

Efficiency of Er: YAG Laser in Veneers Debonding with Two Materials & Thicknesses-An in Vitro Study

Sherien S. Alshafaay¹, Maged M. Zohdy², Tarek S. Morsi³

Abstract:

Objective: To evaluate shear bond strength of laminate veneers after debonding attempt using: Er:YAG laser on two different ceramic materials: Lithium disilicate glass ceramic material and cubic zirconia, in two thicknesses: 0.3mm. 0.7mm. **Materials and Methods:** Fifty-six freshly extracted maxillary premolars were collected, examined and those with cracks or structural defects were discarded. The premolars were stored in saline during the study. The extracted teeth were embedded in acrylic resin blocks for fixation. Using IsometTM 4000, IPS E-max CAD and cubic zirconia specimens were sectioned with dimensions 4x4 mm and thicknesses 0.3 mm and 0.7mm under copious cooling. Cubic zirconia Samples were prepared so as to be 25% larger than the final required size. **Results:** Regardless of the ceramic thickness, E-max samples had statistically significant higher shear bond strength values than cubic zirconia samples in laser treated group. Regardless of the ceramic thickness, E-max samples had statistically significant higher shear bond strength values than cubic zirconia samples in control group. It was found that Regardless of treatment, there was no significant difference between both groups. It was found that there was significant difference between both groups. **Conclusion:** Er:YAG laser is effective in glass ceramic veneer debonding. However, the effect is material dependant since lithium disilicate had superior laser transmission than cubic zirconia. Ceramic thickness had a direct effect on debonding of veneers in E-max while showed no effect in the zirconia specimens due to it lower laser transmission. E-max showed higher bonding strength to enamel than with cubic zirconia.

Introduction

In response to an increasing patient's demand for minimally invasive, more esthetic and durable dental restorations, the use of ceramic laminate veneers over the last decades has become a widespread approach to restore fractured, malaligned, and malformed teeth. Moreover, the clinical indications of these restorations have been progressively increased due to the development of ceramic materials that have been recently introduced in the market together with efficient bonding to enamel and dentin using adhesive materials and techniques.¹

Although ceramic laminate veneers assist clinicians in achieving patient satisfaction, because of their excellent optical properties and biocompatibility, these restorations are bonded glass ceramic material which makes their removal very challenging.²

In cases of removing the veneers a short time after cementation due to improper seating during cementation, veneer fracture and shade mismatching either due to improper selection of veneer cement or improper shade selection of ceramic veneer, preserving the integrity of the laminate veneer becomes critical to avoid their remanufacturing. Using conventional removal techniques as grinding the restoration using abrasive stones or mechanical crown removers is painful to the patient and carries a risk of bypassing the restoration, and damaging underlying tooth structure because of the lack of color contrast between tooth, adhesive resin interface, and the restoration.

¹Postgraduate (phD) student, Department of Fixed Prosthodontics, Faculty of Dentistry, Ain Shams University, Cairo, Egypt. sherodream@hotmail.com

²Assistant Professor of Fixed Prosthodontics Department, Faculty of Dentistry, Ain Shams University, Cairo, Egypt.

³Professor, Head of fixed prosthodontics department Faculty of Dentistry, Ain Shams University, Cairo, Egypt.

To overcome these difficulties, the use of lasers was recently introduced as a more comfortable and more conservative restoration removal technique. Erbium lasers has been used as an alternative for debonding ceramic restorations from natural tooth surfaces. Erbium lasers including Er:YAG laser that have an emission wavelength of 2940 nm which correlates with the absorption peak of water, residual monomers and bonding cements containing water. Therefore, it is considered safe to ablate dental hard tissues.³

Er:YAG laser energy is transmitted through the ceramic surface. The resin cement absorbs the transmitted energy, whose amount depends on the ceramic type; thickness, and composition. When enough amount of cement is ablated through the ceramic, the restoration slides off the tooth surface in one piece. The involved ablation mechanism is explosive vaporization followed by a hydrodynamic ejection.⁴

HYPOTHESIS OF THE WORK

This study was designed to evaluate shear bond strength of laminate veneers after debonding attempt using: Er:YAG laser on two different ceramic materials: Lithium disilicate glass ceramic material, cubic zirconia, in two thicknesses: 0.3mm. 0.7mm.

