COPING MATERIALS FOR IMPROVED AESTHETICS:
Combining Strength and Aesthetics

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Selection of an appropriate framework will significantly influence the definitive aesthetics of any crown or fixed partial denture (FPD). With the proliferation of precious metal copings and computer-assisted design/computer-aided manufacturing (CAD/CAM) materials, restorative options that provide both strength and appearance have increased. In this feature, considerations for selecting among the many framework and CAD/CAM options are reviewed and their characteristics compared.

FIGURE 2. Preoperative view of a fractured tooth. Minimal tooth preparation was performed to preserve as much enamel as possible for better bonding strength. (Dentistry by David Garber, DMD.)

FIGURE 2. Postoperative appearance of the fractured tooth restored with a single pressable all-ceramic crown restoration. Notice the blend of the natural color in the tooth preparation bleeding through and creating an invisible cervical margin with a healthy soft tissue color. (Dentistry by David Garber, DMD.)

FIGURE 3. Preoperative view demonstrates compromised substructure preparation color in the anterior crown. Sufficiently reduced, the crown was replaced with an all-ceramic restoration.

FIGURE 4. Postoperative appearance 15 years later. Some of the natural tooth color from the preparation was allowed to bleed through. (Dentistry by Cathy Schwartz, DDS.)

CONSIDERATIONS

Aesthetics is a matter of opinion; a product is an extension of the fingertips of the operator, and any product is only as good as the operator. The product may or may not be good, but the trick is to know how and when to use it. Many products on the market today possess the desirable optical qualities of fluorescence and opalescence, but matching the product to the restorative environment is critical to its successful utilization. The goal of the ceramist is to create a lifelike appearance and an illusion of reality, mimicking natural teeth. Coping material and technology are among several factors that influence the achievement of that goal. Choice of the most appropriate framework will be determined by consideration of several factors.

Tooth Mobility

Are the teeth mobile? Is there periodontal involvement? Do the teeth need to be splinted? If splinting is necessary, all-ceramic restoration is not an option. A porcelain-fused-to-metal (PFM) or gold (eg, Captek, Precious Chemicals, Altamonte, FL; Bio 2000, Argen Corporation, San Diego, CA) framework is indicated.

Number of Units

Nonmetal copings have not yet demonstrated the flexural strength necessary for restoration of longer spans. When a restoration of more than three units is planned, PFM, gold, or another metal-ceramic framework is indicated.

Tooth Preparation

Each proprietary coping material requires a preparation to meet manufacturer specifications. This is especially true with copings that are machine-fabricated (eg, Procera, Nobel Biocare, Yorba Linda, CA; Lava, 3M ESPE, St. Paul, MN; Cercon, Dentsply Ceramco, Burlington, NJ). If the coping material has not been selected prior to tooth preparation, and the tooth has not been prepared to the manufacturer's specifications, framework selection will be limited and many options foreclosed. The technician cannot create the magic of lifelike restorations without sufficient reduction to layer the ceramic and a preparation design appropriate to the intended framework. Clinicians who prepare teeth as they always have for PFM restorations will be limited to placing PFM restorations.

Substrate Color

What is the substrate color? Is it dark? Nonvital? Is a post and core present? If so, what color is the metal of the post, (eg, gray, silver, gold) (Figure 1)? A single tooth without root canals that has been minimally prepared can be beautifully restored with a pressable ceramic (eg, IPS Empress, Ivoclar Vivadent, Amherst, NY; Authentic, Microstar Corporation, Lawrenceville, GA) in which the framework has been encapsulated in the restoration (Figure 2). Because the restoration's color is a function of the natural tooth color, however, the porcelain, and the cement, an alternative framework is indicated when darkness in the natural tooth is present and will be captured in the pressed-ceramic restoration. If three or fewer units are involved and the teeth are not mobile, this substrate can be blocked with one of the many CAD/CAM products (eg, Cercon, Dentsply Ceramco, Burlington, NJ; Lava, 3M ESPE, St. Paul, MN; Procera Zirconia, Nobel Biocare, Yorba Linda, CA) provided that sufficient space (1.5 mm or more) is available and the ceramist is familiar with the material properties and limitations of whichever product is selected (Figures 3 and 4). Accurate shade

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match to the preparation as well as the natural tooth is necessary with any of these technologies, a task that has been simplified with the advent of shade guidance systems such as the spectrophotometer (eg, SpectroShade, MHT International, Newton, PA; ShadeScan, Cynovad, Montreal, Canada) and the colorimeter (eg, ShadeVision, X-Rite, Grandville, MI).

