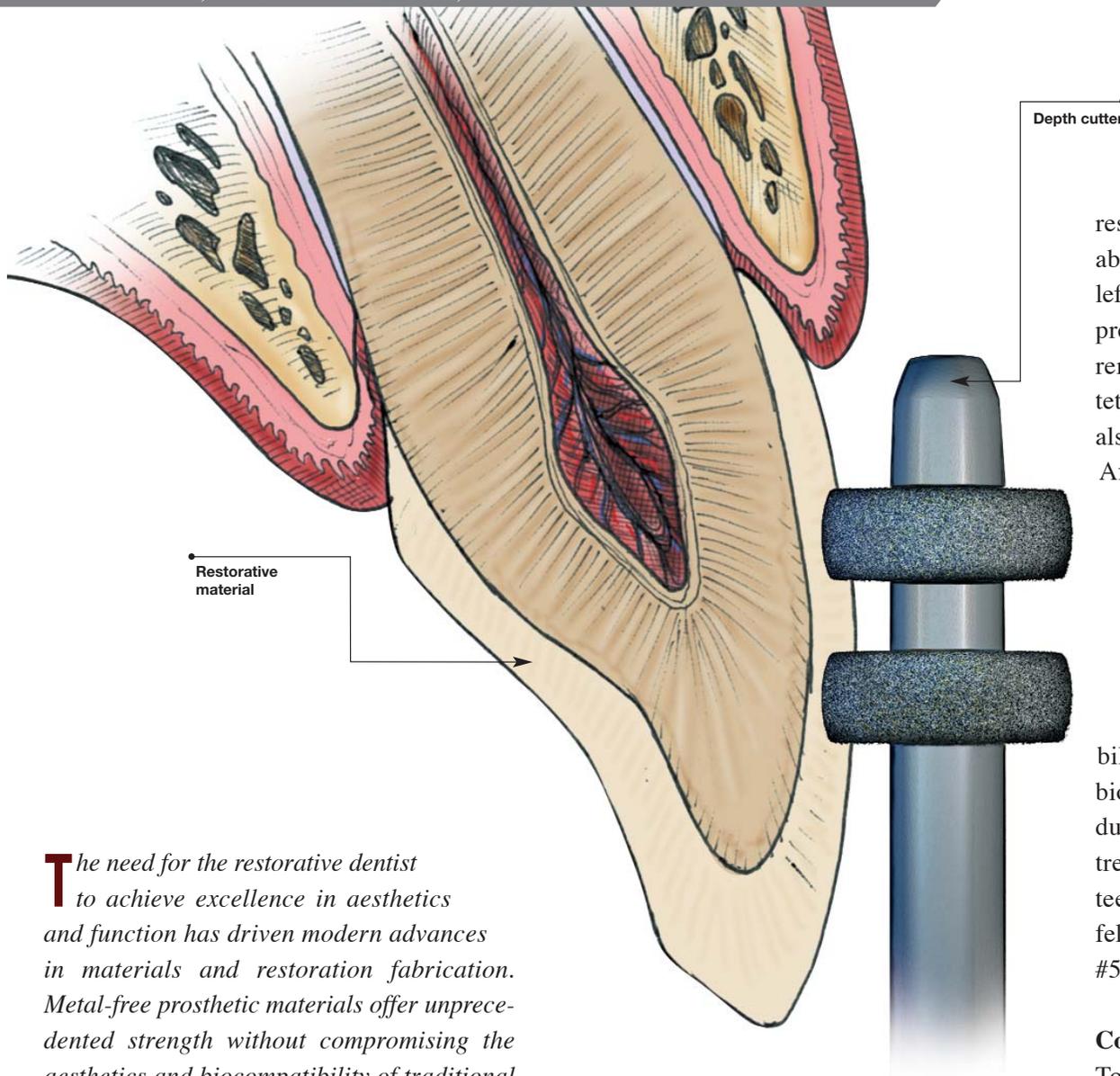


CAD/CAM Technology Gives Us More to Smile About

Lorin Berland, DDS* • Mia Williams, DDS*



The need for the restorative dentist to achieve excellence in aesthetics and function has driven modern advances in materials and restoration fabrication. Metal-free prosthetic materials offer unprecedented strength without compromising the aesthetics and biocompatibility of traditional all-ceramic systems.

