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The Effect of different power settings of Er,Cr:YSGG Laser on Tooth Structure Chemistry and Topography and time of Debonding of Laminate Veneers : "In Vitro Study"

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ABSTRACT

Background: Laminate veneer restorations need minimal preparation and are highly esthetic and biocompatible. However, debonding of laminate veneers without destruction or touching underlying tooth structure is challenging. Laser has afforded a great tool of help. ***Aim of the Study:*** to evaluate the effect of Er,Cr:YSGG laser of different power settings on tooth structure chemistry and topography after debonding of laminate veneers. ***Materials and Methods:*** Fifteen laminate veneers were prepared and bonded to maxillary central incisors and divided into three groups (n=5) according to laser power settings. Each group was subjected to its respective laser power to debond laminate veneers. Tooth structure chemistry was measured using electron dispersive analytical x-ray, surface roughness was measured by profilometer, SEM used for measuring surface microstructure and time was recorded. Digital microscope used to detect mode of failure. ***Results****:* All laminate veneers were debonded with different laser power settings. Calcium and phosphorus showed statistically significant decrease from before bonding to after debonding. Surface roughness showed statistically significant increase from before etching to after etching, but no statistically significant difference after etching and after debonding. Time decreased when increasing power setting. Roughness of fitting surface of laminate veneers showed no statistically significant change before bonding to after debonding. Mode of failure mainly was cohesive with different power settings showing no statistically significant difference. ***Conclusion:*** Laser is useful in laminate veneer debonding. It benefits that tooth structure not affected and laminate veneer remained intact with less time and easier technique for debonding.

Keywords*:* Debonding, Er,Cr:YSGG laser, laminate veneers

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INTRODUCTION

Esthetic dentistry is in demand by patients requesting natural appearance. Recent technologies and materials make it easier for patient and dentist to reach perfect results. Ceramic laminate veneers, a highly accepted option, provide biological, mechanical and esthetics to reproduce the natural tooth shape with great color stability and periodontal biocompatibility. Laminate veneers are an ultraconservative restoration that only needs a minimal amount of reduction, prepared just in the enamel, to achieve the best bond strength and avoid or decrease postoperative sensitivity, also when used correctly, they fulfill functional and aesthetic rehabilitation.[1]

Laminate veneers proved to be a suitable treatment modality in anterior teeth restoring esthetics and function.[2] New generations of adhesive resin cements have increased the success and long-term survival of laminate veneers, improved bonding between tooth and restoration.[3]

Sometimes laminate veneers need to be replaced, due to faulty cementation, caries, leakage, fracture, or due to patient dis-satisfaction with the results.[4]

Till recently the only way to remove a laminate veneer was by using rotary instruments to cut it away, this procedure is both time consuming and destructive rendering it hard to prevent damage as the laminate veneer, the cement and the tooth structure are almost of the same color, So even under magnification it is difficult to distinguish between them.[5]

Laser is recently introduced having many types of different uses.[6] Laser is used in diagnosis like detection of pulp vitality, laser fluorescence in detection of caries, bacteria and dysplastic changes in the diagnosis of cancer. Hard tissue uses like caries removal and cavity preparation, recontouring of bone (crown lengthening), endodontics (root canal preparation, sterilization and apicectomy, laser etching and caries resistance. Soft tissue uses like laser assisted soft tissue curettage and peri-apical surgery, bacterial decontamination, gingivectomy and gingivoplasty, aesthetic contouring, frenectomy, gingival retraction for impressions, implant exposure, biopsy incision and excision, treatment of aphthous ulcers and oral lesion therapy, coagulation and hemostasis, tissue fusion and replacing sutures, laser assisted flap surgery, removal of granulation tissue, pulp capping, pulpotomy and pulpectomy, operculectomy and vestibuloplasty, incisions and draining of abscesses, removal of hyperplastic tissues and fibroma. Laser induced analgesia. Laser activation either restorations (composite resin) or bleaching agents. Last thing is removal of root canal filling material and fractured instrument, softening gutta-percha and removal of moisture and drying of canal.

