Should I switch?

A Closer Look at Zirconium Oxide

"We are what we repeatedly do. Excellence then is not an act, but a habit." – Aristotle Gordon Russell

The new materials of today offer a lot of promise for solving technical and esthetic challenges by new means. How well they will function in real-life situations however is the proving ground that will determine the success or failure of these new technologies.

"Zirconium has a high degree of resistance to moistureinduced strength degradation when compared to other all-ceramic materials." Despite successful sales, there has been reticence in accepting new technologies for fear that new materials have not adequately been proven in the lab or in the field, even though the materials may have grown in popularity across the industry.

One of the latest such trends is the increasing use of zirconium as a restorative material. Many of my clients ask, "Why fix it if it isn't broken?" These same clients have restored countless cases with traditional materials, such as PFM, which has been proven over the years to be very successful in the most challenging situations with gratifying long-term and esthetic results.

These same cases, however, also may be restored with zirconium just as successfully and in some instances, perform better with less effort from the technician. The use of zirconium as a restorative dental material offers many advantages that are appealing to both the dentist and the technician. The question still remains: "How well does it stand up to our most challenging clinical and technical cases?" By the end of this article, I hope you will be able to answer these questions:

- 1. How do zirconium restorations compare to conventional PFMs?
- 2. Can they restore the most demanding functional and esthetic cases we see?

THE MATERIAL – ZIRCONIUM OXIDE (LAVA CROWNS AND BRIDGES)

One of the first questions that may arise is the longevity of zirconium. How well does it hold up to the stresses of daily usage? Current research conducted on Lava Crowns and Bridges now shows that across a span of five years, clinical experience shows no breakage of any units¹. Another point that may allow clinicians to rest more peacefully on their choice of framework is the assurance that 3M ESPE stands behind its product by providing a fiveyear warranty from the date of placement on the copings or substructures made of its Lava Frame Zirconium Oxide. The warranty covers breakage of the frameworks if they are fabricated by an Authorized Lava Milling Center.

INTERPRETATION

Zirconium oxide has been used in posterior bridges since 1998. It has been heavily researched by institutions and independent research facilities. It can withstand many times the level of stress in both anterior and posterior regions of the mouth. (Anterior – 250 N, Posterior – 450 N)². The longterm strength of ceramic materials is directly related to the material's water absorption³. Zirconium has a high degree of resistance to moisture-induced strength degradation when compared to other allceramic materials.

Lava[™] Crowns and Bridges

Optical Properties of Ceramics Translucency comparison as a function of wall (coping) thickness



Fig. 1. Light transmisson of various materials.



Fig. 2. Making minor adjustments in the coping.

Despite common beliefs, zirconium is a highly translucent material. Different grades of zirconium possess different levels of translucency – the higher the grade, the more translucent the material (Fig.1).

On this chart, compare the circled areas for each material, which is the relative light transmission at the material's ideal working thickness. Lava frameworks can be specified with 0.5 or 0.3 mm wall thickness. At this smaller dimension, there is increased light transmission, which is not shown on the chart.

Another quality that zirconium possesses is substrate blocking. Although this characteristic is hard to measure, this material exhibits a great ability to block color from underlying structures⁴. An example of this can be seen in clinical case 1.

ADVANTAGES AND DISADVANTAGES

From a technical standpoint, using zirconium can streamline the technician's workday. The painstaking steps of waxing, casting and metal finishing are transferred to the milling center for processing. One can now spend more time preparing cases as they come into the laboratory, as well as veneering and finishing steps.

One possible disadvantage to the system is that unless you are a milling center doing the scanning and processing, this phase of production is, to some degree, out of your control. Regardless of the process, the possibility of human or mechanical error is always present and this error is much more palatable when the factors are all under our control. Case details such as framework thickness, configuration and shade may be specified in a script and sent to the milling center with your case to achieve your restorative goals. 3M ESPE also is striving to improve this aspect for technicians with the announcement of development of the Lava Scan ST – a new stand-alone scanner that allows labs to bring in-house the ability to control the scanning and design portions of the CAD/CAM process. These labs then electronically send files to one of the Authorized Lava Milling Centers (ALMCs) in the nationwide Lava Network for milling and finishing. 3M ESPE plans to introduce the scanner by the end of 2006.

Another technical advantage is the fact that there is no distortion of the framework when it is fired in the porcelain oven. This is a real concern with PFM restorations, especially if it has been soldered, welded or is a long-span bridge. Here, with zirconium, the emphasis on fit is placed firmly on the often less regarded model fabrication process (one already assumes that the impression taken by the dentist is as accurate as possible).

The accuracy of the model work will determine the accuracy of the final restoration's fit in the patient's mouth. Special care in creating and trimming the dies to define the margin will be rewarded with high accuracy in the frameworks produced. Some important things may be noted regarding the scanning system in use, such as the die stone color. These details can be answered best by the specific milling center you have a relationship with. Generally, no die spacer or die hardener is preferred for the scanning process.

"Using zirconium can streamline a technician's workday."



Fig. 3. Lava copings over simulated roots in reflected light.



