Clinicians are faced daily with restorative situations requiring them to make decisions about the proper selection of materials for enhanced function and esthetics. Through traditional media sources and the Internet, today’s patients are increasingly being made aware of the availability of esthetic dentistry, and they will no longer be satisfied with treatment plans that provide ideal function without also offering an esthetic restoration. Yet, given the wealth of often confusing information and the fact that manufacturers are now producing a greater and better selection of alternatives that are both functionally and esthetically acceptable, choosing the right material in today’s dental marketplace can be challenging. To help make the selection process simpler, clinicians and their patients should be knowledgeable and well-informed about all-ceramic alternatives.

HISTORICAL PERSPECTIVE
In 1885, Logan introduced the Richmond crown in which porcelain was fused to a platinum post. A year later, Land fabricated the first fused porcelain inlay and crown backed by platinum foil. No further advances using porcelain as a restorative material were made until the late 1950s. The oldest all-ceramic material used in dentistry has been traditional feldspathic porcelain, which is developed from a powder and liquid. The material, which gained popularity in the early 1960s, was cemented using traditional zinc phosphate cement. Although highly esthetic, its inability to bond to enamel and dentin resulted in numerous failures. McLean introduced aluminous porcelain with an inclusion of dispersed alumina particles to resist crack formation a few years later.1

Product Developments
The next two decades produced little additional developments. However, the period from the 1980s to today ushered in a number of new products that are currently still available. These include:

Glass-infiltrated alumina. Glass-infiltrated alumina (eg, In-Ceram Alumina®, Vident, Brea, CA) is a material with a sintered alumina glass-infiltrated infrastructure for anterior and posterior crowns, as well as anterior fixed bridges.2 This material demonstrates a flexural strength of 446 MPa.4 The opacous core limits its use as a highly esthetic material. A slip-casting technique or computer-aided design/computer-aided manufacturing (CAD/CAM) technology can be used to fabricate copings or frameworks from this material.

Glass-infiltrated magnesium alumina. Glass-infiltrated magnesium alumina (eg, In-Ceram Spinell, Vident) was developed to produce a coping with greater translucency. However, the strength of the core material must be sacrificed to provide the greater translucency. This material’s flexural strength is approximately 343 MPa,4 and it is recommended for use only as anterior crowns. In this capacity, the material has demonstrated excellent results over a long period of time.3

Glass-infiltrated alumina with partially stabilized zirconia. Glass-infiltrated alumina with partially stabilized zirconia (eg, In-Ceram Zirconia®, Vident) combines 35% partially stabilized zirconia with glass-infiltrated alumina to produce a material with greater strength. The flexural strength of this material is 604 MPa.5 Because of its high opacity, there is no significant advantage to using this material in highly esthetic areas. Slip-casting or CAD/CAM technology is used for fabricating infrastructures from this material.

Densely sintered high-purity aluminum oxide. Densely sintered high-purity aluminum oxide (eg, Procera®, Nobel Biocare, Yorba Linda, CA) is a polycrystalline ceramic. The ceramic core is glass-free, which contributes to its high flexural strength of 650 MPa.4 The material can be used for anterior and posterior crowns, and CAD/CAM technology is employed for fabricating ceramic infrastructures.

Lithium disilicate glass ceramics. Lithium disilicate glass ceramics (eg, IPS Empress® II, IPS Eris®9, Ivoclar Vivadent) were developed mainly for three-unit fixed partial dentures; they may also be used to create anterior/posterior crowns. The lost-wax technique is used and the core is pressed. The material’s flexural strength is approximately three to four times stronger than that of leucite-reinforced glass ceramics.7 Restorations fabricated from this material also must be bonded to achieve their optimum strength.

Yttrium tetragonal zirconia polycrystals. Yttrium tetragonal zirconia polycrystals (Y-TZP) (eg, Lava™, 3M ESPE, St. Paul, MN) are the basis for a high-strength, glass-free polycrystalline ceramic material used for the fabrication of anterior and posterior crown copings and fixed partial denture frameworks.8 The strength of the material is attributed to a process known as transformation toughening.9 If a crack begins to propagate through the ceramic, a high-energy stress state that causes the zirconia to transform from a tetragonal crystal configuration to a monoclinical configuration develops.9 In vitro

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Figure 1. A 45-year-old patient presented with worn, sensitive teeth resulting from bulimia.

Figure 2. The teeth exhibited a favorable color, so a translucent restorative material could be used.

Figure 3. Final restorations were achieved with minimal reduction on the facial and lingual aspects.

Figure 4. The final feldspathic restorations demonstrated satisfactory function and esthetics.
The final bridge and veneer restorations

A 50-year-old patient presented with extensive wear on all her teeth due to gastric reflux. The final restorations achieved satisfactory function and esthetics (Figure 3 and Figure 4).

Figure 5 A 50-year-old patient presented with extensive wear on all her teeth due to gastric reflux.

FACTORs CONTRIBUTING TO RESTORATIVE SUCCESS

Regardless of the type of all-ceramic material used, the success of these metal-free restorations depends on several factors.

