Delivering Optimal Results for
Fixed Partial Dentures

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EDUCATIONAL OBJECTIVES

The overall goal of this article is to provide the reader with information on current materials and techniques for the fabrication of a fixed partial denture (FPD). After reading this article, the reader will be able to:
1. List in detail the steps involved in fabrication of an FPD;
2. Describe the impression materials available, considerations in their selection, and the use of a one-stage or two-stage technique;
3. Review the materials and techniques available for the fabrication of provisional restorations; and
4. List and review the steps involved in the fabrication of full-contour zirconia CAD/CAM restorations.

ABSTRACT

Fixed partial dentures require careful consideration of the materials and treatment protocol that will be followed. The successful recording of preparations, manufacture of multi-unit restorations, and their delivery intraorally is aided by astute attention to material properties at each of these critical stages. Detailed communication and collaboration with the laboratory are also required to ensure clinical success and the best possible outcomes.
Introduction

An FPD remains a viable treatment option for patients who elect to replace missing teeth without receiving implants. Advances in impression materials, cements, and provisional and definitive restorations have expanded the options for clinicians to select a protocol that suits their preferences. These advances have, however, also increased the potential for operator and laboratory error. Techniques and materials may not be interchangeable without consequences, depending on the materials, and clinicians must be astute in their cultivation of a protocol and must work in concert with the laboratory to deliver a predictable restoration for their patients. The first step is pre-operative diagnostics, followed by the clinical and laboratory steps required to deliver the FPD. The value of a diagnostic wax-up in planning fixed restorative procedures is well-documented. Excellent communication and collaboration with the laboratory is important. Following preparation of the abutment teeth, subsequent clinical steps include soft tissue management, the use of a custom tray for the final impression, provisionalization and luting of the final FPD. Each of these is important for the final result and the clinical success of the FPD.

Soft Tissue Management and Impression Taking

The prepared abutment teeth are surrounded by interferences that can prevent their accurate reproduction. Isolation of the areas of interest is primarily concerned with the displacement of the gingiva from the prepared margins of the abutment teeth, which may be achieved through the use of retraction cord, a compressive cap, or expanding pastes. Surgical displacement may be accomplished through methods that include the use of a scalpel, electrosurgery, or a soft tissue laser. Other adjacent structures, such as buccal mucosa and the tongue, can be relocated with cotton rolls, gauze, and saliva evacuator systems. Remaining moisture around the prepared abutment teeth, such as gingival crevicular fluid and blood, can be reduced by the application of ferric sulfate, epinephrine, and other chemical means.

For a traditional impression, a tray is selected to fit the arch. Double-arch trays or “triple trays” are conventionally indicated for one to two units in the same arch when a stable, reproducible occlusion is present. A full-arch tray is selected for bridges to give the laboratory technician more information to correctly articulate models and create an accurate plane of occlusion. An impression for an FPD is more predictably made in a custom tray than a stock tray. A custom tray made from a cured resin is more closely adapted to the arch than a stock tray and thus requires a smaller, more uniform amount of impression material. There are several steps occurring in a short period of time during impression taking that require the clinician’s vigilance. A custom tray relieves the burden of ensuring that the tray has been correctly seated to capture the entire arch. A contemporary method of custom tray fabrication utilizes a visible-light-cured (VLC) custom tray material. The ability to adapt the pliable material in an uncured state, and to cut back borders prior to curing, minimizes the finishing time required. The curing shrinkage is minimal, ensuring a well-adapted result.

Impression Materials

Elastic impression materials should demonstrate excellent dimensional stability, have an adequate working time, short setting time, and be easy to use with sufficient flowability. The requirements for impression materials are addressed by the American National Standards Institute in collaboration with the American Dental Association. Polyvinylsiloxane and polyether impression materials are common choices for indirect restorative procedures. Their dimensional stability permits time for transportation to a dental laboratory, and both materials are suitable for multiple pours without clinically significant loss of accuracy. For restorations with larger numbers of units, a longer working time is required and can be achieved by cooling the impression material in the fridge prior to use. Alternatively, an impression material with extra working time should be selected. The clinician’s selection rests upon his/her comfort with the material’s properties (Table 1).