Materials and Methods:

This in-vitro study was designed to evaluate the efficiency of Er:YAG laser in the debonding of two glass ceramic materials; lithium disilicate (IPS E-max CAD) and cubic zirconia (UTML KATANA) in two thicknesses 0.3 and 0.7mm.

A) Materials:

The materials used in this study are listed in Table (1).

1- IPS E-max CAD block

A 14 mm partially crystallized lithium disilicate glass ceramic block of A1 LT shade was used in this study.



2- Ultra translucent multilayered zirconia

Ultra translucent multilayered (UTML) zirconia blank shade A2 size T18 was used. It contains almost 50% cubic phase zirconia as a result it appears more translucent.

3- PORCELAIN ETCHANT: 9.5% Buffered Hydrofluoric acid gel supplied in a single syringe containing 5g.

4- Porcelain primer (Pre-Hydrolyzed Silane Primer): Silane coupling agent supplied in single bottle.

5- Single Bond Universal Adhesive: Light cured bonding agent supplied in a single bottle.

Table (1): Materials used in this study

No	Description	Trade name	Batch number	Manufacturer
1	Lithium disilicate glass ceramic	IPS E-max CAD	X40783	Ivoclar Vivadent, Liechtensetin, Germany
2	Fully stabilized cubic zirconia	Ultra translucent multilayered zirconia	63201	Kuraray Noritake, Japan.
3	Hydrofluoric acid	PORCELAIN ETCHANT	1800006536	Bisco, Inc.Schaumburg,IL, U.S.A
4	Silane Coupling agent	PORCELAIN PRIMER (Pre-Hydrolyzed Silane Primer)	1900004497	Bisco,Inc.Schaumburg,IL, USA
5	Universal Bonding agent	Single Bond Universal Adhesive	71009B	3M ESPE, GmbH, Germany
6	MDP-zirconia primer	Z-prime plus		Bisco,Inc.Schaumburg,IL, USA
7	Phosphoric acid	Meta Etchant	MET1903291	Meta Biomed Co.Ltd
8	Light cured resin cement	RelyX™ Veneer	NA49201	3M ESPE, GmbH, Germany

Chemical composition:

MDP phosphate monomer, Dimethacrylate resins, HEMA, Vitrebond copolymer, Ethanol, Water and initiators, Filler, Silane.

6- MDP zirconia primer (z-prime plus): Single- component priming agent used in adhesion between indirect restorative materials and resin cements. Z-Prime Plus enhances bond strengths to Zirconia, Alumina and Metal substrates due to its combination of two active monomers, MDP, a phosphate monomer, and BPDm, a carboxylate monomer.

7-Meta Etchant: 37 % Phosphoric acid etchant gel supplied in a single syringe containing 3g.

Chemical composition

37% phosphoric acid, water, thickened polymer and dye colorant.

8- RelyX™ Veneer: Light cured resin cement delivered in a single syringe containing 3gm. Translucent shade was used in this study.

Chemical composition:

Hydroxyethyl methacrylate, Bisphenol A Diglycidyl Ether Dimethacrylate (BISGMA), Ethanol, water and camphorquinone.

B) Methods:

Fifty-six freshly extracted maxillary premolars were used in the study. The teeth were cleaned, examined and those with cracks, caries, restorations and structural defects were discarded. The premolars were stored in saline during the study which was changed every week.

(Laboratory research that does not include human samples, and research that does not include human samples, such as "dental samples, blood samples, tissue samples, saliva....etc" are not reviewed by the Scientific Research Ethics Committee and therefore it doesn't need to be revised by the committee).

I) Fixing extracted teeth in acrylic moulds

The extracted teeth were embedded in a ready made plastic mold tube of 2.5 cm diameter and 4 cm height.

The buccal surface of each tooth was covered with pink modeling wax to prevent it's contact with the acrylic resin, then placed facing a glass slab.

Cold cure acrylic resin was applied into the mold covering the root surface and keeping only the buccal surface exposed.

II) Sample grouping

Samples were randomly divided in a completely randomized design, each sample was labeled then using a table of random numbers using a computer in MINITAB the "SAMPLE" command was chosen to select a random sample of specific size from the list of numbers.

