THE EFFECT OF DIFFERENT VENEERING TECHNIQUES ON SHEAR BOND STRENGTH OF VENEERED YTTRIUM ZIRCONIA RESTORATIONS

Thesis

Submitted for Partial Fulfillment of Master Degree Requirement in Fixed Prosthodontics, Faculty of Dentistry, Ain Shams University.

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2010

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2010

بسم الله الرحمن الرحيم

وَأَنْزَلَ اللَّهُ
عَلَيْكَ الْكِتَابَ
والْحِكْمَةَ
وَعَلَّمَكَ مَا لَمْ
تَكُنْ تَعْلَمُ
وَكَانَ فَضْلُ
اللَّهِ عَلَيْكَ
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صدق الله العظيم

سورة النساء آية
(١١٣)

Acknowledgment

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

First of all, I would like to express my most sincere gratitude and deep appreciation to **Dr. Amina Hamdy,** Associate Professor of Fixed Prosthodontics, Head of the Fixed Prosthodontics Department, Faculty of Dentistry, Ain Shams University. It was a great honor to work under her meticulous supervision and her valuable guidance.

My deepest thanks and appreciation are also due to **Dr. Tarek Salah,** Assistant Professor of Fixed Prosthodontics, Faculty of Dentistry, Ain Shams University for his remarkable help, valuable advice, constant support and encouragement, and for providing me with unlimited time and cooperation throughout the course of this research.

I would like also to thank **Dr. Marwa Wahsh,** Lecturer of Fixed Prosthodontics, Faculty of Dentistry, Ain Shams University,and my collegue, **Dr. Ghada Abdel Fattah** for their unforgettable help and support.

Thanks also are due to **Dr. Hesham Rashed and his Dental lab,** for their help in making my work accurate.

Many thanks would go to **Mr. Mohammed El-Shahat,** metal worker, who without his effort the tools used in this study would never have been done so well.

Last but not least, I would like to thank all **Staff Members** of Fixed Prosthodontics Department, Misr International University, my Professors and my collegues, and particularly **T.A. Yara Mahmoud**, for their constant support and cooperation.

Dedicated To………..

I would like to dedicate this work to

Those who gave me so much care and support

My dear mother and father

My beloved sister and brothers

All my Family

And all my friends

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INTRODUCTION

All ceramic systems have become increasingly popular due to their esthetic and biocompatible properties[1]. They are, however, subject to brittle failure. Various ways have been suggested to improve their resistance to brittle fracture including the fusion to metal and the selection of reinforced ceramic cores combined with esthetic veneer material[2].

Core veneered all-ceramic restorations are possible substitutes for the strong but less esthetic metal core sub-structures. Combining the strength of ceramic cores and superior esthetics of a weaker veneer ceramic can result in a reliable and more biocompatible restoration[3]. The introduction of zirconium dioxide or zirconia opened the door for designing fixed all-ceramic partial dentures without any limitation regarding the size of the fixed partial denture [4]. Its unique qualities, strength, transformation toughening, white color, chemical and structural stability made zirconia the core material of choice[5].

The most recent core materials for all ceramic restorations are the newly developed yttria-stabilized zirconia ceramic containing approximately 95% zirconium oxide (ZrO_2) and 5% yttrium oxide (Y_2O_3) that are industrially manufactured into blanks and milled to the desired dimensions using the Computer Aided Design / Computer Aided Manufacture (CAD/CAM) technology. Cores made in this way are stable, have a high crystalline content and have flexural strength of 900–1200 MPa[6].

Current processing technologies however cannot make zirconia frameworks as translucent as natural teeth. In order to achieve acceptable esthetics, the zirconia frameworks has to be veneered with weaker veneering porcelain. This veneer material is fused onto the ceramic core by sintering, thus producing a three layer system of core-dentin-enamel.

On the other hand, preparing a workable ceramic slurry for manual layering technique is operator-dependent, and variations in the powder: liquid ratio and mixing technique are known to affect the density, the strength, the percentage of structural defects, and the number and size of air bubbles in the fired veneer [(7)]. These structural defects act as stress concentration sites where crack initiation and propagation are highly expected, leaving the veneered restoration susceptible to de-lamination or chipping[(8)].