Impression Techniques

Impressions for indirect restorations follow either a one-step or two-step protocol. The one-step technique captures gross and fine detail at the same time. Both polyether
and polyvinylsiloxane impression materials are available in different viscosities for greater clinician control. The clinician may use a single viscosity impression material, typically of a medium consistency, for both the tray and tooth detail. The advantage to this approach is that using only one material eliminates concerns of a poor mixture of viscosities. Alternatively, the clinician may use two different viscosities: typically, a heavier body or silicone putty for the tray and a lighter body for tooth detail. If the manufacturer’s instructions for working and setting times for both materials are followed, distortions such as pulls and inconsistent mixtures should be eliminated. Note however that an increase in room temperature reduces the working time for impression materials. The advantage gained is the ability of a lighter body material to flow into smaller areas for greater detail, aided by the compressive strength of the surrounding heavier body material. Alternatively, the two-step technique first captures gross detail with silicone putty in the tray. Typically, a thin film spacer is placed over the teeth to leave room for impression material in the second step. Next, the finer tooth detail is captured with a lighter body impression material.

Provisional Fabrication

A successful provisional restoration for an FPD must protect the prepared abutment teeth and gingiva, maintain the three-dimensional relationship between the abutment teeth and the opposing dentition, and maintain function and esthetics.9 These objectives are similar for single-unit provisional restorations; however, strength, rigidity, and ease of use become more critical for multi-unit restorations (Table 2). It is a challenge to fabricate a provisional restoration efficiently while the patient is in the operatory and yet still ensure that all of the parameters for success are met. Fortunately, modern clinicians have a variety of materials and techniques at their disposal to cultivate a procedure that is the most predictable in their hands. Options include chairside and laboratory fabricated provisional FPDs in a variety of materials.

A provisional FPD is intended to last for the duration of time required to fabricate the final restoration. The clinician may also elect to have the patient wear the provisional for an additional “trial” period before final impressions are made to evaluate esthetics or occlusal stability, and/or to allow time for soft tissue healing.

Provisional Materials

The three most prevalent materials used for a provisional FPD are methyl methacrylate, ethyl methacrylate, and bis-acryl composite resin. Methyl methacrylate has the longest track record in dentistry and is still widely used. A powder and liquid are mixed together to initiate the setting reaction. Despite its good strength and longevity when set, methyl methacrylate is known to be problematic during the setting

Table 1. Comparison of common fixed partial denture impression materials

<table>
<thead>
<tr>
<th>Polyvinylsiloxane</th>
<th>Polyether</th>
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<tbody>
<tr>
<td>Excellent dimensional stability</td>
<td>Excellent dimensional stability</td>
</tr>
<tr>
<td>Hydrophobic</td>
<td>Hydrophilic</td>
</tr>
<tr>
<td>Easy removal after setting</td>
<td>More difficult removal after setting</td>
</tr>
<tr>
<td>Fair odor and taste</td>
<td>Poor odor and taste</td>
</tr>
<tr>
<td>Setting inhibited by latex</td>
<td>Setting unaffected by latex</td>
</tr>
<tr>
<td>Can be stored wet or dry</td>
<td>Must be stored dry</td>
</tr>
</tbody>
</table>

Table 2. Optimal properties for provisional bridge restorations

<table>
<thead>
<tr>
<th>Property of Material</th>
<th>Clinical Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of fabrication</td>
<td>Reduced chair time</td>
</tr>
<tr>
<td>Ability to be relined</td>
<td>Ensure marginal fit</td>
</tr>
<tr>
<td>Flexural and compressive strength</td>
<td>Resistant to fracture or distortion</td>
</tr>
<tr>
<td>Rigidity</td>
<td>Maintain abutment relationship</td>
</tr>
<tr>
<td>Biocompatibility</td>
<td>Non-irritating to pulp or gingiva</td>
</tr>
<tr>
<td>Ability to be polished</td>
<td>Resistant to plaque accumulation</td>
</tr>
<tr>
<td>Color stability</td>
<td>Patient acceptance</td>
</tr>
</tbody>
</table>
reaction. The reaction generates significant heat, which may damage the pulp and gingival tissues. Also, the material shrinks while curing, which may lead to poor marginal fit. If the provisional is removed from the abutment teeth while setting and is not quickly reinserted, the shrinkage of the material may distort the provisional’s internal aspects so that it no longer may be seated on the abutment teeth. Concerns have also been raised that pulpal and gingival irritation can result from the presence of free monomer.

