Brazilian Dental Science
unesp
UNIVERSIDADE ESTADUAL PAULISTA "JÚLIO DE MESQUITA FILHO"
Instituto de Ciência e Tecnologia
Campus de São José dos Campos

ORIGINAL ARTICLE
DOI: https://doi.org/10.4322/bds.2024.e4275

Rebonding strengths of lithium disilicate and feldspathic veneers debonded by Er,Cr:YSGG laser

Resistência de recolagem de facetas de dissilicato de lítio e feldspáticas descoladas por laser Er,Cr:YSGG

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How to cite: Youssef AI, Wahsh MM, El Fatta GA, Samhan TM, Gutknecht N. Rebonding strengths of lithium disilicate and feldspathic veneers debonded by Er,Cr:YSGG laser. Braz Dent Sci. 2024;27(2):e4275. https://doi.org/10.4322/bds.2024.e4275

ABSTRACT

Objective: The aim of this study is to identify the shear bond strength of rebonded CAD/CAM laminates made of lithium disilicate or feldspathic ceramics after debonding using Er,Cr:YSGG lasers. **Material and Methods:** Eighty bovine teeth (N=80) were used as a bonding substrate, which were divided into four main groups (20 each) according to the ceramic material and cement-curing mode used as follows: Group AL: lithium disilicate (IPS E.max) with light-cured resin cement, Group AD: lithium disilicate (IPS E.max) with dual-cured resin cement, Group BL: feldspathic porcelain (VITA MARK II) with light-cured resin cement, and Group BD: feldspathic porcelain (VITA MARK II) with dual-cured resin cement. Half the number of each subgroup (n=10/subdivisions) were tested for their shear bond strength without debonding, while the other half of the specimens were tested after Er,Cr:YSGG laser debonding and rebonding. A three-way ANOVA test was used to study the effect of ceramic and curing on shear bond strength. Bonferroni's post-hoc test was used for pairwise comparisons when the ANOVA test was significant. **Results:** After rebonding and using the light-cure mode, there was no statistically significant difference between the mean shear bond strength of the two ceramics (P-value = 0.065). However, after rebonding and using the dual-cured mode, E.max showed significantly lower shear bond strength than VITA (P-value < 0.001). **Conclusion:** Ceramic type, the cement's curing mode, and rebonding after laser irradiation all had a significant effect on the mean shear bond strength.

KEYWORDS

Ceramic veneers; Debonding; Er,Cr: YSGG; Feldspathic; Laser.

RESUMO

Objetivo: Identificar a resistência de cisalhamento de laminados CAD/CAM recolados, feitos de cerâmica de disilicato de lítio ou feldspática, após descolamento utilizando lasers Er,Cr:YSGG. **Material e Métodos:** Oitenta dentes bovinos (N=80) foram utilizados como substrato de colagem, divididos em quatro grupos principais (20 cada) de acordo com o material cerâmico e o modo de cura do cimento utilizado da seguinte forma: Grupo AL: disilicato de lítio (IPS E.max) com cimento resinoso fotopolimerizável, Grupo AD: disilicato de lítio (IPS E.max) com cimento resinoso de dupla cura, Grupo BL: porcelana feldspática (VITA MARK II) com cimento resinoso fotopolimerizável, e Grupo BD: porcelana feldspática (VITA MARK II) com cimento resinoso de dupla cura. Metade do número de cada subgrupo (n=10/subdivisões) foi testada quanto à resistência de cisalhamento sem descolamento, enquanto a outra metade dos espécimes foi testada após descolamento e recolagem a laser Er,Cr:YSGG. Um teste ANOVA de três vias foi usado para estudar o efeito da cerâmica e da cura na resistência de cisalhamento. O teste post-hoc de Bonferroni foi usado para comparações pareadas quando o teste ANOVA foi significativo. **Resultados:** Após a recolagem e usando o modo de fotopolimerização, não houve diferença estatisticamente significativa entre a resistência de cisalhamento média das duas cerâmicas (valor de P = 0,065). No entanto, após a recolagem e usando o modo de dupla cura, o E.max apresentou resistência de cisalhamento significativamente menor que o VITA (valor de P < 0,001). **Conclusão:** O tipo de cerâmica, o modo de cura do cimento e a recolagem após irradiação a laser tiveram efeito significativo na resistência de cisalhamento média.

PALAVRAS-CHAVE

Laminados cerâmicos; Descolagem de cerâmica; Er,Cr; YSGG; Cerâmica feldspática; Laser.

