# Integration of Composite and Ceramic Restorations in Tetracycline-Bleached Teeth: A Case Report

SIMONE DELIPERI, DDS*
M. DEBORA CONGIU, DDS†
DAVID N. BARDWELL, DMD, MS‡

ABSTRACT

The success of an esthetic rehabilitation depends on the understanding of the patient's need and expectation. The management of patients with moderate to severe tetracycline-stained teeth is very challenging. Tooth whitening may be a valid alternative to more aggressive treatments; however, patients should be aware of the limitations of tooth whitening therapy.

Clinicians may select differing treatment plans; tooth whitening can improve intrinsic discoloration in a way so that no further treatment is required. Once tooth whitening is completed, direct or indirect restorative procedures may be afforded to match the existing restoration with the bleached tooth structure.

This article describes a conservative clinical approach to rehabilitate the smile of a patient with moderate to severe tetracycline-stained teeth using a combination of tooth whitening and direct composite and indirect porcelain restorations in the maxillary anterior segment.

CLINICAL SIGNIFICANCE

The combination of tooth whitening and adhesive restorations allows clinicians a significantly more conservative approach to intrinsically stained teeth; tooth preparation for porcelain veneers and porcelain-fused-to-metal and full-ceramic crowns can be restricted to conditions in which persistent tooth discoloration or significant loss of both dentin and enamel exists.

(*J Esthet Restor Dent* 18:126–134, 2006)

Since the introduction of night-guard vital bleaching (NGVB) in 1989,[1,2] development of new techniques and materials with improved properties has occurred. The past 10 years has seen an increase in success among clinicians.[3] NGVB using 10 or 15% carbamide peroxide is the safest and most cost-effective bleaching technique and provides the best risk-benefit ratio.[4] Lately, an increasing number of over-the-counter (OTC) products have been introduced by some of the major dental manufacturers. These products, ideally, should be prescribed by dentists; they may be sufficient for patients with slight discoloration or as a "touch-up" method.[4,5] The inability to afford higher bleaching costs has driven the OTC market.[4] However, NGVB is still the tooth whitening procedure of choice for any tooth whitening treatment and particularly for the treatment of intrinsically stained teeth. A clinical pilot study reported that NGVB with 10% carbamide peroxide can remove tetracycline stains if an extended treatment time is adopted; usually, 6 months of treatment is required for noteworthy results in

*Visiting instructor and research associate, Tufts University School of Dental Medicine, Boston, MA, USA, and private practice, Cagliari, Italy
†Private practice, Cagliari, Italy
‡Associate clinical professor of restorative dentistry, Tufts University School of Dental Medicine, Boston, MA, USA

patients with yellow-brown or grayish horizontal band discoloration.[6] Further reports demonstrated that tooth color improvement can last for various years posttreatment.[7,8]

Conversely, tooth whitening is not the only area of cosmetic dentistry that has undergone dramatic improvement in the last two decades. Acceleration in the development of all-ceramic restorative systems has also occurred.[9] Clinicians can select between the two main ceramic systems available today. Silica-based ceramics are the material of choice for laminate veneers and porcelain inlay/onlay[10]; feldspathic and leucite-reinforced feldspathic ceramics also belong in this category. Conversely, high-strength ceramic restorations find their ideal application in stress-bearing, less conservative anterior and posterior restorations[9,10]; glass-infiltrated aluminum oxide, densely sintered aluminum oxide, and zirconium oxide ceramic all belong to this class of ceramic.

Concomitant with the development of new ceramic systems, the introduction of modern enamel-dentin adhesive systems allowed clinicians significantly more conservative tooth preparation, thus preserving and reinforcing residual sound tooth structure. Interestingly, this potential benefit of bonded restorations has not been completely accepted by clinicians; conversely, adhesive dentistry has suffered from overuse particularly in patients undergoing esthetic-prosthetic rehabilitations.[11]