One such CAD/CAM-based system (Lava, 3M ESPE, St. Paul, MN) utilizes feldspathic porcelain on a zirconium oxide framework.¹ This system offers a more lifelike substrate than did previous systems, utilizing eight shades of colorable frameworks that help create vital, natural-looking crown and bridge-work. The all-ceramic system in question displays strength, excellent marginal fit, and has been proven to have outstanding clinical durability.² Indications include anterior and posterior restorations, from single-unit crowns to three-unit fixed prostheses. The following case presentation illustrates a successful aesthetic and functional application of this exciting zirconia-based system in combination with porcelain veneers for a smile makeover.

CASE PRESENTATION

A 45-year-old male patient presented with an existing 15-year-old 6x8 porcelain-fused-to-metal (PFM) fixed partial denture (FPD) and a similar crown on tooth #9(21) originally placed after an accident avulsed tooth #7(12) and fractured teeth #6(13), #8(11), and #9 (Figures 1 and 2). The prosthesis exhibited the opaque, fake-looking color as well as the black marginal lines on the facial and full metal on the lingual aspects often associated with traditional PFM frameworks (Figure 3). Teeth #6 and #9 had approximately 1.5 mm of gingival recession, exposing the root surface beyond the margin of the crowns. Recession between all the interproximal spaces of teeth #6, #7, #8, and #9 had created unsightly triangular spaces that caused the patient to complain of “annoying spit bubbles,” food

residue, and compromised aesthetics. The abutment crown on tooth #6 and the natural left canine had bulky contours that caused the premolar region to appear recessed. The remaining teeth appeared discolored due to tetracycline staining. Gingival recession was also evident at the premolar regions.

After examining the teeth, the gingival tissues, and appropriate radiographs, and discussing various options, including implants, the Lava zirconia system was selected.³ Replacement of the heavy, unsightly PFM restorations with the much lighter Lava system would greatly improve the aesthetics while still providing the stability and strength required. Furthermore, biocompatibility, gingival health, and conductivity would be greatly improved.⁴ The treatment plan included a zirconia FPD for teeth #6 through #8, a crown on tooth #9, feldspathic porcelain veneers on teeth #4(15), #5(14), #10(22) through #13(25).

Cosmetic Imaging and Smile Library

To aid in the treatment planning for this patient, the Lorin Library Smile Style Guide was used in conjunction with cosmetic imaging. The Smile Style Guide and digital images provided the true 18 aesthetic styles of smiles for the doctor and patient to select from when designing the patient’s smile makeover. In addition, the Library illustrated the four choices of incisal length in relation to the canines. Profile or angled views of each smile design gave the patient the most complete and thorough selection available anywhere when making the final decision concerning the cosmetic dental treatment.⁵

After reviewing the smile designs in full-color portrait, close-up smile, and lateral smile views, the patient chose Smile Design #5 (square centrals/square laterals/pointed canines). The next step was Computerized Cosmetic Imaging. We showed the patient

how he would look with his chosen smile design using a full-face portrait taken with our digital camera and our in-office digital imaging system, Digital Dentist. Once he saw the picture with his cosmetically enhanced smile, he immediately accepted the treatment plan of all-ceramic restorations on teeth #4 through #13. Cosmetic imaging greatly increases patient acceptance, confidence, and ultimate satisfaction.⁶

Preoperative Lab Work

Polyvinylsiloxane impressions of the maxillary and mandibular arches and a bite registration were taken, and this preoperative work was sent to the laboratory along with the cosmetic image and smile design. Teeth #4 through #13 were reshaped, straightened, and built up as detailed by the cosmetic image. This diagnostic waxup was then duplicated in stone for fabrication of the preparation guides and provisional putty matrix. Preparation guides were made to ensure adequate reduction during the preparation appointment.

