# All-Ceramic Crowns and Extended Veneers in Anterior Dentition: A Case Report with Critical Discussion

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All-ceramic crowns and veneers have been used extensively in prosthodontics with proven clinical success. The development of new reinforced ceramics has led to a broader range of indications. Traditional veneer preparations are now often replaced with extended defect-oriented preparation designs, ie, extended veneers. However, although extended veneers can serve as an alternative to full-crown preparations, they are not the best choice for all clinical situations. Choosing correctly between all-ceramic crowns and extended veneers when restoring the anterior dentition is crucial to achieving a conservative and long-lasting treatment. This article addresses key evidence-based considerations regarding the rehabilitation of the anterior dentition using all-ceramic crowns and veneers. Further, a case report involving both types of restorations is presented. *(Am J Esthet Dent 2011;1:60–81.)*

Ceramic is known as the most natural-looking synthetic replacement for missing teeth and is available in a range of shades and translucencies.[1,2] In the past, due to its relatively low tensile strength and brittleness, ceramic was generally fused to a metal substrate to increase fracture resistance, and its indication was limited to full-coverage crowns for

both anterior and posterior dentition.[3] However, the metal base compromises esthetics by decreasing light transmission through the porcelain and by creating metal ion discolorations that can cause significant darkening of the surrounding gingiva. This is known as the umbrella effect.[4] To overcome such problems, new ceramic systems and innovative restorative techniques that wed esthetics with function have been introduced, along with scientific evidence endorsing their clinical application. As a result, all-ceramic systems now represent an excellent restorative alternative for fixed dental prostheses, single crowns, and veneers in the anterior dentition.[5,6]

The successful clinical performance of all-ceramic crowns and veneers has been well established.[6–12] However, the combination of media-driven treatment plans, rushed-to-the-market products, and dentists eager to satisfy their patients' esthetic demands have formed a dangerous triad with little concern for the risk/benefit calculus of dental treatment.[13] The resulting overuse of ceramic veneers is likely a result of these new reinforced ceramics, which have a broader range of indications and which have led to the replacement of traditional veneer preparations with extended defect-oriented preparation designs. These extended veneers offer an alternative to full crowns in the anterior dentition.[10,14–17]

The remarkable clinical success of all-ceramic veneers and crowns notwithstanding,[5,6] the restoration enters into a restorative cycle as soon as it is placed following tooth preparation.[18,19]

All-ceramic crowns have been used extensively in prosthodontics over the past few years because their clinical success has been similar to that of metal-ceramic crowns, with excellent survival rates of 98.9% in the anterior region after 11 years.[5,6,13,20] The main causes of failure include catastrophic fracture, chipping of the veneer ceramic, and secondary caries.[5] Although ceramic veneers are a minimally invasive approach compared to crowns, less tooth reduction does not always result in increased longevity. It has been shown that after 10 years of clinical service, reintervention without restoration replacement occurs in 36% of teeth restored with ceramic veneers, whereas 7% of teeth restored with ceramic veneers might receive a more invasive treatment approach.[21,22] The main reported causes of ceramic veneer failure include fracture, microleakage, and debonding. That is to say, ceramic veneers are more susceptible to future interventions; therefore, it is crucial that the clinician be aware of the correct indications for ceramic veneers to provide the ideal result in terms of longevity.[19] Nevertheless, neither all-ceramic crowns nor traditional ceramic veneers should always be the first choice in the anterior dentition because several factors must be taken into consideration before elaborating a treatment plan.

This article addresses key evidence-based considerations regarding the rehabilitation of the anterior dentition using all-ceramic crowns and veneers. Further, a case report involving both types of restorations is presented.

**Fig 1**    Preoperative labial view. Note the unesthetic appearance of the anterior dentition.



**Fig 2**    Preoperative palatal view showing proximal excess of the former composite resin fillings, especially on the mesial surface of the maxillary left central incisor.

## CASE REPORT

The following case report describes the rehabilitation of the anterior dentition with all-ceramic crowns and extended veneers as well as two ceramic partial-coverage restorations on the maxillary left and right first premolars using leucite glass-ceramic (IPS Empress, Ivoclar Vivadent). The 29-year-old male patient presented for esthetic rehabilitation of the anterior teeth. Clinical and radiographic examination revealed the presence of unsatisfactory Class III and IV composite resin fillings, some of which were associated with secondary caries, discolored teeth due to root canal treatment, and slight tooth misalignment with length discrepancies in the anterior dentition (Figs 1 and 2). Periodontal evaluation found no pathologic probing depths. Occlusal examination revealed

normal Class 1 occlusion with functional canine and incisal guidance and the presence of a slight anterior overjet. No signs of parafunction were observed.

