

# Conservative Zirconia Bridge for Anterior Tooth Replacement



Jack D. Griffin  
Jr, DMD

Conservative replacement of lost or missing teeth is simplified with today's restorative materials, and allows the clinician to create a "marriage" between aesthetics and durability.<sup>1</sup> Implants, full-contour bridges, and a variety of removable bridges must all be considered when planning any tooth replacement case. To achieve long-lasting success, a proper union of material selection, well-planned tooth preparation, proper bridge design, dependable bonding, biologically acceptable soft-tissue treatment, tolerated occlusion, and accurate communication among the patient, dentist, and laboratory must all exist.<sup>2,3</sup>

Popular "metal-free" tooth colored indirect restorative materials include zirconia (no layering porcelain), zirconia (layering with porcelain), lithium disilicate ceramic, and leucite reinforced ceramic. Zirconia has proven to be an excellent choice for bridge substructures, but its bond to tooth structure has been minimal. However, with current primers that are shown to covalently bond to zirconia, conservative, metal-free options can be routinely considered.

This article discusses the clinical applications and techniques for zirconia restorations. A case report is presented that describes a conservative anterior bridge using a new zirconia primer, adhesive bonding, and retentive preparations.

## ZIRCONIA AS A CONSERVATIVE BRIDGE SUBSTRATE

Significant advances with indirect aesthetic materials the last few years have brought the profession higher levels of strength and aesthetics than ever before in bridge design.<sup>4,5</sup> Zirconia has been widely used within the last few years as a bridge framework because of its nonmetallic color, fracture resistance with flexural tests over 1,000 MPa, and excellent long-term clinical success.<sup>6,7</sup> These CAD/CAM fabricated bridge frameworks have been primarily used for full coverage restorations with dependable cosmetic results.<sup>8,9</sup>

Likewise, conservative zirconia-fixed partial dentures can be a minimally invasive



**Figure 1.** The patient had been concerned with darkening of the retained deciduous tooth "h" for several years.



**Figure 2.** Examination revealed an otherwise healthy dentition with slight spaces and incisal wear. The patient wanted the space between the central incisors repaired if possible. Veneers and a full coverage bridge were ruled out.



**Figure 3.** Extraction and replacement of tooth "h" was necessary after an increase in mobility and pain.



**Figure 4.** The permanent cuspid was palatally impacted mesioangularly at the level of the apex of teeth Nos. 9 and 10 and an implant was ruled out.

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alternative for anterior tooth replacement and have proven to be very successful; particularly if retentive preparations are done, there is a defined and limited path of insertion, if bonding is adequate, and if connectors are of sufficient thickness and height.<sup>10</sup> A layering porcelain is added to enhance the aesthetics and has proven durable, particularly if occlusal stresses are minimal.<sup>11,12</sup>

Another advantage of zirconia is that it can be cemented, or in cases with less retention form in the preparations, it can be bonded in place. Zirconia is an acid resistant, polycrystalline ceramic that does not contain amorphous silica, making it ineffective to traditional glass etching treatments such as hydrofluoric acid (HFl) followed by silane.<sup>13,14</sup> Bonding of zirconium based restorations cannot be done with the same

methods as traditional glass-porcelain.<sup>15,16</sup> Bond strengths using differing methods including sand blasting with aluminum oxide, silane treatment, or other chemicals provided a weak bond at best that deteriorated significantly with time.<sup>17-20</sup>

When preparation designs are retentive, as in the case of many full crowns and bridge abutments, bonding to the zirconia becomes less important, and more traditional cementation with dual-cure resin cements such as BisCem (BISCO Dental Products), Maxcem (Kerr), and RelyX Unicem (3M ESPE) can be successfully accomplished.

