Different Materials for Different Situations

Ceramic Solutions for Specific Restorative Indications

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Abstract

The different pure ceramic systems were designed to satisfy the demands of specific restorative indications and must be selected according to the needs of each clinical case. This selection must be made very carefully, taking into consideration the mechanical properties of the material as well as a variety of clinical aspects such as the region to be restored, type of cementation, dental preparation, esthetic aspects, and laboratory technique. The dental market offers a great range of new ceramic materials for the fabrication of dental restorations, which brings new options but also generates new questions about which system to choose.

Key Words: laminate veneers, ceramic crowns, single anterior crowns, anterior esthetic restoration

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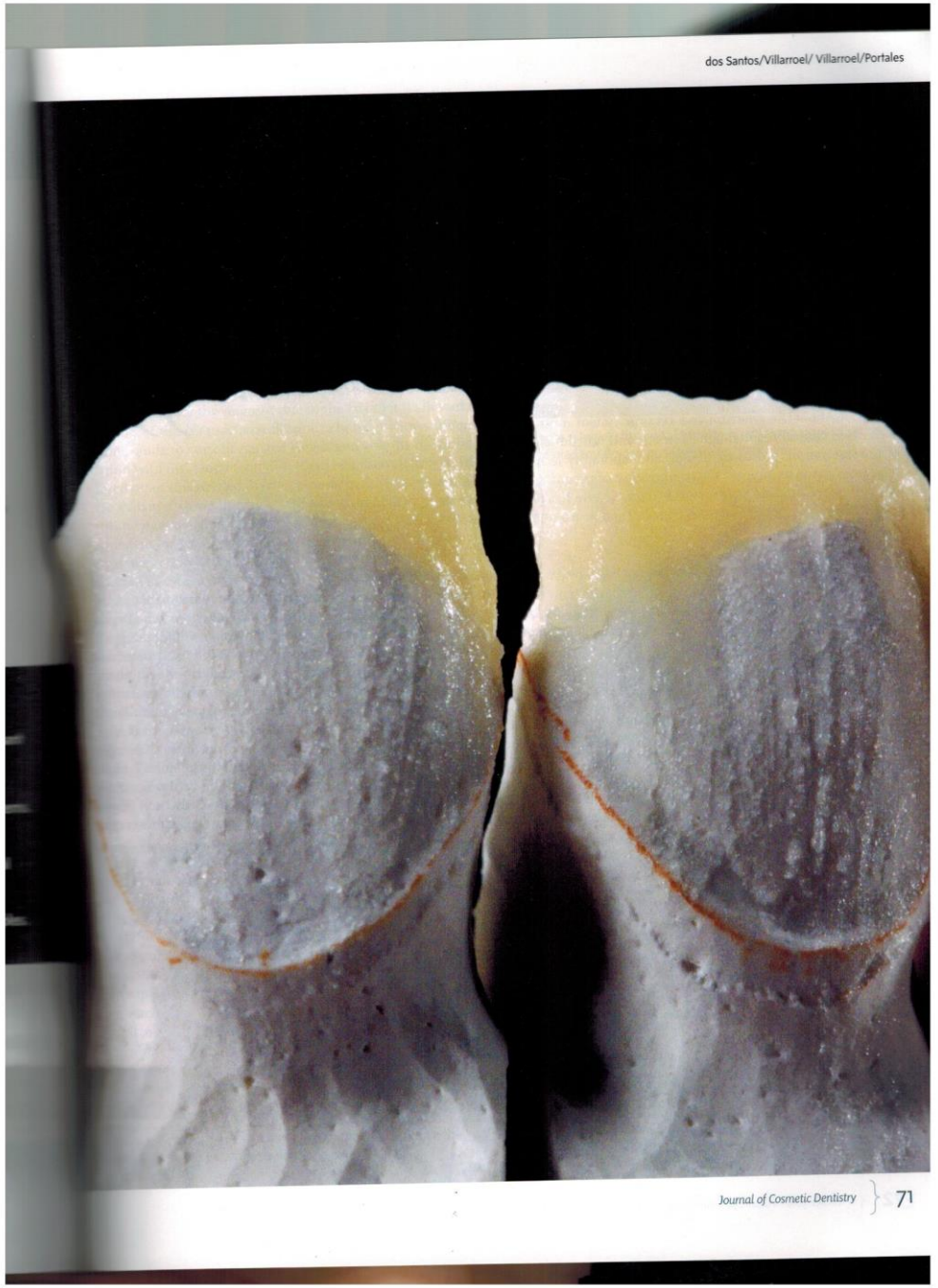
Learning Objectives

After reading this article, the participant should be able to:

1. Compare different ceramic systems.
2. Evaluate the characteristics that create realism in the dental restoration.
3. Reinforce basic bonding principles.