Laser maybe classified in many ways such as: according to wavelength ultraviolet range (140 to 400 nm), visible spectrum (400 to 700 nm) and infrared range (more than 700 nm). Another broad classification is according to tissues: hard tissue laser (CO2 laser, Nd:YAG laser, Argon, Er:YAG and Er,Cr:YSGG) and soft tissue laser (He-Ne laser and diode laser). Also can be classified according to delivery system: articulated arm, hollow wave guide and fiber optic cable. It could be classified according to type of active medium used: gas, solid, semi-conductor or dye lasers. Type of lasing medium is another classification used. Then according to pumping scheme divided either optically pumped laser or electrically pumped laser. Another one is according to operation mode either continuous wave lasers or pulsed lasers. Last thing is according to degree of hazard to skin or eyes following inadvertent exposure.[7]

The introduction of laser for debonding of laminate veneers has proved to be useful to preserve the tooth structure and maintain the integrity of the laminate veneers, offering better results.[8-11]

Erbium lasers (Er:YAG and Er,Cr:YSGG) show high absorption at water and hydroxyapatite so they are best used with mineralized tissues. They act by explosive "thermo-mechanical" ablation. Where radiation is absorbed by water between hydroxyapatite crystals and vaporization of water cause internal pressure increase and micro explosions removing inorganic particles and tissue removal.[12]

However, the effect of the laser on the tooth structure or the laminate veneer is still controversial and lacks evidence concerning the laser parameters and time to use for debonding.

Consequently, this study aimed to study the effect of Er,Cr:YSGG laser on tooth structure chemistry and topography after debonding of laminate veneer. Our null hypothesis is that no difference in tooth surface chemistry and topography and time with different laser powers used in the present study.

MATERIALS A ND METHODS

Based on sample size calculation from the results of Rodriguez et al (2011)[13] using

Calcium weight % as the primary outcome, using alpha (α) level of 0.05 (5%) and Beta (β) level of 0.20 (20%) i.e. power = 80%; the study will include 5 specimens per group for a total of 15 specimens. Sample size calculation was performed using IBM® SPSS® SamplePower® Release 3.0.1

A total of 15 human intact central incisors extracted for periodontal reasons were obtained and cleaned; deposits, attached bone and soft tissue were removed both manually and using ultrasonic scaler, then brushed with a soft tooth brush. Before preparation and during testing, the study teeth were stored in saline to avoid dehydration and to stimulate the hydration of moisture contact in the oral cavity.[8] Samples had taken an IRB approval (IRB#00010118).

Sample Preparation:

A putty index was made for the labial surface of each tooth using addition silicone (zhermach elite hd+, Italy). Teeth and respective indices were numbered to maintain precision. Putty index and periodontal probe were used to standardize the amount of reduction for all samples to 0.5mm. The used central incisors were prepared with a chamfer cervical finish line and feather edge incisal preparation. To standardize preparation at 0.5mm for all of labial surface, a self-limiting depth cutting burs (Gebr. Brasseler, Lemgo, Germany) of 0.5mm were used to define the depth of the cuts, then a 1.4mm tapered diamond bur (Gebr. Brasseler, Germany) was used to refine preparation by removing islands of unprepared tooth structure and to define finish line and prepare the margins. Preparations for all laminate veneers were carried out in the same manner for all included teeth by the same operator.[14,15]

Fabrication of Laminate Veneers:

In purpose of sample standardization fabrication of the laminate veneers involved two processes respectively; first Exo-cad (version matera 2.3, Germany) was used to design and VHF S1 (5 axis milling machine, Germany) mill the laminate veneers in milling wax, second process was pressing of the milled wax.

Each prepared tooth was digitally scanned individually using Medit scanner (identica blue T300, Korea) and software (Exo-cad) was used to design the laminate veneers then were milled in wax. Each design proposal took the same tooth number to avoid error and sample misfit. The wax designed for laminate veneers was standardized at 0.5mm.[16]

The designs were sent to CAD unit as STL (standard transformation language) file to mill the laminate veneer in CAD wax. Checking and verification of fit and margin adaptation of milled wax was done visually using magnification loupes (4x custom made Univet loupes, Italy) and a sharp explorer. Unaccepted samples of milled wax were discarded, re-milled and re-verified.

Bonding of Laminate Veneers:

Tooth Surface Treatment:

Each tooth was etched with scotchbond etchant (35% phosphoric acid, 3M ESPE, USA) for 15 seconds, then rinsed off, excess water was blotted off leaving tooth moist. Two coats of Adper Single Bond Plus Adhesive (3M, USA) was applied with two consecutive coats using a fully saturated brush tip for each coat that were gently dried for 2-5 seconds.

Laminate Veneer Surface Treatment:

Before bonding the intaglios surface of each laminate veneer was etched using porcelain etch (9% buffered hydrofluoric acid, Ultradent, USA) for 20 seconds to the bonding surface and rinse and dry. Silane coupling agent (Rely X ceramic primer, 3M ESPE, USA) was applied to the etched veneer surface and was left to dry, then one coat of Adper Single Bond Plus Adhesive was applied to the surface of the veneer, and dried gently for 2-5 seconds.

