Conservative and Esthetic Cast Gold Fixed Partial Dentures—Inlay, Onlay, and Partial Veneer Retainers, Custom Composite Pontics, and Stress-breakers: Part I: Fundamental Design Principles

RICHARD G. STEVENSON III, DDS*
JANE A. REFELA, DDS†

ABSTRACT

Although in today's dental world implant restorations are considered the standard of care in the replacement of missing teeth, clinical contraindications and patient nonacceptance of implant placement can be encountered. Several scenarios are discussed here in which a single missing tooth can be restored with conservative fixed partial dentures (FPD) that employ cast gold retainers; each with a customized design in order to preserve tooth structure, maintain esthetics, and provide a long-term prognosis. The abutment teeth are prepared for conservative partial coverage restorations by using Brasseler burs (Brasseler USA, Savannah, GA, USA). Impressions are taken of the preparations, along with any retentive features, utilizing either the Vented Pin Channel technique or the Shooshan Plastic Pin technique. The latter technique utilizes Kodex twist drills and corresponding impression pins (Coltene Whaledent Inc., Mahwah, NJ, USA). The conservative FPD with non-rigid connectors is fabricated by using type III gold alloy. The pontic cage portion is chemically prepared utilizing the Panavia F2.0 cement kit (Kuraray America Inc., Houston, TX, USA) or other dual-polymerizing resin cement and restored with any type of direct composite resin material. A palette of opaquers and tints are used for chairside characterization of the esthetic pontic facing. The final polish of the pontic is completed by using FlexiDisc and FlexiBuff discs (Cosmedent Inc., Chicago, IL, USA).

CLINICAL SIGNIFICANCE

In cases where an implant restoration is contraindicated for replacement of a single tooth, a semi-precision FPD is a conservative, functional, and esthetic alternative.

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Although today implants are considered the standard of care in replacing missing teeth, several relative contraindications exist that prevent implants from being the appropriate treatment option.[1,2] Diabetes, a history of chronic heavy smoking, radiation treatment for cancer patients, and other conditions may compromise implant predictability.[1,2] Additionally, some patients elect

*Professor of Clinical Dentistry and Chair, Division of Restorative Dentistry, UCLA School of Dentistry, Los Angeles, CA, USA
†General Practice Resident, UCLA School of Dentistry, VA Long Beach, CA, USA

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Figure 1. Proposed abutment teeth with large existing amalgam and composite restorations, recurrent decay, and fractured functional cusps adjacent to edentulous space.

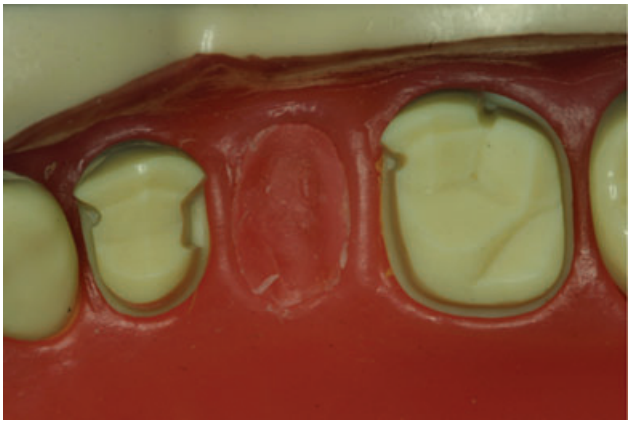

Figure 2. Abutment teeth prepared for 3/4 and 7/8 partial veneer crowns.[3,4]

Figure 3. FPD with rigid connectors utilizing 3/4 and 7/8 crown retainers on the premolar and molar respectively.

to replace teeth with more conventional options, such as fixed/removable partial dentures. In selected cases, a posterior tooth may be replaced with a conservative fixed partial denture (FPD) that employs the use of cast gold retainers, which is both esthetic and functional.