INTRODUCTION

Nowadays, the dental industry has witnessed the emergence of a wide array of innovative materials that can be employed for aesthetic restorative purposes. These materials can be utilized either directly or indirectly, offering a versatile range of applications. The ceramics are among the most sought-after and highly acclaimed restorative materials for the laminate veneers [1]. They possess remarkable esthetic qualities, particularly when manufactured using the layering technique [2,3]. The materials frequently employed for laminate veneers include feldspathic porcelain and lithium disilicate. These two types of veneers boast a multitude of advantages and features. Feldspathic porcelain veneers are suitable prosthetic restorations in the frontal area due to their long-term survival rates, conservative nature, longevity, biocompatibility, and aesthetics. These desirable strength values include flexural strength (62–90 MPa), compressive strength (172 MPa), shear strength (110 MPa), and modulus of elasticity (69 GPa) [4]. As for the lithium disilicate, it is composed of high concentration of crystals which results in a flexural strength similar to enamel (360–400 MPa). Apart from having a low refractive index and a high translucency, lithium disilicate is also known for a unique characteristic known as the “Umbrella Effect,” which permits light to pass through the substance and partially absorb light. This characteristic makes lithium disilicate highly aesthetically pleasing and makes the adhesive processes easier [5].

Notably, the implementation of cutting-edge Computer-aided design and Computer-aided manufacturing (CAD/CAM) technology in the production process renders these veneers exceptionally durable. Furthermore, their construction in thin layers obviates the need for tooth preparation. In essence, this remarkable characteristic of ceramic veneers ensures the preservation of the tooth structure [6].

However, certain local failures might arise, such as discoloration, microleakage, ditching at the margins, or simple fractures. These failures would necessitate repair or replacement [7]. Currently, the prevailing technique for eliminating all-ceramic restorations entails employing a high-speed handpiece with a diamond. Owing to the remarkable color-matching capabilities of both resin-bonding cement and the veneers themselves with the underlying tooth structure, the removal of veneers without causing harm to the natural tooth underneath can prove to be challenging and time-consuming, even with the aid of magnification [8,9]. The enamel, serving as a substrate, plays a crucial role in the long-term success of porcelain veneers. However, the bond strength will significantly decline if veneer preparations are excessively aggressive, resulting in substantial dentin exposure studies have shown that when Ceramic Laminate Veneers were glued to 100% enamel on the finishing surfaces, their shear bond strength test result was around 20 MPa, which is double that of veneers bonded to dentin. Additionally, enamel has a higher degree of mineralization than dentin, and the production of resin protrusion in enamel is facilitated by the honeycomb structure that results from the demineralization of hydroxyapatite. Nonetheless, dentin has a higher concentration of organic components and contains a significant amount of water in its tubules. The collagen fibre network can collapse as a result of improper acid etching and drying, which significantly affects dentin bonding [10]. Hence, it can be inferred that numerous dentists might be interested in discovering a safe, predictable, and efficient method for debonding ceramic veneers without causing any further iatrogenic damage to both the laminate veneer and the underlying tooth structure [9].

A novel technique for the removal of laminate veneers has recently been developed using the Er:YAG laser (2940 nm), which is a type of laser that contains erbium-doped:

yttrium aluminum garnet [11]. This technique was inspired by its successful application on orthodontic ceramic brackets in the 1990s [12,13]. The Erbium, Chromium: YSGG (2780 nm) laser is an additional form of erbium laser. It uses a solid crystal of yttrium scandium gallium garnet doped with erbium and chromium as its active medium. When the samples were viewed under a scanning electron microscope, the effect of Er:YSGG on debonding revealed that the bulk of the adhesive failures of the cements occurred in this manner [14]. So, Er,Cr:YSGG laser has no effect on tooth structure roughness or topography as well as on calcium and phosphorus content of enamel of tooth structure after debonding [15].

The investigation into the application of erbium lasers as a secure and efficient removal of ceramic sample veneers has shown encouraging outcomes. However, there is a lack of research on the surface properties of removed veneers and the durability of reattached restorations, necessitating further investigation [16]. Therefore, it is important to examine the impact of Er,Cr:YSGG laser debonding on the shear bond strength of reattached CAD/CAM blocks made of feldspathic or lithium disilicate. The null hypothesis of our study states that there are no substantial effects on the shear bond strength of rebonded feldspathic or lithium disilicate porcelain veneers, after being debonded by laser.

MATERIAL AND METHODS

Sample size calculation

Based on a prior work by Karagoz-Yildirak and Gozneli [17], who also investigated a related concept about leucite and lithium disilicate veneers debonded with Er:Yag laser, the sample size was determined. By implementing a two tailed Z test for difference between independent proportions with an alpha level of 5% and a power of 80%. The sample size needed was 104 (13 per group) in order to detect a difference of 20%.

Grouping

A total number of 80 specimens were used in this study. Specimens were randomly divided into four main groups (20 each) according to the ceramic material and cement-curing mode used as follows:

Group AL:lithium disilicate (IPS E.max) with Light cured resin cement (RelyX Veneer, 3M™, USA).

Group AD: lithium disilicate (IPS E.max) with Dual cured resin cement (RelyX ultimate clicker, 3M™, USA).

Group BL: Feldspathic porcelain (VITA MARK II) with Light cured resin cement.

