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Marginal integrity of cemented Cerasmart laminate veneers after exposure to commonly consumed beverages (An In-vitro study)

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Abstract :

Aim : This study was designed to evalute the marginal integrity of bonded cerasmart laminate veneers after exposure to commonly consumed beverages(saliva ,coffee, and orange juice) for 24 days.

Materials and Methods :

A total of thirty nine freshly extracted human upper anterior teeth (centrals) were collected. Teeth were mounted in epoxy resin blocks using a custom-made cylindrical holder. The teeth were prepared with butt-joint veneer preparation design. A CAD/CAM system (Cerec premium 4.4 software) was used for the fabrication of all veneers . All samples (39 samples) were divided into to three test groups according to storage media for 24 hours as follows: Group A):(13 Samples) stored in artificial saliva . Group (B): (13 samples) stored in coffee . Group (c): (13samples) stored in carbonated orange juice for . Each sample was photographed using USB Digital microscope with a built-in camera using a fixed magnification of 45X. A digital image analysis system was used to measure and qualitatively evaluate the gap width. Measurements were reported before bonding and immersion, after bonding and before immersion and after bonding and immersion.

Results : The lowest marginal gap mean value recorded *after bonding* stage and this was statistically significant as indicated by two-way ANOVA test ($P=<0.0001<0.05$). the highest mean marginal gap values were recorded with *saliva bonded and immersed group* and this was statistically non-significant as indicated by two-way

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ANOVA test (P=0.3020 > 0.05).The highest mean marginal gap values were recorded with ***saliva bonded and immersed group*** followed by ***coffee bonded and immersed group*** while the lowest marginal gap mean value recorded with ***orange bonded and immersed group*** and this was statistically non-significant as indicated by two-way ANOVA test (P=0.3020 > 0.05).

Conclusion :

CERASMART is a promising material in terms of vertical marginal gap in the esthetic region. Marginal integrity of CERASMART veneers was not affected by coffee and carbonated orange juice which have various pH media.

Key words: Marginal integrity, Marginal gap, Hybrid ceramics, Acidic media,Cerasmart.

Introduction

Conservative and Aesthetic dentistry have become a huge dilemma nowadays. Pain related treatments used to be the most common cause that drives a patient to seek dental treatment, but recently patients became more aware of esthetic dentistry, and more cautious in their requisite to be treated conservatively.[1] Porcelain laminate veneers bonded to enamel applied the rules of conservative dentistry. They were first described in the early 1980s and since then advances in ceramic materials and adhesive technology have enabled the porcelain laminate veneers to evolve into the treatment of choice for minimally invasive aesthetic dentistry[2]. Definition of marginal fit could be explained as the absolute marginal discrepancy, calculated from over and under-extending restoration margins, by way of vertical and horizontal discrepancy, seating discrepancy, and misfit measured at points between restoration surface and the tooth [3]. Established dental literature supports clinically acceptable marginal integrity from 40 to 120 μm[5] with 120 μm considered the "maximum, tolerable marginal opening" for tooth restorations.[4]

As chair-side computer-aided design and computer-aided manufacturing (CAD/CAM) technology gains an increasing foothold in dentistry, milled restorative materials are being increasingly developed and marketed. The variety of available CAD/CAM restorative materials consists mostly of different composite resins and ceramics including Vita Enamic, Lava Ultimate and the material of choice in the current study CERASMART which is a nanoparticle-filled resin.[5]

CERASMART combines the properties of a high strength ceramic and composite with a flexible nano-ceramic matrix structure. This product as claimed by the manufacturer provides optimum physical properties and impact dispersion due to the fully homogeneous and evenly distributed nano-ceramic network in addition to the highest degree of flexibility and strength.[6]

CERASMART is claimed to be used for posterior, anterior, inlay, onlay, laminate veneers ,and single crowns . However, little is known about the effect of different pH media on the marginal integrity of CERASMART hybrid ceramics.[6]

Therefore, It was found worth to spot light the effect of various pH media on the marginal fit of CERASMART veneers.

Methodology:

A total of thirty nine freshly extracted human upper anterior teeth (centrals) were collected. Teeth were mounted in epoxy resin blocks using a custom-made cylindrical holder. A specially designed centralizing device was fabricated to allow accurate vertical centralization of the tooth in the sample holder during construction of epoxy resin blocks.The inner walls of the sample holder were painted with separating medium.