Several clinical scenarios exist that can be treated with such conservative FPDs; each with a customized design in order to preserve tooth structure, maintain esthetics and provide a long term prognosis. Various typical cases will be discussed, each presenting various indications and levels of complexity. A clinical example will also be presented in Part II of this article in order to depict how to create an esthetic facing on the pontic of an inlay-retained cast gold prosthesis with direct composite resin.

PARTIAL VENEER RETAINERS WITH RIGID CONNECTORS

One indication for a conservative FPD is when the proposed abutment teeth have large existing restorations adjacent to the edentulous space. A typodont (SM-PVR-860, Columbia Dentoform Corp., Long Island City, NY, USA) is utilized to depict this scenario (Figures 1 and 2).

The teeth portrayed have large amalgam and composite restorations, recurrent decay, and fractured functional cusps. Although one option is to replace the missing tooth with a FPD utilizing a full coverage Porcelain Fused to Metal (PFM) design, another option would be to use partial gold veneer retainers (Figure 3).[5] Here, the premolar is prepared for a $^{3}/_{4}$ crown, [6]

Figure 4. Plastic pin (#700, The Wilkinson Co. Inc, Post Falls, ID, USA), which will serve as an index for pontic orientation and stability.

Figure 5. The pin is trimmed and becomes incorporated into the pontic wax pattern.

and the molar is prepared for a $^{7}/_{8}$ crown; partial gold restorations that preserve esthetics by leaving the facial and mesiofacial cusps intact, respectively.[7] Both the $^{3}/_{4}$ and $^{7}/_{8}$ crown retainers have very similar high resistance and retention values[4] because of the use of axial grooves ($^{3}/_{4}$ crown)[8] or an axial wall and groove ($^{7}/_{8}$ crown).[9] This FPD may be designed with rigid connectors, as though the retainers were full-coverage restorations.[10,11]

Because each of the retainers and the pontic ideally uses a different investment water/powder ratio,[12] each is cast separately. This allows the technician the ability to fabricate castings that are specific to the preparation design in order to obtain maximum casting accuracy.[13] However, laboratory challenges arise when fabricating FPD with retainers and pontics that are cast independently. Specifically, it is difficult to properly orient the pontic relative to the retainers in preparation for postcast soldering. For this challenge to be addressed, a 700 bur (Brasseler USA, Savannah, GA, USA) is utilized to prepare a hole in the pontic area of the die (Figure 4) for the insertion of a plastic pin (#700, The Wilkinson Co. Inc, Post Falls, ID, USA), which will serve as an index for pontic orientation and stability. After the pin is inserted into the die stone, it is trimmed (Figure 5), the pontic is fabricated in the usual manner, and the pin becomes incorporated into the wax. With this technique, the laboratory technician may easily cast each section separately and reorient the individual components on the working dies with confidence that the vertical and horizontal dimensions will be maintained in preparation for the fabrication of an occlusal soldering index. Please note the utilization of a business card (Figure 6) in order to create the correct space between the individual wax patterns, which serves as an excellent guide for predictable solder joint fabrication (Mr. Ray Barrett, Private Lab Technician, Anacortes, WA, personal communication, 2000). For the pontic for an esthetic facing to be prepared, the facial aspect of the wax pattern is hollowed out (Figure 7) in order to provide space for composite resin, improve casting accuracy, and reduce unnecessary gold consumption. A composite *cage* is created by fixing a bar of wax vertically into a hollowed-out area of the pontic, which will serve to contain

Figure 6. Wax patterns separated by business cards, which provide the correct space between the individual wax patterns for predictable solder joint fabrication.

