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Visionary—Futuristic Dentistry
Dr. Christian Coachman

The Esthetic Jig

Clinical Efficacy in Tooth Whitening—CE/Research

WINTER 2019
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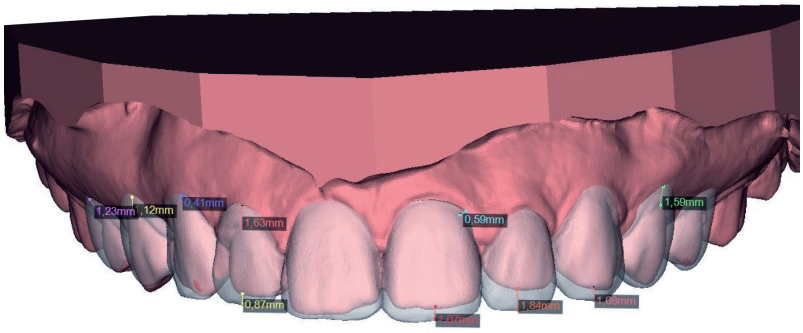

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Challenges & Solutions

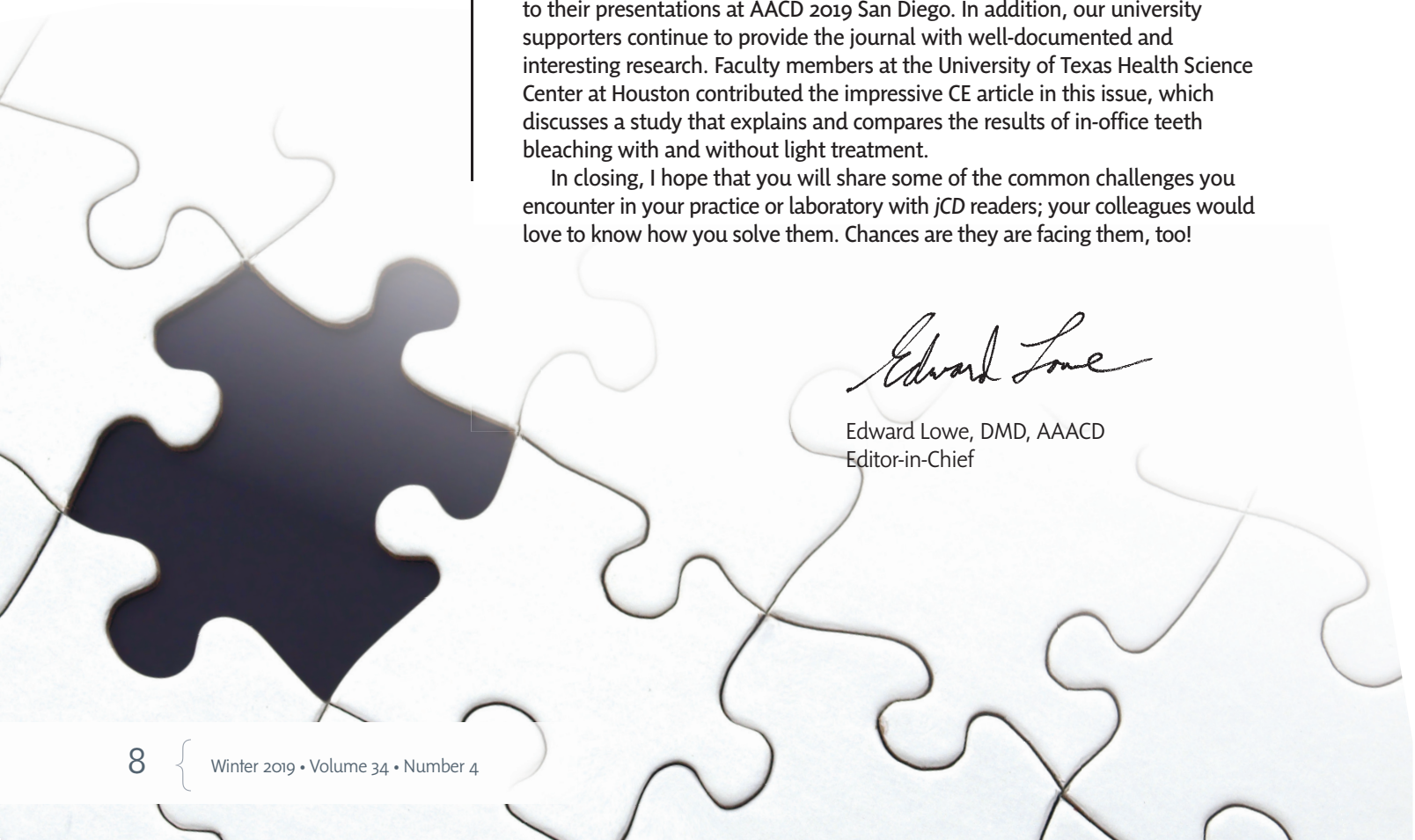
> **Our patients need to know that we can provide them with economical and highly esthetic solutions.**

Trying to solve space, bone loss, and gingival issues in the esthetic zone can be challenging, as there are many factors to consider when faced with esthetic and biological complications. However, our patients need to know that we can provide them with economical and highly esthetic solutions.

In this issue of the *jCD*, Drs. Christian Coachman, Maurice Salama, and Eduardo Mahn continue their three-part series on treating two adjacent missing teeth in the esthetic zone. They discuss challenges faced when working with ceramic bridge framework and provide several reasons why opting for an "in-between" implant bridge can be beneficial. Dr. Alamiro Flavio highlights the importance of the vertical dimension measurement when planning an oral rehabilitation and examines the challenges we encounter when transferring planned measurements to the patient's mouth. He offers an approach using an interocclusal device, called the esthetic jig, which may be useful when reestablishing a patient's occlusal vertical dimension.

In the "Accreditation Essentials" section, Dr. Hanno Venter, and Drs. James Peyton and Brian Gilbert discuss the critical importance of careful patient selection, thorough planning, and close collaboration with an excellent laboratory technician to help with the challenges of restoring a single central incisor. And in interviews with members of the *jCD* Editorial Board, Dr. Pascal Magne and Mr. Leon Hermanides offer both solutions and inspiration related to their presentations at AACD 2019 San Diego. In addition, our university supporters continue to provide the journal with well-documented and interesting research. Faculty members at the University of Texas Health Science Center at Houston contributed the impressive CE article in this issue, which discusses a study that explains and compares the results of in-office teeth bleaching with and without light treatment.

In closing, I hope that you will share some of the common challenges you encounter in your practice or laboratory with *jCD* readers; your colleagues would love to know how you solve them. Chances are they are facing them, too!



Edward Lowe

Edward Lowe, DMD, AAACD
Editor-in-Chief

"I BELIEVE IN THE TRANSFORMATIVE POWER OF DENTISTRY."

A FUTURISTIC VISION

By Christian Coachman, CDT, DDS

I believe that holistic, emotional, digital solutions can help dental practices stay up-to-the-minute. The dental industry is changing like never before and it is hard for smaller private practices to keep up with corporations. Technology is leading the way; we must adapt to the dynamism inherent in dentistry today.

Efficiency and differentiation are the keys to success in the digital era. I have always been fervent about finding reliable ways to improve the smile design and treatment-planning processes. I work with many leading dental professionals around the world—mentors, colleagues, family, friends—who share my desire to find easier ways to communicate with our patients and each other.

Smile simulations are a fast and powerful way for me to connect with my patients and help tell their dental story. It is that emotional reaction that drives my motivation and excitement to work with my team to provide seamlessly integrated communication that helps us understand each patient's smile better.

Guiding clinicians to be ready for the future is what I am most passionate about. Harnessing and incorporating disruptive technology to better diagnose, design, and plan for functional esthetics is the foundation that inspires me to perform. I believe in the transformative power of dentistry...and I am personally committed to helping transform dentistry itself.

Turn to page 36 for the Visual Cover Essay.

Cover and Behind the Cover images by Christian Coachman, CDT, DDS (Sao Paulo, Brazil). Illustration and cover design by NJT Consulting.

Crescendo of Techniques for Anterior Bonded Restorations

An Interview with Dr. Pascal Magne

Pascal Magne, DMD, PhD, is an associate professor and the Don and Sybil Harrington Professor of Esthetic Dentistry at the Herman Ostrow School of Dentistry, University of Southern California. Dr. Magne, co-author of *Bonded Porcelain Restorations in the Anterior Dentition: A Biomimetic Approach*, a leading work in the field of adhesive and esthetic dentistry, will be one of the headliners at AACD 2019 San Diego. His presentation, "Crescendo of Techniques for Anterior Bonded Restorations," on Saturday, April 27, 2019, will be invaluable to all practitioners who wish to update their skills in anterior bonded restorations using direct composite resins and indirect porcelain veneers. In this interview, Dr. Magne answers questions from members of the *jCD* Editorial Review Board. Register today at www.aacd.com/conference

Introduction

Although bonded ceramics seem to represent the ultimate biologic, functional, mechanical, and esthetic restoration for compromised anterior teeth, the number of ultraconservative treatment strategies and materials continues to grow. Today's practitioner can select from among many esthetic treatment modalities and products. The major disadvantage of this evolution is that it becomes increasingly difficult to make the appropriate choices for a given clinical situation. The availability of various treatment alternatives often allows for selection of an approach that conserves the maximum amount of intact tissue and which complies with the biomimetic principle.

Q: What is the most critical factor in success for the more ultraconservative direct bonding procedures (i.e., isolation, bonding technique, material selection, etc.)?

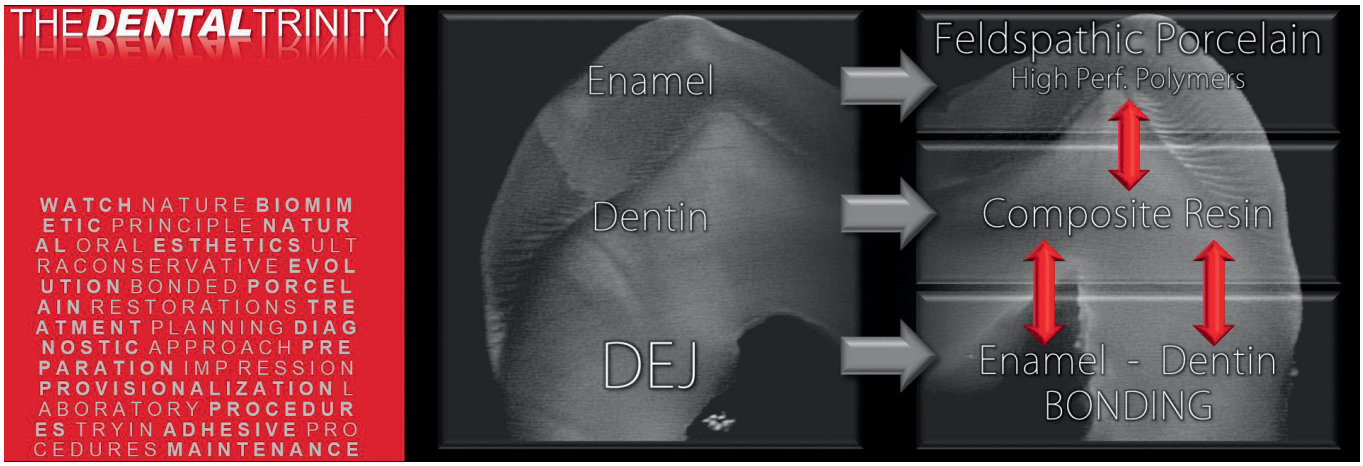
A: It will come as no surprise that my response is that the success of an ultraconservative restoration is due to a combination of the clinician's knowledge, skills, and passion. It may not be a "scientific" answer, but after more than 25 years in adhesive dentistry I can confidently say that it is the *operator* that matters the most; the best clinicians have a genuine passion for what they do.

Q: For minimal or no-prep veneers, which are very thin restorations, the thickness of the luting cement may affect the distribution of stress at the interface between the adhesive and the restoration.[1] If the internal fit of an indirect restoration is poor, higher stresses may occur at this interface.[2] How should a dentist address this concern?

A: Poor fit was definitely a problem with traditionally cemented restorations. Things changed when we started to use regular restorative composite resins as luting agents, which began with the CEREC 1 restorations in the 1990s[3] (possibly due to the poor fit of the original CEREC restorations). In our 1999 study,[1] we looked specifically at shrinkage and thermal loads in porcelain veneers. In this regard, yes, thickness does matter; I have never been a big fan of ultrathin indirect porcelain restorations. There are also practical reasons to avoid them, such as extreme difficulty in handling and delivery, as well as morphological and other considerations that I will address in my presentation in San Diego. Direct composite resin restorations are the best ultraconservative option if one does need to avoid any tooth preparation.

Q: Bond strength is also affected by the type/generation of adhesive used. The total-etch (three-step or etch-and-rinse procedure) and self-etch (two-step) adhesives showed better bond strength in in vitro studies than the simplified all-in-one adhesives.[4,5] On this basis, a simplified adhesive procedure cannot be recommended, as the adhesive strength is not comparable to that of the total-etch procedure (the gold standard). Can you comment on this?

A: It is indeed interesting that those gold standard adhesives are also the ones that have been on the market the longest. Optibond FL (Kerr) was first marketed in 1992 (as Optibond), yet it is still number one today in terms of both strength and longevity. Manufacturers have not been able to improve the bond strength so much and instead focus on simplification. In the biomimetic approach the reference for bonding is the dentinoenamel junction (DEJ). There are many criteria that must be met for a good dentin adhesive to be able to mimic the DEJ. Keep in mind that the DEJ is an inter*phase*, not an inter*face*. It is not a flat surface but rather, is rough, corrugated, and scalloped. It therefore is my opinion (based on new data from our own as-yet unpublished research) that dentin should be as rough as possible for optimal bonding. The problem is that the instruments that create roughness also create a lot of smear layer, hence requiring the use of a total-etch approach. As you can see, there is a domino effect of reactions once you consider bonding with the absolute biomimetic approach, leaving room for just a few adhesives on the market. Another problem with the simplified adhesives is incomplete polymerization by oxygen inhibition due to insufficient thickness, which was discussed in an article published in 2013.[6] A filled adhesive such as Optibond FL, besides being radiopaque, presents a more sufficient, uniform, and predictable thickness. Finally, the adhesive's mode of application is also critical. This was clearly demonstrated by the immediate dentin sealing technique,[7] which was proven to be able to increase the strength of all-ceramic restorations when done properly.[8]



Q: In your book *Bonded Porcelain Restorations in the Anterior Dentition: A Biomimetic Approach* you state, "The success of porcelain laminates is not achieved through the use of so-called high-technology or advanced materials but simply by associating two traditional materials, i.e., hybrid composite resins and porcelain." Does this statement still hold true in today's market and what, if any, changes have you made?

A: The statement is still valid. I call it the "trinity of bonding" because the conscientious operator needs to be an expert in resin-to-restoration bonding (beware of the various types of ceramics, as well as the resin-to-resin bonding with composite resin inlays/onlays/veneers); resin-to-enamel bonding (maybe the most obvious); and resin-to-dentin bonding (discussed in my answer to the previous question). With new technologies come new names for products that can be confusing to clinicians, who may be unsure as to whether the material is a polymer or a ceramic. Much uncertainty can arise during delivery about whether to etch the restorations with hydrofluoric acid or air-abrade them. Regarding new materials, interestingly, the weakest ceramic on the market today (i.e., feldspathic porcelain) remains stronger than enamel itself and has demonstrated its performance since the 1980s when bonded correctly in the form of ceramic veneers. Hence, the more you know about how to bond efficiently and predictably, the less you need strong materials. The current "zircomania" is totally perplexing to me when dealing with the single tooth restoration. I see the point of using zirconia for fixed partial dentures or resin-bonded bridges (Maryland-type) but not in the single restoration.

Q: What continues to fuel your passion for continued growth and knowledge in dentistry after almost 30 years of clinical practice?

A: To answer briefly, it is God who renews my mind with passion and love. He also places countless amazing people on my path to keep the flame alive. "Set your minds on things that are above, not on things that are on earth" (Colossians 3:2).

The Journal of Cosmetic Dentistry *thanks Dr. Magne for sharing his expertise here and at AACD 2019 San Diego.*

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"After more than 25 years in adhesive dentistry I can confidently say that it is the operator that matters the most; the best clinicians have a genuine passion for what they do."

Laboratory Dollars and Sense—Part II

An Interview with Leon Hermanides, CDT

Leon Hermanides, CDT, is the owner of Protea Dental Studio in Redmond, Washington. A clinical instructor at the Kois Center, he has served as president of the Board of Directors of the Washington State Dental Laboratory Association, published in both clinical and technical journals, and lectured throughout the U.S. and internationally on implant restorations, esthetics, and restorative failures. Mr. Hermanides will be presenting at AACD 2019 San Diego on Friday, April 26. He will discuss strategies to manage laboratory profitability and share tips to boost finances. In this, the second part of a two-part interview, Mr. Hermanides answers questions from members of the *jCD* Editorial Board. Register today at www.aacd.com/conference

Q: How are your expenses categorized to give you proper insight into your business? For example, do your general ledger codes group expenses under direct labor and materials; sales, general, and administrative costs; and interest, taxes, and fees? Or are they simply listed alphabetically?