Samples were divided into two groups:

Group (A) Er:YAG

Group (B) control group (no Laser application)

Each group was subdivided into two subgroups according to material used:

Subgroup (i) E-max



Subgroup (ii) cubic zirconia

Each subgroup was further divided into two divisions (N=7) according to material thickness: Division (X) 0.3mm and Division (Y) 0.7mm.

Sample size calculation:

A power analysis was designed to have adequate power to apply a statistical test of the research hypothesis (null hypothesis) that there is no difference between different tested materials and treatments. By adopting an alpha (α) level of 0.05 (5%), a beta (β) level of 0.05 (5%) i.e. power=95%, and an effect size of (1.17) calculated based on the results of Usume, Aslihan, and Filiz Aykent; the predicted sample size (n) was a total of (40) samples and it was increased to (56) samples. Sample size calculation was performed using G*Power version 3.1.9.2.

III) Ceramic sample preparation

Ceramic sectioning:

Using low speed diamond saw, IPS E-max CAD specimens and cubic zirconia specimens were sectioned with dimensions 4x4 mm and thicknesses 0.3 mm and 0.7mm under copious cooling. Cubic zirconia samples were prepared so as to be 25% larger than the final required size.

Ceramic specimens were inspected after sectioning for any surface flaws. Dimensions and thickness were confirmed after sectioning by caliper.

All the samples were prepared by the same operator according to the manufacturer’s recommendation for the purpose of standardization.

Crystallization and glazing of E-max specimens:

IPS E-max CAD Crystal/Glaze paste was applied evenly on one side of the veneer using a brush.

Combination firing (Crystallization/Glaze) cycle was selected in Programat EP 3010 ceramic furnace. After completion of firing, specimens were removed from the furnace and allowed to cool to room temperature.

Sintering of Zirconia samples:

Zirconia samples were sintered and glazed in high temperature furnace according to the manufacturer’s recommendations Table 2. After the sintering process, fine adjustments to the size and thickness of the specimens were made.

Table (2): Sintering instructions for UTML Zirconia restorations

Temperature rise rate	High temperature	Hold time	Temperature decrease rate
T1	T	H	Tr
10°C/min	1550°C	2 hours	-10°C/min

IV) Standardization of tooth preparation

A) Dimensions of preparation:

To confirm that the area of preparation is 4x4 mm, a standard ruler with the same dimension of ceramic disc “4x4 mm” was used. A ceramic disc was used to confirm the dimensions with the ruler.

After confirmation, the ruler was positioned on the tooth. A black marker was used to outline the area of preparation.

B) Depth of preparation:

A three wheel depth cutter diamond stone (909/018) was used to place a number of ‘2’ 0.5 mm depth grooves to guide the amount of preparation.

Buccal surface was painted with a marker to ensure uniform amount of preparation.

Tooth preparation:

Buccal surface was prepared using blue coded round end tapered diamond stone (856 014 F FG) to have a flat surface for the veneer specimens to fit without rocking. Surface was then finished by red coded finishing stone (369/025) and yellow coded finishing stone (368/023). Prepared area was discernible to the magnifying loops.

Ceramic surface treatment:

1) E-max specimens:

Ceramic specimens of E-max group were etched using 9.5% hydrofluoric acid. Etching gel was applied to the fitting surface of specimens for 20 seconds [5] then rinsed thoroughly with water for 60 seconds to completely remove the etchant and dried well.

Then using a microbrush, silane coupling agent was applied on the surface of E-max specimens for 60 seconds⁶ then dried well.

2) Zirconia specimens:

The bonding areas were sandblasted with 50µm aluminum oxide at a pressure of 2 bars at a distance of 10mm for 30 seconds.

Z-plus MDP primer was applied to the pretreated surfaces of the Zirconia samples using a micro-brush and left to react for 60 seconds then dried with a stream of oil-free air as recommended by the manufacturer.

Tooth surface treatment:

The prepared enamel surface of each tooth was etched using 37% phosphoric acid for 30 seconds then rinsed with air/water jet for 60 seconds and dried to remove excess water.

Universal bonding agent was applied to the etched enamel surface and activated for 20 seconds, air dried for 5 seconds



then light cured for 10 seconds according to the manufacturer’s instructions.

Cementation procedure:

Light cured adhesive resin cement (Relyx™ Venner) was applied to the fitting surface of each ceramic specimen, then the specimen is holded using vivastick (Ivoclar Vivadent) and was gently seated on the tooth, and the excess resin cement was removed.

