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CLINICAL SUCCESS:
Strategies for Achieving Efficient, Predictable Outcomes

Finishing and Polishing with Modern Ceramic Systems

John A. Sorensen, DMD, PhD, FACP

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CLINICAL SUCCESS: Strategies for Achieving Efficient, Predictable Outcomes

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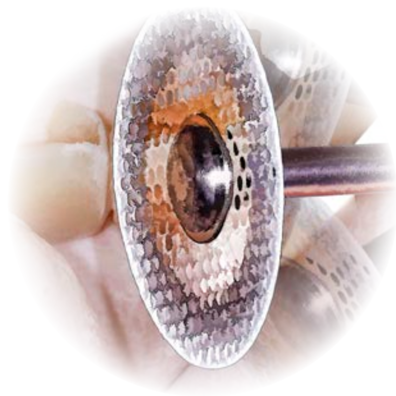

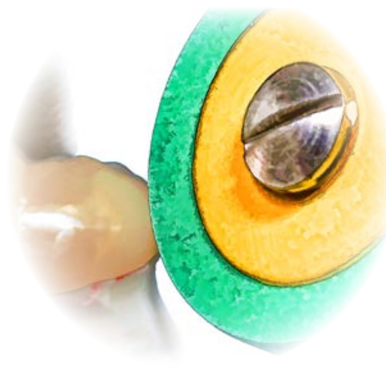

PUBLISHER
AEGIS Communications

EDITOR
Bill Noone | *bnoone@aegiscomm.com*

MANAGING EDITOR
Elizabeth Weisbrod | *eweisbrod@aegiscomm.com*

PRODUCTION/DESIGN
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Dear Reader,

THROUGHOUT OUR 36-YEAR HISTORY, Brasseler USA has strived to continually provide solutions to the needs of the restorative practice by developing innovative products and providing peer-to-peer education on their proper use within a procedure. This publication contains practical educational information from three of today's leading clinicians and is the most recent in Brasseler USA's commitment to our guiding principles of innovation and education.

In his article, "Modern Concepts in Provisionalization," Dr. Gregg Kinzer reminds us that the provisional in the restorative procedure is much more than a simple "placeholder" until the final restoration is seated. A well-crafted provisional serves a number of purposes, not the least of which is contributing to the building of your practice. Dr. Kinzer then takes you step-by-step through the process of creating truly excellent provisional restorations, from trimming and finishing to final polishing.

Our second author, Dr. Robert Winter, guides you through what often proves to be a series of challenging questions: How much tooth reduction is required in veneer preparations in order to achieve the desired outcome? What considerations should be taken into account? How can the precise reduction be most readily achieved? We hope you will find Dr. Winter's detailed, practical instructional, "Outcome-Based Preparation Design for Anterior Veneers Using Specific Depth-Cutting Burs," very helpful in addressing these issues.

Of course, the restoration is not complete until the necessary finishing and polishing is performed. These steps can be challenging in light of recent advances in ceramic restorative materials. In his article, "Finishing and Polishing with Modern Ceramic Systems," Dr. John Sorensen reviews data concerning the effects of material hardness and surface smoothness and wear on opposing dentition. Proper finishing and polishing of modern ceramic restorations, using the correct instrumentation, are critical, and Dr. Sorensen concludes with a review of finishing and polishing instruments designed specifically for these materials.

Our hope is that you find the content in this issue both informative and practical, and that it contributes in some positive way to both your efficiency and quality of your restorative practice.

Sincerely,
Brasseler USA

Finishing and Polishing with Modern Ceramic Systems

Advanced ceramic polishing instruments simplify finishing and polishing and provide superior results.