A: Financial reporting has to provide me with actionable information. I have set up my accounts to reflect revenue by department and direct costs (which include labor and materials) broken into subcategories and fixed expenses (rent, phones, etc.). Because the accounts also must provide accurate information for tax preparation, I work with my accountant to make sure he has the necessary financial information organized for consistent tax filings.

Q: Do you know your margin for every product you sell?

A: I have a baseline number that I work from for every product we sell. I have assigned a specific time and dollar value for each task in the fabrication process, which has to meet my 32-36% labor cost goal. However, the variables I have to account for are unused capacity, remakes (internal and external), and individual technicians' schedules. This analysis becomes part of my budgeting strategy as described in this interview.

Q: Have you set pricing based on your direct labor and materials costs, or just by what the market will bear?

A: Pricing can be a bit of a "chicken and egg" conversation, because whatever the market price is, if I can't fabricate a restoration and sell at a profit I won't have a business for long.

To me, pricing is a comprehensive business strategy that engages every level and every core part of my company. In order to charge what we determine our restorations are worth I have to create value in the eyes of my customers—they have to believe that my brand is worth what they are prepared to pay. At Fiat and Ferrari, for example, brand loyalty looks completely different to fit their specific customer demographic. My responsibility to my employees is to create a process with which they can both deliver a specific quality of restoration and support our customers while continuing to invest in them and our company.

During my budgeting process I undertake a review of our pricing based on financial metrics from previous years; these include breakouts such as overall and direct labor and material costs. If I were struggling to meet my financial goals then pricing certainly would be one of the options to consider changing. Laboratory owners, however, have to very careful as higher prices come with their own unique set of challenges. It is possible to sell a restoration for $700 and not make a living or not meet the market need at that price and have no one willing to buy.

Q: Is your net income goal based on percentage of budget and bottom-up? (For example, if you want to have 20% of revenue remaining at the end of the year, your budget for all other expenses would be 80% of revenue, allocated appropriately between direct labor and materials; sales, general, and administrative costs; and interest, taxes, and fees.)

A: I have two entirely contradictory views regarding budgets. First, I believe that most people get a false sense of accuracy—and subsequently, a false sense of security—from budgets. I don't believe I can account for all the anticipated financial variables in my company over the next three years and therefore my budget for next week will be far more accurate than my budget for 2020. That said, however, because cash flow is the most important ongoing short-term financial issue in most small businesses, I prepare or update a six-week anticipated cash flow report weekly. This is based on my receivables and payables, payroll, taxes, and other anticipated incoming or outgoing cash, most of which are known values at the time I prepare the report.

I absolutely prepare the budgets for my company; however, I believe the process is more important than the result. It can be very difficult to think about my business in a strategic way, but when I take the time to reflect on my budget and financial metrics it forces me back to a strategic plan.

When I budget I begin with the question, "How much money do I need to make and how much time do I need to spend working to have the lifestyle I want?" In essence I want my life to drive my business, not the other way around. Obviously, it makes sense to be realistic (even if I would like to travel everywhere on my own jet I may never have a business that will support it). With my desired lifestyle in mind I evaluate the company based on previous years' history and performance. Applying my best understanding of the business outlook I plug numbers into a spreadsheet and generate a budget. Utilizing a basic principle of overestimating expenses and slightly underestimating income, I go over the numbers until they feel achievable and provide a financial incentive to keep me engaged. If the numbers don't show that my lifestyle is achievable, I have a strategic decision to make that will then be the driver of any growth I choose to undertake.

In closing, there are numerous reasons why small businesses fail at such an alarming rate. However, with a strategic plan for your dental laboratory and by making time to measure your progress I believe this can be one of the most rewarding businesses to lead. Where else can you create art that literally "lives" within people and has the power to change how they feel about themselves and the world?

The Journal of Cosmetic Dentistry *thanks Mr. Hermanides for sharing his thoughts here and at AACD's Annual Scientific Session.*

"To me, pricing is a comprehensive business strategy that engages every level and every core part of my company."

The Challenges of Restoring a Single Central Incisor

Hanno Venter, BDS, FICOI

Abstract

Beginning a case with the end result in mind will guide clinicians in collecting the information necessary to fulfill their patient's needs and expectations. Detailed communication with the patient and the laboratory technician is crucial. A thorough understanding of the ideal anatomy and contours of the tooth being replicated, as well as observation of the surface texture of the surrounding dentition, will facilitate a natural final result. Finally, a thoughtful evaluation of the shades and translucency of the neighboring teeth can enable the clinician/laboratory team to create a restoration that predictably enhances the patient's smile in a lifelike manner.

Key Words: single anterior restoration, porcelain veneer, lithium disilicate, resin cement, Accreditation Case Type II

Figure 1: Preoperative frontal full-smile view (1:2) showing discolored, worn composite on #9.

Figure 2: Preoperative left lateral full-smile view (1:2) displaying visible composite.

> "As a result of patients' esthetic expectations today, the pressure to recreate nature is high."

Introduction

The challenges of restoring a single central incisor may cause mixed feelings in some clinicians. As a result of patients' esthetic expectations today, the pressure to recreate nature is high. However, with thorough planning, clinical skills, knowledge of dental materials, and collaboration with a skilled technician, practitioners can achieve a beautiful dental result in these demanding cases.

Case Presentation

Patient's Complaint and History

A 48-year-old female wanted to replace a Class IV composite on tooth #9 with a porcelain veneer. This composite had been replaced a few times previously but the patient was unhappy with how it tended to discolor and wear at a different rate than the surrounding natural teeth **(Figs 1 & 2)**.

The patient was in good physical and oral health. She had a history of erosion during pregnancy but had been stable since then. She previously had whitened her teeth, until they became too sensitive approximately six months before her initial appointment; she was happy with the current shade of her teeth but wanted #9 to match the surrounding dentition. There were no obvious parafunctional habits or signs of temporomandibular disorder.

Treatment Options and Discussion

The patient was not interested in replacing the existing restoration with composite resin, which was a viable option. Instead, she wanted at least full buccal coverage with porcelain due to its proven excellent light optical properties,[1] highly esthetic appearance, resistance to staining and wear,[2] and biocompatibility with periodontal and dental substrates.[3] IPS e.max lithium disilicate (Ivoclar Vivadent; Amherst, NY) was selected due to its excellent light optical properties, its strength and translucency allowing light to pass through it, giving it a lifelike appearance. It also bonds very well to enamel.[4] This allowed for minimal preparation.

Because most of the tooth structure was intact and undamaged (with some signs of incisal enamel wear on #9 and the contralateral incisor), it was decided to do a laminate porce-

lain veneer that wrapped around the incisal edge but did not encroach upon most of the healthy lingual enamel.

Depending on the light source, the way the restored tooth's shade is perceived can be affected.[5] Sunlight, incandescent light, cool or warm fluorescent light, and natural light will affect our perception of the shade, which is why it is so important during shade-taking to utilize at least three different light sources.

Digital photography is an excellent communication and diagnostic tool in determining surface texture and all the nuances present in adjacent tooth structure we see when observing a restored tooth. It also helps with relaying line angles by means of light reflection **(Figs 3 & 4)**.

Treatment

Models and impressions: The AACD's 12 required preoperative photographs for Accreditation were taken and sent to the laboratory technician.[6] Alginate impressions for a diagnostic wax-up were made; these allowed for all excursions to be evaluated and helped to ensure creation of a restoration that matched the contralateral incisor **(Figs 5 & 6)**. An intraoral mock-up was then created utilizing a dual-cured composite (Tempsmart, GC America; Alsip, IL); slight adjustments were made until the patient was satisfied. An alginate impression was taken over this mock-up to replicate the proposed final shape and size of the restoration (Hydrogum, Zhermack SpA; Badia Polesine [RO], Italy).[5] A lab putty index was made to create a temporary veneer at the preparation visit.

Preparation: A coarse diamond bur (FG 6858.314.014, Komet USA; Rock Hill, NC) was used for the majority of preparation on the tooth's facial aspect to create a fine but definite margin. However, a diamond crown preparation bur (Komet Crown Prep S6882 314 012) was employed on the lingual aspect to ensure there would be adequate incisal thickness for the porcelain, which would be wrapped around the incisal edge. Countouring and polishing discs (Sof-Lex, 3M ESPE; St. Paul, MN) and finishing tips (Enhance, Dentsply Sirona; York, PA) were used to polish and finish the preparation before isolat-

Figure 3: Preoperative right lateral full-smile view (1:2) showing the composite's unnatural and flat appearance.

Figure 4: Preoperative retracted frontal view (1:2) showing discolored and worn old composite resin along with a very thin and chipped incisal edge on #9.

ing the tooth with knitted nonmedicated retraction cord (Knit-Trax, Pascal Int'l.; Bellevue, WA) with gingival hemostatic gel (ViscoStat Clear, Ultradent Products; South Jordan, UT) in preparation for the impression.

Fast-setting A-silicone impression material (Elite HD+ heavy and light body, Zhermack) was used for the final impression in a special tray that was painted with a polysiloxane adhesive (Coltene; Cuyahoga Falls, OH).

Dual-cured composite (Tempsmart) made with the lab putty index created from the adjusted wax-up at the intraoral mock-up visit was used as a temporary veneer. It was spot-bonded with phosphoric acid-etching gel and universal adhesive (K-etchant Syringe and Clearfil Universal Bond, Kuraray Noritake Dental; New York, NY) and flowable composite (G-aenial Universal Flo, GC America).

The proposed final veneer (e.max lithium disilicate shade B1 HT) was tried in with clear try-in paste (Panavia V5, Kuraray Noritake) to ensure that the hue, chroma, and value, as well as the shape and line angles were correct before the laboratory technician executed the final characterization, glazing, and staining.

The technician etched and prepared the final veneer's surface. The temporary veneer was removed and the tooth surface was cleaned using a pumice slurry. K-etchant was applied to enamel for 15 seconds, rinsed off with water for 5 seconds, and lightly air-dried, after which 2% chlorhexidine digluconate (Cavity Cleanser, Bisco; Schaumburg, IL) was applied and lightly air-dried. An adhesive resin cement system (Panavia V5, Kuraray Noritake) was used to bond the veneer to the tooth's surface.

Clearfil Ceramic Primer Plus was applied to the veneer to silanate the porcelain surface. A self-etching primer (Panavia V5) was applied to the tooth surface before seating the veneer. A tack-cure with a curing light (PenCure, J. Morita USA; Irvine, CA) was performed for 5 seconds before the excess cement was removed. The final cure was performed and all margins were polished and finished with Enhance tips. A gingival retractor (3 Meinershagen, Hu-Friedy; Chicago, IL) was used to protect the gingival tissue while polishing the margins.

Figure 5: Postoperative right lateral full-smile view (1:2); the new ceramic laminate veneer gives #9 a more natural appearance, with three buccal planes instead of the flat appearance it had beforehand.

Figure 6: Postoperative retracted frontal view (1:2); veneer demonstrating improved appearance with appropriate line angles; healthy gingiva; and hue, chroma, and value that match #8.

Figure 7: Preoperative frontal full-face view (1:10); the old composite resin does not blend in with the natural surrounding dentition.

Figure 8: Postoperative frontal full-face view (1:10); the new porcelain laminate veneer on #9 blends in harmoniously with the surrounding hard and soft tissue.

Summary

Delivering a single anterior restoration that mimics nature can be a significant challenge, but with the many diagnostic and planning tools in modern dentistry at our disposal it has become a more predictable procedure. With the careful selection of materials, it is possible to deliver an esthetically pleasing restoration to a very satisfied patient **(Figs 7-9)**.

Figure 9: Postoperative; the completed #9 restoration (full-smile 1:2 view).

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The author owns a practice in Bundaberg, Queensland, Australia.

Disclosure: The author did not report any disclosures.

Imperceptible Replacement of a Central Incisor

> "Replicating nature is an extremely complex task that requires detailed communication and cooperation between the technician and the clinician."

Brian J. Gilbert, DDS, AAACD

Numerous factors play a role in the successful replacement of a single tooth in the anterior region with an indirect restoration, one of the greatest challenges in esthetic dentistry. Preparation design, choice of restorative material and, most importantly, detailed communication with the laboratory technician can lead to the creation of a restoration that blends imperceptibly with the adjacent dentition.[1]

When replacing a single anterior tooth, dentist-laboratory technician communication of accurate shade selection is one of the most important issues.[2] In addition to accurate shade selection, the clinician must communicate various other tooth characteristics, including translucency and surface texture. The use of digital photography often can aid in this communication.[3]

According to the AACD's *A Guide to Accreditation Criteria*, the ultimate test of Case Type II is whether the candidate can utilize indirect restorations on one or two anterior teeth so that the resulting restorations virtually "disappear" into the surrounding dentition.[4] Although aspects of smile design do play a role in Case Type II, the main criteria focus on characteristics of contralateral and adjacent teeth that influence the details of the final restoration. From the examiners' perspective, this candidate passed the ultimate challenge. Replicating nature is an extremely complex task that requires detailed communication and cooperation between the technician and the clinician. Dr. Venter demonstrated that achieving excellent results did not occur by chance.

Although no case is perfect, this Case Type II submission successfully passed the majority of examiners. The main comments focused on the following criteria:

The examiners had the following comments:

- **Criterion 53:** *Is the color (hue, value, chroma) selection appropriate/natural, not monochoromatic?* The examiners noted a slightly lower value for tooth #9 as compared to tooth #8 **(Fig 1)**.
- **Criterion 87:** *Are contralateral teeth in harmony in terms of size, shape, and position?* The examiners expressed a minor concern regarding the cervical contour of #9 being slightly wider than that of #8 **(Fig 2)**.

Figure 1: Postoperative retracted frontal view (1:2). Examiners noted a slightly lower value in #9.

Figure 2: Postoperative full-smile (1:2). Examiners noted a slightly wider cervical contour on #9.

This case is a good example of what can constitute success in the Accreditation process: taking the time and necessary steps to utilize proper clinical technique, carefully choosing the best patient for the case type, and communicating effectively with the laboratory technician to obtain a natural, ideal result. Dr. Venter clearly achieved a very positive outcome for his patient.

Dr. Gilbert is an AACD Accredited Member and an AACD Accreditation Examiner since 1998. He practices in Las Cruces, New Mexico.

Disclosure: The author did not report any disclosures.

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Congratulations

to AACD's New Accredited Fellows and Members!

Since 1986, the AACD has provided an exceptional opportunity for dentists and laboratory technicians to enhance their professional skills and knowledge in cosmetic and restorative dentistry through Accreditation. It requires these dedicated individuals to implement and demonstrate what they have learned at a high level of proficiency.

It is necessary to first become an AACD Accredited Member before one can attain AACD Accredited Fellow status. It requires commitment and determination, and its conferral connotes education and excellence.

Well done, everyone. Your dedication, enthusiasm, and insight are inspiring, and we wish you many more years of outstanding success.

Accredited Fellows

Tara N. Hardin, DDS, FAACD
Mason, OH

Sandra Hulac, DDS, FAACD
Hong Kong

Kathy S. Sanders, DMD, FAACD
Kingsport, TN

Accredited Members

Achieving Accredited Member status is an honor, a sign of one's commitment to cosmetic dentistry. Accredited Members often say it's not really about the credential; rather, it's about the learning, the professional growth, and the confidence that come from the journey itself.

Vinay N. Chirnalli, DMD, AAACD
Apex, NC

Ramon A. Duran, DMD, AAACD
San Juan, PR

Sandra M. Finch, DMD, AAACD
White Rock, BC, Canada

Ingrida Ivance, DDS, AAACD
Vilnius, Lithuania

Courtney L. Lavigne, DMD, AAACD
Wayland, MA

Roberto Palmieri, DMD, AAACD
Mooresville, NC

Robert L. Rioseco, DMD, AAACD
White Plains, NY

Keerti S. Sahasrabudhe, DDS, AAACD
Bellevue, WA

Tips for

Restoring a Single Maxillary Central Incisor with an Indirect Restoration

James H. Peyton, DDS, FAACD
Brian J. Gilbert, DDS, AAACD

Introduction

One of the most challenging procedures in cosmetic dentistry is restoring a single maxillary central incisor to ideally match the existing dentition. Because of the complexity of such a restoration, many dentists opt to restore both centrals rather than just the one in order to achieve a predictable result. Certainly, when there is a large restoration or discoloration on the contralateral tooth, or possibly an existing adjacent crown, the choice clearly would be to restore both centrals at the same time.

Unfortunately, this is not the most conservative approach if the adjacent central incisor is a "virgin" tooth. When one of the centrals has no existing restoration, no discoloration, no wear, and is free from decay, it would be considered aggressive overtreatment to restore both centrals when only one needs a crown. In most cases, patients do not want the adjacent healthy tooth to be touched. Therefore, when focusing on restoring a single incisor, the clinician must take into account various factors, including the shade, anatomy, and surface texture of the tooth to be matched, as well as the patient's age and the restorative history of both central incisors.

