSWERS
MATERIALS AND METHODS
Fall Quarter, 1985


CLINICAL COVER CASE

When the *Journal of Cosmetic Dentistry (jCD)* was established in 1985, the Academy's mission was to produce a journal that "will endeavor to provide a format of dynamic interchange and welcomes your participation." Today, the *jCD* holds true to this foundation that was set before us, and we continue to take great pride in publishing quality, peer-reviewed educational content that reflects many different perspectives, from the clinic to the laboratory. We hope that to you we are more than just beautiful images.

We began by publishing reviews on the latest cosmetic dental materials, and we remain dedicated to educating you on the advancements and practical knowledge in cosmetic dentistry. Inclusive of comprehensive cases, new techniques, how-to guides, visual essays, and now research, the journal continues to grow and gain recognition among those in the cosmetic dental community.

In this issue, you will find examples of modern interdisciplinary esthetic dentistry with high-quality images and proven protocols and techniques. This visual approach offers our readership a stimulating way to learn and participate. Stunning photography illustrates incredible details and shows you the power of important documentation. Our content offers a refreshing twist to educational content, one that balances practical techniques and inspirational talent.

With a global circulation of more than 5,000 readers in more than 70 countries, the *jCD* is dedicated to making the satisfaction of the AACD membership our highest priority. Above all, we wish for you to be active participants in your Academy's journal. There are many ways for you to participate:

1. Showcase your artistic mastery by submitting a cover image.
2. Write a well-documented how-to article on a technique you use in your everyday practice.
3. Highlight your amazing photographs in a visual essay.
4. Detail a clinical case from start to finish in a traditional case report.
5. Enlighten our readership by sharing current research with a practical value.

In return, I can assure you that, along with our respected editorial review board, our editorial team will provide you with excellent service. Our goal is to make publishing your work a seamless and enjoyable experience. We also welcome your ideas and feedback as we work to develop more ways to deliver state-of-the-art cosmetic dentistry in collaboration with you, our readership. Please reach out to me at edwardl@aacd.com. I am waiting to hear from you!

Looking forward,

Edward Lowe

Edward Lowe, DMD, AAACD
Editor-in-Chief

> Nature always creates a perfect harmony of a beautiful smile that suits each person's face and personality.

Natural and Facially Driven Designs

By Somkiat Aimplee, DDS, MSc, FACP, AAACD

For me, beauty and function are the same thing. Nature always creates a perfect harmony of a beautiful smile that suits each person's face and personality. My philosophy is to follow what nature already created as a guideline to design a beautiful smile that harmonizes with the patient's functional pattern.

In the age of selfies, preoccupation with personalities, and heavy dependence on social media "influencers," it appears that society is more self-absorbed than ever. People are obsessed with themselves and outward appearances. Confidence in their own smile has become extremely important in social media and real life.

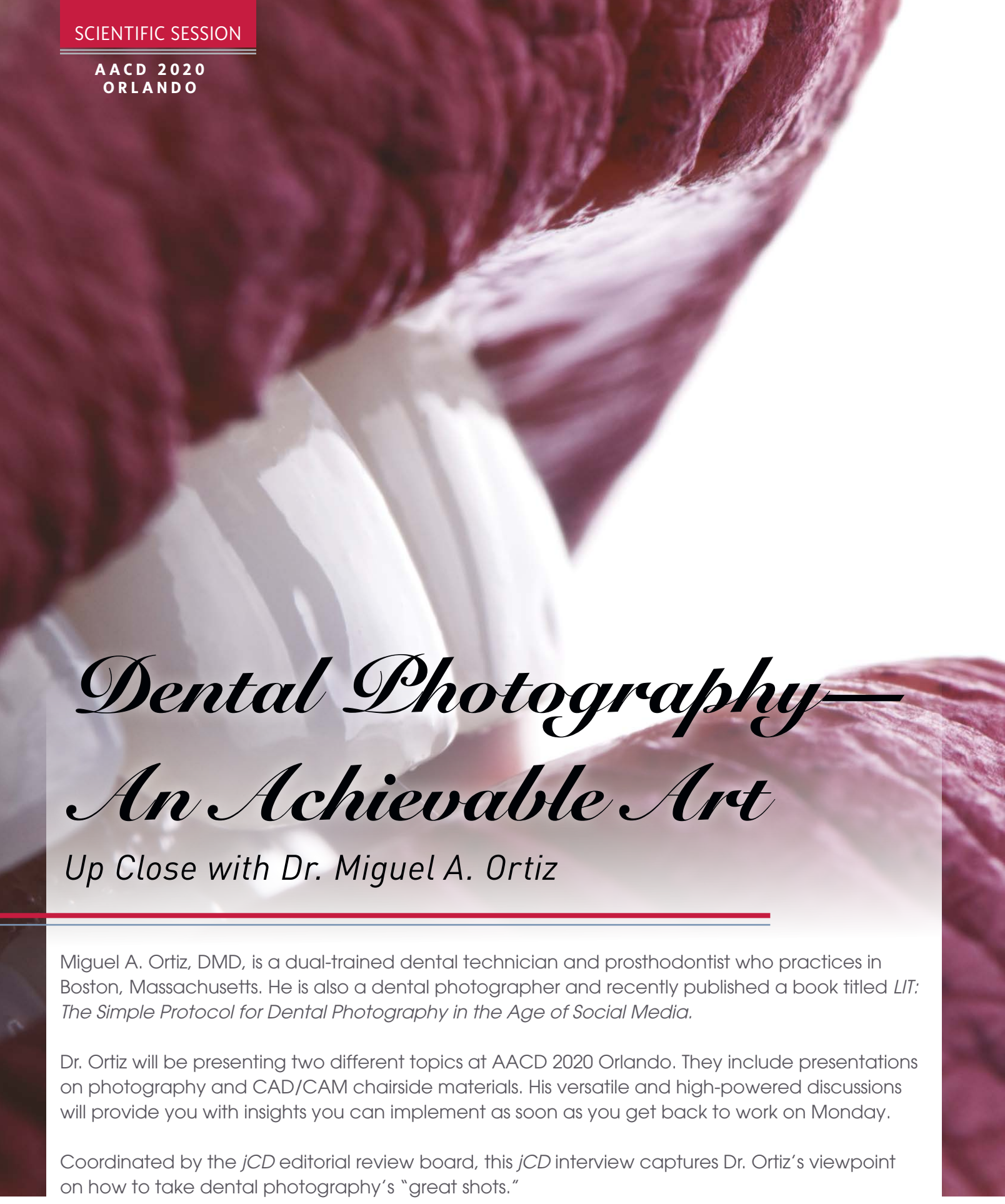
As a cosmetic dentist/smile designer, I am able to express my vision and artistry through my work. By using my knowledge about symmetry, harmony, balance, proportion, and color, it is possible for me to use my designs as a vehicle to create a smile that complements my patients' faces.

I believe in teamwork, so I work closely with other specialists and technician team members to share our expertise and utilize interdisciplinary treatment for every patient. Each patient's treatment always starts with a clear vision and the end result in mind, utilizing all the parameters required for specific materials, parts and components, biological limitations, and technical possibilities.

Digital smile design technology is an amazing tool to share the vision of my smile design with my team and patients. It is also a great opportunity for patients to share their vision of themselves with me. Digital dental technology enhances precision and our team's ability to follow nature and create a personalized, facially driven restoration for each patient.

Cover image photographers: Dr. Somkiat Aimplee and Andres Acevedo, CDT. Camera: Canon EOS-1D X/Canon (Oita, Japan), 100mm f/11, EF 85mm f1.4L IS USM 1/125s, ISO 200.

Turn to page 34 to read the Dr. Aimplee's clinical cover article.



Dental Photography—An Achievable Art

Up Close with Dr. Miguel A. Ortiz

Miguel A. Ortiz, DMD, is a dual-trained dental technician and prosthodontist who practices in Boston, Massachusetts. He is also a dental photographer and recently published a book titled *LIT: The Simple Protocol for Dental Photography in the Age of Social Media.*

Dr. Ortiz will be presenting two different topics at AACD 2020 Orlando. They include presentations on photography and CAD/CAM chairside materials. His versatile and high-powered discussions will provide you with insights you can implement as soon as you get back to work on Monday.

Coordinated by the *jCD* editorial review board, this *jCD* interview captures Dr. Ortiz's viewpoint on how to take dental photography's "great shots."

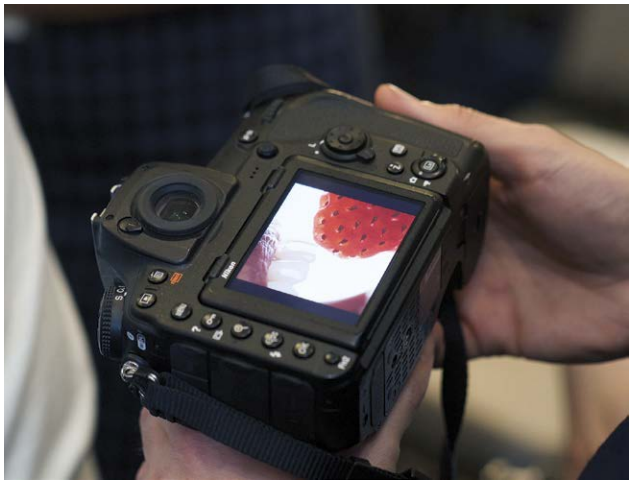
Introduction

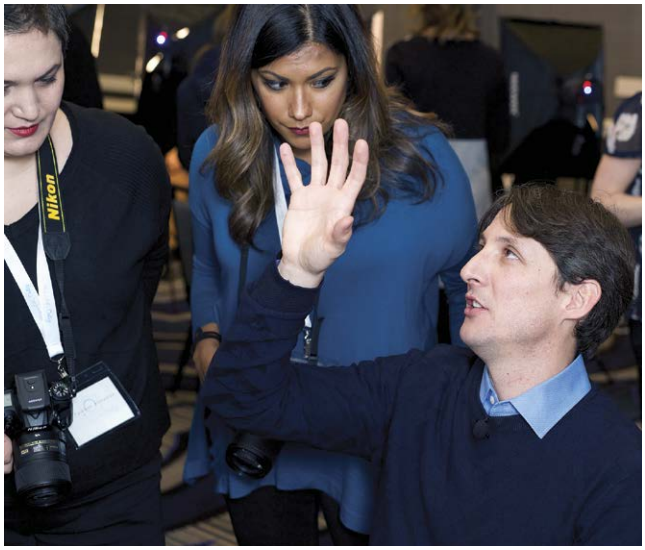
There are many different elements to dental photography and numerous questions arise from all of its aspects. When teaching, I will try to answer some of the most common questions by offering a simple protocol for dental photography. We all want to achieve that perfect shot and with practice and use of proven protocols you can and will capture that "great shot."

Q: What made you decide to focus so intensely on spreading the word about the importance of dental photography?

A: Struggling dentists. Most people who decide to learn photography do it because they already like it. It's a pleasant hobby, not a necessity or burden. But people in our profession feel the pressure—the need—to take great clinical photos, whether they're interested in photography in general or not. When you're forced to learn a fairly complicated skill that you aren't passionate about, it can be extremely difficult.

I decided that I wanted to make it simple, accessible, and beautiful for dentists to learn the craft. I developed a 1-day course that emphasizes hands-on learning with personal coaching. I teach general photographic principles and then apply them to dentistry because I want dentists, technicians, assistants, and hygienists to learn to take photos not just of teeth but also of their vacations, their kids—everything. Not only is photography a crucial professional skill, but it's also an achievable art. It's a form of expression we can all tap into and enjoy.





Q: What is the first piece of advice you give to a dentist or lab technician who is interested in improving their photography skills?

A: Photography is simple, much more so than you think. Don't try to figure it out alone. Don't use trial and error. I've already done it, and so have many others, so there's no need for you to spend years figuring it out, too. I have tried, struggled, failed, and spent way too much money on things I was told I needed but really didn't. Just take a course, any course, and in one day you'll be good to go. It doesn't have to be my course—there are many great dental photography courses out there—but it will save you so much money and energy. Lastly, as with any skill: practice, practice, practice.

Q: Often times, the dental ceramist is far more advanced in photographic skills than the partnering dentist they are working for. Therefore, the beauty of final work is often not transferred back for improvement in the relationship. How do you suggest strengthening the partnership between the dentist and ceramist through photography?

A: I am both a dental technician and a prosthodontist, and I can tell you that Miguel the dental technician is not better than Miguel the prosthodontist at taking photographs. The reason for the difference in results is simple: dental laboratory photography is easy; intraoral photography is not. Miguel the dental technician may be great at taking photographs of crowns on a flat surface, but if you get that same Miguel in the operatory to try and take great intraoral photographs, he will struggle.

Intraoral photography is not easy. If you are a dentist out there who struggles with intraoral and portrait photography, you're not crazy. It is extremely challenging, but it can be done with the right planning. "The Simple Protocol" that I developed is designed for small operatories and enables you to take a full set of intraoral photos without moving the patient, the lights, or the photographer (you). With a plan and practice, you can master intraoral photography.

Q: In your photography course, do you suggest that a dentist–ceramist partnership attend together to improve their skills together?

A: I recommend that everyone in the dental team who is part of the process of photographic documentation and laboratory communication take a photography course. I can't stress this enough. Stop struggling, take a course, and save a lot of time, frustration, and money.

A ceramist and a dentist taking the course together is the ideal situation because by standardizing their knowledge, they will be able to speak the same language. Dentist–technician duos come to my course all the time, and they usually engage in a side conversation with me about their specific needs and struggles, and we work together to iron them out. It's important to make that vital communication smooth. Laboratory communication is an entire chapter in my book and a vital part of my course—that's how important I believe that relationship is.

"A ratio is a way of setting your camera's focus at a specific distance so that you can come back later and take the same photograph as before."

Q: How can dentists standardize their photographs for inter- and intra-patient comparisons?

A: There are many ways to standardize any kind of photography. If we are talking about standardizing the framing, so that the subject in the photograph is in the same position and at the same size from initial photograph to final photograph, then we can use the concepts of ratios. A ratio is a way of setting your camera's focus at a specific distance so that you can come back later and take the same photograph as before.

If we are talking about the way the photograph feels or looks, then we are probably referring to color temperature. Understanding that all light has an inherent "temperature" to it and knowing what the temperature of your lighting is will allow you to create a color-corrected photograph every time by plugging the temperature of your lighting into your camera. Using a gray card as a reference will help you do this.

Exposure is another consideration. If you want your photographs to have the same brightness (not too dark, not too bright), then you can use the camera's histogram.

As you can see, there are many concepts to learn and tricks of the trade that will empower you to take consistent photographs every time.

Q: Many clinicians are confused about whether to use a ring flash or bilateral flashes. In your opinion, which is the ideal choice?

A: This is a great question. I am one of the creators of the dental photography movement called "Free Yourself," which refers to the notion of not having flashes attached to your camera at all. I spend a lot of time discussing this in both my course and my book.