By **John A. Sorensen, DMD, PhD, FACP**

Today's all-ceramic systems facilitate novel restoration designs and increased restorative options along with greater clinical longevity. The evolution of modern ceramic materials as minimal antagonist tooth structure wear and sufficient strength—even for second molars in bruxers—have moved these systems into the realm of routine clinical practice. A factor critical to the strength and abrasiveness of ceramic materials is how the clinician adjusts, grinds, and polishes the ceramic restoration on delivery and cementation. The clinician's goal in finishing and polishing modern ceramic systems is clinical expediency and efficiency—that is, to achieve the most rapid adjustment and polishing while inducing the least amount of damage with the fewest bur changes.

Background

Lithium disilicate ceramics layered with veneering ceramics have shown excellent results in clinical studies up to 10 years in duration with the e.max® Press system (Ivoclar Vivadent). Five clinical studies[1-5] with nearly 500 crowns demonstrated a 98.4% survival rate with a mean observation period of 4 years. Chipping occurred in 1.4% of the restorations; however, all of the cases could be repaired intraorally.

The vast majority of fractures and chipping of ceramic restorations occur in molar restorations. A literature review[6] of all types of ceramic restorations showed fracture rates of 6.7% for molars after 2.5 years; however, the fracture rate of e.max CAD molar restorations was 1%. This compares quite favorably to that of metal-ceramics and other ceramics.[7]

While the zirconia substructure is nearly indestructible—even for posterior 3- and 4-unit bridges[8-10]—at the beginning, chipping of the veneering porcelain was a persistent problem.[10] Improvements made in substructure design, processing protocols, and layering materials for zirconia ceramics have significantly reduced chipping of the veneering porcelain.[11] New design strategies using traditionally layered zirconia substructure systems to replace the lower-strength veneering ceramic create a nearly indestructible full-contour zirconia crown. Restoration fabrication is greatly simplified by making only effective polishing necessary. The monolithic zirconia crown reliably restores even second molars in bruxers (Figure 1 through Figure 3). The author has routinely used this approach for more than 9 years with no failures.

John A. Sorensen, DMD, PhD, FACP

Acting Professor, Department of Restorative Dentistry, University of Washington
Seattle, Washington

Former Director, Pacific Dental Institute
Portland, Oregon

An in vitro wear study measured loss of human tooth structure against a variety of full-crown materials.[12] The enamel wear from antagonist polished Lava™ zirconia (3M ESPE) was similar to a gold-platinum alloy (Aquarius, Ivoclar Vivadent). Similarly, enamel wear from a lithium disilicate ceramic (Empress® 2, Ivoclar Vivadent) was not different from the gold alloy. Given the advantageous wear characteristics of these modern ceramics, it is important for clinicians to understand how to best optimize the antagonist restoration surfaces by proper adjustment and polishing during delivery.

The Principles of Tooth Wear and Ceramic Polishing

The OHSU Oral Wear Simulator (OWS), an in vitro, three-body, wear-testing machine for composite resin filling materials developed by Condon and Ferracane,[13] has demonstrated a strong correlation with clinical trials ($R^2 = 0.94$). The author and colleagues modified the testing system by replacing the composite with a ceramic tile to measure wear against a 10-mm diameter human enamel cusp.[14-16] Running a variety of new ceramics and older porcelains, it was demonstrated that several new fine-grain ceramic systems, such as lithium disilicates, exhibited enamel wear similar to the enamel-enamel control.[14,15]


FIG. 1


FIG. 2


FIG. 3

(1. through 3.) Full-mouth rehabilitation on severe bruxer at 4.5 years. Lava full-contour crown on second molar polished with Dialite System. e.max crowns on molar and premolars.


FIG. 4

(4.) Exposed area of zirconia substructure on palatal cusp of second molar. Note how zirconia is polished to a higher luster than veneering porcelain.

A clinical trial using 3-D surface profilometry on a lithium disilicate ceramic system (Empress 2) revealed little or no wear of opposing enamel surfaces at 1 year and confirmed the validity of the in vitro OHSU OWS.[17-19]

Contrary to many clinicians' beliefs, there is *no correlation* between the hardness of a ceramic and the potential abrasion of natural tooth structure.[14,15,20] Potential abrasion of tooth structure all comes down to the microscopic surface roughness of the ceramic. Like microscopic sandpaper, the finer the grain structure of the ceramic, the lower the wear against tooth structure;[21] and, incidentally, the finer the grain size of the ceramic, the more machinable and more polishable the ceramic. Mean crystalline particle size of zirconia ceramics is approximately 0.5 µm, creating a situation where the zirconia can be polished smoother than the veneering ceramic[8] (Figure 4).