The first consideration in selecting a Type II case for Accreditation should be the patient's gingival health and oral hygiene. Pink, healthy gingiva with no noticeable recession and symmetrical gingival contours would be ideal. The next major factor is the patient's cooperation; it is critical that she or he support your pursuit of Accreditation by being willing and able to return for extra appointments as needed and to have numerous photographs taken. If the patient is very demanding, wants to get things done fast, has a lot of time constraints, and is not willing to undergo the extra procedures necessary to ensure success, then this may not be the ideal case for Accreditation. It is possible to have an ideal Accreditation case, but a less-than-ideal Accreditation patient.[1]

Remember that, even if you have found a seemingly ideal Case Type II (i.e., an extremely cooperative patient with a single maxillary incisor to be restored; and with excellent gingival health, little or no crowding of the upper front teeth, centrals that are similar in shade, and teeth with no recession), it may still be a challenge to match the new restoration to the adjacent tooth.[2] Following are some tips to maximize the chance for success.

Figure 1: Preoperative retracted view (1:1) showing a severely discolored tooth #8.

Figure 2: Postoperative retracted view (1:1) showing a very natural ceramic crown that mimics the natural tooth #9.

Tips for Success

- This cannot be overstated: A great deal of planning should go into Case Type II. Take photographs (full AACD series, plus more), do a diagnostic wax-up, and utilize these tools to help work up the case. Make sure anything that needs to be done (e.g., gingival recontouring, grafting, orthodontic treatment, endodontics) is planned out before you start.
- A common reason for restoring a single central incisor is that the tooth has had endodontic therapy and has become discolored. A tip for this is to use a color similar to the enamel shade of the contralateral tooth (one to two chroma higher) for the build-up material or even to opaque the facial of the tooth needing restoration (e.g., Kolor Plus [Kerr; Orange, CA], Creative Color [Cosmedent; Chicago, IL], Estelite Color [Tokuyama; Encinitas, CA]) **(Figs 1 & 2)**.
- If possible, do not use a metal post, but rather one that is light-colored. Check the value of the prepared tooth using the black-and-white setting on an intraoral camera; if the value is too low, correct it with opaquers. Opaque white shades of composite also can be used (e.g., WD, or XWD Filtek Supreme Ultra [3M ESPE; St. Paul, MN], OW Vitalescence [Ultradent Products; South Jordan, UT], White Renamel Microhybrid [Cosmedent]) and then overlaid with the dentin shade. Having a color-corrected tooth preparation allows the clinician to use a semi-translucent ceramic, which will look more natural in the final result.[3]
- Partner with an excellent laboratory technician (Accredited and Accredited Fellow laboratory technicians can be found at www.aacd.com/profiles) and be prepared to pay more than your usual lab fee. Consult and thoroughly plan the case with the laboratory technician before even picking up your handpiece. The right technician can help guide you as to the amount of reduction needed and which photographs they will need, and they can even suggest tissue correction or tooth movement. Remember, the technician is limited in what he or she can do for you if they are seeing the case for the first time when they receive the final impression. At that point, they have no way to go back and make changes.[4]
- By sending your technician a preoperative impression, they can create a preparation guide to ensure that the tooth has the best form to allow them to achieve an ideal result. Once the tooth is prepared, take photographs of the preparation, select a stump shade, and make an excellent temporary. It is best to create a provisional restoration that is an exact anatomical mirror image of the adjacent central incisor. A high-quality provisional restoration can help guide the soft tissue to heal in an ideal way that will allow the technician to create a nice final restoration. At that point, take a photograph as well as an impression of the temporary and send them both to the lab.[5,6]

- It is always best to schedule a single central incisor case for a try-in appointment to ensure the fit. Take photos and be willing to send the case—along with the patient, if necessary—back to the lab for a better color and contour match. This will provide time to strive for a more natural-looking, esthetically pleasing final restoration. Analyze the restoration with your technician and see what can be done to get the best match. When possible, it is best for the lab technician to be present at the try-in to see how the restoration looks intraorally. Several try-in appointments may be needed; let the patient know this in advance. Once you have achieved a natural-looking restoration that blends imperceptibly with the adjacent teeth, cement/bond the restoration in place.

Through thoughtful analysis and planning, combined with effective communication with the laboratory technician, you can create a restoration that will blend seamlessly with the patient's natural dentition.

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"Through thoughtful analysis and planning, combined with effective communication with the laboratory technician, you can create a restoration that will blend seamlessly with the patient's natural dentition."

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Emotional DIGITAL DENTISTRY

By Christian Coachman, CDT, DDS

The dynamic world of dentistry amazes, energizes, and motivates me. Patients today expect a superior experience and we must be ready to deliver it. That is the reality.

We must first learn how to attract people to our practice, then keep them through emotion. Storytelling should play a significant role in how we draw in and involve our patients.

Start the emotional journey with patients by having conversations with them to gain their trust. This will give you the permission to move forward. Explaining—and showing them—their oral health and dental problems with the use of extraordinary technology can help lead the way. By doing so you can then transition to providing solutions for them that will achieve predictable and esthetic outcomes.

This visual essay shows the clinical work of Dr. Luken de Arbeloa (Madrid, Spain) and Dr. Ricardo Brito (Caracas, Venezuela), combined with the use of my technological concepts from the DSD Planning Center's smile design, guides, and devices.

DIGITAL *restorative* WORKFLOW

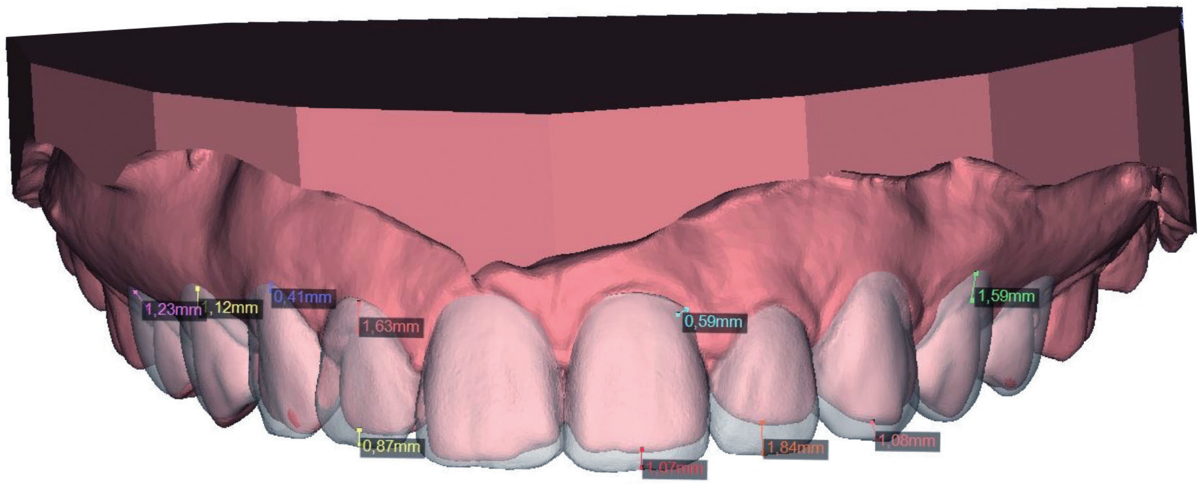
Preoperative image with scanned preoperative model.

2D smile simulation on the DSD app.

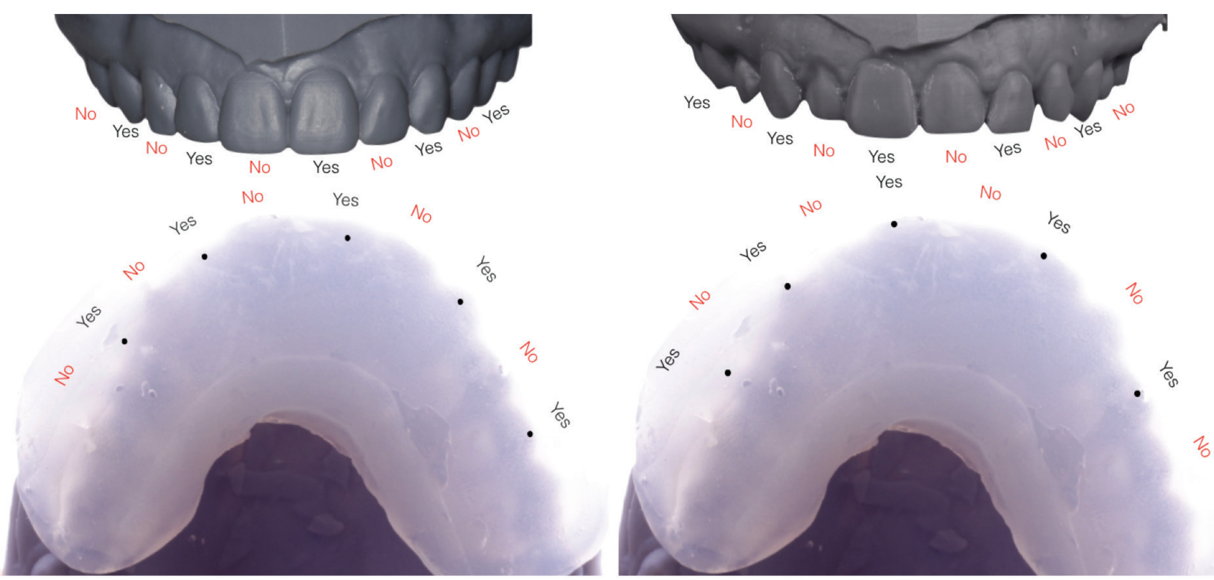
[3D design and motivational mock-up.]

[Final design printed model and final result with injected composite technique.]

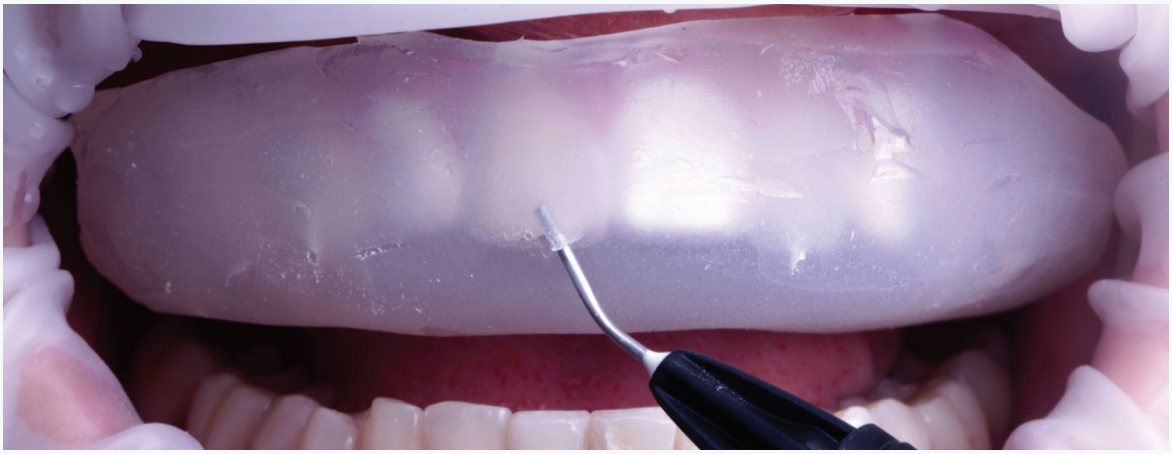
TRANSFORMING TECHNOLOGY

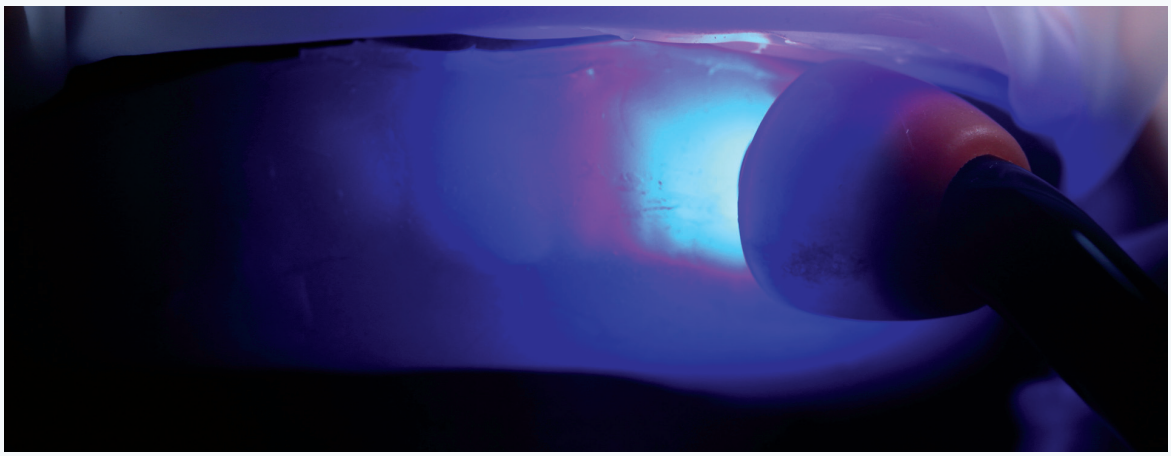


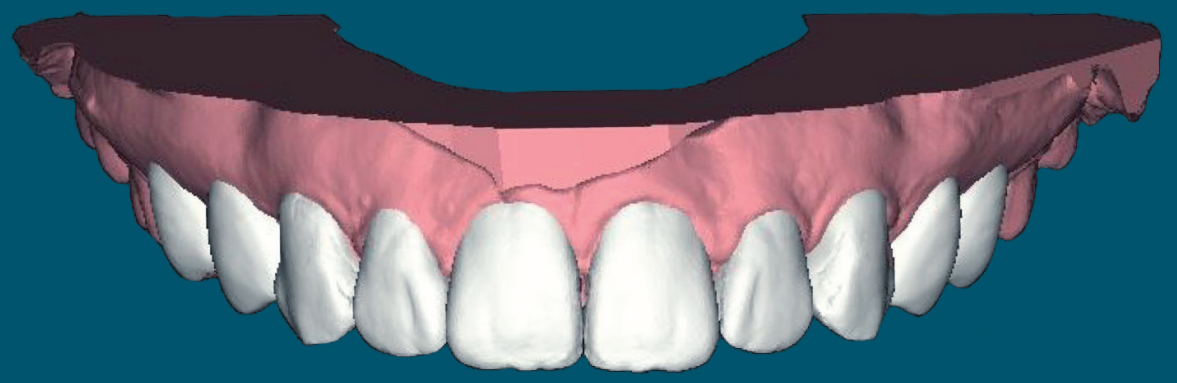
Before the injected composite technique, gingivoplasty was performed guided by the digital periodontal plan.



For the injected technique, the design is transformed in a 2D model. Two transparent silicones guides are fabricated, one with every other tooth design removed and the other with all the teeth designed in place.







Storytelling

HOLISTIC

Modern

THE ESTHETIC JIG

An Original Dental Appliance for Esthetic Rehabilitation of Occlusal Vertical Dimension

Altamiro Flavio, DDS

Abstract

A patient's vertical dimension measurement is an important factor for the clinician to consider when planning an oral rehabilitation. Establishing the correct occlusal vertical dimension (OVD) is dependent upon dental and facial analysis, the latter of which should include measurements of facial anatomic points and evaluation of facial ratios. However, dentists may find it challenging to transfer planned measurements to the patient's mouth. This article describes an interocclusal device, called the *esthetic jig*, which is created according to customized parameters for each patient and that can help dentists to properly achieve the correct OVD.

Key Words: vertical dimension, occlusal vertical dimension, dental occlusion, dental rehabilitation, composite restorations

Introduction

Vertical dimension has been defined as the distance between two selected anatomic points.[1] When the mandibular teeth occlude with the maxillary teeth, the vertical dimension is known as the *occlusal vertical dimension* (OVD). Treatment planning an ideal oral rehabilitation should account not only for the anatomic shape, dimension, and position of the teeth, but also the OVD. These smile components are interconnected and inseparable in the manner in which they strongly influence each other. OVD for dentate individuals is determined primarily by the remaining dentition; hence, loss of tooth structure might influence the OVD, and a loss of OVD can significantly affect patient function, comfort, and esthetics.[2] As soon as the dentist diagnoses an inadequate OVD in a patient, the ideal dimension for that patient should be established.[3,4]

Increasing OVD

From a clinical perspective, increasing OVD has been reported to facilitate the treatment of patients presenting with generalized and complex dental abnormalities such as generalized tooth wear and significant occlusal irregularities.[5-8] However, considerable debate remains in the literature about treatment modalities used to increase OVD. Some authors have assumed that OVD is constant throughout an individual's life and any alteration of OVD will subsequently interfere with masticatory system physiology and the patient's ability to adapt.[9,10] Reported consequences of increasing OVD are masticatory muscle issues, occlusal force elevation, bruxism, and temporomandibular disorders.[2,9,10] Conversely, other authors have reported that such symptoms are transitory.[11-14] Although evidence regarding the implications of increasing OVD is still lacking, rehabilitative procedures involving the increase of OVD should be approached with caution, and appliances that could facilitate its execution are always welcome.[15-23]

Lucia Jig

For example, the Lucia jig—which is considered a neuromuscular reprogramming device—is fabricated at the maxillary central incisors and has been used in dental practice for several purposes. These have included disoccluding the teeth and, consequently, deprogramming the neuromuscular activity pattern; preventing occlusal interferences; enabling better manipulation of the mandible; and allowing evaluation of changes and disorders in dental occlusion.[24] However, this device enables dentists only to evaluate dental occlusion, without providing information about the ideal dental esthetics to be achieved or allowing the use of esthetic references when determining the amount of OVD increase.[25,26]

Esthetic Jig

Alternatively, the esthetic jig is an interocclusal device similar to a provisional central incisor crown restoration. It is fabricated from acrylic resin directly over the maxillary and/or mandibular central incisor, or indirectly on a gypsum cast model.

