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Evaluation of Bond Strength of Two types of Resins with Different Viscositiest to Lithium Disilicate Glass Ceramic after Two Types of Surface Treatments. (In vitro study)

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Abstract

Purpose: To evaluate microtensile bond strength (µTBS) of two types of resin with different viscosities: High viscosity resin (Flowable composite) and Low viscosity resin (Light cured resin cement) With lithium disilicate discs after two types of surface treatment: Laser etching (Er,Cr:YSGG pulsed laser), hydrofluoric acid etching

Materials and Methods: Ceramic slices (n=28) were prepared from IPS Emax CAD/CAM blocks, two surface treatments were applied followed by silane primer: Er,Cr:YSGG laser (group A) and hydrofluoric acid (group B). Two self-adhesive resin cements were injected to the emax specimens using ethelyne tube: flowable composite Z350 (High viscosity resin) sub group (I), mojo veneers resin cement (low viscosity resin) (subgroup II). Thermo-cycling using THE-1100 SD Mechatronics thermo-cycler was done to simulate the oral cavity media,each bonded micro-cylinder assembly resin was subjected to microtensile bond strength. Data was tabulated and statistically analyzed.

Results: HF acid etching & silanation as Surface treatment had a significantly higher (mean±SD) value than Laser surface etching followed by silanation with both high and low viscosities resin. High viscosity resin (flowable composite) should higher bond strength than low viscosity resin (light cure resin cement) but it was statistically insignificant.

Conclusions: Acid etching followed by silanation had a significantly higher value than laser etching followed by silanation for both resin viscocities.

Resin with high viscosity had a higher value of micro-shear bond strength than resin with low viscosity yet the difference was not significant.

Keywords: Ceramic- Er,Cr:YSGG laser- Resin cements- Microtensile Bond Strength.

Introduction

Hot-pressed LDC consisting of a silica glass matrix and lithium oxide (Li2O) not only provides better translucency and aesthetics than zirconia ceramic but also has better flexural strength than leucite-reinforced glass ceramics [1,2].

Clinical restoration mainly depends on the bonding effect between the ceramic and resin cement rather than the strength of the ceramic [3,4] .

Strong interfacial bonding between the ceramic and resin cement increases the fracture resistance[5] and marginal adaptation[6,7] and reduces the microleakage [7,8], resulting in the retention of the restoration.

Surface modification to increase the roughness or to form specific chemical bonds is of great importance for increasing interfacial bonding.

However, due to the relatively low strength, LDC usually suffers from serious surface damage introduced by traditional sandblasting abrasion, leading to a decrease in flexural strength [9,10].

Hydrofluoric acid (HF) treatment is considered as a relatively mild method to chemically modify LDC [11,12]. HF can etch the surface to create an irregular microstructure on the surface [13], resulting in a high specific surface area that increases the bonding area at the interface [14,15] .,

Lasers have been introduced during the last decade as an alternative to traditional methods for ceramic surface treatment. Numerous works have investigated the effects of CO2 lasers in continuous or long pulse mode, on shear bond strength of ceramic to other substrates [16,17]. Short pulse lasers such as Nd:YAG, Er:YAG, and Er,Cr:YSGG have also been tested [21–22]. More recently, Ti:Sapphire laser, which provides ultra-short pulses in the femtosecond range, has been introduced, and is considered an optimal alternative as it does not produce any thermal or mechanical damage to the ceramic surfaces [20,21].

However, there is some controversy about the effects of these lasers on the bond strength between ceramic materials and resin cements and composites, with different studies reporting widely differing results [22,23] .

The luting material plays a major role in the aesthetic outcome of ceramic veneers, allowing good shade matching with adjacent teeth [24]. Thus, changes in the color of resin cement used for luting may become visible, affecting the final aesthetic appearance of the restoration and leading to treatment failure [25] . For the cementation of all-ceramic restorations, resin-based cements are generally used because they can be adhesively bonded to dental structures and they exhibit low solubility, good mechanical properties, and favorable aesthetics [26].

Resin cements are usually divided into three categories, according to their curing mode: chemically activated, light-cured, and dual-cured cements. Chemically activated cements are mostly employed for cementation of metallic and metal-ceramic restorations or cast posts. Light-cured cements have a more restricted indication, used only for the luting of laminate veneers because of the decrease in light intensity during transmission through the restoration [27]. Dual-cured cements were developed to obtain good mechanical properties and a high degree of conversion in either the presence or absence of light [28,29]. However, regarding the color stability of resin cements, for chemically activated and dual-cured materials, the oxidation of the reactive groups present in the tertiary amines may cause a color change in the cement over time [30] . The final color of thin ceramic restorations is determined by a combination of the substrate, the thickness of the ceramic, and the luting material [31,32]. Among these factors, resin cement is the one that can have the most influence on the final color of ceramic laminate veneers [33] .

