

RESTORING TETRACYCLINE-STAINED TEETH WITH A CONSERVATIVE PREPARATION FOR PORCELAIN VENEERS: CASE PRESENTATION

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Tetracycline exposure in utero and in early childhood often results in intrinsic tooth staining that varies in severity based upon timing, duration, and form of tetracycline administered. Traditionally, dental aesthetics compromised by tetracycline staining have been restored with modalities requiring aggressive tooth preparation. In this case involving a patient with extremely severe staining of healthy and aesthetically shaped dentition, a conservative tooth preparation strategy and porcelain veneers were utilized to preserve tooth shape and arch form while restoring natural color.

Learning Objectives:

This case report presents a minimally invasive approach for the restoration of tetracycline-stained teeth. Upon reading this article, the reader should:

- Understand the requirements for material selection when restoring severely discolored dentition.
- Recognize the minimally invasive preparation technique that could be used for optimal results.

Key Words: tetracycline, minimally invasive, porcelain, veneers

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Tetracyclines are a group of broad-spectrum antibiotics originally found in *Streptomyces* bacteria and used in treating many common infections. When administered after the second trimester of pregnancy through the age of 12 years (the period during which permanent teeth are still forming), the antibiotic is deposited within these forming teeth and intrinsic staining may result.¹⁻⁵ Severity of discoloration depends upon the type of tetracycline administered, the dosage, and the duration of exposure to the drug. Regardless of severity, the result is the unaesthetic appearance of the dentition while the health of the teeth is not compromised.

Tetracycline Staining

The period of dental formation during which teeth are most vulnerable to tetracycline staining is from the fourth month in utero through the fifth month postpartum.⁶ In addition to developing fetuses and children under age 13, infants of breast-feeding mothers to whom the drug is administered can be affected.^{3,7} When the drug is administered in courses, discoloration is generalized and band-like; extended use results in a more homogeneous appearance. Different tetracyclines result in different color effects (eg, a slate grey color results from chlortetracycline exposure whereas a creamy discoloration is common with exposure to oxy-tetracycline.^{8,9} Color tends to become browner with sun (ultraviolet) exposure, with anterior teeth more susceptible to light-induced color changes than posterior teeth.

Routine vital bleaching procedures cannot satisfactorily remove dark tetracycline staining.¹⁰ When staining is limited to the gingival third of the tooth and the patient has a lower smile line, cosmetic treatment may not be indicated because the lip will cover the discolored band. When banding exists in the incisal or middle third and/or the patient has a high smile line, the resulting poor aesthetics are, however, most effectively addressed with restorative procedures that mask the dark intrinsic color. Traditionally, these measures have included full-coverage crowns, composite bonding, and porcelain veneers following aggressive preparation of the tooth structure. The results often cannot simulate natural tooth coloration because the underlying darkness (eg, from



Figure 1. Severe tetracycline staining is evident throughout the aesthetic zone in both the maxilla and mandible.



Figure 2. A caliper is used to ensure 1.5 mm of incisal reduction.



Figure 3. Depth cutters are used as a guide for initial facial reduction; a stump shade is taken for communication with the ceramist regarding gingival color.



Figure 4. Gingival margins are prepared with a minimal chamfer line placed in enamel.



Figure 5. Utilizing a football-shaped diamond, discolored tetracycline banding is removed from the middle third of the tooth.



Figure 6. A finishing diamond (8868-016, Brasseler, Savannah, GA) is utilized to smooth all transition areas and refine all margins.



Figure 7. The Luxatemp B1 (Zenith DMG, Englewood, NJ) maxillary provisional is viewed against the severely stained mandibular teeth.



Figure 8. Note the arch form discrepancy and the saturation of color into the gingival third of the mandible.

dentin, metal, or opaquers) can affect the translucent effect of the porcelains.¹⁰ An alternative aggressive method of treatment is elective endodontic therapy with internal bleaching. Though the results are dramatic, the purposeful removal of healthy pulps is considered too radical despite the cosmetic improvement.^{11,12}

The following case presentation demonstrates the restorative protocol used for restoration of severely tetracycline-stained teeth using a minimally invasive approach for delivery of porcelain veneers.