The clinician should remember that, in function over time, the surface of even highly polished porcelain restorations wear, exposing the native internal structure of crystalline particles, voids, and flaws, which are abrasive to antagonist tooth structure.[22] Hence, a significant advantage of the new generation of ceramics, such as zirconia or lithium disilicates, is their finer grain structure, high crystalline content, and considerably reduced glassy phase, as well as their higher quality (substantially reduced flaw distribution).

However, the resulting ceramic surface after clinical adjustment with diamond burs and subsequent level of polishing has a much greater impact by far on antagonist tooth wear than grain structure size of the ceramic.[15,21] Therefore, the roughness of a ceramic surface created by diamond bur occlusal adjustment can potentially abrade the opposing enamel surface by several orders of magnitude greater than that created by the inherent material roughness.

All factors considered, to capitalize on the advantageous qualities of modern ceramics, clinicians must ensure that they properly finish and polish the occlusal surfaces after making adjustments.

Potential Damage to Ceramics from Grinding

A significant cause of chipping of veneering porcelain was theorized to occur from grinding damage during adjustment procedures with diamond burs.[7,23] Surface and subsurface damage from grinding on porcelain is well documented.[24-26] The induced damage can cause crack propagation and failure at the time of grinding or delayed failure under functional cyclic loading.

Chang et al[27] evaluated porcelain cracking from three grits of finishing diamonds grinding on four different all-ceramic veneering porcelains. They theorized that the 46-µm grit diamond caused heat-generated thermal shock, damaging porcelains. While interesting findings, their results must be questioned because they used a handpiece speed of 340,000 RPM. This is contrary to the "Cardinal Rule in Adjustment and Polishing of Ceramics"—that is, *always use low speed and low pressure to minimize heat generation and damage induction.*

(5.) Adjustment of occlusion on full-contour zirconia crown using football-shaped Dialite Double Red-Band Finishing Diamond.
(6.) Grinding in anatomy of zirconia crown using football-shaped Finishing Diamond.
(7.) Primary and secondary anatomy ground in.
(8.) Small round Dialite Double Red-Band Finishing Diamond grinding in grooves and refining secondary anatomy in zirconia.

Advances in Rotary Instrument Technology

Recent rotary instrument technology advances have optimized finishing and polishing of modern all-ceramic systems. Brasseler USA has developed a new multi-layer chromium nitride coating for diamond burs that better bonds diamond particles to the bur and increases the useable life of the bur. For sharper-tip diamond burs, the coating reduces the chances of wearing off the diamond particles and leaving dark metal marks.

The Brasseler red-band Fine Finishing Diamond (mean particle size 30 µm) has been the author's favorite rotary instrument for adjusting and refining the occlusion. The new Dialite finishing diamond with football shape is ideal for occlusal adjustment (Figure 5) and grinding in anatomy of full-contour zirconia crowns (Figure 6 and Figure 7). Fine contouring, grooves, and refining secondary anatomy are rapidly achieved with a small, round Dialite finishing diamond bur (Figure 8). Used at relatively low RPM and low pressure, the finishing diamond is effective for material removal, yet is not traumatic to the ceramic. This is critical for avoiding damage to the ceramic, incurring flaws, which may later propagate into cracks, causing failure in function or parafunction.