Teeth preparation:

Teeth were prepared for laminate veneer with a butt-joint design. Preparations had a 1.2

mm incisal reduction without palatal chamfer . The labial reduction was 0.5 mm at the cervical third and 0.7mm at the middle and incisal thirds to ensure the whole preparation remained within the enamel. The reduction was carried out at two different planes following the contour of the labial surface. The cervical margin of the preparation was ended by a 0.5 mm chamfer finish line.

All sharp line angles that might serve as a focal point for stress concentration were rounded using tapered round end diamond stone.

CEREC CAD/CAM laminate veneers construction:

A CAD/CAM system (Cerec premium 4.4 software) was used for the fabrication of all samples.Scanning was done to obtain a three-dimensional image on the computer screen of the Cerec software system. Scanning is done using the CEREC Omnicam.

Milling was done with CEREC (MC XL) milling machine. To start the milling procedure, the CERASMART block as well as the size were selected and placed in the spindle of the milling chamber and fastened with the set screw.

The veneers were trial fit to the preparation then the veneers were finished using GC Ultimate finishing and polishing kit with low handpiece.

Bonding procedure of veneers:

The internal fitting surfaces were treated by 5% Hydrofluoric acid for 60 seconds then washed under running water, air dried then saline coupling agent was scrubbed on the fitting surface gently and air thinned for 1 min.

35% phosphoric acid was applied for 15 seconds for enamel then rinsed under running water. Gentle air dryness was performed on the etched tooth surfaces to avoid over dryness of any exposed areas of dentin. Finally, the enamel appeared frosty. The prepared teeth were coated with 2 consecutive coats of the single bond adhesiveusing a microbrush .Then 1 coat of adhesive was applied to bonding surface of the veneer,. Then, air dried gently for 5 seconds. The veneers were bonded in place with translucent shade of light cured Rely XTM veneer luting resin cement . The Rely XTM veneer resin cement was applied to the fitting surface of the veneer. Each laminate was seated on its respective tooth with finger pressure, and excess cement was carefully removed from the margins, using blunt instrument after 10 seconds of preliminary light polymerization, and the veneers were then completely light polymerized with an energy density of 480mW/cm2for all aspects of the tooth for 30 seconds each. Cement curing depth for the translucent shade was not less than 1.5 mm according to the curing recommendations.

Thermocycling:

The mean low-temperature point was 6.60C (range 0–360C, median 5.00C). The mean high-temperature point was 55.50C (range 40– 100 0C, median 550C). The majority of reports quoted used just hot and cold temperature points. The number of cycles used varied from 1 to 1 000 000 cycles, with a mean of about 10 000 and median of 500 cycles.

Groups allocation :

After the samples were numbered from 1 to 39 in an ascending order and randomly divided into 3 equal groups (n=13):

Group 1(control group): samples immersed in artificial saliva for 24 days.

- Group 2: samples immersed in coffee for 24 days.
- Group 3: samples immersed in carbonated orange juice for 24 days.

Each group was placed in a tightly sealed container, for storage in the immersion solutions.

Vertical marginal gap distance measurement :

Each specimen was photographed using USB Digital microscope with a built-in camera connected with an IBM compatible personal computer using a fixed magnification of 45X.

A digital image analysis system (Image J 1.43U, National Institute of Health, USA) was used to measure and qualitatively evaluate the gap width. The samples were held in place over their corresponding dies using a specially designed and fabricated holding device .Shots of the margins were taken for each specimen. Then morphometric measurements were done for each shot 5 equidistant landmarks along the cervical circumference for each surface of the specimen (Mesial, buccal, distal, and incisal). Measurement at each point was repeated five times. Then the data obtained were collected, tabulated and then subjected to statistical analysis.

Results

Data was analyzed using IBM SPSS advanced statistics (Statistical Package for Social Sciences), version 21 (SPSS Inc., Chicago, IL). Numerical data was described as mean and standard deviation or median and range. Data was explored for normality using Kolmogrov-Smirnov test and Shapiro-Wilk test.[7]

after immersion in different storage media; it was found that the highest mean marginal gap values were recorded with *saliva immersed group* followed by *coffee immersed group* while the lowest mean marginal gap values were recorded with *orange immersed group* and this was statistically significant as indicated by one-way ANOVA test (P=<0.0001< 0.05). Tukey's pair-wise post-hoc showed non-significant (p>0.05) difference between *coffee* and *orange immersed groups* .