Both lateral incisors and the left central incisor had been endodontically treated, and their clinical crowns were deeply compromised. For these nonvital teeth, fiber posts were cemented, the pulp chambers were restored, and the pre-existing Class III and IV composite resin fillings were replaced. The old composite resin fillings of the remaining vital teeth were replaced as well. Three all-ceramic crowns were planned to restore the nonvital teeth. Extended ceramic veneers were planned to restore the anterior vital teeth, and each premolar would receive a partial-coverage ceramic restoration.

The decision to prepare the vital anterior teeth for extended veneers was based on the extension of the pre-existing composite resin fillings, which further oriented the preparations palatally.[10] Moreover, since these ceramic veneers would be placed adjacent to ceramic crowns, an extended preparation allowed the crowns and veneers to be made with the same ceramic. There is usually an interproximal cosmetic mismatch due to the differing thicknesses of the adjacent restorations, which can be corrected by the ceramist if extended veneer preparations are made.[23] The maxillary premolars were included in the rehabilitation because both had unsatisfactory mesio-occlusodistal composite resin restorations, which were not only associated with secondary caries, but also showed enamel cracks at the mesial and facial surfaces.

Although some of the composite resin fillings were associated with secondary caries, the patient did not present high caries activity. Caries lesions were more likely to be developed due to proximal composite resin excess and poor bonding of the former restorations; therefore, removal of the pre-existing restorations eliminated the source of microleakage and secondary caries incidence.

Leucite glass-ceramic was the material of choice because it allows for adhesive cementation. All vital teeth displayed plenty of enamel, and even the nonvital teeth had preparation margins completely bounded by enamel. Further, the longevity of this ceramic system for both crowns and extended veneers has been well established.[5,6,10,20] Finally, this esthetic material was a feasible choice because the patient did not present any para functional habits.

## Crown preparation

The first phase of the crown preparation involved the use of a spherical diamond bur, which was positioned 45 degrees perpendicular to the tooth long axis on the facial cervical area so that the reduction would end at half of the bur's diameter (Fig 3). A cylindric, tapered, round-end diamond bur was used in the second phase to create three facial reduction grooves respecting the axial inclinations of the tooth. The grooves were subsequently evened (Figs 4 to 6). The depth of each reduction was constantly controlled using the silicone guide. The final crown preparations would be approximately 2.0 mm deep.

**Fig 3** *(right)*   First phase of crown preparation of the maxillary left central incisor. The spherical diamond bur was positioned 45 degrees perpendicular to the tooth long axis.

**Figs 4 to 6** *(below)*   Second phase of crown preparation. Facial reduction grooves were created respecting the tooth axial inclinations.

**Fig 7** Third phase of crown preparation. A 1.5-mm reduction was still necessary to achieve the desired 3 mm. Incisal reduction was performed using the same diamond bur used for the second phase.

The incisal reduction was carried out in the third phase of the preparation. Because the silicone guide registered a pre-existing incisal space of approximately 1.5 mm according to the wax-up, an additional 1.5-mm reduction was performed with the cylindric, tapered, round-end diamond bur to achieve a 3-mm incisal reduction (Fig 7).

