Zirconia: some practical aspects from the technologist's point of view

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During the past decade, zirconia-based ceramics have been successfully introduced into the clinic to fabricate small and large restorations. Today, we have a better understanding of the physical properties, characteristics, and practical behavior of zirconia, which has led to a more predictable fabrication of clinically acceptable, long-term restorations.[1]

Zirconia is normally milled from blocks or discs using various zirconia brands. The selection of the right zirconia is important, and is mainly based on the knowledge of the fabrication process. Even if the chemical composition of the different brands is similar, they can vary widely.

Zirconia exists in three phases: monoclinic, tetragonal, and cubic. The tetragonal phase is the most interesting because, when a crack initiates on the surface, the stress concentration at the top of the crack causes the tetragonal crystals to transform into monoclinic crystals with associated volumetric expansion. In the end, this is what shields the crack tip from the applied stress and enhances the fracture toughness.

A discussion of the various types of zirconia most often used in clinical dentistry follows.

Traditional, tetragonal (opaque) zirconia (900 to 1200 Mpa)

This group includes brands such as Lava (3M), Cercon (Dentsply), Metoxit (Metoxit AG), KATANA Zirprime Noritake (Kuraray Noritake Dental).

Due to its good mechanical properties, this type of zirconia is mostly used in extended restorations and in cases where there is a need to mask dark discolorations from whatever origin (Figs 1a to c). Clinical examples of the use of traditional tetragonal zirconia are layered single crowns and fixed partial dentures (FPDs) on teeth, as well as single crowns and screw-retained superstructures on implants (Figs 2a and b).

High-translucency (HT) zirconia (900 to 1200 Mpa)

This group includes brands such as Prettau (Zirkonzahn), BruxZir (Glidewell), Zenostar (Ivoclar Vivadent), KATANA HT and KATANA ML Noritake (Kuraray Noritake Dental).

For the past few years, there has been a clear demand for more translucent zirconia with which to fabricate more esthetic monolithic restorations (Figs 3a to

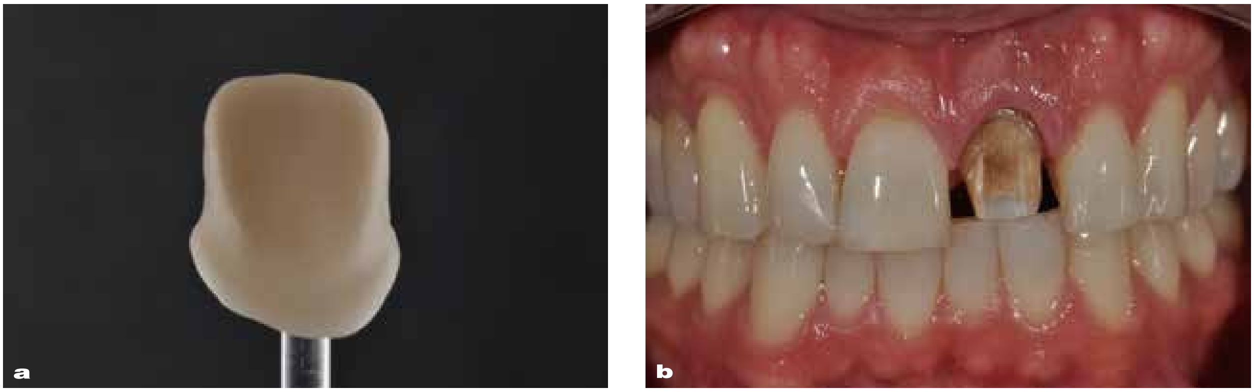

Fig 1 **(a)** Opaque zirconia is an ideal choice to mask dark discolorations from whatever origin. **(b and c)** A clinical case where the dark effect of the discolored natural abutment on tooth 21 has been screened with opaque zirconia layered with a sufficient thickness of feldspathic ceramic to produce a mimetic effect.