Besides preventing damage to the ceramic, another concern is avoiding heat spike generation, which can cause thermal shock damage and phase changes in the ceramic.[27] The zirconia used in dentistry has metal oxides added to create the metastable tetragonal phase, which enables the structure to undergo transformation toughening; this unique property of zirconia ceramics arrests crack formation. Excessive heat generation can cause the zirconia to shift back to its thermodynamically preferred monoclinic state, rendering the ceramic unable to undergo transformation toughening.[28]

The objective in designing efficient polishing instruments is to achieve rapid removal of material, progressively replacing bigger scratches with smaller scratches while minimizing heat generation. Optimization of new polishing systems is achieved by the abrasive particle size, the particle concentration, and the binder used to form the polishing shapes.

The Dialite System by Brasseler was the original benchmark for diamond-impregnated porcelain polishing systems that revolutionized polishing of all types of porcelain and ceramic surfaces. Surface profilometry research showed that the Dialite Kit could polish surfaces to be smoother than overglazed porcelain.[21] The Dialite System uses a three-step process that varies the grain size, grain loading, and binder.

New Frontiers in Ceramic Polishing Technologies

Understanding the unique properties of modern ceramic systems such as lithium disilicate (e.max) and Y-TZP zirconia, Brasseler USA has made revolutionary developments resulting in new polishing systems. These polishing systems have been optimized to: reduce the number of polishing steps (bur changes); polish more efficiently; and achieve an overall higher quality polish and luster. Additionally, the new polishing systems consider the unique properties of lithium disilicate and zirconia ceramics to minimize damage and diminish potential deleterious effects on ceramic strength. The results are polishing instruments that are easy to use and that reduce restoration failure with the right combination of physical and chemical properties of the different ceramics.[28] Therefore, two specialized polishing systems specific to their ceramic structure have been developed.

Dialite LD System

Specific to lithium disilicate ceramics, a system was created that consists of a grinder for contouring and then only two steps for polishing instead of three steps like the original Dialite system. This provides for reduced chairtime in the delivery of e.max restorations, yet enhanced quality of finish, polish, and luster.

Dialite LD Grinder

This epoxy-based diamond impregnated grinder with medium coarse grain efficiently and rapidly removes large amounts of ceramic, yet due to the grain size and binder, minimizes potential damage to the internal ceramic structure (Figure 9).

Red Pre-Polish

This polyurethane-bound fine polisher with high diamond


FIG. 9

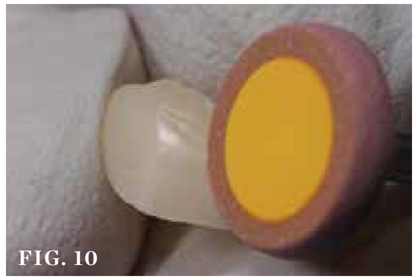
FIG. 10


FIG. 11


FIG. 12


FIG. 13


FIG. 14


FIG. 15

(9.) Gross adjustment of lithium disilicate with Dialite LD Grinder.
(10.) Dialite LD Red Pre-Polish rubber wheel for establishing shine on lithium disilicate.
(11.) Right side polished and left side untreated blasted surface.
(12.) Dialite LD Yellow Fine Polish rubber wheel for establishing high shine and luster on lithium disilicate. Note right side with finish polish.
(13.) Lithium disilicate crown with completed polish.
(14.) Gross adjustment of full zirconia crown with Dialite ZR Grinder.
(15.) Refining adjustment of full zirconia crown with Dialite ZR Medium Grinder.

particle concentration facilitates aggressive removal of ceramic structure and smoothing to a brilliant surface roughness—all with a light touch to minimize heat generation (Figure 10 and Figure 11).

Yellow Fine Polisher
With a smaller diamond grit size than Original Dialite Fine (Grey) polisher, this polisher enables the system to cut and remove structure for superior shine and ultra-high luster (Figure 12). Completed finishing and polishing of a crown is shown in Figure 13.

Dialite ZR System

Specifically designed for zirconia, the Dialite ZR System also reduces the number of steps to involve two rubber wheels instead of three.

Dialite ZR Grinder (Green)
This epoxy-based, high-performance grinder has a high diamond concentration and is optimized for bulk material removal at low speed and low pressure. A major improvement over standard diamond-impregnated stones, its design makes it possible to keep the zirconia below 80°C, even with dry grinding. No water cooling or special equipment is needed (Figure 14).

