The effect of different surface treatments and two types of resin cement on the retention of full coverage zirconia crowns

Thesis

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا
إلا ما علمتنا إنك أنت
العليم الحكيم

صدق الله العظيم

سورة البقرة الآية: ٣٢

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Introduction

Ceramic restorations are a metal-free alternative due to their excellent esthetic and biocompatibility properties. These materials changed the design and application limits of all-ceramic restorations. [(1)] Compared to metals, dental ceramics show better biocompatibility and improved esthetics. These favorable properties are due to the capability of transmission of light through the ceramic mass. In addition, dental ceramics exhibit diminished plaque accumulation, low thermal conductivity, resistance to corrosion and color stability. On the other hand, insufficient mechanical stability and strength caused by brittleness and low tensile strength of these materials limit their range of indication.

In the 1990s, only small FPDs made of glass-infiltrated alumina porcelain were recommended for the replacement of a single missing tooth in the anterior area. Today, a few all-ceramic materials, like glass-infiltrated alumina (In Ceram Alumina, In Ceram Zirconia), glass ceramics (Empress2), or high-strength ceramics (e.g. zirconium- and high-aluminum oxide-based --ceramics), can be used for the fabrication of all-ceramic FPDs with appropriate resistance The mechanical properties of high-strength ceramics make them appropriate as potential core materials for all-ceramic restorations in high stress-bearing areas. The interest in the material zirconia is increasing because of its strength and recent improvements in CAD/CAM technologies

The rapid development of ceramic systems enabled the treatment of teeth in both the anterior and posterior areas, with the primary objectives of properly restoring form, function and esthetic excellence without the presence of metal.

Among the dental ceramics, both lithium disilicate and zirconium dioxide have emerged as versatile and promising materials because of their biological, mechanical and optical properties, which has certainly accelerated their routine use in Computer aided design/ Computer aided manufacturing (CAD/CAM) technology for different types of prosthetic treatment.

CAD/CAM systems have dramatically enhanced dentistry by providing high-quality restorations. The evolution of current systems and the introduction of new systems demonstrate expanded capabilities, improved quality, and wide range in complexity and application. New materials utilized by this technology also are more esthetic, wear more like enamel, and are strong enough for full crowns and bridges. (2)

Research and development appears to be heading in the directions of improving the strength and esthetics of bilayered restorations and achieving full contour restorations without veneering.Theses are called monolithic restorations which are crowns made of the same ceramic material throughout. (3) This can be achieved utilizing materials such as lithium disilicate glass ceramic and zirconium dioxide.

Kelly in 2008 (4) proposed two concepts to help in simplifying the understanding of dental ceramics. First, ceramics fall into three main composition categories: Predominantly glass, particle –filled glass and polycrystalline. Second, ceramics can be considered as a composite material, in which the matrix is a glass that is lightly or heavily filled with crystalline or glass particles. Predominantly glass: have a high content of glass making this type of dental ceramic highly esthetic. This type is the best in mimicking the optical properties of enamel and dentin. Optical effects are controlled by manufactures by adding small amount of filler particles. Another type is particle-filled glass: Filler particles are added to the glass matrix to improve the mechanical properties. Fillers can be crystalline particles of high-melting glasses. Also there is polycrystalline: This type of ceramic contains no glass. Atoms are packed into regular crystalline arrangement making it tougher and less susceptible to crack propagation.

However, high durability of dental restoration is not only the result of mechanical properties but also Retention plays a significant role in the longevity and long-term success of ceramic restorations. [(5)] A high degree of variation in retention is observed for different ceramic systems. Some of the most important factors to be considered are the size of the teeth, magnitude of dislodging forces, geometry of tooth preparation, the material used, roughness of fitting surface, cement to be used and the film thickness of luting agent [(5)]