A new category of veneering ceramics makes use of the lost-wax technique where the required shape and form of the veneer ceramic is built using wax modulation over the zirconia framework and processed by pressing the heated ceramic veneer in a low viscosity state over the zirconia framework. With this technique, the complex anatomical forms of dental restorations, which are difficult to control using manual layering technique, are easily achieved. In addition, the zirconia framework is subjected only to one controlled firing cycle, reducing the possibility of thermal fatigue. Furthermore, the press-on technique is performed under controlled temperature, pressure, and vacuum, all of which result in less incorporation of structural defects in the veneer ceramic[(9)].

As a press-on veneer has a monochromatic color, this technique was basically designed for posterior restorations. To overcome this limitation, the double veneering technique could be used.

Therefore, the combination of the press-on and the layering veneering ceramics in one restoration may provide both superior bond and interface quality with improved esthetics and thus enhance the overall performance of the restoration [(10)].

The core-veneer bond strength was proven to be sensitive to certain pretreatments of the core like using a liner material before the veneering procedure. The liner is mainly used to modify the color of the core. Omitting this liner didn't weaken zirconia– veneer bond strength but it may influence the type of failure of the restoration to an increased chance of interfacial failure [(8)].

Thus the aim of this research is to investigate the bond strength between zirconia substructure material and a variety of veneering ceramic materials using different veneering techniques, in the presence or absence of a liner material.

REVIEW OF LITERATURE

For a long period of time, the porcelain–fused-to-metal technique has proven to be a reliable treatment option for Fixed Partial Dentures (FPD) due to its high predictable strength and the reasonable esthetics of ceramics [(11)].

However, the disadvantage of such restorations is its artificial appearance due to the increased light reflectivity caused by the opaque porcelain needed to mask the metal substrate [(12)] and the greying effect of the metal at the gingival margin [(13)].

The increasing demand for superior esthetics in addition to the increasing public awareness of the adverse side effects of some dental metals and alloys have accelerated the development of alternatives to metallic dental restorations [(14)].

Numerous attempts have been made to develop all-ceramic systems that eliminate metal infrastructures providing optimal distribution of reflected light [(15)].

Dental ceramic materials are known to possess some extremely desirable properties, including biocompatibility, pleasant appearance wear resistance, a coefficient of thermal expansion similar to that of enamel,low thermal conductivity, radioopacity and diminished plaque accumulation [(16)].

Disadvantages of all-ceramic restorations include less than ideal marginal adaptation, excessive wear of the opposing dentition, aggressive preparation design, technique sensitivity and most important of all is its low tensile strength. Being brittle in nature in addition to their sensitivity to flaws and defects, limited their use to low-stress situations as anterior teeth[17].

The ability of all-ceramic restorations to withstand occlusal forces is compromised by the presence of two types of inherent flaws [18]; First, fabrication defects (internal voids, porosities, or microstructural features that arise during processing) and second, surface cracks (defects on the surface as a result of machining and grinding process) [19].

Failure begins with microscopic damage resulting from the interaction of pre-existing defects with applied loads [18], or may also occur because of subcritical crack growth which is enhanced in aqueous environment [20].

Therefore, the mechanical properties of ceramics has to meet the requirements needed to withstand the stresses and strains that can arise in high stress bearing areas [11]. However, an increase in the crystalline content of the ceramic material to achieve greater strength generally results in greater opacity [21].

To overcome this problem, most of all-ceramic systems require the combination of two layers of ceramic material, such as a strong ceramic core and a weak veneering porcelain with better optical properties [22].

High Strength All-Ceramic Systems:

In 1965, Mclean and Hughes [(23)], developed a porcelain jacket crown with an inner core of aluminous porcelain containing 40% to 50% alumina crystals to block the propagation of cracks. The reinforcing inner core is layered with conventional porcelain, resulting in a restoration that is approximately twice as strong as the traditional porcelain jacket crown. Since that time, different materials and processing techniques were introduced in order to improve both the physical and the mechanical properties of all-ceramic restorations [(24)]. High strength ceramic core materials can be classified into three major groups:

Glass-infilterated ceramics

Pressable ceramics

Machinable ceramics.

