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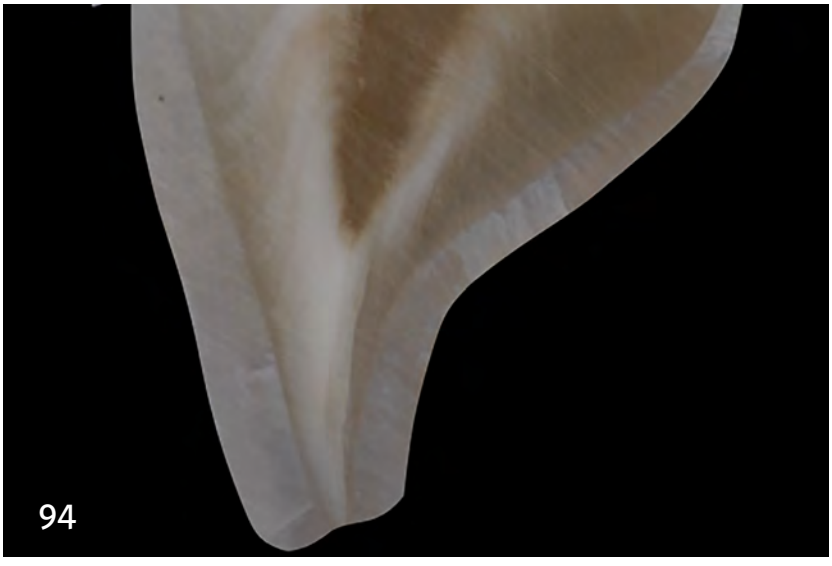


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# Delegating for Productivity

> "Delegate with intention and confidence. Let the person know you trust them 100% to get the task done."

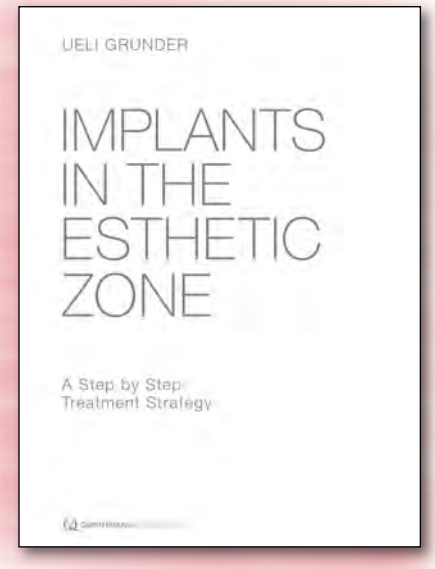
**During dental school I chose to do everything on my own, without the help of a chairside dental assistant.** One classmate always used a RDA and the rest of us laughed at him because our egos thought it meant he was incompetent and needed help. How wrong we were; he was the smart one, as he finished his requirements six months before graduation.

My need to control everything continued into private practice. As a result, my team became dependent on me for every task and decision. Productivity suffered because I took on everyone else's responsibilities. A change was necessary. I began to delegate and in doing so have learned the following:

- Delegate with intention and confidence. Let the person know you trust them 100% to get the task done. Do not micromanage. Give positive reinforcement. If guidance is needed, offer suggestions—not directives—on possible ways to approach the matter from a different angle.
- Require that anyone who comes to you with a question or problem already have two potential answers or solutions. If you condition your team to expect you to solve every little challenge in the office, they will lose their confidence and ability to be problem solvers themselves. Challenge them to use their experience and skills to create a positive outcome.
- Always have others answer the phone. Empower your team to learn what they need to know to answer any inquiries and free you from unnecessary interruptions. The increase in productivity, both yours and theirs, will surprise you.
- Create a general sign-up board for tasks that can be handled by anyone in the practice. Post the assignments and due dates. Any team member can volunteer to undertake any of the listed projects.
- Allow the people to whom you delegate to themselves delegate to others as needed. This optimizes free-flowing communication, a sign of a self-managing, high-performing team.

Purposeful delegation can transform your team into a powerful decision-making alliance. The change of pace and opportunities will give everyone a new energy and sense of accomplishment, and your practice's increased productivity will benefit everyone.

Edward Lowe, DMD, AAACD
Editor-in-Chief

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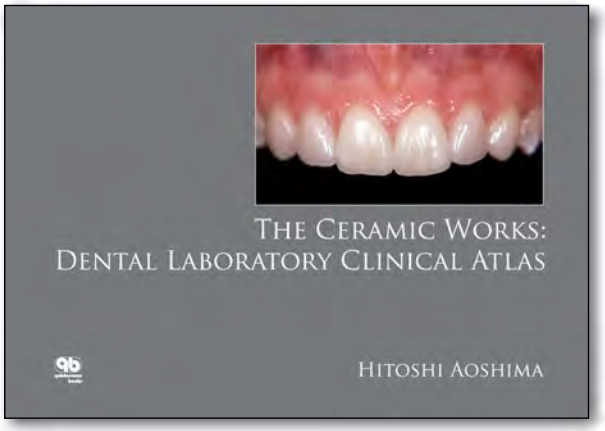


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# BEHIND THE SMILE

> But no matter how striking the clothing or jewelry she wore to her appointments, the one thing she never wore was a smile.

# *A Jewel from Nature*

By Mohan Bhuvaneswaran, MDS, AAACD

India is a land with an exceptionally diverse cultural heritage. Although some aspects of India's culture are gradually becoming more westernized, the desire to dress in traditional attire still lies within the heart of many Indians.

The 22-year-old patient featured on the cover of this issue of the *jCD* loves to dress in a traditional manner. But no matter how striking the clothing or jewelry she wore to her appointments, the one thing she never wore was a smile. This actually diminished the glow of her natural beauty. She hails from the southern part of the country, where fluorosis is more prevalent; this condition affected her smile and therefore, her self-confidence. She had also fractured her centrals as a teenager and although they had been restored with composite she was unhappy with the esthetics. She wondered throughout her college years whether something could be done to improve her smile.

A complete evaluation found that her fluorosis was minimal and could be conservatively managed. Today's dentistry revolves strongly around the concept of minimally invasive treatment, which allows the clinician to preserve as much tooth structure as possible. It was explained to the patient that composite resin restorations would be the best choice in order for her to have minimal or no tooth preparation. Also explained to her were the number of appointments involved and the amount of chairside time required. She readily accepted the treatment and was very excited to begin.

The patient was thrilled with the result at the completion of treatment. Dressed in a stunning traditional costume for her final appointment, she quoted the musical *Annie*: "You're never fully dressed without a smile." She herself never stopped smiling and it was a memorable day for everyone involved. She feels that her smile now complements her dressing style very harmoniously, like a jewel from nature.

*To learn more about this patient's treatment, turn to the Clinical Cover Case on page 26.*

*Cover image by Jimmy Nomula (Fotosaints; Hyderabad, India). Cover image shot with a Canon EOS 5D Mark III (Tokyo, Japan).*

**Preoperative**

**Postoperative**

# Understanding Biomimetic Dentistry

## An Interview with Dr. Kyle Stanley

Dr. Kyle Stanley is an adjunct faculty member at the Herman Ostrow School of Dentistry of USC, Los Angeles, California. He owns and operates a private group practice in Beverley Hills, California. In this interview, Dr. Stanley answers questions from Professional Education Committee Chair Grace Sun, DDS, FAACD. Dr. Stanley will be a presenter at AACD Las Vegas 2017, which will take place April 18-21. Attendees will benefit from a winning approach to comprehensive cosmetic dentistry education featuring three unique groups of educators: the Legends, the Illusionists, and the High Rollers, who will impart their wisdom, reveal their techniques, and share their expertise.

> "Our goal is to try and replicate nature and create a bond just as strong as the dentinoenamel junction."

**Q: What are the, techniques, methods, and materials used in biomimetic dentistry?**

A: *Biomimetics* means to mimic that which is lifelike. Nature has given us such ideal properties in natural dentition that when we restore damaged and broken teeth, we want to restore them to what they once were. Biomimetic dentistry does this in a conservative and attractive way.

Some techniques that are employed in this type of treatment are to reduce stress and do partial-coverage restorations (PCRs) **(Figs 1a-1e)**. By reducing stress in our restorations, we can minimize gaps and sensitivity and make the restorations last much longer than with traditional dentistry. By doing PCRs, we reduce damage to the natural tooth structure, thereby causing fewer iatrogenic problems in the future.

There are many different products used in the practice of biomimetic dentistry and most of them revolve around composite resins. Resins are used in adhesives; in direct composite restorations; when doing milled composite inlays and onlays; and, lastly, we use heated composite resin to actually cement our restorations. Without resins in various forms (i.e., packable, flowable, milled blocks, adhesives), it would be very difficult to practice biomimetic dentistry.

**Q: What is the connection between cosmetic dentistry and biomimetic dentistry?**

A: That is a question many people have. Our main goal is to make synthetic products perform like natural dentin and enamel. By utilizing researched-based approaches, we can get a restored tooth to move and function like a natural tooth. One of the greatest benefits of doing biomimetic dentistry is that the tooth also ends up looking great! For our patients, biology and function always come first and excellent esthetics is a wonderful byproduct.

**Q: How do you implement biomimetic dentistry into everyday general practice?**

A: There are many ways to incorporate biomimetic dentistry into any clinical practice and it all boils down to a good bond. Our goal is to try and replicate nature and create a bond just as strong as the dentinoenamel junction. With proper bonding techniques we can get very high bond strengths **(Fig 2)** that enable us to reduce stress, lower the incidence of chips and fractures, and decrease sensitivity. This allows our restorations to behave like natural teeth, last a lifetime, and look beautiful. I think the biggest example of this in our own practice is that we do not prepare crowns unless the patient comes in with a crown or we are raising the vertical dimension. This means that everything is partial-coverage inlays, onlays, or veneers.


**Figures 1a-1e:** Anterior trauma case showing minimal preparation with partial-coverage restorations that were luted with heated composite resin acting as a cement.

**Figure 2:** Immediate dentin sealing, which increased bond strength by 400%.

**Q: What about biomimetic dentistry is exciting or challenging for you?**

A: There are many aspects of biomimetic dentistry that are both exciting and challenging. I think the most difficult part is achieving excellent isolation. To be successful, this type of treatment requires extreme isolation with a rubber dam or an isolation system. Many clinicians that have had failures with bonding in the past were not using proper isolation.

One of the most exciting parts of biomimetic dentistry for me is supragingival dentistry. I hate packing cord! By practicing supragingival biomimetic dentistry we can raise margins to make them impressable and visible, facilitating access to the clinical situation **(Figs 3a-3e)**. Another exciting part of biomimetic dentistry is being able to tell patients that we do not have to do a crown when something breaks—we can simply replace the broken area by bonding. Our patients love this.

**Q: What is your five-year goal for your practice?**

A: I would like to stop doing root canal therapy! I know this is a difficult goal, but through researched clinical practice we can avoid intentional endodontics by using caries-indicating dye, and also not heat our teeth by not preparing crowns. I also would like to continue research on how to restore teeth with natural dentin and enamel. Recently I was fortunate to coauthor an article with renowned practitioners Dr. Luis Schlichting and Dr. Pascal Magne about a case in which we restored a patient's first molar with her daughter's CAD/CAM-milled third molar. I would love to dive more into using natural tissues to restore teeth in a more biomimetic way.

*The* Journal of Cosmetic Dentistry *thanks Dr. Stanley and Dr. Sun for participating in this interview.*

> "Another exciting part of biomimetic dentistry is being able to tell patients that we do not have to do a crown when something breaks—we can simply replace the broken area by bonding. Our patients love this."


**Figures 3a-3e:** Case showing instead of extracting teeth due to decay, margins were raised by getting close to the bone level then restored with inlays and onlays.

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# Integrating Natural Hard and Soft Tissue

## An Implant-Supported Restoration in the Esthetic Zone

Somkiat Aimplee, DDS, MSc

> **"The successful replacement of anterior teeth with implants requires an interdisciplinary approach."**


### Abstract

The integration of a restoration with the natural hard and soft tissue is a key factor for an excellent esthetic outcome. A comprehensive treatment plan along with a smile design concept, appropriate material selection, and good communication between the surgeon, restorative dentist, and laboratory technician are also crucial in creating a suitable foundation for implant restoration. This article discusses concepts and procedures for implant treatment in the esthetic zone using a diagnostic wax-up and an implant-supported provisional as a blueprint for successful definitive restoration.


**Key Words: delayed implant placement, implant-supported provisional restoration, custom impression coping, veneer restorations, diagnostic wax-up, Case Type III**

### Introduction

Achieving excellent esthetics with an implant restoration in the anterior zone continues to be a challenge in dentistry. The successful replacement of anterior teeth with implants requires an interdisciplinary approach. Accurate diagnosis and treatment planning; meticulous implant site development; and close communication between the restorative dentist, surgeon, and laboratory technician are all critical to success.

## Patient History

The patient was a 40-year-old female with no medical problems. She presented with an edentulous area (the maxillary central incisor, #9) and an existing removable partial denture. We performed a thorough clinical, periodontal, and occlusal examination, including radiographs and photographs **(Figs 1-5)**. Implant treatment was planned based on the data gathered.

## Clinical Examination and Findings

The surgeon and the restorative dentist subsequently examined the patient together. A panoramic radiograph, a periapical radiograph, cone-beam computed tomography of the #9 site, and preoperative photographs were taken. The patient's oral hygiene was fair and there was very slight tissue inflammation. Medium bone loss was observed on the radiographs (AAP Type II). Teeth #7, #8, and #10 exhibited worn incisal edges with discolored composite restorations.

There were no signs or symptoms of functional problems. A thorough examination of muscles and occlusion revealed no abnormal findings. Temporomandibular joint sounds and range of motion were normal, and joint load and immobilization tests were negative. As the patient was determined to have proper function, no occlusal treatment was deemed necessary. A dentofacial examination found medium lip dynamics and a normal-to-flat gingival scallop around the anterior teeth. The patient wanted the restorations to match her exisiting dentition.

**Figure 1:** Preoperative; the patient's unhappy, unconfident smile.

**Figure 2:** Preoperative close-up view; medium smile line.

**Figure 3:** Preoperative intraoral frontal view; worn dentition and missing soft tissue.

**Figure 4:** Preoperative occlusal view; medium bone resorption at edentulous area.

**Figure 5:** Preoperative periapical radiograph; medium bone resorption at edentulous area and faulty restorations.

## Treatment Plan

We began with periodontal therapy consisting of scaling and polishing, with an emphasis on improved home care and six-month recall visits.

Direct composite restorations were planned to replace all the questionable restorations and eliminate decay. Ceramic veneer restorations for #7, #8, and #10 were planned to restore tooth shape and harmonize tooth color. Implant placement was planned for the missing #9. Utilizing a fixed dental prosthesis could decrease the long-term treatment success due to the increased biomechanical risk to the abutment teeth.

To accurately predict peri-implant esthetics, the restorative dentist and the surgeon jointly assessed relative tooth shape and position, form and biotype of the periodontium, and position of the osseous crest. The gingival margin level, the normal-to-thick biotype, and the triangular tooth shape were all taken into consideration.

A diagnostic wax-up was fabricated as a blueprint of the definitive restoration according to the smile design plan. It served as a very effective communication tool between the members of the interdisciplinary team and with the patient **(Fig 6)**.

**Figure 6:** Diagnostic wax-up; this was a blueprint of the definitive restoration and also a good communication tool between team members and the patient.

## Treatment

### Surgery

The surgical procedures were performed under local anesthesia. The soft tissue in the edentulous area was cut using a fine 15C surgical blade (Henry Schein; Melville, NY) to separate the periodontium. The goal was to preserve as much of the gingival architecture as possible and not damage the surrounding bone.[1]

A narrow platform implant (3.5 mm x 11 mm NobelActive, Nobel Biocare; Yorba Linda, CA) was placed 4 mm below the predetermined gingival margin to facilitate adequate postoperative prosthetic emergence. It was placed to engage the cortical bone with the position angled toward the incisal edge and torqued to 50 Ncm **(Fig 7)**. A small cover screw was then placed. The labial bone around the dental implant was augmented with an allograft filler particle (BioOss, Zimmer Dental; Carlsbad, CA) mixed with the patient's blood. A deepithelialized connective tissue graft harvested from the maxillary palate was added to cover the filler particles and increase tissue availability. The surgical site was closed with 4-0 and 5-0 Vicryl sutures (Ethicon; Blue Ash, OH).[2,3] The patient was fitted with a temporary partial denture, which was adjusted so that no pressure would be exerted on the implant site.

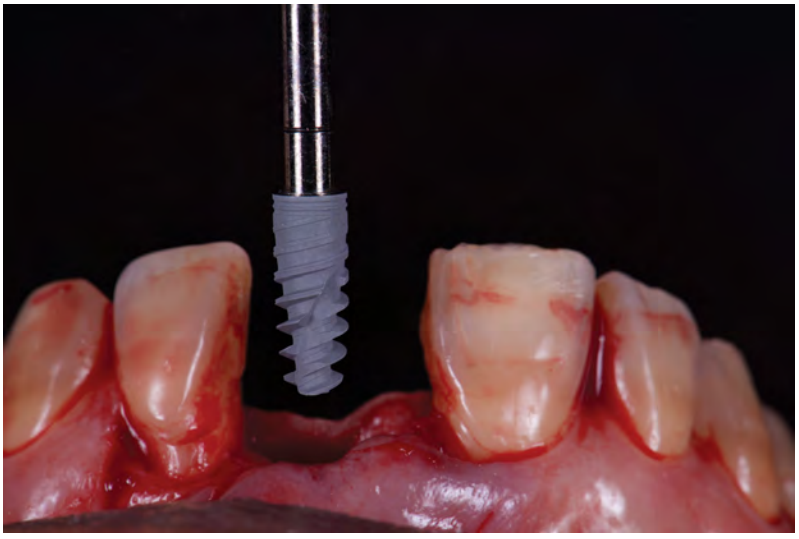


**Figure 7:** Delayed implant placement surgery. A narrow platform implant was selected to allow space for optimal hard and soft tissue, creating a natural-looking contour.

> **"A diagnostic wax-up...served as a very effective communication tool between the members of the interdisciplinary team and with the patient."**

### Healing Period

Both the restorative dentist and the surgeon evaluated the patient regularly during a six-month healing period. An intrasulcular partial-thickness incision was made at the second-stage surgery on #9 and the implant was connected to a suitable healing abutment **(Figs 8a & 8b)**, which was replaced by a customized temporary abutment one week later. A putty index (Sil-Tech, Ivoclar Vivadent; Amherst, NY) made from the diagnostic wax-up was loaded with a Bis-GMA temporary material (Protemp4, 3M ESPE; St. Paul, MN) and placed in the patient's mouth until it was fully set and firmly connected to the temporary abutment. The assembly was unscrewed and the subgingival emergence profile was modified by carefully adding composite resin (Filtek Z350, 3M ESPE) so as not to overcontour the subgingival area, which can cause recession of the soft tissues.[4,5] The patient had several more appointments to groom the tissues into the desired shape by modifying the subgingival emergence profile and changing contours and contact points of the provisional crown **(Figs 9 & 10)**.


**Figures 8a & 8b:** Osseointegrated implant with soft tissue healing.

### Final Restorations

After the ideal tissue contours had been developed and matured by modifying the provisional **(Figs 11a & 11b)** and #7, #8, and #10 were prepared for veneer restorations, a final impression was taken. A fixture level impression with a custom impression coping was made using a polyvinyl siloxane impression material (Extrude, Kerr; Orange, CA).[6] To create the custom implant coping, the provisional crown was removed and then connected to a fixture replica and impressed into a plastic cylinder filled with putty. The provisional crown was then unscrewed, an impression coping was connected to the replica, and the space was filled with acrylic (Pattern Resin, GC America; Alsip, IL **(Fig 12)**. The obtained custom coping was marked on the labial surface to aid orientation and unscrewed from the putty cylinder. It was then connected to the implant fixture and used in an open-tray technique for the final impression.[7] This method replicates the accurate soft tissue contour onto the working cast and provides the laboratory technician with detailed information to duplicate the established emergence profile.[8,9] Multiple shade photographs were taken to communicate with the technician. A custom zirconia abutment (NobelProcera, Nobel Biocare) was fabricated and torqued to 35 Ncm **(Figs 13a-14)**. The ceramics were e.max Press (Ivoclar Vivadent) with a cut-back and layering technique; the ingot was LT A2 layered with A2, E14, TI1, and T Neutral (Ivoclar Vivadent).

**Figure 9:** Implant-supported provisional crown for soft tissue development.

**Figure 10:** Provisional restorations ##7-10.

### Seating

At the seating appointment, the lithium disilicate crown and veneers were tried-in and photographed for analysis.[10] After a retraction cord was placed around the implant abutment, the crown was bonded using a paired adhesive/resin cement system (ScotchBond Universal and RelyX Ultimate, 3M ESPE). The veneer restorations were bonded using an adhesive (Single Bond, 3M ESPE) and a light-cured resin cement (RelyX veneer cement). Static and dynamic occlusion was verified and all necessary adjustments were carried out.

An occlusal guard was fabricated and delivered at a subsequent appointment to provide overnight protection for the new restorations.

The patient returned one week later, at which time a periapical radiograph and final photographs were taken **(Figs 15-18)**.

## Summary

This case demonstrates that implant treatment necessitates meticulous treatment planning along with optimized implant positioning, detailed step-by-step prosthetic procedures and, most importantly, good communication and teamwork between the surgeon, the dentist, and the laboratory technician. The patient was extremely pleased with the outcome and overall positive experience.


### Acknowledgment

*The author thanks Dr. Gerard Chiche, director of the Ronald Goldstein Center for Esthetics and Implants at Augusta University College of Dental Medicine (Augusta, GA) for his guidance.*


### References


1. Phillips KM, Kois JC. Aesthetic peri-implant site development. The restorative connection. Den Clin North Am. 1998 Jan;42(1):57-70.

2. Kan JY, Rungcharassaeng K, Umeza K, Kois JC. Dimensions of peri-implant mucosa: an evaluation of maxillary anterior single implants in humans. J Periodontol. 2003 Apr;74(4):557-62.

3. Babbush CA, editor. Dental implants: the art and science. 2nd ed. Philadelphia: W.B. Saunders; 2001.

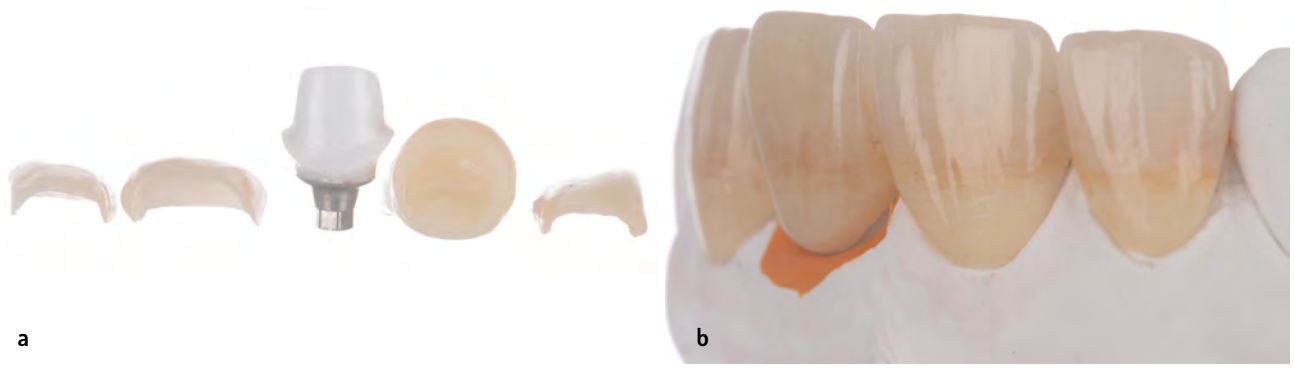
4. Saadoun AP, Le Gall MG. Periodontal implications in implant treatment planning for aesthetic results. Pract Perio Aesthet Dent. 1998 Jun-Jul;10(5):655-64.



**Figures 11a & 11b:** Tissue was developed from the provisional restoration.

**Figure 12:** A customized impression coping was duplicated from the provisional restoration.

> **"Both the restorative dentist and the surgeon evaluated the patient regularly during a six-month healing period."**




**Figures 13a & 13b:** Definitive restoration. The lithium disilicate ceramic veneers and crown were fabricated with a pressed and layered technique to create natural translucence.

**Figure 14:** Preparations #7, #8, and #10, and CAD/CAM zirconia abutment hybrid with titanium base.

**Figure 15:** Postoperative periapical radiograph; crestal bone stability around the implant and complete integration of restorations and abutments.

**Figure 16:** Postoperative frontal intraoral view; harmony of restorations and natural teeth was achieved by following the smile design blueprint.

**Figure 17:** A natural, harmonious smile that follows the patient's upper and lower lips.

5. Tarnow DP, Magne AW, Fletcher P. The effect of the distance from the contact point to the crest of the bone on the presence or absence of the interproximal dental papilla. J Periodontol. 1992 Dec;63(12):995-6.

6. Grunder U. Stability of the mucosal topography around single-tooth implants and adjacent teeth: 1-year results. Int J Periodontics Restorative Dent. 2000 Feb;20(1):11-7.

7. Polack MA. Simple method of fabricating an impression coping to reproduce peri-implant gingiva on the master cast. J Prosthet Dent. 2002 Aug;88(2):221-3.

8. Sclar A. Soft tissue and esthetics considerations in implant therapy. Hanover Park (IL): Quintessence Pub.; 2003. p. 243-61.

9. Kois JC. Predictable single-tooth peri-implant esthetics: five diagnostic keys. Compend Contin Educ Dent. 2004 Nov;25(11):895-6, 898.

10. Chiche GJ, Pinault A. Esthetics of anterior fixed prosthodontics. Hanover Park (IL): Quintessence Pub.; 1996. **jCD**

**Figure 18:** Postoperative full-face smile view. The patient's smile looks very natural and in harmony with her face.

Dr. Aimplee is an assistant adjunct professor, Oral Rehabilitation Department, Augusta University College of Dental Medicine, Augusta, Georgia. He is in private practice limited to prosthodontics and esthetic dentistry in Bangkok, Thailand.

Disclosures: The author did not report any disclosures.

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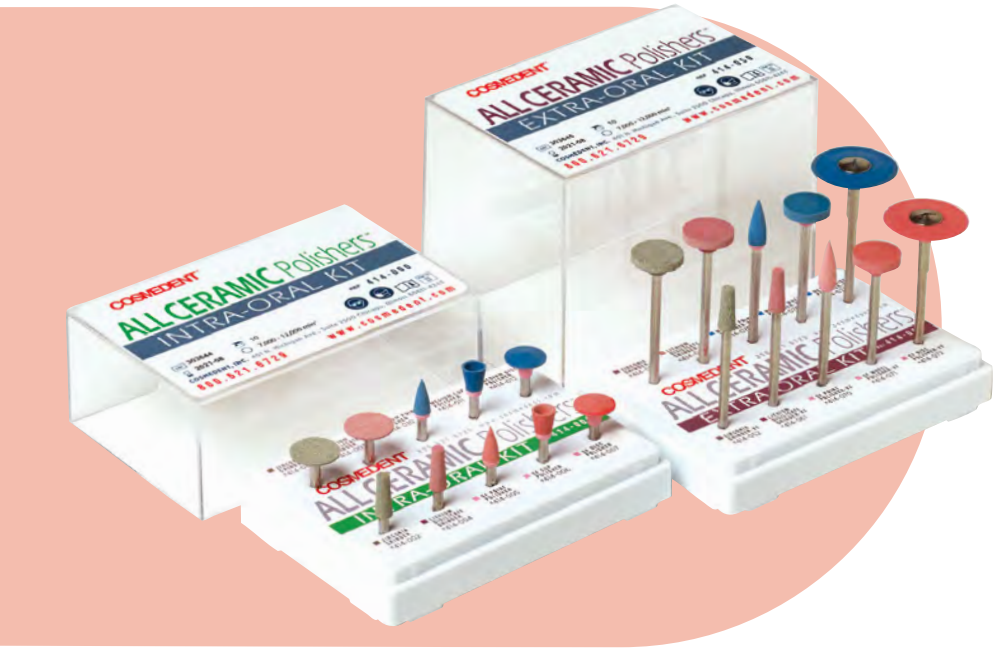


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# Attention to Detail in Case Type III

J.A. Reynolds, DDS, AAACD

**Figure 1:** Gold wire bridge, 500 BC.

**Figure 2:** Tooth riveted with gold strap.

**Figure 3:** First dental implants.

The esthetic replacement of missing teeth has historically been a challenge in dentistry. Fortunately, advances in technology and science have birthed techniques that enable today's clinicians to provide patients with natural-looking tooth replacement options, whether using a bridge or an implant.