Review of Literature

I. Dental Ceramics:

Ceramics are not considered new materials as they were in use more than 10,000 years ago during the Stone Age. [1] They play an integral role in dentistry. Their use in dentistry dates as far back as 1889 when **Land** patented the all-porcelain "jacket" crown. This new type of ceramic crown was introduced in 1900s. The procedure consisted of rebuilding the missing tooth with porcelain covering, or "jacket" as Land called it. The restoration was extensively used after improvements were made by **Spaulding** and publicized by **Capon**. While not known for its strength due to internal microcracking, the porcelain "jacket" crown (PJC) was used extensively until the 1950s. [6]

A resurgence of an all-ceramic restoration came in 1965 with the addition of industrial aluminous porcelain (more than 50%) to feldspathic porcelain manufacturing. **McLean and Hughes** developed this new version of the porcelain jacket crown that had an inner core of aluminous porcelain containing 40% to 50% alumina crystals. [7] Although it had twice the strength of the traditional PJC, it still could be used in the anterior region only (due to its low strength). Its higher opacity was also a major drawback.[8]

Another development in the 1950s by **Corning Glass Works** led to the creation of the castableDicor® crown system. Glass was strengthened with various forms of mica. The process involved the use of the lost-wax casting technique, which produced a casted glass restoration. Then, this was heat-treated "cerammed". The ceramming process provided a controlled crystallization of the glass that resulted in the formation and even distribution of small crystals. Examples of different crystalline formations are leucite, fluoromica glass, lithium disilicate, and apatite glass ceramics.[9] The crystal formation increased the strength and toughness of the glass ceramic. The processing difficulties and high incidence of fracture were factors that led to the abandonment of this system.[6]

During this time, a glass-infiltrated ceramic core system was developed. This glass-infused alumina core had a flexural strength of 352MPa.[10] To increase the translucency and esthetics, Vita replaced the sintered alumina with spinel (MgAl2O4).Vita also added another variation of the infused core by mixing alumina with zirconium oxide crystals, which increased the flexural strength to 700 MPa. It was intended for posterior crowns and bridges.

In the mid-1990s Nobel Biocare introduced the Procera® AllCeram core, which was the first computer-aided design/computer-aided manufactured (CAD/CAM) substructure. This core consisted of 99.9% alumina to which a feldspathic ceramic was layered.

Parallel to the introduction of infiltrated ceramics, two glass-ceramic compositions were introduced: leucite based (IPS-Empress, IvoclarVivadent, Liechtenstein) and lithium disilicate based (IPS-Empress II, IvoclarVivadent, Liechtenstein). Leucite was first added to feldspathic porcelains to raise the coefficient of thermal expansion to match the metals to which they were fired.

The crystalline leucite phases also helped feldspathic porcelain to slow crack propagation. High leucite-containing ceramics Empress® I and optimal pressable glass (OPC) were introduced in the late 1980s and were the first pressable ceramic materials. Although the initial steps for fabrication for Empress and OPC were similar to Dicor and Cerestore in which the restoration was formed in wax, a heated leuci0te-reinforced ceramic ingot was pressed into the mold using a specially designed pressing furnace, whereas the Dicor crown was created using centrifugal casting.

This process of pressing ceramic ingots became very popular due to the esthetics and ease of use in the laboratory. Despite the increase in strength of leucite-reinforced pressed Empress material, fracture was still possible when used in the posterior region. [(7)]

In 1998 Ivoclar introduced IPS Empress II, which was a lithium disilicate ceramic material (2SiO2-Li2O), used as a single- and multiple-unit framework indicated for the anterior region. The frame-work was layered with a veneering ceramic specially designed for the lithium disilicate. A 5-year study revealed a 70% success rate when used as a fixed partial denture framework. [(11)]

Lithium disilicate re-emerged in 2006 as a pressable ingot which can be processed using the lost-wax hot pressing techniques (IPS e. max press) and partially crystalized milling block (IPS e. max CAD) for computer aided design/computer-aided manufacturing (CAD/CAM) milling procedure. The IPS e. max glass ceramic has a flexural strength of 360-500 MPa, which is more than twice that of other glass ceramic monolithic materials. [(12)]