However, depending on the curing mode and commercial brand, cements identified with the same shade (A1, A2, translucent, bleach, etc.) do not have the same color parameters [26]. Therefore, these variations can influence the color stability of the cement and the final color of ceramic restorations [34] . It is important to note that the influence of different shades of dual-cured and light-cured cements underlying ceramic restorations and their long-term discoloration is little known. Also, this discoloration becomes much more important beneath thin-translucent ceramic veneers [30]. Because there are few studies on the long-term (more than one year) color stability of cemented thin ceramic veneers with resin cements having various shades and curing modes [35] . Furthermore, silane coupling is another effective way to increase the bonding effect by forming siloxane bonds at the interface between the ceramic and resins. Importantly, both physical interlocking and chemical bonding can decrease along with cyclic expansion and contraction at high and low temperatures. This effect with the water microleakage induced by chemical degradation at the interface might result in the separation of resin cement from the ceramic [36]. Thus, this bond strength after thermal cycling (TC) influences the longterm restoration. Despite initial progress, the bond durability between LDC and resin and systems controlled by different treatments has been seldom reported. Here in, we tried to illustrate the effect of physical and/or chemical surface treatments on bonding durability. The bond strength between LDC and two kinds of resin cements before and after thermal cycling upon a variety of surface treatments including HF.

2. Materials and Methods

I. Materials:

Brand name, material description, manufacturer and lot number are listed in table (1).

Table (1): List of materials & equipments used.

	Brand name	Material description	Manufacturer	Lot #
1	IPS e-max	lithium disilicate glass ceramic	Ivoclar vivadent	X52446
	Mojo venner light cure resin cement	Light cure resin cement	Pentron	6956590
4	Flowable composite Filteck	Light cure High viscosity resin	3m	Na36575
5	Bisco porcelain etchant	Hydro fluoric acid	Bisco, Inc. Schaumburg,IL60193	1900004495
6	Bisco silane primer	Pre hyrdrolyzed Porcelain silane	Bisco, Inc. Schaumburg,IL60193	1900006365

Samples grouping:

Twenty eight specimens of final dimensions of 14 mm x12mm and 0.5 mm thickness fabricated.

Sampling:

Specimens were divided into two groups according to the type of surface etching:

Group A: Laser etching. (n=14)

Done using Er,Cr:YSGG laser irradiation(Millenium;Biolase Technology,

II. Levels of investigation and factorial design:

Inc., San Clemente, CA,USA) with a 2.78 µm wavelength, pulsed laser-powered hydrokinetics, and energy parameters of 300 mJ at 2.5W, respectively. The air and vapor will be adjusted to 50% of the laser unit. The optical fiber of the laser (400µm diameter, 4 mm length) will be aligned perpendicular to each specimen at a distance of 1 mm and will be moved manually in a sweeping fashion over the entire area during a 60 seconds exposure period.

Group B: Acid etching. (n=14)

Done using hydrofluoric acid 9.5% for 20 sec.

Each group was subdivided into two subgroups according to the type of cement viscosity used:

Table (2): Sample grouping.

Surface Treatment / Type of Cement	Laser Etching Group A	Acid Etching Group B	Total Number of samples
Flowable composite (High viscosity resin) Sub group I	AI N=7	BI N=7	N=14
(Mojo veneer Resin cement) (Low viscosity resin) Sub group II	AII N=7	BII N=7	N=14
Total Number of samples	N=14	N=14	N=28

Subgroup I: Flowable composite (high viscosity resin) (n=7)

Subgroup II: Mojo veneer resin (low viscosity resin) (n=7)

III. Preparation of the specimens:

Blocks of CAD CAM esthetic restorative materials (IPS Emax) were used to prepare slices with the following dimensions: 14mm x 12mm x 0.5mm for Using IsoMet 4000 microsaw with cooling water system, by a dimond disk 0.6 mm thickness with cutting speed 2500 rpm. Then each ceramic disc was examined with a Caliber and digital caliber to make sure they all had the same thickness 0.5 mm each.

Surface Treatments:

For easier handling and fixation during the micro shear test, a number of 28 slices of Emax were embedded in an acrylic blocks, before any surface treatments.

To easily differentiate between the two surface treatment techniques during the rest of the procedures, two different color coded acrylic resin blocks were selected. white color was used for laser surface treatment and Green color for acid surface treatment.

Then each acrylic block was given the Initial letter related to the type of resin,

Before any surface treatments done, 70% ethyl alcohol was used on each of 28 slices for cleaning the surface from any debris and drying these surfaces very well.

1) Hydrofluoric Acid Etching + Silane:

Fourteen of the Emax ceramic slices embedded in acrylic blocks carrying BI & BII initials were etched using Hydrofluoric acid 9.5% for 20 seconds afterwards washed and air-dried with oil-free air/water syringe.

