The effect of surface treatment on retention of zirconium oxide ceramic crowns with two types of cements

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Faculty of Dentistry
Ain Shams University

By

Amir Sabry Hashem Nafea

B.D.S (2005)

Faculty of Dentistry

Ain Shams University

Faculty of Dentistry

Ain Shams University

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<u>*Supervisors*</u>

Dr. Amina Mohamed Hamdy

Professor of Fixed Prosthodontics

Head of Crown and Bridge Department

Faculty of Dentistry

Ain Shams University

Dr. Tarek Salah Morsi

Assistant Professor of Fixed Prosthodontics

Crown and Bridge Department

Faculty of Dentistry

Ain Shams University

بسم الله الرحمن الرحيم

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ ﴿٣٢﴾

صدق الله العظيم

سورة البقرة "ايه ٣٢ "

Dedication

This work is dedicated to
***my mother**,*

For without her continuous persistence and support, this would not have been possible.

Acknowledgement

First and foremost thanks are due to ***Allah*** *the beneficient and merciful.*

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List of Tables

List of Figures

Biocompatibility, non-allergenicity, high tensile strength, high compressive strength, corrosion resistance and good esthetics of zirconium dramatically increased its popularity over the last decade. In addition, zirconium-based ceramics are claimed being able to withstand masticatory forces on posterior teeth due to their superior mechanical properties.

Retention has become the most important clinical success indicator of any fixed prosthodontic restoration. As it represents the long-term durability factor of the restoration, that is looked upon with high importance by patients and dentists.

The clinical success of indirect restorations is dependent on multiple factors that include preparation design, mechanical forces, restorative material selection, oral hygiene, and selection of a proper luting agent. The selection of the luting agent is dependent on the specific clinical situation, the type of restoration utilized and the physical, biologic, and handling properties of the luting agent.

Although it is important to choose the best luting agent for each clinical situation, far greater variations in physical properties result from improper manipulation of a given luting agent than exist between different types of cements.

Several types of luting agents are available and the choice for a material depends of various factors. The resin cements has significant role in increasing crown retention by promoting an adhesive bonding between tooth and restoration, which has increased the use of these luting agents. Nevertheless, the use of these materials requires several steps, mainly for treatment of dental substrate, which make them technically sensitive. Self-adhesive resin cements have been recently introduced on the market. The goal of these luting agents is to combine the easiness of use offered by zinc phosphate cements (they do not demand pretreatment steps) with the favorable mechanical properties, esthetics and adequate adhesion to dental structure of conventional resin cements. (1)

Pretreatment techniques for promoting bonding to zirconia-based ceramics include air-particle abrasion and tribochemical silica coating. These pretreatments are utilized before chemical bonding with a silane coupling agent, ceramic primer, self-adhesive cement or adhesive cement. If ceramic primer, self-adhesive cement or adhesive cement that contains an acidic adhesive monomer is used, air-particle abrasion is the easiest way to form a roughened surface to increase mechanical retention. (2)

This study was designed to determine the effect of surface treatments on retention of zirconium oxide crowns with two types of cements

An increasing number of all-ceramic materials and systems are currently available for clinical use. They offer preferred optical properties for highly esthetic restorations. The various all-ceramic materials have different mechanical and optical properties that affect their indications and limitations, as well as their laboratory and clinical manipulation.

Composition, properties and limitations of dental ceramics:

Dental ceramics consist of a compound of metals (Aluminum, Calcium, Lithium, Magnesium, Potassium, Sodium, Tin, Titanium and Zirconium) and Non-Metals (Silicon, Boron, Flourine and Oxygen) that may be used as a single structural component, such as when used for CAD-CAM Inlay, or as one of several layers used for the fabrication of a ceramic-based restoration.

Most of the ceramics are characterized by their refractory nature, hardness and chemical inertness. A hardness of a ceramic similar to that of enamel is desirable to minimize the wear of resulting ceramic restorations, and reduce the wear damage that can be produced on enamel by the ceramic restoration. Chemical inertness ensures that the surface of dental restorations does not release potentially harmful elements, and reduces the risk for the surface roughening and an increased susceptibility to bacterial adhesion to ensure excellent biocompatibility over time. Furthermore, ceramics demonstrate excellent insulating properties, such as low thermal conductivity, low thermal diffusivity, and low electrical conductivity. Their most attractive property is their potential for matching the appearance of natural teeth, offering great esthetic results. [(4)]Inspite of their excellent esthetic qualities and biocompatibility, dental ceramics are brittle and contain both fabrication defects and surface cracks from which fracture can initiate. Forces in the form of tension cause these cracks to open up, followed by crack propagation.[(5)]