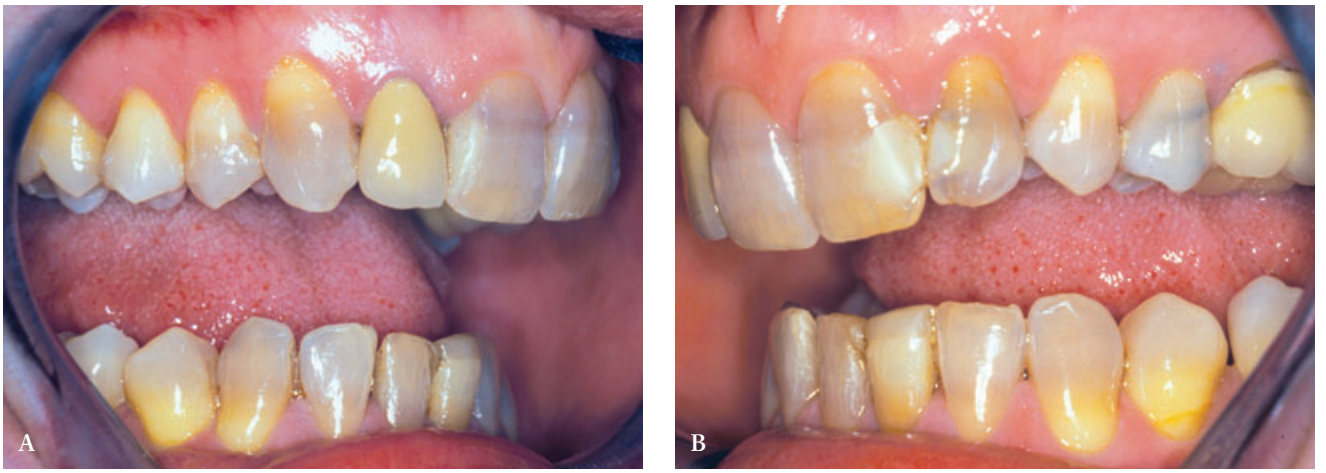
A conservative approach to restore teeth with both direct and indirect restorations has been introduced by various authors.[11–14] The clinical case presented in this article acts as an adjunctive dowel to this rediscovered philosophy of adhesive and cosmetic dentistry.

CASE REPORT

**Case Presentation**

A 38-year-old female patient presented with moderate to severe tetracycline-stained upper and lower teeth (Figure 1). She also presented with a mismatched and incongruous porcelain-fused-to-metal (PFM) crown on the maxillary right lateral incisor and discolored composite resin restorations on maxillary central incisors and left lateral incisor (Figures 2 and 3). The patient had refused in the past any prosthetic-esthetic rehabilitation with either porcelain laminate veneers or full coverage. In the past, these modalities were primary in masking tetracycline-stained teeth. The patient wanted to maintain the structural integrity of her teeth. She expressed a desire to change both the PFM crown and the composite resin restorations and to achieve a better match with the adjacent teeth and surrounding tooth structure. The patient was informed that tetracycline-stained teeth can be manageable with modern tooth whitening procedures even though a 6-month treatment period may be required to achieve satisfactory results. If no color change occurs in the first 3 months, tooth whitening treatment will be suspended at no charge to the patient.

*Figure 1. Preoperative retracted frontal view of discolored tetracycline-stained teeth and direct and indirect incongruous restorations. horizontal violet-gray discoloration accentuated at the cervical third of the dental crown is notable.*




*Figures 2. Preoperative retracted lateral right (A) and left (B) views that point out the characteristic discoloration of tetracycline-stained teeth and the defective restorations.*

The treatment plan was accepted, and informed consent was secured.

**Restorative Procedure**

Alginate impressions of the maxillary and mandibular arch were taken and poured with dental stone, and the resultant casts were trimmed and prepared for a custom stent; a light-cured resin block-out material (Triad Gel, Dentsply Preventive Care, York, PA, USA) was placed on the facial 1 mm from the gingival area. Trays were fabricated with a 0.035 inch–thick, 5 × 5–inch soft tray material (Sof-tray, Ultradent Products Inc., South Jordan, UT, USA) used in a heat/vacuum tray forming machine (UltraVac, Ultradent Products Inc.). Trays were properly trimmed to perfectly fit each model before trying in on the patient. The patient was instructed in the correct care and use. Tooth whitening was accomplished using a 10% carbamide peroxide at-home bleaching agent (Nupro White Gold, Dentsply Preventive Care). After 4 weeks, an initial tooth color change was noticeable (Figure 4), necessitating removal of a PFM crown on the maxillary right lateral incisor (Figure 5). The existing cast gold post and core was sandblasted using 50 µm aluminium oxide and then etched with 37.5% phosphoric acid (Kerr Etchant, Kerr, Orange, CA, USA) to remove any residual debris. An adhesive system (Opti-Bond Solo Plus, Kerr) was applied to the post and cured before applying a white opaque resin tint (Kolor Plus, Kerr) (Figure 6). A self-cured

*Figure 3. Close-up view of the four upper incisors in need of tooth whitening and restorations.*

*Figure 4. Initial whitening of upper tetracycline-stained teeth after 4 weeks of treatment. The unmatched upper right lateral incisor becomes even more evident and requires replacement with a temporary crown.*