The first dental bridges—simple gold wires used to hold teeth in place—were placed around 500 BC by the Etruscans. Later, gold bands, which became increasingly elaborate and indicated the wearer's status **(Figs 1 & 2)**, were utilized. To show off their affluence, wealthy women were even known to have their natural teeth removed and replaced with gold.[1]

Of course, the dental bridge has advanced significantly both clinically and esthetically and is still used today. Interestingly, dental implants share a similar evolution. Evidence shows that, around AD 600, the Mayans implanted nonorganic material in living people using tooth-shaped shell fragments placed in empty tooth sockets **(Fig 3)**. Radiographic evidence shows compact bone formation around the pieces similar to that of a blade implant[2] (undoubtedly this would have been a difficult case selection for Accreditation, but it was a great service to the patient).

In his Case Type III, Dr. Somkiat Aimplee provides a good example of how a dental implant can be a valuable tool in modern dentistry. Knowledge of technique—with both hard and soft tissue—is paramount in achieving a high level of success. In the maxillary anterior, proper implant placement slightly palatally and at least 3 mm apical to the final facial contour allows sufficient room to shape final tissue contours.[3] It is vital to test the emergence profile with the provisionals in situ, allowing time for tissue maturation.[4]

This case is what Accreditation is all about: paying close attention to detail, using proven clinical techniques, listening to and learning from a mentor, and recording the process with quality photography. Congratulations to Dr. Aimplee on a job well done. We certainly have come a long way from gold wire and shell implants!

**Figure 4:** Slightly long contacts due to papilla height.

**Figure 5:** Note contralateral tooth size.

**The examiners passed this case unanimously, with only minor deductions noted as follows:**

- **Criterion #64:** *Is the interproximal contact or connector proper in length and position? Long contact areas are evident, especially distal #9* **(Fig 4).**
- **Criterion #87:** *Are contralateral teeth in harmony in terms of size, shape, or position?* Tooth #8 appears wider than #9 and the lateral incisors are asymmetrical **(Fig 5).**

## References


1. Ring ME. Dentistry: an illustrated history. New York: Harry N. Abrams; 1985. p. 43
2. Ibid., p. 17
3. Butler B, Kinzer GA. Managing esthetic implant complications. Compend Contin Educ Dent. 2012 Jul-Aug;33(7):514-8, 520-2.
4. Schoenbaum TR. Abutment emergence profile and its effect on peri-implant tissues. Compend Contin Educ Dent. 2015 Jul-Aug;36(7):474-9. **jCD**


**"It is vital to test the emergence profile with the provisionals in situ, allowing time for tissue maturation."**

Dr. Reynolds is an AACD Accredited Member and has been an AACD Accreditation Examiner since 2003. He practices in Franklin, Tennessee.

Disclosure: The author did not report any disclosures.

> Many esthetic procedures can also improve the structural integrity of the teeth as well as the health of periodontal tissues.

# Minimal Intervention—Maximum Esthetics

## Emulating Nature with Composite Resin

Mohan Bhuvaneswaran, MDS, AAACD


### Abstract

This article discusses the use of direct resin veneers in a smile rehabilitation case for a patient with discolored upper anteriors. This treatment modality gives the clinician artistic control while facilitating esthetic outcomes with minimal tooth preparation. Improving the structural integrity of the teeth was key in this case. The importance of utilizing the conservative concepts of minimally invasive dentistry, having sound knowledge of scientific and technological advances in procedures and materials, and a meticulous contouring procedure are addressed.


**Key Words: hypocalcification, composite resin, silicone putty index, Class IV defect, midline cant**

## Introduction

Thanks to today's increasingly appearance-conscious patients, esthetic procedures have become a part of our daily practice. Many esthetic procedures can also improve the structural integrity of the teeth as well as the health of periodontal tissues. Minimally invasive dentistry to maintain and protect natural tooth structure and thereby increase the overall oral health of the patient[1-3] has become increasingly popular. It is essential that clinicians possess a sound knowledge of scientific and technological advances in procedures and materials in order to exceed patients' expectations.

Direct composite veneering is one such procedure. Although enhancing a smile using composite material can be challenging, direct resin veneers can give the dentist full artistic control over the esthetic outcome of the case, resulting in a smile that rivals those created by nature.[4,5] They also can be extremely conservative, requiring minimal tooth preparation. This process allows the dentist to utilize and showcase his or her skills in creating a smile directly chairside.

## Patient Complaint and History

A 22-year-old female patient was unhappy with her discolored upper anterior teeth **(Fig 1)**; her greatest wish was to have a beautiful smile. The patient's oral hygiene was extremely good, the soft tissues were in excellent condition, and her medical history was unremarkable. Radiographic and oral examinations were within normal limits. There was no temporomandibular joint pain, clicking, or any other abnormalities. A history revealed that she had fractured teeth #8 and #9 six years previously. They had been restored at the time with composite resin but she was unhappy with the esthetics. The patient had no other complaints.

**Figure 1:** Preoperative full-face view.

## Evaluation, Diagnosis, and Treatment Plan

The patient was from the southern part of India, where many inhabitants exhibit dental fluorosis. Mild fluorosis, as hers was, can be conservatively managed with direct resin veneers. A thorough clinical examination revealed the presence of white hypocalcific bands in the cervical third of all her teeth and randomly distributed mild hypocalcification in her upper and lower anteriors **(Figs 2 & 3)**. The defects in the lower anteriors were relatively minor. Teeth #4, #5, #12, and #13 had composite restorations and were in reasonably good condition, requiring no alterations. The mesioincisal composite restorations at #8 and #9 were discolored and had no contour. The interdental excess of composite between #8 and #9 was impinging on the papilla, causing mild inflammation **(Fig 4)**. Otherwise, the gingival architecture was excellent and required no further intervention. Study models and photographs showed that the proportions were perfect and provided a foundation for a successful smile rehabilitation.[6] A few minor adjustments were needed to correct the mild midline cant and slightly lingually placed #7.

Although restoration with indirect veneers was an option, it would necessitate removing a great deal of tooth structure and not fulfill the goals of conservative treatment. Porcelain laminate veneers cannot be placed ideally without removing some tooth structure to ensure there is sufficient material thickness to enhance the restorations' longevity and esthetic success.[7]

Keeping in mind the above factors, as well as the patient's age and the minimal tooth preparation that would provide sound enamel for bonding, direct resin veneers were proposed as the treatment of choice.

The treatment plan was as follows:

- remove discolored restorations at #8 and #9
- create intraoral mock-up
- fabricate palatal silicone putty index
- place direct composite veneers, ##6-11.

**Figures 2 & 3:** Preoperative full-smile and retracted views.

**Figure 4:** Close-up view showing the hypoplastic spots and the old composite resin impinging on the interdental gingiva.

## Discussion: Composite Resin

It is important that the dentist understand completely the properties of the prospective restorative material to determine its suitability for a particular case and that the desired final outcome be kept in mind.[8] Ever since the introduction of Bis-GMA by Bowen in 1962,[9] composite resin has undergone many technical advances. In the past, microfill was the choice for all anterior esthetic work because it demonstrates high polish and reasonable wear properties. However, its strength was a major drawback. This resulted in the development of nanohybrid composites,[10-12] the current generation of which have excellent polishability, wear resistance, and strength. These high-quality materials in combination with good clinical skills can deliver predictable and long-term results in the most conservative way possible.

## Treatment

### Diagnostic Intraoral Mock-Up

A simple intraoral hybrid composite mock-up was planned because preparation would be minimal. Once the incisal edge positions were checked and the contours were adjusted, a palatal index was fabricated intraorally out of polyvinyl siloxane. The mock-up not only helped with this, but also in creating a shade map. Before the restorative phase began, the occlusion was analyzed to ensure that there were no discrepancies between centric relation and maximum intercuspation. Protrusive movements revealed adequate disocclusion of posterior teeth facilitated by anterior guidance.[13,14]

### Preparation and Layering

The first part of treatment included repairing #8 and #9 because this required correction of the Class IV defect and also the midline cant. Midline cant is best corrected at the beginning of treatment so that the cant does not become incorporated into all the teeth. The composite was removed from #8 and #9, a long bevel was made on the labial surface, and the remaining area was roughened with a medium chamfer diamond bur (Brasseler USA; Savannah, GA). The preparation extended sufficiently interproximally to conceal the tooth-restoration interface. The incisal preparation was very minimal so the surface discoloration disappeared at this point **(Fig 5)**. A short bevel was made at the palatal aspect.[15,16]

**Figure 5:** Note the minimal preparation.

The teeth were managed individually and built up to full contour before they were contoured and polished as a group. As previously mentioned, #8 and #9 were treated first. A retractor (Optragate, Ivoclar Vivadent; Amherst, NY) and "tongue-away" (Dispodent; Chennai, Tamil Nadu, India) were used. Teeth were individually isolated with polytetrafluoroethylene tape and a size #00 retraction cord (Ultradent Products; South Jordan, UT) was placed in the gingival sulcus of #8 and #9. First #8 was etched with 37% phosphoric acid (Total Etch, Ivoclar Vivadent) for 15 seconds and thoroughly rinsed. Excess moisture was removed, with care being taken not to desiccate the tooth. Two coats of bonding resin (Tetric N-Bond, Ivoclar Vivadent) were applied on the tooth structure. After 20 seconds, adhesive layer was thinned out and then light-cured for 10 seconds.

The shade map that had been created earlier **(Fig 6)** served as a blueprint during treatment and facilitated shade matching.[15,17] The first layer of composite was used to create a palatal shelf. The silicone putty material was lubricated using composite wetting resin (Ultradent) prior to composite application. Composite (IPS Empress Direct Trans 30, Ivoclar Vivadent) was used to create the lingual shelf. The index was removed once light-curing was done. This shelf served as a scaffold on which further shades and opacities were built. The next layer, B1 enamel, was used in the proximal area to define the proximal walls. The proximal material was sculpted with a thin blade (TNPFIA6, Hu-Friedy; Chicago, IL). The Class IV defect was then restored with B-1 dentin to the level of the remaining tooth structure **(Fig 7)**. The resin was compacted using spear-shaped blades (TNCCIB, Hu-Friedy). The cervical area was built up with A1 enamel, after which the middle and incisal thirds were built up with B1 enamel. The restoration was contoured (OptraSculpt pad, Ivoclar Vivadent). A #3 artist brush (Cosmedent; Chicago, IL) was used to adapt the composite layer without any voids. Once contouring was completed, the resin was light-polymerized for 40 seconds (Bluephase G2, Ivoclar Vivadent) **(Fig 8)**. To minimize formation of an oxygen-inhibited layer, glycerin gel (Oxyguard, Ivoclar Vivadent) was used before the final cure.

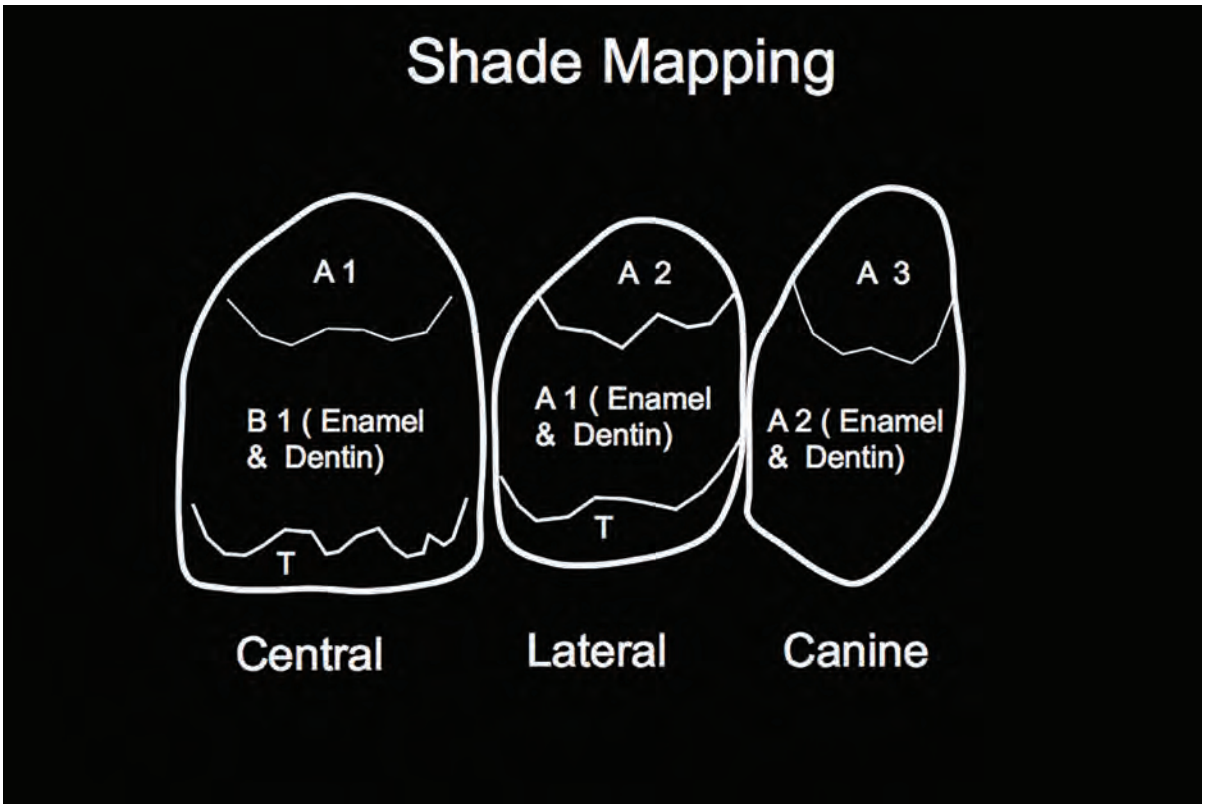



**Figure 6:** Shade map.

**Figure 7:** Initial build of resin.

**Figure 8:** Polychromatic appearance after completion of buildup of #8.

The same process was carried out for #9. Once this was done, photographs were taken and models made to ensure that the midline cant had been eliminated. It is important to note that use of a cheek retractor makes the cant easier to identify in a photograph **(Fig 9)**. After analysis it was found that minor recontouring was necessary. The same procedure was followed at the second appointment and the midline cant was eliminated. During the next two appointments the above-described incremental layering technique was followed for #7 and #10, and #6 and #11, in that order. The shade mapping for the laterals was cervical A2 enamel and the remaining A1 enamel; for the canines it was A3 enamel in the cervical and A2 enamel for the remaining the tooth structure. Preparation for the laterals and canines was very minimal—the hypocalcific spots were removed and other areas were just roughened. All preparations were in enamel only.

**Figure 9:** Evaluation of midline.

### Contouring and Polishing

Excess material was removed from the surface as well as the margin with a #12 Bard-Parker surgical blade (Becton Dickinson; Franklin Lakes, NJ). The occlusion was checked and adjusted with a football-shaped diamond (Mani; Utsunomiya, Tochigi, Japan). Detailing contours of multiple anterior direct restorations can be a daunting task, the most common challenges including contour, polish, and tissue response. To achieve the detailing that is required for this type of case it is better that it be managed over the course of several appointments,[18,19] as was done here. At the end of each visit, a diagnostic impression was taken to create models and photographs that could be evaluated prior to the patient's next appointment. This aided greatly in visualization and in designing naturally balanced contours.

The primary anatomy form and contours were achieved with a series of carbide finishing burs (S.S. White; Lakewood, NJ). To maintain and refine the primary anatomy a lead pencil was used to mark the line angles and the central prominence on the labial surface of all the veneer surfaces.[20,21] The three facial planes of contour were carefully developed and the entire surface was smoothed with a composite abrasive point (Kerr; Orange, CA).

> "Although enhancing a smile using composite material can be challenging, direct resin veneers can give the dentist full artistic control over the esthetic outcome of the case, resulting in a smile that rivals those created by nature."

The secondary anatomy developmental lobes **(Fig 10)** were created using a fine-grit diamond (Mani). Interdental contouring was accomplished with a series of diamond finishing strips (Edenta AG; Au, St. Gallen, Switzerland), ensuring that there was no proximal flash. Once finishing was complete, the tertiary anatomy was crafted with a medium-grit diamond (Edenta) **(Figs 11a-11c)**. The restorations were polished with a series of fine diamond abrasives (OptraPol, Ivoclar Vivadent)[18] and the interproximal areas were polished with Cosmedent strips. Final gloss was achieved using an aluminum oxide-based composite polishing paste (Enamelize, Cosmedent) and the entire surface was buffed (Flexi-Buff, Cosmedent). The entire contouring, finishing, and polishing process took another three appointments.

Postoperative and oral hygiene instructions were given and the patient was scheduled for a follow-up appointment and final photographs two weeks later **(Figs 12-13c)**. She was extremely happy with the treatment outcome **(Figs 14 & 15)** and her confident smile clearly expressed that we had exceeded her expectations.

> “Mild fluorosis…can be conservatively managed with direct resin veneers.”

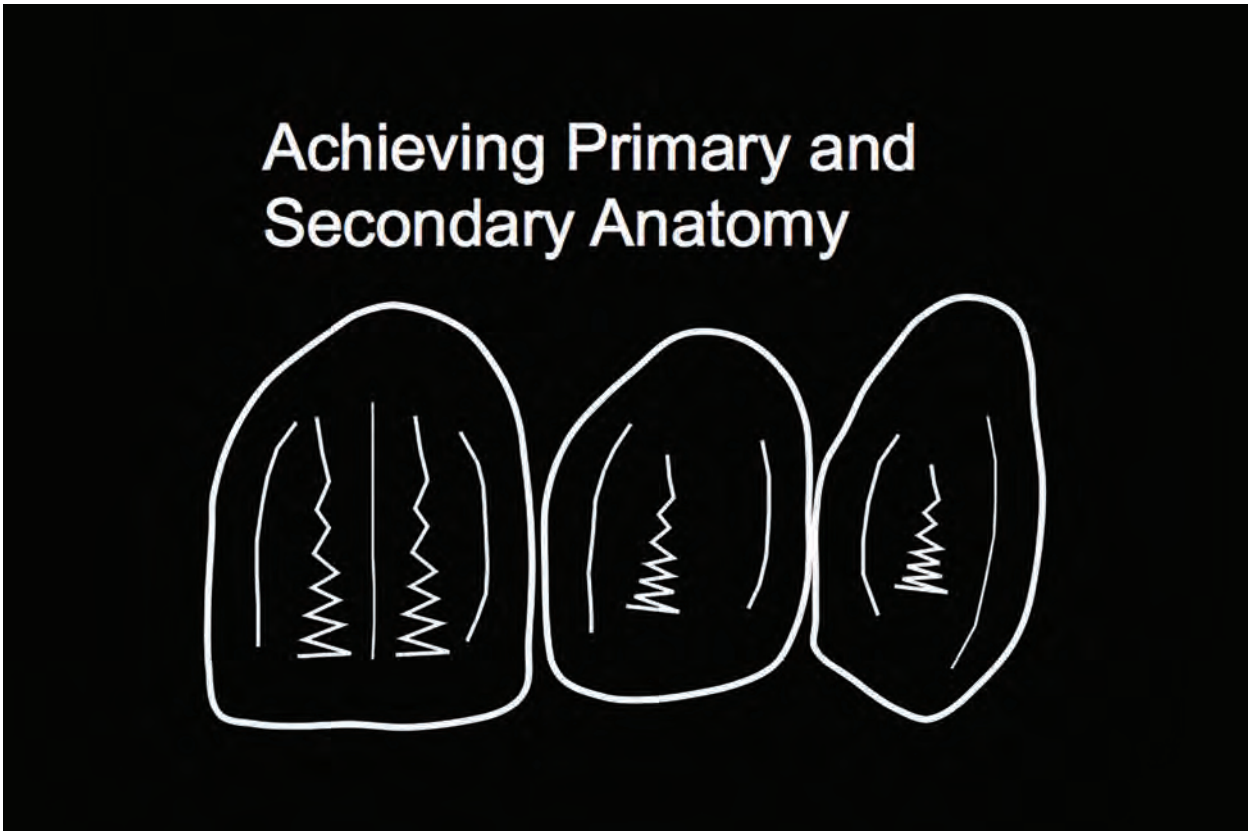
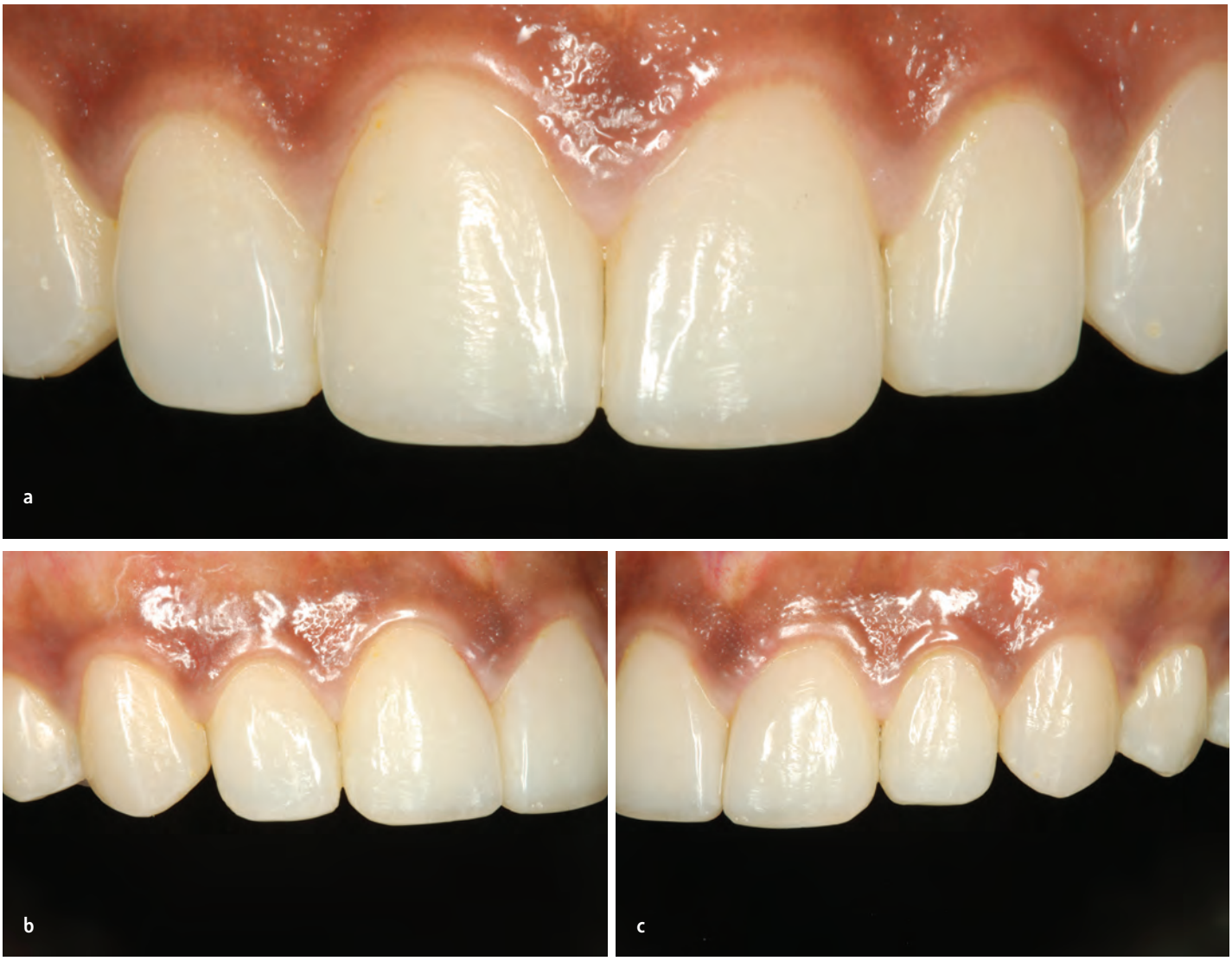



**Figure 10:** Schematic representation of primary and secondary anatomy.


**Figures 11a-11c:** Images taken for final evaluation of the restorations before polishing.

**Figure 12:** Postoperative retracted view; note the harmonious restoration.




**Figures 13a-13c:** Postoperative frontal, right, and left close-up views; the restorations almost emulate nature.

**Figure 14:** Postoperative full-smile view; the restoration blends in seamlessly with the natural dentition.

**Figure 15:** Postoperative full-face image; the patient's happiness with her new smile is reflected in her eyes.

## Summary

The impact of a smile enhancement on an individual can easily be seen in the confidence he or she develops after the treatment, especially as evidenced in a broader, more self-assured smile. Composite material can replace lost tooth structure very conservatively and with an excellent esthetic outcome. With proper treatment planning, careful execution, and keeping the final outcome in mind, smile rehabilitation with direct composite resin veneers can be minimally invasive and long lasting, and can rival the esthetics of ceramic restorations.

### Acknowledgment

*The author expresses gratitude to his mentor, Rebecca Pitts, DMD, FAACD, for her continuous support and encouragement regarding the case discussed in this article.*

### References

1. Ericson D. What is minimally invasive dentistry? Oral Health Prev Dent. 2004;2 Supp1:287-92.
2. Lambert DL. Conservative aesthetic solutions for the adolescent and young adult utilizing composite resins. Dent Clin North Am. 2006 Jan;50(1):87-118.
3. Terry DA. Natural aesthetics with composite resin. Mahwah (NJ): Montage Media; 2003.
4. Malhotra N, Mala K, Acharya S. Resin-based composite as a direct esthetic restorative material. Compend Contin Educ Dent. 2011 Jun;32(5):14-23.
5. Fahl N Jr. A polychromatic composite layering approach for solving a complex Class IV/direct veneer-diastema combination: part I. Pract Proced Aesthet Dent. 2006 Nov-Dec;18(10):641-5.
6. American Academy of Cosmetic Dentistry (AACD). A guide to Accreditation criteria. Madison (WI): AACD; 2014.
7. Giordano R. A comparison of all-ceramic restorative systems. J Mass Dent Soc. 2002 Winter;50(4):16-20.
8. Baratieri IN. Aesthetics: direct adhesive restoration on fractured anterior teeth. Hanover Park (IL): Quintessence Pub.; 1998. p. 35-46.
9. Bowen RL. Properties of a silica-reinforced polymer for dental restorations. J Am Dent Assoc. 1963;66:57-64.
10. Drummond JL. Cyclic fatigue of composite restorative materials. J Oral Rehabil. 1989 Sep;16(5):509-20.
11. Lambrechts P, Vanherle G. Structural evidences of the microfilled composites. J Biomed Mater Res. 1983 Mar;17(2):249-60.
12. Mitra SB, Wu D, Holmes BN. An application of nanotechnology in advanced dental materials. J Am Dent Assoc. 2003 Oct;134(10):1382-90.
13. Dawson PE. Functional occlusion: from TMJ to smile design. St. Louis: Mosby; 2007.
14. Rufenacht C. Fundamentals of esthetics. Hanover Park (IL): Quintessence Pub.; 1990. p. 87-94,127-31.
15. Chan DK. Accreditation clinical case report, Case Type V: six or more direct resin veneers. J Cosmetic Dent. 2010 Spring;26(1):44-53.
16. Peyton JH. Direct restoration of anterior teeth: review of the clinical technique and case presentation. Pract Proced Aesthet Dent. 2002 Apr;14(3):203-10.
17. Dietschi D. Layering concepts in anterior composite restorations. J Adhes Dent. 2001 Spring;3(1):71-80.
18. Finlay S. Accreditation clinical case report, Case Type V: six or more direct resin veneers. J Cosmetic Dent. 2008 Fall;24(3):50-8.
19. LeSage B, Milnar F, Wohlberg J. Achieving the epitome of composite art: creating natural tooth esthetics, texture, and anatomy using appropriate preparation and layering techniques. J Cosmetic Dent. 2008 Fall;24(3):132-41.
20. Peyton JH. Finishing and polishing techniques: direct composite resin restorations. Pract Proced Aesthet Dent. 2004 May;16(4):293-8.
21. Glazer HS. Simplifying finishing and polishing techniques for direct composite restorations. Dent Today. 2009 Jan;28(1):122,124-5. **jCD**

> “Midline cant is best corrected at the beginning of treatment so that the cant does not become incorporated into all the teeth.”