When the flashes are attached to your camera, you have two main issues. First, the camera becomes heavier and bulkier. Second, every time you move back and forth to take a different photograph, your lighting changes. If you get closer, the lighting gets brighter. If you get farther, it gets darker. Additionally, every time you move sideways, you get shadows. This can be very frustrating and require a lot of work to correct.

What I recommend instead is to use a pair of speedlights on two simple, inexpensive tripods, with one speedlight on each side of the patient. Once you set your level of exposure (how bright you want the photograph to be), you can move around as much as you need to with your camera, and all of your photographs will have the exact same lighting conditions.

To answer your question in short: A dual flash is better than a ring flash, but no flash on the camera is better than both by far.

"What I recommend instead is to use a pair of speedlights on two simple, inexpensive tripods, with one speedlight on each side of the patient."

Q: Between private practice, your book publication, Dent Lit, your online social media presence, and your family—how do you manage to balance all of these things?

A: I know how I try to do it. I wake up every morning at 5 am and read between 20 and 40 dental literature articles for the benefit of my patients. I answer between 800 and 1,100 messages a day on my Instagram account. I treat patients with respect, then I come home and keep working. I try to spend a lot of time with my wife and kids. We take as many vacations as possible, more than most people. I do the things I love and the work I love, and I spend time with the people I love. I like to keep busy—I always have.

I won't know whether I have succeeded at the balance in my life until maybe 25 years from now, and I can think of only one test for this that counts: If, in 25 years, my children say, "My dad was a great dad. He was always there, and he loved me dearly," then I will be content. I will be able to say I had a balanced life.

The AACD welcomes Dr. Ortiz *to AACD 2020 Orlando and looks forward to learning more from him. The jCD would like to thank Dr. Ortiz for his time and for sharing his perspective in this interview.*

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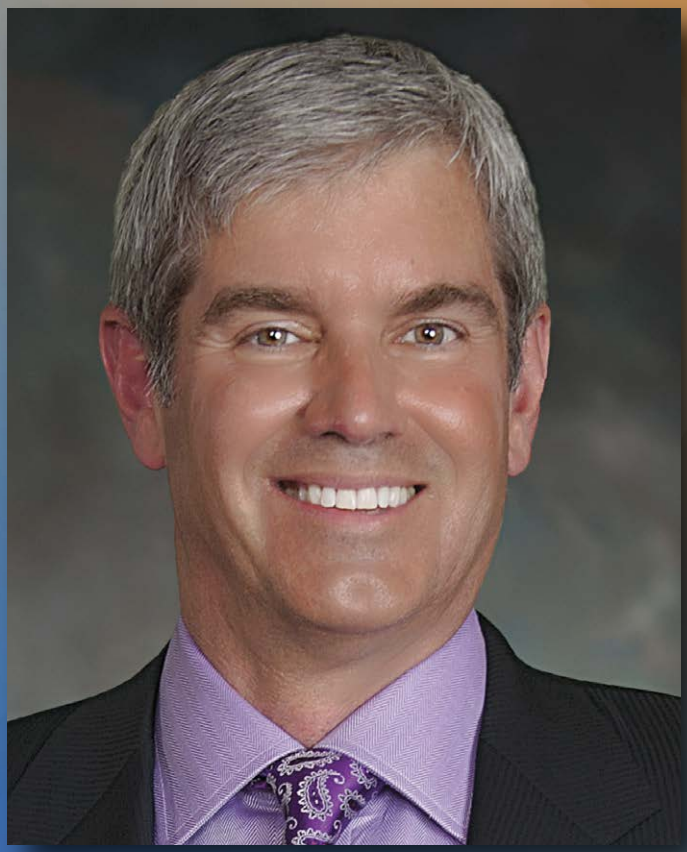

Gary Hubbard, DDS, FAACD
East Lansing, MI

Dr. Gary Hubbard has been an active member of organized dentistry at local, state and national levels, participating in numerous organizations. In 2011, Dr. Hubbard achieved Accredited Member status in the AACD. He completed his undergraduate at Michigan State University and attended the University of Michigan School of Dentistry, graduating as an OKU inductee in 1978. After completing a teaching appointment as a clinical instructor, he returned to Lansing to begin private practice. He has maintained a cosmetically and complex restoratively oriented practice in East Lansing, MI since then.

Combining Orthodontics with a Porcelain Veneer to Restore a Single Anterior Tooth

Petteri Viljakainen, DDS

Abstract

Waiting for the right Accreditation case to present itself can be frustrating. Often a case may seem perfect, but, upon taking a closer look, you may find there is not enough space to achieve perfect symmetry between the teeth or that restorative options may be too invasive. However, when you combine orthodontic treatment with restorative treatment, the game changes, and more options are available to you. A combined approach can make these cases the right cases for Accreditation. Modern digitally planned orthodontic solutions make it easy to achieve space around teeth for restorative materials and create perfectly symmetrical gingival margins without invasive crown lengthening. Add teeth whitening at the end of the orthodontic treatment before restorative work, and you have the perfect method to treat young adults conservatively and comprehensively.

Key Words: minimally invasive dentistry, ortho-restorative, single anterior restoration, laboratory communication, Accreditation Case Type II

Figure 1: A retracted 1:2 view of the patient before orthodontic treatment.

Figure 2: The preoperative portrait view (1:10).

Figure 3: The prerestorative frontal smile view (1:2) shows a dark space on the left side.

Figure 4: The retracted 1:2 view shows a deficient/short tooth #10.

Introduction

Treating patients in the most minimally invasive manner as possible is a goal for which all dentists should strive, and with younger patients, it is essential to be conservative with restorative treatment. In this clinical case, orthodontic treatment was required to obtain an optimal minimally invasive restorative result. A minimally invasive porcelain veneer was chosen to restore a beautiful smile.

Case Presentation

Patient Complaint and History

A 32-year-old female patient presented for a consultation, looking to improve her smile. The patient was in good health with good oral hygiene. There were no symptoms of temporomandibular joint disease.

Oral examination and radiographs were all within normal limits.

Diagnosis and Treatment Plan

The treatment chosen was a minimally invasive porcelain veneer for tooth #10. The patient received a 12-month orthodontic treatment with clear aligners. Initially, the maxillary incisors were aligned by incisal edges, and there was moderate crowding in both arches. Orthodontic treatment was completed to align the teeth, especially the maxillary canines and incisors, and to idealize the cosmetic position of the teeth and gingival margins. Equal gingival zeniths from cuspid to cuspid are an acceptable relationship.[1,2] The patient was happy with the outcome, even though the maxillary teeth were not perfectly aligned. A veneer would be placed on tooth #10 and retained with an Essix retainer to allow the patient the option to continue the orthodontic treatment and fully align the maxillary teeth in the future **(Figs 1-4)**.

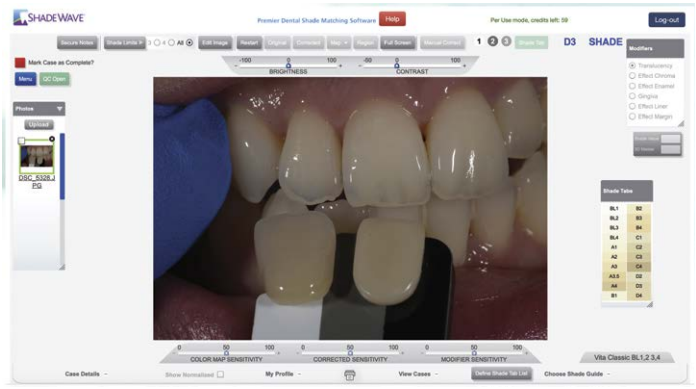

Figure 5: The shade was selected using a shade guide and shade mapping resources.

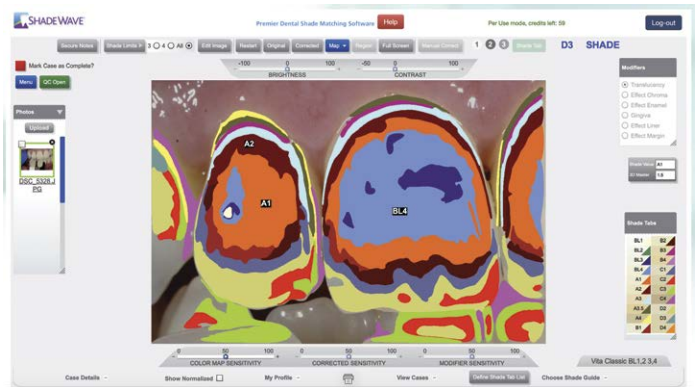

Figure 6: This view shows the gradients of color on the contralateral tooth (#7).

Figure 7: A retracted left lateral view (1:1) shows the prepared tooth #10.

Treatment

Preparation appointments: The complete AACD photographic views were taken before any treatment was started.[3] Preoperative impressions, which were taken using alginate impression material, were sent along with the photographs to the dental technician, who made a diagnostic wax-up to help plan the future restoration.[4]

The patient was scheduled for the next appointment in one week. Several putty preparation indexes from the diagnostic wax-up were made: a labial reduction index, an incisal reduction index, and a putty matrix for the mock-up.

A mock-up with provisional material (Structur2, Voco GmbH; Cuxhaven, Germany) was made directly in the patient's mouth. The length, width, and symmetry of the future restoration were then confirmed with smile photos. The shade D3 (VITA Zahnfabrik; Bad Säckingen, Germany) was selected, aided by the ShadeWave (Issaquah, WA) reference guide **(Figs 5 & 6)**. The patient was happy with the mock-up, and we decided to continue with the treatment.

The patient was anesthetized with 0.9 ml of Dentocaine (4% articaine hydrochloride, 0.009 mg/ml epinephrine tartrate, 0.005 mg/ml epinephrine, Inibsa Dental S.L.U; Barcelona, Spain). Optragate (Ivoclar Vivadent; Amherst, NY) was used for isolation and ease of access. The tooth was prepared with depth cutter burs (Komet Dental; Rock Hill, SC) through the provisional restoration. The depth cuts were placed directly into the provisional restoration, 1.5 mm from the incisal edge and 0.5 mm labially. The cuts were marked with pencil. The tooth was then prepared according to these markings in order to control the amount of enamel necessary to reduce **(Fig 7)**.

A retraction cord containing hemostat (Ultrapak 000 and ViscoStat Clear, Ultradent Products; South Jordan, UT) was placed around the tooth. The margin area was prepared using a fine bur to create a 0.5 mm subgingival margin.[5,6] Sharp edges were rounded using a coarse red disc (Sof-lex, 3M; St. Paul, MN). Photos from the prepared tooth were taken using an IPS Natural Die Material Shade Guide (Ivoclar Vivadent) and a polarizing filter (Polar_eyes cross polarization filter, PhotoMed Int.; Van Nuys, CA). Photos and a color map were then sent to the technician **(Figs 8 & 9)**.

Figure 8: A stump shade is taken to determine the shade of the prepared tooth.

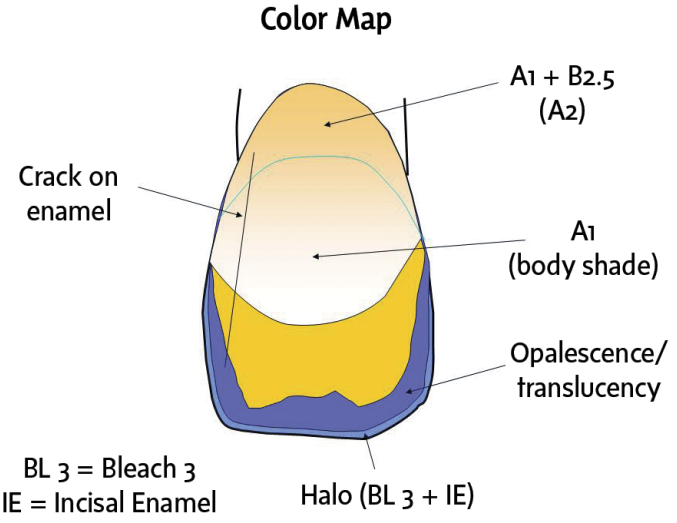

Figure 9: A color map was drawn to act as a blueprint for the creation of the porcelain veneer.

A secondary retraction cord (Ultrapak 0, Ultradent), was placed. Impressions were taken using polyether material (Impregum, 3M). The secondary retraction cord was removed immediately before taking the impression. A metal impression tray was used to take the impressions. The bite was taken using yellow Jet Bite (Coltene; Cuyahoga Falls, OH). A stone model of the mandibular arch was already made from the wax-up.

Tooth #10 was then spot-etched etched using 37% phosphoric acid (Total Etch, Ivoclar Vivadent) for 10 seconds and spot-bonded with an adhesive (Vivapen, Ivoclar Vivadent). The bonding agent was applied for 15 seconds and light-cured without air-drying for 10 seconds (Bluephase Style, Ivoclar Vivadent).

The provisional veneer was placed using a putty matrix taken from the wax-up with Structur2 provisional material. The matrix was removed after four minutes, and the veneer was finished using a fine carbide bur (Komet Dental). ExiTE F (Ivoclar Vivadent) was applied to the provisional restoration and light-cured for 10 seconds to achieve a more natural look. Alginate impressions and photographs were taken with the provisional veneer in place for the dental technician. The next visit for the patient was scheduled two weeks later. The patient saw the dental technician at his laboratory for more accurate shade-taking.

Try-in appointment: For the next appointment, the technician made three different veneers to choose from. The patient was anesthetized with 0.9 ml of Dentocaine. The provisional veneer was removed by making narrow cuts on the labial surface and the incisal edge. A carving instrument was used to separate the provisional veneer. The surface of the prepared tooth was polished using a white stone bur (Shofu Dental; San Marcos, CA). Three different try-in pastes (Variolink, Ivoclar Vivadent) were tested with each veneer: warm, light, and light+. Photos were taken both with and without a polarizing filter (Polar_eyes cross polarization filter) in order to select the most suitable veneer. No isolation was used during cementation because the gingival tissue showed no signs of inflammation or bleeding. The veneer was etched in the laboratory and cleaned with a cleaning agent (Ivoclean, Ivoclar Vivadent) before being silanized for 60 seconds (Monobond Plus, Ivoclar Vivadent). The restoration was then air-dried **(Fig 10)**.

Figure 10: Try-in with light resin cement (1:1).

Figure 11: The postrestorative frontal view (1:2) shows a much more pleasing smile and no dark space.

Figure 12: Retracted frontal view (1:2). The final restoration on tooth #10 matches the contralateral tooth and blends in with the adjacent teeth.

Figures 13a & 13b: Postrestorative full face view (1:10) and portrait view. The portrait view shows a very happy patient with a pleasing smile.

> Being able to create a lifelike restoration in such a conservative manner does a great service to the patient, and it is also very rewarding to the dental artist.