Seating of Laminate Veneer:

Rely X veneer cement (3M EPSE, USA), in shade B 0.5, was applied to the veneer. The veneer was seated with gentle pressure. Tack cure was done to secure the laminate veneer in place by light curing on the facial surface with a small diameter lightcure tip for 5 seconds while taking a good care not to cure the excess cement. Excess cement was removed from the margins using sharp explorer. Then light cure was done for each area and the margins of the laminate veneer for 30 seconds.

Debonding Procedure:

Debonding of the laminate veneers was done by using the Er,Cr:YSGG (2780nm) laser. Using different power settings (2, 4 and 6 Watt) with same frequency of 20Hz and for cooling air was 60% and water was 80% and non-contact method using an MZ8 tip. The tip was positioned perpendicular at 2mm distance from ceramic laminate veneer and scanning method was performed with horizontal movement parallel to the surface. Some of samples were blown out and in others only resin cement softened. Stopwatch was used to measure the time taken for debonding of laminate veneers.

Testing:

To identify tooth structure chemistry Electron dispersive analytical x-ray (EDAX) was used. In this study it was used to measure calcium weight percent, phosphorus weight percent and calcium phosphorus ratio as they are the most important components of enamel. It was performed two times one after preparation and the second after debonding of laminate veneers from tooth to compare the difference between them.[17] Tooth irradiated at the center of the buccal surface and to two additional areas.

To measure the surface roughness for tooth and inner surface of laminate veneers profilometer was used. First the 3D optical profilometer was used to obtain the topography of all teeth after preparation. Secondly after etching a contact 2D mechanical profilometer was used to evaluate tooth roughness. Third after debonding a 2D profilometer was used to evaluate roughness. Roughness for all samples was compared to evaluate the changes after acid etching and after debonding of laminate veneers. It was used also for laminate veneer roughness measured before bonding and after debonding.[18]

Scanning electron microscope (SEM) was used with 3000x magnification, to analyze surface microstructure for tooth and laminate veneers. For tooth surface SEM took place after preparation, after etching and after debonding while for laminate veneer inner surface SEM was carried out before bonding and after debonding.

Mode of Failure:

Digital microscope was used to detect the mode of failure after debonding laminate veneers from teeth. All groups were checked using a USB digital microscope (U 500x Digital Microscope, Guangdong, China), magnification x35, and the images were captured and transferred to a IBM personal computer equipped with the image tool software Image J 1.43U, National Institute of Health, USA) to determine failure mode pattern either adhesive between resin and tooth or between resin and laminate veneer or cohesive.

The modes of failure were classified into 3 types. Type1: Adhesive failure between the inner surface of the laminate veneer and the resin cement, where most of resin remained on tooth surface. Type2: Adhesive failure between the resin cement and the tooth surface, where most of resin remained on the inner surface of the laminate veneer. Type3: Cohesive failure within resin cement.

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). Mineral content data showed normal (parametric) distribution while surface roughness (Ra) and debonding time data showed non-normal (non-parametric) distribution. Parametric Data were presented as mean, standard deviation (SD) and 95% Confidence Interval for the mean (95% CI) values. Non-parametric data were presented as median and Inter-Quartile Range (IQR) values.

For parametric data; repeated measures Analysis of Variance (ANOVA) was used to study the effect of Laser power, condition (before bonding and after debonding) and their interaction on mean mineral content. Bonferroni's post-hoc test was used for pair-wise comparisons when ANOVA test is significant.

For non-parametric data, Kruskal-Wallis test was used to compare between the three Laser powers. Friedman's test was used to compare between surface roughness before bonding, after etching and after debonding. Dunn's test was used for pair-wise comparisons.

Wilcoxon signed-rank test was used to compare between surface roughness of veneers before and after debonding.

The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM (IBM Corporation, NY, USA) SPSS (SPSS, Inc., an IBM Company) Statistics Version 20 for Windows

RESULTS

A. <u>Calcium weight %:</u>

<u>Repeated Measures ANOVA Results:</u>

The results showed that Laser power irrespective of condition (before bonding or after debonding) had no statistically significant effect on mean Ca weight %. Condition (before bonding and after debonding) irrespective of Laser power had a statistically significant effect on mean Ca weight %.The interaction between the two variables had no statistically significant effect on mean Ca weight %. Since the interaction between the variables is not statistically significant, so the variables are independent from each other (Table 1).