Differences also exist between different versions of the same chemical material. Ethyl methacrylate is also a powder and liquid mixture but offers better marginal integrity and less heat generation during setting than methyl methacrylate. However, these advantages are offset by the poor color stability and difficulty of use. Methyl methacrylate and ethyl methacrylate acrylic resins may be used chairside using the direct technique whereby the material sets via self-cure or autopolymerization. When an indirect technique is used in the laboratory, both acrylic resins may be heat-processed for additional strength and color stability (Table 3).

Recently, bis-acryl composite resin has emerged as a popular choice for fabrication of a crown and bridge provisionals. Available in self-mixing cartridges, bis-acryl exhibits good marginal fit and low heat generation during setting. Advantages include less heat generation and shrinkage during polymerization than the methacrylate acrylic resins. One study showed shrinkage of bis-acryl resin to be up to 1.7% by volume compared to 6% for methyl methacrylate. As a composite resin, bis-acryl material is compatible with bonding materials used for operative dentistry. Small areas of the provisional in need of repair or reline may be reliably restored with flowable composite resin, which decreases chair time without sacrificing predictability. Bis-acryl resins may be self-cure, light-cure, or dual-cure, depending upon the clinician’s preference. A notable disadvantage of the material is its decreased strength compared to acrylic resins over time. However, indirect fabrication of a bis-acryl composite resin provisional by a laboratory will improve its strength.

The most recent material development in the provisional resin category is a unique visible-light-cured hybrid resin technology. This material provides for excellent wear rates as well as low solubility and resistance to staining and color change, and is cleared by the FDA for three years of clinical use. The “wax-like” handling characteristics of this resin provide the technician with a familiar, easily adaptable technique that can be utilized to produce extremely accurate provisional restorations. The low wear rate and strength are particularly important for long-term provisional restorations.

### Provisional Cementation

Retention of a provisional restoration is commonly relegated to the weaker cements such as zinc oxide eugenol and zinc oxide non-eugenol, to aid removal when the permanent restoration is ready for placement. Eugenol is respected for its bactericidal properties, which can aid in reducing post-operative sensitivity.

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**Table 3. Comparison of acrylic and composite resin materials for provisional fabrication**

<table>
<thead>
<tr>
<th></th>
<th>Methyl methacrylate - Advantages</th>
<th>Methyl methacrylate - Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethyl methacrylate</strong></td>
<td></td>
<td></td>
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<tr>
<td>Longer term strength</td>
<td></td>
<td>Most significant curing exothermia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Most significant curing shrinkage</td>
</tr>
<tr>
<td><strong>Bis-acryl composite resin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of use and repair</td>
<td></td>
<td></td>
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<tr>
<td>Least significant curing exothermia</td>
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<tr>
<td>Least significant curing shrinkage</td>
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<tr>
<td></td>
<td></td>
<td>Shorter term strength</td>
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<tr>
<td></td>
<td></td>
<td>Expense</td>
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</table>
as a plasticizer, detrimentally affecting the polymerization of acrylic and composite resin. Thus, a provisional that has been previously luted with a eugenol-containing temporary cement will be difficult to reline or repair. The added material will be softer than normal and could potentially unsuccessfully adhere to the original provisional. In addition, eugenol could negatively affect the polymerization of a permanent resin cement. As resin cements grow in popularity, many clinicians prefer to select a temporary cement that does not contain eugenol to avoid such complications. Zinc oxide non-eugenol cements substitute organic acids in place of eugenol, which actually makes the cements stronger. If an FPD provisional is expected to be retained for a long period of time, or if additional retention is required, a stronger cement such as zinc polycarboxylate is often substituted.