MATERIALS

Gold remains an excellent solution for all restorative cases. In recent years, alloys and composite alloys with very high gold content have come to market that combine the color, burnishability, and biocompatibility of pure gold but also display the compromised strength and oxidation associated with most high-gold alloys. Laboratory technicians have addressed these issues with an internally reinforced and strengthened network of high-fusing platinum, palladium, gold particles (average 15 μm), giving the restoration a "skeleton" that does not melt and become distorted during fabrication of the metalwork. Because oxide does not form on the surface during porcelain firing, graying does not occur at the margins of the copings. A wide

FIGURE 5. The patient presented with mobility in teeth #8 and #9 that required splinting. A challenge was presented due to the color differences between the two teeth. Two types of restorations were fabricated for illustration and testing purposes. (Dentistry by Henry Salama, DMD.)

FIGURE 6. The restorative options: two splinted Captek (Precious Chemicals, Altamonte, FL) units and two Procera (Nobel Biocare, Yorba Linda, CA) single-unit crowns.

FIGURE 7. The two single CAD/CAM crowns illustrate the ability to conceal the dark tooth structure and achieve a harmonious blend with the adjacent teeth. (Dentistry by Henry Salama, DMD.)

FIGURE 8. The splinted copings. Notice the nice warm color and very sharp finish lines that were carried all the way to the margin to block out the dark tooth structure.

range of porcelains are compatible with the metal, allowing the use of high-, medium-, and low-fusing porcelains for single-unit anterior or posterior crowns and fixed partial dentures of up to six units (Figures 5 through 9). The improved light-dispersing qualities of the resulting crown produce more natural aesthetics than are typically associated with PFM frameworks with minimal tooth reduction.

Most CAD/CAM systems, on the other hand, begin with innately aesthetic and biocompatible core materials and endeavor to produce natural restorations with greater strength than existing all-ceramic alternatives (Table). Competing CAD/CAM systems are distinguished by their technical and procedural characteristics, including:

- The type of scanner used to capture the data (ie, laser, optical, or mechanical);
- If milling is performed, whether the outcome is a densely sintered (eg, Cercon, Dentsply Ceramco, Burlington, NJ; Procera, Nobel Biocare, Yorba Linda, CA; Lava, 3M ESPE, St. Paul, MN) or infiltrated (eg, Cerec inLab, Sirona Dental Systems, Charlotte, NC; Wol-Ceram, Wol-Dent SDI, Miami, FL) product;
- Whether the system can produce multiunit or single-unit frameworks, or both.

CAD/CAM manufacturing may be performed within the laboratory or be outsourced to the system manufacturer. With an outsourced system, captured data are scanned with the CAD/CAM three-dimensional software that allows for simplified visualization of the die details. After the scanner operator has determined the margin, the final data are precisely calculated and transferred via Internet for fabrication. After the mathematically controlled shrinkage behaviors of the ceramic powder, the final product is densely sintered in a ceramic coping that fits the original master die at the lab. The coping is then returned to the lab for the ordinary porcelain buildup.

In-house systems equip the laboratory to perform all stages of fabrication on the laboratory premises. Due to industrial repeatability, CAD/CAM-generated

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Contemporary CAD/CAM Applications

CAD/CAM systems can be used to produce:

- Copings
- Bridges
- Abutments
- Single-unit crowns
- FPDs
- Laminate veneers

Laminate veneer materials include:

- Zirconia
- Zirconium-oxide
- Alumina
- Pure Polycrystalline oxides
- Titanium
- Densely sintered or infiltrated yttrium-stabilized zirconium-oxide
- Alumina-oxide

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copings are believed to improve consistency and reduce reliance on the subjective skills of the technician, which allows the laboratory to focus more on the aesthetic aspects of restoration (eg, porcelain buildup). This focus on other value-added steps in the production cycle, overall efficiency, and consistency in quality helps improve lab return on investment.