Table (1): Descriptive statistics for Ca weight % values

Laser power	Condition	Mean	SD	95% CI	
				Lower bound	Upper bound
2 W	Before bonding	36.21	2.37	33.27	39.15
	After debonding	31	2.24	28.22	33.79
4 W	Before bonding	33.59	2.81	30.1	37.08
	After debonding	28.98	3.51	24.63	33.34
6 W	Before bonding	31.7	4.45	26.17	37.23
	After debonding	28.28	5.68	21.23	35.33

B. Phosphorus weight %:

Repeated Measures ANOVA Results:

The results showed that Laser power irrespective of condition (before bonding and after debonding) had a statistically significant effect on mean P weight %. Condition irrespective of Laser power had a statistically significant effect on mean P weight %. The interaction between the two variables had a statistically significant effect on mean P weight %. Since the interaction between the variables is statistically significant, so the variables are dependent upon each other (Table 2).

C. Ca:P ratio:

Repeated Measures ANOVA Results:

The results showed that Laser power irrespective of condition (before bonding and after debonding) had no statistically significant effect on mean Ca:P ratio. Time irrespective of Laser power had a statistically significant effect on mean Ca:P ratio. The interaction between the two variables had a statistically significant effect on mean Ca:P ratio. Since the interaction between the variables is statistically significant, so the variables are dependent upon each other (Table 3).

Table (2): Descriptive statistics for P weight % values

Laser power	Condition	Mean	SD	95% CI	
				Lower bound	Upper bound
2 W	Before bonding	14.7	0.91	13.57	15.83
	After debonding	13.85	1.13	12.45	15.25
4 W	Before bonding	15.67	0.14	15.5	15.84
	After debonding	14.93	0.31	14.55	15.32
6 W	Before bonding	14.52	0.75	13.59	14.45
	After debonding	12.28	1.93	9.88	14.68

Table(3). Descriptive statistics for Ca:P ratio values

Laser power	Condition	Mean	SD	95% CI	
				Lower bound	Upper bound
2 W	Before bonding	2.47	0.16	2.27	2.66
	After debonding	2.24	0.08	2.14	2.34
4 W	Before bonding	2.14	0.17	1.93	2.36
	After debonding	1.94	0.23	1.65	2.23
6 W	Before bonding	2.18	0.25	1.87	2.49
	After debonding	2.29	0.20	2.04	2.55

A. <u>Surface Roughness:</u>

a. Comparison between Laser powers:

Either before bonding, after etching or after debonding; there was no statistically significant difference between the three Laser powers.

b. Comparison between Ra before bonding, after etching and after debonding:

Either with 2 W, 4 W or 6 W Laser powers; there was a statistically significant increase in Ra after etching. There was no statistically significant difference between Ra after etching and after debonding. The median Ra after debonding showed statistically significantly higher value than Ra before etching (Table 4).

Table (4). The median, Inter-Quartile Range (IQR) values and results of Kruskal-Wallis and Friedman's tests for comparison between Ra values with different interactions

Condition	2 W		4 W		6 W		*P*-value (Effect of Laser power)
	Median	IQR	Median	IQR	Median	IQR	
Before etching	0.578 [B]	0.205 – 0.893	0.902 [B]	0.423 – 1.463	1.015 [B]	0.628 – 1.294	0.264
After etching	2.602 [A]	2.355 – 2.636	2.571 [A]	1.946 – 2.786	2.053 [A]	2.025 – 2.767	0.779
After debonding	2.639 [A]	2.540 – 2.905	2.285 [A]	1.927 – 2.890	2.001 [A]	1.768 – 2.335	0.102
P-value (Effect of time)	0.368		0.007*		0.015*		

**: Significant at $P \leq 0.05$, Different superscripts in the same column are statistically significantly different*

B. Time taken for Debonding:

The statistically significantly longest debonding time was found with 2 W Laser power with a statistically significant difference from 4 W and 6 W powers. The statistically significantly shortest debonding time was found with 6 W Laser power with a statistically significant difference from 2 W and 4 W powers (Table 5).

Table (5). The median, Inter-Quartile Range (IQR) values and results of Kruskal-Wallis test for comparison between debonding time (Seconds) with the three Laser powers

Laser power	Median	IQR	*P*-value
2 W	75.77 [A]	62.04 – 119.29	
4 W	35.44 [B]	22.9 – 41.21	0.032*
6 W	17.3 [C]	9.01 – 63.7	

**: Significant at P ≤ 0.05, Different superscripts are statistically significantly different*

C. Roughness of Laminate Veneers Inner Surface:

There was no statistically significant change in veneer surface roughness before bonding and after debonding. Ra (µm) (Table 6).

