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On Translucent Yttria Stabilized Zirconia Ceramics:

Mechanical Considerations, Phase Transformation, and Cement Choices

Akademisk avhandling

Som för avläggande av odontologie doktorsexamen vid Sahlgrenska Akademin, Göteborgs Universitet kommer att offentligen försvaras i Arvid Carlsson sal, Medicinaregatan 3, den 9:e juni, klockan 9:00.

av Sebastian Franco-Tabares

Fakultetsopponent:

Per Vult von Steyern, Professor

Malmö Universitet, Sverige

Avhandlingen baseras på följande delarbeten

I. Franco-Tabares S, Stenport VF, Hjalmarsson L, Johansson CB. Limited Effect of Cement Material on Stress Distribution of a Monolithic Translucent Zirconia Crown: A Three-Dimensional Finite Element Analysis. Int J Prosthodont. 2018 Feb;31(1):67–70.

II. Franco-Tabares S, Stenport VF, Hjalmarsson L, Tam PL, Johansson CB. Chemical Bonding to Novel Translucent Zirconias: A Mechanical and Molecular Investigation. J Adhes Dent. 2019;21(2):107–16.

III. Franco-Tabares S, Wardecki D, Nakamura K, Ardalani S, Hjalmarsson L, Stenport VF, Johansson CB. Effect of airborne-particle-abrasion and polishing on novel translucent zirconias: Surface morphology, phase transformation and insights into bonding. In manuscript (Accepted, Journal of Prosthodontic Research, 2020)

IV. Franco-Tabares S, Hjalmarsson L, Kvam K, Johansson CB, Stenport VF. Effect of the cement and airborne particle abrasion on the fracture strength of translucent monolithic zirconia crowns: Remarks on their fracture toughness and hardness. In manuscript (Submitted to the Journal of Prosthetic Dentistry, 2019)

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Abstract

New zirconia formulations (4Y and 5Y-zirconias) have been introduced for prosthodontic therapy and are commercialized as "translucent" zirconias. No clinical information providing their survival rates or complications has been provided to the date. This has investigated thesis aimed to investigate different variables regarding some of their mechanical aspects, crystallographic and morphological characterization and alternatives for their cementation.

A finite element analysis was performed in order to observe the stress distribution on a monolithic translucent zirconia crown when cemented with different cements. The bonding potential of a 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP)-based commercial cement to two translucent zirconias was assessed using Raman spectroscopy (RS), Fourier-transform infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS). A shear bond strength test was complementary to these analytical methods. The crystallographic structure and surface morphology of two translucent zirconias was estimated by X-ray diffraction (XRD) and interferometry after airborne-particle abrasion (APA) and polishing.

The effect of the cement and air-borne particle abrasion and on the fracture strength of monolithic 4Y-zirconia crowns were also evaluated. And lastly, fracture toughness and hardness were estimated by Vickers hardness measurements.

The stress distribution on a monolithic translucent zirconia crown seems to be unaffected by the cement material. Bonding to 4Y and 5Y-zirconias seems plausible by using a 10-MDP-based cement, nonetheless, thermocycling seems to reduce the bond's strength. The APA protocol produced monoclinic zirconia and was inversely related to the yttria content. Polishing did not cause any monoclinic zirconia. The surface area and surface roughness were increased after the APA protocol. The fracture strength of the monolithic 4Y-zirconias was unaffected by the APA protocol and the cement choice. Differences in fracture toughness and hardness were observed.

Within the limitations of the studies presented in this thesis, it could be summarized that the translucent zirconias differentiate themselves from the traditional formulations, specially 5Y-zirconias in fracture toughness. Special caution is recommended in their clinical use. Nevertheless, bonding seems possible via a 10-MDP based cement.

Keywords: zirconia, translucent, yttria, air-borne particle abrasion, 10-MDP, cement

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