Short initial light curing or tack curing for 2-3 seconds was performed to create a semi-gel state in the luting cement for easier excess material removal. Then excess cement was carefully removed by hand scaler at the margins. Curing was continued for 20 seconds at rapid mode.

Laser application:

thermocycling

The specimens were subjected to 5000 thermal cycling, which is equivalent to six months of thermal changes in an oral environment, between 5 and 55 °C in deionized water with a dwell time of 30 s and transfer time of 20 s as recommended in ISO/TS 11405 Technical specification for testing of adhesion to tooth structure.^{7,8}

Following thermal cycling, Er:YAG laser beam with wavelength 2940 nm was applied to half of the samples with 20 % water cooling and 80% air at a power of 5 W. Er:YAG Booster handpiece was selected for the study using a saffire tip of diameter 600 mm positioned perpendicular to the veneer surface at a distance 2 mm. Laser was then applied by scanning method through the surface for 9 seconds with horizontal movements perpendicular to the surface.

Surviving specimens that did not debond after 9 seconds were further tested for shear bond strength.

Measurements:

Shear bond strength testing:

The test was applied to the control groups and the veneers of both ceramic groups that did not debond after the time selected in the study of LASER application to determine the change in bond strength.

In order to carry out the shear bond strength test, each sample was individually placed in the holder of a universal testing machine (Instron Testing Machine). A crosshead speed of 0.5 mm/min and load cell 5 KN with a parallel knife edge blade positioned at the tooth laminate interface incisally was used and the debonding fracture load was recorded in Newtons.

Shear bond strength calculations;

Debonding loads were calculated as shear stress (MPa) by dividing the failure load (N) by the bonding area (mm²).

$$\tau = F/A$$

τ is the shear stress in megapascals (MPa), F is the failure load in newtons (N) and A is the surface area in squaremillimeters (mm²).⁹

Statistical analysis:

Numerical data were explored for normality by checking the data distribution, calculating the mean and median values and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data showed parametric distribution so; it was represented by mean and standard deviation (SD) values. Two-way ANOVA was used to study the effect of different tested variables and their interaction on shear bond strength (MPa). The significance level was set at p ≤0.05 within all tests. Statistical analysis was performed with IBM® SPSS® Statistics Version 26 for Windows.

Results:

Table (3): Descriptive statistics of shear bond strength value (MPa) for different groups

Treatment	Ceramic material	Thickness	Mean	SD
Control	E-max	0.3 mm	10.58	1.52
		0.7mm	10.84	1.45
	Cubic zirconia	0.3 mm	5.38	1.55
		0.7mm	5.64	1.68
Er:YAG	E-max	0.3mm	3.50	1.27
		0.7mm	5.72	1.16
	Cubic zirconia	0.3mm	0	1.35
		0.7mm	1.14	2.05

Table (4): Mean ± standard deviation (SD) of shear bond strength (MPa) for E-max samples with different treatments

Material	Treatment (mean±SD)		p-value
	Control	Er:YAG	
E-max	10.71±1.47	4.61±1.15	<0.001*

*; significant (p ≤ 0.05) ns; non-significant (p>0.05)



Table (5): Mean ± standard deviation (SD) of shear bond strength (MPa) for cubic zirconia samples with different treatments

Material	Treatment (mean±SD)		p-value
	Control	Er:YAG	
Cubic Zirconia	5.51±1.55	0.571±1.68	<0.001*

*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Table (6): Mean ± standard deviation (SD) of shear bond strength (MPa) for E-max samples in 0.3 and 0.7mm thickness.

Material	Thickness (mean±SD)		p-value
	0.3mm	0.7mm	
E-max	7.04±12.76	8.28±13.27	0.031

*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Table (7): Mean ± standard deviation (SD) of shear bond strength (MPa) for cubic zirconia samples in 0.3 and 0.7mm thickness.