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Disclosure: The author is a key opinion leader for Ivoclar Vivadent. He also receives honoraria from Ivoclar Vivadent for lecturing and conducting hands-on courses.


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# Direct Bonding with New-Generation Flowable Composite Resin and a Zirconia All-Ceramic Crown

## Restoration of a Midline Fracture Using a Silicone Jig and Transparent Silicone Key

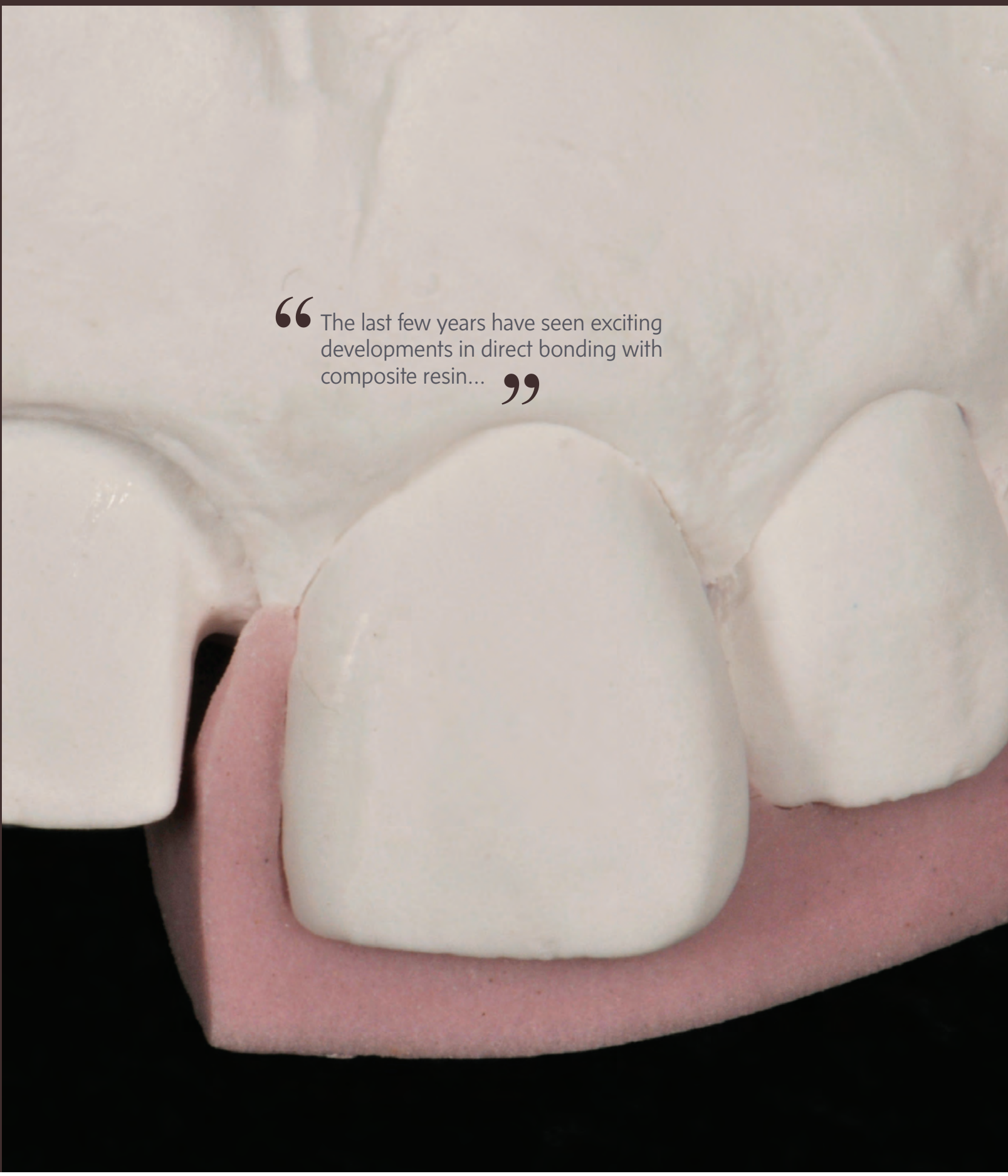
Tomonori Waki, DDS, PhD
Katsuhiro Hatate, RDT

Editor's Note: In 2010, the American Academy of Cosmetic Dentistry and the Japan Academy of Esthetic Dentistry formed a sister relationship for the purpose of sharing educational information. The following article was written to honor this relationship, with the goal of featuring different global perspectives and approaches to cosmetic dentistry.

### Abstract

Exciting progress has been made in direct bonding with composite resin. Direct bonding with composite resin in the esthetic zone has become possible in cases that previously would have required an indirect technique such as restoration with porcelain laminate veneers. However, it can be challenging to fabricate the tooth contour with composite resin. In particular, restoration of the midline of the central incisor is difficult with flowable composite resin freehand. This article describes a technique for fabricating tooth contour and midline using a palatal-side silicone jig and labial-side transparent silicone key from a diagnostic wax-up, as well as new-generation flowable composite resin.

**Key Words: flowable composite resin, direct bonding, silicone jig, transparent silicone key, midline**



> “The last few years have seen exciting developments in direct bonding with composite resin...”

## Introduction

The last few years have seen exciting developments in direct bonding with composite resin[1-5] due to better-performing flowable composite resin materials. As a result, the clinical indications for flowable composites have been expanding.[6-12] The advantage of flowable composite resin is, of course, its lower viscosity, which facilitates manipulation and adaptability to the cavity form walls. Its disadvantage lies in its difficulty in fabricating the tooth contour, because of material "slumping" and shifting prior to photopolymerization.

Restoration of the midline between the central incisors is especially challenging with direct flowable composite resin; although restoration using standard composite resin freehand is possible, the artistic and clinical skills of the dentist must be taken into consideration. Alternatively, restoration of the central incisor contour and midline with flowable composite resin and a silicone jig has become a relatively simple procedure. It now is possible to fabricate the tooth contour and midline using a palatal-side silicone jig, a labial-side transparent silicone key, and a new-generation flowable composite resin.

## Case Presentation

A 36-year-old male patient was dissatisfied with the esthetics of his smile. He presented with a fractured left maxillary central incisor (#9) and an older crown with unacceptable esthetics on the right maxillary central incisor (#8) **(Figs 1-4)**. After obtaining a patient history, initial facial and intraoral photographs, and initial full-mouth periapical radiographs **(Fig 5)**, clinical, periodontal, and temporomandibular joint (TMJ) examinations were completed and study casts were taken to ensure an accurate diagnosis. In addition, an endodontic consultation was obtained for #8.

**Figure 1:** Preoperative facial view.

**Figure 2:** Preoperative lateral smile view.

**Figure 3:** Preoperative smile view.

**Figure 4:** Preoperative intraoral view.

> "This material contains newly developed submicron fillers and silica clusters. Therefore, it has 75 to 81 wt% high filler content material, much like universal composite resin."

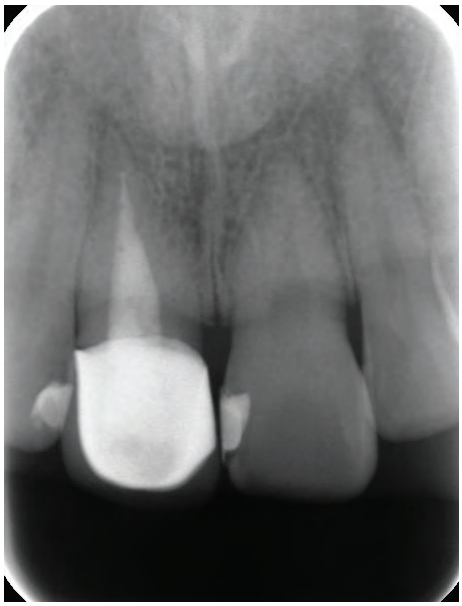


**Figure 5:** Preoperative periapical radiograph, ##7-9.

### Findings

All probing depths were within normal limits (< 3 mm) and there were no signs of tooth mobility. Examination of the TMJ revealed no signs or symptoms of muscle or joint pain. Esthetic analysis revealed that the midline was tilted. The mesiodistal width of the old metal ceramic crown of #8 was wider than #9. There was a marginal gap and secondary caries on #8. The root canal infection was due to coronal endodontic leakage from secondary caries, which is why #8 needed endodontic retreatment. Old composite resin restorations were present on the mesial surface of #7 and #9 with unacceptable esthetics. A fracture was also evident on #9.

## Treatment Plan

Whitening was planned to improve tooth color from premolar to premolar. Direct bonding with flowable composite resin was selected for #7. Root canal treatment, a core buildup with a fiber post and composite resin, and a zirconia all-ceramic crown were planned for #8. Direct bonding with flowable composite resin using a silicone jig and a transparent silicone key was selected for #9. The advantages of the direct freehand technique are the ability to treat the patient in one appointment and that the procedure can begin immediately. The disadvantage of the direct freehand technique is technique sensitivity. It is very difficult to fabricate the symmetric mesial ridge and transition line angles. It is helpful to use a transparent silicone key to fabricate the labial tooth contour, especially for the midline, symmetric mesial ridge, and transition line angles from the diagnosis wax-up. In addition, the low viscosity of the flowable composite resin is optimal for this technique.

## Treatment

### Preoperative Procedures

Before removal of the old crown, an impression (Panasil, Kettenbach GmbH & Co. KG; Eschenburg, Germany) was made for fabrication of a diagnostic wax-up **(Fig 6)**. After that, a silicone jig (Zetalabor, Zhermack, Badia Polesine [RO], Italy) **(Fig 7)**, a transparent silicone key (Glassbite clear, DETAX GmbH & Co. KG; Ettlingen, Germany) **(Fig 8)**, and a provisional restoration autopolymerizing acrylic resin (Jet, Lang Dental; Wheeling, IL) were fabricated.

**Figure 6:** Diagnostic wax-up.

**Figure 7:** Diagnostic wax-up with a palatal silicone jig.

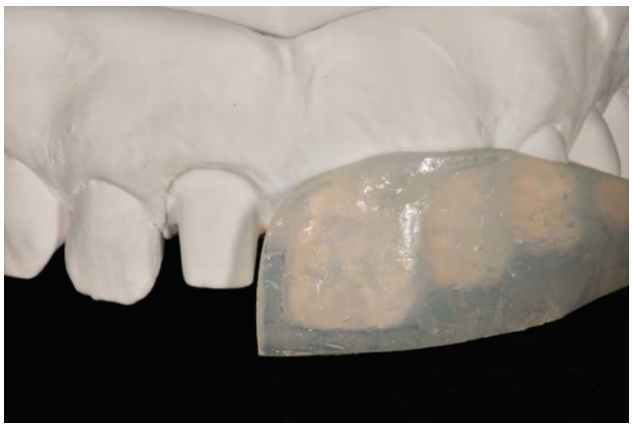


**Figure 8:** Diagnostic wax-up with a labial transparent silicone key.

## Clinical Procedures

The patient received in-office tooth whitening. Two weeks later, the existing crown at #8 was removed and initial tooth preparation was carried out. Using rubber dam isolation, the old composite resin restoration and caries on #9 were removed **(Fig 9)**. The mesial structure of this tooth had been lost. After removal of the restoration, the dentin and enamel were etched with phosphoric acid and disinfected with 10% sodium hypochlorite[13] (AD gel, Kuraray Noritake Dental; Tokyo, Japan) and a bonding agent was applied using a two-bottle light-cured adhesive system (Clearfil SE Protect, Kuraray Noritake Dental). The palatal tooth enamel contour was fabricated with a silicone jig from the diagnostic wax-up using shade A2 flowable composite resin (Clearfil Majesty ES Flow) **(Fig 10)**. The dentin layer was fabricated with Clearfil Majesty ES Flow shade KA6. The labial tooth enamel contour was then fabricated with a transparent silicone key from the diagnostic wax-up using the shade A2 flowable composite resin **(Figs 11 & 12)**. The use of three layers (palatal enamel, dentin, and labial enamel) helped to mimic natural tooth opacity.

After light-curing (Pencure 2000, Morita; Kyoto, Japan) with light intensity of 1,000 mW/cm2 and curing time of 20 seconds **(Fig 13)**, the surplus composite resin was removed and polished **(Fig 14)**. The extra bonding agent was also removed from the sulcus. The rubber dam protects the sulcus from the surplus composite resin and extra bonding agent. Afterward, the provisional restoration was adjusted with Jet autopolymerizing acrylic resin and delivered with temporary cement (Hy-Bond Hard, Shofu Dental; Kyoto, Japan) **(Fig 15)**.

The midline was restored according to the diagnostic wax-up. Muscle retraining exercises[14,15] were initiated soon after fabrication of the provisional restoration because the patient could not smile due to long-standing embarrassment about his preoperative tooth esthetics. Tooth #7 was treated with direct bonding with flowable composite resin. Tooth #8 was referred to an endodontist, who performed endodontic retreatment therapy **(Fig 16)**. A post and core was built up on #8 with a fiber post (Clearfil), silane coupling agent (Clearfil Ceramic Primer), dual-cure bonding agent (Clearfil DC Bond), and dual-cure resin core build-up material (Clearfil DC Core Plus). Final tooth preparation was carried out **(Fig 17)**. The gingival condition of #8 was recovered with subgingival contour of the provisional restoration **(Fig 18)**.

**Figure 9:** After removal of the old crown on #8, the old composite resin restoration and caries at #9 were removed.

**Figure 10:** Intraoral view of the palatal silicone jig with flowable composite resin.

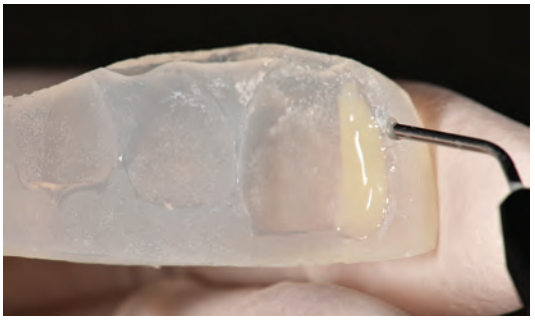


**Figure 11:** Labial transparent silicone key with flowable composite resin.

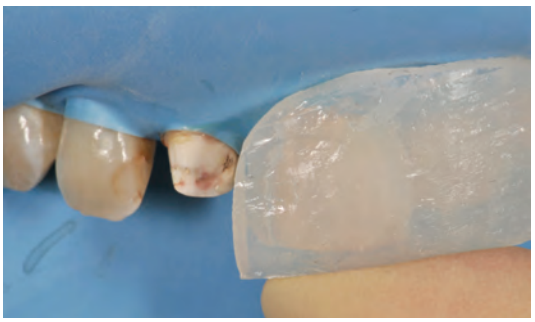


**Figure 12:** Intraoral view of the labial transparent silicone key with flowable composite resin.

**Figure 13:** After curing, the transparent silicone key was removed.

**Figure 14:** After removal of the surplus composite resin and polishing.

**Figure 15:** Intraoral view of the provisional restoration of #8 after direct bonding on #9. Note the midline was restored following the diagnostic wax-up.

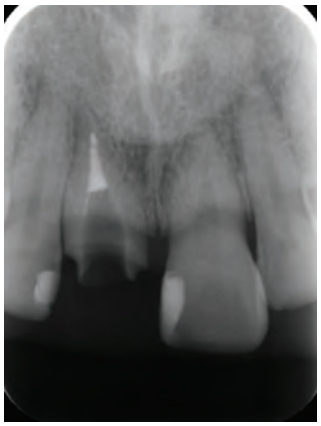


**Figure 16:** Periapical radiograph of #8 after endodontic treatment.

**Figure 17:** Final preparation of #8 after direct bonding on #7.

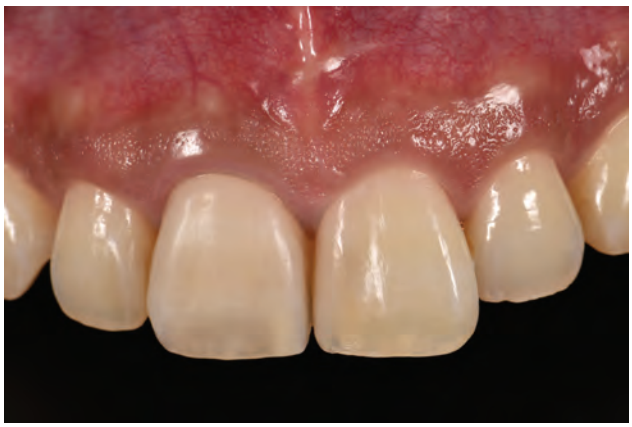


**Figure 18:** Intraoral view of provisional restoration on #8 after gingival recovery.

Two weeks after final tooth preparation, a dental technician performed in-office color mapping for later zirconia surface staining. Then both the final impression (Panasil) and occlusal registration (Greenbite, DETAX GmbH & Co. KG) were taken. A definitive zirconia all-ceramic crown (Aadva, GC Corp.; Tokyo, Japan; and Creation ZI-CT, Creation Willi Geller International GmbH; Meiningen, Austria) for #8 was fabricated and delivered with a self-etch dual-cure composite cement system (Clearfil Esthetic Cement EX). The extra cement and bonding agent were removed from the sulcus. A periapical radiograph was taken **(Fig 19)** to check for extra cement.

When the old composite resin restoration and caries on #9 were removed, a bevel was made on the labial surface. However, this tooth had white transversal lines, which made it difficult to color-match. Therefore, a staining kit (Ceseed N, Kuraray Noritake Dental) was employed to enhance the blending as much as possible. This kit, which includes a primer and eight variations of color coat, was used to restore the white transversal line on the flowable composite resin on #9 under a rubber dam (white color was painted on white transversal lines and A+ color was painted on between white transversal lines, followed by light-curing) **(Fig 20)**.

The midline was restored following the diagnostic wax-up **(Figs 21-23)**. The patient's smile line was changed with the smile training exercises[14,15] and he was happy with the esthetic outcome **(Fig 24)**.

## Discussion: Flowable Composite Resin

In the 1990s, flowable composite resin contained filler content (percent filler to unit weight) that was substantially less than that of universal composite resin, in order to obtain the handling property of reduced viscosity.[16] Unfortunately, reduction in filler content generated a lower, unfavorable modulus of flexural strength; elevated wear rates; and a rough surface that was difficult to polish. Physical material properties and esthetics were compromised.[17-19] Today there are a vast number of different flowable composite resins manufactured, all exhibiting highly variable percentages of filler to unit weight. Fortunately, we now can select composite resins that have a range of desired handling properties and also retain favorable mechanical properties, esthetics, initial polishablity, and retention of surface luster over time.[20]

A light-curable flowable composite resin with filler particles that are treated with a surface-coating technology for better affinity with matrix monomers is now available.[21,22] This material contains newly developed submicron fillers and silica clusters. Therefore, it has 75 to 81 wt% high filler content material, much like universal composite resin.[20,21] The flexural strength of Filtek Supreme Plus Flow (3M ESPE; St. Paul, MN) is 125 Mpa[21] and that of Clearfil

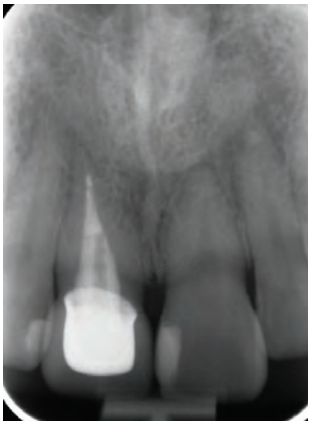


**Figure 19:** Postoperative periapical radiograph of ##7-9.

> "...direct bonding with composite resin in the esthetic zone is now possible in cases that previously would have required an indirect technique such as porcelain laminate veneers."

**Figure 20:** Staining the direct bonding on #9.

**Figure 21:** Postoperative intraoral view of the definitive crown on #8 and direct bonding on #7 and #9.

**Figure 22:** Postoperative lateral smile view.

**Figure 23:** Postoperative smile view.

**Figure 24:** Postoperative facial view. Note how the smile line changed.

Majesty ES Flow is 145 to 151 Mpa;[21,22] the latter is similar to that of universal composite resin.[21,22] In addition, this new flowable composite resin exhibits superior polishability, polish retention,[22] and optical properties. This resin's optical property also diffuses light, thereby enhancing the color matching of natural teeth.

In recent years, advances have been made in adhesive dentistry and the performance of composite resin material has been improved. As a result, direct bonding with composite resin in the esthetic zone is now possible in cases that previously would have required an indirect technique such as porcelain laminate veneers. In addition, restoration with direct bonding using only flowable composite resin is now possible in some cases that previously would have required universal composite resin.

## Summary

This article described the fabrication of tooth contour and midline using a palatal-side silicone jig and labial-side transparent silicone key from the diagnostic wax-up and a new-generation flowable composite resin. It was an effective approach for this case, with reduced chair time and a highly satisfactory esthetic outcome. Careful patient selection, proper treatment planning, and appropriate material selection are important factors for complex clinical procedures in the esthetic zone, especially when newer materials are used.

### Acknowledgment

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### References

1. Beck F, Lettner S, Graf A, Bitriol B, Dumitrescu N, Bauer P, Moritz A, Schedle A. Survival of direct resin restorations in posterior teeth within a 19-year period (1996-2015): a meta-analysis of prospective studies. Dent Mater. 2015 Aug;31(8):958-85. doi: 10.1016/j.dental.2015.05.004. Epub 2015 Jun 16.

2. Fennis WM, Kuijs RH, Roeters FJ, Creugers NH, Kreulen CM. Randomized control trial of composite cuspal restorations: five-year results. J Dent Res. 2014 Jan;93(1):36-41. doi: 10.1177/0022034513510946. Epub 2013 Oct 23.

3. Juloski J, Carrabba M, Aragoneses JM, Forner L, Vichi A, Ferrari M. Microleakage of Class II restorations and microtensile bond strength to dentin of low-shrinkage composites. Am J Dent. 2013 Oct;26(5):271-7.

4. Ozer F, Blatz MB. Self-etch and etch-and-rinse adhesive systems in clinical dentistry. Compend Contin Educ Dent. 2013 Jan;34(1):12-4, 16, 18; quiz 20, 30.

5. Gresnigt MM, Kalk W, Ozcan M. Randomized controlled split-mouth clinical trial of direct laminate veneers with two micro-hybrid resin composites. J Dent. 2012 Sep;40(9):766-75. doi: 10.1016/j.jdent.2012.05.010. Epub 2012 Jun 2.

6. Majety KK, Pujar M. In vitro evaluation of microleakage of class II packable composite resin restorations using flowable composite and resin modified glass ionomers as intermediate layers. J Conserv Dent. 2011 Oct;14(4):414-7. doi: 10.4103/0972-0707.87215.

7. Kubo S, Yokota H, Yokota H, Hayashi Y. Three-year clinical evaluation of a flowable and a hybrid resin composite in non-carious cervical lesions. J Dent. 2010;38(3):191-200.

8. Jafarzadeh M, Malekafzali B, Tadayon N, Fallahi S. Retention of a flowable composite resin in comparison to a conventional resin-based sealant: one-year follow-up. J Dent (Tehran). 2010 Winter;7(1):1-5.

9. Savage B, McWhorter AG, Kerins CA, Seale NS. Preventive resin restorations: practice and billing patterns of pediatric dentists. Pediatr Dent. 2009 May-Jun;31(3):210-5.

10. Beauchamp J, Caulfield PW, Crall JJ, Donly K, Feigal R, Gooch B, Ismail A, Kohn W, Siegal M, Simonsen R. American Dental Association Council on Scientific Affairs. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. J Am Dent Assoc. 2008 Mar;139(3):257-68.

11. Leevailoj C, Cochran MA, Matis BA, Moore BK, Platt JA. Microleakage of posterior packable resin composites with and without flowable liners. Oper Dent. 2001 May-Jun;26(3):302-7.

12. Payne JH 4th. The marginal seal of Class II restorations: flowable composite resin compared to injectable glass ionomer. J Clin Pediatr Dent. 1999 Winter;23(2):123-30.

13. Inoue S, Murata Y, Sano H, Kashiwada T. Effect of NaOCl treatment on bond strength between indirect resin core-buildup and dentin. Dent Mater J. 2002 Dec;21(4):343-54.

14. D'souza R, Kini A, D'souza H, Shetty N, Shetty O. Enhancing facial aesthetics with muscle retraining exercises–a review. J Clin Diagn Res. 2014 Aug;8(8):ZE09-11. doi: 10.7860/JCDR/2014/9792.4753. Epub 2014 Aug 20.

15. Gibson RM. Smiling and facial exercise. Dent Clin North Am. 1989 Apr;33(2):139-44.

16. Hervás-García A, Martinez-Lorano MA, Cabanes-Vila J, Barjau-Escribano A, Fos-Galve P. Composite resins. A review of the materials and clinical indications. Med Oral Patol Oral Cir Bucal. 2006 Mar 1;11(2):E215-20.

17. Bayne SC, Thompson JY, Swift EJ Jr, Stamatiades P, Wilkerson M. A characterization of first-generation flowable composites. J Am Dent Assoc. 1998 May;129(5):567-77.

18. Attar N, Tam LE, McComb D. Flow, strength, stiffness and radiopacity of flowable resin composites. J Can Dent Assoc. 2003 Sep;69(8):516-21.

19. Salerno M, Derchi G, Thorat S, Ceseracciu L, Ruffilli R, Barone AC. Surface morphology and mechanical properties of new-generation flowable resin composites for dental restoration. Dent Mater. 2011 Dec;27(12):1221-8. doi: 10.1016/j.dental.2011.08.596. Epub 2011 Oct 15.

20. Baroudi K, Rodrigues JC. Flowable resin composites: a systematic review and clinical considerations. J Clin Diagn Res. 2015 Jun;9(6):ZE18-24. doi: 10.7860/JCDR/2015/12294.6129. Epub 2015 Jun 1.

21. Kuboe Y, Kita H, Ohara Y, Takahata Y. A high filler loaded flowable composite, "Clearfil Majesty Flow." Paper presented at: IADR 86th General Session & Exhibition; 2008 Jul 3; Toronto, Canada.

22. Kameya T, Tsuji A, Ishino H. Characteristics of a new flowable composite "Clearfil Majesty ES Flow." Paper presented at: 43rd Annual Meeting & Exhibition of the AADR; 2014 Mar 21; Charlotte, NC. Available from: https://www.researchgate.net/publication/266757203_Characteristics_of_a_New_Flowable_Composite_CLEARFIL_MAJESTY_ES_Flow **jCD**

> "... this new flowable composite resin exhibits superior polishability, polish retention, and optical properties."

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# Restoring Without Implants

## Multidisciplinary Restoration of Compromised Teeth: A Case Report

Riccardo Ammannato, DDS
Michele Perelli, DDS
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Hector L. Sarmiento, DMD, MSc
Joseph P. Fiorellini, DMD, DMSc

> “...with this approach, it is possible to delay implant placement that may contribute to a deformity of the surrounding tissues and avoid peri-implant complications such as perimucositis, peri-implantitis, and bone loss compromising esthetic areas.”


