All-ceramic material selection: how to choose in everyday practice

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Nowadays, clinicians have access to a great variety of restorative materials. As there is restricted access to test materials in private practice, most clinicians make their selection of esthetic biomaterials on the basis of scientific articles,[1] lectures, company recommendations, and through the sharing of information and experience among colleagues. In order to choose the right restorative material, it is important as a dentist and as a technologist to be knowledgeable about the material's composition, physical characteristics, and indications.

Recently, new approaches to classifying ceramic restorative materials[2] and composite CAD/CAM blocks[3] have been proposed (Fig 1). These classifications are based on the presence of specific attributes in the formulation of the materials:

- Glass-matrix ceramics: nonmetallic inorganic ceramic materials that contain a glass phase.
- Polycrystalline ceramics: nonmetallic inorganic ceramic materials that do not contain a glass phase.
- Resin-matrix ceramics: polymer matrixes containing predominantly inorganic refractory compounds that may include porcelains, glasses, ceramics, and glass-ceramics.

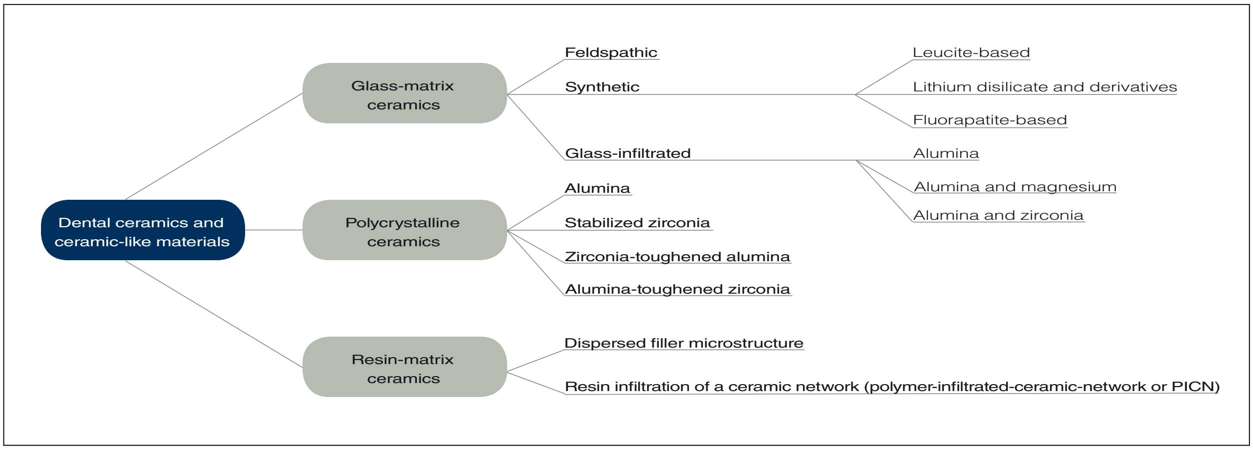


Fig 1 Overview of the proposed classification system of all-ceramic and resin-matrix ceramic materials (reprinted with the permission of and adapted from Gracis et al[2] and Mainjot et al[3]).

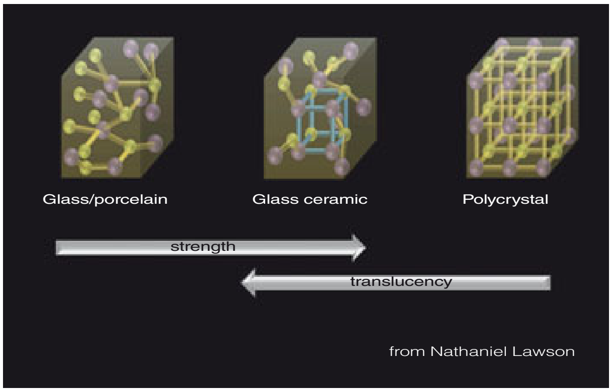


Fig 2 The translucency of glass-ceramics depends largely on the amount of crystals within the glassy matrix and the pore size. As the crystalline content increases to achieve greater strength, the opacity of the material also increases (reprinted with the permission of Lawson and Burgess[8]).

