Cementation of Lava Restorations

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With the multitude of choices for all-ceramic restorations on the market today, many questions can arise clinically. This clearly becomes evident when it is time to cement the restoration. Does the restoration need to be adhesively bonded to increase its strength or can you use conventional luting cements? Does the intaglio surface of the restoration need to be etched? Does it need to be silanated? It is the intent of this article to answer the previous questions and discuss the options for cementation of high-strength zirconia restorations in clinical practice.

The Lava™ System

The Lava™ System (3M™ ESPE™, St. Paul, MN) uses CAD/CAM technology for the design and milling of yttrium tetragonal zirconia polycrystals (YTZP) for the creation of all-ceramic frameworks. Zirconia not only has a high flexural strength (ranging from 900 MPa to 1200 MPa) but also a high fracture toughness.[1-3] The strength of zirconia can be attributed to its small grain structure as well as a process known as transformation toughening. One of the concerns with many dental ceramics is the impact of stress in creating cracks within ceramic. The unique process of transformation toughening present in the Lava system occurs at the leading edge of a propagating crack. The high-energy state in the leading edge of the crack transforms the ceramic in this area from a tetragonal crystal formation to a monoclinic crystal formation. Because of the fact that the monoclinic crystal is 3% to 5% larger than the tetragonal crystal, the area of transformation is placed under compression.[4] The result of this compression is that it stops the propagation of the crack. In a sense this process allows the ceramic to be "self-healing" if a crack develops.

With the Lava system, the working dies are optically scanned. Because of its high strength, Lava is indicated for use with either single-unit restorations or bridges.[5-6] The optical scanning creates a virtual substructure or framework in the case of a multi-unit bridge. The system allows the technician to not only control the margins and thickness/contours of the coping, but also the position and size of the pontics and connectors. The scanning can also take into account the opposing occlusion as well as the soft tissue contours under a pontic to provide a more ideal framework location to support the veneering ceramic. The framework design is then milled into partially sintered YTZP blanks. Because these blocks are not fully sintered, the consistency of the material is relatively soft by comparison. This allows for easier and more efficient milling. To account for the shrinkage that occurs during final sintering, the framework is designed to be 20% larger. The marginal accuracy after sintering is extremely accurate, with marginal gaps ranging from 40 µm to 70 µm.[7] It is also important to point out that as compared to traditional metal-ceramic frameworks that undergo distortion during the process of firing the veneering ceramic, the Lava zirconia framework does not have any distortion during the veneering process. Lastly, one of the other significant benefits of the Lava system is that the zirconia substructure can be custom tinted with one of eight different shades. This allows for greater control of the esthetics of the completed restoration.

Cementation

Given the inherently high flexural strength of zirconia, the restoration does not need to be bonded for strength. Although the restoration can be adhesively bonded, if there is adequate preparation height and taper, traditional luting cements are sufficient. It has been shown that the use of glass-ionomer or resin-modified-glass-ionomer cements can be used successfully.[8,9] Using conventional cements has many distinct advantages. It is less technique-sensitive than bonding, especially if the preparation margins are below tissue and/or tissue management is a problem. It is also much easier to clean up after conventional cementation as compared to cleaning up resin cement. And if the restoration ever has to be removed in the future, it is far easier to remove one that was traditionally luted rather than struggle with a bonded crown.

If there is a desire for increased resistance/retention of the restoration because of a short or excessively tapered preparation, adhesive luting is recommended.[10] Aside from increasing the retention and strength of the restoration, bonding helps decrease microleakage.[11] Traditionally, the protocol for bonding ceramic restorations included the use of chemical etching of the intaglio surface followed by the application of a silane coupling agent before bonding. Although this technique is very predictable at creating adhesion at the coping-resin interface when used with silica-based dental ceramics, difficulties arise with this protocol when applied to Lava for two reasons. First, the application of hydrofluoric acid to the intaglio surface of the high-strength zirconia does not create the same roughened surface. And because there is no silica, the same chemical coupling does not occur.