## Abstract

In recent decades, manufacturers have developed endodontic instruments, surgical techniques, and metal-free restorative materials to restore compromised teeth. If used with appropriate protocols, these modalities can satisfy patients' and clinicians' esthetic and functional demands. Different treatment options are available today to restore compromised teeth, depending on the amount of periodontal support, enamel and dentin loss due to trauma, and caries and/or the size of the existing restorations that have to be removed. It is essential to diagnose and treat the periodontium conservatively to properly restore biomechanics, function, and esthetics. Clinicians must make major efforts to restore compromised teeth before considering implant placement, especially when treating younger or medically compromised patients for whom dental implants are not appropriate. The purpose of this case report is to provide clinical expertise on how to manage and restore a compromised tooth in patients who are not candidates for implant placement, with a predictable outcome utilizing a multidisciplinary approach.


**Key Words: compromised teeth, tooth restorability, single-tooth restoration, implants versus teeth**

## Introduction

Dental implants have shown to be predictable and reliable over time.[1,2] However, clinicians with younger or medically compromised patients who are not candidates for implant surgery must attempt to restore compromised teeth whenever possible. Indeed, if compromised teeth are adequately restored their performance over time is superior to that of implants.[1,2] Furthermore, with this approach, it is possible to delay implant placement that may contribute to a deformity of the surrounding tissues and avoid peri-implant complications such as perimucositis, peri-implantitis, and bone loss compromising esthetic areas.

When diagnosing compromised dentition, the tooth and adjacent tissues must be carefully evaluated and have the proper indications in order for the tooth to be restored. A multidisciplinary approach is essential in achieving a functional and esthetic final outcome.

## Case Presentation

### Patient and Chief Complaint

A 21-year-old female patient was unhappy with her compromised tooth #13 (maxillary left second premolar) **(Figs 1-3)** and referred pain in the upper left sextant due to caries.

### Treatment

With the patient's consent, crown-lengthening surgery was performed to gain adequate ferrule and a gingival scallop in harmony with the adjacent teeth **(Figs 4 & 5)**.[3,4] After suture removal, a rubber dam was placed to isolate #13 **(Fig 6)** and allow a root canal retreatment to be performed (Thermafil, Dentsply Maillefer; Ballaigues, Switzerland) **(Fig 7)**. Afterward, a pre-prosthetic restoration with a carbon fiber post (Ena, Micerium S.p.A.; Avegno, Italy) and composite material (Filtek Supreme XTE, 3M ESPE; St. Paul, MN) was accomplished **(Figs 8-11)**.[5-10] Reduction on #13 was then performed with coarse diamond burs (2979-012, Komet; Milan, Italy) to achieve a 360-degree rounded shoulder, which in this phase must be far away from the soft tissues to allow healing and maturation after crown lengthening. A temporary resin crown was cemented on the abutment (Protemp, 3M ESPE).

The old direct composite restorations were removed on #12, #14, and #15 (the maxillary left first premolar, first molar, and second molar). After caries excavation, a fine diamond bur (838-010, Komet) and ultrasonic tips (SFM7.000.2, SFD7.000.2, Komet) were utilized to refine the remaining sound tooth structure **(Figs 12 & 13)**.[11-14] A three-step etch-and-rinse adhesive protocol was performed (OptiBond FL, Kerr; Orange, CA)[15-19] and wooden wedges and sectional matrices (V3 Ring and Matrix, Triodent; Katikati, New Zealand) were positioned, allowing direct composite restorations to be layered on the three teeth **(Fig 14)**.[20] Since #17 (the mandibular left third molar) was missing, the antagonist tooth #16 was extracted to prevent distal tooth decay on the adjacent tooth.[21]

**Figure 1:** Preoperative; #13 was severely decayed and symptomatic.

**Figure 2:** Preoperative; buccal view.

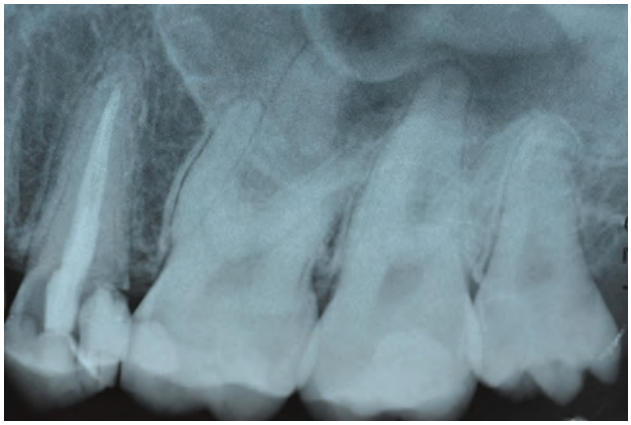
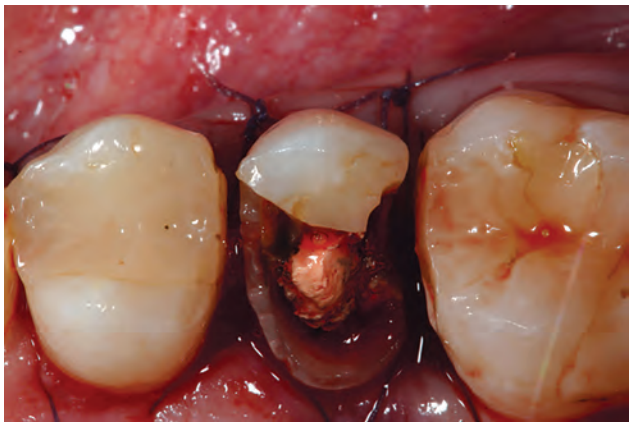
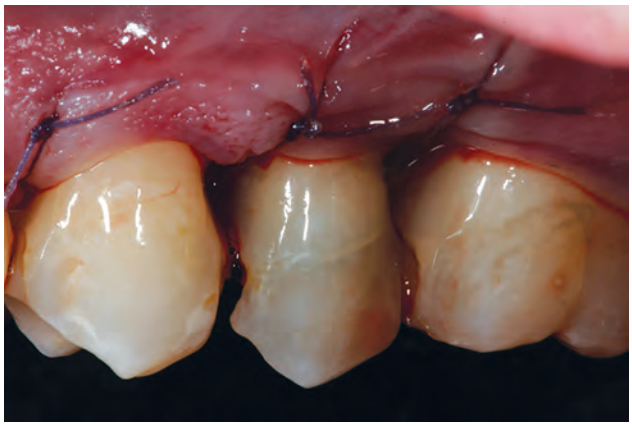


**Figure 3:** Preoperative radiograph.





**Figures 4 & 5:** Crown lengthening was performed to gain ferrule; occlusal and buccal views.

**Figure 6:** Field isolation after suture removal.

**Figure 7:** Caries was removed and root canal retreatment was initiated.

**Figure 8:** A matrix and wooden wedges were placed so that a pre-endodontic buildup could be carried out to hold sodium hypochlorite in the pulp chamber during endodontic treatment.

**Figure 9:** A three-step etch-and-rinse adhesive protocol was performed.

**Figure 10:** After endodontic treatment, a carbon fiber post was tried in to check the fitting.

**Figure 11:** A pre-prosthetic restoration with carbon fiber and composite has been carried out. Tooth #13 will be prepared and a temporary crown will be cemented.

**Figure 12:** After field isolation, the old restorations were ready to be removed.

**Figure 13:** Caries excavation and cavity-finishing protocols were performed.

**Figure 14:** After a three-step etch-and-rinse protocol, the direct composite restorations were completed.

> A multidisciplinary approach is essential in achieving a functional and esthetic final outcome.

Approximately nine months after crown lengthening, final apical relocation and defining of the finishing line on the second premolar abutment tooth (#12) was performed with fine diamond burs (8979-012, Komet) and ultrasonic tips (TD1654, Komet). A two-cord approach (Ultrapak 000 and 00, Ultradent Products; South Jordan, UT) was utilized for the gingival margin and a final impression (Impregum, 3M ESPE) was taken **(Figs 15 & 16)** and sent to the laboratory technician to fabricate the permanent lithium disilicate crown **(Fig 17)**.[22-28]

Once the contact areas, fitting, shape, and color were evaluated, field isolation was achieved with a cord (Ultrapak 000) and a rubber dam (Nic Tone, MDC Dental; Zapopan, Jalisco, Mexico). The abutment tooth received a prophylaxis with pumice and was sandblasted prior to etching with phosphoric acid (Ena etch 37%). Following that, a copious rinsing was done and a three-step etch-and-rinse adhesive (Optibond FL) was applied **(Figs 18 & 19)**. The lithium disilicate restoration was etched with 5% hydrofluoric acid (Porcelain etch gel, Pulpdent; Watertown, MA) **(Fig 20)** and placed in an ultrasonic bath for five minutes before adding the silane (Ultradent) and bonding (Optibond FL) agents.[29]

A preheated light-cured composite (Enamel Plus, Micerium) was placed on the abutment tooth **(Fig 21)**, followed by the crown insertion with a progressive push to let the excess composite cement flow out. This was removed with a probe and floss until the crown was perfectly seated on the finishing line **(Figs 22 & 23)**. Light-curing was done (this can be done for six minutes with one lamp, or three minutes with two lamps, one minute for each surface of the restoration, to allow a perfect composite cement conversion) **(Fig 24)**.[30,31] A small potential for excess cement can occur during this step; it can be removed with a curette. Also, a dual-cure resin cement can be used to cement a lithium disilicate crown. The authors prefer light-cure cement due to better handling, and because the conversion of the cement begins only when the clinician decides.

Occlusal adjustments were made to the restoration. At the four-year follow-up appointment, clinical and radiographic evaluation showed a fully functioning and stable restoration **(Figs 25 & 26)**.

**Figure 15:** A two-cord approach was employed after finishing line relocation.

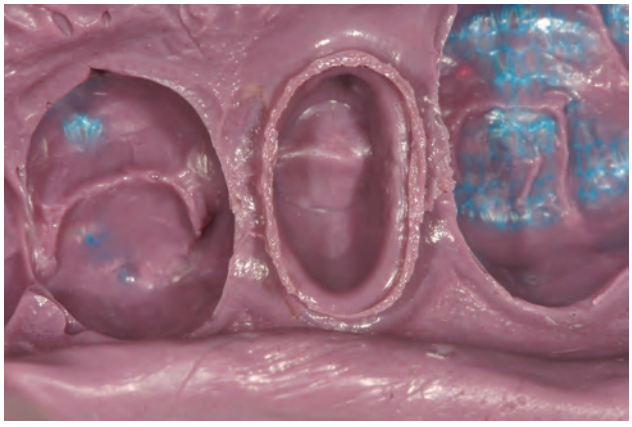


**Figure 16:** Final impression.

**Figure 17:** Bilayered lithium disilicate crown for #13.

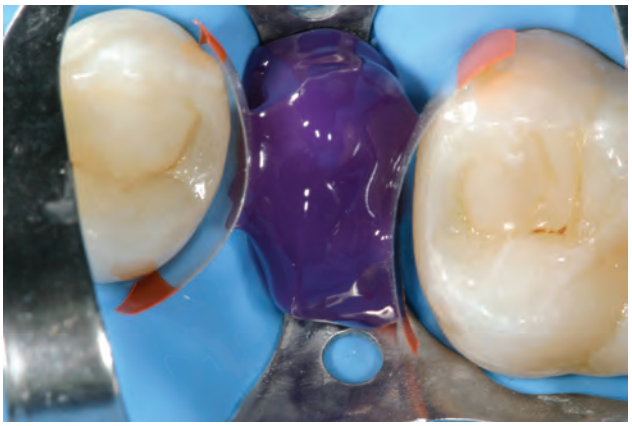


**Figure 18:** After field isolation, a three-step etch-and-rinse was performed to achieve adhesive cementation.

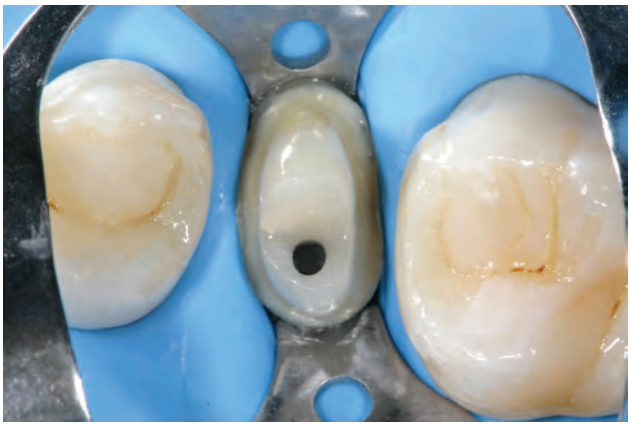


**Figure 19:** Bonding applied on the abutment tooth.

**Figure 20:** Etching of the lithium disilicate crown with 5% hydrofluoric acid for 20 seconds.

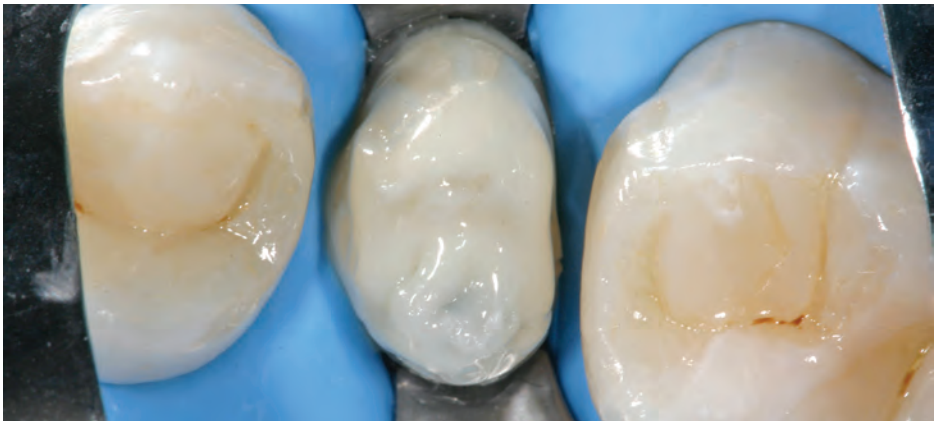


**Figure 21:** A preheated light-cured composite was placed on the abutment.

**Figure 22:** The excess composite cement was removed while the crown was seated.

**Figure 23:** Floss was used to remove excess composite cement in the proximal areas.

**Figure 24:** Light-curing of the final restoration, #13.

**Figure 25:** At the four-year follow-up, buccal view.

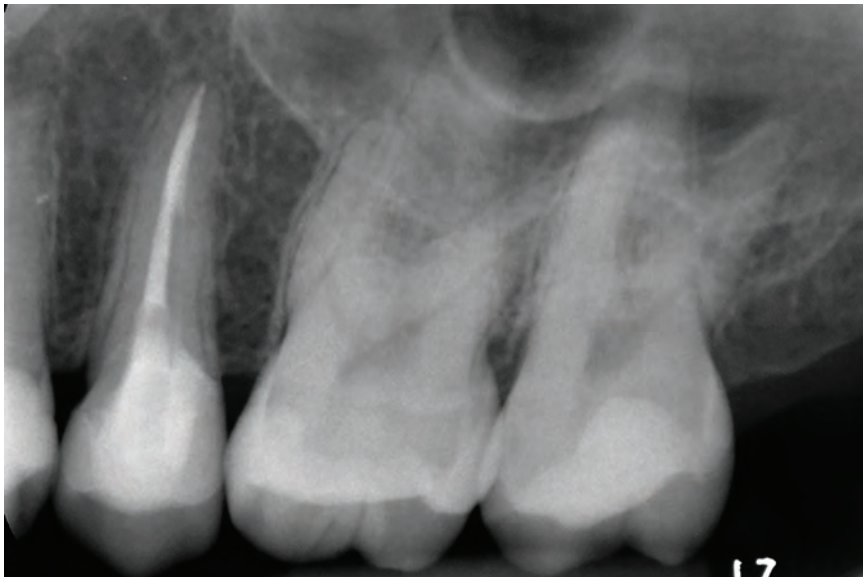


**Figure 26:** Radiograph at the four-year follow-up appointment.

## Summary

Clinicians are obligated to use their greatest efforts, knowledge, and skills to save compromised teeth, especially in young or medically compromised patients. There are numerous techniques and materials available today that allow us to treat eroded and abraded teeth in a highly conservative manner,[32-36] even with "no-prep" protocols. Furthermore, current composite materials enable us to perform very conservative restorations due to minimally invasive preparation, which means that less sound tooth structure is removed, providing a more suitable restoration from a biomechanical perspective.[37] These restorations have good esthetics and are affordable and long lasting. Repairing fractures is relatively easy without having to perform a more aggressive procedure or redo the entire restoration. Implant placement should be considered for cases with a hopeless prognosis.

> "...crown-lengthening surgery was performed to gain adequate ferrule and a gingival scallop in harmony with the adjacent teeth."

## References


1. Tomasi C, Wennström JL, Berglundh T. Longevity of teeth and implants – a systematic review. J Oral Rehabil. 2008 Jan;35 Suppl 1:23-32.

2. Holm-Pedersen P, Lang NP, Müller F. What are the longevities of teeth and oral implants? Clin Oral Implants Res. 2007 Jun;18 Suppl 3:15-9.

3. Veneziani M. Adhesive restorations in the posterior area with subgingival cervical margins: new classification and differentiated treatment. Eur J Esthet Dent. 2010 Spring;5(1):50-76.

4. Gargiulo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans. J Periodontol. 1961;32(3):261-7.

5. Paolone G, Saracinelli M, Devoto W, Putignano A. Esthetic direct restorations in endodontically treated anterior teeth. Eur J Esthet Dent. 2013 Spring;8(1):44-67.

6. Coniglio I, Magni E, Goracci C, Radovic I, Carvalho CA, Grandini S, Ferrari M. Post space cleaning using a new nickel titanium endodontic drill combined with different cleaning regimes. J Endod. 2008 Jan;34(1):83-6.

7. Goracci C, Sadek FT, Fabianelli A, Toy FR, Ferrari M. Evaluation of the adhesion of fiber posts to intraradicular dentin. Oper Dent. 2005 Sep-Oct;30(5):627-35.

8. Schwartz RS, Fransman R. Adhesive dentistry and endodontics: materials, clinical strategies and procedures for restorations of access cavities: a review. J Endod. 2005 Mar;31(3):151-65.

9. Fichera G. Di Napoli C. Re D. Ferrari P. Post-endodontic restoration with fiber posts. Indications and operating procedure. The Modern Dentist. 2005; 9:23-53.

10. Torabinejad M, Corr R, Handysides R, Shabahang S. Outcomes of nonsurgical retreatment and endodontic surgery: a systematic review. J Endod. 2009 Jul;35(7):930-7.

11. Dietschi D, Holz J. Restaurations des dents postèrieures [Restorations of posterior teeth]. Schweiz Monatsschr Zahnmed. 1990;100(11):1324-35. French, German.

12. Magne P, Dietschi D, Holz J. Esthetic restorations for posterior teeth: practical and clinical considerations. Int J Periodontics Restorative Dent. 1996 Apr;16(2):104-19.

13. Dietschi D, Spreafico R. Adhesive metal-free restorations: current concepts for the esthetic treatment of posterior teeth. Hanover Park (IL): Quintessence Pub.; 1997.

14. Edelhoff D, Sorensen JA. Tooth structure removal associated with various preparation designs for posterior teeth. Int J Periodontics Restorative Dent. 2002 Jun;22(3):241-9.

15. Carrilho MR, Geraldeli S, Tay F, de Goes MF, Carvalho RM, Tjaderhane L, Reis AF, Hebling J, Mazzoni A, Breschi L, Pashley D. In vivo preservation of the hybrid layer by chlorhexidine. J Dent Res. 2007 Jun;86(6):529-33.

16. Mazzoni A, Mannello F, Tay FR, Tonti GA, Papa S, Mazzotti G, Di Lenarda R, Pashley DH, Breschi L. Zymographic analysis and characterization of MMP-2 and -9 forms in human sound dentin. J Dent Res. 2007 May;86(5):436-40.

17. Breschi L, Mazzoni A, Ruggeri A, Cadenaro M, Di Lenarda R, De Stefano Dorigo E. Dental adhesion review: aging and stability of the bonded interface. Dent Mater. 2008 Jan;24(1):90-101.

18. Van Meerbeek B, Yoshida Y, Lambrechts P, Vanherle G, Duke ES, Eick JD, Robinson SJ. A TEM study of two water-based adhesive systems bonded to dry and wet dentin. J Dent Res. 1998 Jan;77(1):50-9.

19. Van Meerbeek B, De Munck J, Yoshida Y, Inoue S, Vargas M, Vijay P, Van Landuyt K, Lambrechts P, Vanherle G. Buonocore memorial lecture. Adhesion to enamel and dentin: current status and future challenges. Oper Dent. 2003 May-Jun;28(3):215-35.

20. Bichacho N. The centripetal build-up for composite resin restorations. Pract Periodontics Aesthet Dent. 1994 Apr;6(3):17-23.

21. Bui CH, Seldin EB, Dodson T. Types, frequencies, and risk factors for complications after third molar extraction. J Oral Maxillofac Surg. 2003 Dec;61(12):1379-89.

22. Valenti M, Valenti A. Retrospective survival analysis of 261 lithium disilicate crowns in a private general practice. Quintessence Int. 2009 Jul-Aug;40(7):573-9.

23. Pjetursson BE, Sailer I, Zwahlen M, Hämmerle CH. A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part 1: single crowns. Clin Oral Implants Res. 2007 Jun;18 Suppl 3:73-85.

24. Marquardt P, Strub JR. Survival rates of IPS Empress 2 all-ceramic crowns and fixed partial dentures: results of a 5-year prospective clinical study. Quintessence Int. 2006 Apr;37(4):253-9.

25. Fradeani M, Redemagni M. An 11-year clinical evaluation of leucite-reinforced glass-ceramic crowns: a retrospective study. Quintessence Int. 2002 Jul-Aug;33(7):503-10.

26. Guess PC, Zavanelli RA, Silva NR, Bonfante EA, Coelho PG, Thompson VP. Monolithic CAD/CAM lithium disilicate versus veneered Y-TZP crowns: comparison of failure modes and reliability after fatigue. Int J Prosthodont. 2010 Sep-Oct;23(5):434-42.

27. Gehrt M, Wolfart S, Rafai N, Reich S, Edelhoff D. Clinical results of lithium-disilicate crowns after up to 9 years of service. Clin Oral Investig. 2013 Jan;17(1):275-84.

28. Fradeani M, Barducci G, Bacherini L, Brennan M. Esthetic rehabilitation of a severely worn dentition with minimally invasive prosthetic procedures (MIPP). Int J Periodontics Restorative Dent. 2012 Apr;32(2):135-47.

29. Blatz MB, Sadan A, Kern M. Resin-ceramic bonding: a review of the literature. J Prosthet Dent. 2003 Mar;89(3):268-74.

30. Acquaviva PA, Gagliani MM, Mangani F, Adami G, Cerutti F, Cerutti A. Pre-heating influence on the conversion degree of composite luting materials. Proceedings of the 86th IADR General Session and Exhibition; 2008 Jul 1-5; Toronto. p. 7. Available from: http://heraeus-kulzer.com/media/webmedia_local/international/pdf/FINAL_Scientific_Information_IADR_2008.pdf

31. Magne P, Belser U. Bonded porcelain restorations in the anterior dentition: a biomimetic approach. Hanover Park (IL): Quintessence Pub.; 2002.

32. Dietschi D, Argente A. A comprehensive and conservative approach for the restoration of abrasion and erosion. Part 1: concepts and clinical rationale for early intervention using adhesive techniques. Eur J Esthet Dent. 2011 Spring;6(1):20-33.

33. Vailati F, Belser UC. Full-mouth adhesive rehabilitation of a severely eroded dentition: the three-step technique. Part 1. Eur J Esthet Dent. 2008 Spring;3(1):30-44.

34. Vailati F, Belser UC. Full-mouth adhesive rehabilitation of a severely eroded dentition: the three-step technique. Part 2. Eur J Esthet Dent. 2008 Summer;3(2):128-46.

35. Vailati F, Belser UC. Full-mouth adhesive rehabilitation of a severely eroded dentition: the three-step technique. Part 3. Eur J Esthet Dent. 2008 Autumn;3(3):236-57.

36. Ammannato R, Ferraris F, Marchesi G. The "index technique" in worn dentition: a new and conservative approach. Int J Esthet Dent. 2015 Spring;10(1):68-99.

37. Torbjörner A, Fransson B. Biomechanical aspects of prosthetic treatment of structurally compromised teeth. Int J Prosthodont. 2004 Mar-Apr;17(2):135-41. **jCD**

> Clinicians are obligated to use their greatest efforts, knowledge, and skills to save compromised teeth, especially in young or medically compromised patients. There are numerous techniques and materials available.

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# Diastema Closure
## with Indirect Composite Resin Restorations

### Clinical Considerations and Technique: A Case Report

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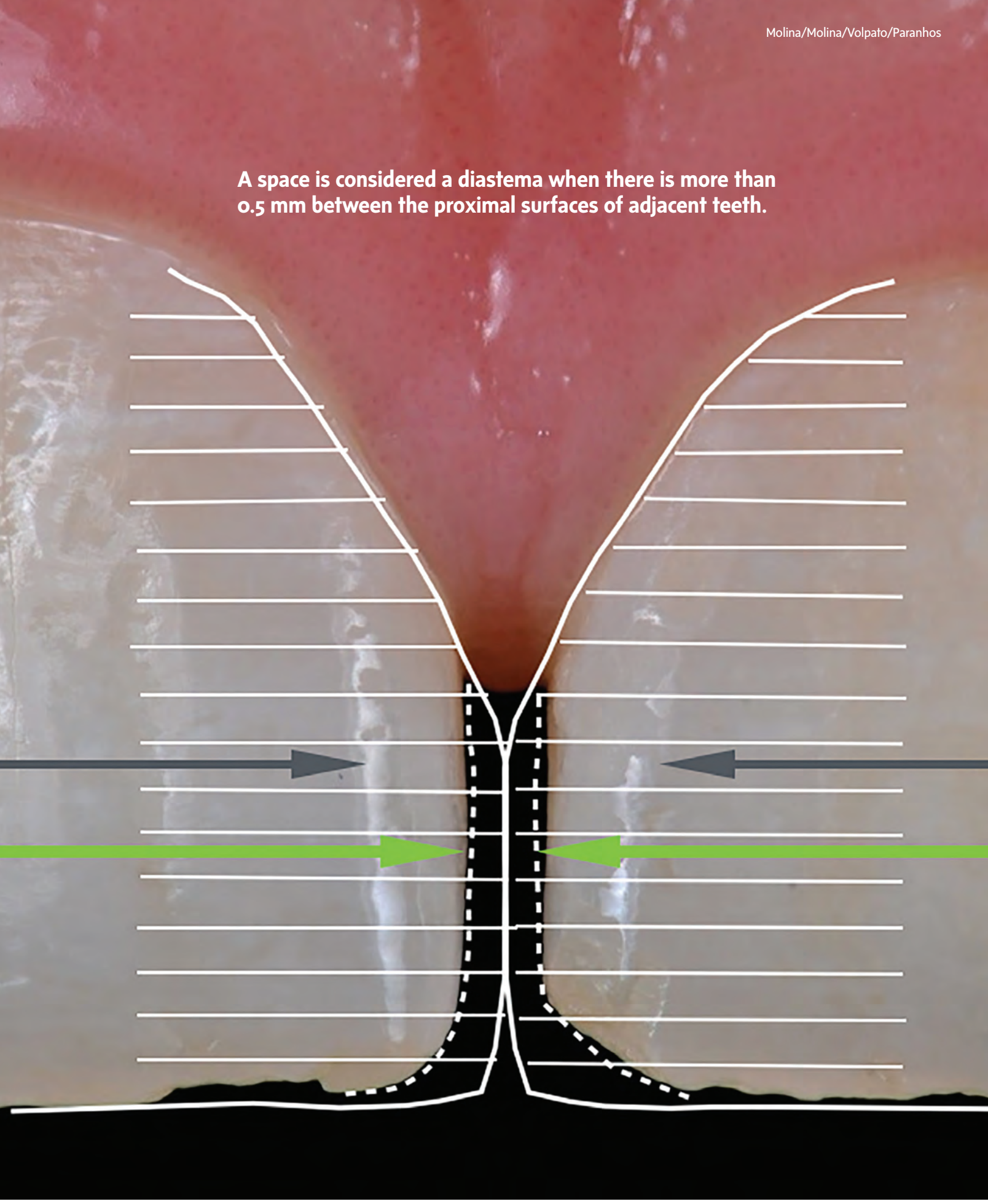
## Abstract
Thanks to advances in restorative materials and adhesive techniques, several treatment options are currently available to restore anterior teeth that are not harmonious in color, shape, or size, or that have a diastema. Orthodontic and restorative therapies are routinely employed to close diastemas. Regardless of the technique used to solve this esthetic problem, the ultimate goal is always to achieve a more pleasing and natural smile. This article reports a case in which the midline diastema was successfully closed using indirect composite resin restorations and highlights the advantages of this restorative approach.