Saliva vs. measurement stages; it was found that the highest mean marginal gap values were recorded *before cementation* stage followed by *immersion in storage media* stage while the lowest mean marginal gap values were recorded *after cementation* stage and this was statistically significant as indicated by one-way ANOVA test (P=<0.0001< 0.05).

Coffee vs. measurement stages; it was found that the highest mean marginal gap values were recorded *before cementation* stage followed by *immersion in storage media* stage while the lowest mean marginal gap values were recorded *after cementation* stage and this was statistically significant as indicated by one-way ANOVA test (P=<0.0001< 0.05).

Orange vs. measurement stages; it was found that the highest mean marginal gap values were recorded *before cementation* stage followed by *immersion in storage media* stage while the lowest mean marginal gap values were recorded *after cementation* stage and this was statistically significant as indicated by one-way ANOVA test (P=<0.0001< 0.05).

Total effect of measurement stages,

Irrespective of immersion media type totally it was found that the highest mean marginal gap values were recorded *before cementation* stage followed by *immersion in storage media* stage while the lowest mean marginal gap values were recorded *after cementation* stage and this was statistically significant as indicated by two-way ANOVA test (P=<0.0001< 0.05) as shown in table (1) and figures (1,2)

Total effect of storage media,

Irrespective of measurement stages totally it was found that the highest mean marginal gap values were recorded with *saliva immersed group* followed by *coffee immersed group* while the lowest marginal gap mean value recorded with *orange immersed group*and this was statistically non-significant as indicated by two-way ANOVA test (P=0.3020 > 0.05) as shown in table (6) , figures (1 ,2).

Table (1) Descriptive statistics of marginal gap results (Mean values± SDs) before and after cementation and after immersion in different storage media.

Variables	Restoration	Mean± SD	Min.	Max.	95% CI		Statistics
					Low	High	P value
Before bonding	Saliva	41.8±12.1	19.4	65.6	35.1	48.5	0.2625 ns
	Coffee	46.6±14.2	17.3	71.9	38.3	54.9	
	Orange	38.7±11.1	16.7	60.2	32.4	44.9	
After bonding	Saliva	17.6±2.1	11.6	26.9	16.2	19.1	0.004 *
	Coffee	17.9±1.9	12.1	22.8	16.7	19.2	
	Orange	21.03±3.5	12.5	28.3	49.02	23.04	
After bonding	Saliva	34.9±4.6	24.9	45.4	32.2	37.5	<0.0001*
	Coffee	27.0±3.7	18.6	37.8	24.7	29.2	
	Orange	25.9±3.8	19.8	39.3	23.6	28.2	

; significant ($p<0.05$) ns; non-significant ($p>0.05$)

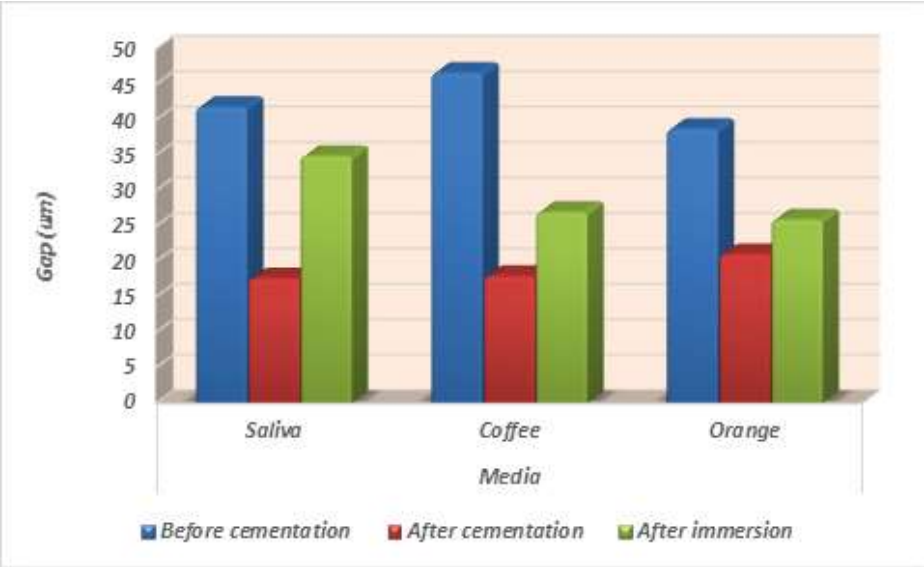

Figure (1) Column chart showing marginal gap mean values for both groups before and after cementation and after immersion in different storage media