## BONDING WITH ZIRCONIA PRIMERS ON LESS RETENTIVE PROSTHESES

Conservative anterior bridges have been

*continued on page xx*

### Conservative Zirconia Bridge...

continued from page 00

tried for many years with varying degrees of success and failure. An increase in adherence may make their use more attractive in future planning. Reliable adhesion, proper abutment preparation using boxes of a single insertion path, and group function or bicuspid disclusion can all be factors affecting predictable long-term success.<sup>21,22</sup>

Despite minimal chemical adhesion with zirconia using traditional bonding systems, micromechanical retention has been sufficient for complete coverage restorations.<sup>23</sup> Studies have been somewhat encouraging with some silanization techniques, but higher bond strengths for conservative restorations would be a significant advantage.<sup>24,25</sup> A zirconia primer, Z-Prime Plus (BISCO Dental Products) has been developed that has been shown to significantly increase the shear bond strength of 4 different light-cured and self-cured resin cements (BisCem [BISCO Dental Products], Unicem (3M ESPE), Bisfix SE (VOCO America), SmartCem 2 [DENTSPLY Caulk]), according to research conducted at Bisco Inc. in 2010. The author considers the use of primers on indirect substrates in retentive cases as an improved means to seal this interface and reduce water penetration between the cement and the zirconia undersurface.

For restorations that have short clinical crowns, or where resistance form is lacking, it is helpful to have a primer that will work on materials that are nonsilica based to increase retention of the restoration.<sup>26,27</sup> Materials such as zirconia, alumina, and metal have no glass component, so traditional etching with HFl is not effective. The phosphate monomers form the basis for chemical bonds between the zirconia and the primer, allowing for a cohesive bond to the resin cement. This reliable bond over time is critical, especially in a minimally retentive case with conservative bridge abutments, as in the case that follows.<sup>28,19</sup>

#### CASE REPORT: CONSERVATIVE REPLACEMENT OF TOOTH NO. 11 Treatment Plan

A 58-year-old woman had a retained deciduous tooth "h" with a mesioangular impacted tooth No. 11 extending under teeth No. 9 through No. 12 (Figure 1). Tooth "h" had become mobile over the last year and reached the point of severe pain upon touch



**Figure 5.** Extraction of "h" was uneventful and the mesial papilla was quite good, but there was slight blunting of the distal papilla.



**Figure 6.** After tooth preparation a temporary was made with a dual-cure composite in a matrix from the pre-op condition of the tooth.



**Figure 7.** Composite was placed on the tissue side, making a convex surface in all directions for tissue adaptation. The material was added and slight blanching of the tissues verified.



**Figure 8.** Granulation tissue was removed and a graft material placed in the extraction site. Before the temporary bridge was cemented, a collagen membrane was laid over the site to keep cement from moving toward the graft.



**Figure 9.** After 3 months of healing, the temporary was removed and a good ovate form was present. The preparations were refined and impressions taken.



**Figure 10.** Photos of the teeth to be matched were taken for the ceramist.



**Figure 11.** Impressions and models were accompanied by photos and a CD containing all images taken before and during the procedure.



**Figure 12.** The lab was instructed to remove a slight amount of stone (about 0.5 mm) in the pontic area so that the bridge would put slight pressure on the soft tissues for support.



**Figure 13.** The bridge framework of zirconia was covered with an add-on porcelain for aesthetics.

with grade 3 mobility. The tooth was deemed hopeless and extraction was indicated (Figure 2). She had a 3-mm overjet and a one-mm deep bite with no centric contact on the lingual of the maxillary incisors. Her occlusion in lateral movements was in group function with the cusp tip of tooth No. 6, slightly worn with generalized enamel crazing. This occlusal scheme would provide a more suitable situation for a conservative bridge than someone with a more advanced deep bite, heavy cingulum contact, and evidence of parafunctional habits. The incisal aspect of tooth No. 9 had an asymptomatic fracture from trauma several years earlier.

Surgical exposure of tooth No. 11 with orthodontic ligation and traction was ruled out because of the unpredictability of forced eruption in adults and the patient's desire to avoid orthodontics. Because of the position

of the impacted tooth, an oral surgeon felt that the extraction, bone grafting, and implant placement would be unpredictable.