Teeth #9 and #11 were protected with polytetrafluoroethylene (PTFE) tape. Prepared tooth #10 was etched with 37% phosphoric acid (Total Etch, Ivoclar Vivadent) for 30 seconds. The phosphoric acid was rinsed using water, and the tooth was air-dried but not desiccated. An adhesive (Vivapen, Ivoclar Vivadent) was applied for 15 seconds, then air-dried and light-cured (Bluephase Style, Ivoclar Vivadent) for 10 seconds. The PTFE tape was then removed. The restoration was cemented in place using a dual-curing luting composite cement (Variolink Esthetic, Ivoclar Vivadent). Excess cement was removed using cotton rolls, dental floss, and sticks. The restoration was light-cured in place for 20 seconds both labially and palatally.[7] The margin was finished using a surgical blade (12, Aesculap; Tuttlingen, Germany). The surface of the restoration was polished using diamond paste (Orbis, Plandent; Helsinki, Finland), polishing spirals with fine and medium (EVE Ernst Vetter Gmbh; Keltern, Germany). The occlusion was then checked. The patient was recalled for final polishing three weeks after the restoration was made, and the 12 AACD posttreatment photographic views were taken at that time **(Figs 11-13b)**.

Summary

The patient was very happy with the final restoration. To achieve optimal restorative results, excellent laboratory communication is a must. Choose a laboratory technician who can perform such a fantastic service. Being able to create a lifelike restoration in such a conservative manner does a great service to the patient, and it is also very rewarding to the dental artist.

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The author thanks laboratory technicians Aki Lindén, MDT, CDT, Denturist; and Inkeri Mäkinen, CDT of Oral Lindent Premium Dentallab and photographer Henri Juvonen (for figure 13b) all from Helsinki, Finland.

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Dr. Viljakainen is in private practice in Helsinki, Finland.

Disclosure: Dr. Viljakainen lectures for Ivoclar Vivadent.

Case Type II: Artistically Restored Single Veneer

James H. Peyton, DDS, FAACD

The restoration of a single anterior tooth that looks natural and blends in with the adjacent teeth is a very challenging dental procedure. Being able to do this in a conservative and esthetic manner is a great benefit to the patient. It also benefits the dentist by knowing that they have provided the best treatment and that the appreciative patient may refer other patients to them. Excellent communication between the laboratory and the restorative dentist is a must. The laboratory technician can create a beautiful porcelain veneer, but the cosmetic dentist and any other specialists involved must provide the foundation for the clinical case to succeed.[1-3]

In this Case Type II, tooth #10 was artistically restored with a single conservative porcelain veneer. It is difficult to tell which tooth was restored; the restoration looks like it *belongs* **(Figs 1 & 2)**.

Figure 1: The prerestorative 1:2 smile view shows an extremely short #10.

Figure 2: The postrestorative 1:2 smile view displays a very nicely restored, natural-looking #10.

As with all Accreditation cases, however, no case is perfect. Getting the color correct is a major restorative concern and probably the most commonly deducted criterion.

The examiners for this case had the following comments:

- **Criterion #53:** *Is the color (hue, value, chroma) selection appropriate/natural, not monochromatic?* Most of the examiners observed that the restoration was lower in value.
- **Criterion #87:** *Are contralateral teeth in harmony in terms of size, shape, and position?* One examiner noted the restored tooth #10 was not in harmony with the natural tooth #7.

The clinician performed a great service for his patient by placing a conservative and esthetic porcelain veneer. The patient was happy, and Dr. Viljakainen should be proud of the final restoration. This is the kind of result Members in the Accreditation Process should strive to accomplish.

> "It is difficult to tell which tooth was restored; the restoration looks like it *belongs*."

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

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AN INTRODUCTION TO Diagnosis and Treatment Planning for Predictable Restorative Outcomes

Nada Albatish, DDS

Abstract

The dilemma in comprehensive dentistry is that dentists are often focused on restoring teeth for esthetic outcomes, and if occlusion is not taken into account during diagnosis and treatment planning, the risk of failure of esthetic restorations is real. Successful indirect and direct restorative dentistry is predicated on performing critical risk assessments and accounting for the findings when treatment planning a case. Unfortunately, many dentists fall into common traps that could potentially result in ongoing breakdown and, ultimately, cosmetic and restorative dentistry failures **(Figs 1 & 2)**. By properly establishing a stable occlusion using simple techniques and technologies, dentists can mitigate risk, reduce unproductive chair time, and increase patient satisfaction. This article provides a basic review of the principles of several essential diagnostic categories that are key to ensuring more predictable esthetic and functional outcomes, with an emphasis on avoiding common occlusal oversights.

Key Words: Occlusion, global diagnosis, joint and muscle diagnosis, functional wear pattern, occlusal traps

> This concept of global diagnosis, as developed by Jeffrey S. Rouse, DDS, and J. William Robbins, DDS, takes into account facial and skeletal proportions, the length of the upper lip and lip mobility, the canting of the maxilla, and dentoalveolar or dentogingival issues affecting the length of the clinical crowns of the maxillary anterior teeth.[3]

Bonus content!

This article has a CE course on AACD's Virtual Campus. To view, go to AACD.com/virtualcampus

Figure 1: In the case of a patient who presented after losing an anterior bridge that had been placed several years ago, it may be natural to assume that decay caused the current problem.

Figure 2: However, by examining the patient's occlusal scheme and tooth wear, it is clear that there is insufficient occlusal space for the bridge, and the current problem resulted from a force fracture. Therefore, the treatment challenge is restoring the space to avoid the same problem in the future.

Figure 3: An upper arch retracted, as you would see looking at an upper model. It appears appropriate here to lengthen the upper teeth incisally.

Figure 4: Same patient's smile photo. The patient's natural smile is excessively gummy, and her teeth are short, suggesting lengthening the anterior teeth is actually not an appropriate treatment option.

Figure 5: The patient's rest position. The excessive tooth show at rest indicates a more complex problem that would require measurement of lip length and lip dynamics to determine the actual diagnosis.

Introduction

The longevity of esthetic treatments depends upon several factors, including restoring teeth to their proper form and establishing and/or maintaining healthy occlusal function.[1] These requisites essentially underscore the need for dentists to visualize the esthetic and functional treatment outcomes.

Such a concept of "reverse engineering the end" is not new to dentistry, but rather has been widely used to guide how clinicians plan, perform the necessary procedures for, and ultimately deliver treatment outcomes. Unfortunately, even with the end in mind, it may be difficult for dentists to determine exactly where the starting point should be for treating a case. Because the most predictable and durable treatments are those that are diagnostically appropriate, dentists must first and foremost render an accurate—and comprehensive—diagnosis.[2] Rendering a diagnosis of the specific patient's condition and determining the etiology of the problem is the basis for planning appropriate treatment options that result in predictable long-term outcomes that truly restore oral health, not just resolve symptoms.

Global Diagnosis

If a dentist looks only at the teeth, that dentist may decide that a patient with worn anterior teeth requires lengthening of the teeth incisally. What the dentist may not realize is that—if the actual problem is something not seen by looking at the teeth alone, such as a "gummy smile"—this treatment plan may make the problem worse. A gummy smile is not in itself a diagnosis, and understanding the etiology is key to diagnostically appropriate treatment planning. Consideration must be given to the position of the teeth and the gingival positions in the face. This concept of global diagnosis, as developed by Jeffrey S. Rouse, DDS, and J. William Robbins, DDS, takes into account facial and skeletal proportions, the length of the upper lip and lip mobility, the canting of the maxilla, and dentoalveolar or dentogingival issues affecting the length of the clinical crowns of the maxillary anterior teeth.[3]

Global diagnosis through the use of photography and facial evaluation is crucial for interdisciplinary treatment planning and to ensure proper tooth positioning.[3] For example, in a case that would ultimately benefit from interdisciplinary care (e.g., orthodontics, orthognathic surgery, periodontal surgery, and complex restorative dentistry), examining only the patient's teeth could lead to a diagnosis of excessive wear and potential loss of vertical dimension, and a reasonable conclusion may be made to add length to the teeth incisally to restore what has been lost. Exclusively intraoral or model evaluation gives limited information in these cases **(Fig 3)**. On the other hand, upon evaluating at the full smile **(Fig 4)** and rest position **(Fig 5)** and measuring facial proportions, it becomes readily apparent that the problem would actually be exacerbated by lengthening teeth incisally (e.g., vertical maxillary excess, short upper lip, occlusal misalignment).[4]

Joint & Muscle Diagnosis

Dentists must be mindful not to focus exclusively on esthetics, but rather also render a joint and muscle diagnosis in order to identify potential functional issues. Although a patient may present without any pain or symptoms, an estimated 33% of asymptomatic patients have disc displacement in at least one joint.[5] If the presence (or absence) of a joint derangement or inflammation is not confirmed prior to initiating any occlusal alterations, the proposed treatment could create a risk for future joint noise, ongoing breakdown, and/or pain that the patient never experienced before. The joint is the first determinant of not only a stable occlusion but also the manner in which the case will be treated overall.[6] Therefore, it is essential for dentists to diagnose the temporomandibular joint; identify where the disc is located (e.g., healthy position between the condyle and glenoid fossa); and determine whether there is inflammation in different areas of the joint space (e.g., capsule, synovial fluid, retrodiscal tissue) or the muscles that could signal overuse and/or active breakdown.[7]

Discovering Disc Position

The gold standard for diagnosing disc position is magnetic resonance imaging (MRI), which shows contrast between hard and soft tissues and enables dentists to see the position of the disc relative to the condyle in closed and open mouth positions. Although cone beam computed tomography (CBCT) allows visualization of the condylar bone, glenoid fossa, and articular eminence, it does not differentiate the soft tissue and therefore is not useful for identifying disc position.

Joint vibration analysis (JVA) is a digital diagnostic tool that can be used to objectively analyze disc position. Demonstrating over 90% diagnostic accuracy between clinicians, use of this technology is based on the fact that when smooth surfaces rub together, little friction (i.e., vibration) is created.[8] When the disc is properly located between the condyle and fossa, the joint movement is smooth and quiet. This technology works on the basis that when the disc is out of place, there is more friction and, hence, vibration, which is recorded in the software.

Another method for diagnosing the temporomandibular joint is using a doppler or stethoscope for joint auscultation. Although far more subjective and with much lower diagnostic accuracy (e.g., below 50%) that is dependent upon operator experience, listening to the joints is a good starting point to understand their condition.[9] With practice, dentists can learn to differentiate background noise and crepitation.

Diagnostic Records

To gain a comprehensive understanding of the masticatory system, beyond single teeth, diagnostic records should be taken for evaluation in a seated condylar position once muscles have been deprogrammed, known as centric relation (CR). A simple way to think of CR is that it is a repeatable position independent of tooth contacts where the lateral pterygoid muscle is relaxed, the elevator muscles are contracted, and the disc is properly interposed between the condyle and the glenoid fossa. In contrast, maximum intercuspal position (MIP) is defined as the "complete intercuspation of the opposing teeth independent of condylar position."[10] MIP is commonly called habitual occlusion.[11]

It is important to recognize that only taking records in MIP ignores the joint position, and any positions occluding more distal than MIP would be missed (e.g., CR and everything in between). Thorough diagnostic records include CR bite records, facebow **(Fig 6)**, impressions or scans, models for mounting on a semi-adjustable articulator **(Fig 7)** or digital articulation. Protrusive bites can be used to set the condylar angle on the articulator to enable visualization of the pathways of mandibular movement with greater accuracy.[12]

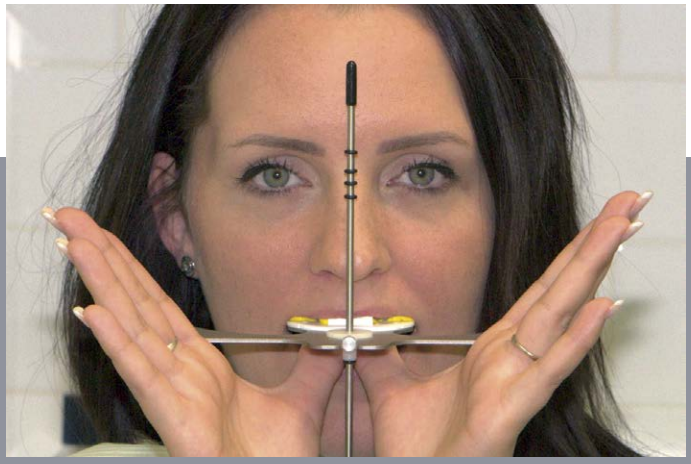

Figure 6: Without a facebow, the maxilla is mounted in an arbitrary position on the articulator.

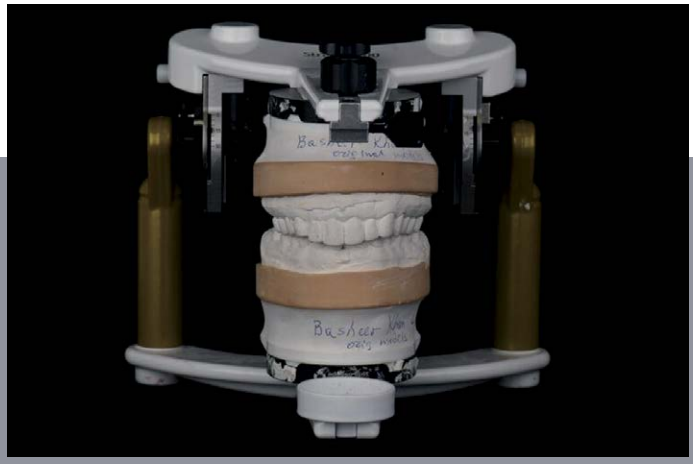

Figure 7: An articulator is invaluable for undertaking a functional analysis, which is necessary in cases involving symptomatic patients, unphysiologic occlusion, and/or restorative needs.

Figure 8: View of a patient with untreated GERD, the prevalence of which ranges from 11.6% to 45.3%.[15]

Etiology of Wear—Diagnostics & Functional Treatment Planning

There are three broad categories of wear etiology: functional, erosive, and parafunctional. Interestingly, beyond a restricted envelope of function, dentists typically do not see true functional wear since tooth contact during function does not actually occur.[13]

Erosive wear is commonly caused by gastroesophageal reflux disease (GERD) and is usually considered to be "heartburn." The wear pattern created by GERD typically appears as smooth cupped lesions of the occlusal surfaces of the lower molars, where the dentin is more worn than the enamel, and thin enamel on anterior teeth with smooth cupped lesions into the dentin.[14] It is important to understand that the prevalence of silent (asymptomatic) GERD may be up to 45% **(Fig 8)**, which means the acid will continue to erode any exposed tooth surfaces in untreated patients.[15] Patients who don't report heartburn but show this unique wear pattern should be tested for GERD. In many cases, the only clue that the disease exists is the condition of the teeth.[16] It is imperative that patients are treated medically for the underlying cause of the erosion. This will help to ensure that erosive wear of any exposed tooth surfaces does not continue after restorative treatment, in addition to improving the patient's overall health and reducing their long-term risk of morbidity due to GERD. Today, studies show a potential link between GERD, bruxism, and restricted inhalation/collapsed airway conditions, so investigating the airway is also important in patients exhibiting both GERD and bruxism.[17,18]

In erosion caused by eating disorders such as bulimia, studies have shown that up to 30% of patients continue to engage in recurrent binge-eating or purging behaviors after 10 years.[19] Smooth lingual wear of the maxillary anterior teeth is typical of the clinical presentation of bulimia patients. As clinicians, it is important to establish a relationship of safety and trust with these patients and to know whether the purging behavior is still active. In ongoing bulimia cases, burying the lingual gingival margins of restorations is an appropriate treatment plan in order to hide exposed tooth surfaces from ongoing acid injury **(Fig 9)**.