Scanning Electron Microscope:

The SEM before bonding showed enamel prism core and boundaries with surface irregularities. After etching of the enamel it showed increased roughness and pores in enamel surface. While after debonding of the laminate veneers the tooth surface showed less intervals and surface irregularities at the boundaries (Figures 1, 2 and 3).

Table (6). The median, Inter-Quartile Range (IQR) values and results of Wilcoxon signed-rank tests for comparison between Ra values of veneers before and after debonding

Before debonding		After debonding		*P*-value
Median	IQR	Median	IQR	
1.26	0.82-1.69	0.82	0.68-1.15	0.116

**: Significant at P ≤ 0.05*

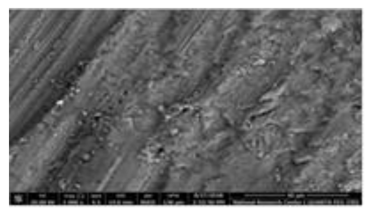

Figure (1): SEM before bonding of laminate

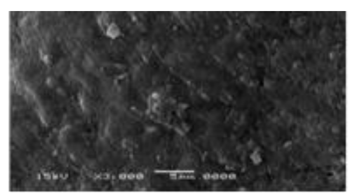

Figure (2): SEM after etching of enamel surface

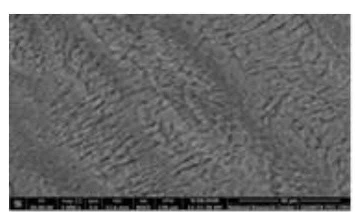

Figure (3): SEM after debonding of laminate

SEM of Inner Surface of Laminate Veneers:

SEM of inner surface of laminate veneer before bonding reveals rough surface with loosed irregular lithium disilicate crystals. While after debonding reveals an adhesive remnants with different laser power settings (Figures 4 and 5).

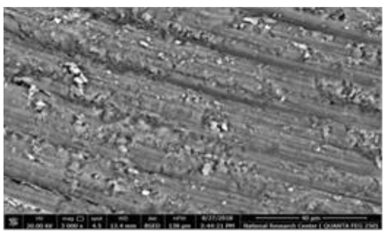

Figure (4): SEM of laminate veneer before bonding

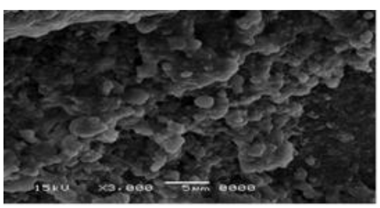

Figure (5): SEM of laminate veneer after debonding

D. <u>Mode of Failure:</u>

Mode of failure data were presented as frequencies and percentages. Fisher's Exact test was used to compare between the groups.

There was no statistically significant difference between modes of failure in the three groups (*P*-value = 1.000, Effect size = 0.270).

DISCUSSION

Laminate veneers are ultra-thin porcelain shells that are used mainly to restore shape and color. They are etched and bonded to enamel. Laminate veneers depend on bonding to enamel and with new bonding techniques the retention of laminate veneers increase it longevity. Also, they are one of the conservative restorations where preparation is in enamel giving an esthetic appearance. Laminate veneers are biocompatible, provide perfect esthetic and resist wear and stains.[19]

However, the debonding or removal of laminate veneer poses a great problem as sometimes they need to be changed due to a fault during cementation, or due to caries, fracture, leakage or the patient is not satisfied with the results. In the past rotary instrument were used to remove a laminate veneer, this technique removes the laminate veneer in a completely destructive manner and may damage the underlying tooth structure. Research is growing in the area of laminate veneer removal; studying the effect of removal on the laminate veneer, resin cement and underlying tooth structure.[20]

This study aimed to evaluate the effect of laser power on tooth structure after debonding of the laminate veneers and time elapsed for debonidng.