In this article, I will focus on the first two families of materials, while the third group will be described in the article by A. Mainjot that is part of these proceedings.

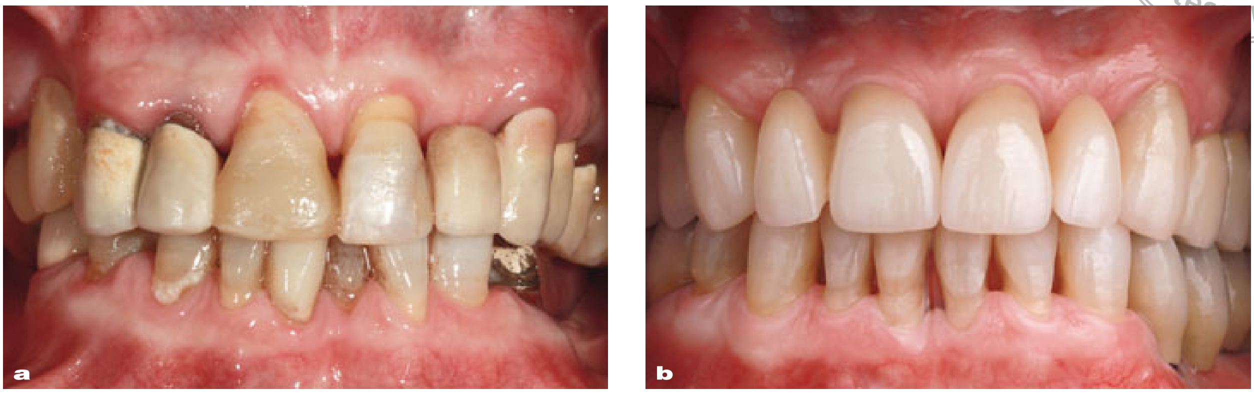
Some important parameters of indirect restorative materials from a clinical point of view are longevity, translucency, and wear resistance. What follows are some considerations regarding each of these variables:

As far as **longevity** of new biomaterials is concerned, it is important to be aware that there is no long-term data on the survival of many all-ceramic materials, especially for larger restorations. Although 3- and 5-year results are helpful, they are not sufficient to make a clinically relevant choice because patients do not usually experience failure after these relatively short time periods. Additionally, the materials – especially zirconia – continue to undergo major changes, and therefore reported survival times refer to different products and compositions.

Last year, Sailer and Pjetursson published an interesting update of their 2007 systematic review[4,5] about the survival and complication rates of all-ceramic and metal-ceramic tooth-supported fixed dental prostheses (FDPs) in two articles: one for single crowns[6] and the other for multiple units.[7] A total of 580 English language articles were found in the time interval of the review, which spans the years 2006 to 2013. However, after the application of the inclusion criteria, which required a minimum observation period of at least 3 years, only 33 articles for single crowns and 41 for multiple units could be used for the analysis.

For single crowns, Sailer[6] reported an estimated 5-year survival rate of 95.7% for metal-ceramic crowns, 96.6% for leucite- or lithium disilicate-reinforced glass matrix ceramics, 94.6% for glass-infiltrated alumina, and 96.0% for densely sintered alumina. The zirconia-based crowns showed an estimated 5-year survival rate of 91.2%. When the outcomes of anterior and posterior single crowns were compared, no statistically significant differences of the survival rates were found. For multiple unit FDPs, Pjetursson[7] reported an estimated 5-year survival of 94.4% for metal-ceramic crowns, 89.1% for reinforced glass ceramics, 86.2% for glass-infiltrated alumina, and 90.4% for densely sintered zirconia.