Material	Thickness (mean±SD)		p-value
	0.3mm	0.7mm	
Cubic zirconia	2.69±2.71	3.35±3.38	0.052

*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Table (8): Mean ± standard deviation (SD) of shear bond strength (MPa) for control samples made with different materials

Treatment	Material (mean±SD)		p-value
	E-max	Cubic zirconia	
Control	10.714±1.47	5.51±1.55	<0.001*

*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Table (9): Mean ± standard deviation (SD) of shear bond strength (MPa) for Er:YAG laser treated samples made with different materials

Treatment	Material (mean±SD)		p-value
	E-max	Cubic zirconia	
Er:YAG	4.614±1.15	0.571±1.68	<0.001*

*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Table (10): P values of interactions between all variables

Interaction	Dependent variable	P value
Material	Control	0.000
	ErYaG	0.000
Thickness	Control	0.0750
	ErYaG	0.000
Treatment	E-max	0.000
	Cubic zirconia	0.000
Material* Thickness	Control	0.503
	ErYaG	0.194

*; significant (p ≤ 0.05) ns; non-significant (p>0.05)

Discussion:

All ceramic restorations have gained popularity among patients and clinicians and are considered a gold standard for restoring damaged or missing teeth.¹⁰ Ceramic materials offer superior esthetics by mimicking enamel and dentin properties and are widely used.¹¹ However, the incorporation of all ceramic prosthesis into the dental practice has also challenged operators in their removal for functional, biological or esthetic failures.¹²

Removal of all ceramic prosthesis is time consuming and distressing for the patient.^[11] High bond strength offered by resin based cements, commonly used to cement the ceramic restorations, may challenge operators by offering resistance

towards an intact removal of ceramic restorations.¹³ Since the restoration, cement and underlying dental tissues have almost the same color, removing such restorations using traditional methods as chisels or crown removals is inconvenient, time consuming and damages the integrity of the ceramic.¹⁴

To overcome these difficulties, the use of erbium lasers was recently introduced as a more suitable alternative to remove all ceramic restorations.¹⁵

Freshly extracted teeth are preferred to simulate clinical conditions.¹⁶

However to obtain sufficient number of teeth it was collected over time and stored in saline through out the

study to prevent dehydration until they were further used in veneer preparation.¹⁷

Two types of dental ceramic materials were selected for this study, lithium disilicate glass ceramics and cubic zirconia (Ultra translucent zirconia) were selected in this study due to their good esthetics & good mechanical strength, owing to incorporation of crystalline materials in the glassy matrix in case of lithium disilicate materials & in case of cubic zirconia FULL crystalline material giving high mechanical strength & improved edge strength.¹⁸ Previous studies showed high successful rates of laminate veneers fabricated from lithium disilicate and zirconia reinforced lithium silicate.¹⁹ which derived us to choose cubic zirconia as newly introduced material to test its bonding strength.

Ceramic specimens of lithium disilicate (E-max) group were etched by 9.5 % hydrofluoric acid etch for 20 seconds followed by application of silane coupling agent for one minute according to manufacturer's recommendation^{5,6}. This protocol was recognized in previous studies as the most accepted surface treatment for glass ceramics.²⁰

While ceramic specimens of cubic zirconia(cz) Group were sandblasted with 50µm aluminum oxide at a pressure of 2 bars at a distance of 10mm for 30 seconds. Then a universal primer (Monobond Plus) which contain both 10-MDP and silane. was applied to the pretreated surfaces of the Zirconia samples using a micro-brush and left to react for 60 seconds then dried with a stream of oil-free air as recommended by the manufacturer.

Prepared enamel surface was etched with 37 % phosphoric acid for 30 seconds to enhance the surface wettability, surface roughness, and surface free energy.²¹

This was followed by the application of Universal bonding agent, activated for 20 seconds than light cured for 10seconds.²²

Light cured adhesive resin cement was applied to the fitting surface of each ceramic specimen, then the specimen was gently seated on the tooth, and the excess resin cement was removed. Light cured resin cement allows extended working time, cement excess removal around the restoration before light activation and reducing time needed for finishing after restorations have been luted. Moreover, light cured resin cements have the great advantage of improved color stability, since no tertiary amines are used as chemical activator, which by time could cause color change.²³

When cementing E-max and cubic zirconia specimens, 1 Kg seating load was applied to ensure a uniform cement space for all specimens.²⁴

Then Short initial light curing or tack curing for 2-3 seconds was performed to create a semi-gel state in the luting cement for easier excess material removal. Then excess cement was carefully removed by hand scaler at the margins. Curing was continued for 20 seconds at rapid mode.