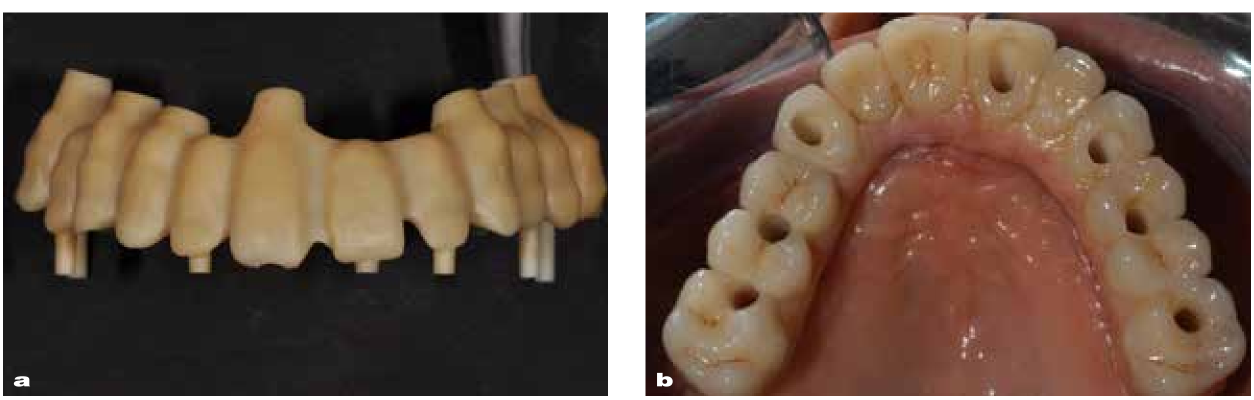

Fig 2 **(a)** Due to the good mechanical properties of tetragonal zirconia, this material is an option for manufacturing implant-supported frameworks veneered with feldspathic ceramic. Pictured here is an example of a screw-retained Toronto Bridge. **(b)** The same screw-retained superstructure as in Fig 2a, completed with white and pink feldspathic ceramic.

c). High-translucency (HT) zirconia is interesting because, thanks to its superior mechanical properties, it allows the fabrication of highly esthetic extended restorations. Furthermore, it allows for a superficial staining of the monolithic restoration.[2]

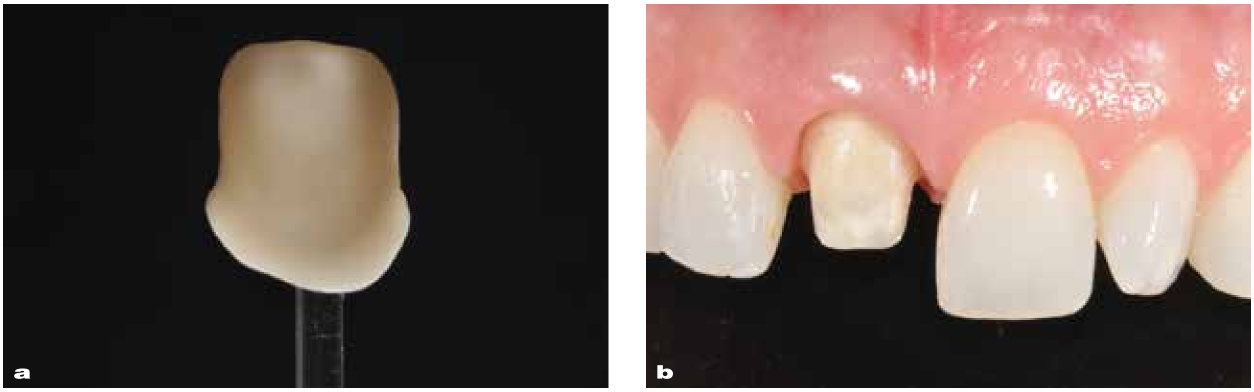

Fig 3 **(a)** HT zirconia is interesting not only for its mechanical qualities but also for the highly esthetic result, achieved thanks to its improved optical properties, especially when the natural abutment is of a normal shade. **(b)** Tooth preparation of tooth 11: the tooth is nonvital. **(c)** For this restoration, an HT zirconia veneered with feldspathic ceramic was used. Thanks to the normal color of the abutment and the high translucency of the material, the apace required for the crown was less than if an opaque zirconia had been used. The restorations have been stained slightly superficially.