More extensive cosmetic/restorative treatment was ruled out for financial reasons and the patient's request to not have teeth "ground on" (Figure 3). The accepted plan was for extraction of "h," a conservative zirconia framework/porcelain bridge to replace tooth No. 11, use of composite on tooth No. 9 and the mesial of tooth No. 10 to improve aesthetics, and on tooth No. 6 to restore the cusp tip (Figure 4).

#### Preparation of Tissues

After administration of local anesthetic, the deciduous tooth "h" was extracted, granulation tissue was removed, and the abutment teeth were prepared using a medium grit tapered diamond (Figure 5). The lateral incisor was prepared with 1 to 1.5 mm reduction with

a rounded shoulder and 1.5 mm deep seating grooves placed on the mesial and distal aspects of the preparation. The box on the distal was 2 to 3 mm into the tooth and 3 to 4 mm in height from gingival to incisal.

The composite on the bicuspid was removed and the lingual cusp reduced for about 2 mm of clearance in excursive movements. Interproximal box preparations with a width and height of about 3 mm were done to provide a dovetail with a definite path of insertion and to provide bulk for connectors. These boxes were made parallel with a limited path of insertion complimenting the preparation of the lateral incisor to decrease chances of displacement and to increase surface area for luting material bonding.

A composite temporary restoration (Luxatemp [DMG America]) with an ovate type pontic was fabricated

continued on page xx

### Conservative Zirconia Bridge...

continued from page 00

from a matrix made from the arch before the extraction was done (Figure 6). The tissue surface was smoothed and a small dome of composite was added to make a 100% convex surface to cover the extraction site and to provide slight pressure so that minimal blanching was seen when fully placed into position. This slight pressure is critical for papilla support and maintenance of aesthetic gingival contours (Figure 7). Support of the gingival tissues with good ovoid pontic form and papilla support are critical in tooth replacement cases. Proper design is needed to maintain buccal-lingual width of the extraction site, to preserve the papilla with support by application of slight pressure, to encourage growth of soft tissue into an "ovoid" form for proper emergence

profile of the final pontic, and to help stabilize the graft material.

Pep Gen granular (DENTSPLY Cera-Med) was then placed in the extraction site to help minimize resorption (Figure 7).<sup>29-31</sup> A collagen membrane was placed over the graft material and the temporary was then cemented (TempBond Clear [Kerr]). It was fabricated to exert slight pressure on the gingiva with slight tissue blanching when in its final position (Figure 8). Final shaping was accomplished followed by polishing with disks.

The patient returned for definitive tooth preparation and impressions 3 months later. The healing of the soft tissue was good with acceptable adaptation to the temporary (Figure 9). The preparations were refined with a fine shamfer diamond with boxes and channel providing a single path of insertion. Vinyl polysiloxane impressions were then taken (Precision [Dis-

cus Dental]) and sent to the lab with a full series of shade and character photos, all preoperative photos, bite registration, and opposing model. A key for giving the ceramist the best chance of matching existing teeth is with good photography on nondesiccated teeth showing at least 2 different shade tabs on the same plane as the teeth being matched, a contrastor to provide a dark background for better character identification, and using a quality camera with good lighting control (Figure 10).

### A Zirconia Framework Bridge

The laboratory prescription was for a zirconia framework bridge with layering porcelain over an ovate pontic design (Figure 11). The lab technician was instructed to create an "ideal" ovate pontic site by removing stone to make a smooth, completely convex surface and a highly aesthetic emer-

gence profile (Figure 12). A CAD/CAM zirconia framework was made (LAVA [3M ESPE]) and layering porcelain (Ceram Overlay Porcelain [3M ESPE]) was added to the external surface for customization (Figure 13).

At the cementation appointment, the temporary was removed and the preparations were cleaned with a pumice and alcohol on a microbrush. The materials needed for cementation of zirconia are a dual-cure dentin bonding agent (All Bond 3 [BISCO Dental Products]), silane, zirconia primer (Z Prime Plus [BISCO Dental Products]), and a dual-cure composite cement (DuoLink [BISCO Dental Products]) (Figure 14). After verification of fit, the bridge was cleaned with ethyl alcohol and an unhydrolyzed 2-part silane agent (Bis-silane [BISCO Dental Products]) was applied.<sup>32</sup> A drop of zirconia primer (Z-Prime [BISCO Dental Products]) was placed on the internal surface of the porcelain abutments and dried after 60 seconds (Figure 15).