**Restoration Insertion**

Successful luting of the final restoration begins with successful debridement of the abutment teeth. After the provisional restoration is removed, debris and provisional cement remnants are removed to ensure proper definitive cementation. Some clinicians elect to mechanically debride the surfaces with an explorer, an air/water syringe spray, polish with pumice slurry, and/or scale with ultrasonic instruments. Other clinicians use chemicals such as a disinfecting agent to decrease post-operative sensitivity and/or a cleansing agent to remove the smear layer and expose dentin tubules for improved resin cement bonding.

**Restoration Adjustment**

When trying in the final prosthesis it may be necessary to reshape the occlusal and interproximal porcelain to achieve harmony with the rest of the dentition. Adjustments with a diamond bur introduce irregularities to the otherwise smooth, glazed porcelain surface. Remaining surface roughness may be treated with a series of extra-or intra-oral polishers to achieve the same smoothness as a glaze finish. A smooth finish is desirable because rough porcelain may injure the opposing dentition and accumulate plaque. Special attention must be paid to ceramic restorations fabricated from zirconia. Due to its unique tetragonal, polycrystalline structure, zirconia increases its volume around a stress-induced crack. This phenomenon, known as transformation toughening, contributes to the material’s high flexural strength of up to 1,200 MPa. Although some studies have concluded that adjusting zirconia can actually increase its strength, other studies have pointed out that significant pressure and use of coarse diamonds can introduce cracks beneath the surface and actually weaken the zirconia. To avoid introducing a critical crack, a light touch with fine diamond burs under copious air/water spray is advised when adjusting zirconia. If the fitting of a zirconia core or full-contour zirconia bridge would require that the intaglio surface be adjusted for proper seating, it is recommended that the abutment tooth be adjusted instead. This is due to the difficulty of polisher systems in accessing the internal aspects of a restoration.

Definitive luting agents are selected based upon the condition of the abutment teeth and the restorative material used for the prosthesis. Traditional dental cements such as zinc phosphate and zinc polycarboxylate are mechanically retentive by flowing into the discrepancy between tooth and restoration and hardening. This hardening is due to an ionic reaction and is therefore soluble in the oral environment over time. Resin cements are retentive by serving as an adhesive medium between the tooth and the restoration. Ideally suited for all-ceramic restorations, which may be capable of being etched and bonded, resin cements are also used with metal-ceramic restorations due to their low solubility.

The resin cement bond to the ceramic restoration is dependent on the nature of the restorative material. Ceramics that contain glass, such as feldspar and lithium disilicate, may be predictably etched with hydrofluoric acid. Subsequent treatment of the etched surface with a silane coupling agent will prepare the glass ceramic for bonding to a resin cement. Zirconia’s polycrystalline structure does not contain glass and therefore cannot form a bond to the resin cement that is as predictable or as strong as a glass ceramic, despite various methods of surface conditioning. The manufacturer’s instructions for a given material must be followed.
The resin cement bond to the abutment teeth is achieved using either a total-etch, self-etch, or self-adhesive protocol. The total-etch technique begins with chemical removal of the smear layer and hydroxyapatite crystals. The etch is washed off and a hydrophilic primer and unfilled bonding resin are applied, which penetrate the exposed enamel and dentin structures to form a hybrid layer. The tooth surfaces with exposed hybrid layers are now able to adhere to the resin cement. Self-etch systems do not completely remove the smear layer and do not penetrate into the tooth structure as deeply. The bond is not as strong as the total-etch technique but there is also a decreased chance of post-operative sensitivity. Self-adhesive systems incorporate the etch, prime, and bonding elements into the resin cement itself. These offer the weakest bond of the resin cement family but are the easiest to use clinically. Self-adhesive cements are not recommended for preparations with insufficient resistance form due to their poorer bond strengths. However, the overall surface area of multiple, prepared abutments for an FPD will generally offer sufficient resistance form for a self-adhesive cement to be used.

Resin cements are also classified as self-cured, light-cured, or dual-cured. Light-cure cements are most predictable when a translucent ceramic restoration is less than 1.5 mm thick. When the thickness of the translucent ceramic restoration is greater than 2.5 mm, penetration of a curing light is unpredictable. In these cases, and for restorations that do not transmit light, a self-cure or dual-cure resin cement is recommended. A final category of luting agent for use with FPD restorations is glass-ionomer and resin-modified glass ionomer cements. A notable advantage with this material is the cariostatic release of fluoride from the cement to the abutment tooth. However, the material is known to expand after cementation, which limits its use to metal-ceramic and zirconia ceramic restorations.

