Zirconia: Clinical Impressions
An In Vivo Comparison of the Aesthetics of Various Zirconia Crowns

INTRODUCTION
There are many developments in dental materials with each passing year, but one of the most established solutions for a broken or structurally compromised tooth is a crown. Dental crowns have been constructed utilizing composite, porcelain and gold (and semi- and nonprecious metals), several all-porcelain varieties, and recently zirconia. The shift in dentistry to lifelike restorations that mimic natural tooth structure is undeniable, and zirconia crowns are considered “cosmetic” in nature compared to certain other alternative crown materials. Based on perceived and actual patient demand owing to aesthetic and health concerns, material choices have dramatically shifted to “metal-free” wherever possible. This shift to “metal-free” is a bit ironic, since dental zirconia is technically an oxidized metal but is considered by dentists and patients to be metal-free.

Initially, zirconia crowns were predominantly fabricated with a zirconia coping layered or pressed with different types of porcelain. Recently, a growing number of monolithic (full-contour) zirconia crowns have been requested by dentists, predominantly as a result of ubiquitous laboratory marketing. These full-contour zirconia crowns are extraordinarily strong, and it has been argued that they are just as aesthetic as layered zirconia crowns. In a routine restorative case, several varieties of zirconia crowns were fabricated for comparison, and the results of this clinical case report follow.

CASE REPORT
Diagnosis and Treatment Planning
A 69-year-old male presented with failing gold onlay restorations on teeth Nos. 29 and 30. After several decades of service, the patient was having occasional symptoms when drinking cold beverages, and a contact had opened between the 2 teeth (Figure 1). In addition, the margins were slightly open in several areas around both gold restorations, and caries were suspected. Finally, the patient desired restorations that were more aesthetic in this region of the mouth.

There are multiple aesthetic materials that would be indicated for this region, including lithium disilicate, leucite-reinforced porcelain, and zirconia-based restorations. A discussion with the patient in this particular case confirmed that both teeth would be crowned with a zirconia-based restoration. Ease of cementation of the zirconia-based restoration with a resin-modified glass ionomer cement contributed to the decision, as the mesial margin of tooth No. 30 would clearly be subgingival based on preoperative radiographs.

Clinical Treatment
The patient was anesthetized with one carpule of Septocaine (Septodont), and the teeth were isolated (Isolite [Isolite Systems]). The old restorations were removed using a raptor 557 bur (Axis Dental) and a high-speed electric handpiece (KaVo Dental Handpieces) (Figures 2 and 3). The remaining cements, liners, and caries were removed with a series of diamond burs, ie, K 50, K 15SC , K 35SC , and K 55SC (KOMET USA) and the rough crown margins were initially prepared (Figures 4 and 5).

After all visible caries were removed (Figure 6), the remaining dark areas were verified to be sound, and an anti-microbial scrub (Consepsis Pumice Scrub [Ultradent Products]) was applied to the preparations and brushed across the teeth with a Star Brush (Ultradent Products) inside a slow-speed latch handpiece (KaVo Dental Handpieces). A size 1 retraction cord (GingiBRAID [DUX Dental]) was carefully placed in the sulcus of both teeth to avoid fluid contamination during the crown buildups and to minimize bleeding poten-

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ential in any subgingival preparation areas.

Once cleaned and ready for the
crown buildups, the teeth were etched
with 37% phosphoric acid (Ultra-Etch
(Ultradent Products)) for 20 seconds
per tooth and thoroughly rinsed. A
desensitizer (Telio Desensitizer [Ivo-
clar Vivadent]) was placed for 20 sec-
onds per tooth, and the excess liquid
was evaporated with a high-speed
evaporation tip. A fifth-generation
adhesive (One-Step [BISCO Dental
Products]) was applied for a period of
more than 20 seconds per tooth, and
the excess solvent was removed again,
with the aid of high-speed evapora-
tion. This evaporation technique effec-
tively removes the undesirable solvent
(acetone), without blowing uncured
liquid resin monomer across the adja-
cent teeth and into the sulcus, poten-
tially causing bleeding. Another ben-
efit is a cleaner margin when the
preparation is completed, as there is
limited concern for unintentional
contamination of the sulcular area
that could have arisen from “blowing”
the monomer with an air syringe to
remove the solvent. The teeth were
each light-cured for 20 seconds with
an LED light (Bluephase [Ivoclar
Vivadent]), and the build-up material
was applied (Luxacore [Zenith Dental])
and light-cured for 20 seconds per
tooth.

Next, the preparations were com-
pleted, and the final margin positions
were established and smoothed with
the KS3SC, KS5SC, KS6SC, and
8856.021 burs (KOMET USA). Careful
consideration was made to ensure
accurate and smooth margins with
minimal disruption to the surround-
ing tissue; even on the mesial of tooth
No. 30 where the previous restora-
tion’s margin was slightly subgingival
(Figures 7 and 8).

Final impressions were made uti-
лизing vinyl polysiloxane impression
material (Imprint 3 Garant [3M
ESPE]). Then, the provisional restora-
tions were formed (Protemp [3M
ESPE]) and seated with provisional
cement (Fynal [DENTSPLY Caulk]).
The patient was given postoperative
and hygiene instructions for care of
the provisionals during the follow-
ing 3 weeks. Instructions were sent to the
dental laboratory team requesting the
fabricating of 4 different types of zir-
conia crowns:

1. Full-contour zirconia: polished
   only (FCZP) (Figure 9)
2. Full-contour zirconia: stained
   and glazed (FCZSG) (Figure 10)
3. Layered porcelain (2 layers) dur-
   ing a zirconia coping (LPZ) (Figure 11)
4. Multilayered porcelain (5 lay-
   ers) over a zirconia coping (MLPZ)
   (Figure 12).