Thermal fluctuations with developing crack propagation, catastrophic failures in ceramic restoration and through hydrolyzing silicon oxygen bonds at the ceramic cement

interface cause ceramic resin bonding weakening over time. Therefore, thermal aging was applied in this study to mimic these clinical situations.²⁵

Er:YAG laser was selected in this study since it is effective in reducing shear bond strength of all ceramic restorations resulting in easy removal of the restorations with none or minimal damage to teeth or ceramic surfaces.²⁶ There are multiple studies in literature performed using Er:YAG laser in debonding of laminate veneers.²⁷

The Er:YAG laser emits at wavelength of 2940 nm which matches with the principal peak of water absorption spectrum. Therefore, the energy might be absorbed by adhesive bonding resin compromised of water or residual monomer.³

Laser irradiation was accompanied by 20 % water cooling to protect pulp tissue and prevent cracking of dental surfaces. Average power of 5 Watt was used to avoid increase in the maximum deviation in temperature.²⁸

Scanning through the surface of laminate veneer and not applying to one point was performed with horizontal movements perpendicular to the surface to decrease the heat conduction to the pulp and the effect of laser energy. This method was reported by Oztoprak et al.²⁹

The laser energy was applied to the test groups for 9 s since this duration is considered safe to the pulpal tissue as described by Nalbantgil et al.³⁰

Shear test was used in this study to measure the bond strength of dental materials since the test procedure is easy, requires minimum equipment and specimen preparation is easier than those of tensile tests.³¹

It was found that Regardless of the thickness of the sample, control samples (10.71±1.47) had statistically significant higher shear bond strength values than laser treated samples (4.61±1.15) (p<0.001). This may be due to the effect of the Er:YAG laser in reducing the shear bond strength of all ceramic restorations.¹¹

The results of this study are in agreement with those published by Oztoprak et al.³² and Iseri et al.,³³ who showed that Er:YAG laser application reduced shear bond strength of lithium disilicate laminate veneers.

Moreover, Rifat et al.,²⁶ used lithium disilicate glass ceramic and concluded that laser treated samples showed significantly lower debonding values than the control group.

Regardless of the thickness of the sample, control samples (5.51±1.55) had statistically significant higher shear bond strength values than laser treated samples (0.571±1.68) (p<0.001). This may be attributed to the effect of laser in decreasing shear bond strength.

The results are in accordance with Rechmann et al.,¹³ who stated the efficiency of Er:YAG in reducing shear bond strength which was due to The observed carbonization at the cement ceramic interface that allowed the speculation with removal of zirconia crowns, the cement fumes as

described, consequently heats up and deteriorates, and it is less likely that an explosive ablation takes place. Nevertheless, it was shown that Zirconia might allow enough laser energy transmission for a debonding effect.

There was significant difference between both E-max thicknesses where higher microshear bond strength within 0.7 mm than that in 0.3mm thickness. This was because of the nature of lithium disilicate material (E-max) & its composition of glassy phase accompanied by disilicate crystals, the glassy phase allowed more laser transmission with 0.3 mm thickness that caused higher debonding than 0.7 mm specimens, the transmitted amount of laser energy depends upon the ceramic thickness and composition.³⁴

While for ultra translucent cubic zirconia micro shear bond strength was slightly higher with 0.7 mm thickness than 0.3mm thickness But there was no significant difference between both thicknesses & this can be explained due to cubic zirconia is isotropic that has larger crystals, decreasing the amount of times the light is scattered, making it appear more translucent & Make the laser radiation scattered easily because of the highly crystalline Nature of the material.

This result was in accordance to Sari et al.,¹² who stated that the power transmitted through different dental ceramics was measured, and the transmitted Er:YAG laser power decreased with the thickness of the ceramic samples.

E-max samples (10.714±1.47) had statistically significant higher shear bond strength values than cubic zirconia samples (5.51±1.55) (p<0.001) in control group. The bond strength of a ceramic to tooth structure varies depending on the type of ceramic, functional monomer content of the adhesive primer and bonding agents.

Z-primer containing 10 MDP was applied for zirconia Zhao et al.,³⁵ concluded that the presence of MDP in the cement did not appear to have a positive effect on long-term bond strength to zirconia. SO may be the significant decrease in zirconia bonding strength compared with the E-max bonding strength was due to thermo-cycling & hydrolytic degradation in MDP primer used in zirconia bonding.