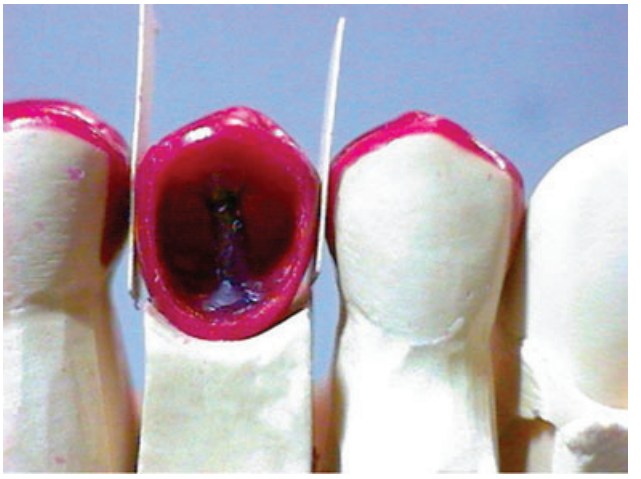

Figure 7. Hollowed-out pontic wax pattern, which will allow for placement of the composite esthetic facing.

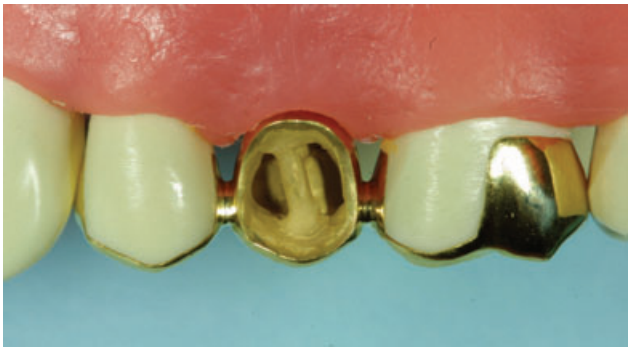

Figure 8. Completed soldered FPD showing the pontic composite cage and soldered joints.

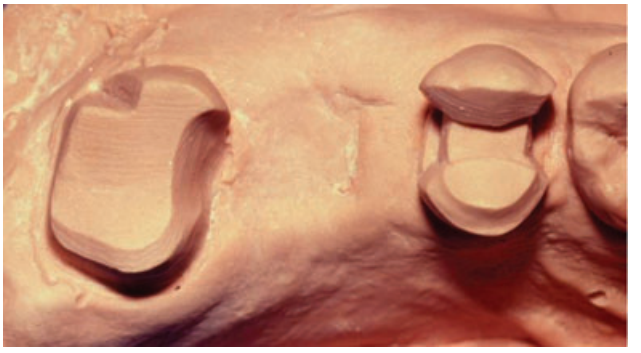

Figure 9. Die Stone Cast.

the composite resin through predictable macromechanical retention. Note in Figure 8 the completed soldered FPD,[14] depicting the composite cage in the pontic and solder joints of adequate dimension and form, ready for delivery by the clinician. The esthetic restoration of the pontic will be discussed in detail in the final clinical case.

CLINICAL EXAMPLE OF SEMI-PRECISION FPDs (FIGURES 9–18)

The following are two clinical scenarios that illustrate the preparation and restoration of non-rigid FPDs, utilizing different partial veneer retainers. In preparing the abutments for partial veneer retainers, consideration to fundamental design principals are employed.

The case shown in Figures 9–13 is #3 $^{7}/_{8}$—#5 MOD onlay FPD. Due to the difference in retention values of the two partial veneer retainers,[11] the use of a stress breaker is indicated.[15] The stress breaker is comprised of a distal segment, containing a distal retainer soldered to a pontic, and a mesial segment. The final esthetic result is shown clinically in Figures 12 and 13.

Figure 10. Segments of stress-broken prosthesis (note: stress broken FPD designed because mesial abutment is an onlay as opposed to previous typodont example with 3/4 partial veneer crown).

