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# Effect of Er,Cr: YSGG Laser on Bonding of Laminate Veneers using CAD/CAM (*In Vitro* Study)

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**Abstract**

**AIM:** This *in vitro* study was designed to evaluate the shear bond strength after bonding between porcelain laminate veneers and the tooth surface using different etching methods

**METHODS:** Thirty freshly extracted maxillary premolars were used and prepared for receiving Enamic laminate veneers. Specimens were divided into two groups (n = 15), according to the surface treatment protocol. The specimens were sandblasted with 50 µm $Al_2O_3$ for 20 s; 2 bar pressure was maintained for air abrasion. Distribution of groups was as follow G1: Prepared enamel surface treatment of each tooth was according to the manufacturer's instructions. G2: The prepared enamel surface of each tooth was subjected to Erbium,Chromium-Doped: Yttrium, Scandium, Gallium, and Garnet laser application. Light cured adhesive resin cement was applied to fitting surface of each ceramic specimen. To simulate thermal aging, the samples were subjected to 5000 thermal cycling in a thermocycler. By dividing the failure load (N) by the bonding area ($mm^2$), debonding loads were calculated as shear stress (MPa). Numerical data were presented as mean and standard deviation values. They were explored for normality by checking the data distribution using Shapiro–Wilk test. Data showed parametric distribution and were analyzed using independent t-test. The significance level was set at $p \le 0.05$ within all tests. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows.

**RESULTS:** Group (II) (15.84 ± 3.09) had significantly higher mean value than group (I) (13.69 ± 2.36) (t = 2.15, p = 0.041).

**CONCLUSION:** Within the limitation of this study, it was revealed that the laser surface treatment for tooth substrate plays a significant role in increasing the shear bond strength of laminate veneers.

## Introduction

The use of dental computer aided design/computer aided manufacturing (CAD/CAM) restorative materials for indirect restorations has recently increased considerably. Ceramics and composite resins are the two main groups of CAD/CAM restorative materials [1]. Ceramic restorations have several advantages, including highly esthetic appearance, wear resistance, biocompatibility, and color stability.

However, ceramics are brittle, causing excessive wear to opposing dentition, and susceptible to fracture due to the formation of flaws or defects in the intaglio surfaces [2]. On the other hand, indirect composite restorations are more compliant and soft, easier to finish and polish, create less wear on opposing dentition, and are conducive to making add-on adjustments, although they experience high wear [3].

Consequently, the development of new restorative materials that combine the advantages of ceramics and composites will enhance the properties and longevity of indirect esthetic restorations.

Recently, a novel CAD/CAM restorative material for indirect restorations has been developed. Patient's need for more esthetics, more durable restoration, and more conservative for tooth structure leading to the use of ceramic laminate veneer which has widely spread to restore malformed, malaligned and fractured tooth. This is due to the rapid development of ceramic materials with efficient bonding to enamel and dentin using adhesive materials and techniques [4].

Bonding of indirect esthetic restorations to the tooth structure remains a challenging matter, as the bonding interfaces are increased with the indirect restorative procedure. The bonding interfaces include the tooth structure and the fitting surface of the restoration. Consequently, to establish a strong and durable bond, appropriate treatment of the respective surfaces is crucial [5].

It is essential to improve the bond strength between indirect restorative materials and cements, since they are the principal factors in the success of resin-bonded fixed dental prostheses [6]. Recently, to enhance the shear bond strength, many types of lasers can be used as erbium lasers. The hypothesis of this study is that there will be no significant difference in shear bond strength between laser treated ceramic restorations and conventional ceramic treatment.

## Materials and Methods

In this study, the material was used is hybrid CAD/CAM restorative material (Vita Enamic [VE]). The materials compositions used in this study are given in Table 1.