Group BD: Feldspathic porcelain (VITA MARK II) with Dual cured resin cement

Each group were further sub-divided into two sub-groups (10 each) as follows:

Subgroup S1: specimens tested for their shear bond strength without debonding.

Subgroup S2: specimens tested for their shear bond strength after rebonding.

Sample Preparation

Freshly extracted bovine teeth that had been preserved in a saline solution were utilized as the bonding substrate and subsequently secured in an acrylic mold. A specific mold was created for each individual bovine tooth, which was then filled with cold cure acrylic resin (Cold cure acrylic resin, Acrostone Dental & Medical Supplies, Egypt), that had been color coded for the purpose of facilitating differentiation between various groups. Prior to pouring the cold cure acrylic resin into the molds, Vaseline was applied to serve as a separating medium. The teeth were then fixed in the cold cure acrylic resin before it fully set. To prepare the labial surfaces of the teeth, depth orientation grooves measuring 0.3 mm in depth were initially placed using a depth cutting stone (MANI, INC., Japan). Following this, a customized parallel device was employed to achieve standardized preparation and smooth the labial surface. For 30 seconds, the teeth were etched using a 37% phosphoric acid gel (Scotch Bond phosphoric acid etching gel, 3MESPE, Germany). After that, a further 30 seconds of air-water rinsing was performed. Following application and activation for 15 seconds, the bonding agent (Adper Single bond 2, 3MESPE, USA) was light cured (MINILEDTM, Acteon, France) in accordance with the manufacturer's instructions.

Fabrication of laminates

Using a low-speed, high-precision diamond saw (Isomet diamond saw 4000, Buehler, USA.), the specified lithium disilicate (IPS E.max CAD, Ivoclar Vivadent, Liechtenstein) and Feldspathic glass-matrix ceramic (Vita Mark II, VITA Zahnfabrik, Germany) LT A1 CAD/CAM blocks were sliced to dimensions of 10×10 mm in accordance with the size of the blocks (C14 & I14). A standardized thickness of 0.7 mm was applied to all groups based on recommendations for all-ceramic samples [10,11]. The slices were cut using an integrated coolant delivery system that tracked the position of the blade at a constant feed rate and inundated the samples from both sides of the blade, cutting off 14.7 mm per minute at 2500 rpm in increments of 50 rpm. Figure 1. To crystallize all the ceramic samples, a furnace (EP3010 programat, Ivoclar Vivadent, Schaan, Liechtenstein) was used (Table I). Glazing were done to the out surface after crystallization process .Afterwards both ceramic samples, were etched using 9.5% HF acid (ITENA Porcelain Etch, France) for a period of 20 seconds [18]. The samples were subsequently rinsed with an air and water spray. Finally, the ceramic sample was silanized (97% ethyl alcohol, ITENA Porcelain Etch, France) in accordance with the instructions provided by the manufacturer.

Laminates cementation

After teeth specimens and ceramic samples preparation and surface treatment, the cement was then applied according to their corresponding group. Cement was applied using either light cured resin cement or dual cured resin cement. After applying cement for 30 seconds, a 50 N force was applied perpendicularly to the external surfaceusing a dental surveyor and light-activated for 40 seconds LED curing light (MINILED™, Acteon, France) using an 11-mm-diameter tip that is positioned 1.0 mm from the sample's surface to direct the light bean on the top surface. Following the cementation process, the samples were kept for 24 hours at 37 °C in distilled water.

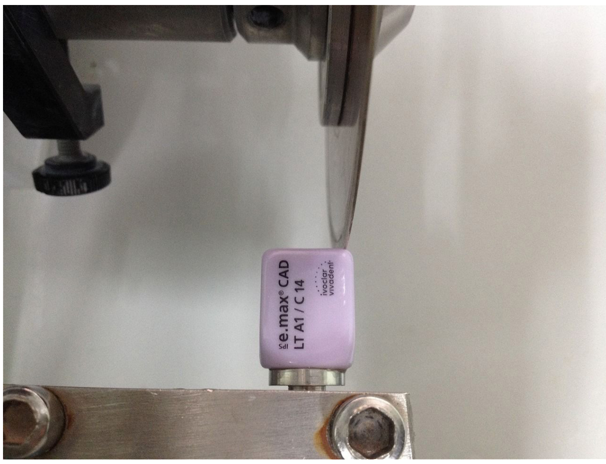

Figure 1 - Cutting lithium disilicate blocks.

Laser debonding

WaterLase IPLUS Er;Cr:YSGG (Biolase, USA) was used to apply a laser beam of wavelength 2780 nm using the following specific settings (Table II) for each group except the specimens of the first subdivision, which were tested for their shear bond strength without debonding and were considered a control group. In order to standardize energy density, the turbo handpiece was placed perpendicular to the ceramic samples' surfaces at a distance that was confirmed by a specially designed positioner with a circular clockwise motion from the outer circle of the cemented veneer sample towards the center. The procedure was repeated until the strokes under the samples veneer exhibited distinct auditory and tactile sensations indicating debonding [17].