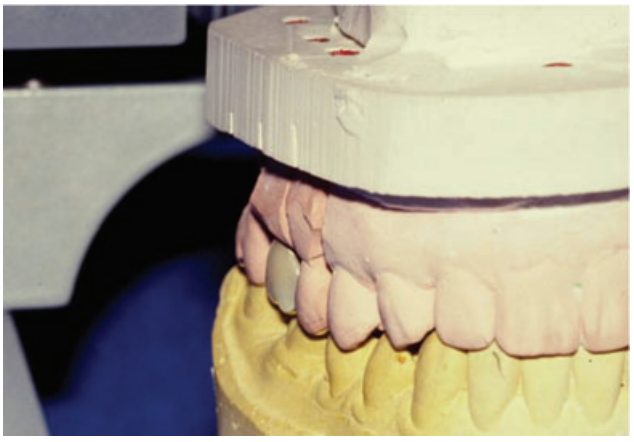

Figure 11. Articulated cast of FPD with custom composite pontic.

Figure 12. Post-cementation with custom composite pontic.

Figure 13. Esthetic appearance of final prosthesis.

Figure 14. Pre-operative view.

Figure 15. Pre-operative view with rubber dam isolation.

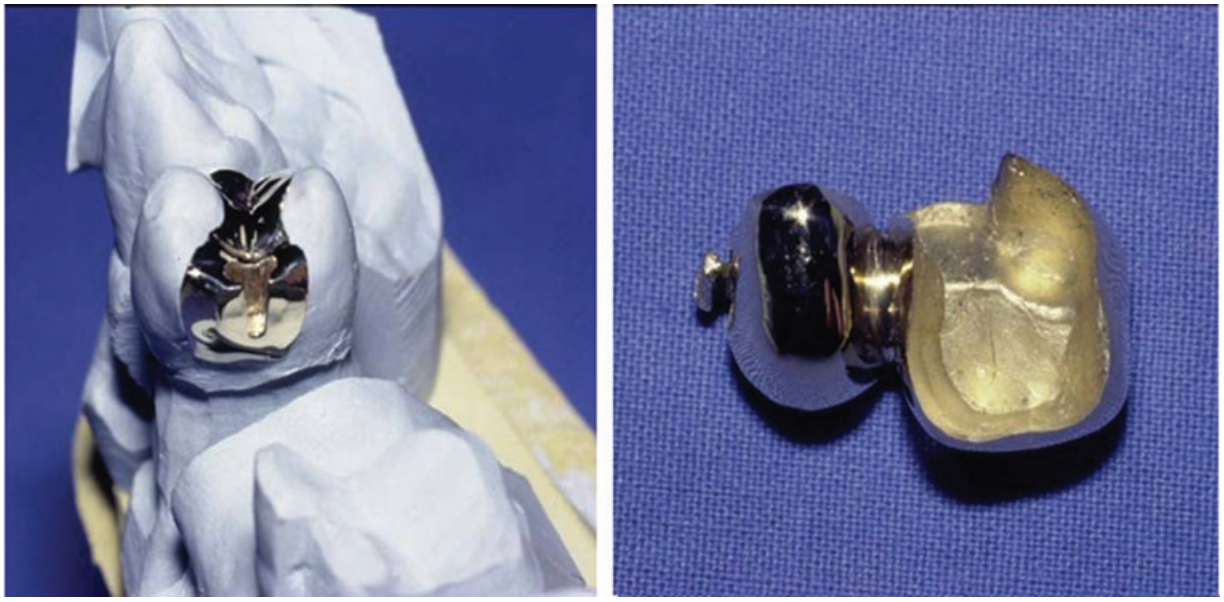

Figure 16. Segments depicting non-rigid connector design.

Figure 17. Post-operative view.

Figure 18. Post-operative view with custom composite pontic.

A similar case depicting the use of non-rigid connectors, #3 $^{7}/_{8}$—#5 DO Inlay FPD, is shown in Figures 14–18. Again, due to the differences in retention value of the retainers, a non-rigid connector is indicated when fabricating the FPD. The mesial and distal segments of the semi-precision FPD are seen in Figure 16. The final cementation and post-operative views are shown in Figures 17 and 18.