Case Study
A 51-year-old male, who was a new patient with no relevant medical history, presented for replacement of a fractured porcelain-fused-to-metal FPD spanning teeth #29 to 31 (Fig. 2). His dental history was significant for bruxism, as was evidenced by the generalized moderate wear facets on the dentition. The existing FPD demonstrated considerable fracturing of porcelain and destruction of the metal substructure. Tooth #31 had a prior history of endodontic therapy that had required access through the occlusal surface of the FPD. This access had been sealed with a composite resin that now showed signs of marginal leakage and may also have contributed to the fracturing of the occlusal porcelain (Fig. 3). The patient was treatment planned for a full-contour zirconia bridge to prevent future...
porcelain fracture associated with his bruxism habit. Preliminary impressions and a bite registration were sent to the laboratory for the development of a wax-up. The FPD would be stained to incorporate the shade of the adjacent teeth in the same quadrant (A3) and the opposing dentition (A2).

At the treatment visit, while waiting for adequate anesthesia, a pre-operative impression was taken using a polydimethylsiloxane impression in a stock tray. This impression was set aside for later use during fabrication of the provisional bridge. The original bridge was carefully sectioned and removed so as to preserve remaining tooth structure. The composite resin filling the endodontic access on tooth #31 was removed and the remaining four walls of tooth structure were etched, bonded, and filled with a dual-cure, fluoride-releasing core buildup material. The preparations were completed with supragingival margins to aid hygiene, although had the tooth margins appeared in the esthetic zone, the margins would have been prepared equi-gingivally.

A custom tray was fabricated using light-cured material, for use during taking of the final impression to improve its accuracy (Fig. 4). A polyvinylsiloxane material was selected as adequate isolation and moisture control had been achieved. Application of a surfactant was performed to optimize flow of the impression material over the tooth surfaces and around preparation margins. A heavy body polyvinylsiloxane impression material was mixed into the custom tray while a light body polyvinylsiloxane impression material was loaded into a metal syringe. The cord
was removed and the light body material was syringed into the sulcus, one prepared abutment at a time. After all surfaces of interest were covered, an air syringe was gently used to thin the impression material to reduce polymerization shrinkage. The full-arch tray of heavy body material was easily seated because it had been customized for the patient. After the setting time of five minutes had expired, the tray and impression material were removed and inspected for accuracy. The margins were shown to be fully captured with additional light body material well into the gingival sulcus (Fig. 5). The opposing arch was recorded with a polydimethylsiloxane impression material in a stock tray. This material demonstrates good dimensional stability and does not have to be poured in stone before transportation to the dental laboratory. An interocclusal record was recorded using rigid fast-set polyvinylsiloxane. This form of polyvinylsiloxane offers less resistance to biting forces and sets more quickly, reducing the chances for jaw movements to alter the record.

A provisional bridge was fabricated by dispensing a bis-acryl resin into the pre-operative impression (Fig. 6). The tray was reseated intraorally and allowed to cure for 90 seconds. After removal, a curing light was held over the provisional bridge for 20 seconds to expedite the curing process (Fig. 7). This step aids in removal of the provisional bridge from the pre-operative impression while avoiding distortion or fracture. The provisional bridge was trimmed with a thin flame diamond bur and checked intraorally for marginal integrity and occlusal harmony. An advantage of bis-acryl resin is its ability to easily bond with composite resin.
Since the original bridge had fractured porcelain, composite resin was added to the provisional bridge to improve strength, function and esthetics (Fig. 8). A non-eugenol zinc oxide cement was syringed into the internal surfaces of the abutments’ restorations and seated. As it was anticipated that a resin cement would be used for the final case, it was important to avoid the use of eugenol in the provisional cement. A sufficient amount of temporary cement was dispensed and the margins were carefully checked with an explorer. The impression and bite registration were disinfected and sent to the laboratory together with the lab prescription.