Introduction

As dentistry continues to advance, esthetic techniques have evolved into more effective, functional, and biocompatible procedures. At the same time, esthetic dentistry has become more complex and technically challenging. With the improvement of the physical and optical properties of ceramics and the establishment of a protocol, ceramic restorations have become increasingly popular. Today, there are diverse ceramic systems that have excellent optical properties such as opalescence, fluorescence, translucency, and chromaticity, which enable clinicians to blend the restoration with the dental structure.[1,2] Furthermore, it has become possible to restore biomechanical integrity in oral rehabilitation treatments.

All of this has led to experimentation with the use of different ceramic systems that range from conventional feldspathic ceramic to more modern versions, which are reinforced, injected, or created with the assistance of CAD/CAM.[3,4] The selection of a ceramic system must be based upon each case's clinical requirements, esthetic and functional needs, location of the restoration, prosthetic design, and laboratory techniques.[5] Efforts have been made to improve the composition of ceramics, mainly regarding the manufacture of pure systems. The objective has been to produce monolithic structures that are more precise and resistant to fracture.[6]

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Translucency

The esthetic characteristics of these ceramic systems have an intimate relationship with the optical phenomena of light, which means the esthetic result of a restoration is directly related to the interaction between light and matter.[7,8] The property that permits the passage of light through a material or tissue is *translucency*. Translucency is very important because it helps to give ceramic restorations a more lifelike appearance. The presence of different degrees of translucency in the different ceramic systems is definitely an advantage when they are carefully managed. An understanding of this optical behavior is essential, as the composition of the different ceramic systems may directly influence the esthetic outcome.[9,10]

Common Challenges

When the clinician and the technician try to emulate the characteristics of a natural tooth in creating a restoration, there can be four common fundamental challenges:

- recreating the adequate shape of a tooth where there is not enough space
- obtaining depth in the restoration when it does not have the adequate space
- masking an unfavorable dental remnant
- imparting a natural appearance when it is necessary to use opaque materials.

These situations may result in the restorations not integrating, as the reproduction of translucency and depth is essential to the creation of esthetically integrated prosthodontics.[11] These natural characteristics are more difficult to achieve in metal-ceramic restorations due to the presence of the metallic structure and the need for an opaque material to conceal it. Generally, when these factors are not well controlled it results in a more opaque or very gray restoration due to an excess of translucency.[12-14]

Dental Substrates

The chromatic analysis of the dental substrate is key when selecting a restorative ceramic system. Dental substrates without color alteration or with mild alterations may be considered as "favorable" substrates due to the fact that they will not produce evident alterations in the final restoration. Chromatic alterations of dental substrates as a consequence of endodontic treatment, use of metal posts, tetracycline stains, or hypoplasia, just to name a few, deem the substrates to be considered "unfavorable" as they will cause chromatic esthetic alterations in the final restoration. Therefore, this group of substrates will need deeper analysis when selecting the restorative ceramic system.

New Options, New Questions

The dental market today offers a great variety of pure ceramic systems for the fabrication of dental prostheses. This means new options but also generates new doubts about which system to choose. Will all ceramic systems have the same optical behavior, or will the different compositions have different outcomes? The authors believe that each case must be analyzed carefully. Evaluation of the degree of translucency and opacity of the dentin-enamel complex delivers information about which ceramic system can provide a better esthetic solution. Only after this determination is made is it possible to select the most appropriate ceramic system to deliver the desired clinical outcome.[15]