Several protocols to provide a predictable bond to zirconia have been tested in the literature. One technique is to sandblast the internal surface of the restoration with aluminum oxide before cementation.[12,13] Although this protocol is easy to implement and can be used effectively, it only provides a relatively weak bond to the zirconia. Using a tribochemical surface treatment with the Rocatec™ system (3M™ ESPE™) has been shown to enhance the bond the zirconia.[14,15] In addition, it has been shown that the use of a modified silane/bonding agent used with a modified resin cement will predictably increase the bond to zirconia.[16,17]

The question becomes, how much bond strength to the zirconia is necessary? I will tell you that the majority of zirconia restorations that I place in the anterior are cemented with a resin-modified-glass-ionomer cement (Rely-X™ Luting Cement, 3M™ ESPE™). This is because occlusal forces in the anterior dentition are significantly less than forces in the posterior and the structural requirements of tooth preparation (height and taper) have been met. When placing restorations in the posterior, my protocol is to use a resin cement (Rely-X™ Unicem, 3M™ ESPE™) and to sandblast the internal surface of the restoration with aluminum oxide before cementation. Although this will not provide the highest bond strength to the zirconia, it will help if the preparation height is less than ideal and will also provide increased security with the higher forces of occlusion.

Case Presentation 1

A 51-year-old patient presented with a six-unit splinted restoration from canine-to-canine replacing congenitally missing lateral incisors (Figures 1A and 1B). The existing metal-ceramic restoration was placed 18 years ago. The primary reason the patient wanted to have the restoration replaced was to change the appearance of the pontics. The patient reported that she never thought the lateral incisors looked like real teeth because they had the appearance that they were sitting on top of the tissue. She also wanted to have the color improved so that it blended more smoothly with her natural teeth.

Figures 1A and 1B—Initial presentation of a patient with a six-unit splinted restoration replacing congenitally missing lateral incisors. The patient did not like the appearance of the No. 7 and No. 10 ridge-lapped pontics.

Figure 2—Removal of the existing restoration allows a more complete evaluation of the edentulous ridges. From this perspective we can see that the edentulous ridges have good tissue height. From Figure 1 we are able to see that there has been mild horizontal ridge loss.

The treatment plan was to replace the six-unit metal-ceramic splint with two three-unit all-ceramic Lava bridges. To improve the esthetics of the pontics, we first had to evaluate the edentulous ridge as well as the pontic-ridge relationship. With the restorations in place, it was apparent that the pontics were sitting facial to the ridge and that the ridges had mild horizontal loss. Upon removal of the existing restorations we could see that the ridges had good vertical height when compared to the height of the interproximal tissue between teeth Nos. 8 and 9 (Figure 2). Two treatment options were discussed with the patient regarding the edentulous ridges. The first option was to surgically augment the facial tissue in the edentulous areas with subepithelial

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Figure 3—The provisionals were created with the intent of bringing the pontics back and creating an ovate pontic form. At a 6-week evaluation, a more ideal tissue-pontic relationship has been created.

Figure 4—The appearance of the pontic receptor site immediately upon removal of the provisional restoration. Note the contours of the tissue as well as the tissue health. Without having the support from the provisional restoration in place, the scallop of the ridge will begin to flatten out.

Figure 5—The definitive Lava restorations after application of veneering ceramic. Note the similarity in coloring between the framework and the veneering porcelain.

Figure 6—During try-in of the definitive restoration it is important to evaluate the relationship of the pontic to the soft tissue profile that was created with the provisionals. The restoration should adequately support that soft tissue facially as well as interproximally.

Figure 7—Given the adequate preparation height and taper, a conventional, resin-modified-glass-ionomer cement was chosen for cementation. Note the tissue blanching that was present in the edentulous area when the restoration was seated. This temporary effect is due to the soft tissue changes that occur without tissue support immediately before cementation.