Parafunctional wear typically appears in a pattern that is dependent upon the patient's direction of movement of opposing tooth surfaces.[20,21] Diagnosing the wear pattern is an essential component of an overall functional diagnosis and is key to appropriate treatment planning. Even in the case of dental implants, occlusal overload is the primary cause of late implant complications.[22]

Force-related anterior wear can be categorized as pathway, end-to-end, and crossover wear **(Table 1)**.[18,20,23] Patients whose parafunction occurs in a combination of pathway and end-to-end movements are the most challenging to treat. These are the patients where overbite is critical, and steepening the guidance may result in wear, dentin exposure, abfractions, and/or fractured porcelain. Posterior wear, on the other hand, most commonly occurs as a result of gastroesophageal reflux, and can also occur when patients seat their condyles and brux on the posterior teeth.

Table 1: Force-Related Anterior Wear Patterns

Pathway Wear	End-to-End Wear	Crossover Wear
Occurs from right, left, and protrusive movements in patients with a restricted envelope of function, resulting in a vertical wear pattern and noticeable wear on the palatals of the upper and facials of the lower teeth **(Fig 10)**. These patients need freedom of movement (i.e., more overjet). Restricting the envelope of function may cause wear, migration, fremitus, and mobility.[23]	Occurs when the patient moves their teeth across the incisal edges, leaving teeth looking worn flat. These patients need broad, flat, and smooth contacts in protrusive and lateral excursions. Note that airway could be a potential cause, and the patient should be screened for a sleep-related breathing disorder.[18]	Occurs when the patient moves their teeth beyond the incisal edges, leaving the appearance of chipping of the upper facial and lower lingual edges. These patients require a smooth transition beyond the end-to-end position. "Destroyers" require protective appliances, and the airway should be considered.[20]

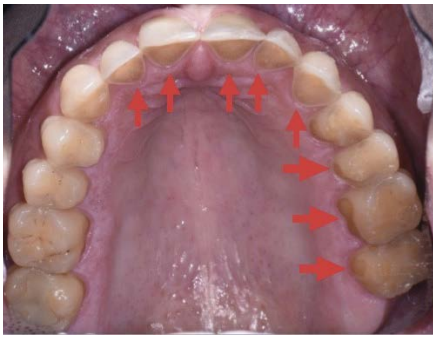

Figure 9: Palatal view of a patient with active bulimia; recurrent purging of stomach contents results in acid erosion of the lingual surfaces of the maxillary teeth.

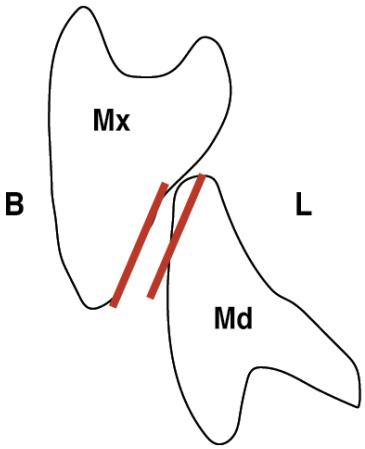

Figure 10: Diagram of pathway wear: vertical wear pattern evident on the palatals of the upper and facials of the lower teeth (areas of wear marked in red on diagram).

Diagnosing the wear pattern and not putting ceramic in the way of function or parafunction is important to enable patients to continue moving in the same way even after restorative treatment.[20] Additionally, creating anterior guidance and eliminating posterior contact in excursions reduces risk of failure in most situations when canines are healthy and intact, because muscle force is increased when posterior teeth are in contact.[24]

Conclusion

Dentists undertake the planning process in collaboration with their patients in order to satisfy their esthetic needs and wants as well as meet their overall treatment expectations. Predictable treatment and longevity of treatment outcomes rely on accurate diagnosis and appropriate treatment planning. Fortunately, a variety of techniques, tools, and educational opportunities can help dentists develop their skills in treatment planning after rendering a comprehensive diagnosis.

It's important to remember that a comprehensive diagnosis encompasses several components, including a global diagnosis, joint and muscle diagnosis, and a diagnosis of functional wear pattern and the patient's existing guidance. This is of course in addition to the standard biology (caries, periodontal disease, endodontic infections, etc.). However, the diagnosis of the etiology of any existing occlusal disease is also essential and must be addressed and subsequently incorporated into appropriate treatment plans that address all diagnosed conditions.[25] Therefore, it behooves dentists to remember and avoid the occlusal traps that could otherwise derail a predictable, diagnostically driven treatment.

TIPS FOR CLINICIANS

Introductory

- Pursue continuing education to master the principles of comprehensively evaluating patients, including airway, joints, muscles, teeth, etc.
- Perform a comprehensive joint and muscle exam, including thorough history, palpations, and range of motion measurements.
- Keep a diagnostic records checklist to ensure completion of CR bite records; facebow; impressions for mounting models on semi-adjustable articulators for evaluation; and protrusive bites to set condylar angle on articulator.

Intermediate

- Undertake esthetic treatment planning to put the incisal edges in the correct position relative to the face.
- Utilize Doppler auscultation to listen to joints for crepitation combined with a comprehensive exam to determine whether potentially more severe conditions exist.
- Use digital tools (e.g., Digital Smile Design or Keynote) to evaluate facial and occlusal planes and facebow records.

Advanced

- Utilize the principles of global diagnosis (e.g., evaluating facial height; lip length and mobility; gingival positions and tooth length; location of the cementoenamel junction) in order to sequence an appropriate treatment plan for addressing problems affecting gingival positions and the smile frame.
- Utilize JVA in combination with a comprehensive exam to more accurately diagnose joint conditions and evaluate joints in various positions.
- Perform a functional diagnosis and treatment plan to identify and treat underlying conditions or to allow function in a specific range of movement to continue without future damage.

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Dr. Albatish is in private practice in Toronto, Canada.

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> “Diagnosing the wear pattern and not putting ceramic in the way of function or parafunction is important to enable patients to continue moving in the same way even after restorative treatment.[20]”

Maximizing Esthetics with Minimally Invasive Feldspathic Veneers: Combining Digital and Analog Workflows

Somkiat Aimplee, DDS, MSc, FACP, AAACD
Pannapa Sinthuprasirt, DDS, MMedSci, PhD
Andres Acevedo, MDC
Alvaro Blasi, DDS, CDT
Aram Torosian, MDC, CDT
Gerard J. Chiche, DDS

Abstract

The keys to obtaining predictable and consistent results in esthetic treatment are diagnosis, smile design, treatment planning, team communication, and understanding patient expectations. Digital technology can facilitate this important communication with the patient in order to provide them with a clear understanding of the initial clinical situation, as well as a simulation of the future restoration. The goal of minimally prepared veneers is to preserve as much enamel as possible because bonding to enamel is more predictable than bonding to dentin. This article emphasizes an interdisciplinary approach, digital workflow, minimally invasive treatment, and material selection based on a digital smile design, printing technology for prototype models, and mock-up.

Key Words: digital smile design, interdisciplinary minimally invasive treatment, feldspathic porcelain laminate veneers, crown lengthening, ceramic layering, minimal preparation, digital workflow

Introduction

The keys to obtaining predictable and consistent results in esthetic treatment are diagnosis, smile design, treatment planning, team communication, and understanding and managing patient expectations. Facially driven esthetic analysis and smile design from the beginning improves communication among team members and enhances the patient's visualization, helping to create a more predictable outcome. At the beginning of each case, accurate treatment planning is required, and it must be clarified whether other interdisciplinary treatment is needed in collaboration with the restorative treatment.

The evolution of ceramic materials has increased and enhanced the minimally invasive treatment options. Ceramic veneers have become a well-established treatment modality for the conservative, highly esthetic restoration of malformed, discolored, malaligned, traumatized, fractured, and/or worn anterior teeth. This concept recommends superficial preparation within the enamel and adhesive luting to facilitate restoration with minimal loss of healthy tooth structure.[1,2,3]

Treatment with traditional feldspathic porcelain in a thickness of 0.5 to 0.7 mm with the goal of minimal removal of healthy tooth structure has been achieved. Significant advantages of conserving tooth structure include the absence of postoperative sensitivity, better bonding to enamel, minimal flexing stress, long-lasting restorations, potential for reversal, and higher levels of treatment acceptance. Based on data available in the literature, a minimally invasive approach can provide a more esthetic and biologically compatible restoration.[4-6]

Digital technology can facilitate this important dialogue. The Digital Smile Design (DSD) app (Miami, Florida)[7,8] and Dental System Software (3Shape; Warren, NJ), printed prototype models and mock-up aim to provide the patient with a clear understanding of the initial clinical situation, as well as a simulation of the future restoration's final result. Patients are more likely to accept treatment when they have a thorough understanding of the clinical problem and the proposed solution.

Case Presentation

A 32-year-old female presented to the office, unhappy with the appearance of her smile, the discolored fillings, and the chipped edges of her front teeth. She also reported additional concerns, including the gingival position, tooth proportion, and wide-open incisal embrasures. The patient had no medical contraindications or allergies **(Figs 1-4)**.

Figure 1: Preoperative full-face frontal view.

Figure 2: Preoperative full-face retracted view.

Figure 3: Preoperative close-up smile.

Figure 4: Preoperative retracted frontal view.

Figure 5: Preoperative intraoral scanning.

Figure 6: Preoperative intraoral scan image.

Evaluation, Diagnosis, and Treatment Planning

Complete intraoral and extraoral examinations were performed that included evaluation of the hard and soft tissues, temporomandibular joints, periodontal health, occlusion, and the conditions 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. Clinical evaluation revealed shape alterations affecting the anterior teeth and asymmetrical gingival zenith lines. A diagnostic model of both the maxillary and mandibular arches was obtained by using an intraoral scanner (Trios; 3Shape) and printing technology (Vida, EnvisionTEC; Dearborn, MI) **(Figs 5 & 6)**.

Smile Design Blueprint

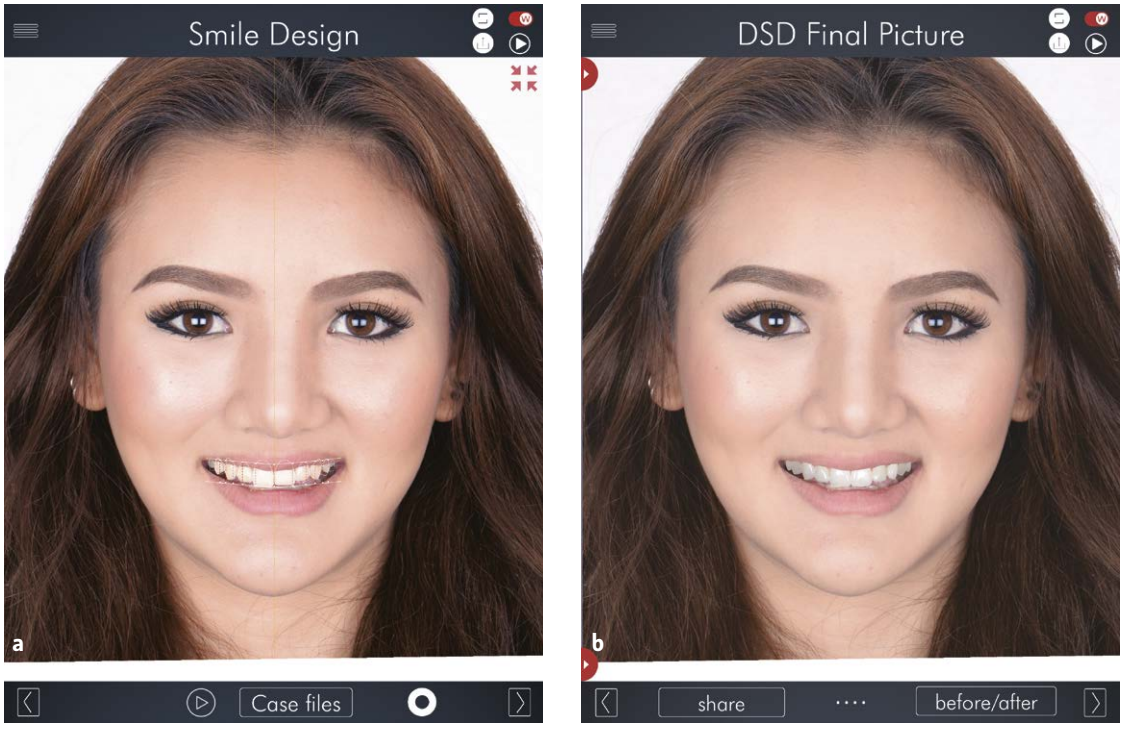
Dentists and laboratory technicians must follow a proper step-by-step protocol to achieve a predictable plan for clinical success. Therefore, the treatment plan should begin with a smile design blueprint. In this case, the clinical evaluation revealed that the gingival zenith lines and teeth sizes were asymmetrical.[9,10] A new gingival zenith and contour were determined for teeth #8 and #9. A smile design blueprint was then designed utilizing the DSD app and Dental System Software in accordance with the correct gingival margin, tooth proportion, and alignment to be established **(Figs 7a-8b)**. The STL files were exported and printed into models. The smile design blueprint model was ultimately used as the prototype for the final restoration **(Fig 9)**.