The teeth were etched 20 seconds with phosphoric acid, rinsed, and left moist. The bonding agent was mixed and placed on both the teeth and bridge and air thinned. The luting cement (Duo-Link) was placed directly on the teeth and the bridge held into position with moderate digital pressure, cleaned, and cured with ultraviolet light (Figure 16). It is important to note that both a dual-cure DBA and luting material were used because of the opacity and low light transmission of zirconia. Occlusion was checked, contact was minimal on the connectors, and group function was maintained.

Composites were placed on teeth Nos. 6, 9, and 10 to correct cosmetic concerns of the patient and to restore the worn cusp tip on the cuspid. Removal of old composite material was done with a finishing diamond. An irregular finish line was created and the teeth were isolated with retractors (SeeMore [Discus Dental]), then etched with 37% phosphoric acid for 15 seconds. After thorough rinsing, several coats of a dentin bonding agent (All Bond 3 [BISCO Dental Products]) were applied and air-thinned. Layers of dentin, enamel, and incisal opacity composites Renamel [Cosmedent] were placed and characterized with stain (Creative Color [Cosmedent]) (Figure 17).

Shaping was completed with disks (SofLex [3M ESPE]) and polishing was performed with rubber cups (FlexiDisk [Cosmedent]) (Figure 18). A

continued on page xx



**Figure 14.** Materials needed for bonding a zirconia bridge include phosphoric acid etch, a dual-cure bonding agent, dual-cure resin cement, silane, and the zirconia primer.



**Figure 15.** After try in, the zirconia wings were cleaned in an ethyl alcohol bath, rinsed, silanated, and the primer applied.



**Figure 16.** The teeth preparations were etched for 15 seconds, rinsed thoroughly, suction dried, and several coats of dual-cure DBA were applied and air thinned.



**Figure 17.** Composite bonding was performed to close the diastema, correct the incisal chipping on tooth No. 9, to correct the size and position of tooth No. 10, and to add the incisal tip of tooth No. 6.



**Figure 18.** Preservation of the ridge with minor grafting, ovoid temporary fabrication, and an ovoid pontic with slight pressure on the gingiva allowed for a natural soft-tissue emergence.



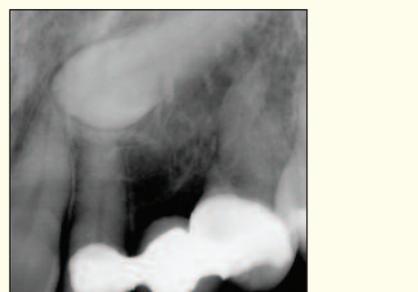
**Figure 19.** Soft-tissue tolerance at almost 2 years was excellent, and the integrity of the materials has been acceptable.



**Figure 20.** The blending of the bridge with composite restorations gave a very natural result with very little occlusal change.



**Figure 21.** The result is an improvement in the smile with a natural blending of materials. The success of this conservative bridge will rely upon the preparation, dentin bonding, and adhesion to the bridge framework.



**Figure 22.** A final PA shows the position of the impacted cuspid and the bonded prosthesis; zirconia is radiopaque.

## Conservative Zirconia Bridge...

continued from page 00

clear vacuum-formed 2 mm hard/soft nocturnal bruxism splint was made (Erkodent [Glidewell Laboratories]), and the patient was encouraged to wear it nightly and daily when grinding/clenching was noticed.

### Follow-up and Evaluation

The soft-tissue response at 16 months was excellent with good papilla support and a natural emergence profile. After almost 2 years, there have been no clinical problems and the patient is very happy with the results (Figure 19). She felt very comfortable with “the fit” and stated she had been flossing under it almost every night and had been wearing the bruxism splint regularly.