**Shade Communication**

Numerous digital color communication technologies have been introduced to the dental profession over the last 15 years. The most impactful device is the digital camera (Fig. 9). The use of 35 mm digital cameras to communicate color and characterization between the operatory and dental laboratory has dramatically reduced the most common reason for disappointment on delivery day—poor color matching.

**Laboratory Technique**

**Provisional Restoration**

A provisional bridge can also be fabricated in the laboratory using hybrid resin. The previously developed patient/clinician-approved diagnostic wax-up was first matrixed with silicone putty. A duplicate cast was minimally prepared and lubricated with petroleum jelly. An initial application of enamel shade hybrid resin material was placed into the matrix from the heated syringe, distributed appropriately with the electric spatula, and allowed to cool. The dentin shade was then syringed into the matrix and seated on the cast while it was ensured that the matrix was completely seated. After the material was allowed to cool for four minutes, the matrix was carefully removed by first carving carefully where significant undercuts existed, to prevent damaging the uncured wax-like material. (Voids from trapped air can be repaired, if necessary, using the electric spatula.) After the hybrid resin had cooled, it was carved to develop the desired final contours and anatomy, after which the occlusal and interproximal contacts were thoroughly checked. The glaze was then applied with a disposable brush and cured. Figure 10 shows the excellent results that can be achieved using this method for a provisional for the same case.

**Fabricating the Definitive FPD**

All ceramic materials and technologies have exhibited an exponential development over the previous 20 years for ceramic indirect restorative advancements. The workhorse porcelain-fused-to-metal restoration is slowly being replaced with high-strength CAD/CAM-developed ceramic materials. Development has moved through leucite-reinforced pressed...
ceramics to pressed or machined lithium disilicate ceramics. The use of YZ zirconium oxide as a substrate veneered with stacked ceramics has evolved into monolithic CAD/CAM-produced restorative systems. In this case, the FPD was created with full-contour zirconia, utilizing a digitally optimized fabrication technique. Upon completion of the master cast fabrication, the casts were articulated in a centric relation utilizing the provided occlusal registration.

The working cast was scanned and, utilizing the design software, the margins were identified at 100 times the actual size, thereby providing a level of accuracy that is impossible to achieve with traditional die trimming (Figs. 11-12). The virtual cement gap was determined specifically for each area of the restoration by establishing independent parameters for margins, axial walls, the occlusal surface, and line angles. The desired external contours were transferred from a scan of the approved diagnostic wax-up (Fig. 13-16). The .stl file was then e-mailed to the central manufacturing facility for milling of the restoration. Upon receipt of the file, the restoration was milled from a pre-sintered zirconium oxide disk. Next, the restoration was dipped in the appropriate stain to achieve the desired dentine shade of the completed restoration. Finally, the restoration was sintered in an oven at 1600 degrees Celsius, fusing the zirconia particles and shrinking them by approximately 30%. The sintering process transforms the zirconia into a more dense material with high strength. The restoration was then returned to the laboratory for
confirmation of internal, occlusal, and interproximal
adaptation. After minimal adjustments were accomplished,
external characterization was applied for appropriate
intra-oral esthetic matching. For optimal results, A-3
Dentine was applied to the areas of wear illustrated on the
buccal cusp tips of teeth #29 and 30 (Fig. 17).

Placement of the FPD
The definitive restoration was tried in to assess marginal
fit, adequate interproximal contact with the distal of tooth
#28, and occlusion. A bitewing radiograph confirmed the
visual inspection that marginal fit had been achieved (Fig.
18). Occlusal and interproximal contacts required no adjust-
ment owing to an accurate impression, bite registration, and
meticulous laboratory work. A dual-cure resin cement was
used to retain the FPD. A resin cement will adhere to the
abutment tooth structure for added retention. The patient
was pleased with the improved function and high esthetics of
the final result (Fig. 19). The selected shade was successful in
blending the opposing dentition (shade A2) with the adjacent
dentition (more A3).

Summary
Dentists today have a variety of materials at their disposal
for each step in the fabrication of an FPD. The successful
recording of preparations, manufacture of multi-unit restora-
tions, and their delivery intraorally is aided by astute atten-
tion to material properties at each of these critical stages.
Figure 19. The completed full-contour zirconia bridge intraorally. Note the successful incorporation of shades A2 and A3 to match the various shades present in the same and opposing quadrants.