Mock-Up and Treatment Plan

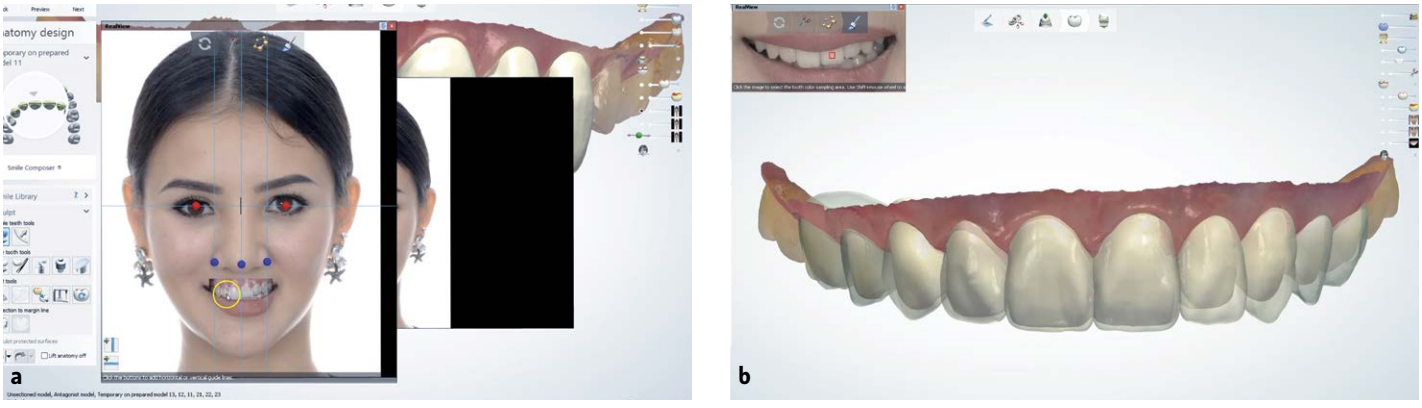
A mock-up can help to evaluate the patient's esthetic desires and expectations. The mock-up also serves as an effective communication tool for the dentist, patient, and dental laboratory technician. During the mock-up, the esthetic analysis should include an evaluation of the following oral features: 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[9-11]

A polyvinyl siloxane (PVS) template was made of the smile design blueprint model and used to transfer the prototype to the patient's mouth **(Fig 10)**. The template was loaded with bis-acrylic resin (Protemp Plus shade A1, 3M ESPE; St. Paul, MN) and seated in the mouth for 5 minutes. The template was taken out and excess material carefully removed with a #12D scalpel (Henry Schein; Melville, NY). Photographs were taken and videos made to guide the final treatment plan. Once the desired esthetic, phonetic, and functional outcomes had been verified with the mock-up, the clinical procedures based on the treatment plan—an interdisciplinary minimally invasive approach combining porcelain laminate veneers for teeth #4–13 and crown lengthening—could begin.

> "The goal of minimally prepared veneers is to preserve as much enamel as possible because bonding to enamel is more predictable than bonding to dentin."



Figures 7a & 7b: Digital smile design blueprint.



Figures 8a & 8b: Facially driven smile design using 3D design software.

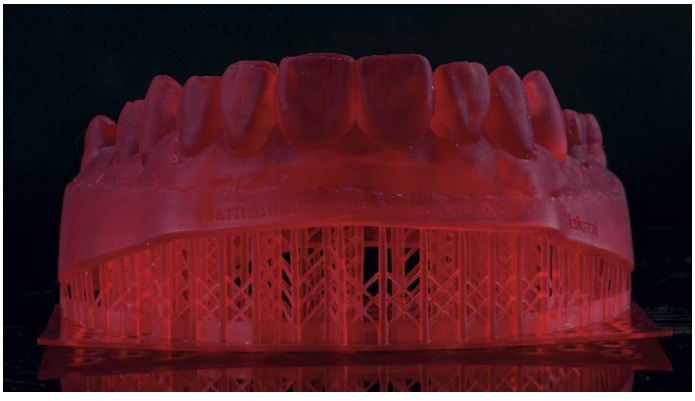


Figure 9: Model printed from the smile design blueprint.

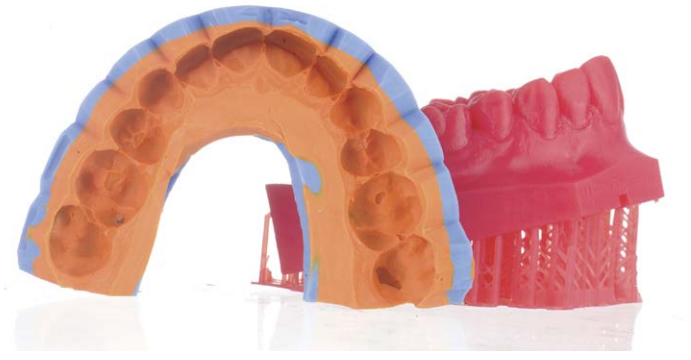


Figure 10: Silicone matrices transferring smile design information to the patient's mouth.

Figure 11: Pre- periodontal surgery frontal view.

Figure 12: Crown lengthening procedure to level gingival position according to smile design.

Figure 13: Gingival position after surgery.

Figure 14: Gingival position after 3 months healing.

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.[12]

To reproduce the new gingival zenith that had been previously determined, the initial mock-up based on the smile design prototype was maintained in a position to facilitate the crown lengthening of teeth #8 and #9. A gingival outline was cut following the future gingival outline according to the smile design blueprint. A bone probe was used to obtain the biologic width of each tooth. An osteotomy was then performed using appropriate burs and micro-chisels. After the osteotomy, probing was done again to check the final establishment of the biological space **(Figs 11-14)**.

Preparation and Final Impression

Twelve weeks post-surgery, preparations were made via the mock-up using the technique pioneered by Gurel[5,13] for minimum preparation design and to create a uniform space for the restorative materials that allowed the dentist to visualize the amount of tooth reduction necessary to achieve the esthetic result **(Figs 15 & 16)**.[14] The final preparations, with minimal reduction of teeth and an optimal path of laminate veneer insertion, were accomplished using the Chiche preparation kit (Brasseler USA; Savannah, GA) and finished with Sof-Lex discs (3M ESPE) **(Figs 17, 18a-18e)**; then, the double-mix single-impression technique with PVS (Extrude, Kerr; Orange, CA) was performed **(Figs 19a & 19b)**. Then, tooth preparation shade photographs were taken with the VITA system (VITA) and IPS natural die material shade guide (Ivoclar Vivadent; Amherst, NY) for lab communication **(Figs 20 & 21)**.

Laboratory Procedure

Appropriate restorative planning in this case was based on the principles of using minimally invasive procedures and selecting the most appropriate materials for the final restorations. Based on the substrate preparation color, it was decided to use a feldspathic porcelain material (IPS Style Ceram, Ivoclar Vivadent) with refractory die technique, which allows the fabrication of very thin and heterogeneous laminate veneers that meet the specifications of color, opacity, translucency, and transparency **(Figs 22a-22c)**.

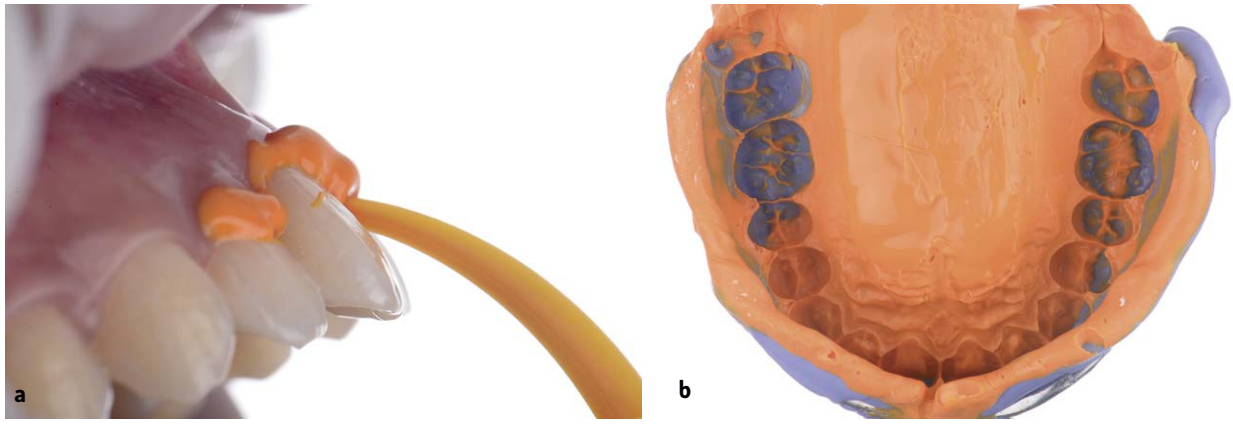
The alveolar "Geller" cast technique was used to retain soft tissue contours while providing an adequate emergence profile for the final restorations **(Fig 23)**.[15]

Figure 15: Bis-GMA mock-up as a reference for minimally invasive veneer preparation using 0.3-mm depth cutting bur.

Figure 16: Marking groove to verify the thickness of veneers and use as reference for uniform preparation.

Figure 17: Minimally invasive preparation for veneers of 0.5-mm thickness with enamel surface intact.

Figures 18a-18e: Step-by-step veneer preparation.



Figures 19a & 19b: PVS impression.

Figure 20: Stump shade photograph for substrate color communication.

Figure 21: Polarizing filter photograph for technical color communication.

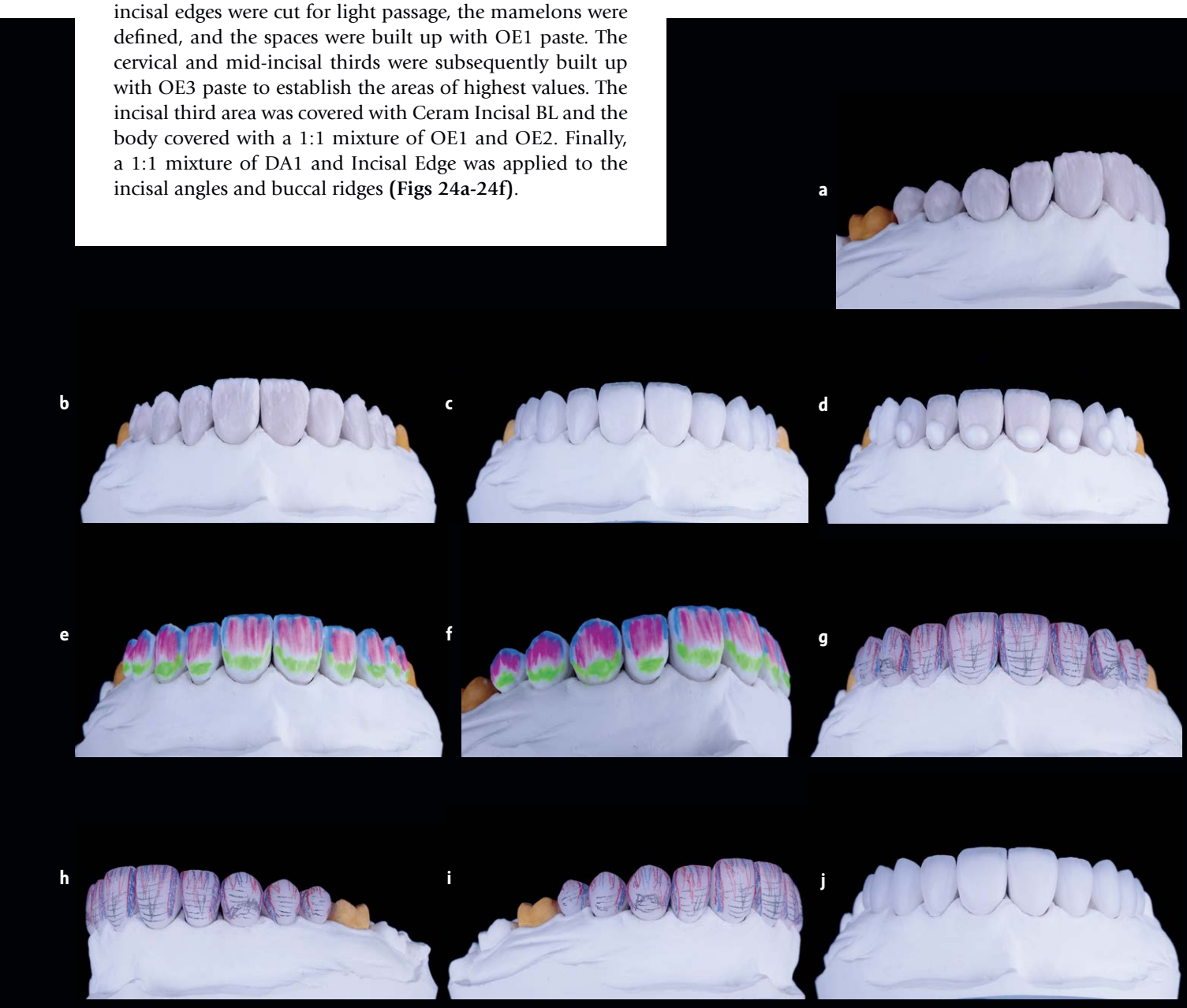
Figures 22a-22c: Ceramic system used to fabricate veneers.

Figure 23: Alveolar (Geller) model to preserve soft tissue information.

Ceramic Layering

After hydration of the refractory dies, the ceramic layers were built up with fluorapatite-leucite glass-ceramic materials. A very thin first layer of opalescent ceramic was built up with Opal Effect 1 (OE1) paste. This step was repeated twice to improve sealing. To create the second layer, Deep Dentin (DD) A1 and Dentin Bleach (DBL4) 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. 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. The cervical and mid-incisal thirds were subsequently built up with OE3 paste to establish the areas of highest values. The incisal third area was covered with Ceram Incisal BL and the body covered with a 1:1 mixture of OE1 and OE2. Finally, a 1:1 mixture of DA1 and Incisal Edge was applied to the incisal angles and buccal ridges **(Figs 24a-24f)**.

The veneers were removed from the refractory dies via sandblasting with 32-micron glass spheres at 1.5 bar pressure, followed by adjustment against the rigid cast. The veneers were 0.5 mm thick in the center and 0.2 mm thick at the margins, with an excellent opalescence resembling a natural tooth **(Figs 24g-24j, 25a & 25b)**.



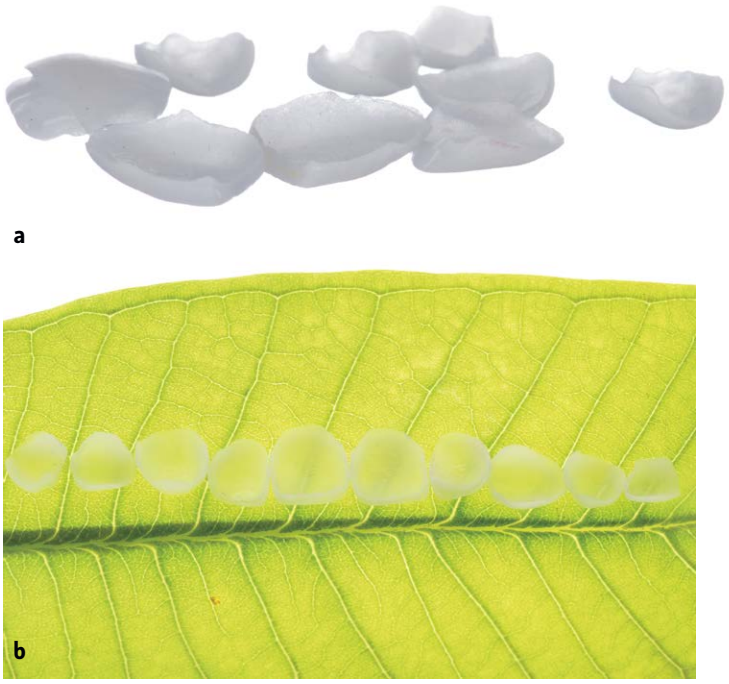
Figures 24a-24j: Step-by-step layering and contouring the feldspathic porcelain veneers.