**Key Words: diastema, interproximal contact area, black triangle, gingival contouring, esthetics**


A space is considered a diastema when there is more than 0.5 mm between the proximal surfaces of adjacent teeth.

## Introduction

The presence of a diastema between the maxillary central incisors is a major esthetic concern.[1,2] When we first look at someone's smile, our eyes tend to focus on the central incisors. Consequently, if any disharmony is present it will be easily perceived, creating a visual tension and negative impact.

A space is considered a diastema when there is more than 0.5 mm between the proximal surfaces of adjacent teeth. Diastemas are more frequent in the midline of anterior maxillary teeth and their incidence is higher in individuals of African American heritage.[3] Diastemas can be closed with orthodontics and/or restorative therapy.[4-7] The appropriate treatment should be selected based on each patient's physical and economic limitations.[5] When orthodontic movement is selected, the length of the treatment must also be taken into consideration. Upon completion of the orthodontic treatment, it often is necessary to modify the shape and size of the teeth with restorations. When restorative therapy is selected, direct composite resin usually is chosen. After performing these restorations, the crown dimensions increase but the root position remains the same.

To achieve esthetic success with direct composite restorations, it is critical to have a skillful operator.[4] Unfortunately, not all operators have the ability to perform extensive direct restorations. To overcome this problem, indirect composite resin restorations have been considered an innovative approach to close diastemas.[8] This technique is more predictable and easier to perform because the shape, color, and texture of the restorations are predefined by the dental technician. Other advantages of the indirect technique are its affordability and the fact that it can be performed by dentists who do not feel comfortable handling direct composite in esthetic areas. A disadvantage of this technique is the lack of an established protocol for adhesive cementation of these delicate restorations.[6,9]

A common problem during diastema closure is the creation of black spaces (known as *black triangles*) between the restored teeth when the gingival tissue does not follow the respective tooth contour and exposes the black background of the oral cavity.[4,10] It is especially difficult when the patient presents with wide gingival embrasures and thick gingival biotype. To prevent the formation of a black triangle between teeth when closing diastemas, it is essential to change the cervical contour and location of the interproximal contact area.[11] In this approach, provisional restorations are used to generate a light tissue compression that results in alteration of the interdental papilla contour.[4] Care should be taken to avoid permanent tissue ischemia and/or trauma resulting from this tissue compression. This article presents a case in which the diastema closure was accomplished using indirect composite resin restorations and gingival tissue recontouring.

## Case Report

### Patient Evaluation and Findings

A 27-year-old male was unhappy with the appearance of his smile **(Figs 1a-1c)**. Clinical examination revealed a moderate midline diastema (approximately 2 mm) between the maxillary central incisors. A significant discrepancy in size between the maxillary central incisors was also observed **(Figs 2a & 2b)**. Due to the patient's age and dental condition, the treatment recommendation was to close the midline diastema using indirect composites. This treatment option would also make it possible to increase the length of the central incisors. To prevent the formation of a black triangle between the anterior teeth after diastema closure, a nonsurgical gingival recontouring of the interdental papilla was indicated. The location of the interproximal contact area after tissue conditioning was also considered.

Despite the diastema's moderate size, the length/width analysis of the maxillary central incisors revealed an unfavorable proportion. Therefore, diastema closure using direct composite resin restorations was not indicated; the resin increment itself would lead to excessive width of the central incisors, resulting in a disparity according to the concept of golden proportion.[12] The reduced size of the lateral incisors would contribute further to the disparity. To overcome this issue, an optical illusion resource was used to virtually reduce the width of the central incisors. The labial embrasure of the central incisors was enlarged to preserve the natural width of the flat surface. When the facial embrasures are opened, it is possible to increase the area of light deflection (shadows) and to virtually reduce the width of the smooth surface (area of light reflection) **(Figs 3a & 3b)**.

After the clinical examination, a preoperative impression of the upper arch was taken using vinyl polysiloxane (VPS) (Express, 3M ESPE; St. Paul, MN) and poured with Type IV dental die stone (GC Fujirock EP White, GC America; Alsip, IL). A diagnostic wax-up and silicone index were made. The proposed treatment was presented to the patient, who was able to visualize the esthetic result via a mock-up (Telio CS, Ivoclar Vivadent; Amherst, NY) **(Figs 4a-4e)**.


**Figures 1a-1c:** Preoperative; notice how the diastema between the central incisors affects the patient's smile.

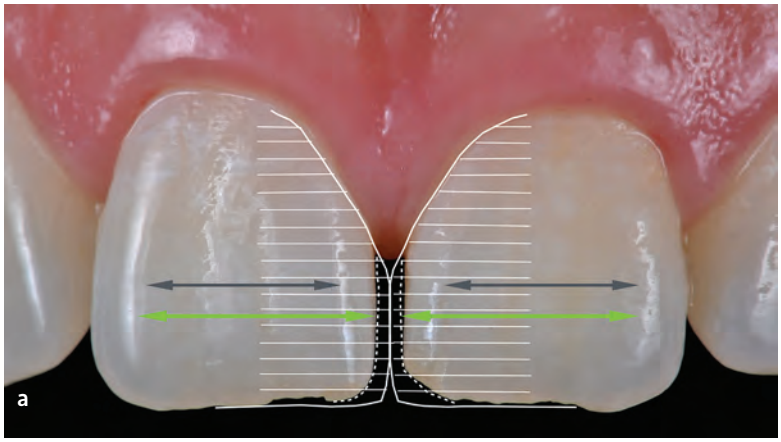



**Figure 2a:** Preoperative frontal view. Illustration simulating the restorative treatment of the maxillary central incisors (white lines). Observe that the width of the flat surface (green arrows) is larger than the original one (black arrows). This restorative strategy would result in excessively wide central incisors.

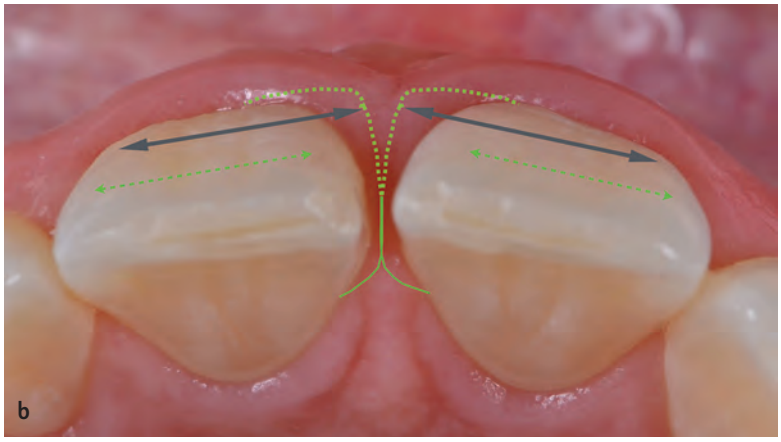
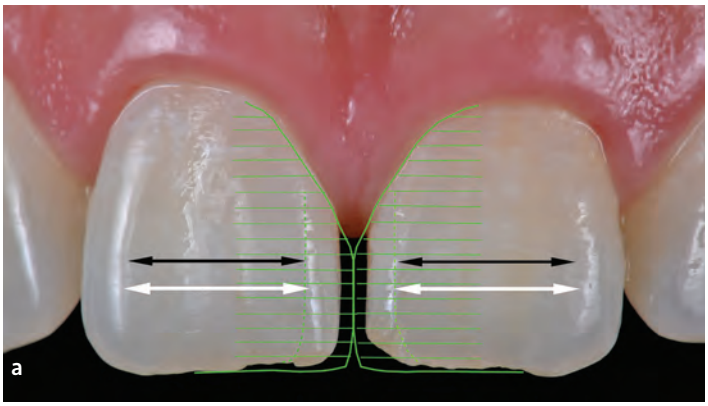



**Figure 2b:** Preoperative occlusal view.




**Figures 3a:** Preoperative frontal view. Observe that the opening of the labial embrasure and the lingual displacement of the contact area provide a flat surface (black arrows) with dimensions similar to the original one (white arrows).

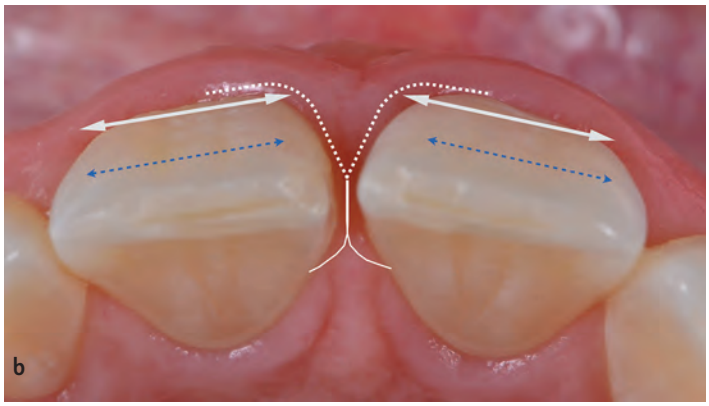
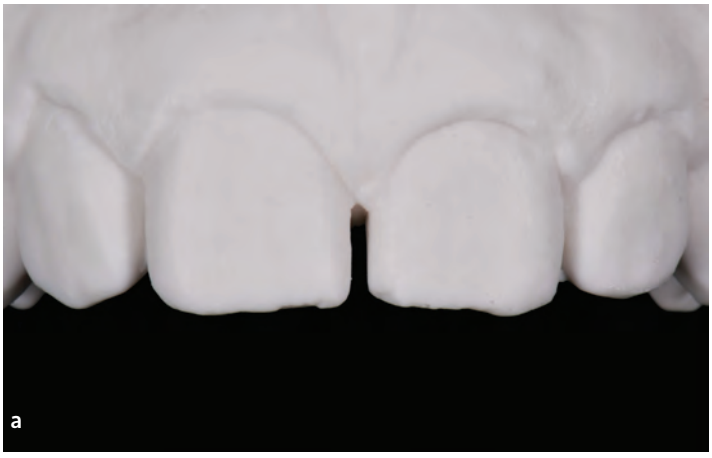



**Figure 3b:** Preoperative occlusal view.





**Figures 4a & 4b:** Diagnostic additive wax-up.



**Figures 4c & 4d:** Mock-up anticipating the design of the final restorations.

**To achieve esthetic success with direct composite restorations, it is critical to have a skillful operator.**

### Treatment

After the patient accepted the treatment, minimally invasive preparations were accomplished with Sof-Lex discs (3M ESPE) to regularize the incisal edges. A one-mix impression technique was used after retracting the gingival tissue with a retraction cord (Ultrapack 000, Ultradent Products; South Jordan, UT) to better visualize the cervical area **(Figs 5a & 5b)**. The margin of the preparation was equigingival and the retraction cord was placed only to deflect the gingival tissue. This procedure helps to establish the limits of the restoration on the master cast. Shade selection was done using composite resin on the hydrated tooth **(Fig 6)**.

The indirect composite resin restorations were fabricated on the stone model **(Fig 7)** using a silicone index to guide the first layer of composite (Vitalescence composite resin, Ultradent) building the palatal surface (Enamel Pearl Frost). After building the palatal scaffold, a layer of composite (Dentin A1) was used to build up the histoanatomical contour of the natural dentin. Orange stain (Kolor Plus, Kerr Dental; Orange County, CA) was placed on the mesial areas to give some depth. A transparent composite layer (Trans Amber) was then placed to simulate the cementoenamel junction (CEJ). The facial anatomy was completed with a mixture of enamel and transparent shades of composite resin (Pearl Frost and Pearl Neutral) with a few white spots (White stain, Kolor Plus) **(Figs 8a-8f)**. The final restorations were finished and adjusted on the master cast using Sof-Lex discs in three different directions/views. Polishing was done with feltrum discs **(Figs 9a-9d)**.

Bonding procedures were performed according to the classic adhesive protocol.[13] The indirect composite restorations were cleaned, the silane was heat-dried, and adhesive resin was applied (Optibond FL; Kerr) **(Figs 10-11c)**. Teeth #8 and #9 were polished (Enamelize polishing paste; Cosmedent; Chicago, IL) and polytetrafluoroethylene (PTFE) tape was inserted for gingival retraction. **(Figs 12a & 12b)**. The teeth were etched with 37% phosphoric acid for 15 to 30 seconds and rinsed with water followed by the application of adhesive (Optibond FL) **(Figs 12c & 12d)**. The indirect composite resin restorations were bonded with resin luting cement (Variolink Transparent, Ivoclar Vivadent) and light-polymerized for 20 seconds per surface. Finishing was accomplished with extra-fine burs at low speed, aluminum oxide discs (Diamond Pro, FGM Dental Products; Joinville, Brazil), polishing strips (Epitex, GC America), and polishing paste (Enamelize) **(Figs 13a-15)**. The final restored teeth are shown in **Figures 16a through 17**.


**Figure 4e:** Mock-up ready for try-in.


**Figure 5a:** Minimally invasive preparations.

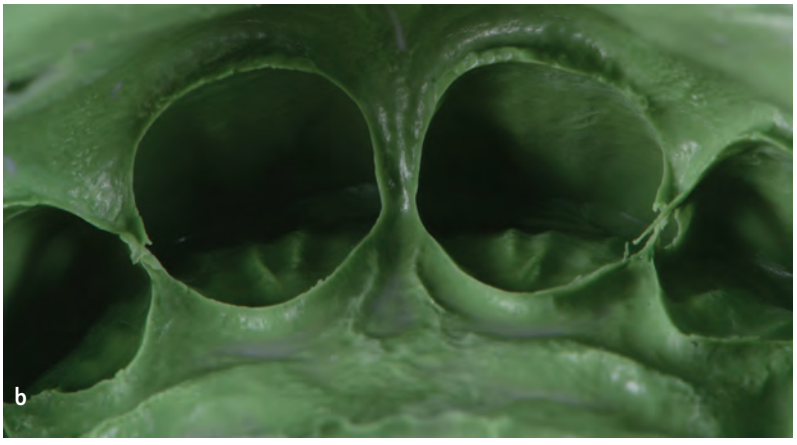



**Figure 5b:** A single-cord technique was used for the final impression.

**Figure 6:** Shade selection using composite resin.

**Figure 7:** Artistic image of the indirect composite resin restorations' fabrication.


**Figure 8a:** The silicone index was positioned and composite resin was placed to build the palatal surface.



**Figures 8b & 8c:** Composite resin was placed on the interproximal area.


**Figure 8d:** Orange stain applied to simulate the CEJ.


**Figure 8e:** White stain and final layer of composite.


**Figure 8f:** Frontal view of the maxillary central incisor after building the facial enamel.

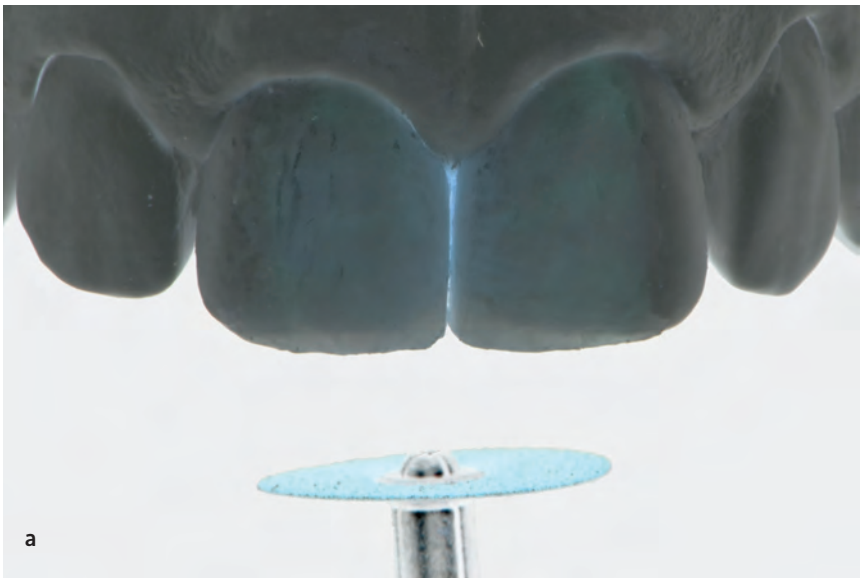


**Figure 9a:** Finishing of the restorations; Sof-Lex discs were used in three directions/views for symmetry. Incisal edge through incisal view.

**Figure 9b:** Transitional line angles through incisal view.

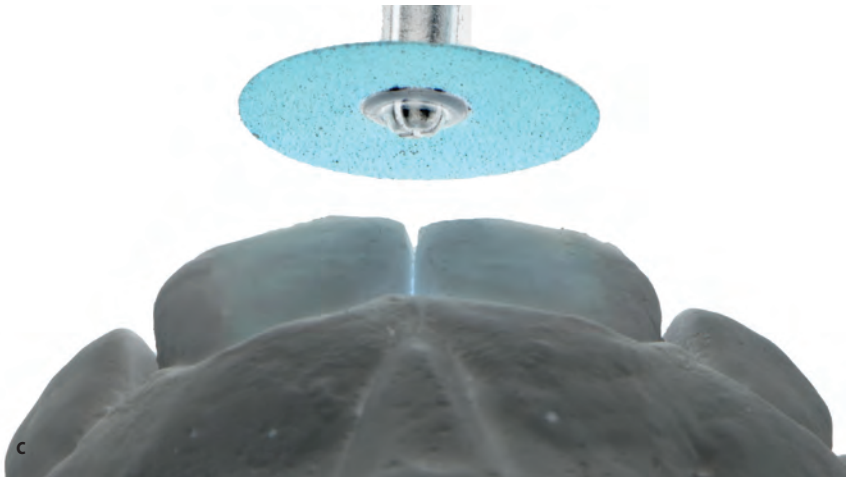


**Figure 9c:** Cervical to incisal view to adjust facial planes.

**Figure 9d:** Final polish with feltrum discs.

a

**Figure 10a:** Cleaning the restoration with 37% phosphoric acid.

b

**Figure 10b:** Water-rinsing.

a

**Figure 11a:** Silane application and heat-drying for 60 seconds.

b

**Figure 11b:** Application of bonding agent.

c

**Figure 11c:** Resin luting cement.


**Figure 12a:** Prophylaxis of enamel surfaces with pumice slurry.


**Figure 12b:** Insertion of PTFE tape for gingival retraction.

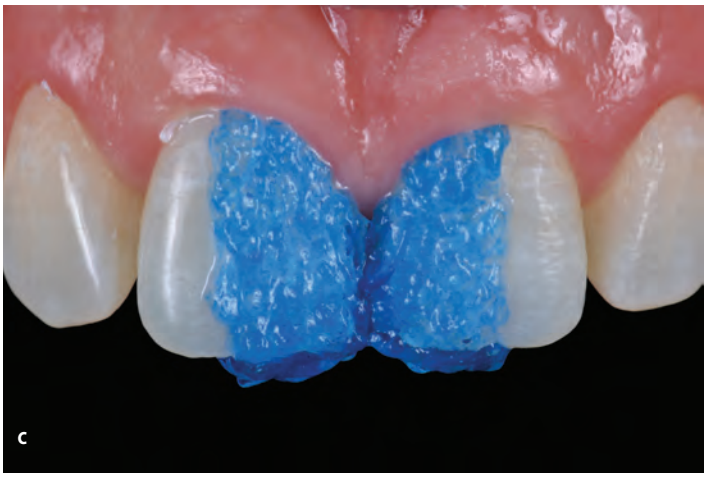



**Figure 12c:** Enamel etching.

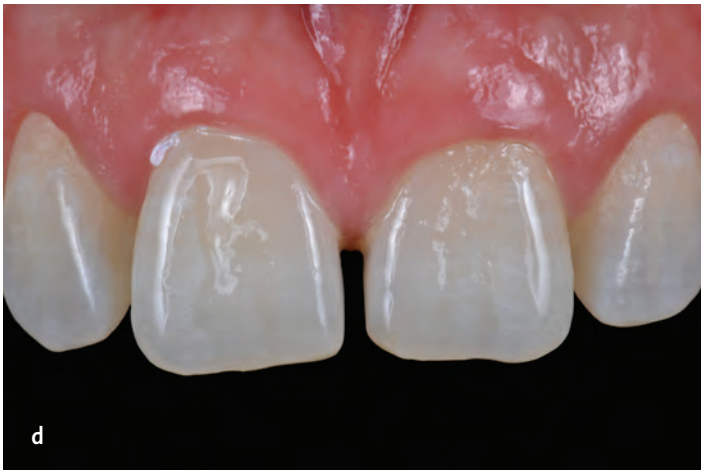



**Figure 12d:** Application of bonding agent.

**Among all therapies indicated for diastema closure, direct composite resin restoration has generally been the treatment of choice.**


**Figure 13a:** Bonding with resin luting cement.

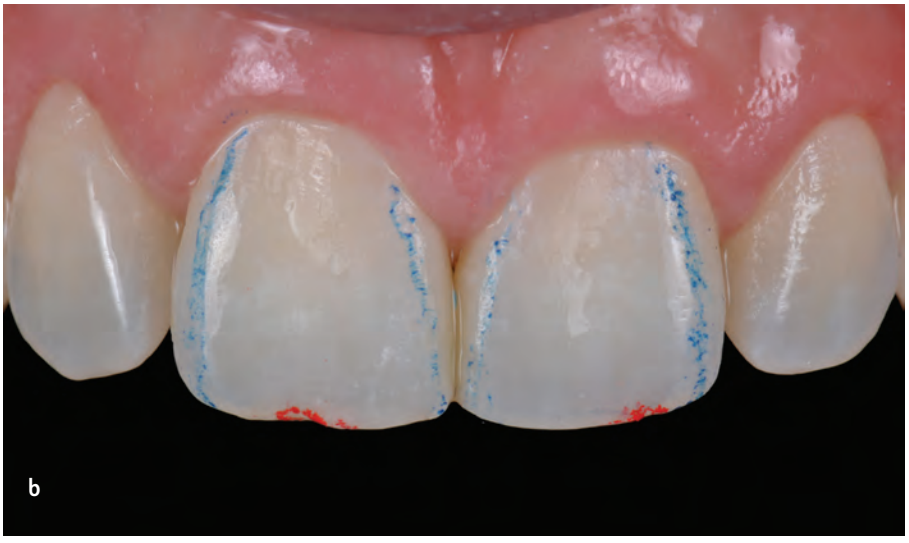



**Figure 13b:** Delimitation of transitional line angles (light reflection areas) that influence the width of the teeth.

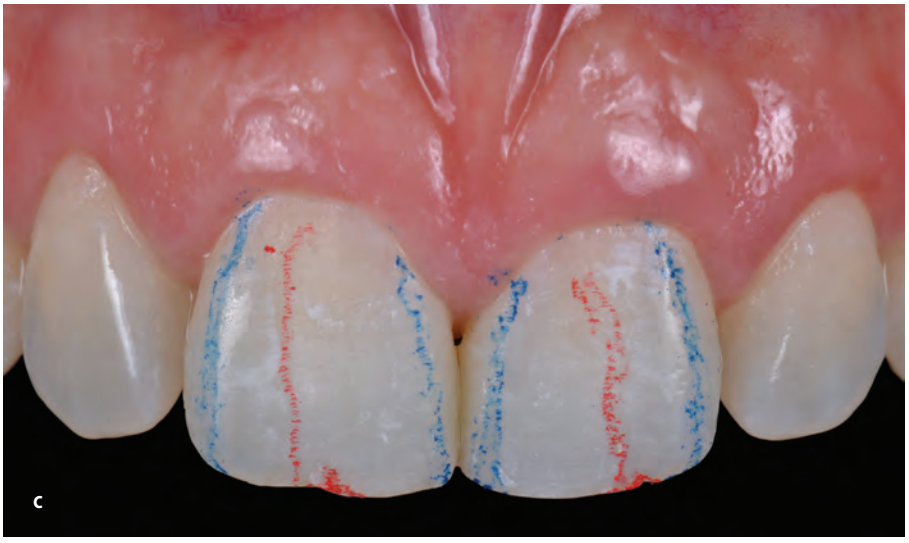



**Figure 13c:** Interface between teeth and restorations.


**Figure 14a:** Finishing.

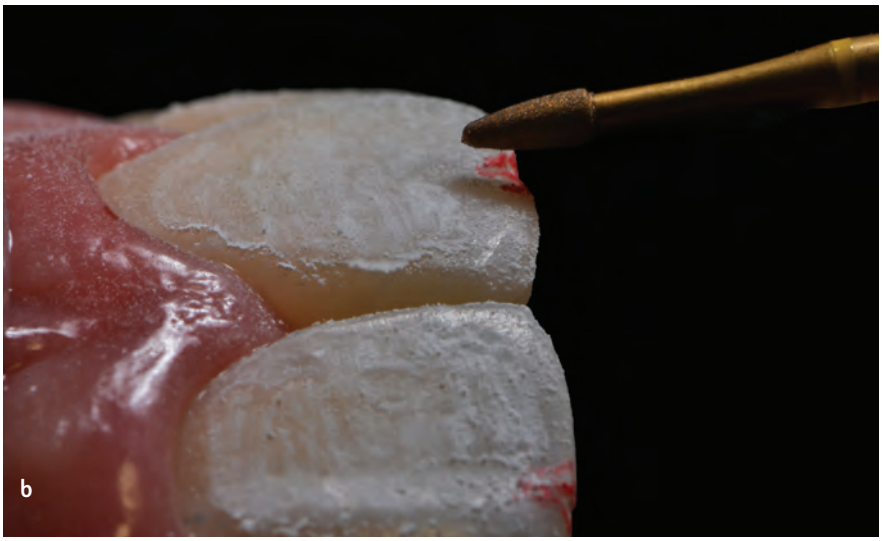
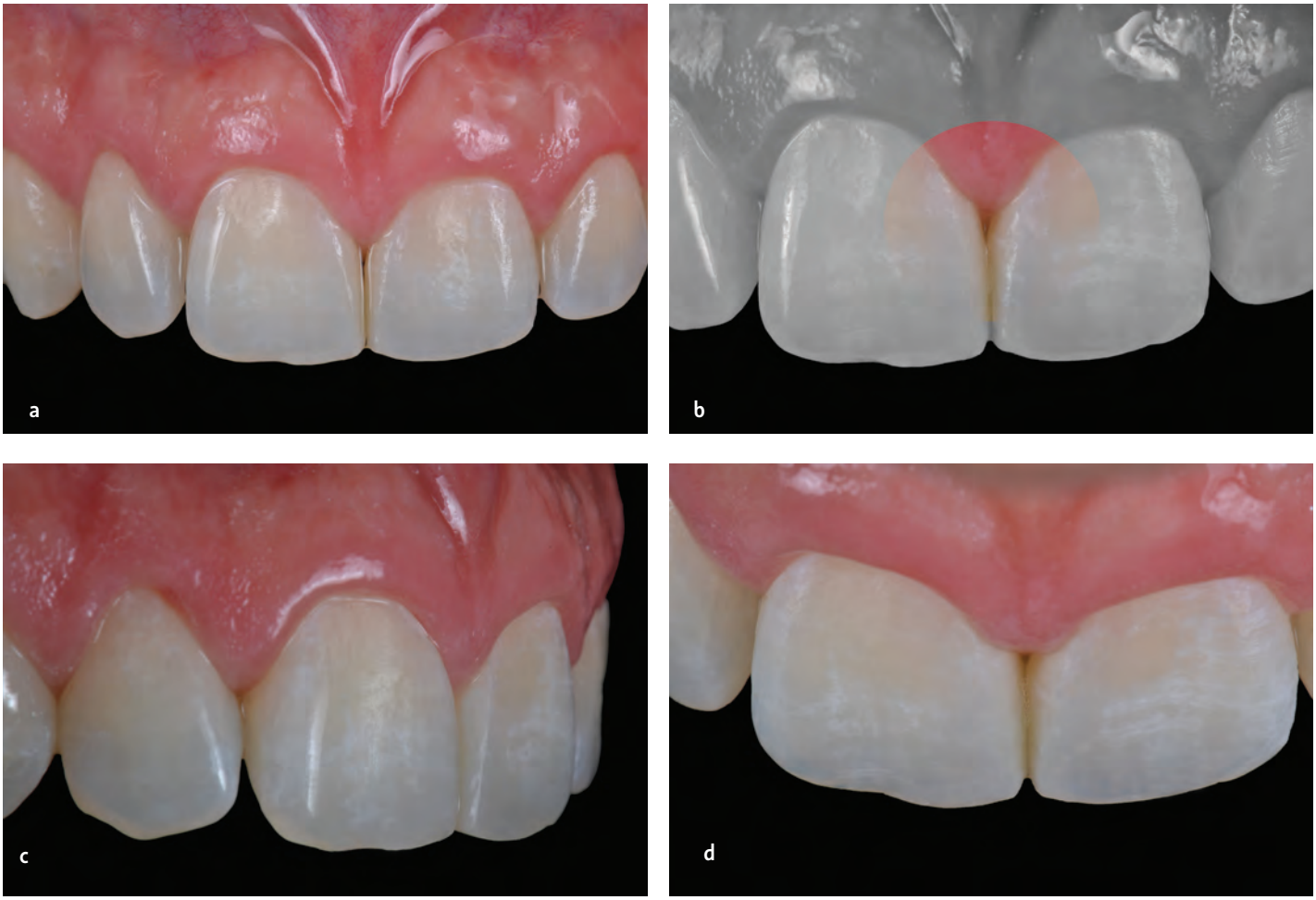



**Figure 14b:** Surface texture.

**Figure 15:** Polishing.




**Figures 16a-16d:** Images after delivery of the indirect restorations. Note the esthetic integration between hard and soft tissues.