Conclusion:

Er:YAG laser is effective in glass ceramic veneer debonding. However, the effect is material dependant since lithium disilicate had superior laser transmission than cubic zirconia. Ceramic thickness had a direct effect on debonding of veneers in E-max while showed no effect in the zirconia specimens due to it lower laser transmission. E-max showed higher bonding strength to enamel than with cubic zirconia.

References:

1. Zarone F, Leone R, Irene M, Mauro D, Ferrari M, Sorrentino R. No-preparation ceramic veneers: a systematic review. *J Osseointegration*. 2018; (10): 17–22.

2. Made SAM Van Der, Meisberger EW, Magne P, Özcan M. Performance of ceramic laminate veneers with immediate dentine sealing: An 11 year prospective clinical trial. *Dent Mater*. 2019; (35): 1042–1052.
3. Ghazanfari R, Nokhbatolfighahaei H, Alikhasi M. Laser-Aided ceramic bracket debonding: A comprehensive review. *J Lasers Med Sci*. 2016; (7): 2–11.
4. Tak O, Sari T, Arslan Malkoç M, Altintas S, Usumez A, Gutknecht N. The effect of transmitted Er:YAG laser energy through a dental ceramic on different types of resin cements. *Lasers Surg Med*. 2015; (47): 602–607.
5. [https:// www. bisco. com/ instructions/% 284% 29 Porcelain %20 Etchant _English.pdf](https://www.bisco.com/instructions/%20Porcelain%20Etchant_English.pdf). Accessed May 1, 2016.
6. Cinar S, Altan B, Akgungor G. Comparison of Bond Strength of Monolithic CAD-CAM Materials to Resin Cement Using Different Surface Treatment Methods. *J Adv Oral Res*. 2019; (10): 120–127.
7. ISO/TS 11405. 2015. Dentistry – testing of adhesion to tooth structure, 3rd ed. Geneva, Switzerland: International Standard Organization.
8. Oztoprak MO, Nalbantgil D, Erdem AS, Tozlu M, Arun T. Debonding of ceramic brackets by a new scanning laser method. *Am J Orthod Dentofac Orthop*. 2010; (138): 195–200.
9. Bahgat SF, Basheer RR, El Sayed SM. Effect of zirconia addition to lithium disilicate ceramic on translucency and bond strength using different adhesive strategies. *Dental Journal*. 2015; (61): 4533.
10. Sailer I, Makarov NA, Thoma DS, Zwahlen M, Pjetursson BE. All-ceramic or metal-ceramic tooth-supported fixed dental prostheses (FDPs)? A systematic review of the survival and complication rates. Part I: Single crowns (SCs). *Dent Mater*. 2015; (31): 603–23.
11. Kellesarian SV, Ros Malignaggi V, Aldosary KM, Javed F. Laser-assisted removal of all ceramic fixed dental prostheses: A comprehensive review. *J Esthet Restor Dent*. 2017; (30): 216–222.
12. Sari T, Tuncel I, Usumez A, Gutknecht N. Transmission of Er:YAG laser through different dental ceramics. *Photomed Laser Surg*. 2014; (32): 37–41.
13. Rechmann P, Buu NCH, Rechmann BMT, Finzen FC. Laser all-ceramic crown removal—a laboratory proof-of-principle study—phase 2 crown debonding time. *Lasers Surg Med*. 2014; (46): 636–643.
14. Rechmann P, Buu NCH, Rechmann BMT, Finzen FC. Laser all-ceramic crown removal and pulpal temperature—a laboratory proof-of-principle study. *Lasers Med Sci*. 2015; (30): 2087–2093.