**Table 1: Materials used in this study**

| No | Description | Trade name | Manufacturer |
|---|---|---|---|
| 1 | Hybrid Ceramic | VITA ENAMIC | |
| 2 | Hydrofluoric acid | PORELAIN ETCHANT | Bisco, Inc.shaumburg, IL, U.S.A |
| 3 | Silane Coupling agent | PORCELAIN PRIMER (Pre-Hydrolyzed silane primer) | Bisco, Inc.shaumburg, IL, U.S.A |
| 4 | Universal Bonding agent | Single bond universal adhesive | 3 M ESPE, GmbH, Germany |
| 5 | Phosphoric acid | Meta Etchant | Meta biomed co. Ltd |
| 6 | Resin cement | Total Cem | Bisco, USA |

Thirty samples were prepared for this study and divided into:

- Group 1: 15 teeth without laser application on enamel surface
- Group 2: 15 teeth subjected Erbium,Chromium-Doped: Yttrium, Scandium, Gallium, and Garnet (Er,Cr: YSGG) laser application.

In this study, 30 freshly extracted maxillary premolars were used. The teeth were cleaned and 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.

A specially designed centralizing device was used to allow accurate centralization of teeth in the expo blocks. The centralizing device consisted of five parts: Part A: Copper cylinder with a hollow internal diameter of 4 cm was fabricated to ensure that the tooth was centralized during pouring of epoxy resin. Part B: Vertical stainless rod fixed to the base. Part C: Horizontal arm attached at one end to the vertical arm allowing movement in vertical direction while the other end is joined to a free vertical rod. Part D: Free vertical rod is attached to the horizontal arm. Part E: Clamp to hold the teeth. The tooth was attached from its buccolingual dimension with the clamp and aligned guided by the centralizing depression in the copper base. Teeth were fixed at a level of 1mm below the cement-enamel junction.

The epoxy resin was mixed according to the manufacturer's instruction. The mix was placed inside the copper base until it was completely filled. During the dough stage, the teeth were inserted with the vertical rod in the center, after polymerization of the epoxy resin, the centralizing device was removed leaving the tooth in a central position inside the copper base.

Using low speed diamond saw Vita Enamic CAD, specimens were sectioned with dimensions 4x4 mm and thickness 0.5 mm under copious cooling (Figure 1). Ceramic specimens were inspected after sectioning for any surface flaws. Dimensions and thickness were confirmed after sectioning by digital caliper. All samples were prepared by the same operator according to the manufacturer's recommendation for the purpose of standardization.

*Figure 1: Enamic block cutting*

To confirm that the area of preparation is 4 × 4 mm, a standard under ruler with same dimension of ceramic disc "4 × 4 mm" was used. A ceramics disc was used to confirm the dimensions with the ruler. After confirmation, the ruler was positioned on the tooth. After confirmation, the ruler was positioned on the tooth. A black marker was used to outline the area of preparation.

A three wheel depth cutter diamond stone 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. Buccal surface was prepared using blue coded around end tapered diamond stone to have a flat surface for the veneer specimens to fit without rocking. Surface was then finished by red coded finishing stone and yellow coded finishing stone prepared area was discernible to the magnifying loops.

The specimens were sandblasted with 50 μm $Al_2O_3$ for 20 s; two bar pressure was maintained for air abrasion. Specimens were mounted in a special holder forming right angles where the distance between the nozzle and the surface was 10 mm. The specimens were cleaned in distilled water, and then air dried.

Group 1: The prepared enamel surface of each tooth was etched using 37% phosphoric acid for 30 s then rinsed with air/water jet for 60 s and dried to remove excess water. Universal bonding agent was applied to the etched enamel surface and activated for

20 s, air dried for 5 s then light cured for 10 s according to the manufacturer's instructions.

Group 2: The prepared enamel surface of each tooth was subjected to Er,Cr: YSGG Laser application (Figure 2).


*Figure 2: Laser surface treatment*

To simulate thermal aging, the samples were subjected to 5000 thermal cycling in a thermocycler which is equivalent to 6 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 of tooth structure.

Light cured adhesive resin cement Choice 2 (Bisco, USA) was applied to fitting surface of each ceramic specimen, then the specimen was gently seated on the tooth and the excess resin cement was removed. Each sample was then loaded with 1 kg using loading device for 5 s. Short initial light curing or tack curing for 2–3 s 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 s at rapid mode.

Er,Cr: YSGG was applied under certain parameters (Table 2).