The design and rationale for the indication of non-rigid connectors in cases employing different partial veneer retainers will be discussed in further detail in the following section.

SIMPLE INLAY RETAINERS WITH A NONRIGID CONNECTOR

The next case illustrates teeth having conservative amalgam

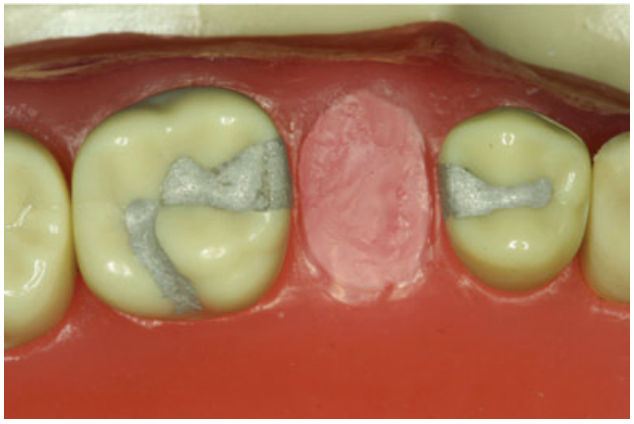

Figure 19. Proposed abutment teeth with conservative amalgam restorations.

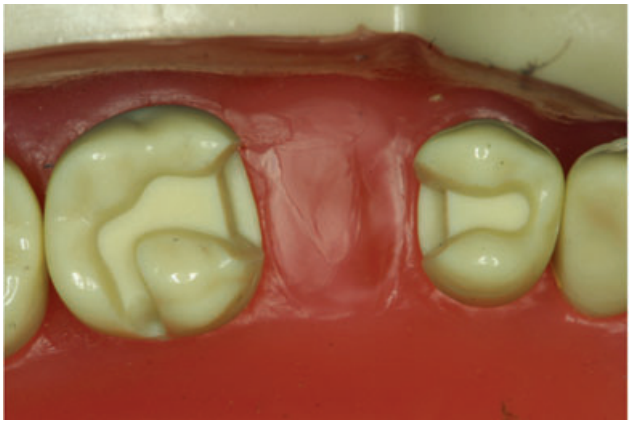

Figure 20. Abutment teeth prepared for conservative MOL and DO inlays.[17]

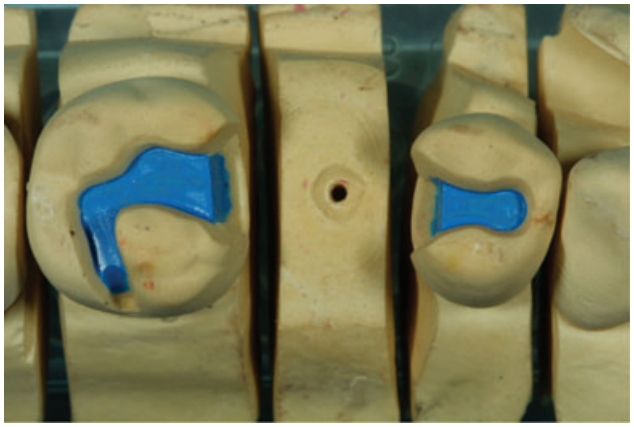

Figure 21. Individual die stone casts of MOL and DO inlay preparations.