PREPARATION

Diamond burs were selected to prepare the dentition with a circumferential chamfer or rounded shoulder at a 4° angle or greater and 0.5 mm, with a rounded contour at the inside of the shoulder.⁷ These types of preparations required less tooth structure removal, decreasing the chances of postoperative sensitivity. A small round diamond bur (#0872-1, Shofu Dental, Menlo Park, CA) was used to outline the preparations (Figure 8). A depth cutter (#0897-1, Shofu Dental, Menlo Park, CA) was used to create facial grooves that greatly facilitate gross reduction. Round-ended tapered diamonds (#0835-1 coarse, 836V-1 superfine, Shofu Dental, Menlo Park, CA) were used to prepare the facial and peripheral aspects of the preparations (Figures 10 and 11), and a small flame-shaped fine diamond was used to reduce the incisal lingual line angles.

Complete caries removal was verified using caries detector. Ideal reduction to allow for the necessary porcelain thickness was verified using the facial and palatal preparation guides, and all line angles were rounded. When the preparations were complete, a gingival retraction cord was placed around teeth #6, #8, and #9 and a retraction material



FIGURE 2. Preoperative appearance of the patient's existing condition.



FIGURE 3. Preoperative retracted appearance demonstrated marginal discoloration and opaque preexisting restorations.



FIGURE 4. Palatal view of the preexisting restorations. Note: Metal frameworks were evident from the lingual aspect.



FIGURE 5. A diagnostic waxup was created to determine the desired restorative parameters.



FIGURE 6. A round diamond bur was used to outline the peripheral margins.



FIGURE 7. A depth cutter was used to create facial grooves that greatly facilitated gross reduction.



FIGURE 8. A coarse round-ended tapered diamond bur was used to prepare the facial and peripheral aspects of the preparations.



FIGURE 9. A superfine round-ended tapered diamond bur was used to smooth the tooth preparations.



FIGURE 10. The ideal tooth reduction was verified using the palatal preparation guide.



FIGURE 11. Reduction was then verified using the facial preparation guide.

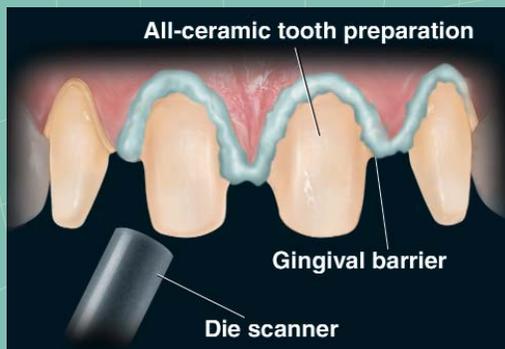


FIGURE 12. Tooth preparation was facilitated following tissue retraction.



FIGURE 13. The provisional restorations were fabricated based on the diagnostic waxup.



FIGURE 14. The zirconia-based system was used to fabricate the substructures for the FPD on teeth #6 through #8 and the crown on tooth #9.



FIGURE 15. The ceramic core relationship to the opposing dentition was evidenced in the laboratory model.



FIGURE 16. Stains and modifier colors were added prior to firing.



FIGURE 17. The first layer of body porcelain was subsequently added.



FIGURE 18. Enamel cutback was performed for mammelon effect and enamel colors were added.



FIGURE 19. Facial view showing porcelain texture after the first bake.

(Expa-syl, Kerr/Sybron, Orange, CA) was placed for four minutes. After thorough rinsing of the retraction material and removal of the retraction cord, a polyether impression (eg, Impregum Soft, 3M ESPE, St. Paul, MN) was taken.

Temporization

For temporization, the putty matrix was filled with an autocure provisional crown-and-bridge material in shade B1 and seated with firm pressure over the prepared teeth. After adjusting the occlusion, cleaning up the margins, and polishing, the provisionals followed the desired shape indicated by the image-inspired waxup (Figure 15). The patient approved the shape, length, and width for fabrication of the final porcelain restorations, and this information was forwarded to the laboratory in the form of photographs and a stone model of the provisionals.

Cosmetic imaging greatly increases patient acceptance, confidence, and ultimate satisfaction

Laboratory Sequence

Lava zirconium oxide frameworks were milled with CAD/CAM technology, in which a scanner using white light scanned the surface of the die to fabricate the framework. This coordinated system provided an excellent accuracy of fit (ie, 50 μ m to 100 μ m).⁸ The framework was equipped with a low coefficient of thermal expansion, and provided the long-term strength needed for both anterior and posterior cases.