"...rehabilitative procedures involving the increase of OVD should be approached with caution, and appliances that could facilitate its execution are always welcome."

Because the esthetic jig is used to determine a patient's current OVD measurements, it is placed over the existing tooth form (i.e., no dental preparation or removal of tooth structure is necessary), making it a practical and simple device. Therefore, composite resin should not be used in its fabrication due to the material's lack of flexibility and susceptibility to fractures during insertion and removal.

Several principles guide the fabrication of an esthetic jig, as follows:

Dimensions: The esthetic jig's width and length are based on facial measurements. Its width is established by dividing the interpupillary distance by 6.6. Because the relationship between the interpupillary distance and the mesiodistal width of maxillary central incisors is stable throughout life beginning at age 4, it is an excellent reference. It also has been reported that in 95% of cases, the maxillary central incisor width could be obtained by dividing the interpupillary distance by 6.6.[27]

In the author's daily routine practice, the average measurement ranges from 8.3 to 8.9 mm for women, and from 8.6 to 9.2 mm for men. Although not exactly the same, they fall within the averages found in the literature, including one study of 100 North American patients that measured the interpupillary distance from the center of the left pupil to the center of the right pupil, along with the width of central incisors at their widest **(Table 1)**.[27]

Table 1. Average Interpupillary Distances and Central Incisor Widths

	Interpupillary Distance	Central Incisor Width
White male	57.87 mm	8.92 mm
White female	56.51 mm	8.52 mm
Black male	59.39 mm	9.13 mm
Black female	62.86 mm	9.02 mm

After determining the patient's ideal central incisor width according to facial analysis, the correct central incisor length for the esthetic jig is then established. This can be determined by multiplying the width by 1.25; however, others have advocated using the width ratio multiplied by 1.33.[28]

Position: The ideal inclination of the buccal (i.e., vestibular) aspect of the esthetic jig should be based on a lateral (i.e., profile) smile evaluation. One study found that the average right central incisor buccal surface inclination is 6.48°, with a standard deviation (SD) of ± 3.99; and the average left central incisor buccal surface inclination is 6.30°, SD ± 3.90.[29] The inclination should result in the incisal edge falling between the dry-wet vermilion of the lower lip.

Additionally, the amount of the esthetic jig's incisal display with an open upper lip (i.e., parted lips) should approximate an average of 2 mm for males and 3.4 mm for females,[30] a difference explained by the fact that women's lips, in general, are shorter than men's. If the esthetic jig display exceeds these measurements, dentists might add acrylic resin to the incisal edge, keeping in mind the maximum length in relation to the width, as determined by multiplying the width by 1.33. However, before multiplying the width by 1.25 or 1.33, it is also important to consider the trespass.[25,26]

Palatal surface anatomy: This aspect of the esthetic jig should incorporate all anatomic points (e.g., proximal crest, cingulum, incisal edge, and palatal concavity) and their respective characteristics. If a proper increase of OVD is not achieved with a maxillary esthetic jig that demonstrates a normal, concave palatal anatomy, the dentist absolutely should not add more acrylic resin; the jig should be left with little or no concavity and, in such cases, an esthetic jig also should be placed on the lower central incisor to antagonize the maxillary jig. This may reveal the need to increase the incisal edges of the anterior teeth to achieve the OVD necessary for rehabilitation.

Finishing and evaluating: After the esthetic jig is fabricated, it should be polished so that it does not interfere with mandibular and labial movements. It should then be tried in the patient's mouth, and any necessary adjustments made. In particular, several aspects should be evaluated and tested **(Table 2)**.

Table 2. Esthetic Jig Aspects to be Evaluated and Tested

Aspect	Ideal
shape	Similar to a natural central incisor.
incisal exposure at rest	2 mm for males; 3.4 mm for females.
buccal surface inclination	Approximately 6.4° when the patient is smiling and observed from the profile view.
length	Esthetic jig length should not be excessive; when the patient is smiling, the incisal edge of the jig should not produce pressure on the upper edge of the lower lip.
trespass	At least 2 mm to produce a mutually protective occlusion and a maximum of 4 mm to facilitate protrusive movements.
incisal dominance	When the patient is smiling and observed from the frontal view, the incisal aspect of the jig should be at a lower horizontal level than the other maxillary teeth.
at centric occlusion	The patient should be asked to occlude the teeth, after which the dentist should evaluate the resulting available interocclusal space between the posterior teeth, which will receive restorations in the future.
facial length and width	Verify that the face is not extremely long. For reference, use the length from the trichion (i.e., hairline) to the base of the chin minus 30%, which equals the female facial width; or minus 35%, which equals the male facial width.[21]
passive labial seal	The patient should be able to passively close the lips.
phonetic test	Movement of the lips and tongue during speech should be observed. The inclination should result in the incisal edge falling between the dry-wet vermilion line of the lower lip.

Figure 1: Pretreatment maxillary occlusal view of the patient's anterior and posterior teeth showing wear due to bruxism and GERD.

Figure 2: Pretreatment mandibular occlusal view.

Case Presentation

Patient Complaint and History

A 37-year-old man presented for treatment with the chief complaint of esthetic deficiency of his anterior maxillary teeth. His posterior teeth were also worn due to parafunction and gastroesophageal reflux disease (GERD) **(Figs 1 & 2)**, both of which caused a loss of OVD.

Treatment

After the initial evaluation, the following treatment plan was executed, demonstrating the use(s) of the esthetic jig.

1. Referral to a gastroenterologist to treat his GERD and prevent future harm.
2. Preoperative botulinum toxin injection in the masseter and temporalis muscles to decrease their contraction strength and muscle tone at rest **(Fig 3)**. It was used preoperatively as supporting therapy to enable dental rehabilitation, which included restoration of OVD, by diminishing the power of the masseter and temporalis muscles in this case of severe bruxism. In this patient, these muscles exhibited hypertrophy by their dimensions, which may contribute to enamel cracks, dental attrition, and bone exostoses in some patients. The bigonial distance almost equaled the bizygomatic distance; it should correspond to 75% of the zygomatic width.[31]
3. Fabrication of the esthetic jig to help reestablish OVD **(Fig 4)**. The esthetic jig was placed over the patient's central incisors, without any cement or adhesive **(Figs 5 & 6)**. Since the proximal surfaces of esthetic jigs are not closed with acrylic, they are flexible; they extend beyond the prosthetic equator of the central incisor during insertion, stabilizing it on the tooth during the rehabilitation process.

The patient's smile was observed from the frontal view to determine whether restorative materials should be added to his mandibular posterior teeth, maxillary posterior teeth, or both to facilitate anterior guidance and function and avoid occlusal contact of posterior teeth during excursive movements **(Figs 7 & 8)**. This decision should be based primarily on the principle of incisal dominance of the central incisors compared to the other maxillary teeth.[32] This principle, which is rooted in tooth function, asserts that maxillary anterior teeth should fall lower than posterior teeth to facilitate grabbing and biting food.

Additionally, it is esthetically unpleasant to observe maxillary posterior teeth at a lower level than anterior maxillary teeth (e.g., cases of maxillary posterior teeth extrusion). It also is important for the incisal aspect of maxillary incisors to fall at a lower horizontal level than the remaining maxillary teeth, as the alignment follows the upper edge of the lower lip.

For these reasons, adding restorative material to the occlusal surface of mandibular posterior teeth and not to the maxillary posterior is preferred. The addition of restorative material to the occlusal surface of the maxillary posterior teeth to increase OVD would also increase clinical crown interferences, as well as contradict the dominance principle of anterior teeth over posterior.

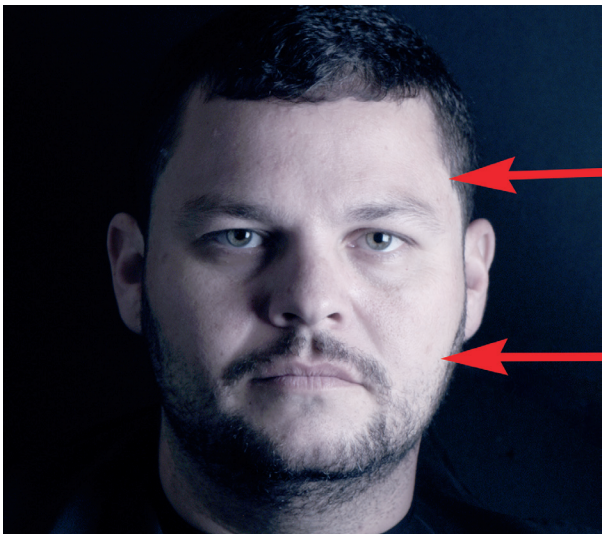


Figure 3: Botulinum toxin was injected in the masseter and temporalis muscles to decrease their strength during parafunction, as well as muscle shortening.

Figure 4: Buccal, palatal, and proximal views of the maxillary and mandibular central incisor esthetic jigs fabricated for the patient.

Figure 5: The esthetic jigs were placed on the central incisors without cement or adhesives to enable a functional evaluation.

Figure 6: The interocclusal space to be restored was evaluated with the patient in central occlusion.

Figure 7: The esthetic evaluation included observation of the amount of the esthetic jig's clinical crown display with open lips.

Figure 8: The esthetic evaluation also included evaluation of the jig's initial position in relation to the upper vermilion of the lower lip.

4. Restorative treatment that included placement of no-preparation direct composite for the final restorations in both anterior and posterior teeth. One advantage of the esthetic jig technique is that the dentist can work independently from the technician. Additionally, placing composite restorations affords the dentist an opportunity to perform artistic work in rebuilding esthetics and function without preparing or removing healthy enamel.

According to the restorative treatment approach, the esthetic jig can be used in two different ways. For direct restorations created on the selected posterior teeth, the esthetic jig is used to verify the height of each restoration and also occlusal function, as well as guide adjustments according to its indexed anterior guidance. When placed on a gypsum model mounted in an articulator, the esthetic jig serves the same purposes for indirect restorations.

Restoring the selected posterior teeth establishes a new OVD **(Figs 9-12)**. The next step is to again place the esthetic jig on a central incisor, where it will serve as a reference during the rehabilitation of the contralateral teeth **(Fig 13)**. This rehabilitation can be performed with direct composite resins in the mouth, or indirectly over the model (e.g., to duplicate the wax-up of the contralateral tooth) **(Fig 14)**. Hence, it will guide both posterior and anterior rehabilitation.

In this case, the ideal length of the esthetic jig (i.e., central incisor) was measured (11.50 mm) to guide composite placement on the gypsum model **(Figs 15 & 16)**. This enabled planning of composite layers directly on the cast, eliminating the waxing stage **(Fig 17)**.

The dentin composite layer restoring the mamelons ended 0.5 mm from the ideal final length **(Fig 18)**, ensuring space for composite layers corresponding to the translucent halo (i.e., 0.3 mm thick) and opaque halo (i.e., 0.2 mm thick). A blue effect composite was added to the incisal to simulate the opalescent halo, in addition to brown strain at the cervical area and ochre over the mamelons **(Fig 19)**. Opaque halo effects and white stain were then applied over the blue effect composite layer **(Fig 20)**. A final layer of enamel composite resin was then applied **(Fig 21)**.

Figures 9 & 10: Direct restorations were placed in the posterior teeth using a metal matrix to fabricate proximal surfaces. This was essential to avoid narrowing of occlusal surfaces.

Figure 11: A dentin layer of direct composite was placed.

Figure 12: A final layer of direct composite resin was placed to complete the posterior restorations.

Figure 13: The posterior teeth intercuspation after posterior restoration placement and adjustment, resulting in simultaneous posterior teeth contact and palatal surface contact of the esthetic jig.

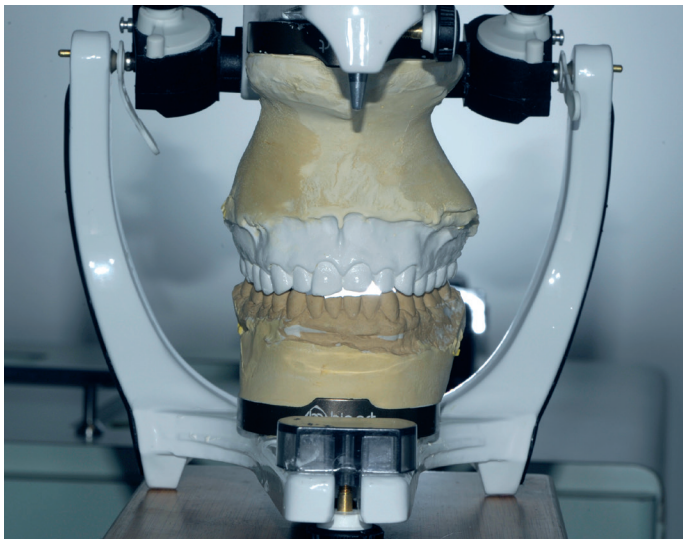


Figure 14: To begin fabricating the maxillary anterior restorations, the case was mounted on a semi-adjustable articulator (optional).

Figure 15: The length of the esthetic jig was measured to guide composite placement on the gypsum model.

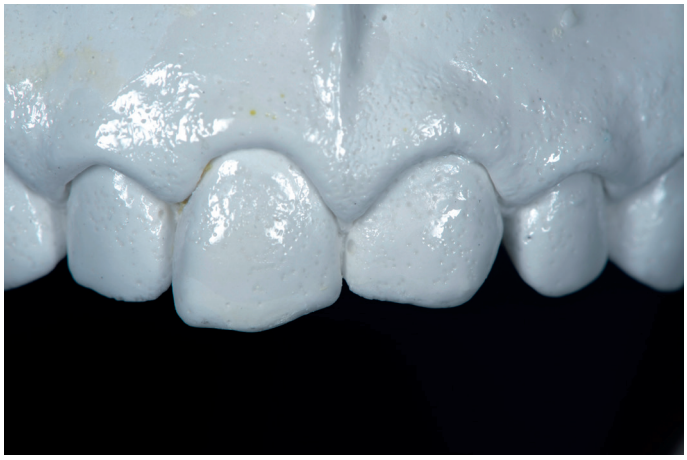


Figure 16: The isolated gypsum model with two layers of cyanoacrylate glue.

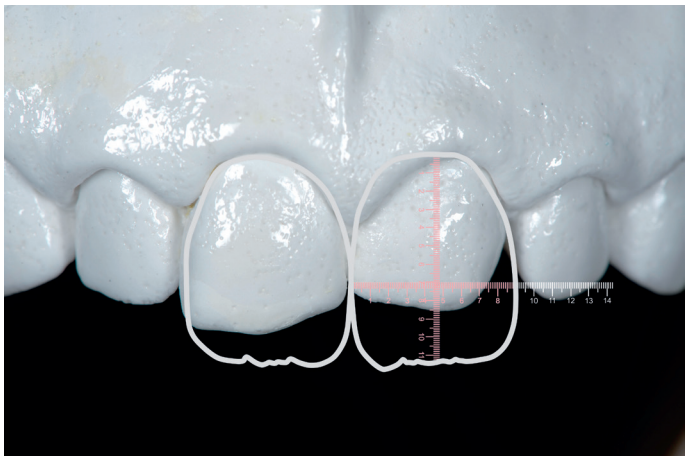


Figure 17: With the ideal length of central incisors (11.50 mm) measured in the esthetic jig, it was possible to plan layers of composite directly on the cast.

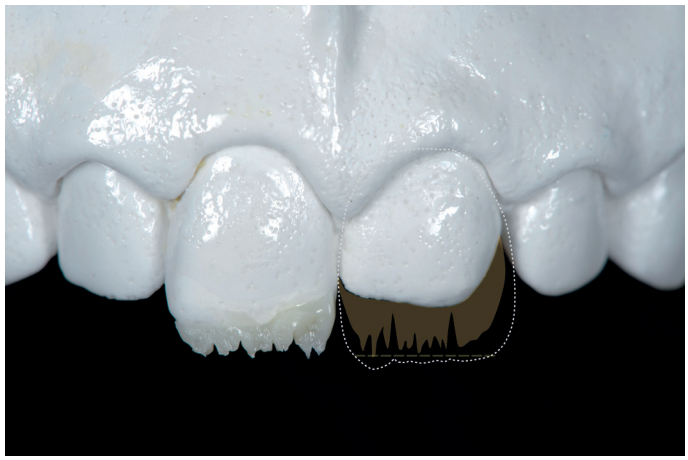


Figure 18: The dentin composite layer restoring the mamelons should end 0.5 mm from the ideal final length.

Figure 19: A blue effect composite was added to the incisal, as well as brown strain at the cervical and ochre over the mamelons.

Figure 20: Opaque halo effects and white stain were applied over the blue effect composite layer.

Figure 21: A final layer of enamel composite was placed.

> "Because the esthetic jig is used to determine a patient's current OVD measurements, it is placed over the existing tooth form (i.e., no dental preparation or removal of tooth structure is necessary)..."