Case 1: Laminate Veneers on Refractory Model

A 35-year-old male patient wanted to improve the appearance of his upper central incisors. Extensive composite resin restorations were noted during the clinical examination. The patient reported that these direct restorations had been replaced three times over a four-year period after his teeth suffered sports-related trauma. The defective restorations presented color deficiencies, evident and stained margins, and lack of gloss **(Fig 1)**. The patient did not want a radical change so it was decided to maintain the basic dental format. Two laminate feldspathic veneers (IPS d.sign, Ivoclar Vivadent; Amherst, NY) were planned on a refractory model. After removal of the restorations and refinement of the dental preparations, favorable remnant dental tissue was observed **(Fig 2)**. This last piece of information was very important for the ceramist due to the fact that it allowed for the planning of the ceramic stratification. **Figure 3** shows the use of a silicone guide to corroborate the length and volume of the final restoration with the dental remnant. It can be observed how the dentin-colored ceramic is needed to compensate for the loss of dentin tissue.

To obtain a chromatic base and adequate opacity in the middle third and incisal region, it was necessary to apply a dentin layer with an augmented opacity to compensate the preparations and even out the substrates in opacity and color, imitating the dental tissue **(Fig 4)**. Silicone gingiva was used to create the emergence profile. The application began with more saturated layers in the cervical region. Then the vestibular margin crests were built until the final dentin shape was obtained **(Figs 5a-5c)**. The internal effects were achieved after an incisal reduction of the dentin for the subsequent application of layers for absorption and reflection of light. Opalescent ceramic was used as a final layer before the first bake **(Figs 6a-6c)**. After the first bake, the incisal ceramic was used on the restoration's entire surface. The final bake allowing the ceramic layers to be observed is shown in **Figures 7a and 7b**. Macro and micro texture was performed for better individualization of the veneers **(Figs 8a & 8b)**. The esthetic potential of veneers fabricated with feldspathic ceramic on a refractory model is an excellent option to solve esthetic problems in the anterior region **(Fig 9)**.

Figure 1: Initial situation; frontal view showing signs of leakage and inadequate composite resin restorations.

Figure 2: Conservative final tooth preparation after determining the cervical, lingual, and interproximal finishing lines. The retraction cords were placed to facilitate finishing of the margins.

Figure 3: Final master cast before preparations to produce the final restorations with the index guide.

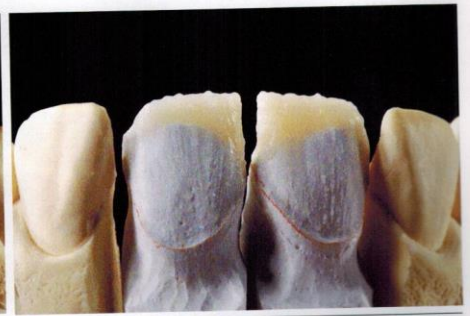


Figure 4: Wash-bake and opaque dentin ceramics must be layered carefully to control light reflection from the abutment.

Case 2: Anterior Crowns Over Different Substrates

A 38-year-old female patient was concerned about the appearance of her smile. She presented with a deficient porcelain-fused-to-metal restoration and metal post in the upper right incisor, darkening of the upper right lateral incisor due to a previous endodontic treatment, and extensive vestibular and palatine composite resin restorations in the upper left central and lateral incisors **(Fig 10)**.

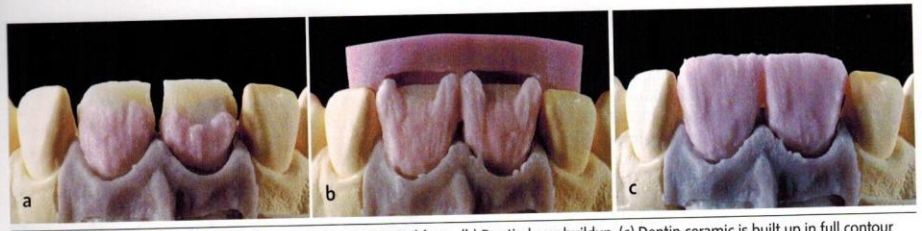
A situation that represents great challenge is the differences between substrates, in this particular case a metallic post (upper central incisor), an obscured dental remnant, and two favorable remnant dental tissues **(Figs 11a & 11b)**. Selecting the correct ceramic is important to prevent the unfavorable substrates from negatively influencing the esthetics of the final result. Taking this into consideration, it was decided to fabricate ceramic crowns using a stratification technique. The copings were MO 0 (IPS e.max Press), to which a fine layer of ceramic (wash) was applied for better adhesion and control of the luminosity **(Fig 12)**. The application of the ceramic layers started on the cervical region until the full shape was conformed. Incisal cuts were made to apply the internal effects **(Fig 13)**. After the first bake, it was possible to evaluate the ceramic and determine whether any corrections were necessary **(Fig 14a)**. To complete the final shape of the crowns an incisal layer was used on the entire surface.