**Table 2: Parameters used for Erbium, Chromium-doped: Yttrium, Scandium, Gallium and Garnet**

| | |
|---|---|
| Wave length | 2780 nm |
| Energy | 0.3 J |
| Pulse duration | 60 us (H–mode) |
| Frequency | 10 Hz |
| Average power | 3 W |
| Peak power | 5000 W |
| Tip size | MZ10 (1000 UM) |

Shear bond strength test was applied to ceramic laminate veneers of both groups. To apply test effectively, each sample was placed in holder of universal testing machine individually (Figure 3). 0.5 nm/min is speed used with load cell 5 KN with a parallel knife edge blade positioned at tooth laminate interface. The debonding fracture load was recorded in

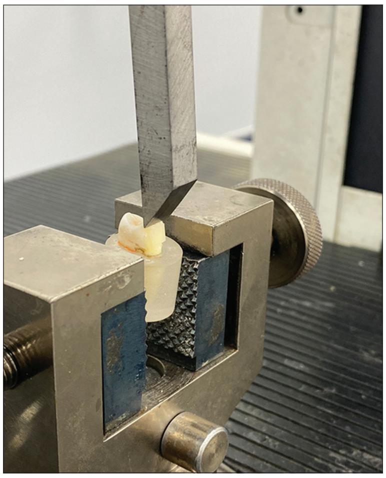

*Figure 3: Shear bond strength testing*

Newton. By dividing the failure load (N) by the bonding area (mm$^2$), debonding loads were calculated as shear stress (MPa).

Numerical data were presented as mean and standard deviation values. They were explored for normality by checking the data distribution using Shapiro–Wilk test. Data showed parametric distribution and were analyzed using independent t-test. The significance level was set at $p \leq 0.05$ within all tests. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows.

## Results

Mean and standard deviation (SD) values of shear bond strength (MPa) for different groups are presented in Table 3 and Figure 4.

**Table 3: Mean ± standard deviation of shear bond strength (MPa) for different groups**

| Group I | Group II | t-value | p |
|---|---|---|---|
| 13.69 ± 2.36 | 15.84 ± 3.09 | t = 2.15 | p = 0.041* |

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

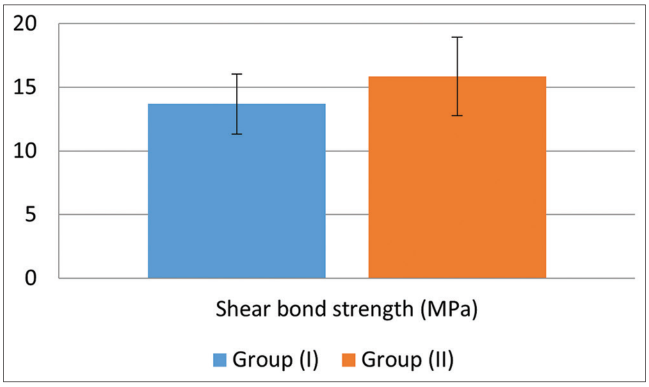


*Figure 4: Bar graph representing shear bond strength (MPa) for different groups*

Group (II) (15.84 ± 3.09) had significantly higher mean value than Group 1 (13.69 ± 2.36) ($t = 2.15$, $p = 0.041$).

## Discussion

Recently, all ceramics restorations have become the most popular choice for patients and clinicians and are considered a gold standard to treat destroyed or missing teeth [7]. The superior esthetic results can be obtained using laminate veneers, build up the anterior region, and single unit fixed dental prosthesis [8]. However, the challenge to eliminate biological, functional and esthetic failure in all-ceramic restorations is still present [9].

Material used in this study is Vita Enamic blocks which is a durable hybrid ceramic that can be processed with efficient CAD/CAM. A diamond stone with three wheel depth cutter was used to obtain a number of "2" 0.5 mm depth grooves on the buccal surface to obtain same amount of reduction.

Recently, using laser etching is one of the types of surface treatment to increase the bond strength [10], [11]. The most popular laser used in restorative dentistry is the Er,Cr: YSGG laser with 2.780 nm wave-length due to its capabilities surface modification to produce roughening of surface [12].