The debonded samples were subsequently examined for any damage using a stereomicroscope.

Rebonding debonded samples

A finishing bur (MANI, INC, Japan) was used to remove the adhesive resin remains from the tooth surfaces, creating a uniformly smooth surface in preparation for the rebonding processes that followed. Then the same ceramic specimens were used after evaluation and were cemented by light or dual-cured resin cement corresponding to their group.

Table I - Firing protocol steps

Standby temp (B) (C°)	Closing time (s) (mm:ss)	Heating Rate (t) (°C/min)	Holding Time (H) (Min.)	Holding temp (T) (°C)	Max Temp. (°C)	Vacuum On (V1) (°C)	Vacuum Off (V2) (°C)	Long time cooling (L) (°C)
403	06:00	90	00:10-07:00	830-850830-850	917	550	830-850	710

Information presented here was obtained from manufacturer technical and informative publication.

Shear bond strength testing

A universal testing machine (Instron, North America) was used to investigate the difference between the shear bond strength of the control-irradiated group (without being debonded by laser) and the lasered groups after rebonding. The samples were mounted onto the machine and were adjusted to guarantee that the shearing blade's 1-mm-thick edge was positioned as near to the tooth-ceramic interface as possible. At a crosshead speed of 1 mm/min, the shear force was applied. The values of the shear bond strength were noted in MPa [19].

Statistical analysis

Numerical data were explored for normality by checking the distribution of data and using tests of normality (Kolmogorov–Smirnov and Shapiro-Wilk tests). For Non parametric data; Mann–Whitney U test was used to compare the two ceramics. Surface roughness (Ra) and EDX data showed a non-normal distribution so we used a non-parametric test, while debonding time and shear bond strength data showed a normal distribution so we used a parametric test. Non-parametric data were presented as median and range values while parametric data were presented as mean, standard deviation and 95% Confidence Interval for the mean values.

Table II - WaterLase parameters for debonding procedures

Operation Mode	Free Running Pulse
Hand piece	Turbo handpiece (MX7)
Repetition rate	20 Hz
Power	4.5 W
Pulse duration	(60μs) H mode
Air	60%
Water	80%
Non-Contact mode	5mm away

For non-parametric data; Mann–Whitney U test was used to compare between two ceramics. The Kruskal-Wallis test was used to study the effect of curing on (Ra). Dunn's test was used for pair-wise comparisons.

For parametric data, Student's t-test was used to compare between debonding times of two ceramics.Three-way ANOVA test was used to study the effect of ceramic and curing on shear bond strength. Bonferroni's post-hoc test was used for pair-wise comparisons when the ANOVA test was significant. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.

RESULTS

The findings of the three-way ANOVA (Table III) indicated that the mean shear bond strength was statistically significantly influenced by the ceramic type, curing mode, and rebonding on their own, irrespective of the effects of other factors. The mean shear bond strength was also statistically significantly affected by the interaction between the three factors. The variables are dependent on one another because of their statistically significant interaction.

IPS E.max CAD had a statistically significant lesser mean shear bond strength than VITA (at P-value <0.001, Effect size = 0.788) and at P-value <0.001, Effect size = 0.935) correspondingly in the control group, regardless of whether light or dual cure resin cement was used. While E.max showed statistically significantly lower mean shear bond strength than VITA (at P-value <0.001, Effect size = 0.939) after rebonding and using dual-cure mode, there was not a statistically significant distinction between the mean shear bond strength of the two ceramics after rebonding and using light cure mode (P-value = 0.065, Effect size = 0.102).

Table III - Three-way ANOVA results for the effect of different variables on mean shear bond strength in Mpa

Source of variation	Type III sum of Squares	df	Mean Square	F-value	P-value	Effect size (Partial eta squared)
Ceramic Type	130770.660	1	130770.660	690.468	<0.001*	0.956
Curing Mode	48839.132	1	48839.132	257.870	<0.001*	0.890
Rebonding	7636.932	1	7636.932	40.323	<0.001*	0.558
Ceramic x Curing x Rebonding interaction	8564.402	1	8564.402	45.220	<0.001*	0.586

df: degrees of freedom = (n-1). *Significant at P ≤ 0.05.

Regarding the control group, whether with E.max or VITA, light curing modes revealed a mean shear bond strength that was statistically substantially lower than that of dual curing (P-value = 0.003, Effect size = 0.242; and P-value <0.001, Effect size = 0.629). After rebonding whether with E.max or VITA, Mean shear bond strength was statistically considerably lower in light curing modes (P-value <0.001, Effect size = 0.541) and in dual curing (P-value = 0.003, Effect size = 0.966), respectively.