To achieve an esthetic integration of the restorations, correct morphology and texture must be considered in addition to color. The color markings allow visualization of the areas of light reflection, making any corrections easier. The macro and micro texture will impart individualized characteristics and, therefore, a more natural appearance **(Fig 14b)**. In the postoperative appointment, it was possible to observe how the shape, texture, and color favored the integration. Selecting the right ceramic system (IPS e.max Ceram) prevented the different substrates from negatively influencing the final outcome **(Fig 15)**.

Figure 10: Preoperative view showing defective crowns and discolored teeth.

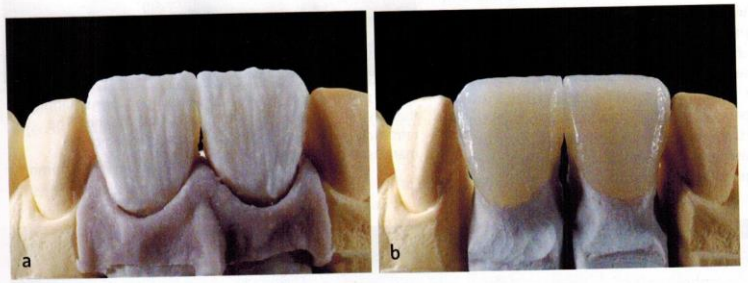
Figures 11a & 11b: Intraoperative views of the abutment tooth after crown preparation.

Figure 12: The copings in position on the solid model.

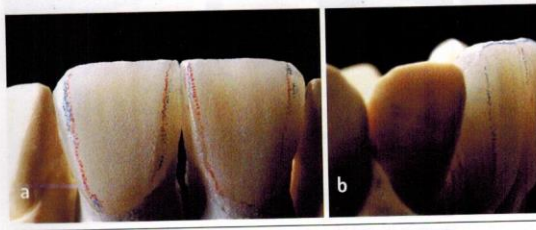


Figures 5a-5c: (a) The shape is sculpted to create the anatomical form. (b) Dentin layer buildup. (c) Dentin ceramic is built up in full contour according to the diagnostic wax-up.

Figures 6a-6c: (a) Dentin ceramic was cut back. (b) At the incisal edges, the mamelons were shaped to conform to the transparency. (c) Layering of feldspathic ceramic onto the refractory dies to build up the incisal wall and proximal aspect.



Figures 7a & 7b: (a) Enamel layer buildup. It is important not to overbuild ceramics when fabricating laminate veneers. (b) Completed ceramic layering.



Figures 8a & 8b: (a) Final shape. (b) Final texture of the laminate veneers.

Figure 9: Final result 30 days after placement of feldspathic laminate veneers on the central incisors.

Case 3: Single Anterior Crown Over Unfavorable Substrate

One of the biggest challenges in dental rehabilitation is the restoration of a single central incisor. In these cases the shape and color are essential for integration of the restoration. It is necessary to carefully observe the homologous tooth to be able to reproduce its most evident characteristics in the ceramic. The final value of the restoration must be the closest to the natural tooth due to the fact that minor differences in color may always exist. All these considerations will result in a more natural-looking restoration.

A 35-year-old female patient presented with a provisional crown and wished to have a definitive restoration. Once the provisional was removed, an obscured dental remnant with a composite resin was found. To mask the unfavorable dental tissue it is necessary to use a material that possesses enough opacity to hide the tooth but at the same time delivers an adequate chromatic base for the stratification. Therefore, a zirconia coping was created (Amann Girrbach North America; Charlotte, NC) **(Figs 16a-16c)**. After the first ceramic bake it is helpful to make a try-in, which will allow evaluation of the ceramic stratification **(Figs 17a-17c)**. Small differences in color are always present; therefore, when restoring a single tooth the shape and secondary characteristics of morphology will play a very important role in the integration of the restoration. Ten days after cementation, it was possible to see that the shape, texture, and color were very close to the patient's natural teeth, achieving a good integration **(Figs 18a & 18b)**.