Case Presentation

A 43-year-old male patient presented with severe staining of all the teeth in the aesthetic zone (Figure 1). The staining was caused by exposure to tetracycline for the treatment of severe ear infections from birth until four months of age.⁶ The patient also exhibited a high “dental IQ” developed over a long and fruitless history of consultations in search of an acceptable restorative approach. Despite the extreme discoloration of his teeth, the patient had rejected prior treatment plans in order to preserve the existing tooth structures. The patient recognized that the aggressive preparation required for conventional restorative options would remove large amounts of tooth structure and may deliver unnatural aesthetics. By the time he arrived in the author’s practice, the patient had delayed treatment in order to secure a minimally invasive technique that delivered natural aesthetics. Because of his previous rejection of treatment, the patient’s anterior teeth had never been treated prosthetically and presented in virgin condition, making a conservative preparation design possible and desirable. Discoloration was pronounced in the middle third of all the teeth and, to a lesser degree, in the incisal third. The shade of the gingival third was nearly ideal in the maxilla, but stained in the mandible.

The patient’s resolve regarding reduction of tooth structure exerted a decisive influence on the treatment planning, diagnostics, material selection, tooth preparation, provisionalization, and final restoration of the case. It also necessitated an exceptionally thorough and detailed collaboration between the clinician and the ceramist that included a trial of alternative restorative materials.



Figure 9. The mandibular preparations remove dark banding and correct the misaligned arch form without opening contacts.

The patient's goal of preserving existing natural tooth shape, maxillary arch form, and most of the mandibular arch form necessitated meticulous collaboration between the clinician and the ceramist to develop a treatment plan that was both clinically sound and technically viable. Mounted casts in centric relation with face-bow, occlusal evaluation, and complete digital photography conforming to AACD protocols were prepared for communication with the laboratory and the patient. The clinician and ceramist conferred verbally and electronically (ie, e-mail correspondence, e-mail transmittal of digital photography), and five pretreatment consultations were held with the patient. The ceramist often participated in patient conferences via telephone conferencing. It was agreed that because of the desirable shape and orientation of the patient's natural dentition, a diagnostic waxup was not necessary.

To determine whether the discoloration could be masked with minimal tooth preparation, a trial veneer was placed on a single tooth outside the aesthetic zone. The #12(24) premolar was reduced by approximately 0.7 mm to expose negative color in the dentin, and a shade match was obtained. Blanks of three different restorative materials (AO++ Authentic, Microstar, Lawrenceville, GA; Empress II ingot 50, Vivadent, Amherst, NY; and d.Sign Brilliant Dentin White, Ivoclar, Amherst NY) were tried on the prepared tooth. In order to identify the material that would achieve complete masking with the least amount of porcelain and the most conservative tooth preparation, each material was



Figure 10. Try-in of all ceramic units finds no show-through of the middle band except in teeth #7(12) through #10(22), where reduction was insufficient in the middle facial preparation.



Figure 11. In the laboratory, the ceramist defers fabrication of final restorations for teeth #7 through #10 because of concern that preparations might not be sufficient for complete masking of the tetracycline staining.

successively thinned by the ceramist at chairside and tried in by the dentist until discoloration from the prepared tooth became evident. Complete masking was attained with 0.6-mm thickness of a pressed ceramic material (ie, AO++ Authentic, Microstar, Lawrenceville, GA). The preparation requirements for use of the material conformed to the patient's expectations, and the treatment was accepted.

Preparation

Preparation requirements differed somewhat in the two arches because discoloration was more severe in the middle and cervical thirds of the mandibular teeth and because the patient desired a slight correction of the mandibular arch form.

In the maxilla, the incisal edges were reduced by 1.5 mm (Figure 2) to create sufficient restorative space to achieve lifelike translucency. Depth cutters were used



Figure 12. The final preparation of teeth #7 through #10 achieves sufficient amount of reduction to block color.



Figure 14. The final result exhibits excellent incisal translucency and youthful incisal embrasures.