The high strength of zirconia allows a framework thickness of 0.5 mm, enabling minimal tooth preparation and aesthetic layering with the feldspathic veneer ceramic.⁹ Improvements in previous zirconia materials give it a high-density content with low porosity, minimizing opaqueness and allowing the translucency needed for optimal aesthetics.¹⁰ In addition, these frameworks can be colored using 7 Vita-Classic shades for characterization to give an excellent natural-looking finish.

For all these reasons, the Lava system was chosen to restore teeth #6 through #8 with a three-unit FPD and #9 crown, and #4, #5, #10 through #13 would be restored with feldspathic porcelain veneers.

Restoration Fabrication

Fully centered zirconia framework substructures were fabricated for the #6 through #8 FPD and #9 crown (Figures 16 and 17). For teeth #4, #5, #10 through #13, lithium disilicate 3-G pressable ceramic cores were fabricated, and all cores were stained and fired (Figure 18). The first buildup of body porcelain completed the bulk of the contours and shape of the restorations (Figure 19). After firing this first layer, the porcelain was cut back for mammelon effect, and enamel color was added (Figure 20). The ceramic material used was a low-fusing porcelain which fires at 1390 degrees with minimal shrinkage (Figure 21). The porcelain layering technique used produces a special effect of translucent porcelain blended on the incisal edge (Figure 22). After the second layer of porcelain that finalized all the detail, shape, and form desired was completed, surface detail and texture were added (Figure 23), and the restorations were glazed. The porcelain was fitted to a stone model, and occlusion, interproximal contacts, and marginal fit were verified to minimize the need for chairside adjustments (Figures 24 and 25).

Seating Appointment

The resin temporaries were sectioned and removed with a spoon excavator. Any residual temporary cement was removed with rubber cup pumice and air abrasion. The bridgework and crowns were tried in to verify the excellent marginal fit and aesthetics exhibited by the Lava system (Figure 26). The Lava restorations (#6 through #8, and #9) were seated using RelyX Unicem cement (3M), a self-adhesive dual-cure resin cement. Pretreatment steps are not needed with Unicem, further decreasing the chances of postoperative sensitivity and providing strong adhesion with just one working step.

Abutments #4, #5, and #10 through #13 were etched with 34% phosphoric acid for 15 seconds and then thoroughly rinsed and dried. For these teeth, Single Bond (3M ESPE, St. Paul, MN) light-cured adhesive was applied and



FIGURE 20. Lingual view showing translucent porcelain blending on the incisal edge.



FIGURE 21. Second buildup layer of porcelain after the second bake, ready for glazing.



FIGURE 22. Appearance of the definitive FPD and crown restorations.



FIGURE 23. Final restorations fitted to the stone model.



FIGURE 24. The all-ceramic FPD and crowns were tried in intraorally to verify marginal fit and aesthetics.



FIGURE 25. Postoperative appearance of the retracted oral environment.



FIGURE 26. Palatal evaluation demonstrated aesthetic integration and harmony.



FIGURE 27. Postoperative appearance of the definitive restorations using contemporary all-ceramic treatment options.

air dispersed to a glossy appearance, and cured. These veneers were seated using A-1 RelyX veneer cement (3M ESPE, St. Paul, MN).

All contacts were flossed and excess resin was removed using a sable brush. The bonded restorations were then thoroughly cured. When polymerization was complete, the gingival marginal flash was removed with a Bard Parker blade No. 12. The Shofu Contemporary Polishing Kit, which includes six shapes of fine and superfine NTI Diamonds, was used to smooth the lingual incisal margins and interproximals.

CONCLUSION

In the quest to provide improved aesthetics and function to increasingly discriminating tastes, dentists and dental laboratories have turned to new and exciting materials and techniques. The Lava system provides innovative technology using strong CAD/CAM fabricated copings and highly aesthetic all-ceramic restorations on a zirconium oxide base. The evolution of dental materials continues to revolutionize the way we practice modern dentistry, satisfying a broad range of patient and practitioner demands. ■

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CONTINUING EDUCATION EXERCISE

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article "CAD/CAM Technology Gives Us More to Smile About" by Lorin Berland, DDS, and Mia Williams, DDS. This article is on pages 26-30.

