Effect of shade and thickness of ultratranslucent polychromatic zirconia on the degree of conversion of light cure resin cement

Thesis Submitted for Partial Fulfillment of the Master Degree of Science Requirement in Fixed Prosthodontics, Faculty of Dentistry, Ain shams University

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2019

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Acknowledgment

First thanks to **ALLAH** *to whom I relate any success in achieving any work in my life.*

I wish to express my deepest thanks, gratitude and appreciation to ***Dr. Marwa Mohammed Wahsh,*** *Associate Professor, Fixed Prosthodontics department Faculty of Dentistry - Ain Shams University for her meticulous supervision, kind guidance, valuable instructions and generous help.*

I am deeply thankful to ***Dr. Maged Mohamed Zohdy,*** *Associate professor, Fixed Prosthodontics department Faculty of Dentistry - Ain Shams University for his great help, outstanding support, active participation and guidance.*

Mina Kamel Mohamed Alkaabi

Dedication

This work is dedicated to My Parents, Sisters for believing in me and for their endless support.

Last but not least, deepest thanks to my dear Prof. ***Dr. Mohamed Katamish****.*

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Abb.	Full term
CAD/CAM	Computer-aided design/computer-aided manufacturing
CTE	Coefficient of thermal expansion
DC	Degree of conversion
FDPS	Fixed dental prostheses
FTIR	Fourier transform infrared
L-DIS	Lithium disilicate
UTLM	Ultra Translucent Multi-Layered zirconia

1- Introduction

Ceramics are progressively being promoted as high strength materials for dental prostheses. An effort has been made to create a restoration combining the function, form and shade of the natural teeth. At the early 2000s; zirconium dioxide (zirconia) was introduced. Because of its high mechanical, physical properties, biocompatibility, high strength, durability, thermal expansion which is near to hard tooth structure and its natural appearance, its uses in dentistry field have been increased. [(1)]

Zirconia is reported to be less translucent than glass and lithium disilicate. This could affect the esthetic appearance and the clinical choices made when using zirconia-based restorations.[(2)]To provide enough space for the veneering ceramic to compensate for the zirconia opacity, substantial tooth reduction is needed.[(3)]In addition, the most frequent clinical complication of veneered zirconia restorations is cohesive chipping of the ceramic veneer.[(4)], as zirconia veneering ceramics necessarily contain lower quantities of reinforcing high coefficient of thermal expansion fillers, making them less than the ones applied to metal-ceramic restorations. Furthermore, residual tensile stresses caused by rapid cooling to room temperature at the end of the sintering phases may also enhance their propensity to fracture. [5]

An alternative for preventing chipping is the use of monolithic restorations without a veneering ceramic. The major clinical advantage of monolithic construction is a lower ceramic thickness. [6]A new generation of cubic zirconia which has been introduced “ultratranslucent multilayered zirconia” with the advantages of; more conservative preparations, thinner and more translucent crowns allowing a greater amount of light transmission through the ceramic and an increased conversion degree during cementation with resin-based materials, positively affecting polymerization.[7]

In cases with non-retentive preparations like veneers, a stable long-term bond of the restoration to the tooth is mandatory for long-term success. The degree of conversion of resin-based materials is essential in determining their mechanical performance. Multiple factors affect the degree of conversion of resin cements; including the light curing duration, light unit system used, light curing tip distance from the curing surface, in addition to the shade and thickness of the restoration through which the light is cured.[8]

Cubic zirconia used as single crowns and small FPDs are successful from the prospective of flexural strength and fracture toughness. However, there are a limited number of studies about its performance. More data and research are still needed about the degree of conversion of resin cement underneath the restorations with different thicknesses and shades.