*Figure 5. A cast gold post and core had been used to support the porcelain-fused-to-metal crown, and it was decided to leave it in place as no infiltration was clinically evident at the dentin margins.*

*Figure 6. The post was sandblasted with 50 µm aluminium oxide, residual particles were removed with phosphoric acid, and a fifth-generation adhesive system was placed and cured before covering the post with an opaque white resin tint.*

bis-acrylic composite resin Vita shade A2 (Protempt III, 3M ESPE, St. Paul, MN, USA) was placed in a template to fabricate a direct provisional crown. The resulting temporary crown was trimmed and polished, and a mixture of violet and brown composite tints was applied to the cervical third of the temporary crown and cured (Figure 7). In the next few months, modification of tint colors was performed to match the lighter tooth structure of adjacent teeth, further motivating the patient. Tooth whitening was considered acceptable after 6 months of treatment (Figure 8).

Restorations were delayed 3 weeks to better match the adjacent tooth structure and avoid oxygen inhibition of adhesive and composite resins. Restorative procedures were started with the direct composite resin restoration of the two upper central incisors and upper left lateral incisor.

A rubber dam was applied, existing restorations were removed, and cavity preparation was completed (Figure 9). Enamel and dentin hybridization was completed using a 35% phosphoric acid (UltraEtch, Ultradent Products Inc.) and a fifth-generation 15% filled ethanol-based adhesive system (OptiBond Solo Plus, Kerr). A QTH light (VIP Light, Bisco Inc, Schaumburg, IL, USA) was used to polymerize both the adhesive system and the composite resin. Vit-l-escence microhybrid composite resin (Ultradent

Products Inc.) was selected to restore the teeth. Stratification and polymerization of composite resin were accomplished using a technique reported elsewhere.[15] Figure 10 shows the clinical appearance 1 week after completing the two direct composite resin restorations, still in need of final polishing.

The existing composite resin restoration was also removed on the devitalized left lateral incisor. However, upon removal of composite resin, a fracture of the residual enamel facial wall occurred and just a thin enamel layer remained intact on the distal surface. At this point, 3 to 4 mm of gutta-percha was removed from the canal to expose dentin and increase microretention when using enamel dentin adhesive systems to bond a direct fiber-reinforced post system. Coronal and radicular dentin was etched with phosphoric acid (UltraEtch), and a fifth-generation 40% filled ethanol-based adhesive system (PQ1, Ultradent Products Inc.) was used according to the manufacturer's instructions. An ultrahigh molecular weight polyethylene triaxial fiber (Ribbond Triaxial, Ribbond, Seattle, WA, USA) was selected and placed into the canal according to a previously described protocol.[16] After completing the tooth buildup with regular composite resin, tooth was prepared for a full ceramic crown and a temporary crown was fabricated according to the same technique adopted for the right lateral incisor.

*Figure 7. The temporary crown in place after 10 weeks of tooth whitening. The temporary crown looks lower in value than the adjacent teeth, demonstrating that tooth whitening continued in the meantime.*

*Figure 8. Retracted frontal view of upper teeth at 6 months after completing the tooth whitening treatment. The temporary crown shade was changed again using a higher value tint to match with the adjacent teeth.*

*Figure 9. Close-up view of the two central incisors ready to be restored with composite resin after removing the existing restoration.*

*Figure 10. Frontal view of the two restored teeth still in need of final polishing 1 week after completing the restorations. The perfect blend of shade, form, and texture helped mimic the two composite restorations with the surrounding tooth structure.*

At the next appointment, shade selection was accomplished using a Vita Shade Guide (Vident, Brea, CA, USA) (Figure 11). Tooth preparation of upper lateral incisors was refined using an ultrasonic bur (Brassler-Komet, Lemgo, Germany). On the right lateral incisor a chamfer preparation was obtained from the existing preparation; conversely, on the left lateral incisor a more conservative chamfer preparation was created. An impression of the upper arch was taken using a custom impression tray and a combination of medium- and low-viscosity polyether impression material (Impregum Penta & Permadyne Garant 2:1, 3M ESPE). The impression was sent to the laboratory to fabricate two all-ceramic crowns based on densely sintered aluminum oxide ceramic (Procera AllCeram, Nobel Biocare AB, Gothenburg, Sweden). The aluminum oxide cores were layered with conventional feldspathic ceramic (Creation, Klema, Switzerland). At the next appointment, the two Procera crowns were tried in for correct fit, shade, contact points, and texture before starting cementation procedures. As increased retention was not required, conventional glass ionomer cement (Ketac Cem Aplicap, 3M ESPE) was considered the material of choice for cementation of the two crowns. Figures 12 and 13 show the dramatic esthetic improvement after completing both the tooth whitening and the restorative procedures at the 6-month recall.