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 paste (RelyX Veneer TR, 3M ESPE) was 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 teeth were air-particle–abraded using 29-micron aluminum oxide (AquaCare, Velopex International; Saint Cloud, FL) to increase micro-mechanism retention. The veneers were rinsed to remove the try-in paste, followed by application of Ivoclean (Ivoclar Vivadent) for 20 seconds to remove saliva and contaminated objects after intraoral try-in, and 9% hydrofluoric acid etch (Ultradent Porcelain Etch, Ultradent, GA) was applied for 90 seconds. After rinsing, ceramic primer (Monobond Plus, Ivoclar Vivadent) and a hydrophilic adhesive resin (Single Bond, 3M ESPE) were then applied and thoroughly air-dried **(Figs 26a-26e)**. An Ultrapak #000 cord (Ultradent) was subsequently placed around each preparation to control sulcular fluid and facilitate cement removal.

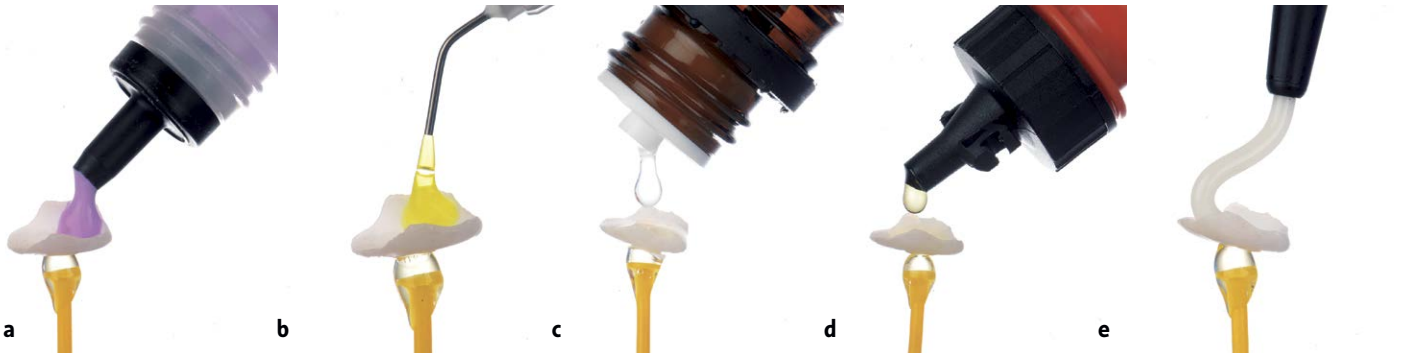
The enamel surfaces were etched with 35% phosphoric acid (Scotchbond Phosphoric Etchant, 3M ESPE) for 20 seconds, followed by a thorough 30-second rinsing with water and gentle air-drying for 15 seconds. A hydrophilic adhesive resin (Single Bond, 3M ESPE) was then applied to the enamel surfaces, air-thinned to remove residual solvent and light cured for for 20 seconds. The adhesive was also applied to the previously etched internal surfaces of the veneers, and this adhesive was air-thinned to remove residual solvent, but not cured. After adhesive thinning, light-cured luting cement (RelyX Veneer TR, 3M ESPE) was loaded **(Figs 27a-27d)**. The veneers were gently placed on the teeth, and the excess cement was carefully removed from the surfaces and interproximal spaces with artist brushes and dental floss, respectively. The veneers were then photopolymerized for 5 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 for 40 seconds, followed by careful removal of the retraction cords and of any remaining resin cement with a #12D scalpel. Occlusion was evaluated, and interferences in the lateral, lateral protrusive, and protrusive excursions were identified and removed. All finishing and polishing procedures were completed. An occlusal guard to provide night-time protection for the new restorations was fabricated and delivered to the patient at an appointment the following day. The patient returned 2 weeks later for a final check of the restorations, which met the desired esthetic and functional specifications **(Figs 28a-28d)**.

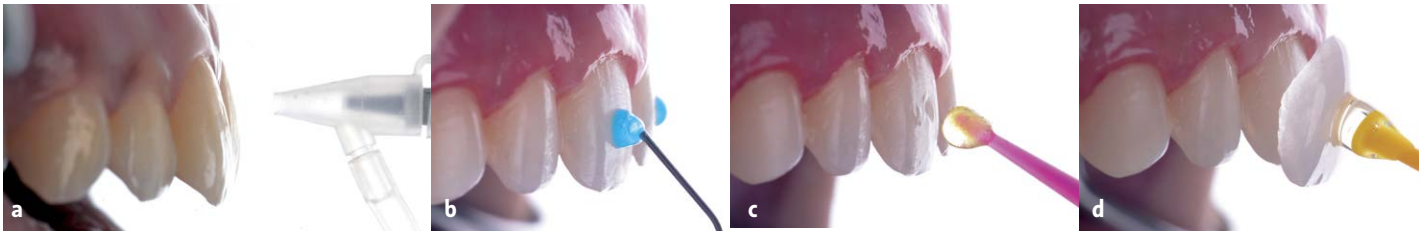


Figures 25a & 25b: Feldspathic porcelain veneers showing translucency with different backgrounds.

> The veneers were 0.5 mm thick in the center and 0.2 mm thick at the margins, with an excellent opalescence resembling a natural tooth.



Figures 26a-26e: Step-by-step preparation of feldspathic veneer surface with cleaning paste, 9% hydrofluoric acid, ceramic primer, adhesive, and resin cement.



Figures 27a-27d: Step-by-step preparation of tooth surface with 29-micron aluminum oxide sandblasting, 35% phosphoric acid etch, and adhesive.

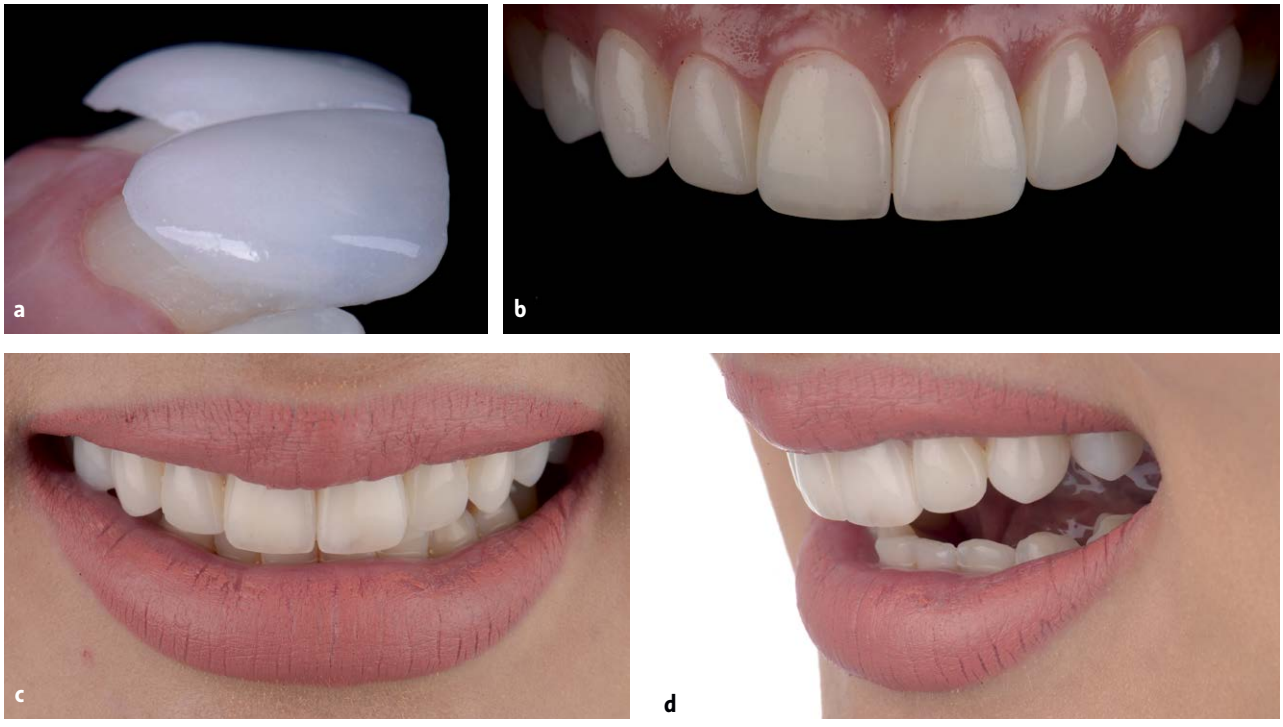


Figure 28a-28d: Final result.

Summary

There are numerous benefits to conservative care, including tooth conservation and longevity; maintenance of periodontal health; and a reduced chance for endodontic consequences. Additionally, porcelain is considered the most esthetic and biocompatible material in dentistry, as it has the capacity to replicate the esthetically pleasing characteristics and vitality of natural teeth.

Ultimately, restorative success must always begin with an appropriate diagnosis, a smile design blueprint, and a well-thought-out treatment plan, which often mandates an interdisciplinary approach. Porcelain veneers produce excellent esthetic results with minimal biological costs and the adhesive technology to warrant a long-term successful result.

This article has demonstrated the use of digital smile design software, a printing technology for prototype models, and a mock-up blueprint that communicates precise minimum tooth reduction and sufficient thickness to the technician in the creation of a natural-looking restoration with feldspathic porcelain material. A natural and facially driven smile design was delivered to the patient.

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Dr. Aimplee is an assistant adjunct professor in the Oral Rehabilitation Department at the Augusta University Dental College of Georgia (DCG). He maintains a private practice limited to prosthodontics and esthetic dentistry in Bangkok, Thailand.

Dr. Sinthuprasirt is currently a lecturer at Chulabhorn International College of Medicine, Thammasat University, Thailand. She is a specialist in prosthodontics and esthetic dentistry in Bangkok, Thailand.

Mr. Andres Acevedo is a Master Dental Ceramist and maintains a dental laboratory in Madrid, Spain.

Dr. Blasi is a Board Certified Prosthodontist, Dental Technician and Adjunct Assistant Professor in Restorative Sciences Department at Augusta University DCG. He maintains a private practice focused on esthetics and implants in Barcelona, Spain.

Mr. Torosian is a Master Dental Ceramist at the Goldstein Center for Esthetic and Implant Dentistry at the Dental College of Georgia (DCG) at Augusta University, Augusta, Georgia.

Dr. Chiche is a clinical professor at DCG, Augusta University, Augusta, Georgia.

> "Ultimately, restorative success must always begin with an appropriate diagnosis, a smile design blueprint, and a well-thought-out treatment plan, which often mandates an interdisciplinary approach."

Interdisciplinary Treatment Planning and Digital Workflow
Integrating Digital Smile Design and Orthodontic Aligners: *A Case Report*

Rafael de Liz Pocztaruk, PhD
Newton Sesma, PhD
Karina Pintaudi Amorim, DDS
Christian Coachman, DDS, CDT

Abstract
An interdisciplinary approach in dentistry is important for comprehensive, complete, and effective patient care because patients are becoming more discriminating, increasing demands for more accurate diagnoses and more detailed treatment plans. The clinical report presented here describes an esthetic rehabilitation using a digital smile design protocol for diagnosis, planning, and execution with a fully digital workflow and performed by an interdisciplinary team. At the first clinical appointment, all examinations, photographs, and videos required for the facially guided smile plan were obtained. With this information, the need for an interdisciplinary team to carry out the rehabilitation, which involved clear orthodontic aligners (Invisalign) as well as periodontal and prosthetic treatment, was verified. The final project planned by the team was forwarded to a digital planning center that transformed the 2D design into 3D and made guides for all stages of the treatment. These procedures and the use of a digital workflow made the treatment more predictable and reliable, and the result of the treatment was directly related to the planning and execution integrating all the specialties involved.

Key Words: computer-aided design, crown lengthening, dental technology, veneers, orthodontics, periodontology, prosthodontics

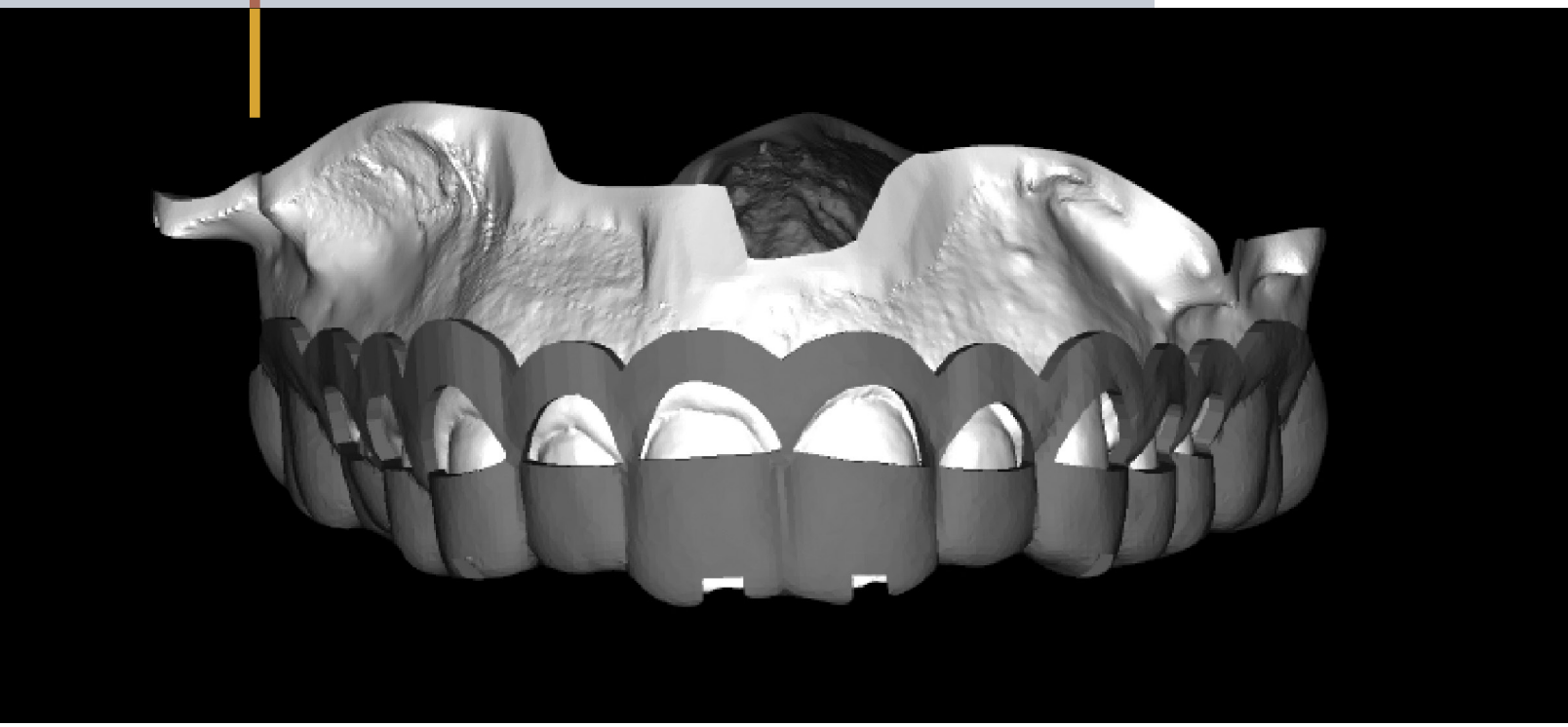
CE CREDIT

Learning Objectives

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

1. Understand the key benefits of using an interdisciplinary team and improving communication among team members with the use of a digital planning center and digital workflow.
2. Understand the process of transforming a 2D design into a 3D design for making guides for all stages of a multidisciplinary treatment plan to make the treatment more predictable and accurate.
3. Understand the use of defined planning to simulate the treatment outcome as a motivational and instructional patient tool.