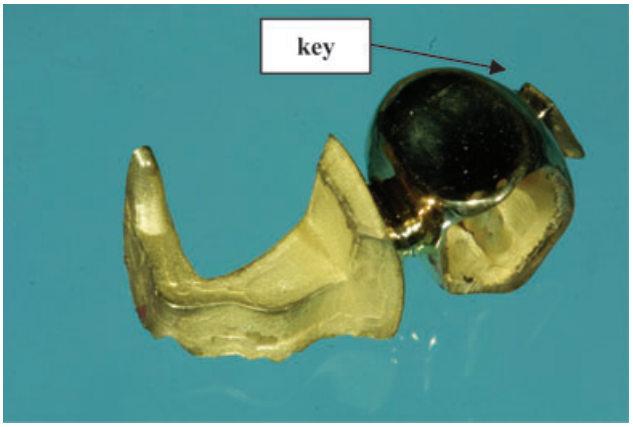

Figure 22. Distal segment of non-rigid FPD with key on mesial portion.

restorations, allowing for a very conservative FPD with inlay retainers. Because inlays have lower overall retention than full coverage crowns (on the same teeth, all other things being equal)[10] and the individual retainers have a disparity in retention values,[11] there is an increased indication for the use of stress breakers.[15] It must be noted that teeth move different amounts during function,[16] depending on their anterior–posterior relation in the arch, root morphology and orientation, surface area, and bone density, further indicating the use of stress breakers.[17] If a FPD with inlay retainers were designed without stress breakers, the abutment containing the inlay with the least retention would be susceptible to dislodgement over time.[18] The design of a FPD with a nonrigid connector includes a distal segment comprised of a distal retainer soldered to a pontic, and a mesial segment. The distal segment will have a key on the mesial surface of the pontic, and the mesial segment will have a keyway on the distal surface of the inlay (Figures 19–21).[15]

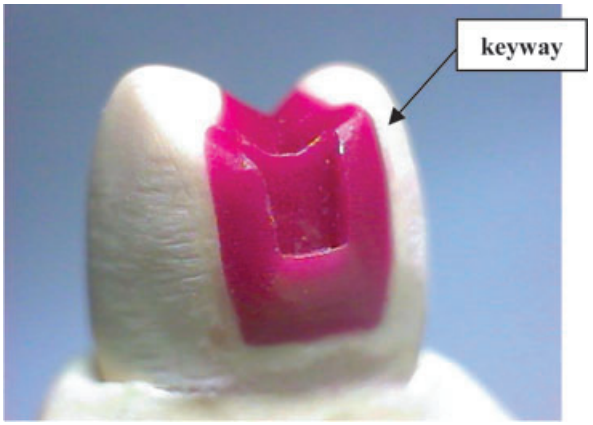

Figure 23. Wax pattern of mesial segment of non-rigid FPD with keyway on distal portion.

Figure 24. Inlay which serves as the mesial segment of non-rigid FPD. Note the smooth and well defined intaglio, which facilitates proper seating and cementation.

Figure 25. Completed Inlay Retained FPD with non-rigid connector.

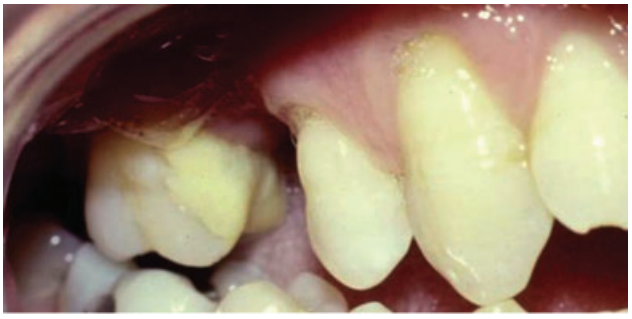

Figure 26. Pre-operative view of FPD.