Glass Infiltrated Ceramics

These products consist of infiltrating molten glass to partially sintered oxides. The main representatives of this category are In-Ceram Alumina, In-Ceram Spinell and In-Ceram Zirconia

In-Ceram Alumina*

In-ceram Alumina system, was introduced by Sadoun in 1989 [(25)], based on slip-casting of an alumina slurry that results in a porous partially sintered alumina structure. Low viscosity glass is

* *Vita, D-Bad Säckingen*

then infilterated through the porous network, which is then veneered with amourphous feldspathic glass. The strength of this material has been reported to be ranging between 236 and 600 MPa which exceeds the maximal occlusal loads recorded intra-orally on anterior teeth.

It is recommended for anterior and posterior crowns, as well as for 3-unit anterior fixed partial dentures (FPD).Because of its semiopaque core, the ceramic does not allow full transmission of light so providing limited esthetic results [26].

In-Ceram Spinell*

The In-Ceram Spinell consists of $MgAl_2O_4$ core infiltrated with glass. The fabrication procedures are the same as those for In-Ceram Alumina. Its flexural strength is lower than that of In Ceram Alumina ranging between 283 and 377 MPa [27], but its translucency is twice as high, therefore, it is indicated for anterior crowns where esthetic demands are higher [15].

In-Ceram Zirconia*

The In-Ceram Zirconia core consists of glass-infiltrated alumina with 35% partially stabilized zirconia. Its flexural strength ranges from 421 to 800 MPa[13]. The high opacity of its core restricts its application only for the fabrication of posterior FPD's, resulting in successful short-term data [28].

* *Vita, D-Bad Säckingen*

Pressable Ceramics

The pressable ceramics (Heat pressed ceramics) are increasing in popularity in dentistry. It relies on the application of external pressure to sinter and shape the ceramic at high temperature.It's also called "High temperature injection molding" [29].

The **IPS Empress*** (heat pressing ceramics) consists of leucite crystals (40%) that are homogenously distributed in a glass matrix. These restorations are highly translucent providing the potential for a highly esthetic restoration. The main disadvantage of IPS Empress is its relative low flexural strength (ranges from 105 - 120 MPa) as compared to other all ceramic restorations [29]. Because of their high translucency, they aren't recommended for cases where the underlying abutment is a discolored tooth, a metallic core build up, or a metal implant abutment [11]. Their indication is restricted only for veneers or crowns at the front region giving survival rates up to 95% after 11 years of clinical service [15].

IPS Empress 2* differs from the early Empress system in that its increased strength is related to the presence of lithium disilicate crystals (SiO_2-LiO_2) and thus has sufficient flexural strength (350 MPa) that permits its use as anterior FPD [30].

IPS Empress 2 is veneered with glass-ceramic containing microcrystals of fluoroappatite [30].

* *Ivoclar Vivadent, Schaan, Leichtenstein*

In 2005, another pressable ceramic system, **IPS e.max Press*,** was introduced. It is a lithium disilicate glass ceramic for the press technology.

The microstructure of **IPS e.max Press** contains lithium disilicate crystals (approximately 70%), which measure between 3 and 6 μm in length. The pressed, tooth-colored and highly esthetic frameworks are then veneered using **IPS e.max ceram*** which is a nano-fluoroappatite layering ceramic [(31)]. The lithium disilicate framework and nano –fluoroappatite veneering permit the fabrication of all-ceramic restorations that are similar to natural teeth [(31)].

Machinable Ceramics

This category contains materials with densely packed particles. They cannot be processed into shapes without the use of CAD/CAM technology.

The term CAD/CAM, designates the three-dimensional planning of a workpiece on the screen of a computer with subsequent automated production by a computer controlled machine tool[(4)]. In 1971, **Francois Duret** [(32)], introduced CAD-CAM technology to the field of dentistry. His idea was based upon the assumption that the technologies established in industry could be easily transferred to dentistry.

* *Ivoclar Vivadent, Schaan, Leichtenstein*