The fourth phase consisted of the interproximal and palatal wraparound. A very thin and tapered diamond bur was used to create a slit from the facial to palatal surfaces (Figs 8 and 9). This maneuver created space for the application of a larger bur for the wraparound (Figs 10 and 11). The palatal surface was then reduced with the aid of a spherical diamond bur positioned parallel to the tooth long axis to create a supragingival cervical groove (Fig 12). Next, a cylindric, tapered, round-end diamond bur and a rounded bur were applied parallel to the tooth long axis on the palatal surface and palatal concavity, respectively, to create functional room for the ceramic (Figs 13 and 14). Following these reductions, the gross preparation was completed.
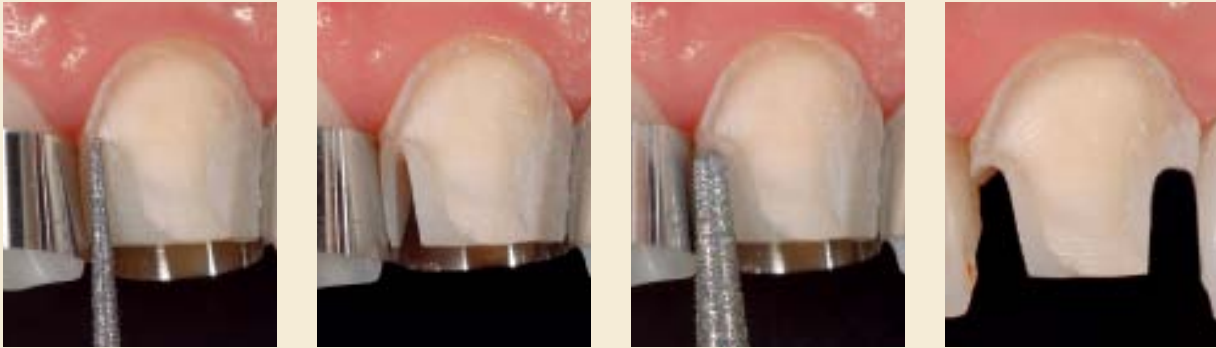
**Figs 8 to 14** Fourth phase of crown preparation, which consisted of the interproximal and palatal wraparound.
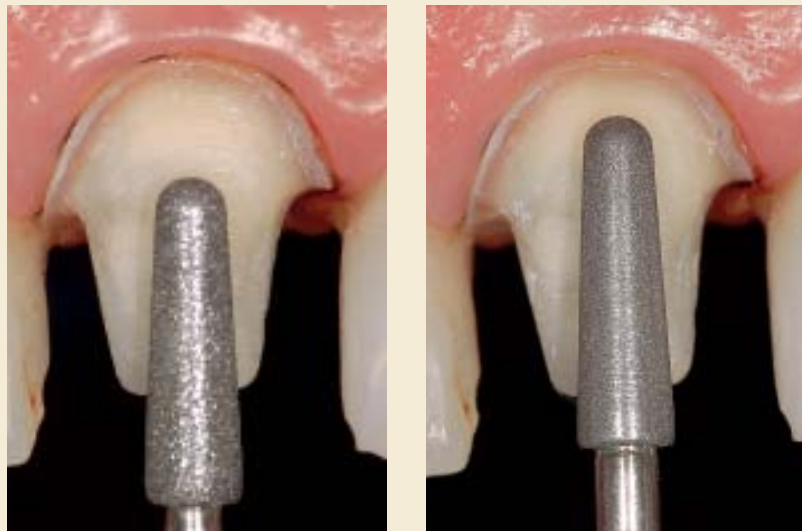



**Figs 15 and 16** Finishing was carried out using extra-fine diamond finishing burs with decreasing coarseness.

Special extra-fine finishing diamonds with decreasing coarseness were used along with rubber points to obtain a well-refined preparation and working cast (Figs 15 and 16). Finishing is essential to eliminate sharp angles and undercut and provide smooth contours.[24] Well-finished preparations reduce the risk of postbonding cracks and facilitate the technician's work.[25,26]

**Figs 17 to 19**  Completed tooth preparations.

## Extended veneer preparation

The preparation sequence for the extended veneers was similar to that described for the crown reductions. However, veneer preparations are by nature less invasive and do not involve the entire palatal surface. The first phase consisted of the use of a spherical diamond bur with a 1-mm-diameter head. The diamond was positioned 45 degrees perpendicular to the tooth long axis on the facial cervical area so that the reduction would end at half of the bur's diameter, thus generating an approximate 0.5-mm depth reduction. A cylindric, tapered, round-end diamond bur was used in the second phase. Three facial reduction grooves were created respecting the axial inclinations of the tooth, and the grooves were subsequently evened. The interproximal finish lines were extended to the linguo-proximal line angle. If pre-existing resin restorations are located at the preparation margins, the linguoproximal extension is extended deeper into the palatal surfaces until the margins are on sound enamel. The extended veneer preparations were then finished and polished similarly to as described for the crown preparations.

The completed preparations are shown in Figs 17 to 19. The extended

**Fig 20** Acrylic resin–based provisional restorations.

veneer preparations were kept slightly supragingival because no discoloration was shown for the vital teeth, whereas the crown preparation margins were kept in the intrasulcular space for esthetic reasons.