Kimyai *et al.* examined the impact of three methods of surface treatment, 2 W Er,Cr: YSGG laser, air abrasion, and diamond bur application, on the repair bond strength of a laboratory composite and confirmed the effect of Er,Cr: YSGG laser on laboratory composite repair [13]. Furthermore, in a recent study, different power settings (1.5, 2, and 3 W) of Er,Cr: YSGG laser were compared on indirect resin composite, and no differences were determined between power settings [14]. In this study, 2 W and 71 $J/cm^2$ energy density Er,Cr: YSGG laser was used. This method was found to be as effective as Al2O3 sandblasting and CoJet in accordance with the previous reports.

Resin cements commonly used to cement the ceramic prosthesis give the restoration high bond strength leading to difficulty in the removal of restorations [15]. Freshly extracted teeth are perfectly selected *in vitro* studies to simulate closely the clinical conditions. To obtain sufficient number of teeth for research, the collection of teeth is made over time so storage following extraction is a must to prevent dehydration of teeth [16]. All extracted teeth were stored in saline solution during this research until teeth were prepared to receive laminate restoration.

The depth of preparation was 0.5 mm to be sure that preparation was within enamel only. Many studies recently evaluated that the highly survival rate of ceramics veneers when bonding of preparation restricted only to enamel. However, there was increase in failure rate of laminate veneers when dentin is exposed within preparation as fracture or debonding [17], [18]. This is because of different in composition between enamel and dentin. The enamel is homogenous in composition which leads to mechanical interlocking with ceramic. On the other hand, dentin has lower inorganic content, tubular structure with variations in this structure, and outward intratubular fluid movement [19].

In addition of dentin has a less rigid base for placement of restoration than enamel so the flexural strength of tooth/porcelain may be affected but because of the lower modulus of elasticity of enamel than porcelain, the flexural strength of tooth/porcelain will not be affected [20].

The ceramic specimens were sandblasted with 50 μm $Al_2O_3$ for 20 s; two bar pressure was maintained for air abrasion. Prepared enamel surface was etched with 37% phosphoric acid for 30 s to enhance the surface wettability and surface free energy [21]. This was followed by the application of universal bonding agent, activated by 20 s which was light cured for 10 s according to the manufacturer's instructions. The use of universal adhesive along with phosphoric acid was recommended by many researchers to achieve optimal bonding [22], [23].

There are two types of adhesive resin cements light and dual cured resin cement, in this study, light cured cement is used. The light cured resin cement has many advantages as extended working time, excess cement removal before light activation, and reduce time for finishing after the restorations have been luted. Furthermore, light cured resin improves color stability as no tertiary amines are used as chemical activator which by time could cause color change.

All specimens were subjected to 5000 thermal cycling, which is equivalent to 6 months of thermal changes in 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/TS11405 technical specification for testing of adhesion to tooth structure [24], [25], [26].

In this study, $Al_2O_3$ sandblasting caused the highest roughening surface. These irregularities, which result from sandblasting, also help to provide better retention for resin cement [27].

Thermal fluctuation with developing crack propagation, catastrophic failures in ceramic restoration, and through hydrolyzing silicon in ceramics restoration and through hydrolyzing silicon oxygen bonds at ceramic cement interface cause ceramic resin bonding weakening overtime. Therefore, thermal aging was applied in this study to mimic these clinical situations [27].

In this study, the shear bond strength test is used to evaluate the bond strength of ceramics laminates as the test procedure is very simple, easy, need minimum equipment, and specimens preparations are simpler than those of tensile test [28].

Tam and McComb [29] and Fuentes *et al.* [30] found conflicting results, as neither of them could detect a considerable increase in bond strength following the application of silane.

Our results were in accordance with Mirzaei *et al.* [31] evaluated efficiency of laser treatment in increasing the shear bond strength and compared the different powers of Er,Cr: YSGG laser (1–6 W) on a microhybrid composite resin with SEM. They found that laser surface treatment showed the surface irregularities in their study.

The hypothesis of this study was rejected as there was a significant difference between laser surface treatment and conventional surface treatment, where laser surface treatment of hybrid ceramics showed higher shear bond strength than conventional treatment.

Up-to-date, there is still lack of evidence base literature regarding the influence of laser surface treatment on the efficiency of bonding, and more research studies are needed in the coming future.