Regarding E.max with light-curing mode, the mean strength of shear bond did not vary in a way that was statistically significant (P-value = 0.598, Effect size = 0.009). While with dual curing mode, rebonding revealed a mean shear bond strength that was statistically notably greater than the control (P-value <0.001, Effect size = 0.840). While rebonding demonstrated a statistically significant lower mean shear bond strength than control for VITA with light curing mode (P-value <0.001, Effect size = 0.848). Rebonding demonstrated a statistically significant increase in mean shear bond strength compared to the control group (P-value <0.001, Effect size = 0.853) for VITA with dual curing mode Table IV.

Scan Electron Microscope Evaluation:

▪ The IPS Emax CAD displayed the characteristic rod-shaped, randomly arranged, and interlocked lithium disilicate crystals encased in a glass matrix. The microstructure of the VITA MARK II was characterized by a porous substance with roughly 4 μm grains of aluminum, potassium, and sodium-based silicate. This material was described as having a honeycombed surface Figure 2. Failure Mode Analysis from SEM pictures with magnification (500 X) (Figure 3).

After SBS testing following rebonding of laser debonded ceramic specimens, failure mode analysis showed no statistically significant difference in the distribution of different modes of failures within both ceramic materials. The highest percentage of samples had an adhesive failure, (P-value = 0.998, Effect size = 0.118) (Figure 4). The SEM images with magnification (500 X).

DISCUSSION

The removal of ultrathin laminate veneers is a challenging and unavoidable procedure due to their possible fractures, incorrect placement, or recurrent caries.The enhanced bonding of the veneers to the enamel surface using resin cements causes difficulties upon their removal. The conventional method of laminates removal using drills, impose a great risk to the tooth structure underneath because of the lack of color contrast between the teeth, adhesive resin contact, and the restoration [20]. Recently, the introduction to laser technology has provided a more comfortable and conservative approach

Table IV - The mean, standard deviation (SD) values and results of three-way ANOVA test for comparison between shear bond strength values with different interactions of variables

Bonding/ Rebonding	Curing	E.max		VITA		The P-value (effect of ceramic)	Effect size (Partial eta squared)
		Mean	SD	Mean	SD		
Control	LC cement	91.3	11.3	186.2	15.1	<0.001*	0.788
	DC cement	27.2	6.1	214	16.7	<0.001*	0.935
	P-value (curing mode)	<0.001*		0.003*			
	Effect size (Partial eta squared)	0.629		0.242			
Rebonding	LC cement	86.7	11	70.1	12.7	0.065	0.102
	DC cement	140.1	16	332.5	17.5	<0.001*	0.939
	The P-value (Effect of curing)	<0.001*		<0.001*			
	Effect size (Partial eta squared)	0.541		0.966			
The P-value (Effect of rebonding)	LC cement	0.598		<0.001*			
	DC cement	<0.001*		<0.001*			
Effect size (Partial eta squared)	LC cement	0.009		0.848			
	DC cement	0.840		0.853			

*Significant at P ≤ 0.05.