Fig. 4. Simulated roots with Lava copings transmitted light.



Fig. 5. Lava (left) vs. PFM (right) reflected light.



Fig. 6. Lava vs. PFM transmitted light. Note shadow from framework, even with 360 ceramic shoulder.

"The strength of zirconium allows it to be used as a restorative material in all areas of the mouth for crown and bridge restorations."

The strength of zirconium allows it to be used as a restorative material in all areas of the mouth for crown and bridge restorations. It is not indicated at this point for restoring veneer cases, though this application is in testing. This characteristic also can give the technician some challenges because it is a very hard substance to adjust. As one grinds on it, too much pressure builds up heat within the frame and creates sparks, causing micro-cracks. These cracks will compromise the strength and longevity of the material. As a result, it is ideal to avoid grinding on the material. In order to steer clear of this risk, use computer software to virtually create your specific frame configuration. The Wax Knife program allows one to account for deficient preparations, symmetry issues and creating additional support where needed in any area of the coping, much as one would in the laboratory using conventional wax techniques.

Once your framework is fabricated, only minor adjustments may need to be performed in the lab. Diamonds or stones are preferable to accomplish necessary adjustments (Fig. 2). During the veneering stages, take special care with the connector areas of bridgework since adjustments in these areas are often done with a diamond disc. It is crucial to avoid contact with the zirconium in this critical strength area.

Maybe the most appealing aspect to technicians is that this is a technology they can get into with very little expense. The number of laboratories outsourcing zirconium frameworks is increasing and makes it accessible and relatively easy for anyone to start incorporating zirconium restorations into their work. At this point, all the major porcelain manufacturers carry zirconium compatible ceramics to layer over these frameworks. 3M ESPE has



Fig. 7. Incident light on teeth.



Fig. 8. Finished crowns. Lava on left, PFM on right reflected light.

developed its own veneering porcelain that has been designed to be used with Lava frameworks, and has been used in all of the patient cases in this article. The latest kit employs ceramic materials with a full complement of shades and modifiers, as well as naturally fluorescing and opalescent materials and enamels.

A new challenge that may occur is work scheduling, as it will involve shipping time in addition to lab time. Turnaround times should be adjusted so that there is no interruption of case delivery to the clients. The time it takes for each milling center to produce a coping varies, starting from a 24-hour turnaround. Check with the individual milling center for specific times. Some laboratories are opting instead to purchase their own milling systems in order to keep all services under one roof. Not only are the bigger labs purchasing systems, but small ones have also entered the milling outsourcing arena. To them, the possibility of an outsourcing business offsets the costs of the equipment.

WHY DOES IT LOOK BETTER?

As previously discussed, zirconium is a lighttransmitting material. From the outside, when placed next to a conventional PFM crown built in exactly the same fashion, these two crowns will look very similar. The difference becomes visible, however, once the location of the light source is changed. When we see transmitted light (from inside or behind the crown) rather than reflected light, the optical properties of zirconium are dramatically highlighted when compared to a PFM (Fig. 2-5).

In a real-life situation, however, what does this mean? For example, when we see a person's smile, the light approaching them is generally from one direction – the front. There is very little transmitted light from inside or behind the teeth (Fig. 6). The advantage of the translucent core is apparently nullified. Both types of crowns should perform esthetically the same given the same circumstances based on the direction of the light. The reason, however, that allceramic restorations generally look better than PFMs is because:

- 1. The light goes into the crown (and into the framework) farther. It is diffused and diffracted within the framework and then reflected back to the eye, creating the illusion of depth. In the PFM, the metal framework is impenetrable to light. All the light-transmitting structures behind this wall are in shadow, unused by the crown. All-ceramic restorations harness these shadowed structures by allowing light to pass through, reacting with these structures as natural teeth.
- 2. The surrounding hard and soft tissues are illuminated more. Interdental papillae and adjacent teeth receive the benefit of light transmitted through the crown, illuminating these structures much the same way as natural teeth. This happens as the light is refracted within the crown and tooth structure. Again, the metal in a PFM hinders light's ability to reach the underlying and adjacent natural structures.

This is why, when placed side-by-side in the mouth, all-ceramic restorations "just look better" than PFMs (Fig. 7-8). One should also note that this visible difference between PFMs and all-ceramic restorations is greatly reduced in the hands of talented technicians who employ techniques and special materials to overcome some of the drawbacks of the metal substructures of PFMs. "Placed sideby-side in the mouth, all-ceramic restorations 'just look better' than PFMs."



Fig. 9. Lava (left) vs. PFM (right) transmitted light. Notice shadow from metal framework.



Fig. 10. Preparation shade difference.



Fig. 11. First attempt with PFM... too low in value, 'headlight' from coping visible.



Fig. 12. Labial clearance compromised.



Fig. 13. Coping shade after adjustment firing. Note masking effect.