**To prevent the formation of a black triangle between teeth when closing diastemas, it is essential to change the cervical contour and location of the interproximal contact area.**

**Figure 17:** Final result.

## Discussion

Diastemas are spaces between natural teeth that can be caused by hereditary or acquired factors. Discrepancies in the bone base; abnormalities in size, shape, and tooth position; rotations, dental agenesis, and supernumerary teeth not erupted; excessive horizontal trespass; palatal insertion of the upper frenulum; lingual frenulum with low insertion; and macroglossia are some hereditary factors that may lead to the emergence of diastema.[2,3] Significant acquired causes include periodontal disease and tooth loss; and parafunctional habits such as tongue thrusting, nail biting, and inserting objects between the teeth.[3]

Among all therapies indicated for diastema closure, direct composite resin restoration has generally been the treatment of choice. When correctly indicated and planned, the direct restoration can be performed in one clinical session, with minimal or no preparation of the tooth structure.[4-6,9] These restorations are very conservative, fully reversible, and can be easily repaired when necessary.[14]

Because diastema closure is usually indicated for anterior maxillary teeth, it is essential that the restorations be esthetically excellent. However, not all clinicians are able to reproduce color, translucency, shape, and texture of anterior teeth using direct composite in esthetic areas. In such instances, the use of indirect composite resin restorations can facilitate the achievement of esthetic excellence, ensuring the predictability of the final restoration.

Even though closing a diastema with composite resin seems to be a simple and affordable technique to give the patient a natural and pleasant smile, it is not always possible to eliminate the black triangles. Tissue remodeling prior to the restorations has been indicated[4] to avoid these black spaces; only then can harmony between hard and soft tissue be achieved. It is important to remember that when the distance between the proximal contact area and the alveolar bone crest is 5.0 mm or less, interdental papilla is present.[11] Such distance was deliberately created in this clinical case.

## Summary

Midline diastema closure with indirect composite resin restorations can be a useful treatment approach, especially when the clinician is not comfortable performing direct composite restorations in the esthetic area. To achieve the best esthetic outcome, it is important for clinicians not only to select the appropriate materials and adhesive protocols but also to understand the process of integration between hard and soft tissues and their role in the restoration's esthetic success.

### References


1. Kirtley GE. Diastema closure: a restorative design and treatment challenge. Dent Today. 2015 Sep;34(9):122-5.

2. Fasanaro TS. Closing anterior diastemas with cosmetic bonding. J Am Dent Assoc. 1986 Oct;113(4):592-5.

3. Oesterle LJ, Shellhart WC. Maxillary midline diastemas: a look at the causes. J Am Dent Assoc. 1999 Jan;130(1):85-94.

4. De Araújo EM Jr, Fortkamp S, Baratieri LN. Closure of diastema and gingival recontouring using direct adhesive restorations: a case report. J Esthet Restor Dent. 2009;21(4):229-40.

5. Hwang SK, Ha JH, Jin MU, Kim SK, Kim YK. Diastema closure using direct bonding restorations combined with orthodontic treatment: a case report. Restor Dent Endod. 2012 Aug;37(3):165-9.

6. Frese C, Schiller P, Staehle HJ, Wolff D. Recontouring teeth and closing diastemas with direct composite buildups: a 5-year follow-up. J Dent. 2013 Nov;41(11):979-85.

7. Calamia V, Pantzis A. Simple case treatment planning: diastema closure. Dent Clin North Am. 2015 Jul;59(3):655-64.

8. Lacy AM. Application of composite resin for single-appointment anterior and posterior diastema closure. Pract Periodontics Aesthet Dent. 1998 Apr;10(3):279-86.

9. Prabhu R, Bhaskaran S, Geetha Prabhu KR, Eswaran MA, Phanikrishna G, Deepthi B. Clinical evaluation of direct of composite restoration done for midline diastema closure—long-term study. J Pharm Bioallied Sci. 2015 Aug;7(Suppl 2):S559-62. doi: 10.4103/0975-7406.163539.

10. Oquendo A, Bra L, David S. Diastema: correction of excessive spaces in the esthetic zone. Dent Clin North Am. 2011 Apr;55(2):265-81.

11. Tarnow DP, Magner AW, Fletcher P. The effect of the distance from the contact point to the crest of bone on the presence or absence of the interproximal dental papilla. J Periodontol. 1992 Dec;63(12):995-6.

12. Javaheri DS, Shahnavaz S. Utilizing the concept of the golden proportion. Dent Today. 2002 Jun;21(6):96-101.

13. Fabianelli A, Pollington S, Papacchini F, Goracci C, Cantoro A, Ferrari M, van Noort R. The effect of different surface treatments on bond strength between leucite reinforced feldspathic ceramic and composite resin. J Dent. 2010 Jan;38(1):39-43.

14 Jepson HJ, Nohl FS, Carter NE, Gillgrass TJ, Meechan JG, Hobson RS, Nunn JH. The interdisciplinary management of hypodontia: restorative dentistry. Br Dent J. 2003 Mar 22;194(6):299-304. **jCD**

**Midline diastema closure with indirect composite resin restorations can be a useful treatment approach, especially when the clinician is not comfortable performing direct composite restorations in the esthetic area.**

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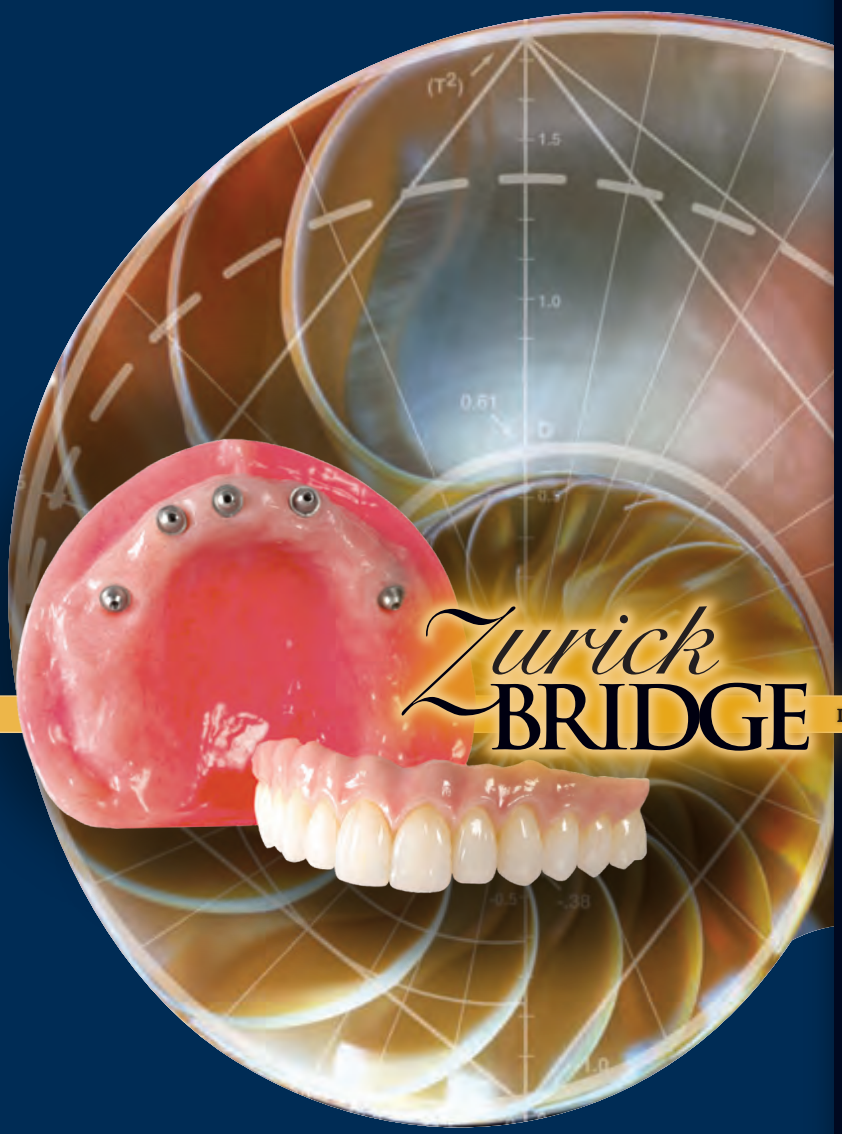

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# A Cost-Effective Solution for a Provisional After an Extraction in the Anterior Maxilla

## A Conservative Step-by-Step Approach for Fabricating an Esthetic Fiber-Reinforced Resin-Bonded Bridge

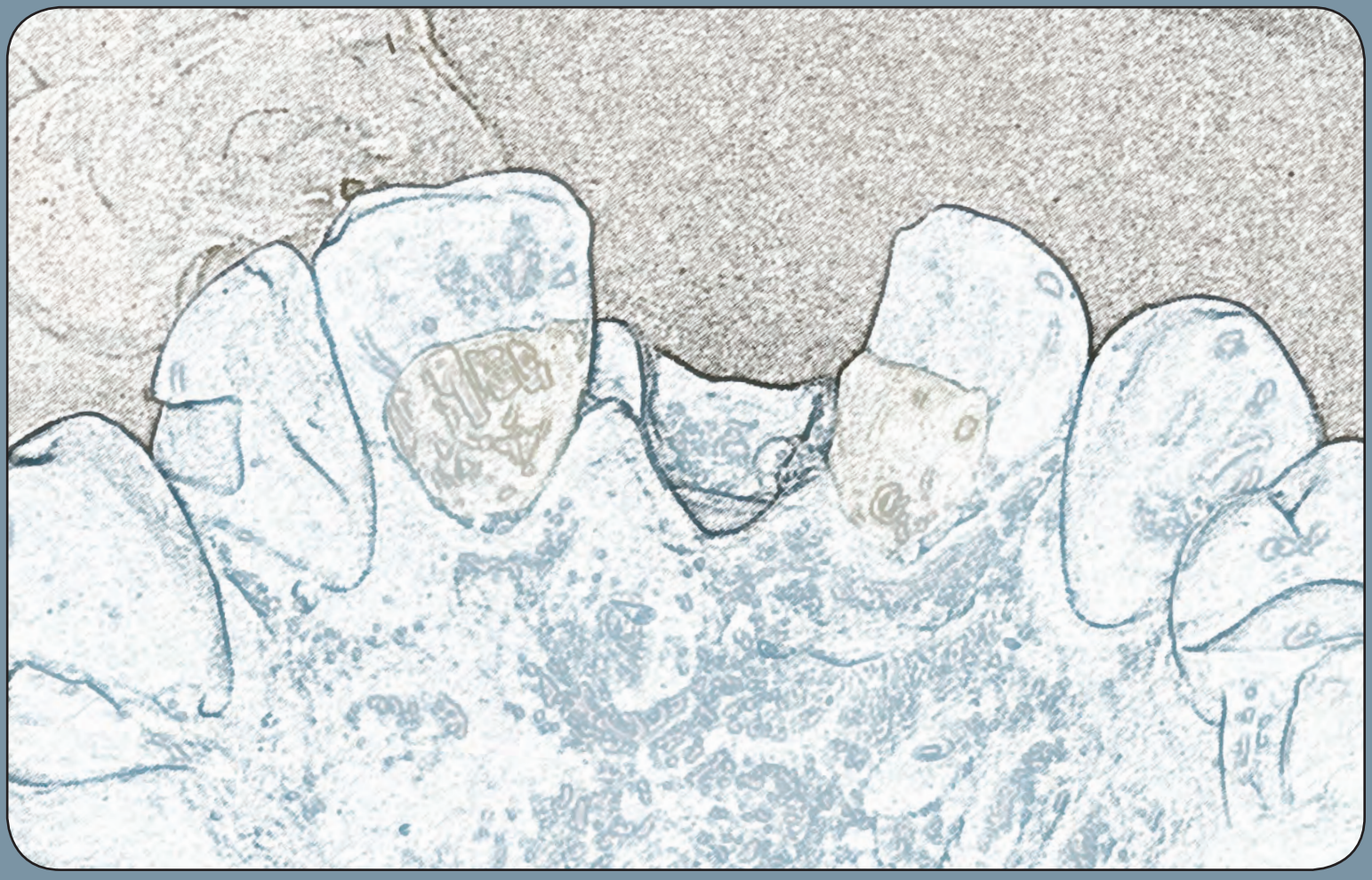
Robert C. Margeas, DDS

### Abstract

A number of treatment options, ranging from Maryland bridges, to fixed partial dentures, to implants, are available for the replacement of a missing anterior tooth. Reinforcing composite resin with glass fibers significantly improves the material's mechanical properties. These types of restorations can offer a good alternative for the young patient who is still growing, or the adult patient who cannot have an immediate implant placed. This article presents the case of a patient who had a root fracture and no facial plate, thus prohibiting implant placement at the time of extraction.

**Key Words: conservative, fiber-reinforced composite, silicone, cost-effective**

Immediate replacement in the esthetic zone can be a challenge, especially when the adjacent teeth have good esthetics and are caries-free.



## Introduction

Losing an anterior tooth is a traumatic experience. Most patients cannot go about their daily lives with a missing anterior tooth due to the unacceptable esthetics and wish to have the tooth replaced immediately. However, immediate replacement in the esthetic zone can be a challenge, especially when the adjacent teeth have good esthetics and are caries-free. Removable appliances are seldom acceptable, either psychologically or functionally, and can cause undue pressure on the papilla and flattening of the gingival architecture. Crowning the adjacent intact teeth is too invasive and is considered radical treatment by many practitioners.[1]

### Fiber-Reinforced Composite

Fiber-reinforced composite (FRC) fixed prostheses are an excellent alternative to traditional treatment. Studies have shown that they provide restorations with a considerable increase in strength.[2-4] FRC comprises two components: the resin matrix and the fiber. Some materials currently available contain only the fibers. Polyethylene and glass fibers are the materials most frequently used for fixed partial bridges.[5] Fiber direction and pretreatment of the material are important factors in increasing the FRC's performance.[5] Glass fibers are treated with a silane-coupling agent to allow dental resins to chemically bond to the glass fiber strands. To improve the bonding of resin to polyethylene fibers, the fibers are treated chemically with thorough surface etching. Without this treatment, there would be no surface wetting of resin and bonding between the two substrates.[6] Fibers are either unidirectional or multidirectional. Multiple-fiber orientations can be achieved in one of two ways: by placing unidirectional fibers in multiple directions or by using a braided or woven fabric.[7] It is important to have adequate adhesion between the fibers and the composite.[8] Without adequate adhesion, the fiber acts as an inclusion in the resin matrix, which actually weakens the composite.[9,10]

In dental applications the fibers can be limited, due to the fact that they should be covered with a layer of unfilled resin or with a layer of filled composite.[11] To optimize the mechanical properties for dental restorations, the fibers' position and orientation should maximize the stress transfer from matrix to fibers.[8]

FRC offers an excellent replacement for missing teeth. This material can be used with composite pontics or with the patient's natural extracted tooth.[12] Acrylic resin denture teeth with or without lingual wire reinforcements have been described in the literature[13] but may be contraindicated with tight occlusion. To use the technique effectively without preparing the adjacent teeth, an adequate amount of overjet is necessary due to the minimal thickness of the wings.

It is important to have adequate adhesion between the fibers and the composite.

These types of restorations are ideal when the patient desires an immediate, minimally invasive approach and cost is an issue. All types of resin-bonded bridges provide an effective short- to medium-term option, with all-ceramic performing least well and having the least favorable mode of failure.[14] Other options include zirconia-type Maryland bridges, but these restorations will entail a laboratory fee. The following case report describes the steps necessary to fabricate a fiber-reinforced resin-retained bridge.

## Case Report

### Patient Complaint and Findings

A 57-year-old man presented with a swollen and loose left central incisor **(Figs 1 & 2)**. A radiograph revealed a root fracture **(Fig 3)**. Upon probing and bone sounding, it was determined that the patient did not have a facial plate and had a low crestal bone; this made immediate implant placement impossible. There also was exudate upon probing. The patient was placed on antibiotics as the tooth could not be removed for five days due to scheduling difficulties.

### Treatment Description

Once the tooth was extracted the swelling and facial plate collapse could be clearly seen **(Figs 4 & 5)**. An alginate impression was made of the extraction socket and adjacent teeth **(Fig 6)**. The alginate was injected with a silicone material (Quick-Die, Bisco; Shaumburg, IL) **(Fig 7)** to create a study model that would be used to fabricate the resin retained bridge. The silicone model is not only flexible, but it also prevents the composite material from sticking to it, making removal of the bridge from the model very easy. Composite resin was then added to the lingual of the adjacent teeth to fabricate wings **(Fig 8)**. While the material was soft, composite fiber (Dentapreg, Cosmedent; Chicago, IL) **(Fig 9)** was measured and cut to fit the area, embedded into the composite wings **(Fig 10)**, and allowed to curve labially **(Fig 11)**. This type of design allows for the highest stress reduction ratio under all loading conditions, compared to it being curved lingually or in the center of the pontic area.[15]

**Figure 1:** Preoperative close-up image of failing left central incisor.

**Figure 2:** Preoperative smile.

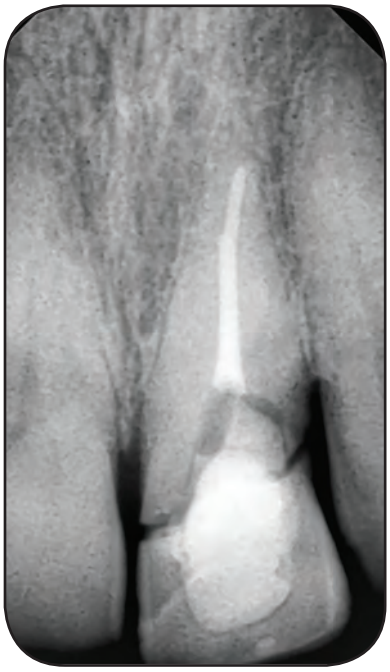


**Figure 3:** Radiograph.

Upon probing and bone sounding, it was determined that the patient did not have a facial plate and had a low crestal bone; this made immediate implant placement impossible.

**Figure 4:** Extraction socket.

**Figure 5:** Extraction socket, incisal view.

**Figure 6:** Alginate impression.

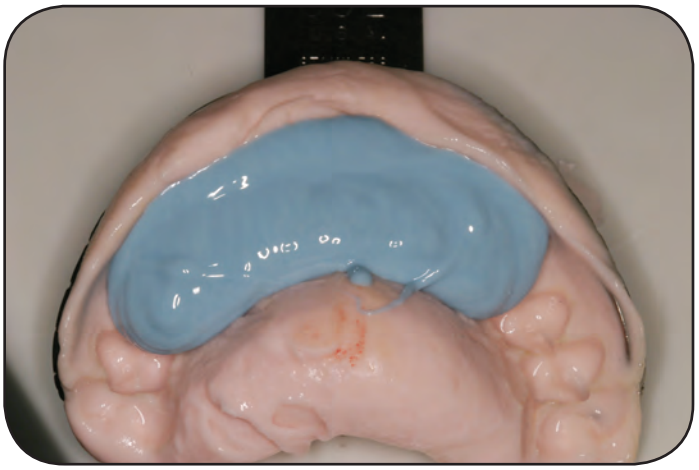


**Figure 7:** Silicone material injected into alginate.

**Figure 8:** Composite resin wings added to model.

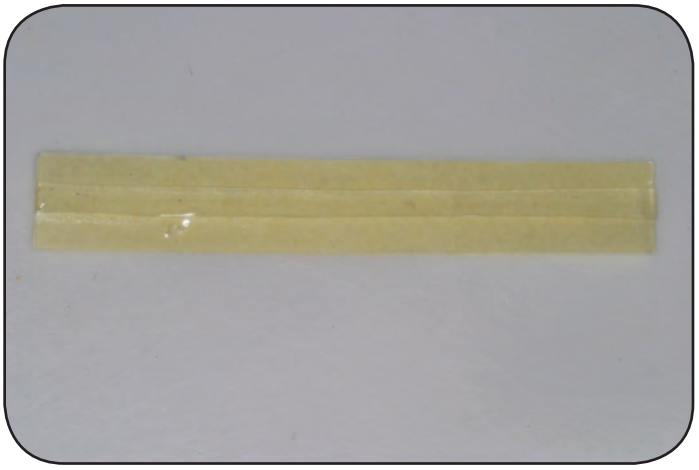


**Figure 9:** Composite fiber material.

**Figure 10:** Material embedded into composite wings.

**Figure 11:** Incisal view of framework design.

Core buildup material (Cosmecore, Cosmedent) was injected into the extraction site on the model to form an ovate pontic **(Figs 12 & 13)**. The rest of the pontic area was filled in with composite resin to form the framework **(Figs 14 & 15)**. This was kept slightly lingual so a free-hand veneer could be created in the mouth. The final framework design is shown in **Figure 16**.

Once the framework was fabricated it was bonded in the mouth. The teeth were etched and a bonding adhesive was placed on the teeth **(Fig 17)**. Bonding adhesive and a light-cured resin cement were added to the wings, placed in the patient's mouth, and light-cured **(Fig 18)**. The lingual view shows that there was still enough room to build the facial veneer **(Fig 19)**. The veneer was then fabricated freehand over the framework. The final lingual view can be seen in **Figure 20**, and the final restoration and smile are shown in **Figures 21 and 22**.

## Summary

The described technique is a conservative, esthetic, and cost-effective way to replace a missing tooth. The fiber-reinforced composite fixed partial denture can be used as a long-term provisional in patients who are too young for an implant or conventional fixed restoration, or as a short-term solution for a missing tooth. The materials seem to be improving and becoming easier to use, but more research is needed to draw further conclusions about using this approach.

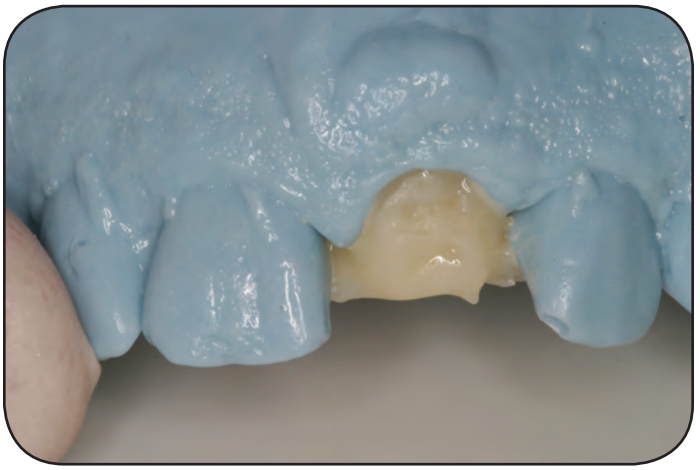


**Figure 12:** Pontic buildup.

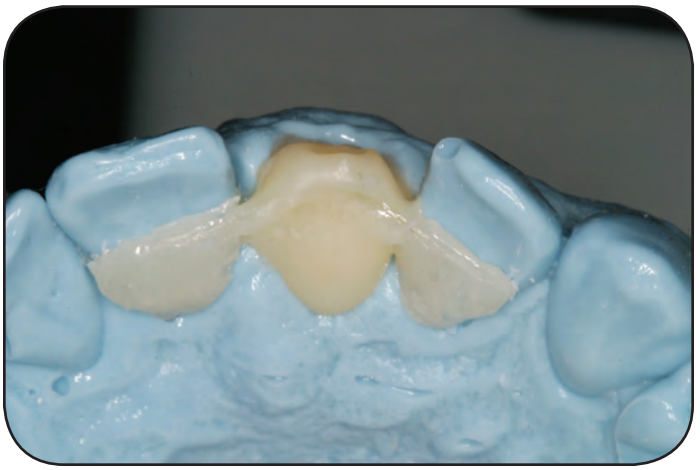


**Figure 13:** Lingual view of framework buildup.

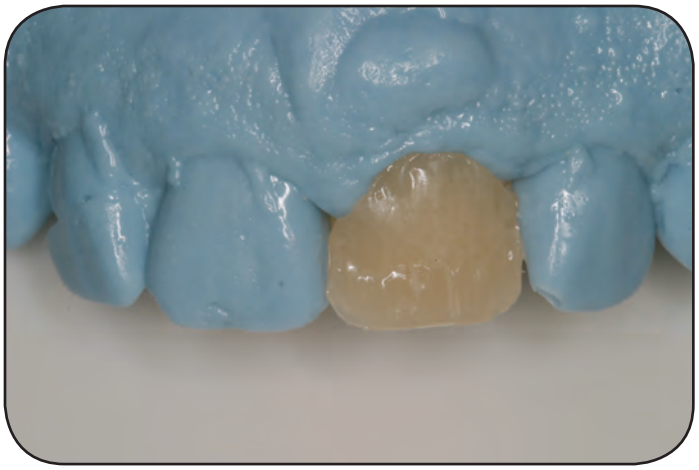


**Figure 14:** Framework design.

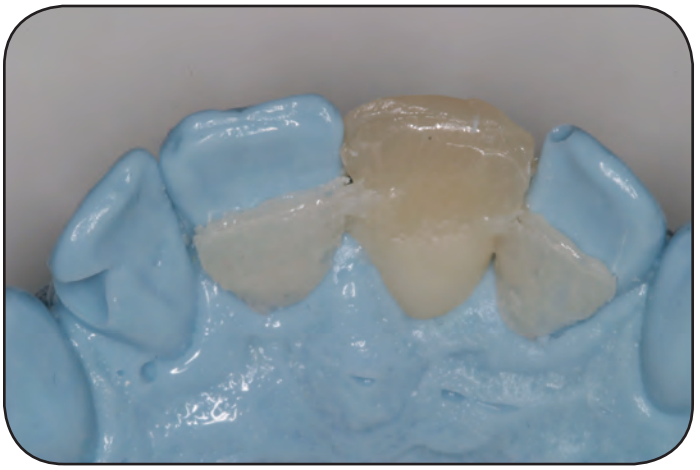


**Figure 15:** Lingual view.

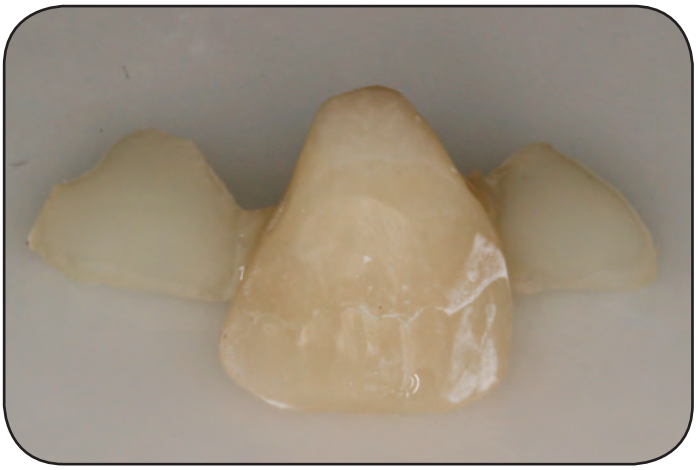


**Figure 16:** Ovate pontic and framework.

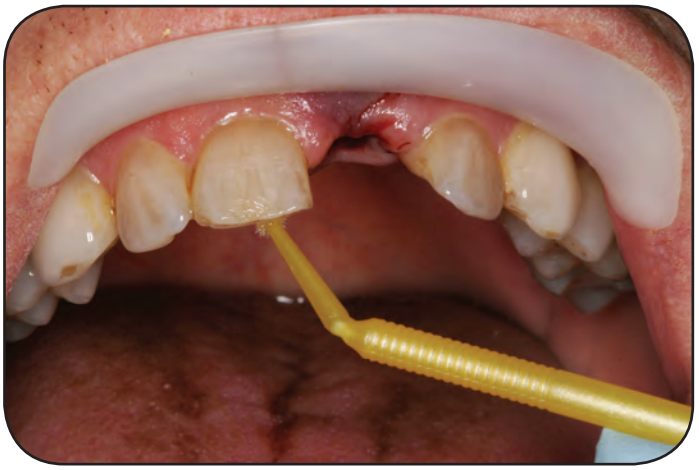


**Figure 17:** Adhesive placed.

**Figure 18:** Framework bonded into place.

**Figure 19:** Lingual view.

**Figure 20:** Day of surgery, lingual view.

**Figure 21:** Day of surgery, final restoration.

**Figure 22:** Day of surgery, final smile.

## References


1. Danan M, Degrange M, Vaideam T, Brion M. Immediate replacement of a maxillary central incisor associated with severe facial bone loss: use of Bio-Oss Double—case report. Int J Periodontics Restorative Dent. 2003 Oct;23(5):491-7.