Because excess composite may be incorporated into the restoration, requiring adaptation and slight contour corrections, the restoration would only be finished and polished after cementation, which was accomplished using a dental resin **(Fig 22)**. Additionally, finishing and polishing prior to cementation could inhibit the resin cement from achieving complete adhesion.

After cementation, the composite restorations were finished intraorally **(Fig 23)**. A disc was used to simultaneously touch up and adjust the mesial portion of the buccal surfaces **(Fig 24)**.

Once the restorations were complete, the final anterior guidance outcome of the anterior maxillary teeth (e.g., palatal surface) and incisal of the mandibular anterior teeth were compared to the initial gypsum model, which was cut using a model trimmer to evaluate anterior guidance **(Figs 25 & 26)**. At rest, the patient displayed more of his central incisors following rehabilitation **(Fig 27)**, and the direct composite restorations were successful in increasing his OVD **(Figs 28 & 29)**.

5. Fabrication and delivery of a nightguard.

Figure 22: The composite restoration was cemented using a dental resin.

Figure 23: The restoration was finished intraorally.

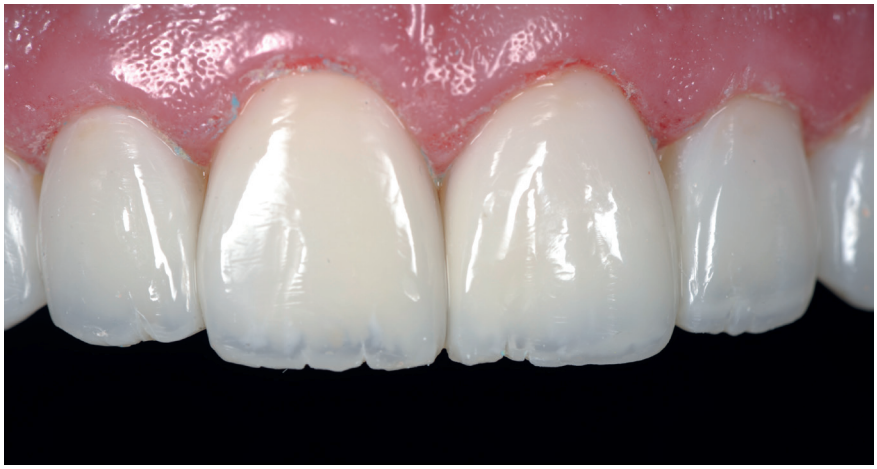


Figure 24: View of the final result after polishing.

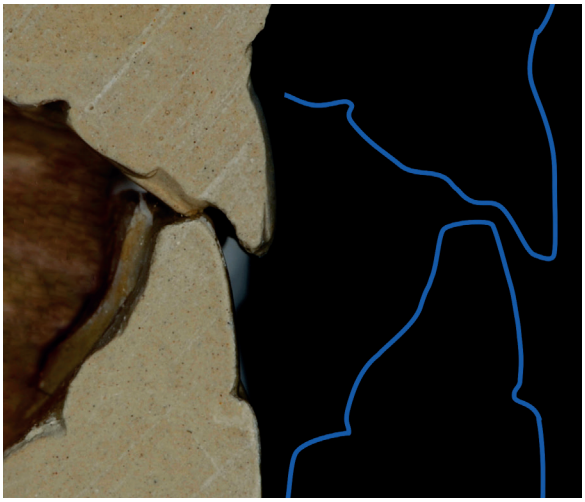


Figure 25: View of the initial gypsum model that was cut using a model trimmer to evaluate anterior guidance.

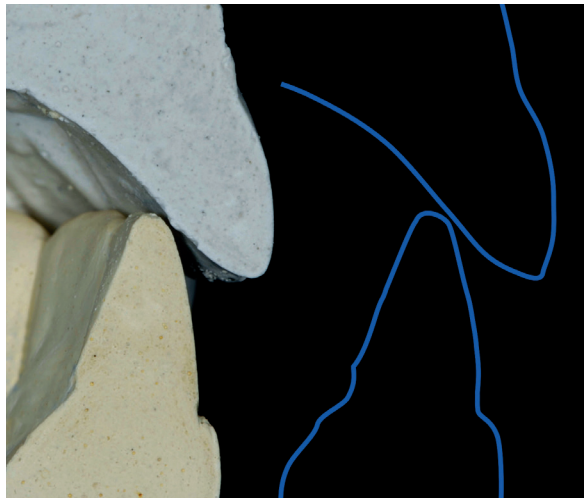


Figure 26: Final anterior guidance outcome after direct restoration of the anterior maxillary teeth (e.g., palatal surface) and incisal of the anterior mandibular teeth.

Figure 27: Note the amount of central incisor display demonstrated by the final restorations when the patient's lips are at rest.

Figure 28: Postoperative retracted view of the direct composite restorations to increase OVD.

Figure 29: Postoperative close-up view of the patient's restored smile.

Summary

The diagnosis and rehabilitation of patients with a loss of OVD are complex procedures for dentists, partly because this vertical dimension is often defined in random ways. Although employing a Lucia jig has been useful and well described in the literature, it provides few references for establishing a new OVD. However, an easily reproduced guide such as the esthetic jig might facilitate the OVD restorative process and contribute to satisfactory results. Fabricated from an acrylic material based on a combination of interdependent facial, esthetic, functional, and dental references, the device enables dentists to determine the anatomy, dimensions, and position of restorations created during treatment. As a result, it can contribute to a successful oral rehabilitation when reestablishing a patient's OVD is required.

Acknowledgment

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Dr. Flavio owns a practice in Goiania, Brazil.

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"For direct restorations created on the selected posterior teeth, the esthetic jig is used to verify the height of each restoration and also occlusal function..."

Treating Two Adjacent Missing Teeth in the Esthetic Zone

Part 2: The Pink Hybrid Restoration and the "In-Between" Implant Concept for the Anterior Mandible

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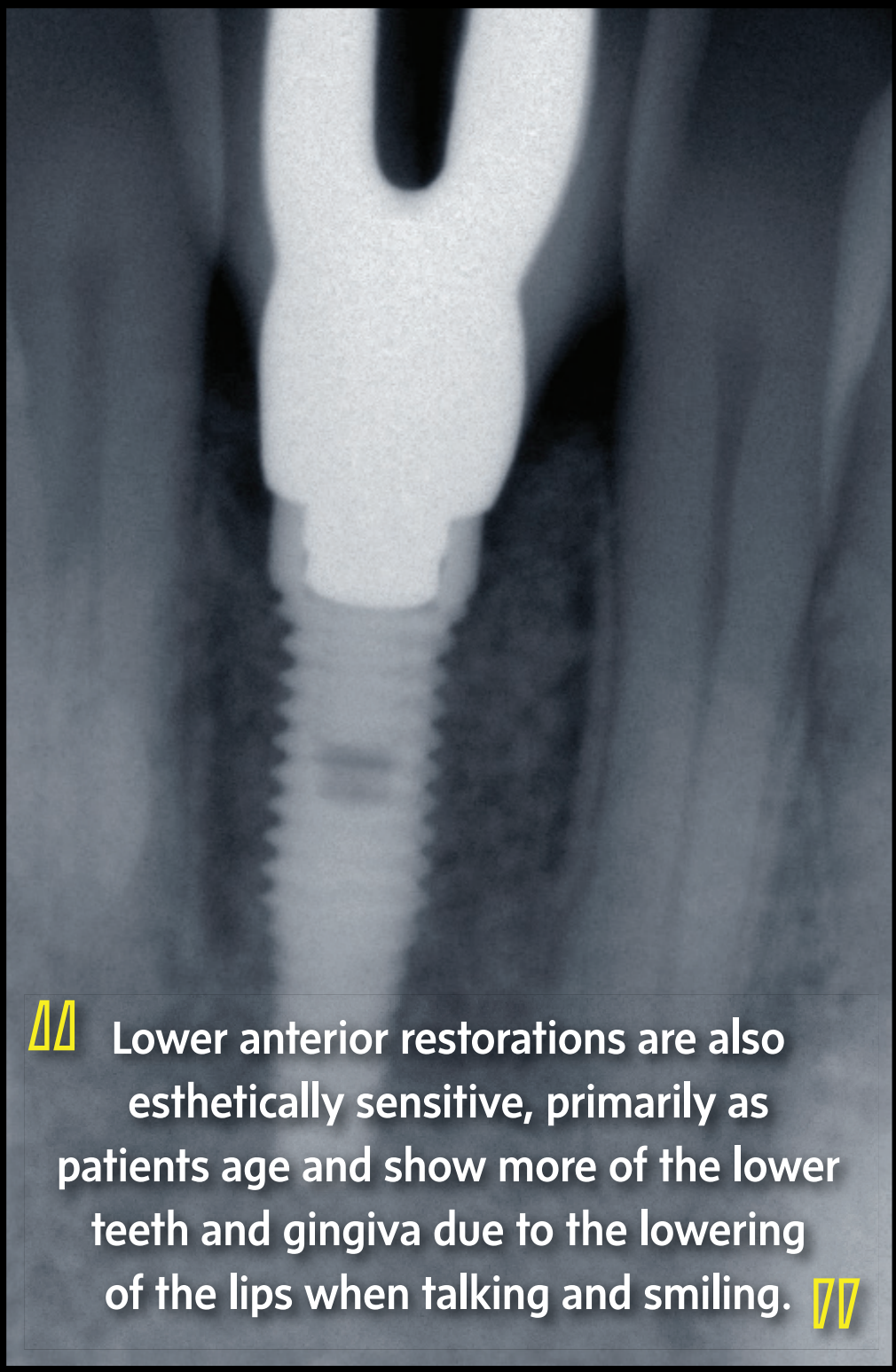
Maurice A. Salama, DMD
Eduardo Mahn, DDS, DMD, PhD

Abstract

This article, the second in a three-part series, outlines the issues, considerations, and advantages of utilizing an "in-between" single implant placement approach for cases involving the replacement of two missing adjacent teeth in the anterior mandibular esthetic zone when combined with a pink defect. This is an area in which lack of space and gingival issues are common challenges and can present esthetic and biological complications. Particularly when used in combination with pink ceramics or pink hybrid restorations, placement of a single implant between two teeth presents a viable treatment option for addressing space problems, bone loss, and gingival issues in a simple, economical, and highly esthetic manner.

Key Words: "in-between" implant, adjacent missing teeth, single implant, anterior mandible, pink hybrid restoration (PHR)



> Lower anterior restorations are also esthetically sensitive, primarily as patients age and show more of the lower teeth and gingiva due to the lowering of the lips when talking and smiling.

Introduction

When dealing with cases that involve two missing teeth in the anterior mandibular region, clinicians and technicians often find themselves confronting a "tight" situation, literally and figuratively. The reasons for this include the following:

- The diameter of anterior lower incisors is minimal and sometimes approximates a reduced diameter implant.[1]
- In other cases, although the diameter of the implant and tooth might be similar, the space between the teeth is insufficient to ensure adequate interproximal bone and soft tissue formation between two implants and the neighboring teeth.[2]
- Lower incisors often are crowded,[3] further minimizing the space for two implants after two teeth are extracted.
- When two lower incisors are missing, the adjacent teeth tend to shift to close the gap.
- Even if the teeth did not shift, crowding may already have existed before tooth loss, meaning that the space available after extraction is less than what corresponds to two perfectly aligned lower central incisors. In many such cases, even when the patient is missing two teeth, it is difficult to place two implants, and when placement is attempted, esthetic and biological complications can occur in the short and/or long term.

Considering these factors, it is not difficult to understand why the prospect of restoring two adjacent missing teeth by placing a single implant was first proposed to resolve issues in the anterior mandibular area, a highly esthetic zone prone to spacing, bone loss, and gingival challenges. It was suggested in particular for older patients, whose lower teeth and gums show more due to the drooping of the lower lip with age. Particularly when used in combination with pink ceramics or pink hybrid restorations (PHR), single implant placement in between two teeth represents a viable treatment option to address spacing, bone loss, and gingival deficiencies in a simple, economical, and highly esthetic manner.

Advantages of "In-Between" Implant Placement When Using Artificial Gingiva Between the Ideal Positions of the Crowns

As previously stated, lower anterior restorations are also esthetically sensitive, primarily as patients age and show more of the lower teeth and gingiva due to the lowering of the lips when talking and smiling.[4] When using artificial gingiva, placing implants in between the ideal position of the crowns offers numerous advantages. These include the following:

- Better primary osseous integration (placement over the bone crest provides immediate loading).
- Easier hygiene (there is only a single abutment instead of two, and two half cantilevers on each side instead of a full cantilever on one side, so there is no need to use a threader in between the implants).
- Better occlusal load distribution (the implant axis will be positioned in the middle of the mesiodistal gap, thus generating more centric occlusal forces).
- Better lingual morphology (the implant screw access will exit on the interproximal area, allowing ideal lingual anatomy development, less lingual volume, and more comfort for the tongue).
- Better interproximal, cervical, and gingival margin esthetics (the "in-between" implant position affords clinicians more freedom and space to work with the emergence profile and connector positions and to create more natural-looking color and translucency in restorations.

Two-Unit Implant Bridge: Esthetic Framework Challenges

Hiding a ceramic bridge framework, however, is always difficult. When a two-unit implant bridge is fabricated, the main esthetic challenges regarding the framework include the following:

- Hiding the areas that have a thinner ceramic layer, where the framework can show through.
- Hiding the connector in between the two crowns. This is probably the biggest challenge because a natural-looking interproximal area—one that creates the illusion of two separated crowns—must be created without revealing the connector. On a conventional bridge, the connector is placed on the contact area in between the two crowns. In addition to the previously cited esthetic challenges, this requisite connector placement also blocks light transmission around this area, an important consideration because it is close to the incisal edge, a region with high light transmission. A very common problem when trying to make a bridge look like individual teeth is hitting and exposing the framework when using a disc to esthetically develop the interproximal morphology. Consequently, single crown restorations are esthetically easier to create than bridge restorations.
- Hiding the screw channel. The implant position must accommodate development of a framework design that incorporates the diameter of the screw channel, thickness of the framework material for proper resistance, and esthetic layering material to hide all of the above.

"In-Between" Implant Bridge: Advantages

The advantages of opting for the "in-between" bridge include the following:

1. It creates an esthetic situation in which the two crowns will behave as a single unit, even though they are connected, since the connector will be moved cervically behind the artificial papillae. This makes it easier to address the challenges of hiding the connector and screw channel.
2. When a two-unit bridge with artificial papilla in between is present, the area with the greatest volume of esthetic material (i.e., ceramic and/or composite) is the papilla region,

making it the best location for placing the connector and screw channel. The "in-between" implant placement specifically allows this consideration.
3. It requires less critical implant positioning (e.g., away from adjacent teeth and interproximal bone and away from the apex of adjacent teeth, especially when the apex is converging apically and decreasing space for the implant in this area). Additionally, bone resorption after tooth extraction causes a shorter ridge and small perimeter arch,[5] situations that force implant placement to another nonideal position unless the surgeon compensates for it by performing a bone graft.
4. It makes it easier to handle the soft tissue because only some compression is needed. It also eliminates concerns about an unsatisfactorily built papilla or gingival esthetics in between the two artificial crowns, situations that occur frequently.[6]
5. It is less costly due to the need for fewer implants and less complex reconstructive surgeries.
6. The surgeries required are less critical in nature. Typically, in these cases, the most unpredictable procedures are ridge augmentation surgeries, since there are many prosthetic implications resulting from tooth loss.[7] The "in-between" implant bridge technique eliminates those steps.
7. It enables a shorter treatment period. In most cases, the duration is less than four months. Treatment typically involves an initial appointment for simple and fast implant placement (e.g., one that does not attempt vertical ridge augmentation); a second appointment after three months of healing for try-in and placement of the ceramic bridge; and—only if required for the particular case—a third appointment one week later for intraoral application of pink composite.

Case Presentations

Two clinical cases are described below. They have the same objective (replacing two lower incisors in the esthetic zone with implant-supported restorations). However, they employ two different approaches (two-implant placement versus single-implant placement) to examine the respective challenges and possible outcomes of each in order to determine which offers the best esthetic, osseous integration, load distribution, lingual morphology, and hygiene results.

Case 1

Two implants were placed to restore the patient's missing mandibular central incisors (#24 and #25) in a very tight space **(Fig 1)**. The restoration design attempted to overcome space deficiencies **(Fig 2)**, but the final outcome demonstrated an inappropriate biological and esthetic result **(Fig 3)**.

When anterior mandibular teeth are missing, it is common to find severe bone defects with complete papillae loss. Consequently, the papilla between the two missing teeth likely will require artificial restoration since it is difficult to reestablish natural papilla form, even in cases where the ridge height has been recovered.[3] If the papilla between two missing teeth needs to be restored with artificial pink, the "in-between" implant position represents the best option.

Figure 1: Two implants placed to restore both missing lower incisors in a very tight space.

Figure 2: The restoration design attempted to overcome the space problem.

Figure 3: The final outcome demonstrated an inappropriate biological and esthetic result.

Case 2

This patient's mandibular central incisors (#24 and #25) exhibited major soft and hard tissue loss. The treatment approach sought to provide a solution that not only was more likely to achieve better esthetics but also would decrease the possibility of technical and biological complications and minimize treatment cost and effort. The teeth required extraction due to a lack of bone support, which was visible radiographically **(Fig 4)**. The restoration's design required particular attention, since it would have a significant impact on smile esthetics because when the patient smiled the exact area of intervention was revealed **(Fig 5)**.