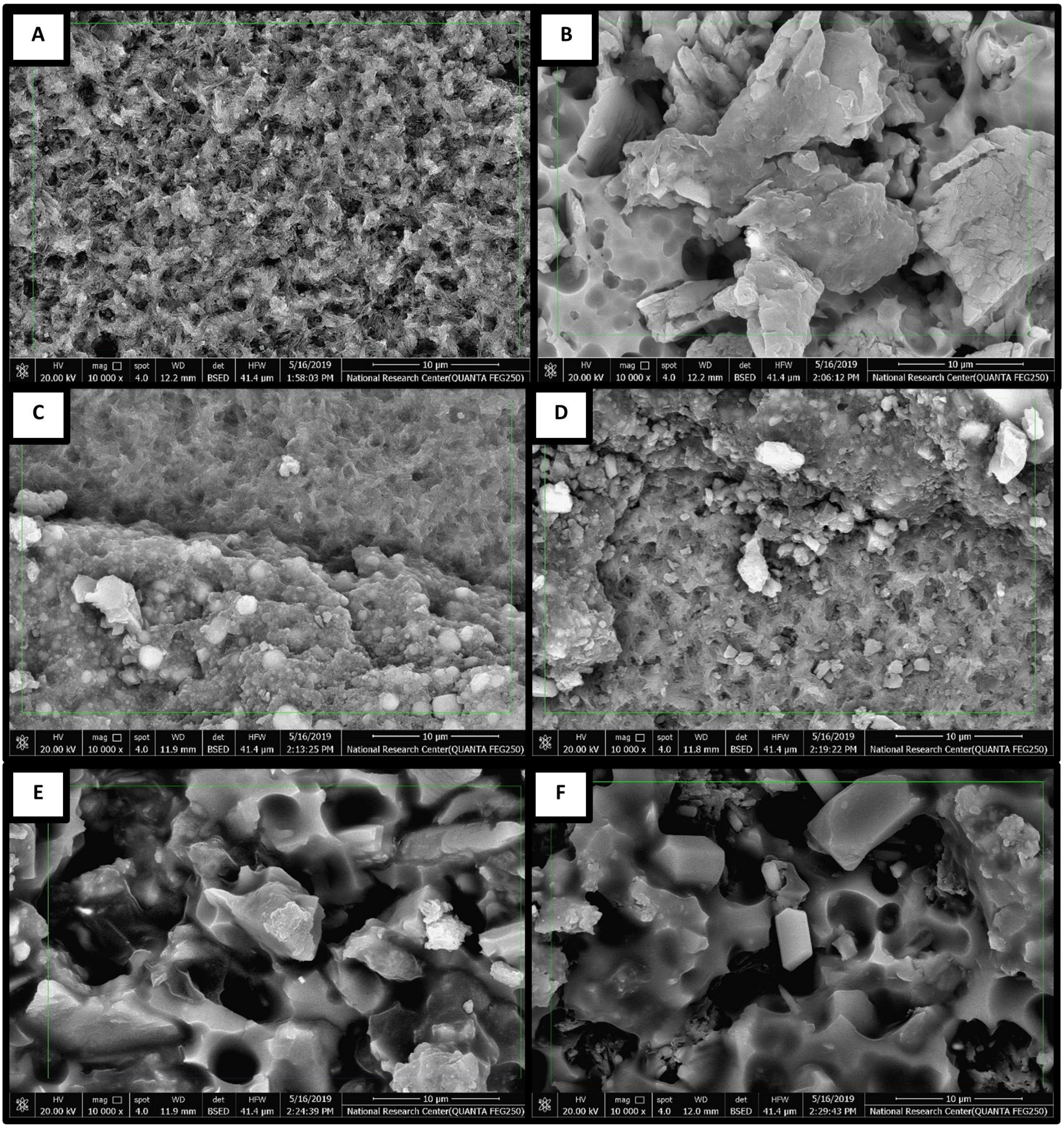

Figure 2 - (A) SEM IPS Emax CAD evaluation at baseline; (B) SEM VITA MARK II evaluation at baseline; (C) After laser debonding processes, IPS Emax CAD cemented by light cure resin cement evaluation; (D) After laser debonding processes, IPS Emax CAD cemented using Dual cure resin cement evaluation; (E) Following laser debonding techniques, VITA MARK II was bonded using an assessment of light cure resin cement; (F) Dual cure resin cement assessment of VITA MARK II cemented following laser debonding processes.

for the removal of ceramic veneers [21]. This approach has proved great success in previous studies, however, it is worth noting that only a limited number of studies have been conducted in this particular area of research. Consequently, it became a matter of interest to examine the alterations in shear bond strength of reattached veneers samples subsequent to laser debonding [9,22].

Two specific types of materials were chosen: lithium disilicate (IPS E.max) and feldspathic porcelain (Vita Mark II). These materials were chosen due to their ability to offer a satisfactory level of esthetics and mechanical properties. Both materials were utilized in the form of CAD/CAM blocks in order to ensure standardized manufacturing techniques [6].

