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Letter to Editor

Overview of Zirconia Material in Dentistry

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Introduction

The introduction of Zirconia, especially Y-TZP, in dentistry has expanded the possible applications of metal-free ceramic restorations with greater success and reliability. It was introduced as a good alternative for metal frameworks thanks to the excellent mechanical properties of this material compared to the early ceramic materials which are brittle. In the same context, the development of CAD/CAM technology makes the production of Zirconia restorations a totally digitized process which is faster and more accessible. This enlarged the field of Zirconia in dental implantology.

Structure and Mechanical Properties

Zirconia is chemically an oxide and technologically a ceramic material that does not enhance the bacterial adhesion. In addition, it shows a low corrosion potential with favorable radio opacity. It presents 3 crystallographic phases at different temperatures: cubic© (from 2680°C, the melting point, to 2370°C); tetragonal (t) (from 2370°C to 1170°C); monoclinic (m) (from 1170°C to room temperature). The transformation from (t) to (m) phase which is more stable occurs with a volume increase of the crystals (3-5%) creating a high compressive stress in the material and is defined as transformation toughening[1].

Because of this volume change (3-5%) whichoccurs during the transformation to the monoclinic phase, pure zirconia is considered as non stable and cannot be used at elevated temperatures. This change is sufficient to exceed the elastic and fracture limits, resulting in cracks and flaws in ceramics (Denry& Kelly, 2008). For that, different oxides, such as yttrium oxide(Y_2O_3), calcium oxide (CaO) or magnesium oxide (MgO), can be added to zirconia to stabilize it, allowing the tetragonal form to exist at room temperature after sintering, the mechanical properties of Zirconia were proved to be higher than those of all other ceramics for dental use with a fracture toughness of 6-1O Mpa/$m^{1/2}$, a flexural strength of 9OO-12OO MPa and a compression resistance of 2OOO Mpa. An average of load-bearing capacity of 755 N was reported for Zirconia restorations[2].

What about Chipping and Aging?

The survival and complication rates of Zirconia based restorations indicated that the most frequent technical complication with Zirconia based FDPs was chipping of the veneering porcelain. Chipping is related to many factors including adequate framework design to support the veneering porcelain and adequate veneering techniques.

One ultimate solution for the chipping is not to use porcelain for veneering. Using a high translucent Zirconia for full-contour Zirconia manufacturing might be an elective alternative to avoid the chipping of veneering porcelain[3].

Aging or zirconia degradation at low temperature (LTD) is a progressive and spontaneous phenomenon that is exacerbated in the presence of water, steam or fluids. The consequences of the material aging process are many, including surface deterioration, micro-cracks and decreased resistance in medium and long term periods.

Bonding or Cementation?

Zirconia has a dense and hard surface which gives an higher resistance to wear. On the other hand its great surface stability creates several problems especially as regards the efficiency and duration of the chemical or mechanical bond with the different cementing systems.Common etching with hydrofluoric acid in combination with silanization acts on glassy matrix of other ceramics systems. However, they have not been proven useful against high acid resistance of Zirconia.For that, Zirconia bonding is still questionable. In order to obtain the strong bond to Zirconia ceramics in clinical conditions, it is important for the bonding surface to be roughened, activated for chemical bonding and freeof any contaminants[4]. The application of a tribochemical silica coating after airborne particle abrasion with 50-110 µm alumina particles at 0.25 MPa maybe a solution for Zirconia bonding.

However, this would possibly create sharp crack tips, this makes structural defects a subject of concern regarding Zirconia resistance to possible radial cracking during function.

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