## Provisionalization

Provisionalization was carried out with acrylic resin–based restorations, which were fabricated at the laboratory. The provisional restorations (Fig 20) were contoured so that a smooth emergence profile could be achieved. The patient was then able to floss under the connectors of the provisionals. After 1 week, the patient assessed the function and esthetics of the restorations. Following clinical evaluation of the function, phonetics, and esthetics, along with the patient's feedback, it was decided that the definitive restorations should be at least 1 mm shorter in length. A transfer impression with the provisionals in place was made and sent to the laboratory along with instructions regarding the definitive restorations.

## Impression taking

Appropriate reproduction of the preparations, adjacent teeth, and surrounding soft tissues is mandatory. To obtain

a high-quality impression, addition silicone materials (polyvinyl siloxane) are recommended due to their elasticity and resistance to tearing. They also allow multiple pours, which is an essential requirement for fabrication of adequate master casts.[27]

A double-cord technique was used for gingival deflection. The cords were soaked in astringent solution (25% aluminum sulfate; Gel Cord, Pascal International). Compression cord with a small diameter (no. 00, Ultrapak, Ultradent) was placed at the bottom of the sulcus. Next, a more superficial and thicker deflection cord (no. 0, Ultrapak) was inserted in the entrance of the sulcus. Deflection of the gingival sulcus was carried out for 4 minutes while the deflection cord expanded due to water sorption. With this technique, the first compression cord must remain in place during impression taking to seal the sulcus and limit the flow of the crevicular fluid, whereas the deflection cord is removed after deflection.

A one-step, double-mix impression technique was carried out. The deflection cord was removed, and the gingival sulcus remained deflected due to its viscoelastic behavior. It is important to emphasize that the deflection cord must be wet during removal so that it does not attach to the inner walls of the gingival sulcus and cause bleeding. After removal of the deflection cord, the gingival sulcus was air dried, and the light-body impression material was inserted throughout the gingival sulcus to penetrate into the sulcus and slightly beyond the preparation margins of each tooth. Gentle air was blown on the light-body material to ensure penetration into the sulcus. A full-mouth metallic tray was loaded with the heavy-body impression material, inserted into the patient's mouth for 5 minutes, and then removed.

## Definitive restorations

After 2 weeks, the patient returned for placement of the definitive ceramic restorations (Figs 21 and 22). Try-in of the definitive restorations must be carried out before initiating the luting procedures. After removal of the provisional restorations, the preparations were cleaned with pumice and dried. The transparent try-in paste (Variolink II Try In, Ivoclar Vivadent) was placed, and any excess was removed with a spatula. The adaptation of the restorations was checked with a probe, and the patient assessed the esthetics of the final restorations with the aid of a mirror.

Adequate surface treatment for both the hard tissues and ceramic is crucial to achieve successful bonding.[5] The ceramic restorations were placed on the original stone die, and addition silicone was manipulated and placed over them. After setting, the addition silicone was removed with the restorations attached (Fig 23). This provided protection of the glazed external ceramic surfaces and facilitated the handling of the ceramic during surface treatment. A hydrofluoric acid was applied at the inner walls of the restorations for 60 seconds (Fig 24). After rinsing, the ceramic residues and remineralized salts were eliminated by applying phosphoric acid for 20 seconds, followed by rinsing and air

**Figs 21 and 22**   Leucite glass-ceramic restorations.

**Fig 23** Removal of the addition silicone with the restorations attached for surface treatment.



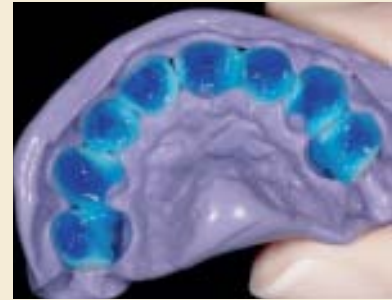**Fig 24** Etching of the inner walls of the restorations with hydrofluoric acid for 60 seconds.



**Fig 25** Application of 35% phosphoric acid to the inner walls for 20 seconds.







**Figs 26** *(above)* **and 27** *(top right)* The phosphoric acid was rinsed off, and the restoration was air dried.

**Fig 28** *(bottom right)* Silanization.

drying (Figs 25 to 27). Silane, a chemical coupling agent, was applied with a microbrush to the inner surfaces of the restorations and left for 1 minute (Fig 28).