2- Review of Literature

Metal ceramic restorations are a type of ceramic system for fixed prosthetic rehabilitation that has been widely used since the early 1960s. They have superior physical properties, and their marginal and internal adaptation and esthetics are clinically acceptable. [9] However, light reflecting from the opaque porcelain used to mask the metal, particularly at the cervical third of the restoration causes a light grey appearance of the adjacent gingival tissue. This phenomenon led researchers to search for more esthetic solutions to produce fixed prostheses. [10]

Although the first feldspathic porcelain crown was introduced to the field of dentistry in 1903, the development of metal-free ceramics only gained speed after the first attempt to strengthen feldspathic porcelain by adding Al_2O_3 by in 1965. [11] Since then, several types of full ceramic systems have been developed to meet the demands of highly required for highly esthetic and natural-appearing restorations. However, some of the mechanical properties of these materials, such as brittleness, crack propagation, fracture toughness, low tensile strength, wear resistance, marginal accuracy and difficulty of repair, have limited their clinical use.[12]

❖ Zirconium dioxide:

- **Evolution of Zirconia:**

Over the last decade, zirconia technology has a rapid development of metal free dentistry that may provide high biocompatibility, enhanced esthetics, and improved material strength. (13) The extensive knowledge gained with regard to zirconia ceramic chemistry, crystallography, and the production of these engineering ceramic led to promising and advanced dental applications. (14)

Techniques previously applied to metals are now considered applicable to differentiate ceramic system. Phase trans- formations alloying, quenching, and tempering high techniques are currently applied to a range of zirconia ceramic systems.(15) Significant improvements to the fracture toughness, ductility and impact resistance have minimized the gap between the physical properties of ceramics and metals. Moreover, recent development in non oxide and tougher ceramics and massive investment in dental industry (e.g., CAD/CAM systems) have also created that ceramic materials have potential application in clinical dentistry. (16)

Zirconia was introduced in dentistry in the early 1990s and has been used as a core material to support more aesthetic ceramic materials. Zirconia shows similar mechanical properties to stainless steel and the highest ones among ceramics used in dentistry. [17]

Zirconium dioxide (ZrO2), known as zirconia, is a white crystalline oxide of zirconium. Although pure zirconium oxide does not occur in nature, it is found in the minerals baddeleyite and zircon (ZrSiO4). [18] Zirconia is obtained as a white powder and possesses both acidic and basic properties. Zirconium oxide crystals are arranged in crystalline cells which can be categorized in three crystallographic phases: 1) the cubic (C) 2) the tetragonal (T) and 3) the monoclinic (M). The cubic phase is stable above 2,370°C and has moderate mechanical properties, the tetragonal phase is stable between 1,170°C and 2,370°C and allows a ceramic with improved mechanical properties to be obtained, while the monoclinic phase, which is stable at room temperatures up to 1,170°C, presents reduced mechanical performance and may contribute to a reduction in the cohesion of the ceramic particles and thus of the density. [19]

Zirconium oxide ceramic, a high strength ceramic, was introduced for dental use as a core material for conventional and resin bonded fixed partial (FPDs) dentures and full coverage crowns. [20]

The use of the zirconium oxide all ceramic restorations provide several advantages, including: high flexure strength, desirable optical properties and reduction in the layer thickness of veneer ceramic required achieving the desired color. Its young modulus is similar to that of stainless steel. [21] In added development of technology, such as computer aided design/computer aided manufacturing (CAD/CAM) allows the fabrication of zirconia restoration to be a more practical process. Various zirconia materials are available commercially. Their fabrication processes are different even though they share similar chemical structure. [22]

Zirconia with its opaque white color and insufficient translucency require glassy porcelain veneering on the framework to achieve a natural appearance and acceptable esthetics. However, cracking or chipping of the porcelain veneer has been reported to be a major complication of these restorations. The possible causes of porcelain veneer cracking are; differences in coefficient of thermal expansion (CTE) between framework and porcelain, firing shrinkage of porcelain, porosities, poor wetting of veneering, and flaws on veneering, inadequate framework design to support veneer porcelain, overloading and fatigue. [23]

There are several solutions to overcome the veneer cracking problem due to its multifactorial nature: alternative application of techniques for veneering such as CAD/CAM