Upon reading this article and completing this exercise, the reader should:

- Understand how to utilize the Lava CAD/CAM system to create aesthetic all-ceramic restorations.
- Explain the process and procedures used when creating all-ceramic restorations with a CAD/CAM system.

1. The porcelain-fused-to-metal fixed partial denture in this case presentation exhibited:

- a. Black marginal lines on the facial aspect.
- b. Opaque color.
- c. Full metal on the lingual aspects.
- d. All of the above.

2. Based on this article, patient evaluation should include:

- a. Presentation of various treatment options.
- b. Examination of the dentition and gingival tissues.
- c. Radiographic evaluation.
- d. All of the above.

3. Which type of restorative combination was acceptable for the case presentation described in this article?

- a. Feldspathic porcelain veneers on teeth #4, #5, and #10 through #13 and a zirconia PFD for teeth #6 through #8, and a crown on tooth #9.
- b. Feldspathic porcelain veneers on teeth #6 through #8, a zirconia PFD for teeth #4, #5, and #10 through #13, and a crown on tooth #9.
- c. Feldspathic porcelain veneers on teeth #4, #5, and #10 through #13 and a zirconia PFD for teeth #6 through #8, and a crown on tooth #10.
- d. Feldspathic porcelain veneers on teeth #6 through #8, a zirconia PFD for teeth #4, #5, and #10 through #13, and a crown on tooth #10.

4. Preoperative materials and information forwarded to the laboratory included:

- a. Smile design, cosmetic images, radiographs, and a diagnostic waxup.
- b. Smile design, cosmetic images, polyvinylsiloxane impressions, and a bite registration.
- c. Smile design, cosmetic images, a full-face portrait, and a stone model.
- d. Smile design, cosmetic images, provisional putty matrix, and a preparation guide.

5. What type of preparation sequence was advocated in the aforementioned case presentation?

- a. The dentition was prepared with a circumferential chamfer with a rounded contour; preparations were outlined with a small round diamond bur; incisal lingual line angles were reduced with a small flame-shaped fine diamond; facial grooves were cut with a depth cutter; and facial and peripheral aspects were prepared using fine-tapered diamonds.
- b. Dentition was prepared with a circumferential chamfer with a rounded contour; facial and peripheral aspects were prepared using fine-tapered diamonds, incisal lingual line angles were reduced with a small flame-shaped fine diamond; and facial grooves were cut with a depth cutter.
- c. Dentition was prepared with a circumferential chamfer with a rounded contour; preparations were outlined with a small round diamond bur; facial grooves were cut with a depth cutter; facial and peripheral aspects were prepared using fine-tapered diamonds, and incisal lingual line angles were reduced with a small flame-shaped fine diamond.
- d. Dentition was prepared with a circumferential chamfer with a rounded contour; incisal lingual line angles were reduced with a small flame-shaped fine diamond; facial grooves were cut with a depth cutter; preparations were outlined with a small round diamond bur; and facial and peripheral aspects were prepared using fine-tapered diamonds.

6. In order to ensure restorative success, which of the following parameters should be approved by the patient?

- a. Shape, width, and root length of the teeth.
- b. Working length, width, and shape of the teeth.
- c. Shape, length, and contour of the teeth.
- d. Shape, length, and width of the teeth.

7. The accuracy of fit was confirmed as accurate to within:

- a. 50 μ m to 100 μ m.
- b. 25 μ m to 50 μ m.
- c. 75 μ m to 100 μ m.
- d. 100 μ m to 150 μ m.

8. The framework used in this case presentation:

- a. Was equipped with a low coefficient of thermal expansion and provided short-term strength.
- b. Was equipped with a high coefficient of thermal expansion and provided short-term strength.
- c. Was equipped with a low coefficient of thermal expansion and provided long-term strength.
- d. Was equipped with a high coefficient of thermal expansion and provided long-term strength.

9. Zirconia materials allow for:

- a. High-density content with high porosity.
- b. High-density content with low porosity.
- c. Low-density content with high porosity.
- d. Low-density content with low porosity.

10. The high strength of zirconia allows a framework thickness of:

- a. 0.15 mm.
- b. 0.05 mm.
- c. 0.1 mm.
- d. 0.5 mm.