No rubber dam was used for adhesive placement. Although total isolation could be achieved for some teeth, other abutments, especially those with crown preparations and subgingival margins, did not allow proper isolation. The cementation sequence depends on the arrangement of proximal contact points, which can be better controlled when all teeth are isolated at the same time. A relative isolation with retraction cords is feasible and allows good isolation, especially for the maxillary anterior dentition. Thus, relative isolation was used. Compression cord was inserted at the bottom of each tooth's gingival sulcus

**Figs 29 to 32** Insertion of compression cord and application of 35% phosphoric acid onto each abutment tooth. Note that the entire extended veneer preparation is located within the enamel shell.



(Fig 29), and surface conditioning of the preparations was carried out following the two-step etch-and-rinse strategy. First, 35% phosphoric acid was applied on the preparations and approximately 2 mm beyond the preparation margins for 30 seconds on enamel and 15 seconds on dentin, when such tissue was present (Figs 30 and 31). After rinsing and air drying (Fig 32), a dual-curing adhesive (Excite DSC, Ivoclar Vivadent) was rubbed against the preparation surfaces and a little beyond the surrounding preparation margins, followed by gentle air thinning, and was left unpolymerized (Figs 33 and 34). A coat of the adhesive was applied to the inner walls of the restorations, which were then loaded using the transparent paste of the light-curing resin cement system (Variolink II,

**Figs 33 and 34**   Hybridization of the dental hard tissues and application of a dual-curing adhesive system onto the maxillary right central incisor.




**Figs 35 and 36**   Application of a coat of adhesive onto the previously silanized ceramic restoration and subsequent loading with the transparent paste of the light-curing resin cement.



**Fig 37** *(left)*   Placement of the restoration with gentle finger pressure.

Ivoclar Vivadent). Both restorations were slowly seated by gentle finger pressure along the insertion axis (Figs 35 to 37). Gross excess of the resin cement was eliminated with a spatula. The instrument was guided using a cutting motion parallel to the margin to avoid extraction of resin cement from the marginal joint (Fig 38). Flossing should be avoided before light curing because it can dislocate or detach the ceramic from the teeth. Light curing was performed at the
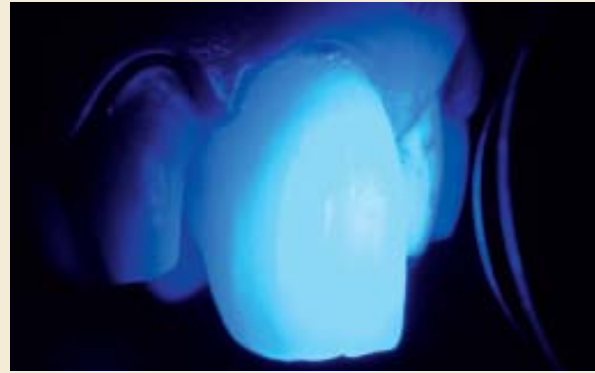
**Figs 38 and 39**    Removal of excess resin cement with a spatula, followed by light curing.



**Figs 40 and 41**    Removal of the compression cord and scraping of the polymerized resin cement with a surgical blade.



**Figs 42 and 43**    Placement sequence.

facial, incisal, and palatal surfaces for 90 seconds at each surface (Fig 39). Next, the gingival cord was removed using dental pincers, and excess resin cement was removed and chipped off with a no. 12 surgical blade (Figs 40 and 41). Refined finishing and polishing were performed at a subsequent session. The cementation sequence is shown in Figs 42 and 43. The final result is shown in Figs 44 to 50.
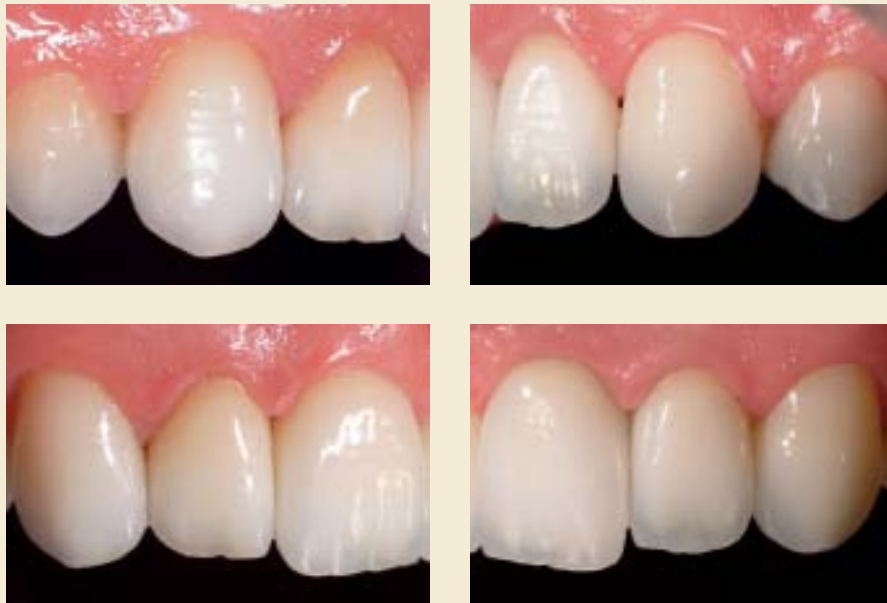
**Figs 44 to 50**   Final result.