## Conclusions

Within the limitation of this study, it was revealed that the laser surface treatment for tooth substrate plays a significant role in increasing the shear bond strength of laminate veneers.

## References

1. Bhattacharjee D, Sharma K, Sahu R, Neha K, Kumari A, Rai A. Comparative evaluation of shear bond strength of brackets bonded with self-etch primer/adhesive and conventional etch/primer and adhesive system. J Pharm Bioallied Sci. 2021;13 Suppl 2:S1168-73. https://doi.org/10.5005/jp-journals-10024-1649
   PMid:35017950
2. Elsaka SE. Bond strength of novel CAD/CAM restorative materials to self-adhesive resin cement: The effect of surface treatments. J Adhes Dent. 2014;16(6):531-40. https://doi.org/10.3290/j.jad.a33198
   PMid:25516881.
3. Martínez-Insua A, Da Silva Dominguez L, Rivera FG, Santana-Penín UA. Differences in bonding to acid-etched or Er: YAG-laser-treated enamel and dentin surfaces. J Prosthet Dent. 2000;84(3):280-8. https://doi.org/10.1067/mpr.2000.108600
   PMid:11005900.
4. Gökçe B. Bond Strengths of Full Ceramic Materials to Tooth Surfaces Prepared with Different Methods. Dissertation, Turkey: Ege University; 2004.
5. Chimello-Sousa DT, de Souza AE, Chinelatti MA, Pécora JD, Palma-Dibb RG, Corona SA. Influence of Er: YAG laser irradiation distance on the bond strength of a restorative system to enamel. J Dent. 2006;34(3):245-51. https://doi.org/10.1016/j.jdent.2007.09.005
   PMid:16153764
6. Ritzberger C, Apel E, Höland W, Peschke A, Rheinberger V. Properties and clinical application of three types of dental glass-ceramics and ceramics for CAD-CAM technologies. Mater (Basel). 2010;3(6):3700-13. https://doi.org/10.3390/ma3063700
7. 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(6):603-23. https://doi.org/10.1016/j.dental.2016.09.032
   PMid:25842099
8. Kellesarian SV, Malignaggi VR, Aldosary KM, JavedF. Laser-assisted removal of all ceramic fixed dental prostheses: A comprehensive review. J Esthet Restor Dent. 2018;30(3):216-22. https://doi.org/10.1111/jerd.12360
   PMid:29282849
9. Sari T, Tuncel I, Usumez A, Gutknecht N. Transmission of Er: YAG laser through different dental ceramics. Photomed Laser Surg. 2014;32(1):37-41. https://doi.org/10.1089/pho.2013.3611
   PMid:24328609
10. Burnett LH Jr., Shinkai RS, de Eduardo CP. Tensile bond strength of a one-bottle adhesive system to indirect composites treated with Er: YAG laser, air abrasion, or fluoridric acid. Photomed Laser Surg. 2004;22(4):351-6. https://doi.org/10.1089/pho.2004.22.351
    PMid:15345180
11. Kursoglu P, Motro PF, Yurdaguven H. Shear bond strength of resin cement to an acid etched and a laser irradiated ceramic surface. J Adv Prosthodont. 2013;5(2):98-103. https://doi.org/10.4047/jap.2013.5.2.98
    PMid:23755333
12. Hossain M, Nakamura Y, Yamada Y, Suzuki N, Murakami Y, Matsumoto K. Analysis of surface roughness of enamel and dentin after Er,Cr: YSGG laser irradiation. J Clin Laser Med Surg. 2001;19(6):297-303. https://doi.org/10.1089/104454701753342749
    PMid:11776447
13. Kimyai S, Mohammadi N, Navimipour EJ, Rikhtegaran S. Comparison of the effect of three mechanical surface treatments on the repair bond strength of a laboratory composite. Photomed Laser Surg. 2010;28(Suppl 2):S25-30. https://doi.org/10.1089/pho.2009.2598
    PMid:20950189.
14. Harorli OT, Barutcugil C, Kirmali O, Kapdan A. Shear bond strength of a self-etched resin cement to an indirect composite: Effect of different surface treatments. Niger J Clin Pract. 2015;18(3):405-10. https://doi.org/10.4103/1119-3077.151783
    PMid:25772927
15. Rechmann P, Buu NC, Rechmann BM, Finzen FC. Laser all-ceramic crown removal and pulpal temperature--a laboratory proof-of-principle study. Lasers Med Sci. 2015;30(8):2087-93. https://doi.org/10.1007/s10103-015-1738-1
    PMid:25782432
16. Van As G. Erbium lasers in dentistry. Dent Clin North Am. 2004;48(4):1017-59, 8. https://doi.org./10.1016/j.cden.2004.06.001
    PMid:15464563.
17. Gurel G, Sesma N, Calamita MA, Coachman C, Morimoto S. Influence of enamel preservation on failure rates of porcelain laminate veneers. Int J Periodontics Restorative Dent. 2013;33(1):31-9. https://doi.org/10.11607/prd.1488