Figure 13. The final result achieves the goal of eliminating the tetracycline staining while preserving the aesthetic shape, form, and alignment of the patient's natural teeth.

for the facial reductions (Figure 3), and interproximal contacts were maintained in order to preserve tooth width, shape, and contour. Negative space in the buccal corridor was maintained in conformance with the patient's wishes. The natural color was nearly ideal in the cervical third, and a traditional feldspathic veneer preparation was utilized. Approximately 0.5 mm of enamel was removed, and a definitive chamfer line was placed in enamel (Figure 4).¹³ In the middle third of the teeth, a red football-shaped finishing diamond (368EF-023, Brasseler, Savannah, GA; 1923F, Microcopy, Kennesaw, GA) was utilized to remove the 0.6mm of discolored tooth structure necessary to attain complete masking with the pressed ceramic restorative material (Figure 5). The more aggressive preparation in the middle third was necessitated by the degree of staining in this area. All transition areas were smoothed and margins refined uti-

lizing a finishing diamond (8868-016, Brasseler, Savannah, GA) (Figure 6). Maxillary full-arch impressions (eg, Honigum, Zenith DMG, Englewood, NJ; Take 1, Kerr/Sybron, Orange, CA) and maxillary provisionals (Luxatemp B1, Zenith DMG, Englewood, NJ) were fabricated utilizing a silicone matrix.

In the mandible, tetracycline staining was more severe in the middle and cervical thirds of the anterior teeth (Figure 7). The same principles of preparation design used in the maxillary arch were applied to the mandibular teeth; however, a more extensive middle and cervical-third reduction was prepared. Additionally, the patient desired a slight realignment of the arch form from teeth #23(32) through #26(42) (Figure 8), where tooth #24(31) was in facial version to #25. To correct the alignment without changing tooth width or form, the facial incisal third of #24(41) was removed and brought to the lingual, and the lingual incisal third of #25 was brought to the facial. The distal incisal corner of tooth #26 was more modestly brought to the lingual to complete the realignment (Figure 9).

Full-arch impressions (Honigum, Zenith DMG, Englewood, NJ) of the mandibular teeth and a face-bow (Stators, Ivoclar, Amherst, NY) were taken. Registration bites were obtained with and without a stick bite lined up with the patient's eyes. To aid in communication with the ceramist regarding final shade selection for the veneers, numerous digital photographs were taken with shade tabs adjacent to the prepared stumps. Provisional restorations (eg, Luxatemp B1, Zenith DMG, Englewood,

NJ; BioTemps, Glidewell Laboratories, Newport Beach, CA) were bonded (Tempbond Clear, Kerr, Orange, CA; TempoCem, Zenith DMG, Englewood, NJ), and further digital photographs were taken with the provisionals in place.

Prior to cementation and after the veneers had been tried in for proximal continuity and marginal fit, the veneers were color evaluated with water-soluble try-in gels (3M Try-In Gel, 3M ESPE, St. Paul, MN) (Figure 10). Due to insufficient reduction in the middle third of teeth # 7(12) through #10(22), the pressed ceramic did not block out the dark zone (Figure 11). Utilizing a silicone index (Sil-tech, Ivoclar, Amherst, NY), the clinician removed sufficient additional tooth structure (0.5mm) to achieve complete masking (Figure 12). The four mandibular incisors were temporized; the remaining final restorations were cemented with laser-cured 3M Luting Cement (3M ESPE, St. Paul, MN) (Figure 13). One week later, the final four restorations were delivered. The final result exhibited excellent incisal translucency and characterization, round incisal edges, youthful incisal embrasures, and natural color (Figures 14 and 15).

Conclusion

The aforementioned case demonstrated that even extreme tetracycline staining can be aesthetically and conservatively treated provided that the following key principles of treatment are observed:

- *Thorough patient consultation.* The patient's determination to preserve his natural smile in this case established the parameters for planning the case. Understanding and respecting patient needs and desires are fundamental.
- *Careful material selection.* The technical capabilities of restorative materials differ. Testing alternative restorative products verified the feasibility of the patient's ideals and allowed selection of the most appropriate material.
- *Meticulous laboratory collaboration.* The technical capabilities and requirements of the restorative materials determined preparation design. Observing these was possible only with complete involvement of the ceramist.