## DISCUSSION

Tetracycline exposure in utero and in early childhood often results in intrinsic tooth staining that varies in severity based on the timing, duration, and concentration of tetracycline administered. Traditionally, dental esthetics compromised by tetracycline staining have been restored with modalities


*Figures 11. (A–C) Shade evaluation of hydrated teeth adjacent to the prepared lateral incisors using the Vita Shade Guide.*

*Figure 12. Postoperative facial view of final direct composite and indirect ceramic restorations in the four upper incisors.*

requiring aggressive tooth preparation. The clinical case reported represents an example of successful treatment of tetracycline-stained teeth using a combination of the most conservative techniques available today. Tooth whitening has the most relevant role in a minimally aggressive approach used in the esthetic rehabilitation of intrinsically stained teeth. The efficacy of NGVB is 98% for non–tetracycline-stained teeth, whereas tetracycline-stained teeth can be expected to lighten in at least 86% of cases, although an extended treatment time is required. Retention of the shade change is expected in at least 43% at 10 years of posttreatment[17]; similar results have been reported for tetracycline-stained teeth at the 90-month recall.[8] Similarly, Haywood reported that after an initial relapse in the first 2 weeks in which the treatment is completed, color tends to be stable for 1 to 3 years, with some treatments being permanent.[18] Patient motivation and acceptance of extended tooth whitening treatment are key factors in a positive final outcome. Tooth sensitivity is an important issue when bleaching teeth, particularly when an extended treatment is required. Tooth sensitivity was very mild or totally absent throughout the treatment, which is key for patient compliance; probably the use of 10% carbamide peroxide helped achieve this result.[19]

The esthetic integration of a large Class III composite resin restoration with both the surrounding tooth structure and adjacent aluminum oxide all-ceramic crowns is a factor in restorative success. This phenomenon gives credit to the ever-improving physical and mechanical characteristics of composite resin that have occurred in the last decade. The integration of direct and indirect restorations was the result not only of an accurate shade match but also the correct blending of shade, form, and surface texture.

All-ceramic crowns were limited to only two teeth, one of which had already received a PFM crown in


*Figure 13.* A, B *Postoperative lateral views of final restorations.*

the past. An aluminum oxide ceramic crown was preferred versus a zirconium oxide ceramic because it combines long-term excellent mechanical properties and good esthetic characteristics.[20]

Although the custom gold post and core was masked with a tint on the right lateral incisor, the Procera crown demonstrated excellent masking ability and capability to naturally reflect light owing to its translucent but not transparent core. Lately, the more opaque zirconium oxide ceramics have also been introduced, but just a few long-term clinical studies are available.[21,22]

The cementation procedure of aluminum oxide all-ceramic crown remains a subject of controversy among authors. Burke and colleagues recommended adhesive cementation of high-strength ceramic restorations.[23] However, recent in vitro studies reported that resin bonding to high-strength ceramics is less predictable owing to the intrinsic composition of the ceramic, thus resulting in an adhesive interface that is more susceptible to failure.[24–26] Conventional cementation with glass ionomer cements remains the most predictable method for cementation of aluminum oxide all-ceramic crowns.

Spear recommended the use of PFM crowns with ceramic butt-joint and facial cutback of the metal framework for the restoration of a single anterior discolored tooth and pointed out the difficulty in matching metal-free ceramics in similar situations[27]; the competence of a well-trained laboratory technician is of paramount importance in this contest. However, it was thought that the tooth color achieved after bleaching could also have matched very well using an aluminum oxide–based ceramic; shade matching is easier with high-value teeth using a densely sintered aluminum oxide ceramic versus medium-value/higher-chroma teeth. Moreover, a less aggressive tooth preparation was required for the left lateral incisor than may have been necessary for a PFM crown. Extending more conservative preparation to all-ceramic crowns is the next goal clinicians should pursue in the near future.

## CONCLUSION

Preserving natural tooth structure by using adhesive restorations may be considered one of the most important conquests of modern restorative dentistry. The advent of tooth whitening has further increased clinicians' ability to save the remaining sound tooth structure. Dentists should take advantage of modern materials and techniques, extending their application even to the most challenging clinical situation; efforts should be directed at precluding the use of more extensive restorative treatment on a regular basis, delaying expensive crown and bridge procedures.

## DISCLOSURE AND ACKNOWLEDGMENTS

The authors do not have any financial interest in the companies whose materials are discussed in this article.

The authors would like to express their gratitude to Mr. Salvatore Giagheddu, University of Cagliari, for his precious help.