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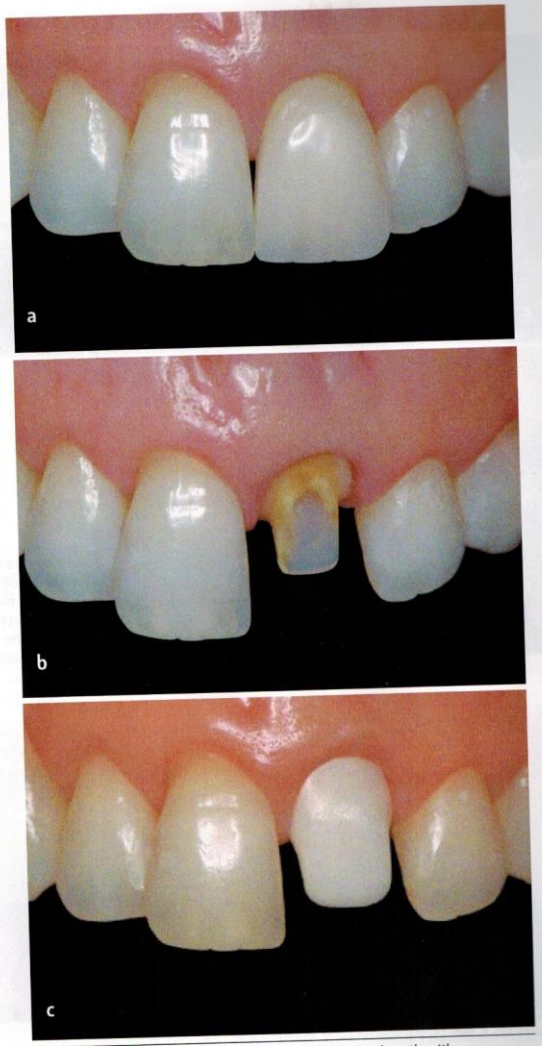
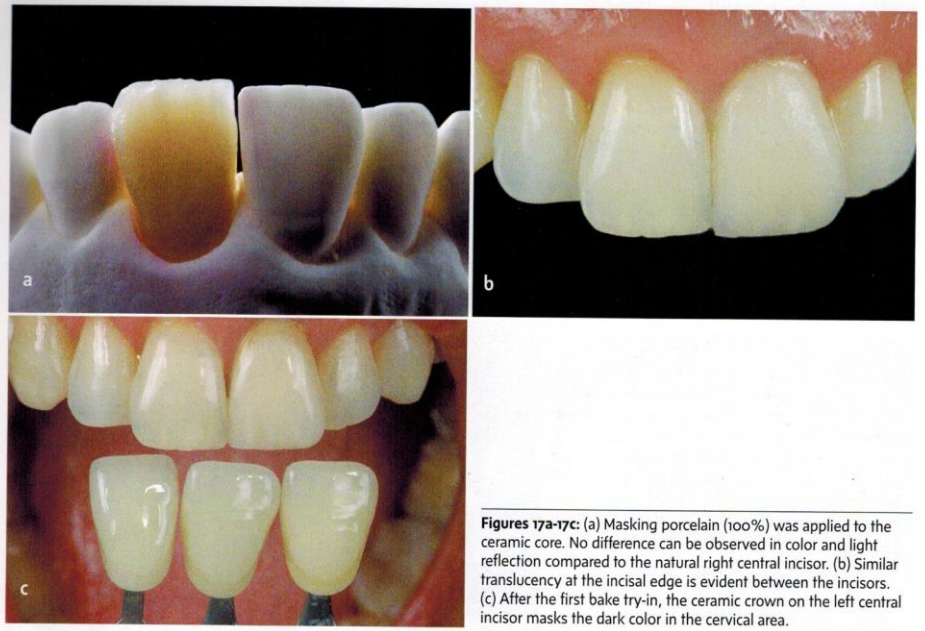
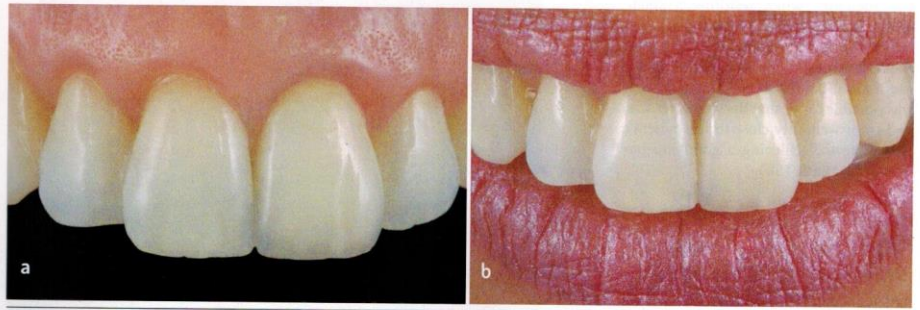