Disclosures: The authors did not report any disclosures.



"Thus, a prerestorative orthodontic treatment guided by the smile design will allow simulations of treatment integrated with the face and with dental movements to make dental preparations less invasive and preserve the dental structure."

> *A mock-up presentation was prepared for several analyses, such as for whether the occlusion would interfere with the trajectory of the anterior guide.*

Introduction

An interdisciplinary approach must be implemented in dentistry because of the increasing complexity of the skills and knowledge necessary to effectively provide patients with care.[1] This approach is extremely important to ensure a correct diagnosis, expand treatment options, and attain a higher quality of the work.[2] Thus, a team composed of different specialties in which each member contributes their knowledge and skills to solve problems, diagnose patients' conditions, and plan and execute therapies must be organized.[3]

Highly organized communication among team members is necessary for all aspects to be equally expressed and interpreted.[4] Technological resources such as the digital smile design (DSD) protocol facilitate dialogue among professionals who are members of the team and between professionals and patients[5,6] so that everyone involved in the treatment follows the same project and has the same ultimate goal.

Facial analysis and facial references are extremely important components of smile design because they guide the rehabilitative treatment.[7] These references must be in accordance with esthetic principles,[8] as they are directly related to better facial harmony.[9,10] DSD utilizes facial references to guide the dental design. In addition, a comprehensive approach to rehabilitative planning and treatment provides results with higher levels of esthetics and function and thus patient health.[9]

Based on this information, orthodontics is a specialty in dentistry that can contribute to more effective patient treatment.[10] By combining the advantages of digital resources[11-13] with the advantages of orthodontic aligners such as Invisalign (Align Technology; San Jose, CA),[14,15] treatment plans can be visualized through ClinCheck software, which predicts the possible movements that the aligners will perform. Thus, a prerestorative orthodontic treatment guided by the smile design will allow simulations of treatment integrated with the face and with dental movements to make dental preparations less invasive and preserve the dental structure.

Through facial and dental analyses, it is possible to combine photos (jpeg files), digital models (STL files), and cone beam computed tomography (CBCT) (DICOM file) to simulate the final result and carefully observe possible limitations or risk factors by using interdisciplinary planning software integrated into the digital orthodontic, periodontal, and restorative planning.

This case report describes an interdisciplinary treatment plan with a comprehensive approach to esthetic rehabilitation. It demonstrates a facially guided treatment using DSD and clear orthodontic aligners, crown enhancement, and ceramic laminates, all performed within a digital workflow.

Case Report

The patient, a 32-year-old woman in good general health, was referred to a dental clinic specifically for esthetic rehabilitation. She was dissatisfied with a nonesthetic smile, specifically with the size and cant of the teeth and the gingival smile. She requested ceramic veneers. A complete examination was performed, including radiographic, clinical, film, and photographic examinations, and the DSD protocol was performed with initial documentation **(Figs 1 & 2)**.

Figure 1: The pretreatment situation. Frontal view of patient's smile and lips at rest; facial profiles with lips at rest and smiling. Patient at 12 o'clock position. Maxillary and mandibular arch occlusal views; intraoral left and right lateral views.

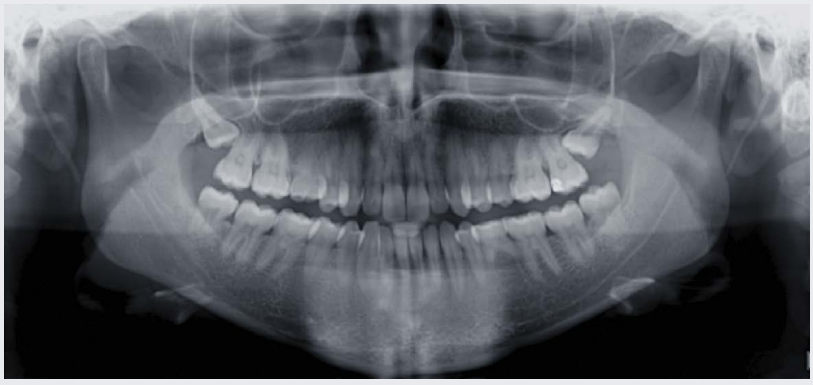


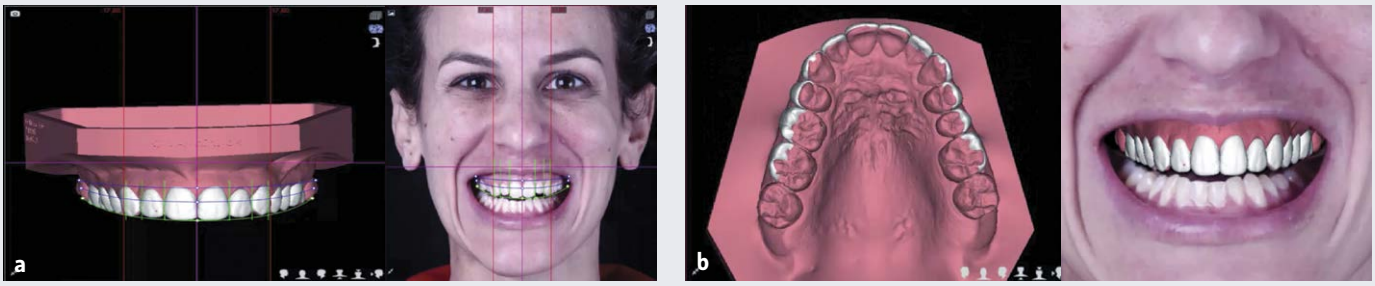
Figure 2: Pretreatment panoramic radiography.

Analysis & Diagnostics

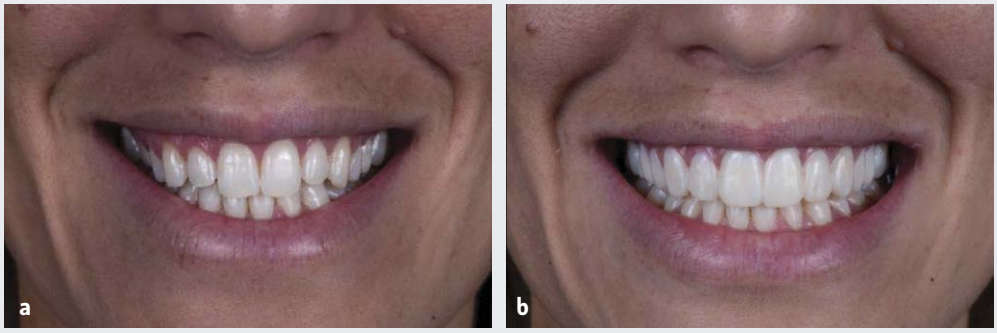
After examination by all team members and observation of facial references to guide the patient's new smile design, and taking into consideration the patient's good periodontal status, the need was identified for an interdisciplinary approach including orthodontic and periodontal (crown lengthening) treatment and prosthetic rehabilitation. As part of the treatment, orthognathic surgery was also proposed to the patient; however, she did not consent to this or to having conventional orthodontic treatment performed, which led to the team changing the plan.

Communication

DSD was then performed in 2D for treatment predictability and for better communication among the team members and the patient. The smile design project was sent to the planning center (DSD Planning Center; Madrid, Spain). With the help of NemoSmile Design software (Nemotec; Madrid, Spain), a virtual wax-up guided by the 2D drawing was performed on the 3D digital model **(Figs 3a & 3b)**, and the functional analysis of overbite was made in the virtual articulator within the software. This STL file was printed with a 3D printer (Form 2, Formlabs; Somerville, MA). For this model, a silicone barrier was fabricated for making a motivational mock-up with bis-acrylic resin to present to the patient for her final approval **(Figs 4a & 4b)**.



Figures 3a & 3b: Frontal views of facial reference lines, dental reference lines, and smile design model. Occlusal view of the new smile design model and enlarged view of smile with the new smile design.



Figures 4a & 4b: Test of new smile design in the mouth with motivational mock-up through a barrier of silicone and bis-acrylic resin. Frontal views before and after the mock-up.

Diagnosis

The patient was diagnosed with the need for orthodontic movements to be performed using clear orthodontic aligners (Invisalign), crown lengthening, and veneer restorations. A mock-up presentation was prepared for several analyses, such as for whether the occlusion would interfere with the trajectory of the anterior guide. The mock-up was presented to the patient, and she was given explanations about all the planning and all the necessary observations regarding possible difficulties, such as some orthodontic movements, misalignment of the upper and lower midlines, possible occurrence of ankylosed teeth, and third molar extractions, as well as treatment time, sequence, and value. After all the analyses and the conversation, the patient accepted the treatment plan.

Treatment

Orthodontics

Thus, rehabilitation began with orthodontic treatment **(Figs 5a-5c)**. The DSD project for orthodontic movement guided by the smile design was carried out through collaboration between ClinCheck software and NemoSmile Design. A total of 22 aligners were used to complete the orthodontic treatment. The purpose of the treatment was to expand the arches and align the teeth with consideration to the final restorations. Then, a minimally invasive preparation would be performed to receive the veneers. To accelerate the orthodontic movement and reduce the treatment time,[16,17] a technique introduced by Murphy[18] in 2006 was performed. The micro-osteoperforation procedure (Excellerator RT, Propel Orthodontics; Milpitas, CA), which consists of bone perforations, was performed. The purpose of this type of procedure was to induce inflammatory markers such as chemokines and cytokines, which are responsible for osteoclast recruitment, bone remodulation, and osteoclast maturation in the area.[16,17,19] Thus, the procedure allowed the patient to change aligners every three days. On conclusion of the orthodontic treatment, digital quality control was performed to evaluate whether the aligner treatment objectives had been reached. This was done by superimposing the images from the initial file onto the postorthodontic treatment file with ClinCheck.

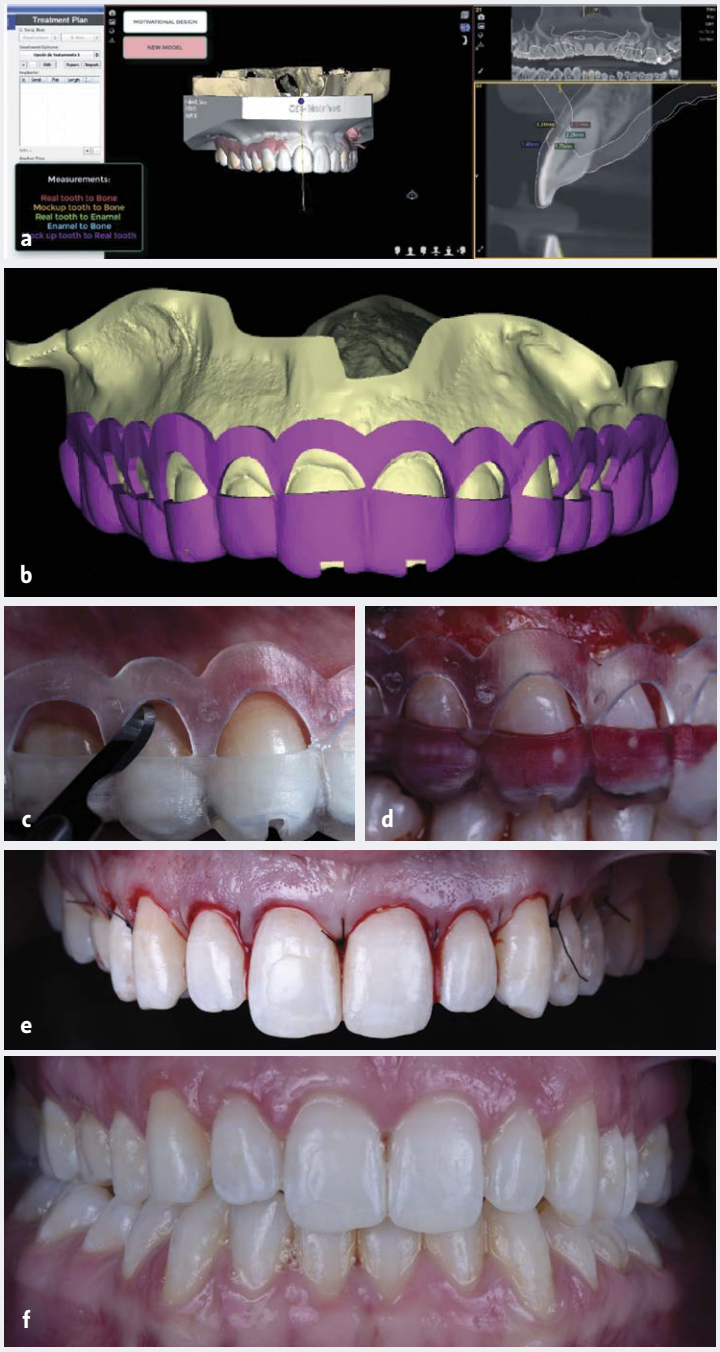
Periodontal Procedures

After orthodontic treatment, considering that the patient had good periodontal status with a maximum probing depth of 3 mm and no bleeding on probing, the periodontal treatment began. For crown lengthening, the planning center used the perio analysis tool of the NemoSmile Design software. The CBCT image was superimposed onto the STL file of the virtual wax-up model; thus, it was possible to define the ideal gingival level

Figures 5a-5c: Planning the result of orthodontic treatment with clear aligners via facially guided alignment and verifying with software. Patient placing the aligner in position. Intraoral view after orthodontic treatment.

because the wax-up was based on the facially guided digital design. The bone level was defined from the future gingival level for the purpose of maintaining the biological space; thus, a digital guide for the dual technique was created for use during surgery. This guide provided references for the gingival (bottom of the guide) and bone (top of the guide) levels and thus provided an acceptable reference for maintaining the biological space **(Figs 6a-6f)**. The guide was printed with a 3D printer (Form 2), making the surgery more predictable. Gingivectomy and bone reduction for crown lengthening were performed. Even with the increase in the clinical crown length, the patient still presented a gingival smile, as foreseen in esthetic planning. The patient was presented with the possibility of using botulinum toxin (Botox, Allergan; Dublin, Ireland) to paralyze the muscles; however, the results of this treatment last for a maximum of six months, and the patient would need to have applications at least two times per year to maintain the results. The patient agreed to this treatment, and a controlled quantity was then used to minimize the mobility of the upper lip elevator muscles, consequently minimizing gingival exposure in the broad smile.[20]

> *"To accelerate the orthodontic movement and reduce the treatment time,[16,17] a technique introduced by Murphy[18] in 2006 was performed."*



Figures 6a-6f: CBCT image for periodontal treatment planning superimposed onto the virtual model with virtual wax-up of tooth #8, with measurements for gingivectomy and osteotomy (demarcation levels denoted using the lower and upper part of the guide, respectively). Intraoral view immediately after crown lengthening surgery and of the crown lengthening result.