Silane coupling agent was applied for 60 seconds. Then air drying was done for the specimens using oil free air way syringe.

2) Laser etching + silanation:

The ceramic slices were subjected to laser irradiation followed by the application of silane primer. In this group Er,Cr:YSGG laser with wave length 2780nm, pulsed lased-powered hydrokinetics, was used. Vapor and air were adjusted to 50% of the laser unit

The optical fiber of the laser unit were 400µm in diameter and 4mm in length, arranged perpendicular at distance≈ 1mm over each ceramic slice and moved manually in a sweeping manner to cover all the surface area during the adjusted exposure period. The laser parameters were adjusted so that, the power was 2.5 W for AI & AII acrylic blocks carrying Emax slices.

The repetition rate was 20 Hz for 60 seconds at surface of the slices those specific laser parameters where chosen according to **Pinar Kursoglu, et al in 2013** [(74)]. The slices were then rinsed with distilled water and air dried. Silane primer was then applied to the irradiated surfaces for 60 seconds and then air dried for 60 seconds.

IV) Application of resin cement material:

Emax slice Received 5 resin micro cylinders. Irises of polyethylene tube having 1mm diameter and 1mm height (fig15) were positioned over the disc surface, then cement was injected into the tubes through the mixing tip, light curing was done through the tube for 20 seconds, with a LED light-curing unit * with an irradiance of 1200 mW/cm2 according to the manufacturer's instructions

Polyethylene tube irises were not removed in order not to subject the resin micro cylinders to shear stress at the interface, and to eliminate any pretest failures according to **Andrade et al. (2012)**

V) Thermocycling:

In order to simulate the oral cavity media, specimens were thermo-cycled using THE-1100SD Mechatronics thermo-cycler between 5 ºC and 55 ºC for 5000 cycles with a 20 seconds dwell time and 5 seconds transfer time.

VI) Micro-Shear Bond Strength Test:

Each block with its own bonded micro-cylinders was secured horizontally with tightening screws to the lower fixed compartment of a universal testing machine * with a loadcell of 5 kN and data were recorded using computer software **.

A loop prepared from an orthodontic wire (0.014" in diameter) was wrapped around the bonded micro-cylinder assembly as close as possible to the base of the micro-cylinder and aligned with the loading axis of the upper movable compartment of the testing machine.

As hearing load with tensile mode of force was applied via materials testing machine at a crosshead speed of 0.5 mm/min. The load required to debonding was recorded in Newton.

Micro-Shear Bond Strength Calculation:

The load at failure was divided by bonding area to express the bond strength in MPa: $\boldsymbol{\tau = P/ \pi r2}$

Where; $\boldsymbol{\tau}$ = μ-shear bond strength (in MPa), **P** =load at failure (in N), $\boldsymbol{\pi}$ =3.14 and **r** = radius of micro-cylinder (in mm)

Scanning digital microscope:

after micro shear test was done, Shots of each resin tags was taken for each disc using hand held digital microscope.

3. Results

1. Descriptive statistics:

Table (7): Descriptive statistics for micro-shear bond strength (Mpa) for different groups

Surface treatment	Resin cement	Mean	Std. Deviation	Median	Range
Laser etching	High viscosity	13.51	5.24	12.70	19.08
	Low viscosity	12.58	4.84	11.06	16.98
Acid etching	high viscosity	21.80	5.86	20.93	18.44
	low viscosity	18.39	5.34	18.85	15.00

* Elipar S10, 3M Espe, St. Paul, MN

* (Model 3345; Instron Industrial Products, Norwood, MA, USA)

** (Instron® Bluehill Lite Software)

2. Effect of different variables and their interaction:

Only type of surface treatment had a significant effect on micro-shear bond strength (p<0.001).

3. Main effects:

A-Effect of Surface treatment:

Acid etched samples (20.09±5.78) had a significantly higher value than laser etched samples (13.04±4.98) (p<0.001).

B-Effect of resin viscosity:

Resin with high viscosity (17.65±6.90) had a higher value of micro-shear bond strength than resin with low viscosity (15.48±5.81) yet the difference was not significant (p=0.120).

4. Interactions:

1-Effect of type of resin cement viscosity within each Surface treatment:

- **Laser etching:**

Resin with high viscosity (13.51±5.24) had a higher value of micro-shear bond strength than resin with low viscosity (12.58±4.84) yet the difference was not significant (p=0.634).

- **Acid etching:**

Resin with high viscosity (21.80±5.86) had a higher value of micro-shear bond strength than resin with low viscosity (18.39±5.34) yet the difference was not significant (p=0.085).