- *Elimination of a dual interface.* Tetracycline-stained teeth have traditionally been etched and bonded with resin bonding in the dark-banded zone before veneering, a technique that presents technical difficulties (eg, the resin composite sometimes separates from the tooth when the provisional restoration is removed) and does not predictably mask color. It also requires more severe tooth preparation in order to create space for two restorative materials. Utilizing a single interface simplified the restorative process, increased operator control, and improved predictability.

When treatment was completed, the patient was satisfied and reassured that postponing treatment during his long and frustrating quest for a conservative treatment for preserving his smile was justified by the final result.

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CONTINUING EDUCATION (CE) EXERCISE No. 18

To submit your CE Exercise answers, please use the answer sheet found within the CE Editorial Section of this issue and complete as follows: 1) Identify the article; 2) Place an X in the appropriate box for each question of each exercise; 3) Clip answer sheet from the page and mail it to the CE Department at Montage Media Corporation. For further instructions, please refer to the CE Editorial Section.

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article: "Restoring tetracycline-stained teeth with a conservative preparation for porcelain veneers: Case presentation," by Joyce Basset, DDS, and Brad Patrick, BSc. This article is on Pages 481-486.

1. At what stage of life are tetracycline stains developed?

- a. Throughout the adolescent years only.
- b. After the second trimester of pregnancy through the age of 12 years.
- c. In utero only.
- d. None of the above.

2. Tetracycline staining is initiated by:

- a. The administration of broad-spectrum antibiotics originally found in *Streptomyces*.
- b. The use of tetracyclines used in the treatment of many common infections.
- c. Administration of tetracycline antibiotics after the second trimester of pregnancy through the age of 12 years.
- d. All of the above.

3. According to the aforementioned article, a variety of porcelain materials were selected based on an initial try-in to ensure proper:

- a. Biocompatibility of the porcelain to the tooth structures.
- b. Concealment of the dark, tetracycline-stained tooth structures beneath the proposed veneers.
- c. Shade match with the patient's natural tooth color. Care was taken to place dark striations throughout the proposed veneers for an accurate match.
- d. All of the above.

4. Teeth are most vulnerable to tetracycline staining:

- a. From the fourth month in utero through the fifth month postpartum.
- b. From the fourth month in utero through birth.
- c. Only during breast-feeding.
- d. Only in utero.

5. Routine vital bleaching procedures are sufficient in removing tetracycline staining. Anterior teeth are more susceptible to light-induced color changes than posterior teeth.

- a. The first statement is true, the second statement is false.
- b. The first statement is false, the second statement is true.
- c. Both statements are true.
- d. Both statements are false.

6. Which of the following can be affected by tetracycline staining:

- a. Developing fetuses.
- b. Children under age 13.
- c. Infants of breast-feeding mothers.
- d. All of the above.

7. In reference to color effects, which of the following is false?

- a. A slate grey color results from chlortetracycline exposure.
- b. A creamy discoloration is common with exposure to oxy-tetracycline.
- c. Color depends on the age when a person is exposed to tetracycline.
- d. Color tends to become browner with sun (ultraviolet) exposure.

8. Following aggressive preparation of the tooth structure, the restoration of tetracycline-stained teeth have included:

- a. Full-coverage crowns.
- b. Composite bonding.
- c. Porcelain veneers.
- d. All of the above.

9. Conservative results cannot generally simulate natural tooth coloration because the underlying darkness can affect the restoration's translucency. Underlying darkness is defined as all of the following EXCEPT:

- a. Dentin.
- b. Gingival pathology.
- c. Metal.
- d. Opaquers.

10. An alternative aggressive method of treatment is elective endodontic therapy with internal bleaching. Despite the dramatic results, many clinicians prefer more conservative treatment due to:

- a. Time and cost of treatment.
- b. The removal of healthy pulps.
- c. The pain patient endures during treatment.
- d. Temporary results.