The **translucency** of glass-ceramics depends largely on the amount of crystals within the glassy matrix and the pore size.[8] An increase in the crystalline content to achieve greater strength often results in greater opacity (Fig 2). In a recent article, Zhang[9] states that "careful examination revealed that commercial zirconia restorative materials,



Figs 3a and b Pre- and post-treatment images of a patient who underwent a full-mouth rehabilitation on teeth and implants, which was completed using lithium disilicate for the anterior maxillary and mandibular teeth. PFM was used for the premolars and molars.

Fig 4a Pre-treatment image of a patient with a failing composite restoration on the maxillary left central incisor. The tooth had lost part of the crown due to a trauma.

Fig 4b The tooth after being restored with a feldspathic ceramic laminate veneer. The right central incisor presented with a horizontal crack line that did not require intervention.

including all major brands, remain essentially opaque when their thicknesses approach 1 mm or greater." On the other hand, the recently introduced translucent zirconia is significantly more translucent than conventional zirconia. Interestingly, this esthetic advantage is achievable while still maintaining approximately two thirds more flexural strength than lithium disilicate.[10] Harianawala et al[11] concluded that high translucency lithium disilicate was the most translucent material among the esthetic ceramic materials studied. At the same time, lithium disilicate is available in so many different gradations of opacity and color that choosing the proper ingot is difficult, which is why the technologist has to be involved in the biomaterial selection process.

Hmaidouch and Weigl published a systematic review[12] of **tooth wear** against ceramic crowns in the posterior region (*in vitro* and *in vivo*). The article

Fig 5 Posterior teeth restored with single PFM crowns.

concluded that various studies have demonstrated that there is no strong correlation between ceramic hardness and wear rate of human enamel; however, it was confirmed that the wear process is affected by ceramic microstructure and ceramic roughness, and that the surface treatment of ceramics plays a significant role in the wear of opposing tooth structure. This review indicated that some all-ceramic crowns are as wear-friendly as metal-ceramic crowns. However, up until now, it has been impossible to associate tooth wear with any specific causal agent.

When attempting to select the most appropriate all-ceramic material for a specific clinical situation, it can be of help to first decide whether to attribute more importance to the esthetic appearance (color and translucency) or to the mechanical properties (fracture resistance, fracture toughness) of the restoration – assuming, of course, a clinically acceptable survival rate.[13] In the anterior region, the optical properties of the materials are paramount, especially when dealing with single tooth restorations and normal color abutments. In the posterior region and when replacing missing teeth with a FPD, the mechanical properties of the materials are the most important consideration in order to assure longevity, especially in the presence of a parafunctional activity.

The following are some recommendations, which are based on a personal inquiry and the clinical experience of members of the EAED:

Anterior area – single crowns

- with normal color abutments and the need to imitate high-translucency teeth: lithium disilicate (Fig 3a and b), and feldspathic ceramics (Fig 4a and b);
- with dark abutments or low-translucency teeth: porcelain fused to metal (PFM);
- in case of bruxers: monolithic lithium disilicate superficially colored restorations.

Anterior area – replacement of missing teeth

- with normal color abutments: lithium disilicate;
- with dark abutments: PFM.

Posterior area – single crowns

- with normal color abutments and the need to imitate high-translucency teeth: monolithic lithium disilicate;
- with dark abutments or low-translucency teeth: PFM or zirconia.

Posterior area – replacement of missing teeth

- for the fabrication of a three-unit bridge: PFM or zirconia;
- for the fabrication of a bridge with more than three units: PFM (Fig 5).

In other words, it seems that in more risky esthetic and/or biomechanical situations, such as dark abutments and long-span restorations, metal-ceramic still acts as the gold standard.[14] Nowadays, zirconia cannot yet be considered as a full substitute for PFM.[15] There are many aspects of this material that are unclear, and, as previously underlined, clinical trials do not give meaningful data because the composition of zirconia continuously changes. For single tooth restorations in the anterior and posterior regions, lithium disilicate represents an esthetic as well as long-term survival solution.

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