2-Effect of Surface treatment type within each resin viscosity:

- **High viscosity:**

Acid etched samples (21.80±5.86) had a significantly higher value than laser etched samples (13.51±5.24) (p<0.001).

- **Low viscosity:**

Acid etched samples (18.39±5.34) had a significantly higher value than laser etched samples (12.58±4.84) (p=0.004).

II-Mode of failure

After testing mode of failure three patterns were revealed:

A- Total adhesive failure :

1-Mode of failure in different surface treatments:

Frequencies (n) and Percentages (%) of mode of failure in different surface treatments were presented in table (12) and fig. from (29) to (31)

There was a significant difference in the distribution of different modes of failure within samples subjected to different surface treatments (p<0.001). For laser etching, most of the samples had an adhesive mode of failure 49 (70.0%), lower percentage had mixed failure mode 21 (30.0%) while there was no samples with a cohesive mode of failure. For acid etching, most of the samples had a cohesive mode of failure 56 (80.0%), lower percentage had mixed failure mode 14 (20.0%) while there was no samples with an adhesive mode of failure.

-Mode of failure in different types of resin cement:

Majority of samples cemented with high viscosity resin cement 32 (45.7%) had a cohesive mode of failure, while most of the low viscosity samples 29 (41.1%) failed adhesively, yet the difference between both groups was not significant (p=0.259).

3-Mode of failure within each type of cement:

- **High viscosity**

There was a significant difference in the distribution of different modes of failure within samples subjected to different surface treatments (p<0.001). For laser etching, most of the samples had an adhesive mode of failure 20 (57.0%), lower percentage had mixed failure mode 15 (42.9%) while there was no samples with a cohesive mode of failure. For acid etching, most of the samples had a cohesive mode of failure 32 (91.4%), lower percentage had mixed failure mode 3 (8.6%) while there was no samples with an adhesive mode of failure.

- **Low viscosity**

There was a significant difference in the distribution of different modes of failure within samples subjected to different surface treatments (p<0.001). For laser etching, most of the samples had an adhesive mode of failure 29 (82.9%), lower percentage had mixed failure mode 6 (17.1%) while there was no samples with a cohesive mode of failure. For acid etching, most of the samples had a cohesive mode of failure 24 (68.6%), lower percentage had mixed failure mode 11 (31.4%) while there was no samples with an adhesive mode of failure.

4-Mode of failure within each surface treatment:

Laser etching:

Majority of samples of both types of resin cement failed adhesively, with low viscosity cement 29(82.9%) having a significantly higher percentage (p=0.036).

- **Acid etching:**

Majority of samples of both types of resin cement failed cohesively, with high iscosity cement 32(91.4%) having a significantly higher percentage (p=0.034).

4. Discussion

Recently, the revolution in dental ceramics in respect to microstructure, optical properties and mechanical properties offered wide range of indications, moreover the increase in demand and interest in achieving ultimate esthetic paved the way to the use of ceramic restorations in anterior zone.[147]

The clinical success and long-term intra-oral survival of different indirect ceramic restorations relay mainly on achieving a strong and durable bond between substrate and resin cements that can provide an impregnable seal [148]. Resin cements were used with ceramics restorations not only for providing the bond strength needed, but also to strengthen the brittle ceramics materials.

The main concern of bonding ceramic restorations to tooth structure is the bond strength at the two interfaces: tooth/resin interface and ceramic/resin interface, as the weak bond at any interface will significantly affects the final bond strength so affecting the clinical success of the ceramic restoration.[149]

Discussion

Due to its optical properties and strength properties, lithium di-silicate was selected in this study, allowing it to be used in thin sections without affecting both esthetically and functionally the final results.

The properties of a luting agent and the surface treatments for ceramic surfaces before cement application play a major role in the clinical success of many indirect ceramic restorations.

Selection of the luting agent assumes to be significant factor while bonding to indirect restorations. Resin cements provide ceramic materials with both the strength needed for these brittle materials, and a secure seal between the restorations and tooth structure. Two types of resin-composite cements were used in this study to evaluate their bond strength.

Light cured resin luting material enables a simplified bonding technique and also provides the cured cement with excellent colour stability. For highly esthetic veneer restorations, this feature is vital. Most ceramic and composite veneers are sufficiently thin and translucent to allow adequate penetration of light through the veneer to cure the cement completely.[37]

Composite resin is a widely used material for the direct restoration of anterior and posterior teeth. Due to their advantages in terms of mechanical properties and extended handling time, in early days Besek et al.[38] were the first to recommend composite resin for the luting of CEREC ceramic inlays as well. At that time, this CAD/CAD system was rather inaccurate so the use of a resin composite as a luting agent was an efficient solution to protect restoration margins from micro leakage, esthetic defects, and caries.

Light cured self-adhesive flowable composite that contains photosensitive aliphatic tertiary amine initiator, with high filler content and (UDMA) content in its matrix replacing (TEGMA) which is the main reason of water sorption.