Two diagnostic wax-ups were made to evaluate the esthetics of two alternative treatment approaches. In the first restorative option, one large central was placed in the position of the two missing teeth **(Fig 6)**. However, the one implant/one central solution created an excessively wide and unattractive tooth **(Fig 7)**. In addition, the computerized tomography (CT) scanning used for three-dimensional (3D) planning of the implant position revealed insufficient space for normal centrals and two implants **(Fig 8)**.

In the second restorative option, the adjacent laterals were minimally stripped in the cast model, and two centrals were placed—minimally overlapping them toward the laterals—to recreate a natural, slightly crooked position **(Fig 9)**. From an esthetic perspective, the second option appeared to be the best alternative. Therefore, digital planning was performed to place an implant at the "in-between" position to support two centrals and reshape the mesial aspect of both laterals **(Figs 10 & 11)**.

During implant placement surgery, the open flap revealed the defect. The lack of buccal and interproximal bone support clearly emphasized how challenging it would be to develop papilla in between the two prosthetic crowns **(Fig 12)**, already indicating that a small artificial pink papilla might be needed to avoid the problem presented in Case 1 **(Fig 3)**. A surgical guide fabricated based on the "in-between" digital planning **(Fig 13)** was used, and the "in-between" implant (i.e., a 3.3 x 13-mm implant) was placed **(Fig 14)**. Bone grafting was performed **(Fig 15)** and the graft was covered with a membrane **(Fig 16)**.

After healing, an ideal soft tissue condition was achieved with ample keratinized tissue around the implant. This resulted from the guided bone regeneration and connective tissue graft performed during implant placement, as well as the implant's adequate positioning (i.e., correct distance to the neighboring teeth) **(Fig 17)**.

To open space for the two centrals, the mesial side of the laterals was trimmed according to the design created on the wax-up **(Fig 18)**. The final metal-ceramic bridge featured screw access on the lingual and pink porcelain on the buccal sides. The "in-between" implant placement created two half cantilevers on each side of the bridge; this facilitated much better load distribution **(Fig 19)** and also enabled easier and better access for hygiene (i.e., floss goes around the two half cantilevers on each side for cleaning) **(Fig 20)**.

The patient's smile, which revealed the treated area and definitive metal-ceramic restoration, emphasized the increased importance of achieving ideal esthetics in this area **(Figs 21 & 22)**.

Figure 4: The lack of bone support, necessitating extraction of both lower central incisors, was visible radiographically.

Figure 5: Preoperative view of #24 and #25. Restorative esthetics was an important concern because the exact area of intervention was revealed when the patient smiled.

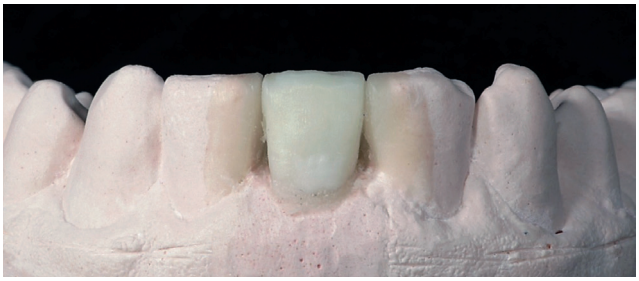


Figure 6: A diagnostic wax-up of the first restorative option consisted of one large central in the position of the two missing teeth.

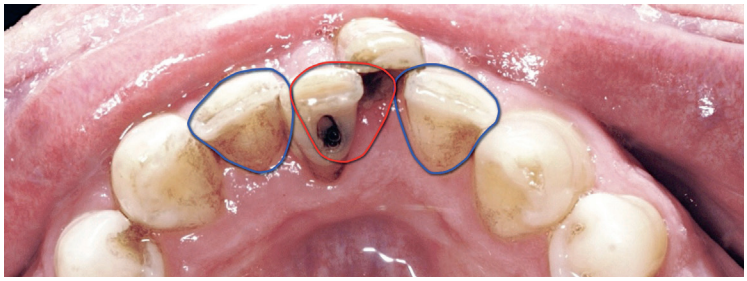


Figure 7: A two-dimensional (2D) digital sketch illustrates that the one implant/one central solution created an excessively wide and unattractive tooth.

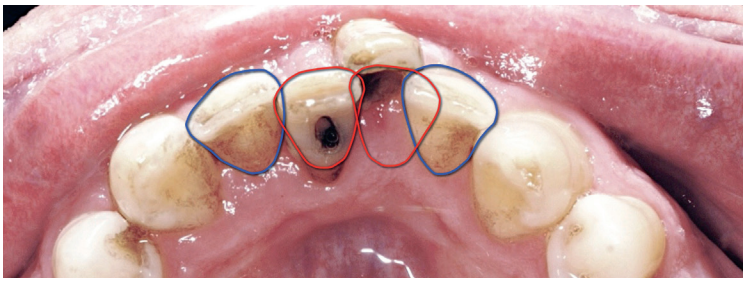


Figure 8: A 2D digital sketch illustrates that the space was too tight for normal centrals and two implants.

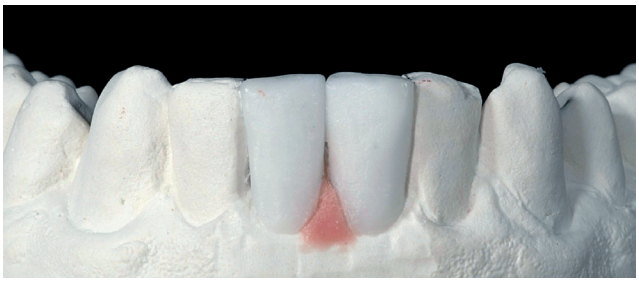


Figure 9: The diagnostic wax-up of the second restorative option involved minimal stripping of the adjacent laterals in the cast model and placing two centrals—minimally overlapping toward the laterals—to recreate a natural-looking small, crooked position.

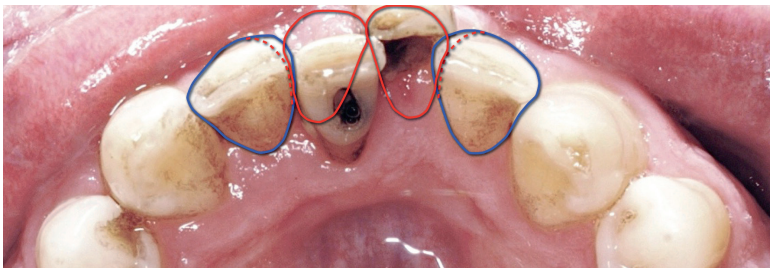


Figure 10: A 2D digital sketch demonstrates that the ideal restorative solution combines an "in-between" implant supporting two centrals and reshaping the mesial of both laterals.

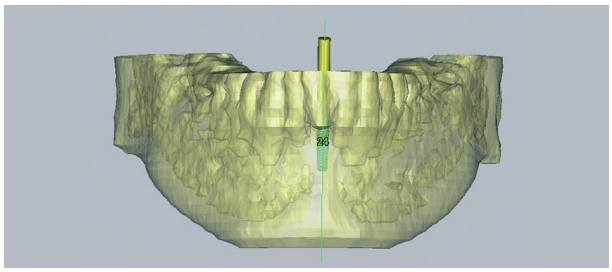


Figure 11: 3D digital planning was performed to place the implant at the "in-between" position.

> "If the papilla between two missing teeth needs to be restored with artificial pink, the 'in-between' implant position offers the best option."

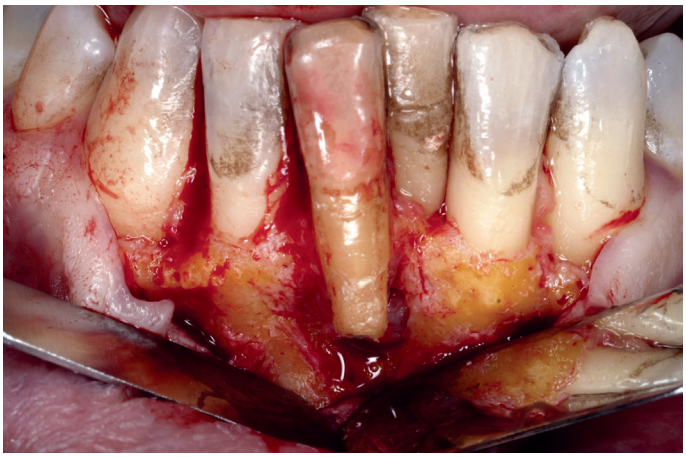


Figure 12: The open flap revealed a lack of buccal and interproximal bone support, which would make it challenging to develop papilla between the two prosthetic crowns.

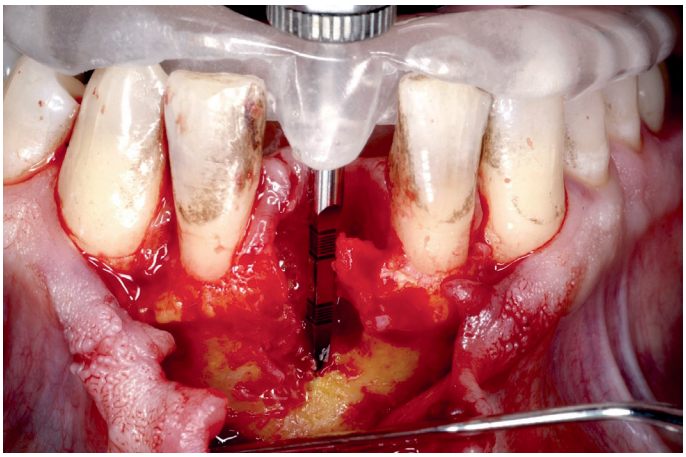


Figure 13: A surgical guide fabricated based on the "in-between" digital planning was used during implant placement.

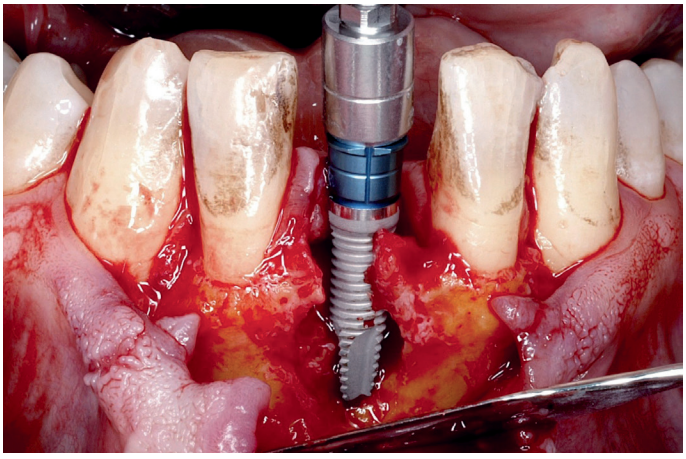


Figure 14: The "in-between" implant was placed.

Figure 15: Bone grafting was performed.

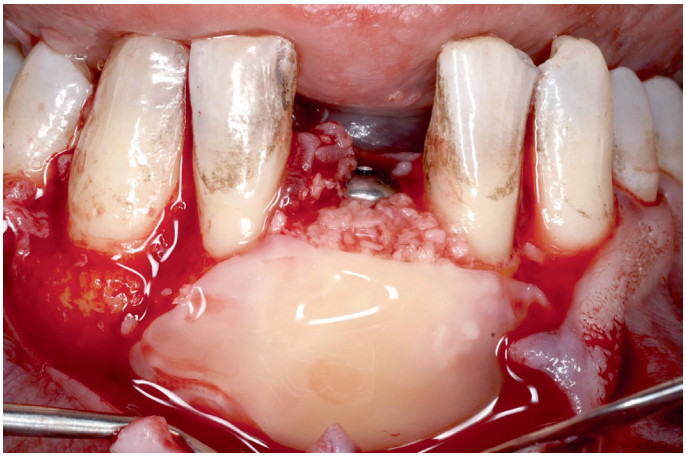


Figure 16: The bone graft was covered with a membrane.

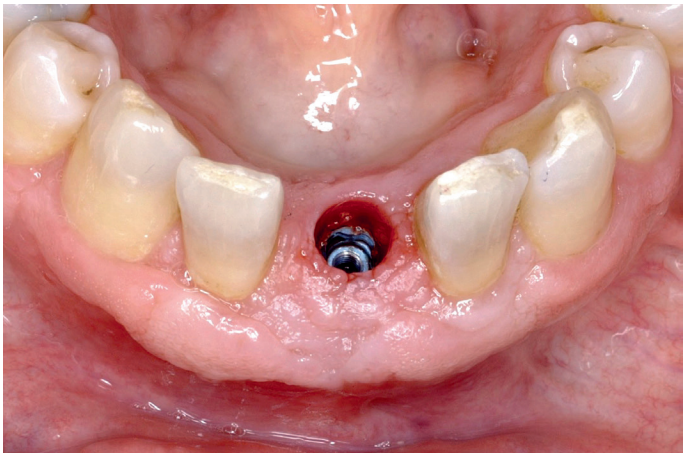


Figure 17: After healing, there was ample keratinized tissue around the implant.

Figure 18: Following the design created on the wax-up, the mesial side of the laterals was trimmed to create space for the two centrals.

> "...the prospect of restoring two adjacent missing teeth by placing a single implant was first proposed to resolve issues in the anterior mandibular area, a highly esthetic zone prone to spacing, bone loss, and gingival challenges."

Figure 19: Views of the definitive metal-ceramic bridge with the screw access on the lingual and pink porcelain on the buccal sides.

Figure 20: The "in-between" concept makes hygiene easier; floss goes around the two half cantilevers on each side for fast, efficient, and thorough cleaning.

Figure 21: The final metal-ceramic bridge. The patient's smile reveals the restored area, emphasizing the increased importance of good esthetics. *(Clinical work by Maurice Salama, DMD; ceramic work by Christian Coachman, CDT, DDS)*

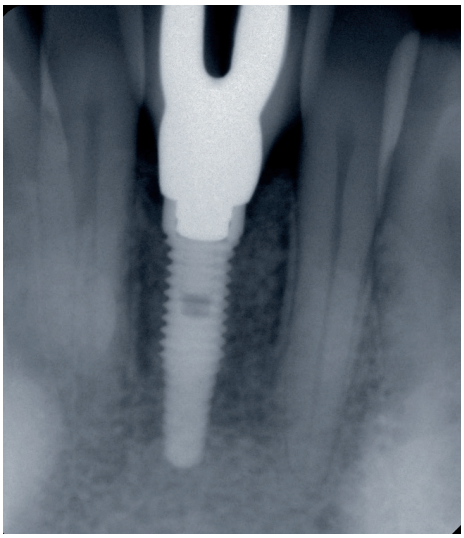


Figure 22: Radiographic image of the "in-between" implant. Note the implant's appropriate distance from the adjacent natural teeth roots.

Summary

Traditional implant placement aims to restore missing teeth. Ideally based on esthetic integration and load distribution, implants should replace teeth on a one-to-one basis. When implant bridges are fabricated, the classic approach has been to place them where a natural tooth was located and replace the other missing tooth with a cantilever or intermediary, and then place the next implant. However, when only two teeth are missing and a cantilever is the replacement choice, the load distribution is less than ideal. Particularly in cases where two lower incisors are missing, the space issue also presents challenges because those teeth often are quite small and likely to be crooked. In addition, if the teeth loss has been of long duration, the adjacent teeth tend to have (at least partially) closed the gap. All of these factors make one-to-one tooth implant placement impossible.

The "in-between" single implant concept represents an interesting solution, especially in the anterior mandibular region, an area particularly prone to spacing, bone, and gingival challenges. This approach provides the implant with more distance between the natural teeth, allowing better bone and papilla formation, and the prosthesis with better load distribution, since two half cantilevers are created. The medial papilla is created with pink ceramics, which blend naturally with the underlying natural gingiva. Whenever two adjacent teeth are missing and, due to a major soft and/or hard tissue defect, artificial pink is required between the two crowns, the "in-between" implant position presents a viable option for clinicians and technicians to achieve simple, hygiene-friendly, and highly esthetic results with less treatment time, lower cost, and fewer complications.

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> "This approach provides the implant with more distance between the natural teeth, allowing better bone and papilla formation, and the prosthesis with better load distribution, since two half cantilevers are created."

Clinical Efficacy & Sensitivity of In-Office Tooth Whitening With & Without Light Treatment Combined With At-Home Bleaching

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Abstract

This article discusses a study that compared clinical in-office bleaching of 6% hydrogen peroxide (HP) with and without light, plus three nights of treatment with 16% carbamide peroxide (CP). Visual and instrumental color measurements were performed on 77 subjects immediately, one week, and two weeks after in-office bleaching. Data were analyzed at 0.05 level of significance using paired t-test and patient surveys. Results indicated shades were 6 to 7 shades lighter visually depending on light or no light treatment respectively, and 7.4 with respect to ΔE^*. Some mild tooth or gingival sensitivity was reported. The study concluded that bleaching was significantly greater between light and no-light groups visually, but not instrumentally.

Key Words: whitening, bleaching, materials, sensitivity, esthetics

CE CREDIT

Disclosures: The authors receive grants/research support from Philips Oral Healthcare.