15. Gurney ML, Sharples SD, Phillips WB, Lee DJ. Using an Er,Cr:YSGG laser to remove lithium disilicate restorations: A pilot study. *J Prosthet Dent.* 2016; (115): 90–94.
16. Homaei E, Farhangdoost K, Pow EHN, Matinlinna JP, Akbari M, Tsoi JKH. Fatigue resistance of monolithic CAD/CAM ceramic crowns on human premolars. *Ceram Int.* 2016; (42): 15709–15717.
17. Van As G. Erbium lasers in dentistry. *Dent Clin North Am.* 2004; (48): 1017–1059.
18. Saad SA, Shalaby YA, Azer AS, El-Sharkawy FM. Spectrophotometer Analysis of Cad-Cam Zirconia Reinforced Lithium Silicate and Lithium Disilicate Glass Ceramics. *Alexandria Dent J.* 2019; (44): 53–58.
19. Al-Akhali M, Chaar MS, Elsayed A, Samran A, Kern M. Fracture resistance of ceramic and polymer-based occlusal veneer restorations. *J Mech Behav Biomed Mater.* 2017;(74):245–250.
20. Sundfeld Neto D, Naves LZ, Costa AR, Correr AB, Consani S, Borges GA, et al. The effect of hydrofluoric acid concentration on the bond strength and morphology of the surface and interface of glass ceramics to a resin cement. *Oper Dent.* 2015; (40): 470–479.
21. Wong J, Tsujimoto A, Fischer NG, Baruth AG, Barkmeier WW, Johnson EA, et al. Enamel Etching for Universal Adhesives: Examination of Enamel Etching Protocols for Optimization of Bonding Effectiveness. *Oper Dent.* 2020; (45): 80–91.
22. Beltrami R, Chiesa M, Scribante A, Allegretti J, Poggio C. Comparison of shear bond strength of universal adhesives on etched and nonetched enamel. *J Appl Biomater Funct Mater.* 2016; (14): 78–83.
23. Novais VR, Raposo LHA, de Miranda RR, Lopes C de CA, Simamoto Júnior PC, Soares CJ. Degree of conversion and bond strength of resin-cements to feldspathic ceramic using different curing modes. *J Appl Oral Sci.* 2017; (25): 61–68.
24. Sagen MA, Kvam K, Ruyter EI, Rønold HJ. Debonding mechanism of zirconia and lithium disilicate resin cemented to dentin. *Acta Biomater Odontol Scand.* 2019; (5): 22–29.
25. Kiomarsi N, Saburian P, Chiniforush N, Karazifard MJ, Hashemikamangar SS. Effect of thermocycling and surface treatment on repair bond strength of composite. *J Clin Exp Dent.* 2017; (9): 945–951.
26. Rifat G, Merve KY, Sinem OK. Effects of Different Er:YAG Laser Parameters on Debonding Forces of Lithium Disilicate Veneers: A Pilot Study. *Eur J Res Dent.* 2019; (1): 8–13.
27. ALBalkhi M, Swed E, Hamadah O. Efficiency of Er:YAG laser in debonding of porcelain laminate veneers by contact and non-contact laser application modes (in vitro study). *J Esthet Restor Dent.* 2018;(30): 223–228.
28. Nalbantgil D, Tozlu M, Oztoprak MO. Comparison of Different Energy Levels of Er:YAG Laser Regarding Intrapulpal Temperature Change during Safe Ceramic Bracket Removal. *Photomed Laser Surg.* 2018; (36): 209–13.
29. Oztoprak MO, Nalbantgil D, Erdem AS, Tozlu M, Arun T. Debonding of ceramic brackets by a new scanning laser method. *Am J Orthod Dentofac Orthop.* 2010; (138): 195–200.
30. Nalbantgil D, Oztoprak O, Tozlu M, Arun T. Effects of different application durations of ER:YAG laser on intrapulpal temperature change during debonding. *Lasers Med Sci.* 2011; (26): 735–40.
31. Alkhurays M, Alqahtani F. Influence of different luting cements on the shear bond strength of pretreated lithium disilicate materials. *J Contemp Dent Pract.* 2019; (20): 1056–60.
32. Oztoprak MO, Tozlu M, Iseri U, Ulkur F, Arun T. Effects of different application durations of scanning laser method on debonding strength of laminate veneers. *Lasers Med Sci.* 2012; (27): 713–6.
33. Iseri U, Oztoprak MO, Ozkurt Z, Kazazoglu E, Arun T. Effect of Er: YAG laser on debonding strength of laminate veneers. *Eur J Dent.* 2014; (8): 58–62.
34. Seydler B, Schmitter M. Esthetic restoration of maxillary incisors using CAD/CAM chairside technology-a case report. *Quintessence Int (Berl).* 2011; (42): 533–7.
35. Zhao L, Jian YT, Wang XD, Zhao K. Bond strength of primer/cement systems to zirconia subjected to artificial aging. *The Journal of prosthetic dentistry.* 2016; (116): 790-6.