Different surface treatments were applied in this study on the CAD/CAM material surface to be evaluated and tested, these surface treatments include: acid etching (9.5% buffered hydrofluoric acid) followed by silane primer, & laser etching using Er,Cr:YSGG pulsed laser followed by silane primer.

The first applied surface treatment was hydrofluoric acid etching. As acid etching is the most commonly employed technique to improve the bond strength. The HF surface treatment modifies the microstructures of CAD/CAM ceramic surface by partial dissolution of the glassy phase of the ceramic, forming micro porosity on the ceramic surface.[39]it increases the surface area by creating micro-pores into which uncured flowable resin penetrates to provide durable micro-mechanical interlocking.[40]

The ceramic slices were treated with hydrofluoric acid etching prior to silane primer application, Etching was done for 20 seconds, results in the dissolution of the glassy phase predominantly and creating small isolated pores and fissures,& subsequent silanization was performed for 60 seconds this protocol coincide with **Helo-sa A. B. Guimarães et al. in 2018** [41]**.**

The second applied surface treatment was laser etching, the ceramic slices were subjected to laser irradiation followed by the application of silane primer. In this group Er,Cr:YSGG laser (Water lase i Plus; Biolase Technology Inc., Irvine, CA, USA) with wave length 2780nm, pulsed lased-powered hydrokinetics, was used. as ER:YAG (erbium: yttrium, aluminum, garnet) laser was reported to remove the glass phase of the ceramic creating rough surface suitable for bonding to the resin cement, Vapor and air were adjusted to 50% of the laser unit. The optical fiber of the laser unit were 400µm in diameter and 4mm in length, arranged perpendicular over each ceramic slice and moved manually in a sweeping manner to cover all the surface area during the adjusted exposure period using Power of 2.5 W, with repetition rate of 20 Hz for 60 seconds at approximately one mm distance from the surface of the slices. The slices were then rinsed with distilled water and air dried then Silane primer was applied to the irradiated surfaces for 60 seconds and air dried for 60 seconds. This protocol coincides with Pinar Kursoglu***, et al, in 2013***[42]**.**

Since restorations normally fail after being aged in a humid and thermally dynamic oral environment[43] so in attempt to simulate bonded restorations in the oral cavity we used thermal cycling as an artificial aging method of dental materials, and thermal strain which is simulated on the bonding surface by influence of liquids and thermal change[44] So In our present study, aging protocol was applied on all specimens, it was done through thermo-cycling after surface treatments were done and resin was applied. It was done to simulate the oral cavity environment after cementing the restoration using light cured resin.

Under thermal aging, the bond strength is affected by several factors including temperature settings, dwell time, and the number of cycles, in which the latest is the most influential factor.(45) Mean while in our study The aging protocol was done after application of surface treatments and resin micro-tubes positioned. A total of 5000 thermal cycles were done, which simulates 6 month of *in vivo* function. Temperature between 5°C and 55°C with 20 seconds dwell time and 5 seconds transfer time. This aging protocol was also used by ***Al-Thagafi in 2016***(46)

After finishing the aging step through thermo-cycling, specimens were ready for testing its bond strength, using micro-shear bond strength test (μ-SBS test), Which is considered a relatively simple test that permits efficient screening of adhesive protocols, regional and depth profiling of a variety of substrates.(47)

Most micro-shear studies use polyethylene tubes as molds, which are then filled with a resin composite. After water storage for 24 h, in other studies the operator uses a scalpel blade to remove these tubes manually, resulting in cylindrical composite specimens. The pressure exerted on the blade by the operator in order to cut and remove the polyethylene tubes may be transferred to the resin cylinder and consequently form cracks along the specimen. Therefore, it is fair to hypothesize that micro shear specimens may fail under relatively low loading levels or fail prematurely due to propagation of these cracks.(48)

For this reason in the present study, the polyethylene tubes irises were not removed in order not to subject the self adhesive resin cement micro cylinders to shear stresses at the interface and to eliminate any pretest failures according to ***Andrade et al. in 2012***(49)

In this study it was found that using hydrofluoric acid 9.5% conc. As a surface treatment for lithium di-silicate based ceramics is recorded the highest bond strength values, and this result was in co-ordinance with Cengiz-Yanardag etal in 201(50), who concluded that prior to bonding, HF acid treatment is the best surface treatment method regarding the bond strength followed by silane application for all CAD-CAM restorative materials as examined.

In addition to the traditional surface treatments that were used to increase the Bond Strength between the ceramic surface and resin cement, in the present study, we aimed at evaluating the effect of laser irradiation on Bond Strength; however, there have been few studies on laser irradiation [51,52].