Learning Objectives

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

1. Objectively compare in-office bleaching using 6% hydrogen peroxide with and without use of a light.
2. Evaluate compounds that can be used with bleaching to decrease tooth sensitivity and maximize bleaching effectiveness.
3. Better understand the actual mechanism of tooth bleaching and tooth sensitivity related to the bleaching process.

Introduction

In-office whitening of discolored teeth has been performed in dentistry as early as 1884 using hydrogen peroxide (HP).[1] The use of light to supplement the whitening of nonvital teeth with HP has been reported in the dental literature as early as 1918.[2] Bleaching of vital teeth was introduced to the dental profession in 1989, utilizing 10% carbamide peroxide (CP) in a custom bleaching tray for at-home use.[3] Materials and methods for at-home bleaching have become well established in the dental market over the past several decades, showing differences in efficacy related to levels of active ingredients hydrogen peroxide or carbamide peroxide.[4] Improvement in bleaching products in the mid 1990s, such as light and chemical application of peroxides, increased the use of in-office vital tooth bleaching.[5]

Both HP and CP compounds can be employed in the dental office, at home, or sequenced using a combined in-office/at-home technique. Compared to at-home whitening, in-office bleaching methods typically utilize higher concentrations of peroxide, which also may be used in combination with supplemental light to enhance the effect of tooth whitening.[6,7] Bleaching lights in the past relied on heat or thermal decomposition of the bleaching agent, whereas contemporary bleaching lights aim to achieve photolysis of the bleaching agent or stain particles at specific wavelengths to potentiate the effects of the active bleaching agent. There also is a trend to use lower concentrations of HP with bleaching lights to minimize treatment sensitivity.

The complex chemistry of HP and stain molecules involves interaction of factors such as the bleaching agent's pH, the presence of chemical activators, and the specificity of the light intensity spectrum. The mechanism of light and peroxide interaction is complex and its role in enhancing or accelerating the bleaching process is still not well understood.[8] Manufacturers of whitening lamps in dentistry have used various light sources with different spectral outputs, making it difficult to generalize the effect of light on the bleaching outcome.[9] These various light sources with different spectral distributions and efficiencies currently on the market all aim to accelerate or enhance the bleaching process. The popular consumer term for in-office bleaching with light is *laser bleaching*; however, most lights used for bleaching in dentistry are not lasers but rather, high-intensity discharge (HID) lamps (metal halide, xenon arc, plasma arc) or some type of blue light-emitting diode (LED) lamp. Blue LEDs generally produce less heat than HID lamps and emit a near-monochromatic light energy source, which purportedly can be optimized for embedded tooth chromogens and/or a specific bleaching formula activator. Equivocal outcomes reported in the literature on the effects of whitening lamps when used as a supplement to bleaching have led to unanswered questions about the effect of light on bleaching efficacy and tooth sensitivity.[10]

The purpose of this study was to evaluate, visually and instrumentally, the efficacy of color change using 6% HP with and without a light system (Philips Zoom WhiteSpeed, Philips Oral Healthcare; Stamford, CT), as well as to evaluate the maintenance of bleach color change following an at-home regimen consisting of CP. The null hypotheses of the study were that in-office bleaching utilizing WhiteSpeed 6% HP with light would result in no greater shade change visually or instrumentally compared to treatment without light, immediately or after three nights of take-home 16% CP.

Materials, Methods, and Study Design

A total of 82 subjects 18 years or older were recruited for in-office tooth whitening treatment using Philips Zoom WhiteSpeed 6% HP with and without supplemental light exposure (blue LED 456 nm, 190mW/cm2, WhiteSpeed LED Accelerator), plus three nights of at-home 16% CP (NiteWhite, Philips) based on inclusion/exclusion criteria listed in **Table 1**. Of the subjects recruited, 77 completed the study, comprising a total of 308 teeth (4 teeth per subject were included in the analysis). Enrolled subjects were scheduled for four visits as described below. Visual and instrumental color measurements were performed on all subjects before bleaching (visit 1), before and immediately after in-office bleaching (visit 2), one week after in-office bleaching (visit 3), and two weeks after in-office bleaching (visit 4). All subjects were treated for three nights with 16% CP in custom trays overnight starting at the third visit.

"The mechanism of light and peroxide interaction is complex and its role in enhancing or accelerating the bleaching process is still not well understood."

Table 1: Inclusion and Exclusion Criteria for Study Participation

Inclusion	Exclusion
• Be age 18 years or older. • Be in generally good health. • Have no restorations on anterior teeth assessed. • Have a tooth shade of 2.5M2/3M2 (16) or greater on anterior teeth assessed using VITA Bleachedguide 3D Master. • Have a strain-free surface of teeth to be treated. (At the discretion of the examiner, surface can be polished with cup and standard prophylaxis paste.) • Be willing to refrain from smoking and consuming dark- staining food and drink for 30 minutes after bleaching treatment. • Be willing to abstain from the use of whitening products not associated with the study. • Be willing and physically able to carry out all study procedures and instructions and be available for all study visits. • Have teeth professionally cleaned and examined within 1 year. • Provide written informed consent.	• Currently report sensitivity of anterior teeth. • Have teeth with notable intrinsic staining (tetracyline, fluorosis). • Have severely malposed anterior teeth. • Have visable supragingival calculus on the facial surfaces of maxillariy anterior teeth. • Undergoing treatment for caries, gingivitis, or periodontitis. • Currently using chlorhexidine mouth rinse. • Report to be pregnant or nursing. • Pre-existing medical or dental condition considered by investigators to place patient at increased health risk or impact patient's ability to participate in the study. • Have previously used professionally dispensed take-home or in-office bleaching products within the last year.

Visit 1: Consent, Randomization, and Color Assessment

Subjects signed an informed consent that was approved by the UT-Health Internal Review Board, filled out a medical/dental history form, and eligibility was confirmed. To ensure treatment selection was free of bias, light treatment was randomized to either maxillary or mandibular arches by coin flip, while the opposite arch was assigned whitening with no supplemental light. The color examiners were blinded to which arch received the light for all color evaluations.

Visual color measurement: Visual color change was measured in shade guide units (SGU), which represent the difference in the absolute numbers of shade guide "steps" in a visual evaluation, using a commercial shade guide for monitoring bleaching (VITA Bleachedguide 3D Master, VITA Zahnfabrik; Bad Sackingen, Germany). The color assessment was performed using a hand-held color-corrected light (Rite-Lite, AdDent; Danbury, CT) with a correlated color temperature of 5500 K, and a color rendering index > 92, at a distance of approximately 25 to 35 cm (10 to 14 in).

The color evaluators assigned to the study tested superior for color discrimination competency according to guidelines on color measurement in dentistry (ISO/TR 28642).[11] The competency test consisted of matching pairs of shade tabs from two identical shade guides (with original markings blinded). Data from the literature on visual thresholds were used in result interpretation: $\Delta E^* \leq 2.7$ for 50:50% acceptability threshold, and $\Delta E^* \leq 1.2$ for 50:50% perceptibility threshold.[11]

Instrumental color measurements: Instrumental color measurements were obtained with a contact-type intraoral spectrophotometer (VITA Easyshade) and expressed in ΔE^* units of the CIELAB color notation system,[12] calculated and compared for each visit as follows:

$\Delta E^* = [(\Delta L^*)2 + (\Delta a^*)2 + (\Delta b^*)2]1/2$ where ΔL^*, Δa^*, and Δb^* are differences in lightness (achromatic coordinate), green-red coordinate, and blue-yellow coordinate, respectively.

The spectrophotometer was used with a custom positioning jig. The custom jig was made for both arches by attaching a 5-mm diameter acrylic rod, which corresponds to the probe diameter of the Easyshade device, to the middle third of the teeth to be evaluated (central and cuspid of maxillary and mandibular arches) using a flowable light-cured resin. The acrylic rod was slightly curved at one end when used on the cuspids for better adaptation. A clear silicone registration material (Clear-Bite, DenMat; Lompoc, CA) was injected around the four cylinders and along the incisal edge to capture the bite **(Figs 1a & 1b)**. Upon setting, the jig assembly was removed with light pressure and the acrylic rods were pushed out. The jig was tried in the mouth for accuracy and used for repeat instrumental measurements.

Custom shield and take-home trays: Maxillary and mandibular impressions were made for fabrication of take-home bleaching trays and a protective shield, using alginate replacement impression material (Silgimix; Sultan Healthcare; York, PA). After pouring the impressions in micro stone, a custom-made protective shield was fabricated for the arch that was randomly selected to have no light as follows: A vinyl sheet was heated with a vacuum former and adapted to a 3- to 4-mm labial spacer modified cast. This served as a reservoir for the bleach material and ensured adequate space and no contact between bleach material and protective shield during treatment. Polyvinyl siloxane material (Exaflex, GC America; Alsip, IL) was then rolled in a horseshoe shape and adapted to cover facial and occlusal surfaces of each subject's stone cast. After setting, the protective shield was removed from the cast and trimmed **(Figs 2a & 2b)**.

Custom bleach trays for the maxillary and mandibular arches were fabricated by heating .9 mm, 5" x 5" vinyl sheet material with a vacuum former unit and scalloped around the facial gingival crest. All subjects were given an ADA-recommended manual toothbrush and toothpaste (True White, Sensodyne; Brentford, UK) to use for the duration of the study.

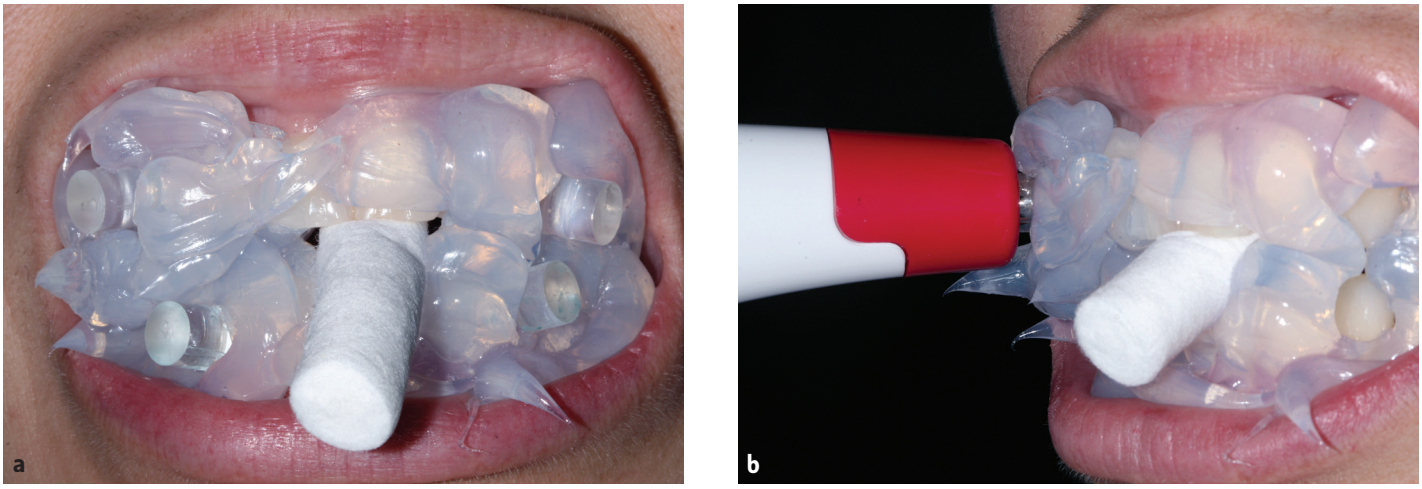


Figure 1: Custom positioning jig. a) Clear silicone registration material injected around acrylic rods and incisal edge. b) Instrumental measurement with jig in place.

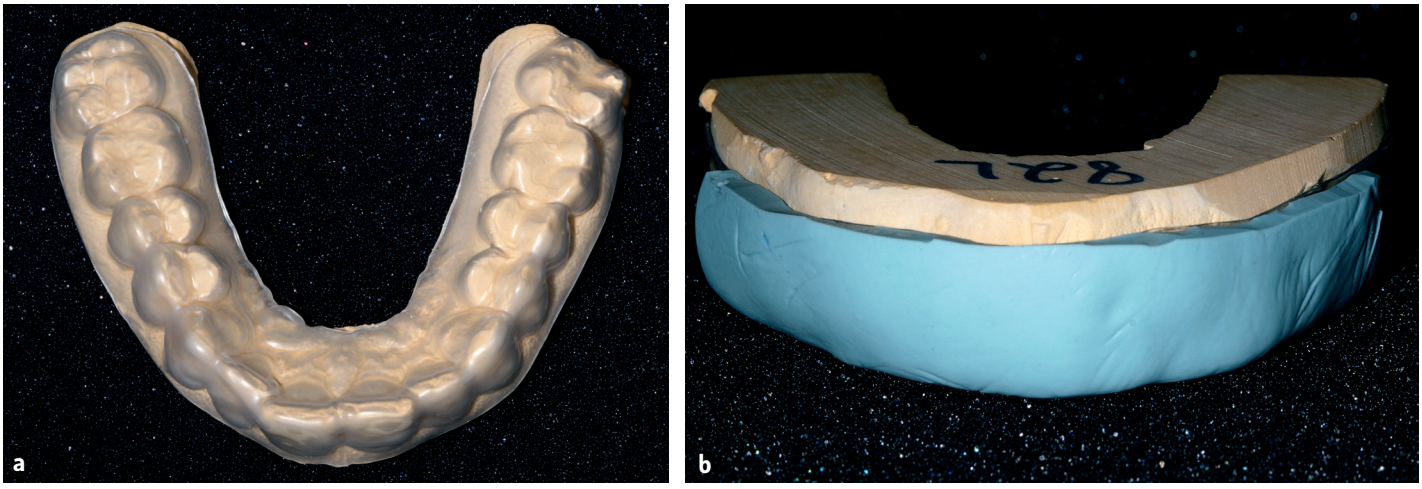


Figure 2: a) Vinyl sheet adapted to the cast. b) Polyvinyl siloxane material adapted to cover the cast's facial and occlusal surfaces.

Visit 2: In-Office Treatment

A limited oral examination was performed and baseline shade was confirmed visually and instrumentally. Protective lip cream was applied and soft tissue isolation using a light-cured resin barrier (Liquidam, Philips) was carried out for gingival protection of the maxillary and mandibular arches. The custom protective shield was tried in the patient's mouth for fit **(Fig 3)**. The upper and lower teeth to be bleached (from second premolar to second premolar) were treated with pH booster solution (Whitening Accelerator, Philips) to increase enamel surface pH as whitening gel was applied. All materials were supplied in the bleaching kit. The pretreatment solution and the bleaching agent (6% HP) were repeated 4 times for 15 minutes each, for a total of 60 minutes.

Light-protective eyewear was provided to each patient during treatment. After applying the bleaching agent on both arches, the protective shield was placed on the previously selected arch before light treatment began.

Between light cycles, the bleaching material was removed from both arches using surgical suction and gauze. Ten to 15 minutes after the last cycle (to allow for tooth rehydration), visual and instrumental color measurements were completed on the selected teeth. Subjects completed a log to document levels of tooth and gingival sensitivity: mild, moderate, or severe, immediately after bleaching (day 1). Subjects kept this log to record sensitivity for the remainder of the study.

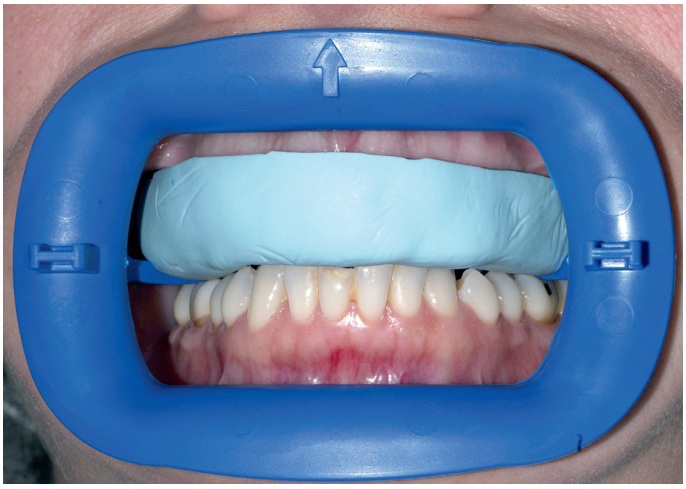


Figure 3: Light-protective shield tried in the patient's mouth.

"A wide range of HP concentrations (from 6% to 40%) has been used for professional in-office whitening."

Visit 3: One Week Post In-Office Treatment

Subjects returned for the third visit one week after in-office bleaching for visual and instrumental color measurements, and for sensitivity reporting. Subjects were given maxillary and mandibular custom trays to use with 16% CP (NiteWhite, Philips) for three nights. Subjects were instructed to continue sensitivity documentation on days 8-14.

Visit 4: Two Weeks Post In-Office Treatment

Subjects returned for visit 4 two weeks after in-office bleaching. Visual and instrumental color measurements were documented and the final sensitivity data were collected.

Statistical analysis: A paired *t*-test at the 0.05 alpha level was performed for subjects at each time point for instrumental and visual data comparisons between the light and no-light treatment groups. The mean color change outcomes were ΔE* values and SGU by bleaching guide, tested separately, with Bonferroni adjustment for multiple comparisons. A power of 90% to detect an effect size of 1 SD comparing the posttreatment outcomes was determined after Bonferroni adjustments. Descriptive statistics and scales were plotted for posttreatment visits to show tooth and gingival sensitivity.