Studies of Y-TZP indicate flexural strengths of 900 MPa to 1,200 MPa. Some Y-TZP restorative systems produce the substructure using CAD/CAM technology or by employing wax-up and milling processes. The size of the partially sintered, milled infrastructures is increased to compensate for shrinkage of 20% to 25% that occurs during final sintering. Esthetic layering porcelains may be used over the copings, or pressed ceramics can be employed.

Figure 6 Although bonded onlays could have been used on some of the posterior teeth, ease of cementation made zirconium restorations the ideal choice.

The patient's bite was opened enough to fulfill the requirements of the restorative material and provide an esthetic result.

Figure 8 The patient's bite was opened enough to fulfill the requirements of the restorative material and provide an esthetic result.

Figure 12 The final restorations were seated using resin-reinforced glass ionomer cement.

Figure 14 The teeth were prepared for new veneers for Nos. 6, 7, and 11 and a lithium disilicate glass-ceramic bridge for Nos. 8 through 10.

Figure 15 The final bridge and veneer restorations were seated using composite resin cement according to a dentin bonding protocol.

Figure 10 The patient exhibited previously placed composite resin restorations.

Figure 11 Based on their masking ability, strength, and ease of cementation, alumina crowns were selected for the final restorations.

Figure 9 A 65-year-old patient presented with worn dentition.

A 65-year-old patient presented with extensive wear on all her teeth due to gastric reflux. The treatment plan involved preparation of her teeth for full-coverage zirconium restorations. Because of the patient's history

Figure 13 A 40-year-old patient presented with an avulsed left central incisor that had been placed for the final restorations.

The patient's bite was opened enough to fulfill the requirements of the restorative material and provide an esthetic result.

Figure 7 The restorations were bonded with a self-etching, priming, and bonding resin to achieve the final result.

Another important consideration is the fact that anterior and posterior restorations require different materials. For a patient with no parafunctional habits, a feldspathic jacket bonded to an anterior tooth may be the most esthetic restoration available. This may not be the best option for a posterior molar, however. Other clinical factors that require consideration are: placement of margins, health of the tissue, and whether the tooth presents with either a high translucency or a dark substructure.

The ability to cement all-ceramic restorations has made indirect metal-free procedures faster and more efficient. Often, however, compromises must be made when clinicians and patients are faced with choosing between the ultimate esthetics and function. The following case histories demonstrate some of the possible clinical situations dentists may encounter and the options that are available to patients.

**CLINICAL CASE 1**

A 45-year-old patient presented with worn, sensitive teeth resulting from bulimia. She desired longer teeth. The teeth exhibited a favorable color, which made the use of a translucent material, such as feldspathic porcelain, a recommended option (Figure 1 and Figure 2). Exhibiting no posterior wear, her occlusion was ideal. The preparations were very conservative, with a minimal reduction of approximately 1 mm on the facial and lingual aspects. The feldspathic restorations were seated using resin cement after following a dentin bonding protocol. The final restorations achieved satisfactory function and esthetics (Figure 3 and Figure 4).

CLINICAL CASE 2

A 50-year-old patient presented with extensive wear on all of her teeth as a result of gastric reflux (Figure 5 and Figure 6).

The treatment plan involved preparation of her teeth for full-coverage zirconium restorations. Because of the patient's history
of clenching, the zirconium restorations were considered ideal to provide the greatest strength, as well as enable the simplest way to conventionally cement the restorations. Although bonded onlays could have been used to restore some of the posterior teeth, the ease of cementation made these restorations appropriate choices. The bite was opened enough to fulfill the requirements of the restorative material and provide an esthetic result. The restorations were bonded using a self-etching, priming, and bonding resin to achieve the final result (Figure 7 and Figure 8).

CLINICAL CASE 3
A 65-year-old patient presented with worn dentition and previously placed composite resin restorations (Figure 9 and Figure 10). The patient desired longer and brighter teeth, stated that he had fractured the bonding on several occasions, and indicated that he was ready for what he considered more definitive restorations. Alumina crowns were selected based on their masking ability, strength, and ease of cementation. The eight maxillary anterior teeth were prepared for full-crown restorations. The restorations were seated using resin-reinforced glass ionomer cement (Figure 11 and Figure 12).

CLINICAL CASE 4
A 40-year-old patient presented with an avulsed left central incisor that had been bonded to the adjacent teeth (Figure 13). Teeth Nos. 6 through 8, 10, and 11 all presented with previously placed porcelain veneers. The patient had lost facial bone on the left central incisor that had been avulsed and was ready for what he considered more definitive restorations. The ability to cement all-ceramic restorations has made the procedures faster, as well as more efficient and esthetic. Yet, with more options, there may also be more confusion. To decide on the best material choice, clinicians and patients must carefully weigh the advantages and disadvantages of each on a case-by-case basis. Depending on the particular patient’s needs and desires, these decisions may involve compromises or a choice between different cementation modes on the fracture resistance of feldspathic ceramic crowns. Int J Prosthodont. 1997;10:169-177.

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