Laser surface etching followed by silane application, The majority of the previous studies evaluated the effect of erbium:yttrium-aluminum-garnet (Er:YAG) and neodmium:yttrium-aluminum-garnet (Nd:YAG) lasers on zirconia ceramics (53,54) and have demonstrated controversial results. Er, Cr:YSGG laser irradiation shows its effect on hard and soft tissues through the interaction of laser energy with atomized water droplets on the tissue interface, resulting in micro-explosions and ablation of the tissue. Therefore, the effect of Er, Cr:YSGG laser on different restorative materials might vary due to the water content of the restorative materials.(50)

In this study it was found that using hydrofluoric acid 9.5% conc. As a surface treatment for lithium di-silicate based ceramics recorded a significantly higher bond strength values than those obtained from ones treated with er:Cr laser… regardless to the type of cement used;

The results obtained in the present study are in agreement with Kursuoglu et al. [55], who reported that laser irradiation led to higher Bond Strength in the bonding between IPS Empress II and resin cement compared to a control group but to lower Bond Strength compared to that achieved through acid etching. Additionally, the high laser power output appears to weaken the bonding between full ceramic restoration and resin cement [56].

One more interpretation was described by Cengiz-Yanardag et al in 2018 (50) who found that the low bond strengths resulting from laser surface treatment may be due to thermal surface damage caused by laser power settings, on the contrary, this disagreed with the results from others Haluk Baris Kara et al(**) in 2012 and Barutcigil et al in 2019 (22). These differences may be attributed to the lower repetition rate which is 10 HZ in addition to that this studies didn't apply thermocycling measures to simulate oral cavity conditions, so may be those were the reason for the difference between the two studies' results.

It also was found that flowable composite had an insignificant higher bond strength than mojo this may be attributed to the higher mechanical prop. Of the high visc. Comp

This was in agreement with Tissiana Bortolotto et al.(57) who found The least amount of residual UDMA monomer was observed in the micro hybrid composite resin. Due to an increased filler level in composite resin and concluded that Hybrid composite showed the best results in terms of shrinkage development and stability against leaching. Shrinkage values of the self-adhesive cement tested (self-cured or light cured) were higher than those observed for the hybrid composite.

5. Conclusions

Within the limitation of this in Vitro study it was concluded that:

1) Acid etching followed by silanation had a significantly higher value than laser etching followed by silanation for both resin viscocities.
2) Resin with high viscosity had a higher value of micro-shear bond strength than resin with low viscosity yet the difference was not significant.

References

1- Yang Y, Yu J, Gao J, Guo J, Li L, Zhao Y, et al. Clinical outcomes of different types of tooth-supported bilayer lithium disilicate all-ceramic restorations after functioning up to 5 years: A retrospective study. J Dent. 2016; 51:56–61.

2- Gresnigt MM, O¨ zcan M, van den Houten ML, Schipper L, Cune MS. Fracture strength, failure type and Weibull characteristics of lithium disilicate and multiphase resin composite endocrowns under axial and lateral forces. Dental materials. 2016; 32(5):607–614.

3- Gorodovsky S, Zidan O. Retentive strength, disintegra-tion, and marginal quality of luting cements. J Prosthet Dent. 1992; 68:269–274.

4- El-Mowafy O. The use of resin cements in restorative dentistry to overcome retention problems. J Can Dent Assoc. 2001; 67:97–102.

5- Jensen ME, Sheth JJ, Tolliver D. Etched-porcelain resin-bonded full veneer crowns: in vitro fracture resistance. Compendium. 1989; 10:336–347.

6- . Rosentritt M, Behr M, Lang R, Handel G. Influence of cement type on the marginal adaptation of allceramic MOD inlays. Dent Mater. 2004; 20:463–469.

7- Alber FE, El-Mowafy OM. Marginal adaptation and microleakage of Procera AllCeram crowns with four cements. Int J Prosthodont. 2004; 17:529–535.

8- Sorensen JA, Kang SK, Avera SP. Porcelain-composite interface microleakage with various porcelain surface treatments. Dent Mater. 1991; 7:118–123.

9- Uwalaka CO, Karpukhina N, Cao X, Bissasu S, Wilson RM, Cattell MJ. Effect of sandblasting, etching and resin bonding on the flexural strength/bonding of novel glass-ceramics. Dent Mater. 2018; 34 (10):1566–1577.

10- Guarda GB, Correr AB, Gonc¸alves LS, Costa AR, Borges GA, Sinhoreti MA, et al. Effects of Surface Treatments, Thermocycling, and Cyclic Loading on the Bond Strength of a Resin Cement Bonded to a Lithium Disilicate Glass Ceramic. Operative Dentistry, 2013; 38(2):208–217.

11- Bruzi G, Carvalho AO, Giannini M, Maia HP, Magne P. Post-etching cleaning influences the resin shear bond strength to CAD/CAM lithium-disilicate ceramics. Applied Adhesion Science. 2017; 5(1):17.