### SUMMARY

The demand for metal-free restorations coupled with the desire for conservation of tooth structure has put new demands on our profession. There is a symbiotic synergy among the great skills of our ceramists, the commitment to successful chemistry of our researchers and manufacturers, and the unwavering desire for happy patients and long lasting restorations by clinicians (Figure 20). With continually improving bonding materials and when tooth preparation and occlusion are well planned, conservative anterior bridges should be considered in many partially edentulous cases (Figure 21). This treatment option was particularly appropriate in the case described in this article, where an impacted cuspid limited the choices of treatment and the desire for conservative dentistry was maintained. (Figure 22). ♦

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souri since 1988. In a very busy practice, he and his staff have consistently maintained a 50% to 55% overhead by emphasizing cosmetics while doing all phases of general dentistry. He has been awarded by his peers Diplomate status with the American Board of Aesthetic Dentistry; holds accredited status with the American Academy of Cosmetic Dentistry; and has achieved Mastership in the AGD. He is the MasterTrack/CE chair for the Missouri AGD and is on the Council of Scientific Affairs for the Greater St. Louis Dental Society. He considers it an honor to have taught many dentists how to improve their skills with digital photography, direct bonding techniques, efficiency with porcelain veneers, practice management, and CAD/CAM dentistry in lectures and scientific publication. He is grateful to be surrounded by those to help make the dental experience both rewarding and enjoyable. He can be reached at esmilecenter@aol.com or visit eurekasmile.com.

Disclosure: Dr. Griffin reports no disclosures.

Dr. Griffin has practiced in St. Louis county Mis-

continued on page xx



### Conservative Zirconia Bridge...

continued from page 00

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The following 8 questions were derived from the article *Conservative Zirconia Bridge for Anterior Tooth Replacement* by Jack D. Griffin Jr, DMD, on pages xx through xx.

#### Learning Objectives

**After reading this article, the individual will learn:**

- Clinical applications and techniques for zirconia restorations, and
- A technique for a conservative anterior bridge using a new zirconia primer, adhesive bonding, and retentive preparations.

**1. Current popular metal-free indirect restorative materials include all of the following except:**

- a. Full contour zirconia.
- b. Zirconia with layered porcelain.
- c. Captek.
- d. Lithium disilicate.

**2. An advantage of zirconia-based restorations is resistance to fracture because of flexural strength that is near:**

- a. 100 MPa.
- b. 1000 MPa.
- c. 10,000 MPa.
- d. 50,000 MPa.

**3. Advantages of using zirconia include all of the following except:**

- a. It has a nonmetallic color.
- b. It can have porcelain layered to its surface to increase aesthetics.
- c. It can be cemented or bonded into place.
- d. It can be porcelain etched and silanated like traditional ceramics.

**4. Treating the internal surface of zirconia by aluminum oxide sand blasting:**

- a. Provides a weak bond at best and may provide little aid in retention.
- b. Is the preferred method for bonding zirconia.
- c. Gives reported bond strengths of around 45 MPa.
- d. Microetches the surface to provide a high level of mechanical retention.

**5. The reason zirconia doesn't etch like porcelain is its lack of:**

- a. Silica.
- b. Tin.
- c. Aluminum.
- d. Quartz.

**6. The following factors are critical to long-term success with conservative anterior bridges except:**

- a. Ovoid pontic design.
- b. Adhesive luting.
- c. Proper tooth preparation with single path of insertion.
- d. Controlled occlusion in excursive movements.

**7. It is best to use a dual or self-cure luting material with zirconia because:**

- a. Light transmission is accentuated by its high translucency.
- b. Lack of an air inhibited layer may decrease setting.
- c. Opacity of zirconium oxide may prevent adequate light penetration.
- d. Dual-cure materials exhibit more chance of post-cure color change.

**8. Important occlusal considerations for conservative anterior bridges, particularly cuspid replacement, is for the patient to have:**

- a. A limited deep bite.
- b. Lack of evidence of parafunctional habits.
- c. Group function in lateral excursions.
- d. All of the above.

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