PATIENT CASES

Case #1: Two Centrals

Patient presented with an old, failing crown on tooth 9. The patient opted to restore both centrals in order to get the best match between the two teeth. After preparations were completed, tooth 9 was severely discolored. Multiple attempts to restore with PFMs yielded crowns that were too dense and low in value. This patient was very sensitive to the labio-lingual thickness of the restorations and had some parafunction habits, limiting the external dimensions of the restorations. Using Lava, we were able to achieve density similar to natural teeth while masking the discolored preparations and maintaining a very thin dimension (Fig. 9-22)



Fig. 14. Full contour buildup with index in place. Notice some show through of copings through dentin.



Fig. 15. Glazed & polished Lava crowns.



Fig. 16. Lateral view.



Fig. 17. Finished crowns on stump dies. Resulting crowns have the same shade regardless of understructure shade.



Fig. 18. Total thickness of finished crown is...



Fig. 19. under 0.8mm.



Fig. 20. Day of try in.



Fig. 21. Result #8-9.



Fig. 22. Close-up 1 month post-op.



Fig. 23. Close-up of the tooth, intentionally underexposed to reveal value and translucency information.



Fig. 24. A1, B1 shade tabs respectively.

Case 2: Single Central

The single central is arguably one of the most challenging cases a ceramist can undertake. He or she must rely on prior case experience, good technique execution and an understanding of the materials to ensure a good outcome. This patient presented with an old, discolored crown on tooth 9 with minimal clearance on the lingual (Fig. 23-35).



Fig. 25. Effects buildup.



Fig. 26. Glaze medium applied to adjacent teeth to check contours prior to glaze.



Fig. 27. Lateral view.



Fig. 28. Incisal view checked to mimic contours of adjacent tooth.



Fig. 29. Finished crown.



Fig. 30. At the try in, the crown is evaluated. Photos are taken along with notes. Strengths and weaknesses are recorded.



Fig. 31-32. A second crown is fabricated from the beginning, making adjustments seen from the first try in.



Fig. 33. Finished crown in situ.



Fig. 34. 10 month post-op.



Fig. 35. Final smile.

Case 3: Full-Mouth Reconstruction

This patient presented with many old, failing restorations, loss of vertical dimension and severely worn dentition. Here we see the use of Lava in all areas of the mouth (Fig. 36-49).



Fig. 36. Retracted preoperative view.



Fig. 37. Diagnostic waxup from which provisionals are made.



Fig. 38. Upper master model.



Fig. 39. Lower master model.



Fig. 40. Finished upper crowns.



Fig. 41. Finished lower crowns.



Fig. 42. Anterior view of finished restorations.



Fig. 43. Lateral view close up.



Fig. 44. Central incisors showing surface texture.



Fig. 45. The lingual anatomy bears the pattern established from the occlusion from the provisionals.



Fig. 46. Completed lower posterior crowns.



Fig. 47. Note light transmission especially through the connectors.



Fig. 48. Full smile. Function and esthetics restored.



Fig. 49. 2 month post-op.



Fig. 50. Preoperative situation.



Fig. 51. Diagnostic wax-up from which provisionals will be made.

Case 4: Diastema

This patient's desire was to eliminate the space between her two central incisors. After studying her case, the laterals and canines were also prepared in order to achieve an ideal tooth balance and proportion (Fig 49-59).



Fig. 52. Preparation of the model to create pressure on the papilla to close diastema. Pencil outline shows material taken away from the master model after adjustments were made.



Fig. 53. After soft tissue adjustments. Tissue mesial to the lateral incisors was also adjusted.



Fig. 54. Interproximal space between centrals not completely closed at the tissue in order to allow for movement of papilla due to pressure created.



Fig. 55. Lateral view of finished crowns.



Fig. 56. Incisal edge position and phonetics checked as well as function.







Fig. 58. Retracted view.



Fig. 59. Closeup of final restorations showing successful diastema closure.

CONCLUSION

The use of zirconium has greatly increased since its introduction. The objective for its use for dental technicians and restorative dentists remains the same as prior to its emergence. Restoring missing, lost or damaged tooth structure in a predictable, durable, economic and esthetic manner can now be achieved with exceptional results. Zirconium restorations are an excellent alternative to PFMs, whether faced with simple or the most challenging restorations.

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"Restoring missing, lost or damaged tooth structure in a predictable, durable, economic and esthetic manner can now be achieved with exceptional results."

PRODUCT LIST		
Indication	Name	Manufacturer/Distributor
Veneering porcelain	Lava Ceram Zirconia	3M ESPE
	Overlay Porcelain	

Bio

Originally from Canada, Gordon Russell, RDT, earned a bachelor's degree in biology from the University of Windsor in 1988 and then completed the dental technology program at George Brown College in Toronto, graduating with honors. In 1994, he earned his RDT, which requires proficiency in all areas of dental technology.

He worked as an in-house ceramist for a prosthodontic practice specializing in implants and full-mouth reconstruction. In 1999, he moved to California to grow under the guidance of Don Cornell and Dr. Robert Winter. Gordon has a passion for creating restorations resembling natural teeth in esthetics, form and function. He currently focuses on crown and bridge, implants and full-arch/mouth reconstruction at his lab in Huntington Beach, California. Many thanks to Dr. C. John Dehner, Dr. Cesar Escudero and Dr. Michael Ross.

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