It was requested that the 4 crown
types were to be made as identical as
possible in shape and contour for
comparison purposes at the delivery
appointment.

Observations at Placement

As this was an experiment for the pur-
pose of comparing the aesthetics of
different zirconia crown types, each
crown was photographed in the
patient’s mouth. The crowns will be
discussed in 2 categories: full-contour
and layered.

In the case of the full-contour
restorations, the FCZP pair appeared to
have a high luster, and the physical zir-
conia material simply looked different
in every way than a natural tooth
(Figures 13 and 14). Zirconia is opaque
by nature, and the more translucent
a restoration is (given a healthy prepa-
rachment stump shade), the more natural
...the lack of in vivo studies makes it difficult to draw any effective
conclusions regarding full-contour zirconia-based crowns, render-
ing the growing use of these crowns for our patients premature.
the restoration will appear.9,10 As there is no ability to “block out” the opaque zirconia coping with layering, the polished-only crowns’ opacity stood out significantly among the surrounding natural dentition.

The FCZSP pair clearly appeared more aesthetic than the FCZP crowns (Figures 15 and 16). From the author’s experience, in restorative situations where there is a dark preparation stump, zirconia restorations are often considered or selected as the coping material. This selection is based on zirconia’s ability to block the dark underlying stump from show-through in the restoration.7,11 However, if the entire crown is comprised of this opa- cious material, the limited light transmis- sion through this thickness of restorative material appears to have a substantial aesthetic downside. In fact, while the FCZSPG crowns offered slight aesthetic improvement, it is very difficult to consistently stain and glaze an all-zirconia crown.12

It was subjectively determined that the 2 varieties of layered crown pairs were aesthetically superior. Not only did the layered restorations more closely mimic the natural shade and translucency characteristics of the surrounding natural dentition; they looked far more realistic to the patient himself. When layering the porcelain, a zirconia coping is designed to fit to the restoration margin, much like a metal coping would be designed prior to layering porcelain over a PFM crown.13,14 Although the zirconia coping is opaque, the porcelain layered over it can be much more translucent. The combination of coping and layered porcelain can produce very aesthetic results while still achieving an extremely accurate marginal fit of the crown without adding substantial fabrication time.15,16

There was a slight increase in aesthetics with the MLZPZ pair versus the LPZ pair (Figures 17 to 20), and this was selected as the crown pair to cement into place after discussion with the patient.

**DISCUSSION**

The layering technique requires more time and, therefore, typically higher dental laboratory fees for the final restoration. In general, the strength of layered porcelain to substrates (coppings) is in the 120 MPa range;2 this applies to PFM crowns as well as layered zirconia restorations. This means a decrease in strength from more than 1,000 MPa (the full-contour zirconia restoration), but clearly a more aesthetic restoration for the patient.12 It has been proven that the coping design for layered zirconia crowns has the largest impact on resistance to chipping of layered porcelain off of these restorations.10,17,19 If the dental laboratory team is able to meet the known ideals in coping design, a strength of layered porcelain in the 120 MPa range should be successful, as it has been utilized for decades with PFM restorations.

A potential drawback of full-contour zirconia based restorations could be wear compatibility to the opposing enamel, reminiscent of Vita Alpha porcelain, during routine function. Wear to teeth opposing zirconia has not been studied with significance.10,21 Furthermore, in a clenching or bruxing patient, what is the impact of full-contour zirconia on the opposing dentition long-term?

Unfortunately, no dental restoration can be expected to last forever. Therefore, inevitably many of these crowns will need to be replaced. When the time comes, can a full-contour zirconia crown be easily removed? Will the heat and vibration generated in the removal of a full-contour zirconia crown likely damage instruments and, more importantly, the patient’s underlying tooth? If the pros and cons of layered versus full-contour zirconia crowns are compared, the less aesthetic full-contour zirconia restorations, as subjectively determined in this case study, also have the least long-term research on wear to the opposing dentition, and would be the most difficult and poten- tally damaging to remove in the future.

It appears that the increasing trend toward full-contour zirconia-based crowns should be met with caution, and not only due to aesthetic limitations. Practices placing these full-contour restorations must be equipped with staining, glazing, and polishing equipment for use before seating these crowns. Other factors need to be considered, including occlusal adjustments that would require the placement of the opposing tooth against a “nonpolished” zirconia crown that will potentially wear faster.

**CONCLUSION**

Today, dentists and patients demand predictable materials, treatments, and results. However, the lack of in vivo studies makes it difficult to draw any effective conclusions regarding full-contour zirconia-based crowns, rendering the use of these crowns for our patients premature.

**Acknowledgement**

The author extends a special thanks to Todd Franssen of First Impressions Dental Lab in Schaumburg, Ill, for his outstanding laboratory work, and for his willingness to make the extra restorations required for the purpose of material and technique comparisons.

**References**


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Disclosure: Dr. Engelberg reports no disclosures.

**DENTAL MATERIALS**

**Figure 17.** Clinical lateral view of the layered zirconia restorations.

**Figure 18.** Clinical occlusal view of the layered zirconia restorations.

**Figure 19.** Clinical lateral view of the multiple layered zirconia restorations.

**Figure 20.** Clinical occlusal view of the multiple layered zirconia restorations.