Machinable ceramics

Manual-aided design/Manual -aided manufacturing The CELAY system produced by a manually guided copy-milling process. This method is based on the pantographic principle that was employed hundreds of years ago to copy or enlarge paintings then later for engraving. The same principle is applied at the hardware store when making duplicate keys. Using exact mechanical tactile model surveying and analogous milling, it is considered to be highly precise in transfer accuracy. First a coping or framework is manually fabricated in wax or composite, and then the pattern is placed in the pantographic machine. The copying arm of the machine traces the wax pattern while the cutting arm, which has a carbide cutter mills a selected green or pre-sintered zirconia block. The final shape is 20 – 25 % larger in order to account for shrinkage during the sintering step. Besides the lower cost factor for these types of machines, this method of milling allows the dental technician to correct any discrepancies found in the tooth preparation by compensating during the wax pattern fabrication.(6)

Computer-aided design/computer-aided manufacturing

Machinable ceramics that are available as prefabricated glass-ceramic ingots. They are cut by tools that are controlled by the computer. After the tooth is prepared, an optical impression is taken for the preparation by a special scanner. The image is then transferred to the system's software. Then the software designs the restoration and sends the data to the computer controlled milling machine that grinds the ceramic block according to the desired shape.(7)

Examples of materials available for the CAD/CAM technology:(8)

(a) Silica based ceramics
(b) Infiltration ceramics
(c) Oxide high performance ceramics

(a) Silica based ceramics

Several CAD/CAM systems offer silica based ceramic blocks for the fabrication of inlays, onlays, veneers, partial crowns and full crowns. Blanks with multicolored layers [VitablocsTriLuxe (Vita), IPS Empress CAD Multi (IvoclarVivadent)] are available in addition to the monochromatic blocks for the fabrication of posterior crowns. Lithium disilicate ceramic blocks have high stability values (360 MPa) making them suitable for fabrication of posterior crowns and 3-unit FPDs.(9)An example of a lithium disilicate ceramic block is the IPS e.max® CAD which is used frequently because of its superior esthetics, excellent color stability, and its high resistance to wear.(10)Glass ceramics are highly esthetic even without veneering, and can be etched with hydrofluoric acid for adhesive bonding.(11), (12)

(b) Infiltration ceramics

Blocks of infiltrated ceramics for CAD/CAM systems originate from the Vita In-Ceram system. They have the same composition and clinical indications of the three previously mentioned Vita In-Ceram products.(8)

(c) Oxide high performance ceramics

Blocks of aluminum oxide and zirconium oxide are currently available for the CAD/CAD technology.(8)It is considered as a high performance ceramic. It is ground then sintered at a temperature of 1520°C. It is clinically indicated in cases of crown copings in the anterior and posterior area, and 3-unit FPDs in the anterior region. Alumina Oxide (Al2O3) In-Ceram AL Block (Vita) and inCoris Al (Sirona) are examples of aluminum oxide blocks that are available in the market.(8)

<u>Zirconium oxide</u> ceramics have excellent mechanical properties. They have high flexural strength (750- >1000 MPa) when compared to other dental ceramics.[8], [10] Yttrium-oxide is added to zirconia in order to stabilize the tetragonal phase at room temperature, which as a result can prevent crack propagation in the ceramic (Transformation strengthening).[13], [14]

Zirconium oxide ceramics are indicated for the fabrication of crowns, FPDs and individual implant abutments.[8]The cores have high radiopacity which is very useful in evaluation of marginal integrity.[15]Zirconia has a color similar to teeth but if translucency is needed then other ceramic materials should be considered.[16]

Cements:

The inherent brittleness of some ceramic materials, specific treatment modalities, and certain clinical situations require resin bonding of the completed ceramic restoration to the supporting tooth structures for long-term clinical success. Multiple clinical studies document excellent long-term success of resin-bonded restorations, such as porcelain laminate veneers, ceramic inlays and onlays, resin-bonded fixed partial dentures, and all ceramic crowns. A strong, durable resin bond provides high retention, improves marginal adaptation and prevents microleakage, and increases fracture resistance of the restored tooth and the restoration. Based on the current evidence, adhesive cementation procedures are necessary to support all-ceramic materials.

Resin-based composites are the material of choice for the adhesive luting of ceramic restorations. They consist of inorganic fillers embedded in an organic matrix. They can be classified according to their initiation mode as autopolymerizing (chemically activated), photo activated, or dual-activated materials. Resin cements with reduced filler contents offer improved flow, increased surface wettability, and optimal positioning of the restoration. Highly filled resin cements may improve abrasion resistance at the marginal area, reduce polymerization shrinkage, and facilitate removal of excess cement.[3]