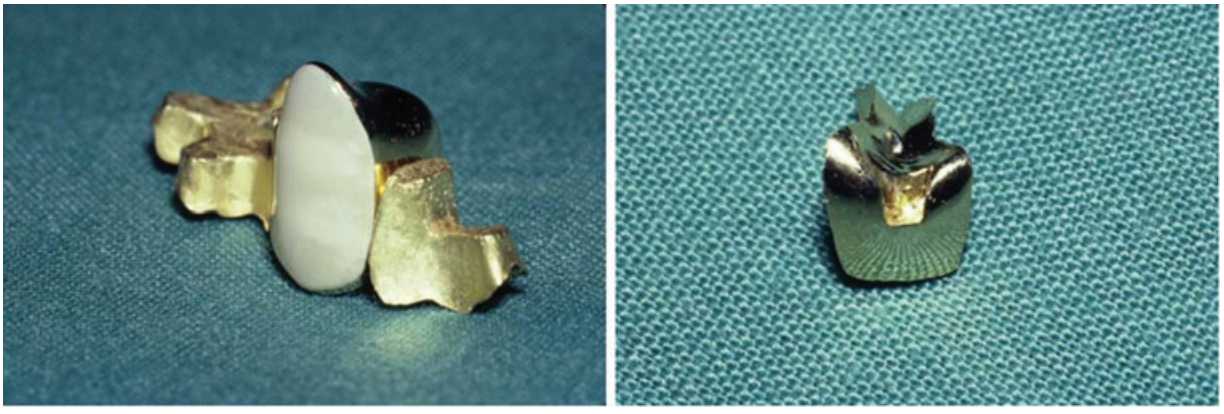

Figure 27. Segments depicting non-rigid connector design.

Figure 28. Pre-operative view of FPD with block-out removed, prior to cementation.

Figure 29. Post-operative view with custom composite pontic.

Figure 30. Esthetic appearance of final prosthesis showing lateral disclusion.

In preparing the teeth for the semi-precision attachments, the axial depth of the mesial abutment is increased[15] in the area of the keyway, and a box is placed in the distal abutment in order to allow the key to remain within the contours of the tooth. In having the keyway in the mesial segment and the key in the distal segment, any natural mesial drift of the teeth will result in further seating of the key into the keyway.[15] If the locations of the key and keyway were reversed, the mesial drift of teeth would result in an unseating action.[15] The flares of each preparation must also be extended enough faciolingually to allow for adequate connector (solder joint) dimensions. During try-in and cementation, the mesial segment must be seated first followed by the distal segment (Figures 22–25).

CLINICAL EXAMPLE OF FPD #3 MOL INLAY—#5 DO INLAY

This clinical case also illustrates the indication for a non-rigid connector when different partial veneer retainers are designed in a FPD. The pre-operative view is seen in Figure 26, in which the patient is missing tooth #4. The mesial and distal segments are fabricated with the keyway and key respectively (Figure 27), as discussed earlier. The inlay preparations and final cementation of the semi-precision FPD are seen in Figures 28 and 29. The esthetic result of the final prosthesis is shown clinically upon full smile and in lateral disclusion (Figure 30). Development of the custom composite pontic will be

discussed in detail in Part II of this manuscript, titled "Utilization of Additional Retentive Features & Fabrication of Custom Pontic Facings".

SUMMARY

This article has demonstrated various clinical indications and techniques to fabricate and deliver conservative and esthetic FPDs. Although in today's dental world, implant restorations are considered the standard of care in the replacement of missing teeth, several clinical contraindications and patient nonacceptance of implant placement can be encountered. In such cases, a semiprecision FPD is a conservative, functional, and esthetic alternative to implant restorations.

Unlike FPDs with full-coverage retainers, carefully designed FPDs with nonrigid connectors and inlay retainers allow for preservation of healthy tooth structure. Through the use of stress breakers, the inlay retainers (with different retention values) are effectively designed to move independently, preventing dislodgement of the retainers from the abutment teeth over time. With nonrigid connectors allowing independent movement of the retainers, each abutment can be prepared with an independent line of draw, facilitating the most conservative preparations possible.

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Reprint requests: Richard G. Stevenson III, DDS, UCLA School of Dentistry, 33-009A CHS, 10833 Le Conte Ave, Los Angeles, CA 90095-1668, USA; Tel: (310) 794-4387; Fax: (310) 825-2536; email: rstevenson@dentistry.ucla.edu