# DISCUSSION

To optimize the longevity of all-ceramic crowns and veneers on anterior dentition, the clinician must have a thorough understanding of all patient-related factors, the quality of the remaining tooth tissue, and the proper ceramic system for the individual situation.[5,16,17]

## Patient-related factors

Several patient-related factors can influence the survival of crowns and veneers. As with any restorative approach, patients with high caries activity do not respond well to treatment because of the high incidence of secondary caries, especially if the preparation margins are localized on dentin.[28,29] For these patients, any attempt to restore the anterior dentition with all-ceramic crowns and veneers should only be made if preventive and monitoring measures have been carried out.[30]

Age matters. The longevity of all-ceramic restorations can be compromised in individuals over the age of 60.[18] There may be an increased load due to the lack of posterior dentition, reduced salivary flow resulting from the use of medication, and periodontal problems that can weaken the stability of the tooth. Because enamel thickness diminishes over time, ceramic restorations in elderly patients also do not perform as well because the cervical area of the tooth may have little or no enamel.[18,31] Root dentin exposure is common,[32] and thus the preparation margins are usually localized on dentin, which is related to microleakage incidence.[33] Due to these

factors, extra attention and strong monitoring must be conducted for elderly patients with all-ceramic restorations. Patient compliance with the clinician's recommendations is also particularly important in such cases.

## Remaining tooth tissue

The amount and quality of remaining tooth tissue is an essential factor when choosing between all-ceramic crowns and veneers in the anterior dentition. During elaboration of the treatment plan, the clinician must verify whether the tooth is endodontically treated or vital. If the tooth is nonvital, the need for placement of intraradicular posts must be evaluated, and the clinician should bear in mind that a minimum of 1 mm of sound dentin must be maintained circumferentially as ferrule design after post placement.[34] The presence of darkened substrate is common for nonvital teeth, and an extra reduction of approximately 2 mm may be required to provide room for an esthetic restoration.[35,36] All-ceramic crowns are superior to veneers for nonvital teeth because they provide increased strength, retention, esthetics, and longevity.[35–37] However, stability of the endodontically treated abutment tooth can be diminished by the large amount of tooth structure removed.[5,6,37]

Ceramic veneers should only be chosen when bonding is a completely feasible option, which means the more enamel the better. The tooth preparation should be confined primarily within the enamel shell or should display a substantial (50% to 70%) enamel

area, especially at the preparation margins.[33,38] Debonding of ceramic veneers has been reported to occur when dentin comprises 80% or more of the tooth substrate. In contrast, debonding is highly unlikely when a minimum of 0.5 mm of enamel remains peripherally.[13,33,38] Therefore, to avoid microleakage and secondary caries, it is crucial that the preparation margins are bound by enamel and do not end in composite resin fillings.[18,39] Moreover, partial adhesion to dentin or to extensive composite resin restorations and high load during static and/or dynamic occlusion increase susceptibility to ceramic fracture.[18] If dentin is the main bondable substrate or if there are extensive Class III and IV composite resin restorations whose dimensions extend beyond the crown, all-ceramic crowns should be the first restorative choice.

## Ceramic system

In a recent review conducted by Della Bona and Kelly,[6] it was concluded that for veneers and crowns for single-rooted anterior teeth, clinicians may choose from any of the all-ceramic systems available. However, the choice of ceramic system is highly dependent on the type of restoration (crown or veneer), type of cementation (adhesive or traditional), and esthetic and functional demands.