Results

Mean Reduction in SGU

Immediately following in-office bleaching the mean reduction in SGU for 6% HP with supplemental light was 6.9, compared to 5.3 for the no-light group. The difference was statistically significant (P = 0.0001). For ΔE*, the mean color change for 6% HP plus light group was 7.3, and 6.8 without light (P = 0.315).

At one week following 6% HP in-office bleaching, the mean reduction in SGU with supplemental light was 4.4, and 3.6 without light. The difference was statistically significant (P = 0.009). For ΔE*, the mean color change for 6% HP with light was 7.7, and 6.7 without light (P = 0.057).

At two weeks following in-office bleaching plus three treatments of NiteWhite 16% CP, the mean reduction in SGU for the 6% HP with supplemental light was 6.9, and 6.2 without light. The difference was statistically significant (P = 0.015). For ΔE*, the value for 6% HP with light was 7.4, and also 7.4 without light (P = 0.97).

The results showed that there were significant differences between the light and no-light groups at each time point compared to baseline (P = 0.0001, 0.0089, 0.0148, respectively). These differences were still significant even after Bonferroni correction for the three tests.

With respect to ΔE*, the outcomes did not show any significant difference at any time point, nor before Bonferroni correction. **Figures 4 and 5** provide bar chart comparisons of the two efficacy endpoints at each time point.

Sensitivity

Some mild tooth and gingival sensitivity was reported during the at-home whitening period with 16% CP, while the great majority of subjects reported no tooth or gingival sensitivity during or immediately after chairside whitening with 6% HP. The number of subjects reporting tooth or gingival sensitivity for both in-office and at-home phases of the study is shown in **Figures 6a and 6b**.

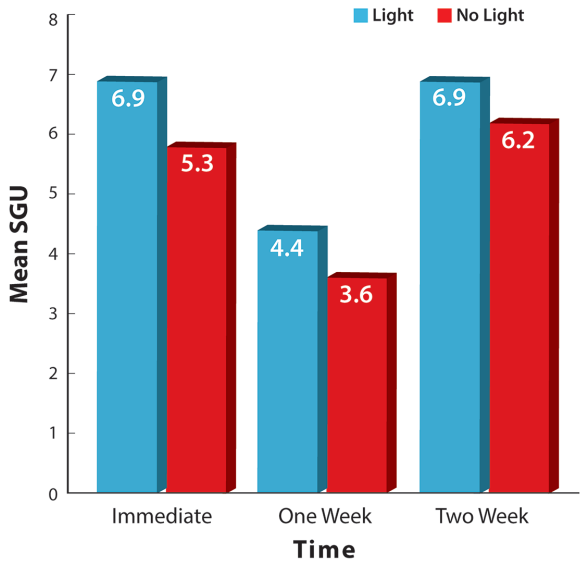


Figure 4: Visual color measurements (SGU = shade guide units). Mean for each time point compared to baseline (T1 = immediate, T2 = one week, and T3 = two weeks); $p < 0.05$ between light and no-light groups at each time point.

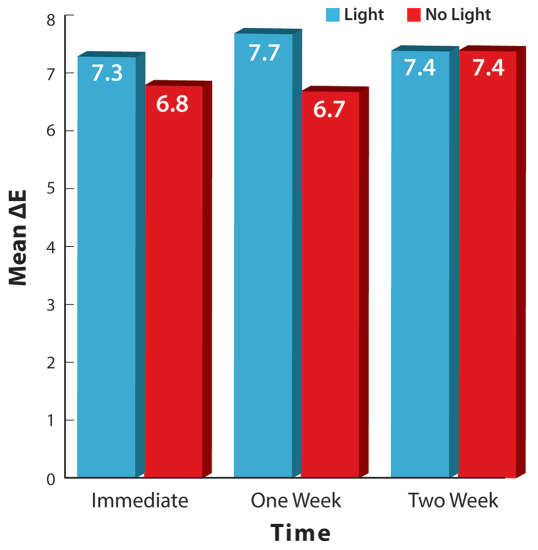
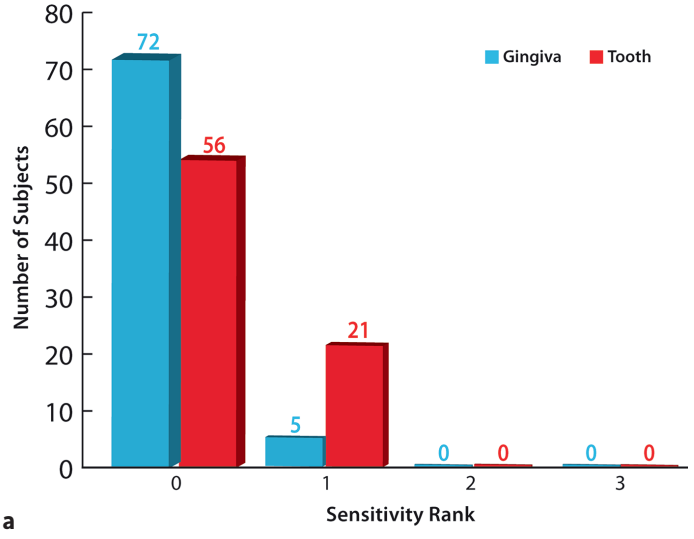


Figure 5: Instrumental color measurements (ΔE* = total color difference) for each time point compared to baseline (T1 = immediate, T2 = one week, and T3 = two weeks); $p > 0.05$ between light and no-light groups at each time point.



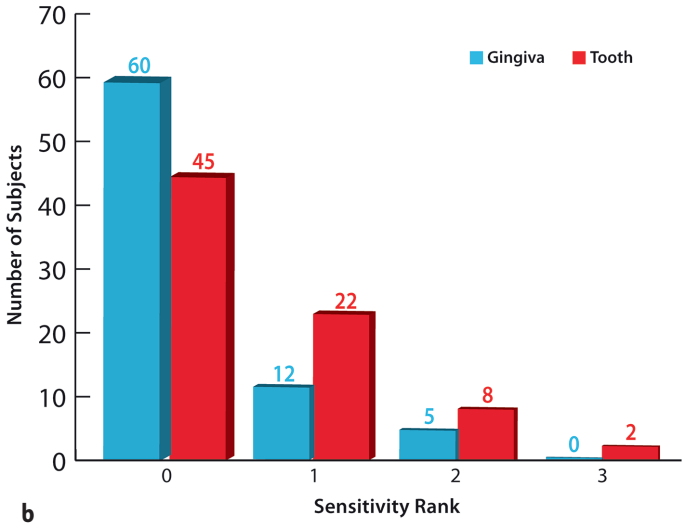


Figure 6: a) In-office 6% HP sensitivity. b) At-home 16% CP sensitivity.

Discussion

SGU and ΔE* Analysis

Past recommendations for measuring bleaching efficacy include use of the 16-step shade guide (Vita Classical) arranged according to the so-called "value scale."[13] Studies using this scale often set the tooth shade threshold as A3 or darker. More recently, the ADA Council on Scientific Affairs recommended adoption of a 29-step shade guide, as used in the present study (Vita Bleachedguide), for the evaluation of bleaching efficacy.[14] The later standard allows for monitoring of subjects with lighter teeth than previously captured visually (lighter than shade B1 on the Vita Classical scale). Shade #16 or darker on the Bleachedguide scale was adopted as the threshold for the present study. The tab order for this shade guide is known to better correspond to the manufacturer's visual light-to-dark suggested order, which was not the case for the classical value scale. The same is true for tab order and whiteness, and tab order and yellowness, with the latter corresponding largely to the uniform increase in chroma (predominant change during tooth whitening).[15,16]

The results of this study showed 6% HP was effective in achieving an average 4 to 6.5 shades visually. The shade changes were statistically significant for visual comparisons (SGU) of light versus no light at each time point, and mean differences were above the 50:50 perceptibility threshold. Instrumentally, average ΔE* values ranged from 7.1 to 7.4. This is greater than two times the 50:50 acceptability threshold of 2.7, documenting the efficacy of the evaluated whitening procedures.[11] Both SGU and ΔE* values in this study correspond to the ADA recommended efficacy level for in-office tooth whitening products of at least 5 color change units.[14]

Peroxide Concentration and pH

A wide range of HP concentrations (from 6% to 40%) has been used for professional in-office whitening.[7] For example, current EU regulations limit application of HP in concentrations no higher than 6% (approximately 18% CP), while in the U.S. higher concentrations of HP may be used. Studies have looked at the effect of lowering HP concentration on whitening efficacy. Rezende and colleagues showed that reducing the concentration from 40% HP to 20% HP did not affect the overall whitening efficacy in a single in-office bleaching treatment when combined with 10% HP at-home for two weeks.[17] Another recent clinical trial compared effectiveness and tooth sensitivity when using 4% HP or 10% HP in custom trays for 2 weeks, twice a day, for 30 minutes. The results showed no significant difference in tooth whitening efficacy between the two concentrations, while the frequency and intensity of tooth sensitivity was shown to be lower with the lower 4% HP concentration.[18]

Hydrogen peroxide is stored at an acidic pH to maintain a stable shelf life. The protocol used in this study involved the use of an alkaline solution (pH = 9; whitening accelerator pH booster) swabbed on the enamel surface immediately prior to in-office application of 6% HP. The HP formula is supplied in a dual-barrel syringe containing the peroxide in one compartment and sodium hydroxide (pH ~ 10) in the other. This solution application and activator-mixed formula is designed to elevate the pH at tooth contact. Previous investigations have reported that increasing the alkalinity of HP to approximately pH = 9 can increase its dissociation rate and increase the effectiveness of bleaching.[19]

Light and Efficacy

Several studies have reported no difference in whitening efficacy with supplemental light during the bleaching process,[20-24] while others have shown a difference.[13,25-28] Martin and colleagues demonstrated that 6% HP with nitrogen-doped titanium dioxide light-activated agent was as effective as 35% HP alone when activated with an LED/laser hybrid light.[28] Bleaching agents used with supplemental light have worked by adding activators such as metal oxides (e.g., titanium, iron) or highly conjugated compounds of the complement color, such as beta carotene, to accentuate photolysis of HP. Some of the confounding variables in many of these studies may be related to the use of different light spectra; the concentration, contact time, and form of the bleaching agent used; as well as the instruments and methods used for color measurements.[9] The system used in the present study works on the theory that blue light energy is absorbed by, and interacts with, the conjugated organic chromophores embedded in the natural tooth substrate. Although this mechanism may contribute to these results, more research is needed to explain the reasons why the addition of LED light may improve tooth-bleaching outcomes with low-concentration HP.

Sensitivity

Sensitivity is a known concern when prescribing at-home or in-office bleaching. The exact mechanism of sensitivity is not fully understood, but it is believed to be caused by peroxide passing through enamel and dentin to the pulp chamber. Higher concentrations of bleaching agent have been previously observed to be associated with greater tooth sensitivity compared to peroxides of lower concentration.[27] The low-concentration 6% HP utilized for in-office treatment in the present study was shown to provoke minimal levels of tooth sensitivity **(Fig 6a)**. It is noted that the HP formula used in this study includes the active ingredients of potassium nitrate and amorphous calcium phosphate. The addition of compounds such as potassium nitrate, fluoride, and amorphous calcium phosphate to bleaching agents has been shown to reduce sensitivity,[29-31] which may account for the low levels of tooth and gingival sensitivity observed in this study. A previous two-week study demonstrated that subjects experienced minimal tooth sensitivity (mean score of 2 on a 10-point scale) with nightly use of a high-concentration (22%) CP gel in a formulation that contained potassium nitrate.[32]

In a clinical study using an earlier-generation Zoom whitening lamp (Zoom AP) and 25% HP, treatment with supplemental light showed greater tooth sensitivity than the no-light treatment group.[26] The light source in the same study was a high-intensity xenon-arch whitening lamp, which is associated with emitted extraneous heat and high power. It has been reported that, as the power output from the light increases, the potential for generating damaging temperatures in the pulp and oral tissues also increases.[33,34] In the present study, however, a blue LED lamp (Zoom WhiteSpeed), which included an adjustable multi-intensity control setting, was utilized. The intensity was maintained on the high setting (190 W/cm2).

Combination Technique

Subjects in the present study followed a protocol of 6% HP in-office treatment with an additional three nights of treatment with 16% CP. A combination technique of in-office bleaching plus home bleaching has been shown to be more effective than in-office bleaching alone.[31] Seven days of at-home bleaching with 10% CP has been shown to be equivalent to three 15-minute applications of in-office 38% HP, [35,36] or five days of at-home bleach and 1-hour treatment with 28% HP with supplemental light.[37]

Some visual color rebound was observed at visit 3 in the present study (one week after in-office treatment with 6% HP). However, combining the additional three nights of treatment with 16% CP was successful in restoring the original whitening effect and thus preventing the rebound effect, independent of supplemental light.

Visual color changes, as indicated by SGU outcome, showed significant differences between the light and no-light groups at each time period. On the other hand, ΔE* data did not show any significant difference at any time period. Therefore, the null hypothesis was not rejected for instrumental results, but was rejected for visual evaluation.

Summary

In-office tooth whitening with 6% HP and the Zoom WhiteSpeed LED acceleration lamp exceeded the ISO/TR 28642-defined ΔE* visual thresholds (AT and PT) at all time points. The addition of three take-home treatments with 16% CP (Philips NiteWhite) was similarly effective and helped prevent color rebound. In-office tooth bleaching with 6% HP and WhiteSpeed LED acceleration was superior to in-office bleaching without LED acceleration, as measured by the VITA Bleachedguide 3D Master shade guide, but not instrumentally.

Acknowledgments

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"A combination technique of in-office bleaching plus home bleaching has been shown to be more effective than in-office bleaching alone."

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"Some of the confounding variables in many of these studies may be related to the use of different light spectra; the concentration, contact time, and form of the bleaching agent used; as well as the instruments and methods used for color measurements."

AACD Self-Instruction

(CE) Exercise No. jCD36

Esthetic/Cosmetic Dentistry

AGD Subject Code: 780

3 Hours Credit

This Continuing Education (CE) self-instruction exam is based on the article *Clinical Efficacy and Sensitivity of In-Office Tooth Whitening With and Without Light Treatment Combined With At-Home Bleaching* by Dr. Joe C. Ontiveros, Dr. Magda S. Eldiwany, Dr. Dianna M. Arriaga, Dr. Rose-Marie Fay, Dr. Maria D. Gonzalez, Dr. Natalie A. Pereira Sanchez, Dr. Marilia M. Sly, and Dr. Rade Paravina. This article appears on pages 70-80.

The examination is free of charge and available to AACD members only. AACD members must log onto www.aacd.com to take the exam. Note that only Questions 1 through 5 appear in the printed and digital versions of the *jCD*; they are for readers' information only.

1. **Which of the following is correct regarding tooth bleaching with and without a light?**
   a. Light was used to supplement the whitening of nonvital teeth approximately 70 years before bleaching of vital teeth was introduced to the dental profession.
   b. Light was used to supplement the whitening of vital teeth approximately 70 years before bleaching of nonvital teeth was introduced to the dental profession.
   c. Light was used to supplement the whitening of both vital and nonvital teeth many years after bleaching without a light began.
   d. Light can be used only to supplement the whitening of nonvital teeth. This technique is never used for bleaching of vital teeth.

2. **How does the concentration of peroxide in in-office bleaching methods compare to that in at-home whitening?**
   a. The concentration of peroxide in at-home methods typically is higher.
   b. The concentration of peroxide in at-home methods is the same as in in-office bleaching.
   c. In-office methods typically utilize a higher concentration of peroxide.
   d. The main difference between in-office and at-home bleaching methods is the use of supplemental light to enhance the effect of tooth whitening.

3. **How have bleaching lights changed since they were introduced to the dental profession?**
   a. Bleaching lights in the past relied on photolysis of the bleaching agent or stain particles at specific wavelengths to potentiate the effects of the active bleaching agent.
   b. Bleaching lights in the past relied on heat or thermal decomposition of the bleaching agent.
   c. Contemporary bleaching lights rely on photolysis of the bleaching agent or stain particles at specific wavelengths to improve the bleaching effect.
   d. Contemporary bleaching lights rely on heat or thermal decomposition of the bleaching agent for an optimal result.

4. **How did evaluators in this study visually compare the change in tooth shade following bleaching?**
   a. Shade was evaluated with a standard 3D VITA shade guide under fluorescent light.
   b. Shade was evaluated by matching pairs of shade tabs from an unmarked VITA shade guide using a hand-held color-corrected light.
   c. Shade was evaluated with a spectrophotometer under fluorescent light.
   d. Shade was evaluated visually under natural light (5500K) with the VITA Bleachedguide and instrumentally with a spectrophotometer.

5. **How did the evaluators in this study compare bleaching with and without a light?**
   a. Half the participants bleached with the addition of a light, half without.
   b. During in-office bleaching, the participants' right side received light, the left no light.
   c. During in-office bleaching, participants had a protective cover over one arch to prevent light from affecting the bleaching material.
   d. The participants bleached first without the light and evaluated the color change, then they bleached with a bleaching light to compare their results.

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Antonia Mihale

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