12- Piwowarczyk A, Lauer H C, Sorensen J A. In vitro shear bond strength of cementing agents to fixed prosthodontic restorative materials. J Prosthet Dent. 2004; 92(3):265–273.

13- Kang SH, Chang J, Son HH. Flexural strength and microstructure of two lithium disilicate glass ceramics for CAD/CAM restoration in the dental clinic. Restor Dent Endod. 2013; 38:134–140.

14- Peutzfeldt A, Sahafi A, Flury S. Bonding of Restorative Materials to Dentin With Various Luting Agents. Oper Dent. 2011; 36(3):266–273.

15- Moro AFV, Ramos AB, Rocha GM, Perez CDR. Effect of prior silane application on the bond strength of a universal adhesive to a lithium disilicate ceramic. J Prosthet Dent. 2017; 118(5).

16- Ersu B, Yuzugullu B, Ruya Yazici A, Canay S. Surface roughness and bond strengths of glass-infiltrated alumina-ceramics prepared using various surface treatments. J Dent. 2009; 37:848–56

17- El Gamal A, Medioni E, Rocca JP, Fornaini C, Muhammad OH, Brulat-Bouchard N. Shear bond, wettability and AFM evaluations on CO(2) laser-irradiated CAD/CAM ceramic surfaces. Lasers Med Sci. 2017; 32:779–785

18- Barutcigil K, Barutcigil C¸, Kul E, O¨ zarslan MM, Buyukkaplan US. Effect of Different Surface Treatments on Bond Strength of Resin Cement to a CAD/CAM Restorative Material. J Prosthodont. 2016; E-pub ahead of print.

19- Paranhos MP, Burnett LH Jr, Magne P. Effect Of Nd:YAG laser and CO2 laser treatment on the resin bond strength to zirconia ceramic. Quintessence Int. 2011; 42:79–89

20- Vicente M, Gomes AL, Montero J, Rosel E, Seoane V, Albaladejo A. Influence of cyclic loading on the adhesive effectiveness of resin-zirconia interface after femtosecond laser irradiation and conventional surface treatments. Lasers Surg Med. 2016; 48:36–44

21- Fiedler S, Irsig R, Tiggesba¨umker J, Schuster C, Merschjann C, Rothe N et al. Machining of biocompatible ceramics with femtosecond laser pulses. Biomed Tech (Berl). 2013; Epub ahead of print

22- . Esteves-Oliveira M, Jansen P, Wehner M, Dohrn A, Bello-Silva MS, Eduardo CP et al. Surface Characterization and Short-term Adhesion to Zirconia after Ultra-short Pulsed Laser Irradiation. J Adhes Dent. 2016; 18:483–492

23- Kasraei S, Rezaei-Soufi L, Heidari B, Vafaee F. Bond strength of resin cement to CO2 and Er:YAG laser-treated zirconia ceramic. Restor Dent Endod. 2014; 39:296–302

24- Perroni AP, Kaizer MR, Della Bona A, Moraes RR, Boscato N. Influence of light-cured luting agents and associated factors on the color of ceramic laminate veneers: A systematic review of in vitro studies. Dent Mater. 2018; 34(11):1610–24.

25- Archegas LR, Freire A, Vieira S, Caldas DB, Souza EM. Colour stability and opacity of resin cements and flowable composites for ceramic veneer luting after accelerated ageing. J Dent. 2011; 39(11):804– 10.

26- Kilinc E, Antonson SA, Hardigan PC, Kesercioglu A. Resin cement color stability and its influence on the final shade of all-ceramics. J Dent. 2011; 39 Suppl 1:e30–6.

27- Archegas LR, de Menezes Caldas DB, Rached r N, Soares P, Souza EM. Effect of ceramic veneer opacity and exposure time on the polymerization efficiency of resin cements. Oper Dent. 2012; 37 (3):281–9.

28- . Braga RR, Cesar PF, Gonzaga CC. Mechanical properties of resin cements with different activation modes. J Oral Rehabil. 2002; 29(3):257–62.

29- Calgaro PA, Furuse AY, Correr GM, Ornaghi BP, Gonzaga CC. Influence of the interposition of ceramic spacers on the degree of conversion and the hardness of resin cements. Braz Oral Res. 2013; 27 (5):403–9.

30- Turgut S, Bagis B. Colour stability of laminate veneers: an in vitro study. J Dent. 2011; 39 Suppl 3:e57– 64.

31- Calgaro PA, Furuse AY, Correr GM, Ornaghi BP, Gonzaga CC. Post-cementation colorimetric evaluation of the interaction between the thickness of ceramic veneers and the shade of resin cement. Am J Dent. 2014; 27(4):191–4.