Ceramic is particularly well suited for veneer restorations and should be primarily used with an additive approach to restore missing enamel. Therefore, it is paramount that the ceramic system allows for surface treatment by etching with hydrofluoric acid followed by silanization prior to bonding to the tooth substrate.[13,36] Further, since esthetics is of primary concern for the anterior dentition, an adequate ceramic system for veneers should have a relatively translucent core for the ceramist to build in color intrinsically. Leucite glass-ceramic and traditional feldspathic ceramic are the two systems that best meet such requirements.[5,6,10,36]

For all-ceramic crowns, a broader range of systems can be used. Leucite glass-ceramic and lithium-disilicate glass-ceramic (IPS e.max, Ivoclar Vivadent) are suitable for cases in which adhesive bonding is possible. Leucite glass-ceramics especially rely on the bond strength between tooth and ceramic and provide good esthetics with proven longevity.[5,6,12,20] Ceramics that cannot be etched and bonded, such as alumina- and zirconia-based ceramics, are known as high-strength all-ceramic materials due to their improved physical properties. These are best used in patients with high functional or parafunctional loads. On the other hand, such ceramics present inferior esthetic features compared to glass-ceramics. Alumina and zirconia systems are recommended for cases in which adhesive cementation is not feasible.[5,6] These systems, along with monolithic lithium-disilicate crowns for the posterior dentition, can be conventionally luted with glass-ionomer or zinc-phosphate cements, which are less technique-sensitive than adhesive cementation.[32,40,41] Table 1 summarizes the advantages and disadvantages of all-ceramic crowns and extended veneers in the anterior dentition.

**Table 1**  Advantages and disadvantages of all-ceramic crowns and extended veneers in anterior dentition

|  | All-ceramic crowns | Extended veneers |
|---|---|---|
| Tooth structure removal | − | + |
| Restoration stability | + | − |
| Abutment stability | − | + |
| Risk of discoloration due to abutment tooth | + | − / +* |

+ = recommended; − = not recommended
*If translucent glass-ceramic is employed.

## Critical discussion of case report

Some specific aspects of the illustrated case report should be discussed. Leucite glass-ceramic was the material of choice due to the possibility of adhesive cementation since all vital teeth displayed a sufficient amount of enamel. Even the preparation margins of the nonvital teeth were totally bounded by enamel. Finally, leucite glass-ceramic has proven long-term results for both crowns and extended veneers.[5,6,10,20]

Although the restorations can be considered esthetically successful overall, a subtle value mismatch is evident between the maxillary right lateral incisor and the remaining restorations. This value discrepancy was not noticed during try-in, most likely because the final chromatic result of the cured resin cement can be different from that achieved with the homologous glycerin-based try-in paste.[42] The value mismatch might have been caused by a lack of ceramic thickness due to insufficient facial reduction during preparation. Since extra reduction of endodontically treated teeth is not recommended,[43] the use of a lithium-disilicate glass-ceramic system with adequate masking power (IPS e.max Press LT or MO) could be an alternative to overcome the insufficient masking ability of the leucite glass-ceramic. Lithium-disilicate glass-ceramic provides better strength and responds better chromatically to small thicknesses than does leucite glass-ceramic in cases with discolored abutment teeth.[5,44,45] If lithium-disilicate glass-ceramic is selected to mask the discolored abutment tooth, the authors recommend restoring all other teeth with the same system to achieve a harmonic esthetic outcome. Table 2 summarizes the indications for all-ceramic crowns and extended veneers in the anterior dentition.

**Table 2**  Indications for all-ceramic crowns and extended veneers in anterior dentition

|  | All-ceramic crowns | Extended veneers |
|---|---|---|
| Preparation margin located exclusively in dentin | + | − |
| Nonvital teeth | + | − |
| Extensive composite resin fillings | + | − |
| Large amount of enamel including preparation margins | − | + |
| Discolored teeth | + | − / +* |

+ = recommended; − = not recommended.
*If opacious glass-ceramic with high masking ability is used.

## CONCLUSIONS

Restoring the anterior dentition with ceramic is an excellent approach if the correct treatment plan is developed. Several patient-related and material factors can determine the success or failure of all-ceramic crowns and veneers. Neglecting even a single step of the restorative process can severely compromise the treatment outcome.

## ACKNOWLEDGMENTS

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