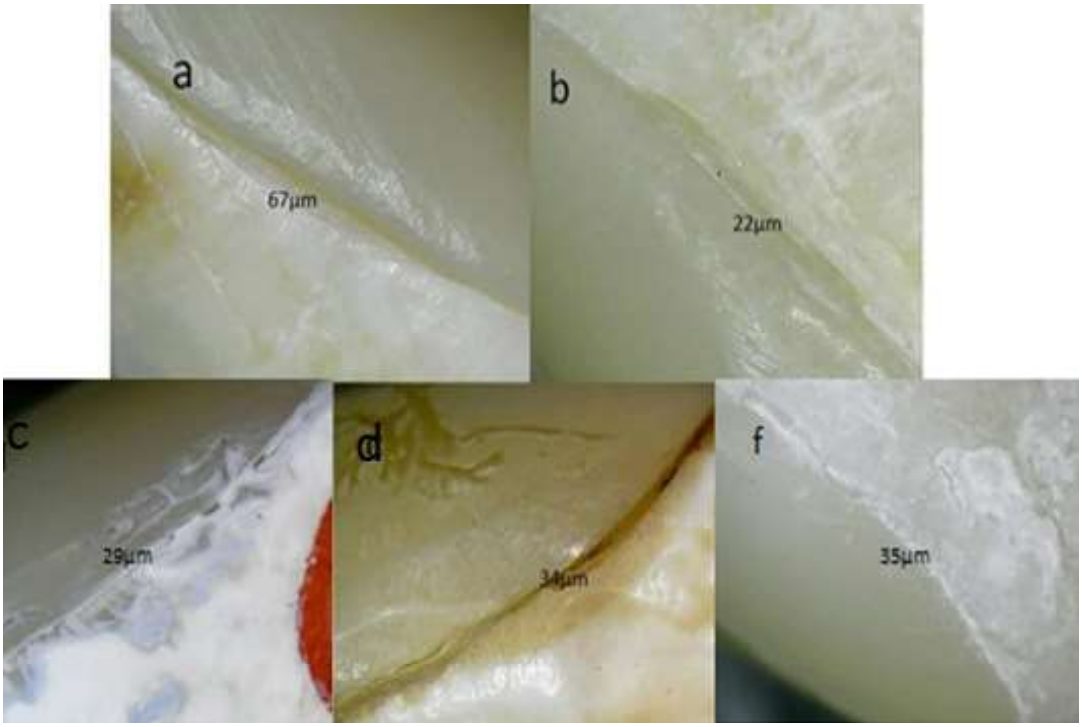

Figure (2):Images showing changes in margin during measurement stages;(a)before bonding and immersion (b)after bonding before immersion (c)after bonding and immersion in coffee (d)after bonding and immersion in carbonated orange juice(f)after bonding and immersion in saliva .

Discussion:

The practice of fixed prosthodontics has changed dramatically since the introduction of dental ceramics. Because this change was mainly due to the esthetic advantage of dental ceramics over its counterparts of metallic and metal-ceramic restorations.[8]

Comparing the brittle and rigid structures of ceramics with composite restorations is essential to clarify the point of weakness of each type and to choose the best type of restoration for each individual.

Unfortunately the presence of several reported failures of all-ceramic restorations (such as porcelain chipping or even total failure) directed dental companies to develop new biomaterials mimicking the physical properties of natural tooth as much as possible.

