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The Effect of Fractional Co2 Laser & Sandblasting Surface Treatment on Shear Bond Strength of Cubic Zirconia

(in Vitro Study)

Thesis

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Introduction

The introduction of computer-aided–design and computer aided manufacturing (CAD/CAM) technology has provided us with high strength ceramic like zirconia with flexural strength 900-1200 MPa. Zirconia or zirconium dioxide (ZrO_2) is modified by addition of yttria (Y_2O_3) tetragonal polycrystal (Y-TZP). The addition of yttria is for stabilizing the crystal structure transformation during firing at high temperature and improved the physical properties of zirconia. [1]

The major complication of zirconia is their lack of translucency and their tenacious need for veneering that commonly subjected to chipping and cracking. So, by the introduction of nano zirconia that allow us to overcome the polycrystalline birefringence barrier and to manufacture a translucent, high strength monolithic restorations, like ultra-translucent zirconia that showed a significantly higher degree of translucency, which improved the esthetics. [2,3]

The dental team faces questions and decisions to choose the appropriate system and means of cementation. Several ceramic types demand different surface treatments and cementation procedures that will contribute to long-lasting restorations. Some zirconia restorations should be cemented with resin luting agents. These include zirconia restorations with limited mechanical retention that depends on resin bonding like resin-bonded fixed partial prostheses, bonded inlays/onlays, laminate veneers and crowns to teeth with short clinical crowns. [1,2]

The surface conditioning methods of the ceramic and the type of the luting cements have been proven to have a great influence on the bond strength of all ceramic restorations. However, the composition and the physical properties of zirconia differ from silica-based ceramics because it is a non-silicate ceramic. So, it requires alternative bonding techniques to achieve a strong, long term and durable bond. Recently, many techniques are being used such as sandblasting, laser, silica coating to address this problem and other approaches are under investigation. (4,5)

Lasers have been used for different purposes in dentistry among which conditioning tooth structure or restorative surfaces, studies employed different lasers such as Nd:YAG, Er:YAG and CO2 for surface modification of zirconia ceramic, and reported varying degree of success. The CO2 laser is generally employed for intraoral soft tissue surgery because of its great absorption. The wavelength of the CO2 laser (10600nm) is also well absorbed by ceramic materials, making it a suitable instrument for ceramic surface treatment.(6,7,8)

Therefore this study was carried out to evaluate the effect of surface treatment with sandblasting technique and CO2 laser technique with different parameters on the bond strength between cubic zirconia and MDP containing resin cement. In addition, to study their effect on the surface morphology and the shear bond strength between cubic zirconia and the resin cement.

Review of Literature

Zirconia based ceramics:

Development of dental ceramics introduced zirconia based ceramics which is a strong material with better fracture resistance and long term durability when compared to other dental ceramics. Zirconium oxide (ZrO_2) is a metal oxide that was known as a reaction product of heating the gem (zircon) by Martin Heirich Klaproth in 1989. [(4)]

Zirconia is a well- known polymorph that can exist in three metamorphs (phases) termed: monoclinic (m), tetragonal (t) and cubic (c). The unalloyed zirconia at room temperature has a monoclinic crystal structure. This phase is stable up to 1170°C. [(9,10,11)]

Different oxides are added to zirconia in order to stabilize the tetragonal and /or cubic phases like: Yttria (Y_2O_3), Magnesia (MgO), Calcia (CaO) and Ceria (CeO) to allow generation of multiphase materials known as partially stabilized Zirconia (PSZ). [(9)]

The conventional available zirconia restorations are yttria-tetragonal zirconia polycrystals ceramics that consists of (2-3%) Y_2O_3 as a stabilizing agent. Also, it is characterized with transformation toughening property as considered to be the base of the high strength yttria-tetragonal zirconia polycrystal. The opaqueness is because of the large grain size and presence of porosities which is evidently seen at the microstructural level. This opaqueness has placed these restorations with poor esthetics when compared to lithium disilicate and leucite reinforced ceramics, so it should be veneered with a layer of porcelain. [(4)]