## REFERENCES

1. Haywood VB, Heymann HO. Nightguard vital bleaching. Quintessence Int 1989;20:173–6.
2. Haywood VB. History, safety, and effectiveness of current bleaching techniques and application of nightguard vital bleaching technique. Quintessence Int 1992;23:471–88.
3. Deliperi S, Bardwell DN, Papathanasiou A. Clinical evaluation of a combined in office and take home bleaching system. J Am Dent Assoc 2004;135:628–34.
4. Haywood VB. New bleaching considerations compared with at-home bleaching. J Esthet Restor Dent 2003;15:184–7.
5. Christensen GJ. Bleaching teeth—which way is best? J Esthet Restor Dent 2003;15:137–9.
6. Haywood VB, Leonard RH, Dickinson GL. Efficacy of six months nightguard vital bleaching of tetracycline-stained teeth. J Esthet Dent 1997;9:13–9.
7. Leonard RH, Haywood VB, Eagle JC, et al. Nightguard vital bleaching of tetracycline-stained teeth: 54 months post-treatment. J Esthet Dent 1999;11:265–77.
8. Leonard RH, Haywood VB, Caplan DJ, Tart ND. Nightguard vital bleaching of tetracycline-stained teeth: 90 months post-treatment. J Esthet Restor Dent 2003;3:142–53.
9. Raigrodski AJ. All-ceramic full-coverage restorations: concepts and guidelines for material selection. Pract Proced Aesthet Dent 2005;17:249–56.
10. Magne P, Belser UC. Bonded porcelain restorations in the anterior dentition. Chicago: Quintessence; 2002.

11. Spear FM. Esthetic correction of anterior dental malalignment: conventional versus instant (restorative) orthodontics. J Esthet Restor Dent 2004;16:149–64.

12. Magne P, Belser UC. Novel porcelain laminate preparation approach driven by a diagnostic mock-up. J Esthet Restor Dent 2004;16:7–18.

13. Deliperi S, Bardwell DN. Two-year clinical evaluation of nonvital tooth whitening and resin composite restorations. J Esthet Restor Dent 2005;17:369–78.

14. Deliperi S, Bardwell DN, Zawawi KH. Clinical evaluation of direct cuspal coverage composite resin restorations [abstract 0165]. [Special Issue A] J Dent Res 2005;84.

15. Deliperi S, Bardwell DN, Congiu MD, Kugel G. New layering and curing techniques for class III restorations: a case report. Pract Proced Aesthet Dent 2005; 17:221–8.

16. Deliperi S, Bardwell DN, Coiana C. Reconstruction of devital teeth using direct fiber-reinforced composite resins: a case report. J Adhes Dent 2005;7:165–71.

17. Leonard RH Jr. Long-term treatment results with nightguard vital bleaching. Compend Contin Educ Dent. 2003;24: 364–74.

18. Haywood VB. Current status of nightguard vital bleaching. Compend Contin Educ Dent 2000;28(suppl):S10–7.

19. Matis BA, Wang Y, Jiang T, Eckert GJ. Extended at-home bleaching of tetracycline-stained teeth with different concentrations of carbamide peroxide. Quintessence Int 2002;33:645–55.

20. Andersson M, Razzoog M, Odèn A, et al. PROCERA: a new way to achieve an all-ceramic crown. Quintessence Int 1998;29:285–96.

21. Oden A, Andersson M, Krystek-Ondracek I, Magnusson D. Five-year clinical evaluation for Procera all-ceramic crowns. J Prosthet Dent 1998;80:450–60.

22. Odman P, Andersson B. Procera all-ceramic crowns followed for 5 to 10.5 years: a prospective clinical study. Int J Prosthodont 2001;14:504–9.

23. Burke FJT, Fleming GJP, Nathanson D, Marquis PM. Are adhesive technologies needed to support ceramics? An assessment of the current evidence. J Adhes Dent 2002;4:7–22.

24. Kern M, Thompson VP. Bonding to glass infiltrated alumina ceramic: adhesive methods and their durability. J Prosthet Dent 1995,73:240–9.

25. Friederich R, Kern M. Resin bond strength to densely sintered alumina ceramic. Int J Prosthodont 2002;15:333–8.

26. Blatz MB, Sadan A Soignet D, et al. Long-term resin bond to densely sintered aluminium oxide ceramic. J Esthet Restor Dent 2003;15:362–9.

27. Spear FM. The metal-free practice: myth? Reality? Desirable goal? J Esthet Restor Dent 2001;13:59–67.

---

*Reprint requests: Simone Deliperi, DDS, Via G. Baccelli, 10/b, 09126, Cagliari, Italy; e-mail: simone.deliperi@tufts.edu*