Figures 8A and 8B—The final restorations at a postinsertion evaluation reveal a more ideal pontic-ridge relationship without any soft tissue augmentation. The definitive restorations blend naturally with the smile and existing dentition.

connective tissue grafts. This procedure can be used very predictably to augment horizontal loss of ridge volume.[18] Although, given the good ridge height with only mild horizontal loss, the other option given was to bodily bring the position of the laterals more palatal as well as create a more "ovate" pontic form. The main goal when trying to make a pontic appear as if it is not a pontic is to have the tissue facial to the pontic. This gives the appearance that the pontic is "emerging" out of the tissue rather than "sitting" on the tissue. Bringing the position of the laterals back and creating an ovate pontic would help create this more ideal pontic-ridge relationship. Given the fact that the ridges were not that resorbed, it was decided to try and work out the esthetics of the pontics in the provisional phase of treatment, with the current ridges. If we did not like the result that was obtained in the provisionals, we would then augment the ridges.

The provisionals were fabricated with an ovate pontic form created using a direct technique on a stone model. Manual pressure was used to seat the provisionals in the mouth with no other adjustment made to the soft tissue (Figure 3). The provisionals were in place for 4 to 6 weeks to allow for full tissue maturation around the new pontic contours (Figure 4). Once we were satisfied with the esthetics of the pontics, final impressions were taken and poured. The working dies were trimmed and scanned along with the soft tissue contours of the edentulous ridges and two Lava frameworks were fabricated and later veneered (Figure 5). The completed restorations were tried in to evaluate fit and esthetics (Figure 6). Specific attention was given to the pontic-tissue relationship. Given the length and taper of the preparations, a conventional luting cement was chosen. Before cementation, the intaglio surface of the restoration was cleaned with 35% phosphoric acid for 10 seconds and rinsed with water. This was done to clean the intaglio surface of the restoration but had no effect on surface itself. The restorations were cemented with a resin-modified-glass-ionomer cement (Rely-X Luting Cement, 3M™ ESPE™) (Figure 7). The excess cement was cleaned and the occlusion verified. The definitive restorations reveal a more acceptable pontic-ridge relationship (Figures 8A and 8B). To obtain a more ideal result, soft

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Figures 9A and 9B—Initial presentation of teeth Nos. 8 and 9. The patient desired to have the central incisors restored to lengthen the worn incisal edges as well as correct the color difference. Tooth No. 8 has a history of trauma and root canal therapy.

Figure 10—Tooth No. 8 was prepared for a full-coverage Lava restoration. This restoration was chosen for its ability to mask the dark underlying preparation color. In addition, the restorative margins were placed subgingivally to mask the dark preparation and to try to lighten the appearance of the tissue. Tooth No. 9 was prepared for a ceramic veneer.

Figures 11A and 11B—The final restorations at a postinsertion evaluation blend well with the adjacent dentition.

tissue augmentation would be required to bring the tissue more facial.

Case Presentation 2

A 39-year-old man presented with the chief complaint that he did not like the appearance of his maxillary central incisors (Figures 9A and 9B). Clinical evaluation revealed localized incisal wear on both maxillary centrals incisors. In addition, there was a significant color difference between the centrals, with tooth No. 8 being three to four shades darker. Tooth No. 8 had a history of trauma and subsequent endodontic treatment. The treatment goals were to lengthen the incisal edges of both central incisors and provide a uniform color matching the adjacent dentition. To accomplish this, a veneer restoration was planned for tooth No. 9. Given the extreme color difference of the adjacent central and the difficulties that would accompany trying to mask this color with a veneer restoration, a single Lava crown was treatment planned for tooth No. 8. The restoration was chosen for its ability to mask the darkness of the underlying preparation rather than fight its show-through. Although a traditional porcelain margin can be used with the Lava system, given the desire to completely mask the dark preparation color, the margin was placed subgingivally and the Lava coping carried all the way to the cavosurface margin (Figure 10). The final restorations were tried in and evaluated for fit, occlusion, and esthetics. The Lava restoration was cemented with resin-modified-glass-ionomer cement (Rely-X Luting Cement) while the veneer restoration was cemented with a resin cement (Rely-X Veneer Cement) (Figures 11A and 11B).

Summary

With the inherently high flexural strength of Lava restorations, conventional cementation with a resin-modified-glass-ionomer or traditional glass-ionomer cement has been shown to be successful. Many protocols exist for the adhesive luting of Lava restorations. Although the different methods for adhesive luting provide varying levels of bond to the intaglio surface of the Lava restoration, each can be used successfully in clinical practice.

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