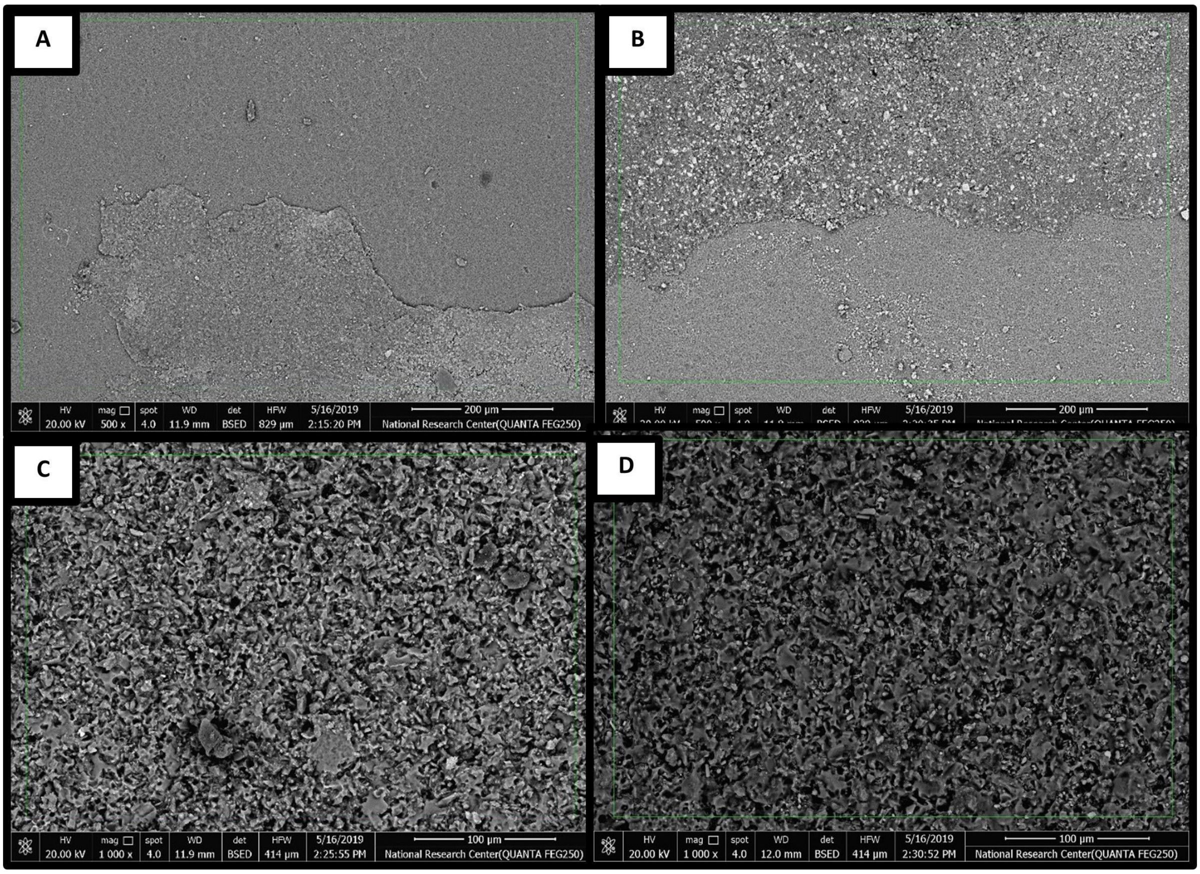

Figure 3 - Adhesive failure mode evaluation (500 X) after laser debonding (A) IPS E max CAD cemented by light Cured Resin Cement; (B) IPS Emax CAD cemented by Dual Cured Resin Cement; (C) VITA MARK II Cemented Light Cure Resin Cementd) VITA MARK II Cemented by Dual Cure Resin Cement; (D) IPS Emax CAD cemented using Dual cure resin cement evaluation using scan electron microscope after laser debonding.

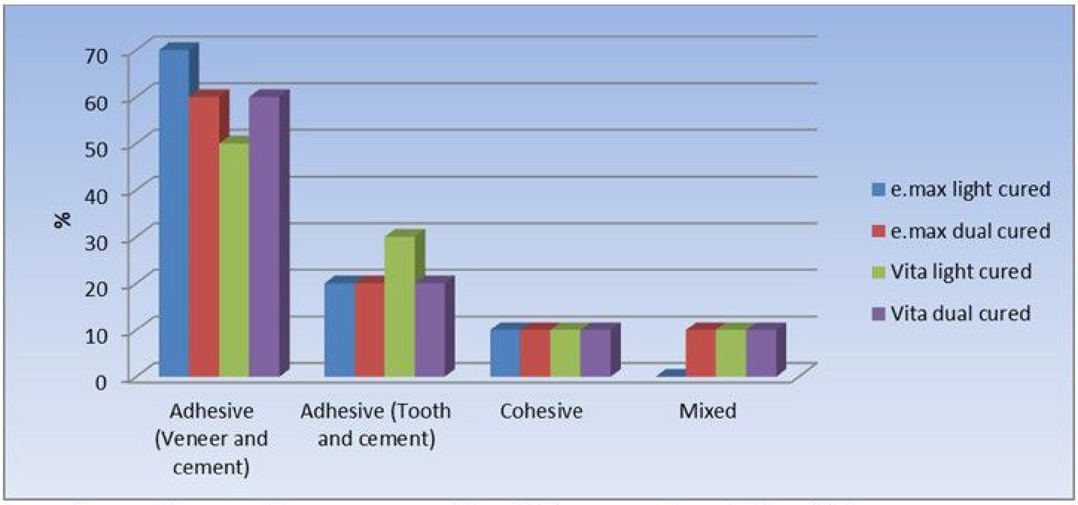

Figure 4 - Bar chart representing failure modes of the different groups.

One group of ceramic samples was adhered using light cure resin cement due to its desirable aesthetic properties, low solubility, strong bond strength, and outstanding mechanical properties that enhance ceramic restorations and/or serve to illustrate various curing methods. Dual cure resin cement was used to cement the other group [17,23].

Considered as a control group, half the specimens were put through a shear bond strength test while the other half were debonded using Er,Cr:YSGG laser. After debonding, rebonding was performed followed by testing the shear bond strength of the rebonded specimens.

When examining ceramic samples it was observed that rebonding of both ceramics showed no statistically significantly between mean shear bond strength than control group that was not previously lasered. The reason for this could be that there are no significant changes observed between the inner surface examined under a scanning electron microscope before and after laser debonding techniques. The results of this study are consistent with Karagoz-Yildirak and Gozneli [17] whose results showed there was no significant difference between the control and rebonded groups. All-ceramic restorations may be successfully removed using laser irradiation without compromising the strength of rebonding .