Figures 16a-16c: (a) Preoperative situation. (b) Prepared tooth with grave discoloration in the cervical area superior. (c) Clinical appearance of zirconia copings positioned above the abutment. *(Photographs courtesy of Dr. Luis Garbelotto and Dr. Claudia Volpato)*



Figures 17a-17c: (a) Masking porcelain (100%) was applied to the ceramic core. No difference can be observed in color and light reflection compared to the natural right central incisor. (b) Similar translucency at the incisal edge is evident between the incisors. (c) After the first bake try-in, the ceramic crown on the left central incisor masks the dark color in the cervical area.



Figures 18a & 18b: (a) Intraoral view of the definitive crown. (b) Integrated relationship between the teeth and lips.

Discussion

Bonding

Not only is it important to select the right material for each clinical situation, but it also is important to consider the type of cementation used with each system. Appropriate bonding is a critical factor in the clinical success of all-ceramic restorations. However, the wide variety of all-ceramic systems available today may be confusing to the clinician. In terms of achieving reliable results, each system must undergo different and sometimes specific methods of surface treatment before bonding. Knowledge of proper surface treatment, based upon the composition and physical properties of the ceramic materials, is essential to achieving a long-term, durable bond.

Bonding Strength

Glass-based ceramics (i.e., feldspathic, leucite-reinforced, and lithium disilicate) have shown high bonding strength to resin cements. Bonding to feldspathic porcelain and glass ceramic can be achieved through etching. For feldspathic porcelain, 9% to 12% hydrofluoric acid gel is necessary for 60 to 80 seconds[16,17] and for glass ceramic, 5% hydrofluoric acid gel is necessary for 20 seconds.[18] The following steps are the same for both ceramic systems:

- **Cleaning.** Cleaning the etched porcelain is critical. During the etching process, dissolution of the glassy matrix ultimately leaves retentive holes, tunnels between the acid-resistant crystals, and ceramic residues and remineralized salts, leaving a typical whitish residue. Ultrasonic cleaning, which can be preceded by phosphoric acid precleaning, is essential to remove the residues, enlarging and enhancing access to the micro retentive features.
- **Bonding.** It is necessary to apply a layer of bonding material. The use of silane promotes additional chemical bonding.

After these steps the ceramic surface is ready to receive the resin cement.[19,20]

High-strength ceramics are not silica-based (i.e., zirconia or yttria-stabilized zirconia, alumina). The bio-inert high-crystalline and low-glass composition makes high-strength ceramics corrosion- and acid-resistant, rendering adhesion protocols applied for silica-based ceramics ineffective. Currently, no consensus exists regarding the best adhesion protocol for zirconia used in dentistry; this is important particularly for restorations where mechanical retention is deficient. Systematic reviews analyzed the adhesion potential of resin-based and glass-ionomer luting cements to zirconia and aimed to highlight the possible dominant factors affecting the bond strength results to this substrate.[21]

Luting

Regarding luting technique, the combination of mechanical and chemical pretreatment appeared particularly crucial to obtain durable bonding to zirconia ceramics. Increased adhesion can be expected after physicochemical conditioning of zirconia. Air particle abrasion, ceramic primer (with monomer 10-methacryloyloxydecyl dihydrogen phosphate [MDP]) and MDP-based resin cements tend to present better results than those of other cement types.[21-23]

Summary

The light-transmission characteristics of teeth and restorative materials must be examined to allow a fully esthetic integration. Favorable dental substrates allow better esthetic outcomes, while unfavorable dental substrates must be overcome to produce desireable results. As restorative materials continue to evolve, clinicians and technicians will be able to create improved esthetics and harmony, thus increasing patient satisfaction with the definitive result.