References

Weblogiography
1. The value of a diagnostic wax-up in planning fixed restorative procedures is ________.
   a. dubious
   b. well-documented
   c. negligible
   d. none of the above

2. The prepared abutment teeth are surrounded by interferences that can prevent their accurate ________.
   a. preparation
   b. bite registration
   c. reproduction
   d. all of the above

3. ________ may be used to displace the gingiva from the prepared margins of the abutment teeth.
   a. Retraction cord
   b. A compressive cap
   c. Expanding pastes
   d. all of the above

4. ________ can be reduced by the application of ferric sulfate.
   a. Gingival crevicular fluid and blood
   b. Salivary flow
   c. Xerostomia
   d. all of the above

5. Double-arch trays or “triple trays” are conventionally indicated for ________.
   a. one to two units in opposing arches
   b. multiple units in opposing arches
   c. multiple units in the same arch
   d. one to two units in the same arch

6. A full-arch tray is selected for bridges to give the laboratory technician more information to ________.
   a. correctly articulate models
   b. properly capture the margins
   c. create an accurate plane of occlusion
   d. a and c

7. The ability to adapt pliable material in an uncured state and to cut back borders prior to curing a custom tray minimizes ________.
   a. tray errors
   b. the curing time
   c. the finishing time
   d. none of the above

8. The two-step technique captures gross and fine detail ________.
   a. at the same time
   b. one after the other
   c. poorly
   d. none of the above

9. ________ impression materials possess dimensional stability that permits time for transportation to a dental laboratory, and they are suitable for multiple pours without clinically significant loss of accuracy.
   a. Alginate
   b. Polyether
   c. Polyvinylsiloxane
   d. b and c

10. An increase in room temperature ________ for impression materials.
    a. reduces the working time
    b. increases the working time
    c. increases the setting time
    d. b and c

11. Electing to have a patient wear the provisional for an additional “trial” period before final impressions are made provides the option to ________.
    a. evaluate esthetics
    b. evaluate occlusal stability
    c. allow time for soft tissue healing
    d. all of the above

12. If a methylmethacrylate provisional is removed from the abutment teeth while setting and is not quickly reinserted, the shrinkage of the material may ________.
    a. distort the provisional’s internal aspects
    b. provide for space for the luting agent
    c. result in an inability to seat the provisional on the abutment teeth
    d. a and c

13. One study showed shrinkage of bis-acryl resin to be up to ________ by volume compared to ________ for methyl methacrylate.
    a. 0.7%; 2%
    b. 1.2%; 4%
    c. 1.7%; 6%
    d. 2.2%; 8%

14. Visible-light-cured hybrid resin technology for provisional restorations offers ________.
    a. low solubility
    b. a low wear rate
    c. resistance to staining
    d. all of the above

15. To avoid introducing a critical crack, a light touch with ________ under copious air/water spray is advised when adjusting zirconia.
    a. coarse diamond burs
    b. fine diamond burs
    c. a sanding disk
    d. fine tungsten carbide burs
16. The use of a __________ on the preparation surfaces can reduce the hydrophilic properties of a polyvinylsiloxane impression material.
   a. desensitizer
   b. surfactant
   c. tubule occluding agent
   d. none of the above

17. Zinc oxide non-eugenol cements substitute __________ in place of eugenol.
   a. inorganic acids
   b. organic acids
   c. base solutions
   d. none of the above

18. Using a scanner and specific design software __________.
   a. the margins can be identified at 100 times their actual size
   b. enables accuracy that is impossible to achieve with traditional die trimming
   c. helps establish independent parameters for margins, axial walls, the occlusal surface and line angles
   d. all of the above

19. Using rigid fast-set polyvinylsiloxane for the interocclusal record __________.
   a. results in less resistance to biting forces
   b. results in a faster setting time
   c. reduces the risk of jaw movements, while the record is setting, that would alter the record
   d. all of the above

20. Ceramics that contain glass, such as feldspar and lithium disilicate, may be predictably etched with __________.
   a. phosphoric acid
   b. hydrofluoric acid
   c. acetic acid
   d. lactic acid