Regarding curing mode, mode it was observed that whether with E.max or VITA, light curing modes exhibited statistically significantly lower mean shear bond strength, compared to dual curing. The strength of bond was additionally influenced by the mode of adhesive curing, with the light curing mode yielding a lower shear bond strength when compared to the dual curing mode endorsed by El-Mowafy and Rubo [24], who emphasized that the development of dual-cure resin cements was necessary to ensure polymerization, particularly in areas that could not be reached by the curing light. Furthermore, alterations in the shade of the resin cement and the thickness of the ceramic material may produce notable discrepancies in the microhardness of the materials and the final polymerization outcome. Hofmann et al. [23] also mentioned that the energy provided during light polymerization, which is defined as the product of light intensity and exposure duration, determines the degree of conversion in the polymerization reaction.

Up to our knowledge, there is a scarcity of data regarding the impact on bond strength subsequent to the rebonding procedure, as well as there is a complete absence of data on how the bond strength of rebonded ceramic restorations is influenced by laser debonding.

Furthermore, the failure mode serves as a crucial parameter in assessing the potential risks associated with tooth and ceramic damage. A fracture can happen at the surface of the tooth or inside the ceramic if the force required to detach the restoration from the tooth is greater than the cohesive strength of the tooth structures or the ceramic material. In our study, the examination of the scanning electron microscope data revealed that there was no statistically significant difference in the baseline and roughness (Ra value) following the peeling procedure. There was no indication of any damage, ablation, or ablation pits on the ceramic laminate's surface.

In an alignment with Morford et al.'s [25] research, it was noted that the bond between the veneer and enamel was primarily disrupted at the veneer cement interface, resulting in the majority of the veneer surface being left clean, This observation highlights that during veneer debonding, the main outcome is laser ablation rather than cement thermal softening. The main outcome is laser ablation rather than cement thermal softening. Considering the mentioned wavelength's mechanism, it primarily operates by absorbing laser energy in water. It is possible conclude that the energy of Er, Cr: YSGG laser passes through the veneer and into the resin cement, which then absorbs the remaining energy and vaporizes the cement as a result. Once a sufficient amount of cement is removed from the veneer, it detaches from the tooth's surface. It can also be stated that the cement curing method does not influence the debonding process, as it is solely dependent on the the resin cement's water content not the other ingredients. It is now clear that a clean and effective laser debonding may be accomplished. For pulp safety, it is also highly recommended to utilize a potent air-water cooling spray.

Conflicting results are present in the existing literature regarding the impact of repeated bonding on the shear bond strength of ceramic brackets. While some studies have shown a significant decrease in strength after the second bonding [23], others have indicated consistent values comparable to the initial bond strength. Bulut and Atsü [26] noted that there was no notable distinction between the initial bonding strength and the strength after the first and second rebonding on enamel, or between the initial bonding strength and the strength after the first rebonding on dentin.

In the current study, the bond strength of IPS E.max cemented using light-curing resin showed no change from the control group, while the group re-cemented using dual-cured resin showed a higher mean shear bond strength than the control group. Feldspathic VITA MARK II ceramic samples rebonded using light-cured resin showed a lower mean shear bond strength than the control, while when re-cemented using dual-cured resin, a higher mean shear bond strength was obtained compared to the control. As a conclusion, the interaction between the three variables (ceramic type, curing mode, rebonding after laser irradiation) had a significant effect on the mean shear bond strength.

Within the conditions of this study and according to the study results, the null hypothesis was approved.

CONCLUSION

In summary, the three factors, namely the type of ceramic utilized, the mode of curing for the cement, and the process of rebonding subsequent to laser irradiation, exerted a noteworthy influence on the average shear bond strength. The shear bond strength of E. Max was unaffected by the rebonding process following light cure cementation, whereas the bond strength diminished with vita restorations. On the other hand, the application of dual cure cementation for rebonding exhibited an augmented shear bond strength for both materials.

Author's Contributions

AIY: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Writing – Original Draft Preparation, Writing – Review & Editing. MMW: Supervision, Validation, Visualization, Writing – Review & Editing. GAEF: Project Administration, Visualization, Writing – Review and Editing. TMS: Supervision, Data Curation, Writing – Review & Editing. NG: Supervision, Formal Analysis Validation, Visualization, Writing – Review & Editing.

Conflict of Interest

There is no conflict of interest.

Funding

The authors declare that no financial support was received.

Regulatory Statement

This study protocol was reviewed and approved by the ethical committee of the Faculty of Dentistry, Ain Shams University, Cairo, Egypt, protocol number Fpr 19-(119)-M.

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Date submitted: 2024 Feb 20
Accept submission: 2024 July 11