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The dental market today offers a great variety of pure ceramic systems for the fabrication of dental prostheses.

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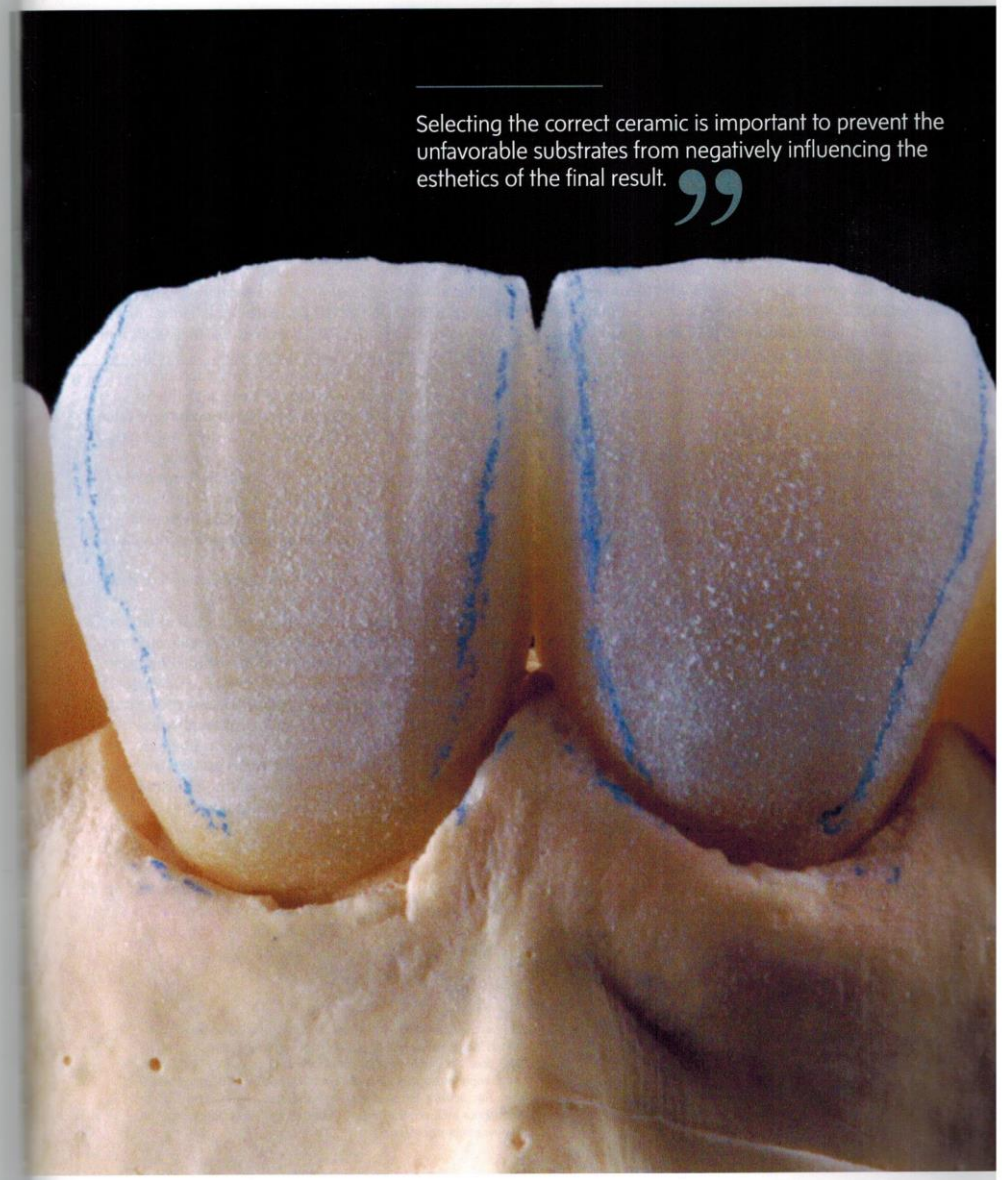

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