21. Zirconia’s polycrystalline structure __________.
   a. does not contain glass
   b. contains apatite
   c. cannot form a bond to the resin cement that is as predictable or as strong as a glass ceramic
   d. a and c

22. Self-etch systems __________.
   a. do not completely remove the smear layer
   b. do not penetrate into the tooth structures as deeply as other adhesive systems
   c. offer a decreased chance of post-operative sensitivity
   d. all of the above

23. The resin cement bond to abutment teeth is achieved using a __________ protocol.
   a. total-etch
   b. self-etch
   c. self-adhesive
   d. any of the above

24. Eugenol __________.
   a. is respected for its bactericidal properties
   b. can aid in reducing post-operative sensitivity
   c. acts as a plasticizer
   d. all of the above

25. __________ offer cariostatic release of fluoride from the cement to the abutment tooth.
   a. Glass ionomer and resin-modified glass ionomer cements
   b. Polycarboxylate cements
   c. Zinc phosphate cements
   d. all of the above

26. Supragingival margins on preparations __________.
   a. aid hygiene
   b. are ideal in the esthetic zone
   c. compromise biologic width
   d. none of the above

27. Using a digital camera __________.
   a. aids communication about color and characterization between the operatory and the dental laboratory
   b. reduces the occurrence of poor color matching
   c. is less effective than a written prescription for color communication
   d. a and b

28. Glaze can be applied to a laboratory-fabricated hybrid resin provisional __________.
   a. after it has cooled
   b. after it has been carved to the desired final contours
   c. with a disposable brush and cured
   d. all of the above

29. Definitive luting agents are selected based upon the __________.
   a. condition of the abutment teeth
   b. restorative material used for the prosthesis
   c. patient’s preference
   d. a and b

30. Due to its unique tetragonal, polycrystalline structure, __________ increases its volume around a stress-induced crack.
   a. leucite
   b. feldspathic porcelain
   c. zirconia
   d. none of the above
CE ANSWER FORM  (E-mail address required for processing)  

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EDUCATIONAL OBJECTIVES
1. List in detail the steps involved in fabrication of a FPD;  
2. Describe the impression materials available, considerations in their selection, and the use of a one-stage or two-stage technique;  
3. Review the materials and techniques available for the fabrication of provisional restorations; and  
4. List and review the steps involved in the fabrication of full-contour zirconia CAD/CAM restorations.  

COURSE EVALUATION
Please evaluate this course using a scale of 3 to 1, where 3 is excellent and 1 is poor.
1. Clarity of objectives ____________________________________________  
2. Usefulness of content ____________________________________________  
3. Benefit to your clinical practice ____________________________________________  
4. Usefulness of the references ____________________________________________  
5. Quality of written presentation ____________________________________________  
6. Quality of illustrations ____________________________________________  
7. Clarity of quiz questions ____________________________________________  
8. Relevance of quiz questions ____________________________________________  
9. Rate your overall satisfaction with this course ____________________________________________  
10. Did this lesson achieve its educational objectives? Yes ___ No ___  
11. Are there any other topics you would like to see presented in the future? __________________________________________________________________________  
12. Rate the relevancy of content ____________________________________________  
13. Rate the clarity of quiz questions ____________________________________________  
14. Rate the quality of the written presentation ____________________________________________  
15. Rate the quality of the illustrations ____________________________________________  
16. Rate the usefulness of content ____________________________________________  
17. Rate the usefulness of the references ____________________________________________  
18. Rate your overall satisfaction ____________________________________________  
19. Is the course an improvement over others you have taken? Yes ___ No ___  
20. Did the course fulfill the educational objectives? Yes ___ No ___  
21. If you did not like the course, please explain ____________________________________________  
22. What can we do to improve the course? ____________________________________________  
23. Rate the usefulness of the content ____________________________________________  
24. Rate the clarity of the quiz questions ____________________________________________  
25. Rate the quality of the written presentation ____________________________________________  
26. Rate the quality of the illustrations ____________________________________________  
27. Clarity of objectives ____________________________________________  
28. Usefulness of the content ____________________________________________  
29. Benefit to your clinical practice ____________________________________________  
30. Usefulness of the references ____________________________________________  

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