Today, with the introduction of laser and increase of its uses in dentistry, studies are focusing on using laser for debonding of the laminate veneers to maintain their integrity. Thermal ablation may cause overheating of the pulp while rapidly ablating the cement can avoid conduction of heat that is seen by slow process of thermal softening. Erbium laser can be safely used for ablation of tooth structure and resin cements.[8, 20, 21]

Erbium lasers are considered a tool for debonding of laminate veneers as stated in previous studies. Erbium lasers are either erbium, chromium-doped yttrium, scandium, gallium and garnet laser (Er,Cr:YSGG) or erbium-doped yttrium, aluminum, and garnet (Er:YAG) laser with wavelengths of 2780 nm and 2940 nm respectively. Its absorption occur in water, hydrated tissues, residual monomers and bonding cements containing water.[8-12, 22]

In our study Er,Cr:YSGG laser used instead of Er:YAG laser as literature lacks studies using Er,Cr:YSGG laser in debonding of laminate veneers.

According to the results of the present study the null hypothesis was accepted as Er,Cr:YSGG laser didn't affect tooth structure and when increasing the power the time for debonding decrease.

On comparing the results of the current study showed that the calcium weight % to different power settings either before bonding or after debonding all showed almost no differences in calcium content. So calcium decrease is not related to the laser power settings.

While on comparing calcium weight % before bonding to after debonding with different power settings it showed decrease in calcium content either with 2Watt or 4Watt or 6Watt. But this can be attributed to the use of total etch resin cement. As the preparation in enamel and total etch technique is best used, having separate step of etching. The action of etch on tooth structure is removing the inorganic component decreasing calcium content. Prolonged etching time more than the recommended increase the surface roughness and decrease surface hardness affecting the bond strength of adhesive materials.[23,24]

So this means that calcium content decrease not affected by laser power but affected either before bonding or after debonding of laminate veneers attributed to the etching step.

The Ca:P ratio with different power settings when compared to each other didn't show any difference as they all decrease with near difference between each other. While they showed difference depending on condition either before bonding procedures or after debonding of laminate veneers. As calcium and phosphorus content decrease from before bonding to after debonding.[23,24]

Our results showed that Er,Cr:YSGG laser has no effect on tooth structure chemistry and this finding is matched with previous study made by Lesniak et al[25] that debonding using erbium laser didn't affect tooth chemistry content.

The surface roughness (Ra) was measured three times: after preparation before etching, after etching and after debonding. Comparison before etching, after etching or after debonding showed no difference between different laser power settings. This shows that different laser power settings didn't affect surface roughness.

Comparison between Ra before bonding, after etching and after debonding with different laser power settings there was an increase in Ra after etching. As etching increase the surface roughness for better bonding.[18]

There was no difference between Ra after etching and after debonding. This shows that different laser power settings didn't affect the surface roughness.

The surface roughness after debonding increased than before etching. Because etching increase the surface roughness not the laser that used for debonding. This results is matched by the study made by Zhang et al[26] that debonding didn't damage the enamel surface under scanning electron microscope.

Time taken for debonding showed that increasing the laser power lead to decrease in time taken for debonding laminate veneers.

This is accepted by Alikhasi et al[27] study that low power cause thermal softening where bonding agent is heated until softening. While high power cause either thermal ablation when energy is high enough to raise the temperature of resin cement causing vaporization and blow out or photo ablation where high laser energy interact with resin cement causing its decomposition.

Roughness of laminate veneers inner surface before bonding and after debonding of laminate veneers (Ra) showed no difference. This proved that different laser power settings didn't affect the surface of the laminate veneers.

Scanning electron microscope on enamel showed irregularities of preparation. Then after etching showed irregularities and pores due to the effect of etching. After debonding showed less irregularities and sealed of the pores by adhesive remnants.

SEM on the inner surface of the laminate veneers showed adhesive remnants when seen with different groups.

Under detection of tooth and laminate veneer under digital microscope it showed cohesive failure in the resin cement layer which means that resin cement remnants on tooth structure and inner surface of laminate veneers.

But cement remnants showed to be more on tooth surface. As on the tooth structure more than 50% are covered but there are areas that didn't contain resin cement. This showed that the outer surface of the resin cement was softened by laser matching previous studies made by Karagoz.[28]

CONCLUSION

From the limitations of this study, it has been concluded that:

1) Er,Cr:YSGG laser has no effect on surface roughness of laminate veneer after debonding.

2) There is an inversely relationship between Er,Cr:YSGG laser power setting and time for debonding.

3) Er,Cr:YSGG laser has no effect on tooth structure roughness or topography after debonding.

4) Er,Cr:YSGG laser has no effect on calcium and phosphorus content of enamel of tooth structure after debonding.

5) The optimum laser power is 4 Watt. As 2 Watt needs longer time and 6 Watt caused a burning line in the veneer in one sample.

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