CONCLUSION

The PFM restoration remains the restorative workhorse when teeth are mobile and require splinting, when

FIGURE 9. Postoperative appearance of the splinted restoration. The blend is harmonious with the adjacent tooth structure. While both restorations were acceptable to the patient, the splinted gold substructure was selected due to tooth mobility. (Dentistry by Henry Salama, DMD.)

FIGURE 10. Preoperative view of a patient's smile showing unaesthetic PFM crowns. Tooth #8 required extraction. The treatment plan called for fabricating a three-unit bridge with one porcelain laminate veneer.

FIGURE 11. Postoperative appearance of the three-unit pressed-to-metal bridge. Note the large porcelain finishing margin due to the pressable lost wax technique.

FIGURE 12. The three-unit bridge with a single porcelain veneer as viewed on the solid soft tissue model.

FIGURE 13. Postoperative appearance following cementation. The pressed-to-metal bridge and the porcelain laminate veneer blend harmoniously. (Dentistry by Anita Tate, DMD.)

tooth color is so dark that a translucent restoration will be unaesthetic, and/or when fixed partial dentures in excess of six units are planned (Figures 10 through 13). When these conditions are not present, the clinician and the laboratory may choose from a growing selection of framework materials that advance the goal of achieving a lifelike look. ■

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CONTINUING EDUCATION EXERCISE

The 10 multiple-choice questions for this Continuing Education (CE) exercise are based on the article "Coping materials for improved aesthetics: Combining strength and aesthetics," by Pinhas Adar, CDT. This article is on Pages 000-000.

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

- **Understand the role of treatment planning on appropriate framework selection.**
- **Recognize the clinical indications for various contemporary substructures and restorative options.**

1. Which of the following factors will influence appropriate framework selection?
a. The degree of tooth mobility.
b. The number of units being restored.
c. The degree of tooth preparation necessary.
d. All of the above.

2. When evaluating tooth mobility, the clinician should notify the technician if:
a. Periodontal involvement is evident.
b. Nonmetal copings are required to provide predictable long span restoration.
c. All-ceramic restoration is indicated to restore dentition that require splint placement.
d. CAD/CAM restoration is indicated due to the need for multi-unit restoration (ie, more than 4 spaces).

3. Contemporary CAD/CAM systems can be used to restore teeth if:
a. The dentition are not mobile.
b. Three or fewer units are involved.
c. Sufficient space (1.5 mm or more) is available.
d. All of the above.

4. Accurate shade match to the preparation as well as the natural tooth is required for aesthetic restoration. This match can be achieved using traditional shade tabs and contemporary shade guidance systems.
a. Both statements are true.
b. Both statements are false.
c. The first statement is true, the second statement is false.
d. The first statement is false, the second statement is true.

5. What types of technical and procedural characteristics are used to distinguish amongst competing CAD/CAM systems?
a. The type of scanner used to capture the data.
b. Whether the system can produce multiunit or single-unit frameworks, or both.
c. If milling is performed, whether the outcome is a densely sintered or infiltrated product.
d. All of the above.

6. How has potentially compromised strength and oxidation associated with most high-gold alloys been addressed?
a. Oxidation does not occur in high-gold alloys.
b. By using porcelain substructures that do not suffer from oxidation during firing, prior to the addition of gold.
c. By using an internally reinforced network of high-fusing platinum, palladium, and gold particles to provide a "skeleton" that does not melt and become distorted during fabrication.
d. None of the above.

7. How does the color of the substrate influence the definitive aesthetics of a prosthodontic restoration?
a. The presence of a metal post and core may shine through the porcelain and adhesive.
b. The presence of a dark or nonvital substrate will influence the type of framework used for the definitive restoration.
c. Both a and b are correct.
d. Neither a nor b are correct.

8. A single tooth without root canals that has been minimally prepared can be predictably restored using:
a. Metal-ceramic substrates.
b. Pressable ceramic materials.
c. Such teeth require extraction.
d. Porcelain-fused-to-metal crowns only.

9. All-ceramic restorations are indicated when:
a. The tooth's color is extremely dark.
b. Teeth are mobile and require splinting.
c. When fixed partial dentures in excess of six units are planned.
d. None of the above.

10. The restorative team's primary goal should be to:
a. Improve or restore the patient's function.
b. Create a lifelike appearance and an illusion of reality, mimicking natural teeth.
c. Both a and b are correct.
d. Neither a nor b are correct.