Laminate veneers now became the restoration of choice because of their esthetic appeal, biocompatibility and adherence to the physiology of minimal-invasive dentistry. Porcelain or composite laminate veneers used to correct tooth forms, tooth position, close diastemas, restore tooth fracture, erosions or mask tooth discolorations. These restorations provide a valid conservative alternative to complete coverage as they avoid aggressive dental preparation; thus, maintaining tooth structure.[9]

Ceramics and resin-based composites are the two main classes of dental restorative materials. Resin-based composites are composed of an organic polymer matrix and reinforcing inorganic filler particles. Dental ceramics are essentially inorganic materials commonly composed of a crystalline phase and/or glass matrix.[10]

Although ceramic blocks have good mechanical properties in terms of strength and stiffness, excellent esthetics and biocompatibility, they are brittle, have low fracture toughness and are difficult to machine. Moreover, restorations may cause wear of the opposing natural teeth. [11]

On the contrary, resin composite blocks have a low brittleness index; thus better machinability and the fabricated restorations cause lower wear to opposing teeth. Composites have the advantage of having material characteristics similar to those of natural tooth substance, such as the dentine-like modulus of elasticity, together with a very high filler content and low shrinkage. The use of composite blocks makes it possible to mill even thinly tapering edges precisely and without the risk of chipping or breakages. This means high edge strenghth and precision-fit restorations, yet another advantage is that there is no need for the firing process required when using ceramics.[18]

CERASMART material is one of the most recently introduced materials. CERASMART blocks, which is a flexible nanoceramic matrix structure claimed to be used for anterior, posterior, inlay, onlay and laminate veneers. CERASMART material claimed to have unsurpassed physical properties and impact dispersion due to the fully homogenous and evenly distributed nanoceramic network. It is composed of composite resin material (BisMEPP,UDMA,DMA) with 64.1wt% silica(20nm) and barium glass(300 nm) nanoparticels56 with a modulus of elasticity of 8.3 GPa , flexural strength of 216.5 ±28.3 MPa, Vickers hardness of 0.66 ±0.02 GPa fracture toughness of 1.2 ±0.17 MPa.m1/2. [18]according to these mechanical properties it was found that the material can be milled to thin layers; the produced crowns had a thickness ranging from 0.5 to 1.5 mm. but are still strong enough to prevent cracks which are stopped by the nanoparticles within the resin network[19]. Patients suffering from loss of tooth structure (dental erosion, amelogenesi-simperfecta) or even young patients could benefit from minimally-invasive restorations.[12]

In the current study CERASMART CAD/CAM blocks were milled into laminate veneers by CEREC milling machine under copious water irrigation which provided better standardization of the samples within the needed thickness and dimensions.[13]

The digital microscope was the selected method for measuring the marginal accuracy, as it allowed long-term study without sacrificing the samples.Measurements carried out by using digital microscope and with no cementation first to eliminate the factor of overlapping some of the margins with excess cement. The results in this study showed that the marginal gap before bonding was much greater that the marginal gap after bonding as This big difference because RelyXTM Veneer resin cement filled the spaces and reduced the gap. The results of the study also, showed that the CERASMART veneers reported acceptable marginal integrity, despite of thermocycling and immersion in different acidic solutions simulated the complex environment of the oral cavity. The results in this study was in agreement with a study done by gungor et al .[14] in 2018 who reported that CERASMART and other hybrid ceramic restorations showed low marginal and internal discrepancies which were considered clinically acceptable. These findings was disagreed by Celik and Gemaalmaz in 2002 who reported that indirect composite laminate veneers do not have perfect marginal integrity due to polymerization shrinkage and viscosity of the material .[15]

It was found that after bonding and immersion, the highest mean mean marginal gap values were recorded with *saliva immersed group* followed by *coffee immersed group* while the lowest marginal gap mean value recorded with *orange immersed group* and this was statistically non-significant . Acidic beverages did not cause more marginal discrepancies than that caused by saliva . this finding was in agreement with a study done by Hamza et al 16 who found that there was no statistically

significant difference in mean marginal gap values between distance of non-aged and aged in low pH saliva specimens of Lava™ Ultimate veneers .

This may be disagreed by magnur et al [17] who claimed that low pH soft drink caused highly significant microleakage at the tooth and composite material interface.

Conclusion:

Within the limitations of the present study it was concluded that:

1-CERASMART is a promising material to be used for laminate veneers in terms vertical marginal gap in the esthetic region.

2-Marginal integrity of CERASMART veneers was not affected by coffee and carbonated orange juice which have various pH media.

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