32- Turgut S, Bagis B. Effect of resin cement and ceramic thickness on final color of laminate veneers: an in vitro study. J Prosthet Dent. 2013; 109(3):179–86.

33- Chen XD, Hong G, Xing WZ, Wang YN. The influence of resin cements on the final color of ceramic veneers. J Prosthodont Res. 2015; 59(3):172–7.

34- Alqahtani MQ, Aljurais RM, Alshaafi MM. The effects of different shades of resin luting cement on the color of ceramic veneers. Dent Mater J. 2012; 31(3):354–61.

35- Smith DS, Vandewalle KS, Whisler G. Color stability of composite resin cements. Gen Dent. 2011; 59 (5):390–4.

36- Elsayed A, Younes F, Lehmann F, Kern M. Tensile Bond Strength of So-called Universal Primers and Universal Multimode Adhesives to Zirconia and Lithium Disilicate Ceramics. Journal of Adhesive Dentistry. 2017; 19(3):1.

37- 3M ESPE. Rely x veneer cement system technical product profile, 2010.

38- Besek M, Mörmann WH, Persi C, Lutz F. The curing of composites under Cerec inlays. Schweiz Monatsschr Zahnmed 1995; 105: 1123-1128.

39- Elsaka SE. Influence of surface treatments on bond strength of metal and ceramic brackets to a novel CAD/CAM hybrid ceramic material. Odontology. 2016; 104:68-76.

40- Ramakrishnaiah R, Alkheraif AA, Divakar DD. The Effect of Hydrofluoric Acid Etching Duration on the Surface Micro morphology, Roughness, and Wettability of Dental Ceramics. International Journal of Molecular Sciences. 2016; Vol. 17 (6)

41- www.vident.com.

42- www.vident.com.

43- Elsaka SE: Repair bond strength of resin composite to a novel CAD/CAM hybrid ceramic using different repair systems. Dental Materials Journal. 2015;34:161-167.

44- Baur V and Ilie N. Repair of dental resin-based composites. Clinical Oral Investigations. 2013; 17 (2): 601-8.

45- Wahsh MM and Ghallab OH. Influence of different surface treatments on micro-shear bond strength of repair resin composite to two CAD/CAM esthetic restorative materials. Tanta Dental Journal. 2015; 12(3):178–84.

46- Al-Thagafi R, Al-Zordk W, Saker S. Influence of Surface Conditioning Protocols on Reparability of CAD / CAM Zirconia-reinforced Lithium silicate ceramics. Journal of Adhesive Dentistry. 2016; 18(2): 135-141.

47- Armstrong S, Geraldeli S, Maia R, Raposo LHA, Soares CJ, Yamagawa J. Adhesion to tooth structure: a critical review of “micro” bond strength test methods. Dental Materials. 2010; 26(2):50-62.

48- Andrade AM, Moura SK, Reis A, Loguercio AD, Garcia EJ, Grande RH. Evaluating resin-enamel bonds by microshear and microtensile bond strength tests: effects of composite resin. Journal of Applied Oral Science. 2010; 18(6):591-598.

49- Andrade AM, Garcia E, Moura SK, Reis A, Loguercio A, Mendonc L, et al. Do the Micro-shear Test Variables Affect the Bond Strength Values?. International Journal of Dentistry. 2012.

50- Cengiz-Yanardag E, Kurtulmus Yilmaz S, Karakaya I, Ongun S. Effect of Different Surface Treatment Methods on Micro-Shear Bond Strength of CAD-CAM Restorative Materials to Resin Cement. Journal of Adhesion Science and Technology. 2019; 33(2):110-123.

51- Ozcan M, Vallittu PK. Effect of surface conditioning methods on the bond strength of luting cement to ceramics. Dent Mater. 2003;19:725–731.

52- Maruo Y, Nishigawa G, Irie M, et al. Does acid etching morphplogically and chemically affect lithium disilicate glass ceramic surfaces? J Appl Biomater Funct Mater. 2017;15:e93–e100.

53- Turp V, Akgungor G, Sen D, Tuncelli B. Evaluation of surface topography of zirconia ceramic after Er:YAG laser etching. Photomedicine and Laser Surgery. 2014;32(10):533–539.

54- Akın H, Ozkurt Z, Kırmalı O, et al. Shear bond strength of resin cement to zirconia ceramic after aluminum oxide sandblasting and various laser treatments. Photomedicine and Laser Surgery. 2011;29(12):797–802.

55- Kursuoglu P, Motro PF, Yurdaguven H. Shear bond strength of resin cement to an acid etched and a laser irradiated ceramic surface. J Adh Prosthodont. 2013;5:98–103

Attia A. Influence of surface treatment and cyclic loading on the durability of repaired allceramic crowns. J Appl Oral Sci. 2010;18:194–200

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