



Editorial

Do Zirconia Ceramics Have a Future in Restorative Dentistry?

Zirconium oxide is a material that has attracted attention in the dental community over the past decade. Several studies have shown that the biologic properties of zirconia ceramics are excellent. However, important issues have arisen with dental usage of these materials. In the case of zirconia materials, there are a number of clinical and laboratory procedures that may contribute to aging and initiate low temperature degradation. The addition of di- and trivalent metallic ions, such as magnesium, calcium, and yttrium, leads to the stabilization of high-temperature tetragonal or cubic phases. This makes possible a stress-induced transformation around crack tips resulting in a highly significant increase in fracture toughness and strength.¹

A decade or so ago, zirconia was made commercially available in dentistry. With clinical experience, a number of complications were observed and a variety of "handling" requirements were identified. Sadly, these technical solutions were not available to the technician/clinician when the product was introduced to the marketplace. Instead, it was clinical usage that identified risks and complications that eventually led to revised technical instructions designed to improve performance. The following 10 years have demonstrated clear evidence that veneer fracture occurs at a higher rate with zirconia cores than with most other materials, creating a clinical risk. Regardless of whether this was a material that was introduced prematurely or was one that was used in clinical applications for which it was not suited, the practitioners were primarily responsible for identification of the problems, while technicians, ceramic scientists, and manufacturers identified solutions. Further, the solutions discussed in this

editorial may have been discovered in the laboratory had the product been tested more thoroughly.

Some of the mechanisms suggested for failure included core design, the presence of residual stresses associated with thermal expansion mismatch between veneering core and zirconia, and cooling procedures inducing so-called "tempering stresses" following the sintering or final glaze fire cycle. In addition, zirconia as a framework material is highly susceptible to surface modifications due to improper laboratory and clinical handling that can contaminate or induce damage. Adjustments should be performed with fine-grained diamonds followed by a polishing sequence. Veneer slow cooling has been proposed and proven to be a controlling factor to minimize chipping. Ceramic ovens require attention so that they are accurately calibrated. Technicians working with zirconia will need to add significant time to allow zirconia/feldspathic restorations to be slow cooled. This will increase restoration fabrication time and will tie up important and frequently used laboratory equipment.

Aiming to eliminate the risk of veneer chipping or fracture, full anatomical monolithic zirconia restorations and subsequent surface characterization and glazing have been established and promoted by several companies. Although several short-term studies indicate that full-contour zirconia restorations can be used successfully in dentistry, the influence of surface adjustment and in-mouth polishing and food abrasion is unknown. After adjustments, opposing tooth wear may become a long-term problem. Adhesion to the intaglio surface of the restoration is a problem, in part because the milled internal sur-

face is smooth, and complaints exist as restorations are coming out in function. Very little clinical data on the performance of monolithic zirconia restorations have been available until today.

It is critical to understand that clinical research in ceramics requires an adequate number of units (usually 500) and sufficient time (usually 5 years) to establish clinical and statistical significance. The testing units should be in a similar position in the mouth, as it has been shown that confounding variables play an important part in proving long-term survival.²

Implant manufacturers offer zirconia abutments for esthetic implant-supported restorations, but there is a lack of knowledge about the outcome of zirconia abutments other than single crowns. Little is known as to the effect of abutment design on restoration reliability.

We suggest that more clinical data are needed before full anatomical monolithic zirconia restorations, zirconia implants, and zirconia abutments for fixed partial dentures can be recommended for private practice. Unfortunately, manufacturers will not pay attention because they too often look at the clinician as the beta tester for new ceramic materials.

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References

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