2. Behr M, Rosentritt M, Leibrock A, Schneider-Feyrer S, Handel G. In vitro study of fracture strength and marginal adaption of fiber-reinforced adhesive fixed partial inlay dentures. J Dent. 1999 Feb;27(2):163-8.

3. Ramos V, Runyan DA, Christensen LC. The effect of plasma-treated polyethylene fiber on fracture strength of PMMA. J Prosthet Dent. 1996 Jul;76(1):94-6.

4. Vallittu PK. Flexural properties of acrylic resin polymers reinforced with unidirectional and woven fibers. J Prosthet Dent. 1999 Mar;81(3):318-26.

5. Rappelli G, Coccia E. Fiber-reinforced composite fixed partial denture to restore missing posterior teeth: a case report. J Contemp Dent Pract. 2005 Nov 15;6(4):168-77.

6. Strassler HE, Tomona N, Spitznagel JK Jr. Stabilizing periodontally compromised teeth with fiber-reinforced composite resin. Dent Today. 2003 Sep;22(9):102-4, 106-9.

7. Freilich MA, Meiers JC, Duncan JP, Goldberg AJ. Fiber reinforced composites in clinical dentistry. Hanover Park (IL): Quintessence Pub.; 2002. p. 57.

8. Vallittu PK. The effect of void space and polymerization time on transverse strength of acrylic-glass fiber composite. J Oral Rehabil. 1995 Apr;22(4):257-61.

9. Chung K, Lin T, Wang F. Flexural strength of provisional resin material with fibre addition. J Oral Rehabil. 1998 Mar;25(3):214-7.

10. Vallittu PK. Some aspects of the tensile strength of unidirectional glass fibre-polymethyl methacrylate composite used in dentures. J Oral Rehabil. 1998 Feb;25(2):100-5.

11. Vallittu PK. Glass fiber reinforcement in repaired acrylic resin removable dentures: preliminary results of a clinical study. Quintessence Int. 1997 Jan;28(1):39-44.

12. Antonson DE. Immediate temporary bridge using an extracted tooth. Dent Surv. 1980 Jan;56(1):22-5.

13. Ibsen RL. Fixed prosthetics with a natural crown pontic using adhesive composite. J South Calif Dent Assoc. 1973 Feb;41(2):100-2.

14. Miettinen M, Millar BJ. A review of the success and failure characteristics of resin-bonded bridges. Br Dent J. 2013 Jul;215(2):E3. doi: 10.1038/sj.bdj.2013.686.

15. Yokoyama D, Shinya A, Lassila LV, Gomi H, Nakasone Y, Vallittu PK, Shinya A. Framework design of an anterior fiber-reinforced hybrid composite fixed partial denture: a 3D finite element study. Int J Prosthodont. 2009 Jul-Aug;22(4):405-12. **jCD**


The described technique is a conservative, esthetic, and cost-effective way to replace a missing tooth.

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Disclosure: The author did not report any disclosures.

> “...there were two problems with conventional isolation: the patient still had primary teeth in the posterior area, and the mesial portion of the fracture was under the gingival margin.”

# The "Three-Teeth Shell" Technique

## Class IV Restorative Procedure for a Difficult Isolation Scenario

Gaetano Paolone, DDS


## Abstract

Restorative procedures for anterior teeth today are well established and predictable if basic requirements are met. However, when it is not possible to achieve good isolation in a conventional manner, alternatives should be employed. This article describes a case that called for single clamp isolation and a molding technique involving a customized transparent acrylic tray.


**Key Words: Class IV, anterior direct restoration, "three-teeth shell," composite layering**

## Introduction

Restorative procedures for anterior teeth are well established today and modern materials and techniques can help dentists achieve noninvasive adhesive composite restorations.[1-11] The use of palatal and sagittal silicone indexes under extensive isolation (usually from premolar to premolar) allows the clinician to perform direct restorations in anterior teeth in a predictable way. In some cases, however, this is not possible because of isolation issues or when a significant portion of the restoration margin is below the gingival margin. This case report describes a technique that can be used when the clinical situation is not ideal.

## Patient Complaint and Treatment Plan

A 7-year-old female presented with a fractured right upper central incisor **(Fig 1)**. The pulp was not exposed and the tooth was not mobile. Unfortunately, the patient and her family had been unable to find the missing tooth fragment. After thorough examination and evaluation, a treatment plan was devised as follows:

- seal the dentin, compile a color chart, take impressions, create a wax-up
- restore the tooth directly with composite resin
- schedule follow-up appointments.

## Treatment

### Pre-Restorative Phase

The first procedure was to seal the dentin with a self-etch two-step adhesive system (XTR, KerrHawe; Bioggio, Switzerland) to protect the tooth and reduce sensitivity. At the same appointment initial images were taken and a personalized color chart was compiled under a light source of 5,500 K. A custom shade guide (My Shade Guide, Smile Line; Saint-Imier, Switzerland) made with the same composites that would be used for the restoration (CeramX Duo, Dentsply DeTrey GmbH; Konstanz, Germany) was employed **(Fig 2)** to select the dentin and enamel shades.[12]

Precise silicone impressions were taken to make extra-hard plaster casts and a diagnostic wax-up **(Fig 3)**. These plaster models are generally used to create a series of laboratory-fabricated rigid silicone indexes, both palatal and sagittal. They facilitate the molding of the restoration's palatal shell and evaluation of the thickness of the layers. These tools can be used when conventional isolation with a rubber dam from premolar to premolar can be achieved. In this case, however, there were two problems with conventional isolation: the patient still had primary teeth in the posterior area, and the mesial portion of the fracture was under the gingival margin.

**Figure 1:** Preoperative situation.

**Figure 2:** Color selection using a custom shade guide.

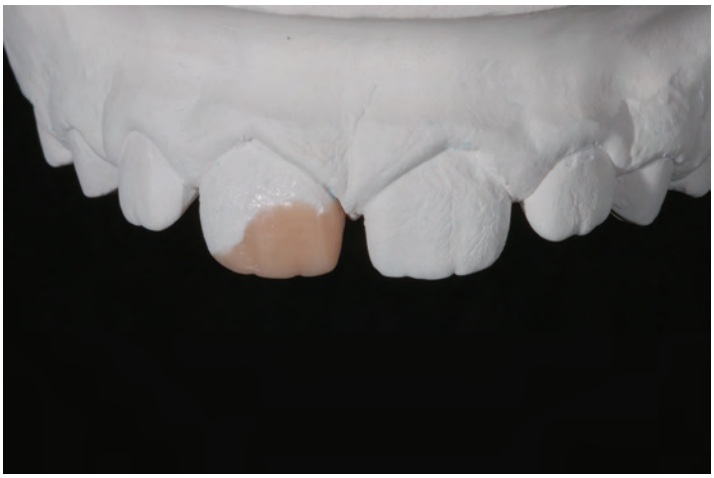

**Figure 3:** The wax-up.

The only way to restore this central incisor under isolation was to utilize an anterior clamp (#212, Heraeus Kulzer GmbH; Hanau, Germany). This clamp does not allow the use of the palatal silicone index so in this case another layering protocol was employed. First the wax-up model was duplicated **(Fig 4)** and a customized transparent tray was manufactured **(Fig 5)** with a dental laboratory vacuum thermoform machine (PlastVac, Bio-Art Dental Equipment; São Paulo, Brazil). Another technique using a modified silicone index has also been described for cases with similar difficult isolation issues.[13]

The thermoformed sheet was used as a molding device instead of the silicone index. The three-teeth extension was marked on the thermoformed sheet with a felt pen **(Fig 6)**. Excess material was removed with scissors and the margins were refined with rubber points mounted on a laboratory handset. The resulting "three-teeth shell" is shown in **Figure 7**.

> "The only way to restore this central incisor under isolation was to utilize an anterior clamp."

**Figure 4:** Wax-up cast duplicated.

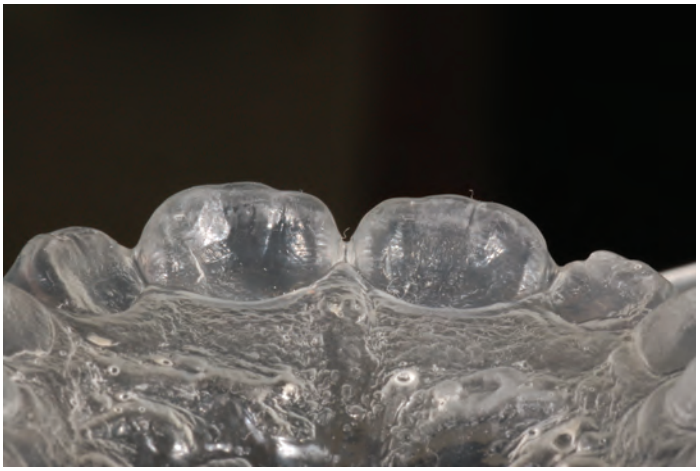

**Figure 5:** Acrylic shell made with the thermoform machine.

**Figure 6:** Outlining the three-teeth shell.

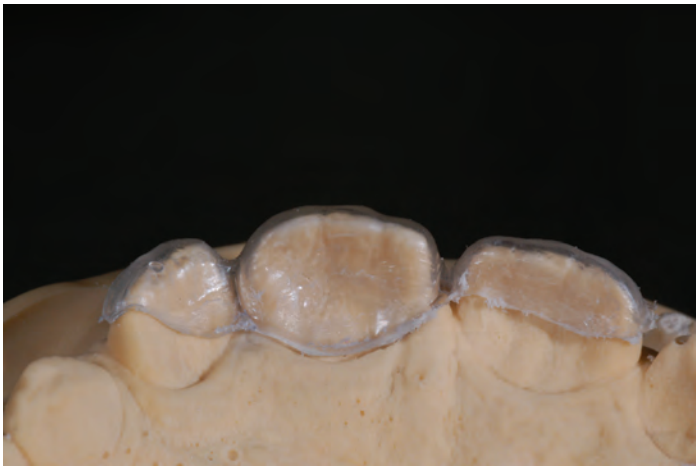

**Figure 7:** The three-teeth shell after trimming.

**Restorative Phase**

The day of the restoration appointment a dental dam (Isodam, Hedy; Calgary, Canada) with three holes—one for the tooth to be restored, the other two for the adjacent teeth that could easily be exposed during single-tooth, single-clamp isolation—was inserted. Isolation was improved further with liquid dental dam (Top Dam, FGM; Joinville, Brazil) **(Fig 8)**.

The passive fit of the acrylic index was checked **(Fig 9)**. Seating on the right upper lateral and the left upper central incisor allowed the index to remain stable during the molding procedure.

The cavity design was characterized by a small chamfer on the buccal finishing line to mask the transition from composite to natural enamel. A butt joint finishing line was made in the interproximal and palatal margins to control excess and make finishing and polishing easier.[14]

Great care was taken to finish and polish the margins using silicone points mounted on a blue ring, low-speed handpiece under a constant cooling spray. Creating smooth margins is very important because it helps to remove unsupported enamel prisms, which could break off during light-curing contraction, causing pigmentation of the restoration's margin.[15]

Adhesive procedures were executed with a three-step etch-and-rinse system (OptiBond FL, Kerr; Bioggio, Switzerland). A 37% phosphoric acid was used to etch the enamel for 30 seconds and the dentin for 15 seconds. Primer was added and then air was applied gently. The bonding agent was applied and excess material was removed with paper points and dry brushes (Roeko GmbH & Co. KG; Langenau, Germany). The restoration was light-cured for 20 seconds, moving the lamp tip in different directions (VALO, Ultradent Products; South Jordan, UT).

The CeramX Duo composite resin was placed directly on the transparent index **(Fig 10)** at the incisal, palatal, and interproximal of #11. The shades, D3 and E1, had been chosen based on the initial color chart.[16] The acrylic index, along with the composite masses yet to be cured (a thin layer of dentin on the incisal margin, and enamel on the mesial and palatal) was inserted on the exposed teeth **(Fig 11)**. The composite had been adapted to the prepared tooth by pushing with instruments on the transparent matrix and slightly moving the matrix. After that, the composite masses were cured for 60 seconds.

The index was then gently removed and the composite resin was cured for an additional two minutes, again moving the lamp in different directions. Missing composite **(Figs 12 & 13)** was added either freehand or with the use of transparent sectional matrices (VariStrip, Garrison Dental Solutions; Spring Lake, MI).


**Figure 8:** Isolation using rubber and liquid dams.

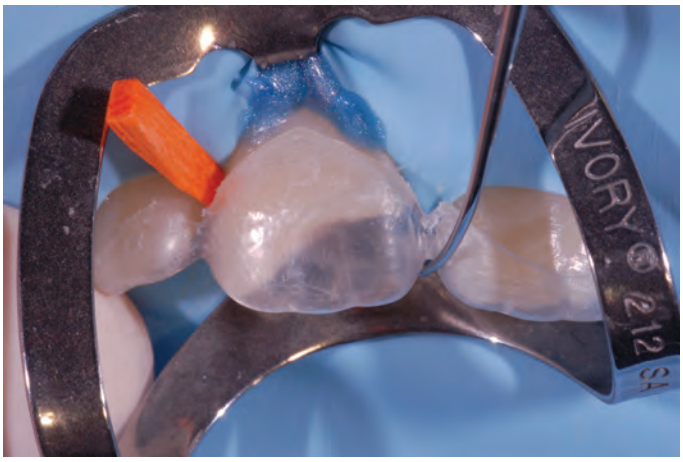


**Figure 9:** Checking stability and fitting of the acrylic shell.

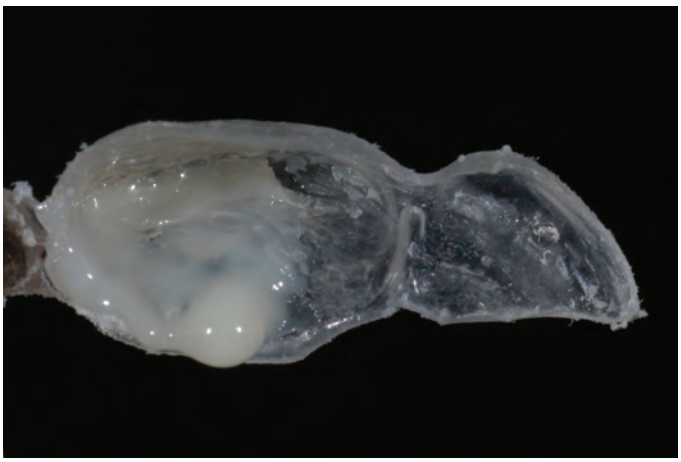

**Figure 10:** The composite placed inside the shell.


**Figure 11:** Molding the composite.

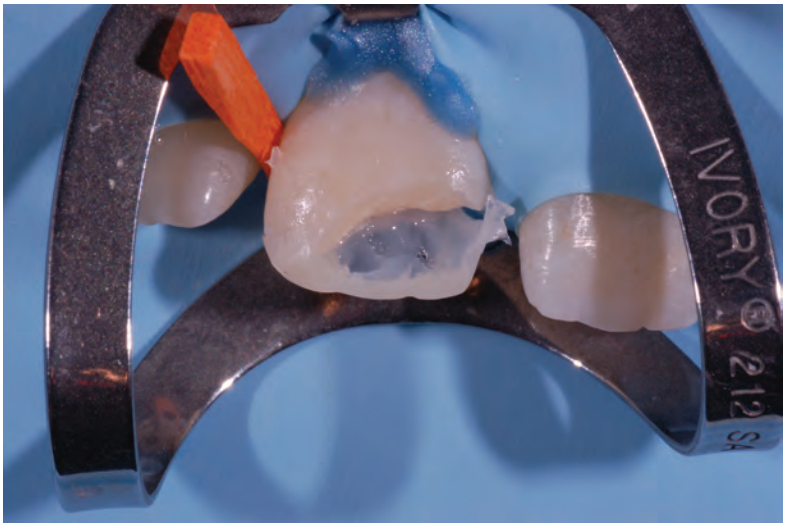


**Figure 12:** After removal of the acrylic shell.


**Figure 13:** Adding composite to complete the frame.

Once the tooth's frame was defined, the dentin was layered. The dental body was modeled **(Fig 14)**, leaving space to add the specific opalescent masses according to the initial color scheme. The final enamel layer (no thicker than 0.5 mm) was applied and cured **(Fig 15)**; an additional 60 seconds of curing was performed under glycerine to increase the composite resin's surface conversion and performance. The restoration was then finished and polished **(Fig 16)**. Fine and ultra-fine diamond burs (8862.314.012, 862EF.314.012, Komet, Gebr. Brasseler GmbH & Co. KG; Lemgo, Germany) were used, as well as silicone rubber points (Enhance, Dentsply). Diamond pastes (Prisma Gloss, Dentsply) were applied with brushes and aluminum oxide paste (Enamelize, Cosmedent; Chicago, IL) was applied with felt.[17,18] The patient was evaluated at one-week and six-month recall appointments **(Figs 17-19)**.

## Discussion

Among the advantages of this technique are extreme stability and the capability to light-cure the composite through the transparent matrix. Part of the buccal surface can also be molded this way. A complete restoration can also be molded, but the clinician should consider possible shrinkage issues and the esthetic outcome (layering control). This technique can also be useful with children because of its quick implementation. A disadvantage is difficulty in adapting the composite to the prepared margin; some gaps can result even if they are quite easy to fix. Although the margin was subgingival, some margin exposure techniques (e.g., gingival trimming) could have been used but considering the patient's young age and good compliance a less invasive treatment was chosen. Fortunately, when applying the dental dam the mesial margin became more visible and the mesial wall could be restored easily with a transparent matrix.

## Summary

Various alternative approaches can sometimes be employed to achieve a predictable result in less-than-ideal clinical situations. The "three-teeth shell" technique described in this article offers a stable and predictable molding device for use in difficult isolation circumstances.

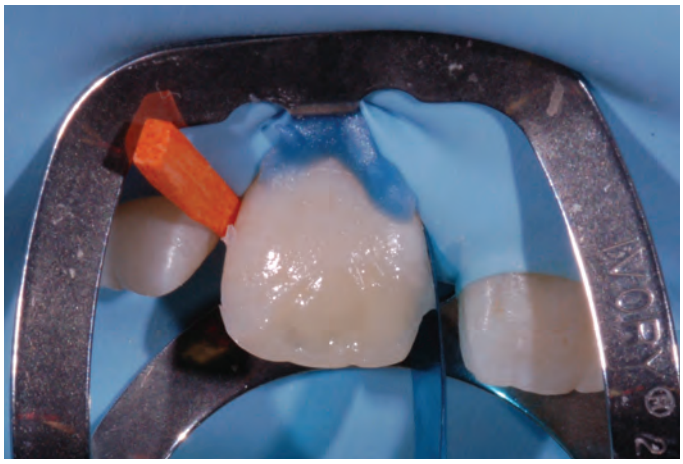


**Figure 14:** Dentin body was modeled, leaving space for color characterization.


**Figure 15:** Final enamel layer applied and cured.


**Figure 16:** Finishing and polishing.

**Figure 17:** One week postoperative.

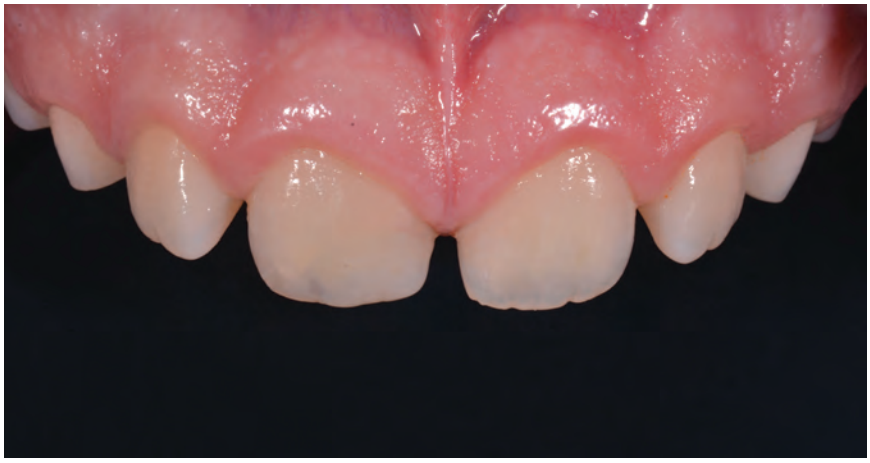

**Figure 18:** Six months postoperative.

**Figure 19:** Six months postoperative, right lateral view.

## References


1. Dietschi D. Free-hand bonding in the esthetic treatment of anterior teeth: creating the illusion. J Esthet Dent. 1997;9(4):156-64.

2. Dietschi D. Layering concepts in anterior composite restorations. J Adhes Dent. 2001 Spring;3(1):71-80.

3. Fahl N Jr. A polychromatic composite layering approach for solving a complex Class IV/direct veneer-diastema combination: part I. Pract Proced Aesthet Dent. 2006 Nov-Dec;18(10):641-5.

4. Fahl N Jr. A polychromatic composite layering approach for solving a complex Class IV/direct veneer/diastema combination: part II. Pract Proced Aesthet Dent. 2007 Jan-Feb;19(1):17-22.

5. Fahl N Jr. Single-shaded direct anterior composite restorations: a simplified technique for enhanced results. Compend Contin Educ Dent. 2012 Feb;33(2):150-4.

6. Furuse AY, Baratto SS, Spina DR, Correr GM, da Cunha LF, Gonzaga CC. Planning extensive esthetic restorations for anterior teeth: use of waxed-up study casts and composite resin mock-ups. Gen Dent. 2016 Jan-Feb;64(1):e6-9.

7. Okuda WH. Achieving optimal aesthetics for direct and indirect restorations with microhybrid composite resins. Pract Proced Aesthet Dent. 2005 Apr;17(3):177-84.

8. Paolone G. Direct composite restorations in anterior teeth. Managing symmetry in central incisors. Int J Esthet Dent. 2014 Spring;9(1):12-25.

9. Paolone G, Saracinelli M, Devoto W, Putignano A. Esthetic direct restorations in endodontically treated anterior teeth. Eur J Esthet Dent. 2013 Spring;8(1):44-67.

10. Heintze SD, Rousson V, Hickel R. Clinical effectiveness of direct anterior restorations—a meta-analysis. Dent Mater. 2015 May;31(5):481-95.

11. Fahl N Jr, Paravina RD. Direct composite restorations—the ugly duckling classic. J Dent. 2013 Nov;41 Suppl 5:e1-2.

12. Paolone G, Orsini G, Manauta J, Devoto W, Putignano A. Composite shade guides and color matching. Int J Esthet Dent. 2014 Summer;9(2):164-82.

13. Fahl N Jr. Coronal reconstruction of a severely compromised central incisor with composite resins: a case report. J Cosmetic Dent. 2010 Spring;26(1):92-113.

14. Vanini L, Mangani F, Klimovskaia O. Il restauro conservativo dei denti anteriori [The restoration of the front teeth]. Viterbo (Italy): ACME; 2003.

15. Duarte S Jr, Perdigão J, Lopes M. Composite resin restorations—natural aesthetic and dynamics of light. Pract Proced Aesthet Dent. 2003 Oct;15(9):657-64.

16. Sensi LG, Marson FC, Roesner TH, Baratieri LN, Junior SM. Fluorescence of composite resins: clinical considerations. QDT 2006;29:43-53.

17. Antonson SA, Yazici AR, Kilinc E, Antonson DE, Hardigan PC. Comparison of different finishing/polishing systems on surface roughness and gloss of resin composites. J Dent. 2011 Jul;39 Suppl 1:e9-17.

18. Terry DA, Geller W, Tric O, Anderson MJ, Tourville M, Kobashigawa A. Anatomical form defines color: function, form and aesthetics. Pract Proced Aesthet Dent. 2002 Jan-Feb;14(1):59-67. **jCD**


> “This technique can be useful with children because of its quick implementation.”


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# A Dynamic Process:

## Elucidating the Mechanism of Tooth Whitening

So Ran Kwon, DDS, MS, PhD


### Abstract

Tooth whitening is the most popular elective dental procedure, and demand has spurred development of many products for professional and in-home use. Despite the popularity of these products, the mechanism that drives tooth whitening is not fully understood. Indeed, most research on tooth whitening has focused on the safety of the materials (primarily based on hydrogen peroxide or carbamide peroxide) and not their mechanism of action. Most study of stains has been done for the textile industry; and even in that very different arena, the chemistry of stain removal is not well understood. Research into dental stain prevention and removal must take into account that the tooth is a living, semipermeable structure and surface whitening agents penetrate to enamel and deep within the dentin. In addition, the dynamic flow of dentinal fluids must be considered, since this may affect not only stain deposition, but also delivery of whitening materials. This article reviews the traditional theory of the mechanism of tooth whitening and expands upon it to provide a broad and in-depth understanding of three different aspects: diffusion, interaction, and surface changes. Questions are also raised to help direct future research.


**Key Words: tooth whitening, mechanism, color, diffusion, chromophore, hydrogen peroxide**

> “...although tooth whitening is considered safe and effective when performed under a dentist's supervision, the mechanism underlying this noncomplex treatment is not fully understood.”