PMid:23342345.

18. Gresnigt MM, Özcan M, van den Houten ML, Schipper L, Cune MS. Fracture strength, failure type and Weibull characteristics of lithium disilicate and multiphase resin composite endocrowns under axial and lateral forces. Dent Mater. 2016;32(5):607-14. https://doi.org/10.1016/j.dental.2016.01.004

    PMid:26935018

19. Öztürk E, Bolay Ş, Hickel R, Ilie N. Shear bond strength of porcelain laminate veneers to enamel, dentine and enamel-dentine complex bonded with different adhesive luting systems. J Dent. 2013;41(2):97-105. https://doi.org/10.1016/j.jdent.2012.04.005

    PMid:22521701.

20. Farias-Neto A, de Medeiros FC, Vilanova L, Chaves MS, de Araújo JJ. Tooth preparation for ceramic veneers: When less is more. Int J Esthet Dent. 2019;14(2):156-164.

    PMid:31061996.

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(1):80-91. https://doi.org/10.2341/18-275-l

    PMid:31226005.

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(1):e78-83. https://doi.org/10.5301/jabfm.5000261

    PMid:26952584

23. Tsujimoto A, Barkmeier WW, Takamizawa T, Watanabe H, Johnson WW, Latta MA, *et al*. Influence of duration of phosphoric acid pre-etching on bond durability of universal adhesives and surface free-energy characteristics of enamel. Eur J Oral Sci. 2016;124(4):377-86. https://doi.org/10.1111/eos.12284

    PMid:27315775.

24. International Standard Organization. Dentistry-Testing of Adhesion to Tooth Structure. 3rd ed. Geneva, Switzerland: International Standard Organization; 2015. p. 12.

25. Eliasson ST, Dahl JE. Effect of thermal cycling on temperature changes and bond strength in different test specimens. Biomater Investig Dent. 20209;7(1):16-24. https://doi.org/10.1080/26415275.2019.1709470

    PMid:32128509

26. Moghaddas MJ, Mohammadipour HS, Daluyi RA, Nia AJ. The effect of lithium disilicate ceramic thickness and translucency on shear bond strength of light-cured resin cement. J Dent Mater Tech. 2017;6(3):108-16. https://doi.org/10.4103/1735-3327.208762

27. 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(8):e945-51. https://doi.org/10.4317/jced.53721

    PMid:28936282

28. 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(9):1056-60. https://doi.org/10.5005/jp-journals-10024-2641

    PMid:31797829

29. Tam LE, McComb D. Shear bond strengths of resin luting cements to laboratory-made composite resin veneers. J Prosthet Dent. 1991;66(3):314-21. https://doi.org/10.1016/0022-3913(91)90256-v

    PMid:1800726

30. Fuentes MV, Ceballos L, González-López S. Bond strength of self-adhesive resin cements to different treated indirect composites. Clin Oral Investig. 2013;17(3):717-24. https://doi.org/10.1007/s00784-012-0752-y

    PMid:22619093

31. Mirzaei M, Yasini E, Tavakoli A, Chiniforush N. Effect of different powers of Er,Cr: YSGG laser treatment on surface morphology of microhybride composite resin: Scanning electron microscope (SEM) evaluation. J Lasers Med Sci. 2015;6(2):62-6. https://doi.org/10.1007/s00784-012-0752-y

    PMid:25987970