Fig 4 **(a)** Multilayered, HT zirconia offers the possibility of using the cut-back design technique to reduce the layer of the veneer on the vestibular area and to maintain the monolithic palatal area only, polished with diamond paste. **(b)** A clinical case of two ML zirconia crowns on natural abutments for the central incisors, and two screw-retained crowns on implants in position 22 and 12. All the restorations had a cut-back design and were layered with feldspathic ceramic only on the buccal surface. Palatally, the zirconia is monolithic.

Recently, a multilayered (ML) technology was introduced for zirconia – an alternative to the process of the infiltration of color liquids, which may have a critical impact on the structure of the zirconia. Blocks or discs of zirconia with dif-

Fig 5 **(a)** Multilayered, high-translucency (HT) zirconia is also interesting for monolithic solutions. The multilayered composition offers a different chromaticity; it is therefore possible to solve esthetic challenges without using the infiltration technique and without layering it with a veneer. **(b)** A multilayered zirconia monolithic crown for the natural abutment of tooth 26. Stain was applied only in the fissures, while the external surface was glazed and the occlusal area highly polished.

ferent layers of translucency and color have the opportunity to produce more esthetic multicolor dentin and enamel. Furthermore, the multilayered option allows for the cut-back technique, which combines the functional part with the monolithic part without limiting the esthetics (Figs 4a and b).

Clinical examples of the use of HT zirconia are layered single crowns (Figs 5a and b), and FPDs on teeth, as well as single crowns and screw-retained superstructures on implants, pre-infiltrated monolithic solutions, and complex monolithic multilayered solutions.

Cubic ultra-translucent (UT) zirconia (500 to 800 Mpa)

This group of zirconia includes brands such as Prettau Anterior (Zirkonzahn), DD cube X² (Dental Direkt), KATANA Zirconia ST and KATANA Zirconia UT Noritake (Kuraray Noritake Dental).

The most recent zirconia to have been introduced is the cubic formulation. Cubic zirconia is well known as a substitute for diamonds in the jewelry sector. It is a cocktail of tetragonal and cubic zirconia, used for monolithic or hybrid restorations, ie, veneered by a ceramic of choice. This last generation of zirconia has excellent optical features compared to the two types of zirconia described previously. It is not white but totally transparent. The opportunity to stratify and color it makes cubic ultra-translucent (UT) zirconia a versatile product that is ideal for high esthetic solutions.[3] In fact, cubic zirconia offers a translucency similar to lithium disilicate, although its mechanical properties are not as good as the other types of zirconia.

In 2015, two new products were introduced: cubic ultra-translucent (UT) and super-translucent (ST) zirconia. Both products are available in a multilayered version (UTML and STML). UT and ST zirconia represent a significant advancement in esthetic, minimally invasive monolithic CAD/CAM restorations. The flexural strength of UT zirconia is 550 MPa, while that of ST zirconia

Fig 6 **(a)** Ultra-translucent cubic zirconia is ideal for monolithic solutions in the anterior area, whether they are crowns or laminates. **(b)** Six monolithic anterior crowns using UTML and a staining technique. With this approach, it is possible to produce a predictable esthetic outcome without using the ceramic layering technique.

is 750 MPa. Clinical examples of the use of cubic UT zirconia are layered single crowns and small FPDs in general, single crowns, screw-retained superstructures on implants, as well as monolithic colored and multilayered solutions.

Thin, single anterior crowns of 0.8-mm wall thickness (1 mm for posterior crowns) are feasible with cubic zirconia. Furthermore, ultra-thin laminate veneers of 0.4 mm are fabricated. From a clinical point of view, cubic zirconia requires a simple adhesive cementation (Figs 6a and b).

In summary, the advances in the field of zirconia are impressive. Due to the rapid development of both biomaterials and processing technologies, more esthetic solutions are possible. However, dentists and technologists must be aware of the impact that this development (and, for the moment, possible unknown changes) may have on the clinical stability of zirconia. Although single restorations and small FPDs seem to be successful from the perspectives of flexural strength and fracture toughness, more clinical data and longer clinical evaluations of extensive restorations are still needed for the long-term survival of new-formulation, zirconia-based restorations to be proven.

References

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