Dialite ZR Medium Grinder (Pink)
This medium grinder system has similar characteristics to the ZR Grinder abrasive only and would be an intermediary step between green coarse grinder and polishing instruments (Figure 15).

Green Medium Fine Polish
This very soft, polyurethane-matrix-bound, high-concentration,


FIG. 16


FIG. 17


FIG. 18

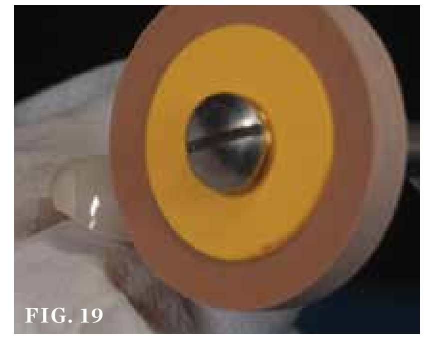
FIG. 19


FIG. 20


FIG. 21

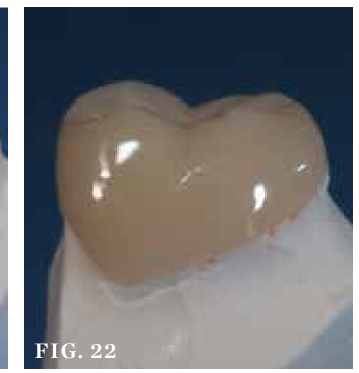
FIG. 22

(16.) Dialite ZR green Medium Fine polishing wheel for establishing shine on zirconia. Note right side with high polish, even with Medium Fine polishing only.
(17.) Dialite ZR green Medium Fine polishing point for crafting a shine in the occlusal grooves.
(18.) Dialite ZR orange Fine polishing point for high shine in the occlusal grooves.
(19.) Dialite ZR orange Fine polishing wheel for creating high shine and luster in zirconia.
(20.) Dialite ZR orange Fine polishing pointed disk for high shine in broad grooves.
(21.) Completed full-contour zirconia crown No. 18 and lithium disilicate crown No. 19.
(22.) Completed full-contour zirconia crown No. 20 with durable high shine and luster.

medium-fine grain diamond polisher allows a soft touch, with a high material removal rate to achieve a brilliant surface structure with a wheel on the broad surfaces (Figure 16) and points in the occlusal grooves (Figure 17).

Orange Fine Polish
A polyurethane binder with super-high loading of fine diamond particles, this super-soft matrix instrument promotes achievement of ultra-high polish and luster with minimum heat generation, using a fine polishing point for high shine in the occlusal groves (Figure 18), a fine polishing wheel for creating high shine and luster on the broad surfaces (Figure 19), and a narrow fine polishing disk for high shine in broader grooves (Figure 20).

The Dialite polishing instruments help to achieve a durable high-luster finish intraorally (Figure 21 and Figure 22).

Dialite and Lava

3M ESPE recently introduced the Lava Plus All-Zirconia Monolithic System, a highly esthetic system that comes in a wide selection of shades matched to the Vita Classic Shade guide with 16 shades and two bleaching shades (Figure 23). This highly translucent monolithic zirconia works perfectly with the Brasseler Dialite ZR polishing kit to produce an extremely esthetic full-contour crown despite being all zirconia. Studies show that Lava Plus is more translucent when shaded than other full zirconia systems.[29] Note the enhanced appearance of a Lava Plus crown polished with the Brasseler system versus a zirconia crown stained and glazed (Figure 24 and Figure 25).

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DISCLOSURE

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FIG. 23


FIG. 24


FIG. 25

(23.) The new Lava Plus All-Zirconia Monolithic system achieves esthetic results that match the Vita Shade Guide. (24. and 25.) Lava Plus monolithic translucent zirconia crown differentially colored with incisal and dentin internally then polished with Dialite ZR system.