Restorative Steps

After the 90-day period of gingival stabilization after surgery,[21] restorative treatment began. For precise and predictable execution, the planning center forwarded the motivational mock-up STL file and two other STL files for two different situations. One of these two files guided the dental preparations, called the ideal pretreatment STL, and the other guided the final rehabilitation, called the ideal posttreatment or technical STL, which could be used for the provisional and the final prostheses. Thus, a model was printed, and a silicone index was made from the ideal pretreatment STL. A mock-up was made of bis-acrylic resin to guide the dental wear. Thus, a minimally invasive preparation that preserved tooth enamel was performed **(Figs 7a-7d)**.[22]

After this, a digital scan (iTERO, Align Technology) of the preparations was performed. The ideal posttreatment STL was superimposed onto the STL of the preparations to guide the CAD production of the laminated veneers (Zirkonzahn; Gais, Italy). Lithium disilicate HT BL1 blocks (IPS e.max CAD, Ivoclar Vivadent; Schaan, Liechtenstein) were milled on the Zirkonzahn M1 wet milling machine (Zirkonzahn). The parts and the teeth were prepared in accordance with the manufacturer's instructions, and cementation was performed with RelyX Veneer cement B ½ (3M ESPE; St. Paul, MN), controlling the moisture and avoiding contamination. The occlusion was evaluated, excess cement was removed, and polishing was performed.

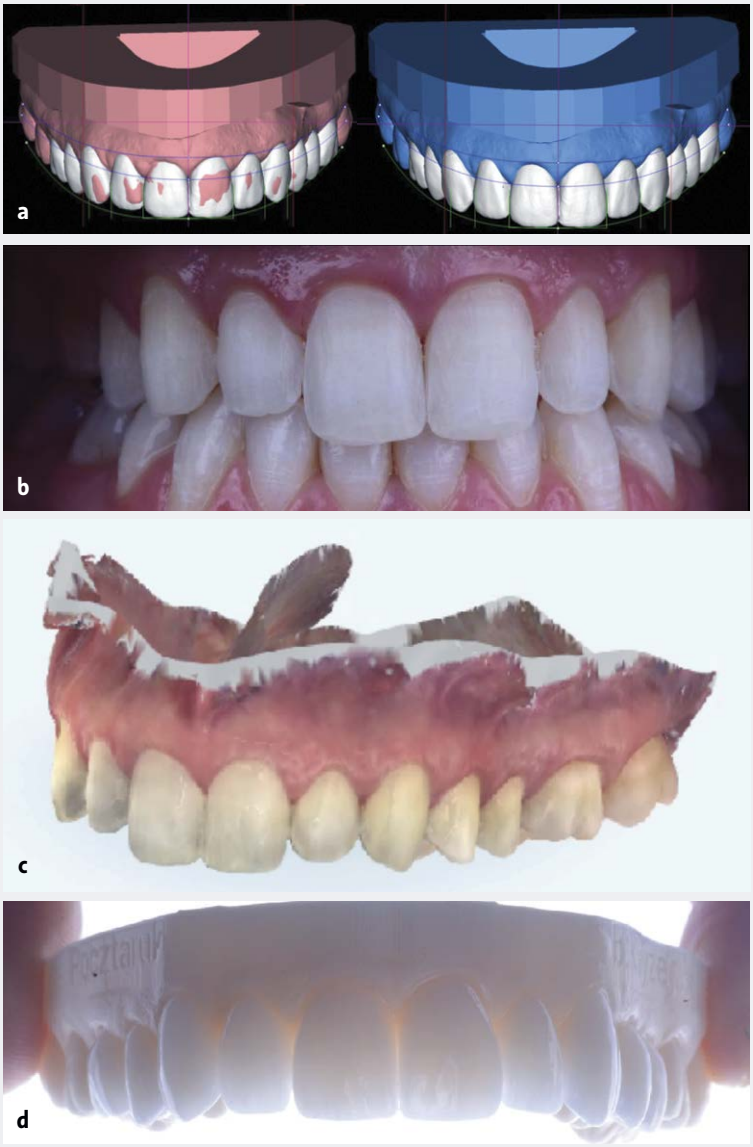
The case was completed, and the patient was satisfied with the result **(Figs 8a & 8b)**. The patient received necessary postoperative instructions, and follow-up assessments were made the following week, the following month, and then at least once a year.

Discussion

Digital Technology

The implementation of digital technology is advancing in dentistry. The conventional workflow has been replaced by the digital workflow because the latter is more efficient.[12,13] In addition, computers and a digital workflow make jobs easier, faster, cheaper, and more predictable.[11,13]

Following the digital workflow concept, a DSD protocol was used to guide the plan digitally, integrating all facets of the treatment. Subsequently, the project was forwarded to a digital planning center (DSD Planning Center) to ensure accuracy and equivalence between planning and execution. Thus, the planning center transformed the 2D project created by the dentist using his software or app into a 3D format and created guides for the prosthetic, periodontal, and orthodontic treatments. Thus, all the necessary procedures throughout the treatment could be predictable.



Figures 7a-7d: Pretreatment STL for guiding the dental preparation and the ideal posttreatment STL. Intraoral view of the dental preparation after determining the end line and conservative preparation. Intraoral scan of the preparations. Ceramic-laminated veneers in the model.

> *The use of a double technique for crown lengthening allowed references for gingival and bone reduction during surgery, and this technique was able to reduce errors and create predictable gingival and alveolar margins.*[24]

Integrated Plan

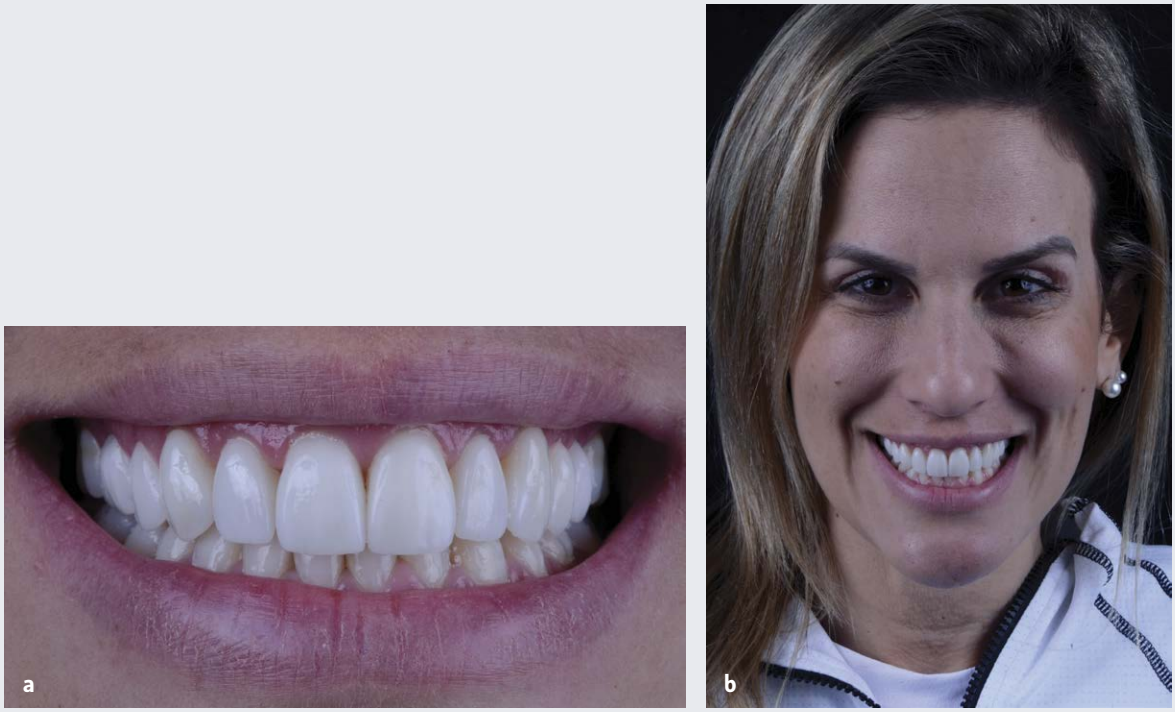
The need for greater harmony and better dental esthetics in periodontal procedures commonly arises in esthetic rehabilitation.[23] The use of digital resources and planning guided by facial references and smile design were key factors in achieving this goal. The use of a double technique for crown lengthening allowed references for gingival and bone reduction during surgery, and this technique was able to reduce errors and create predictable gingival and alveolar margins.[24]

In contrast to using only orthodontic aligners, in which the treatment is oriented only by the teeth in the arch, the integration of a DSD-Invisalign protocol allowed the orthodontist, by means of ClinCheck, to visualize the rehabilitator's esthetic planning in harmony with the patient's face. Thus, he was able to perform dental movements into ideal positions that resulted in minimally invasive preparations.

With the defined plan, a motivational mock-up could be performed to simulate the entire treatment outcome, which the patient could consider during the planning stage. This integration made it possible to predict the final result even before starting treatment. The two major technical impacts of DSD on orthodontic alignment were face-oriented orthodontic planning and interdisciplinary integration in planning. In this case, the aligners were able to safely correct the dental arches and perform movements equivalent to those that were planned. As a limitation, however, the patient had two deciduous teeth (#A and #K) that did not adequately respond to the orthodontic movement because they were ankylosed.

The entire treatment was based on DSD performed through facial analysis. Combining the technologies of DSD and ClinCheck, the orthodontic movements were performed with consideration to what the result of the treatment would be. This protocol was more predictable and led to a less invasive preparation for receiving veneers. Furthermore, using the STL model from the DSD and merging it with the DICOM file from the CBCT, it was possible to predict the crown lengthening so that the final restorations would not invade the biological space. Without these technologies, the treatment would not have been as predictable. In addition, the technologies allowed the dentists to feel more confident while performing the treatment because of the correct planning and all the guides it provided.

The favorable outcome of this treatment was directly related to the planning and execution that integrated all the specialties involved. In addition, the digital workflow was responsible for treatment predictability and accuracy.



Figures 8a & 8b: Final treatment result. Extraoral close-up frontal and full-face views of the enlarged smile resulting from the treatment.

Summary

This case report described an interdisciplinary approach using orthodontic, periodontal, and prosthetic treatment for an esthetic rehabilitation using a digital workflow. Through a fully digital, interdisciplinary, and facially guided plan integrating DSD and orthodontic aligners, it was possible to predictably obtain a final result equivalent to the planned one.

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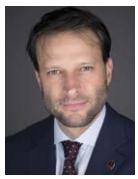
Prof. Dr. de Liz Pocztaruk helps maintain a private practice in Porto Alegre, Brazil.

Prof. Sesma teaches at the University of São Paulo in São Paulo, Brazil.

Dr. Amorim is a master's student at the University of São Paulo, São Paulo, Brazil, and is Professor of the postgraduate program in Prosthodontics at IMED University. Dr. Amorim can be reached at karina@usp.br



Dr. Coachman is an adjunct professor at the University of Pennsylvania (Philadelphia, Pennsylvania) and coordinator of the digital dentistry postgraduate program at Avantis University in Balneario, Camboriu, Brazil. He maintains a private practice in São Paulo, Brazil, and is the founder and CEO of Digital Smile Design (Miami, Florida).

"The bone level was defined from the future gingival level for the purpose of maintaining the biological space; thus, a digital guide for the dual technique was created for use during surgery."

JCD Self-Instruction

Fixed Prosthodontics (CE) Exercise No. jCD39 AGD Subject Code: 610

3 Hours Credit

This Continuing Education (CE) self-instruction examination is based on the article *Interdisciplinary Treatment Planning and Digital Workflow Integrating Smile Design, and Orthodontic Aligners: A Case Report* by Professor Rafael de Liz Pocztaruk, Dr. Newton Sesma, Dr. Karina Pintaudi Amorim, and Dr. Christian Coachman. This article appears on pages 48-57. The exam is free of charge and available to AACD members only. AACD members must log onto www.aacd.com/jcdce to take the exam. Note that only Questions 1 through 5 appear in the printed and digital versions of the *jCD*; they are for readers' information only. This exercise was developed by members of the AACD's Written Examination Committee and *jCD*'s Contributing Editors.

1. What is the main advantage of using a digital smile design (DSD) protocol?

a. Improved communication among the professional(s) involved in the treatment and the patient.
b. Less need for radiographs during treatment.
c. Decreased cost for the patient.
d. Minimized need to include other dental specialists in the treatment.

2 DSD uses which of the following to guide the dental design?

a. Study models mounted in centric relation.
b. Radiographs combined with a full periodontal evaluation.
c. Facial references.
d. Evaluation of the bite and golden proportion of the anterior teeth.

3. ClinCheck software allows a dentist to predict which of the following?

a. The magnitude of occlusal forces during chewing.
b. Possible movement of the teeth with Invisalign aligners.
c. The amount of preparation needed for successful restorations.
d. The benefits of opening the bite through posterior tooth movement.

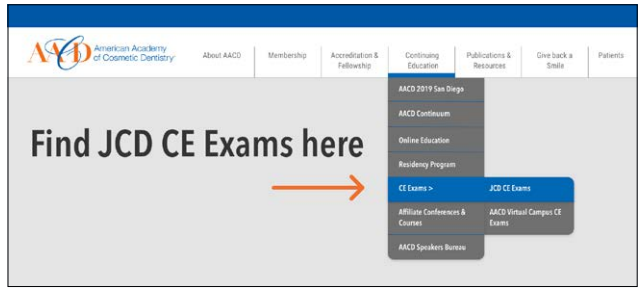
4. What is micro-osteoperforation?

a. A sandblasting technique used during crown lengthening to soften the bone.
b. Numerous small perforations that allow bone growth factors to be applied to thicken the bone.
c. Bone perforations that induce inflammatory markers responsible for faster bone remodeling.
d. When the alveolar bone is roughened during crown lengthening to improve the amount of attached tissue.

5. In the case presented, why was micro-osteoperforation completed?

a. To improve blood flow for healthier gingival tissues after crown lengthening.
b. To accelerate the orthodontic movement and reduce the treatment time.
c. To thin the bone in the areas of crown lengthening.
d. To avoid the need for crown lengthening.

To take the complete exam, log onto www.aacd.com/jcdce



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