CE CREDIT

**Learning Objectives**

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

1. **Have a greater comprehension of the mechanism that drives tooth whitening.**
2. **Understand the chemistry of stain removal as it relates to teeth.**
3. **Understand the composition and microstructure of teeth and how they relate to perceived tooth color.**

## Introduction

Tooth whitening is among the most frequently requested dental services and now represents the most common elective dental procedure.[1] The demands of our highly appearance-driven society are also reflected in the wide range of whitening modalities available: professionally applied in the office, using material that contains high concentrations (up to 40%) of hydrogen peroxide; professionally dispensed, applied at home by the patient using custom-fabricated trays with lower concentrations of hydrogen peroxide or carbamide peroxide; over-the-counter (OTC) products in various delivery methods such as strips, pens, and brushes; and do-it-yourself whitening using substances including certain herbs, spices, and fruits.

Surprisingly, although tooth whitening is considered safe and effective when performed under a dentist's supervision, the mechanism underlying this noncomplex treatment is not fully understood.

## The Composition and Nature of Teeth

### Tooth Color

The tooth consists of enamel, which forms a protective covering for the crown; and dentin, which encloses the central pulp chamber. The enamel is hard, inert, and acellular, consisting of more than 96% inorganic material in the form of hydroxyapatite crystals and traces of organic material.[2] Dentin is more elastic and is 70% mineral, 20% organic (mainly fibrillar collagen), and 10% water.[2] The dentin occupies most of the tooth and therefore contributes to its overall chromaticity. Although dentin does not regenerate like bone tissue, it responds to various stimuli (e.g., attrition, caries, or dental procedures) by forming tertiary dentin that may also affect tooth chromaticity. It is worth noting that dentinal tubules can become occluded with calcified material, termed *sclerotic dentin*. Sclerotic dentin increases with age and assumes a glassy and translucent appearance.

The tooth section illustrated in **Figure 1** demonstrates how different types of dentin can affect the tooth's chromaticity. A change in translucency is observed only on the lingual side, and may be caused by the occluding action of the opposing tooth over a lifetime. Since enamel is highly mineralized, it is considered translucent and affects tooth color by minute alterations in its reflecting and scattering properties.[3] The illustration depicts why differences in the thickness and composition of the enamel and dentin will cause the perception of color to vary, even within the same tooth. Understanding the composition and microstructure of the enamel and dentin and how they relate to the perceived tooth color is critical in furthering our knowledge of the tooth staining and whitening processes.

> "The dentin occupies most of the tooth and therefore contributes to its overall chromaticity."

### Tooth Permeability

In a strict biologic sense tooth enamel is a dead tissue; however, it is permeable and allows dynamic exchange of ions at the surface. Furthermore, teeth withstand the various assaults of the challenging oral environment because of the dynamics of dentinal fluid, which produce a controlled centrifugal (outward) flow of dentinal fluid.[4] This seems to act as a buffer to protect against erosion and attrition on the tooth surface, and may also protect the tooth from discoloration. Studies on the fluid pathways show that fluids flow in the enamel interprismatic spaces and the dentinal tubules.[5-7] Thus, the tooth can be considered a semipermeable membrane that selectively allows outward as well as inward flow, depending on the structure, size, and composition of the permeating molecule.

The permeability of extracted teeth can be demonstrated and effectively visualized with laser scanning confocal microscopy. **Figure 2** shows a section of tooth that was inversely attached to a cover slip and sealed with wax at the borders. The tooth section was then immersed in a 100-mM Rhodamine B solution (Sigma-Aldrich; St. Louis, MO) and penetration of the dye was tracked over time with a LSM 710 confocal laser microscope (Carl Zeiss MicroImaging GmbH; Jena, Germany). The fluorescence changes over time as the fluorescent dye penetrates the outer enamel, moves into the dentin, and eventually reaches the pulp **(Figs 3 & 4)**. In the natural oral environment, a situation where the tooth would be exposed for hours to a dye solution and turn pink, red, or blue is rarely encountered; however, this in vitro experiment likely reflects some key mechanisms of discoloration and how the tooth is able to withstand and protect itself from the continuous challenges faced in the oral environment.

It is important to determine when an external stain from substances such as tobacco, coffee, and tea can become internalized, and it is critical to understand their preferred sites of binding within the enamel and dentin microstructure and how they change the optical properties of the tooth. Insight about the mechanism that underlies tooth discoloration should ultimately inform development of innovative whitening alternatives. The best solution might be an anti-staining formulation that would prevent chromophores from bonding with the organic or inorganic content of the dental hard tissues in the first place.

**Figure 1:** Ground section of tooth showing translucency change in lingual dentin.

**Figure 2:** Tooth section that was inversely attached to a cover slip and sealed with wax at the borders.

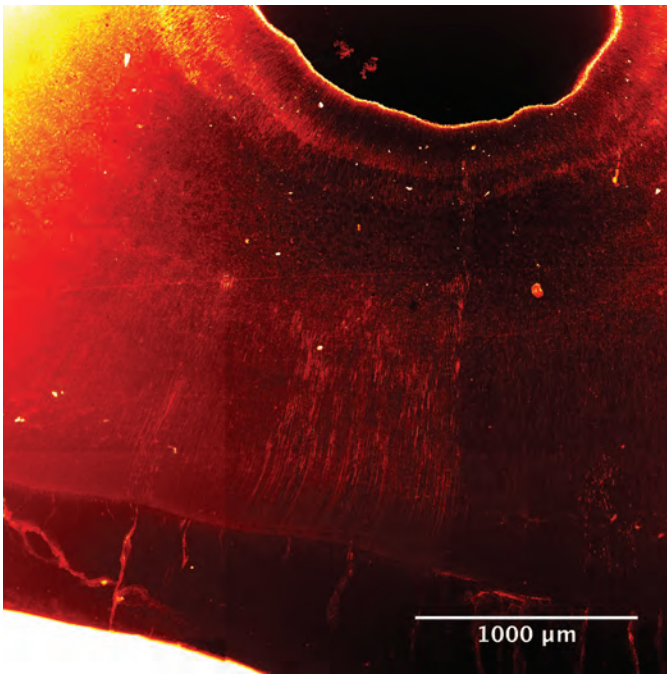


**Figure 3:** The Rhodamine B dye penetrates into the tooth from the exterior surface deep into the pulp cavity. The micrograph was taken by scanning nine segments of the tooth and merging the images with the tiling feature on the confocal laser microscope.

> “In a strict biologic sense tooth enamel is a dead tissue; however, it is permeable and allows dynamic exchange of ions at the surface.”

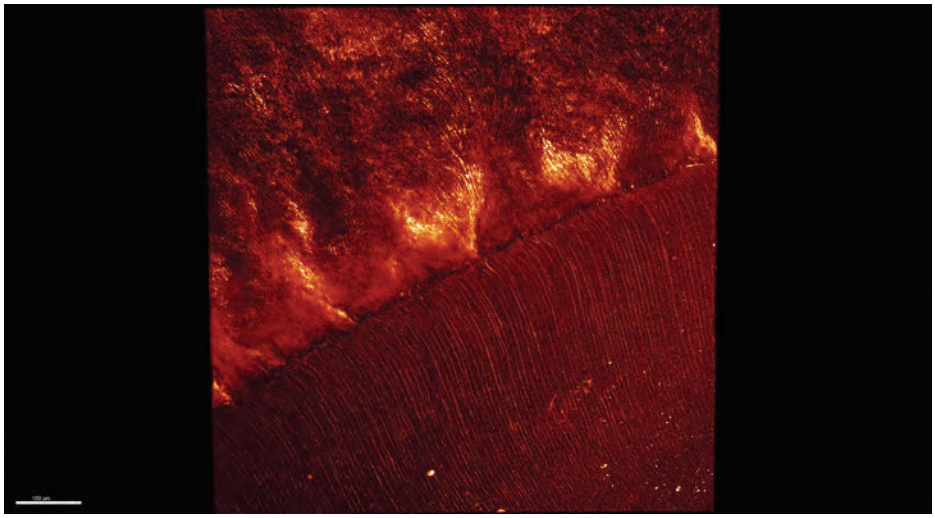

**Figure 4:** When applied to the external surface of the tooth, Rhodamine B readily penetrates into the enamel and dentin via the interprismatic spaces in the enamel and dentinal tubules in the dentin.

## Dominant Chromophore Effect Theory

The safety and efficacy of tooth whitening material and techniques has been studied extensively. A clinical study compared three representative whitening modalities: in-office with 38% hydrogen peroxide, at-home with 10% carbamide peroxide used with a custom-fabricated tray, and an OTC product containing 5.3% hydrogen peroxide on a strip. The study found that to achieve a six-tab difference on a Vita Classical shade guide, the fastest method was the in-office whitening, followed by at-home, with the OTC method requiring the most time.[8] The various techniques caused similar levels of gingival and tooth sensitivity, and patients tended to prefer at-home whitening.[8] However, the mechanism causing the color change and the rate of stain molecule breakdown is not fully known. The Dominant Chromophore Effect theory, which dates to 1991, is favored by the author and is based on the chemical reaction between hydrogen peroxide and organic chromophores within the tooth structure.[9] According to the theory, hydrogen peroxide is a strong oxidizing agent that is attracted to areas with high electron density (i.e., stain molecules) and converts them to simpler structures. The structure change decolorizes or fades the stain molecules and may also change the tooth's light-absorbing or reflecting nature, thus altering its color.[10]

### Stain Types

The Dominant Chromophore Effect theory originates mainly from our knowledge of stain chemistry. In the textile industry, stains are broadly classified into four categories: enzymatic, oxidizable, greasy, and particulate. This is a simplification since most stains are composed of a combination of types. In dentistry, the most relevant types of stains are enzymatic and oxidizable. Enzymatic stains include blood stains, which are largely composed of proteins. To break down enzymatic stains, the textile industry commonly uses other enzymes, such as proteases. Brightly colored stains often fall into the category of oxidizable stains and are caused by substances like tea, coffee, and red wine. These stains are susceptible to hydrogen peroxide, which breaks down color-causing sections of chemical structures, diminishing the stain's appearance.[11] Nevertheless, it is important to note that no study has ever actually determined the location and specific binding sites of stain molecules, or the fate of stain molecules after oxidation. These issues remain to be investigated and elucidated.

## The Mechanism of Tooth Whitening

The Dominant Chromophore Effect theory is not entirely accepted by the dental profession because it considers only the interaction between the stain molecule and the whitening material. The mechanism must be more complex because of the delivery dynamics of the peroxide-based material to the enamel and dentin. During the course of diffusion, the whitening material interacts not only with stain molecules intercalated within the tooth but also with microstructures of sound enamel and dentin. Ultimately, whitening might cause micromorphologic changes at the tooth surface that could alter its optical properties and henceforth the perceived color of the tooth.

### Peroxide-Based Material

The movement of peroxide-based material into the tooth structure has been extensively investigated and shown to follow Fick's second law of diffusion from 1855.[12] Thus, the extent of hydrogen peroxide diffusion into the tooth is proportional to exposure time and surface area, and indirectly proportional to the distance. Studies show that, with the use of a simple spectrophotometric evaluation method, hydrogen peroxide penetration can be enhanced by several factors: high concentrations of

hydrogen peroxide;[13-16] prolonged application;[14,16] increased temperature;[13,17] the size of the dentinal tubule openings, which are particularly large in young teeth;[18] variations in tooth structure due to location, acid etching, or restorations;[19-22] and light activation.[23] Penetration can also be improved by specific formulations and delivery systems.[15,24-28] It is helpful to relate the amount of hydrogen peroxide penetration with tooth whitening efficacy in terms of overall color change. The two key factors in determining this outcome are the concentration of the peroxide and the duration of the application.[29] Thus, the higher the concentration and the longer the exposure time the faster the initial rate of tooth whitening.[30-33] The resulting higher peroxide penetration with light activation in vitro may be related to its effect on efficacy with higher color change or faster rate of whitening.[34-36] A direct correlation of peroxide penetration with tooth whitening efficacy is currently not possible to establish because all penetration measurements have been performed on extracted teeth. On another note, it is important to realize that the higher peroxide penetration might adversely affect the pulp tissue, so it is advisable to minimize diffusion into the pulp cavity without compromising the whitening efficacy.

During diffusion, peroxide-based materials actively interact with stain molecules, as they convert the chains of the latter into simpler structures or alter their optical properties to diminish the appearance of the stain.[10] Although it is not known how the whitening agent interacts with the stain molecules, chemical oxidation is thought to be involved. Ideally, oxidation should be limited to the stain molecules; however, studies using Fourier transform infrared spectroscopy revealed that hydrogen peroxide treatment induces loss of organic components from enamel and dentin.[37,38] Furthermore, studies using ion-selective electrode probes, FT-Raman spectroscopy, and a combination of SEM and energy-dispersive x-ray spectrometer and micro-computerized tomography showed a change in inorganic components.[39-46] Overall, these studies suggest hydrogen peroxide interacts with all components of dentin and enamel. Nevertheless, the clinical significance of these studies should be interpreted carefully since the models lacked the full dynamics of the oral cavity.

The lightening of tooth color has also been associated with micromorphologic changes at the tooth surface. Most inherent tooth color is attributed to diffuse reflectance from the inner dentin through the outer translucent enamel layer.[47] It is well known that a rough or coarse surface results in more diffuse reflection.[10] Although an increase in surface roughness post whitening is not necessarily anticipated, where present it actually improves the digital color reading.[48-53]

> “The permeability of extracted teeth can be demonstrated and effectively visualized with laser scanning confocal microscopy.”

## Summary

Tooth whitening with peroxide-based materials is a dynamic process initiated by the movement of the whitening material into the tooth structure, where it interacts with stain molecules and also induces micromorphologic alterations on the tooth surface and within the tooth. All of this affects the tooth's optical properties. Any affinity-based interaction is unlikely to be limited to the organic stain molecules, and probably also affects sound enamel and dentin structures.[54,55] More research into the dynamic process is warranted and will lead to innovative approaches and alternatives for tooth whitening in the future.

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### References

1. Dutra A, Frary J, Wise R. Higher-order needs drive new growth in mature consumer markets. J Bus Strategy. 2004;25(5):26-34.
2. Nanci A. Ten Cate's oral histology. 8th ed. St Louis: Mosby; 2013. p. 1-4.
3. Joiner A. Tooth colour: a review of the literature. J Dent. 2004;32 Suppl 1:3-12.
4. Roggenkamp C. Dentinal fluid transport. Loma Linda (CA): Loma Linda University Press; 2005.
5. Lindén LA. Microscopic observations of fluid flow through enamel in vitro. Odontol Revy. 1968;19(4):349-65.
6. Pashley DH. Dynamics of the pulpo-dentin complex. Crit Rev Oral Biol Med. 1996;7(2):104-33.
7. Kwon SR, Wertz PW, Li Y, Chan DC. Penetration pattern of rhodamine dyes into enamel and dentin: confocal laser microscopy observation. Int J Cosmet Sci. 2012 Feb;34(2):97-101.
8. Auschill TM, Hellwig E, Schmidale S, Sculean A, Arweiler NB. Efficacy, side-effects and patients' acceptance of different bleaching techniques (OTC, in-office, at-home). Oper Dent. 2005 Mar-Apr;30(2):156-63.

9. Markovic L, Fotouhi K, Lorenz H, Jordan RA, Gaengler P, Zimmer S. Effects of bleaching agents on human enamel light reflectance. Oper Dent. 2010 Jul-Aug;35(4):405-11.

10. Albers HF. Lightening natural teeth. ADEPT Report. 1991;2:1-24.

11. Compound Interest [Internet]. The chemistry of stain removal. Available from: www.compoundchem.com/2015/06/18/stain-removal/

12. Fick A. On liquid diffusion. J Membrane Sci. 1995;100:33-8. Available from: http://tinyurl.com/zuzvb8f

13. Bowles WH, Ugwuneri Z. Pulp chamber penetration by hydrogen peroxide following vital bleaching procedures. J Endod. 1987 Aug;13(8):375-7.

14. Hanks CT, Fat JC, Wataha JC, Corcoran JF. Cytotoxicity and dentin permeability of carbamide peroxide and hydrogen peroxide vital bleaching materials, in vitro. J Dent Res. 1993 May;72(5):931-8.

15. Gökay O, Müjdeci A, Algin E. Peroxide penetration into the pulp from whitening strips. J Endod. 2004 Dec;30(12):887-9.

16. Palo RM, Valera MC, Camargo SE, Camargo CH, Cardoso PE, Mancini MN, Pameijer CH. Peroxide penetration from the pulp chamber to the external root surface after internal bleaching. Am J Dent. 2010 Jun;23(3):171-4.

17. Rotstein I, Torek Y, Lewinstein I. Effect of bleaching time and temperature on the radicular penetration of hydrogen peroxide. Endod Dent Traumatol. 1991 Oct;7(5):196-8.

18. Camps J, de Franceschi H, Idir F, Roland C, About I. Time-course diffusion of hydrogen peroxide through human dentin: clinical significance for young tooth internal bleaching. J Endod. 2007 Apr;33(4):455-9.

19. Benetti AR, Valera MC, Mancini MN, Miranda CB, Balducci I. In vitro penetration of bleaching agents into the pulp chamber. Int Endod J. 2004 Feb;37(2):120-4.

20. Camargo SE, Valera MC, Camargo CH, Gasparoto Mancini MN, Menezes MM. Penetration of 38% hydrogen peroxide into the pulp chamber in bovine and human teeth submitted to office bleach technique. J Endod. 2007 Sep;33(9):1074-7.

21. Palo RM, Bonetti-Filho I, Valera MC, Camargo CH, Camargo S, Moura-Netto C, Pameijer C. Quantification of peroxide ion passage in dentin, enamel, and cementum after internal bleaching with hydrogen peroxide. Oper Dent. 2012 Nov-Dec;37(6):660-4.

22. Patri G, Agnihotri Y, Rao SR, Lakshmi N, Das S. An in vitro spectrophotometric analysis of the penetration of bleaching agent into the pulp chamber of intact and restored teeth. J Clin Diagn Res. 2013 Dec;7(12):3057-9.

23. Camargo SE, Cardoso PE, Valera MC, de Araújo MA, Kojima AN. Penetration of 35% hydrogen peroxide into the pulp chamber in bovine teeth after LED or Nd:YAG laser activation. Eur J Esthet Dent. 2009 Spring;4(1):82-8.

24. Cooper JS, Bokmeyer TJ, Bowles WH. Penetration of the pulp chamber by carbamide peroxide bleaching agents. J Endod. 1992 Jul;18(7):315-7.

25. Thitinanthapan W, Satamanont P, Vongsavan N. In vitro penetration of the pulp chamber by three brands of carbamide peroxide. J Esthet Dent. 1999;11(5):259-64.

26. Pignoly C, Camps L, Susini G, About I, Camps J. Influence of in-office whitening gel pH on hydrogen peroxide diffusion through enamel and color changes in bovine teeth. Am J Dent. 2012 Apr;25(2):91-6.

27. Bharti R, Wadhwani K. Spectrophotometric evaluation of peroxide penetration into the pulp chamber from whitening strips and gel: an in vitro study. J Conserv Dent. 2013 Mar;16(2):131-4.

28. Park S, Kwon SR, Qian F, Wertz PW. Evaluation of various in-office tooth whitening systems on hydrogen peroxide penetration. J Dent Res. 2016;95 Spec Issue A #0635.

29. Joiner A. The bleaching of teeth: a review of the literature. J Dent. 2006 Aug;34(7):412-9.

30. Kihn PW, Barnes DM, Romberg E, Peterson K. A clinical evaluation of 10 percent vs. 15 percent carbamide peroxide tooth-whitening agents. J Am Dent Assoc. 2000 Oct;131(10):1478-84.

31. Matis BA, Mousa HN, Cochran MA, Eckert GJ. Clinical evaluation of bleaching agents of different concentrations. Quintessence Int. 2000 May;31(5):303-10.

32. Gerlach RW, Sagel PA, Jeffers ME, Zhou X. Effect of peroxide concentration and brushing on whitening clinical response. Compend Cont Educ Dent. 2002 Jan;23(1A):16-21.

33. Ferrari M, Kugel G, Cagidiaco MC, Barker ML, Gerlach RW. Clinical trial evaluating the peroxide concentration response of whitening strips over 28 days. Am J Dent. 2004 Aug;17(4):291-4.

34. Ontiveros JC, Paravina RD. Color change of vital teeth exposed to bleaching performed with and without supplementary light. J Dent. 2009 Nov;37(11):840-7.

35. Kossatz S, Dalanhol AP, Cunha T, Loguercio A, Reis A. Effect of light activation on tooth sensitivity after in-office bleaching. Oper Dent. 2011 May-Jun;36(3):251-7.

36. Calatayud JO, Calatayud CO, Zaccagnini AO, Box MJ. Clinical efficacy of a bleaching system based on hydrogen peroxide with or without light activation. Eur J Esthet Dent. 2010 Summer;5(2):216-24.

37. Sato C, Rodrigues FA, Garcia DM, Vidal CM, Pashley DH, Tjäderhane L, Carrilho MR, Nascimento FD, Tersariol IL. Tooth bleaching increases dentinal protease activity. J Dent Res. 2013 Feb;92(2):187-92.

38. Jiang T, Ma X, Wang Y, Zhu Z, Tong H, Hu J. Effects of hydrogen peroxide on human dentin structure. J Dent Res. 2007 Nov;86(11):1040-5.

39. Rotstein I, Lehr Z, Gedalia I. Effect of bleaching agents on inorganic components of human dentin and cementum. J Endod. 1992 Jun;18(6):290-3.

40. Rotstein I, Dankner E, Goldman A, Heling I, Stabholz A, Zalkind M. Histochemical analysis of dental hard tissues following bleaching. J Endod. 1996 Jan;22(1):23-5.

41. de Freitas PM, Turssi CP, Hara AT, Serra MC. Monitoring of demineralized dentin microhardness throughout and after bleaching. Am J Dent. 2004 Oct;17(5):342-6.

42. Efeoglu N, Wood D, Efeoglu C. Microcomputerized tomography evaluation of 10% carbamide peroxide applied to enamel. J Dent. 2005 Aug;33(7):561-7.

43. Bizhang M, Seemann R, Duve G, Römhild G, Altenburger JM, Jahn KR, Zimmer S. Demineralization effects of 2 bleaching procedures on enamel surfaces with and without post-treatment fluoride application. Oper Dent. 2006 Nov-Dec;31(6):705-9.

44. Efeoglu N, Wood DJ, Efeoglu C. Thirty-five percent carbamide peroxide application causes in vitro demineralization of enamel. Dent Mater. 2007 Jul;23(7):900-4.

45. Al-Salehi SK, Wood DJ, Hatton PV. The effect of 24h non-stop hydrogen peroxide concentration on bovine enamel and dentin mineral content and microhardness. J Dent. 2007 Nov;35(11):845-50.

46. Berger SB, Cavalli V, Martin AA, Soares LE, Arruda MA, Brancalion ML, Giannini M. Effects of combined use of light irradiation and 35% hydrogen peroxide for dental bleaching on human enamel mineral content. Photomed Laser Surg. 2010 Aug;28(4):533-8.

47. Paravina RD, Powers JM. Esthetic color training in dentistry. St. Louis: Elsevier Mosby; 2004.

48. Markovic L, Jordan RA, Lakota N, Gaengler P. Micromorphology of enamel surface after vital tooth bleaching. J Endod. 2007 May;33(5):607-10.

49. Pedreira De Freitas AC, Botta SB, Teixeira Fde S, Salvadori MC, Garone-Netto N. Effects of fluoride or nanohydroxyapatite on roughness and gloss of bleached teeth. Microsc Res Tech. 2011 Dec;74(12):1069-75.

50. Grundlingh AA, Grossman ES, Shrivastava S, Witcomb MJ. Visual and digital comparative tooth colour assessment methods and atomic force microscopy surface roughness. SADJ. 2013 Oct;68(9):412-4, 416-21.

51. Vieira GF, Arakaki Y, Caneppele TM. Spectrophotometric assessment of the effects of 10% carbamide peroxide on enamel translucency. Braz Oral Res. 2008 Jan-Mar;22(1):90-5.

52. Ma X, Jiang T, Sun L, Wang Z, Zhou Y, Wang Y. Effects of tooth bleaching on the color and translucency properties of enamel. Am J Dent. 2009 Dec;22(6):324-8.

53. Ma X, Li R, Sa Y, Liang S, Sun L, Jiang T, Wang Y. Separate contribution of enamel and dentine to overall tooth colour change in tooth bleaching. J Dent. 2011 Nov;39(11):739-45.

54. Ubaldini AL, Baesso ML, Medina Neto A, Sato F, Bento AC, Pascotto RC. Hydrogen peroxide diffusion dynamics in dental tissues. J Dent Res. 2013 Jul;92(7):661-5.

55. Kwon SR, Wertz PW. Review on the mechanism of tooth whitening. J Esthet Restor Dent. 2015 Sep-Oct;27(5):240-57. **jCD**

> “More research into the dynamic process is warranted and will lead to innovative approaches and alternatives for tooth whitening in the future.”

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**(CE) Exercise No.** jCD25

# Tooth Whitening/Bleaching (Esthetics)

**AGD Subject Code: 781**

The 10 multiple-choice questions for this Continuing Education (CE) self-instruction exam are based on the article, *A Dynamic Process: Elucidating the Mechanism of Tooth Whitening* by So Ran Kwon, DDS, MS, PhD. This article appears on pages 94-101.

The examination is free of charge and available to AACD members only, and will be available for 3 years after publication. AACD members must log onto www.aacd.com to take the exam. **Note that only Questions 1 through 5 appear in the printed and digital versions of the *jCD*; they are for readers' information only.** The complete, official self-instruction exam is available online only—completed exams submitted any other way will not be accepted or processed. A current web browser is necessary to complete the exam; no special software is needed. The AACD is a recognized credit provider for the Academy of General Dentistry, American Dental Association, and National Association of Dental Laboratories. For any questions regarding this self-instruction exam, call the AACD at 800.543.9220 or 608.222.8583.

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**1. What part of a tooth contributes most to that tooth's color?**

a. The inorganic material comprising most of the enamel.
b. The inorganic material comprising most of the dentin.
c. The enamel, which occupies most of the tooth.
d. The dentin, which occupies most of the tooth.

**2. What component of the dentin affects tooth chromaticity?**

a. The water portion of the dentin.
b. The fibrillar collagen portion of the dentin.
c. Tertiary dentin formed as the tooth responds to stimuli.
d. Sclerotic dentin formed as the tooth is erupting.

**3. Which component of tooth enamel affects the chromaticity of the tooth?**

a. Enamel is considered translucent and does not affect the color of the tooth.
b. Because enamel is highly mineralized, it affects tooth chromaticity by altering the tooth's reflecting and scattering properties.
c. An abundance of fibrillar collagen in tooth enamel changes the tooth's chromaticity.
d. The water present within enamel alters the chromaticity of the tooth.

**4. Which of the following best describes fluid flow within tooth structure?**

a. Enamel is impermeable except at the cementoenamel junction.
b. Enamel allows dynamic exchange of ions at the surface.
c. Dentinal fluid dynamics produce a controlled centrifugal flow of dentinal fluid in an outward direction.
d. Dark fluids can flow into the dentin and crystallize there.

**5. Why is a tooth considered a semipermeable membrane?**

a. Fluids move in an inward direction only.
b. Fluids move in an outward direction only.
c. Fluids flow in the enamel interprismatic spaces and the dentinal tubules.
d. Fluids can selectively flow inwardly as well as outwardly, depending on the composition of the permeating molecule.

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

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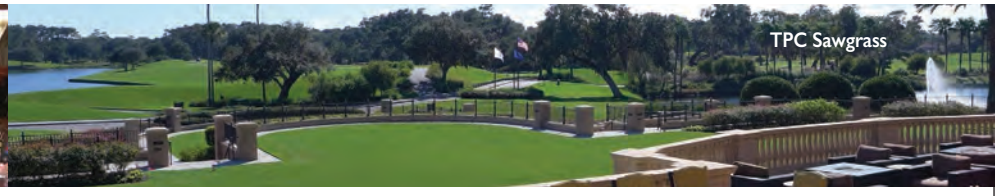


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