EJONS International Journal on Mathematic, Engineering and Natural Sciences ISSN 2602 - 4136

Article Arrival Date 13.04.2020 | Article Type Research Article | Article Published Date 12.06.2020

Doi Number: http://dx.doi.org/10.38063/ejons.214

FARKLI DENTAL DOKULARA UYGULANAN LAMINATE VENEER RESTORATIF MATERYALLERININ MAKASLAMA BAĞLANTI DAYANIMI

Ayşegül GÖZE SAYGIN (DDS,PhD)

Sivas Cumhuriyet Üniversitesi, Diş Hekimliği Fakültes, Protetik Diş Tedavisi A.D., Sivas, Türkiye ORCID: 0000-0003-2826-5011

Merve YÜKSEL (DDS,PhD)

Sivas Cumhuriyet Üniversitesi, Diş Hekimliği Fakültes, Protetik Diş Tedavisi A.D., Sivas, Türkiye ORCID: 0000-0002-6847-1824

ÖZET

Amaç: Bu çalışmada farklı restorative materyallerin farklı preparasyon derinliklerinde minimal preoarasyon gerektiren laminate veneer restorasyonların makaslama bağlantı dayanımlarının (SBS) incelenmesi amaçlanmıştır.

Materyal metod: 128 adet çekilmiş üst kesici diş yapışma yüzeyine göre rastgele iki ana gruba (Grup E ve ED) ayrıldı [mine (E) ve mine-dentin(ED)]. Gruplar yüzey işlemlerine göre Kontrol(C), 1.5 watt Er-YAG lazer(L), Hidroflorik acid (HF), Tribokimyasal kaplama (TC) 4 subgruba ayrıldı(n=8). Yüzey şartlandırma işleminden sonra porselen (VITA Porcelain) ve kompozit (Herculite XRV Ultra) disk örnekler (5 mm çap, 2mm yükseklik) ışınla sertleşen siman (Rely X TM Veneer) ile diş yüzeyine simante edildi. SBS testi, yapay yaşlandırma işleminden sonra 1 mm/dk kafa hızında universal test cihazında gerçekleştirildi. Kırılma tipleri stereomikroskop altında değerlendirildi.

Sonuç: En yüksek makaslama dayanım değeri Grup E-TC grubunda görüldü. Grup ED-C and E-C grubunda diğer gruplarla karşılaştırıldığı zaman en düşük değerler elde edildi ve bu farklılık istatistiksel olarak anlamlı bulundu($p<0.05$). Farklı materyallerin SBS değerleri istatistiksel olarak anlamlıydı. Tribokimyasal kaplanan kompozit örnekler porselene göre daha yüksek değerler gösterdi. Yüzey işlemlerine göre materyaller arasındaki bu farklılık istatistiksel olarak anlamlıydı ($p<0.05$). Adheziv kopma diğer kopma türlerine göre daha yaygın görüldü.

Çıkarım: Dental dokuların özelliklerine bağlı olarak materyallerin SBS değerleri değişmektedir. Mine dokusuna adhezyon daha etkilidir ve restoratif materyallerin bağlatısı yüzey koşullandırma ile güçlendirilebilir.

Klinik Çıkarım: Laminate veneer restorasyonların uygulanmasında eğer mümkünse mine dokusu korunmalı, eğer preparasyon gerekli ise yeterli mine dokusunun bırakılması gerekmektedir. Uzun dönem kullanım ve iyi bir bağlantı için tribokimyasal kaplama ile alternatif yüzey şartlandırmalar önerilebilir.

Keywords: laminate veneer restorasyonlar, feldspatik porselen, dental kompozit , makaslama bağlantı dayanımı, dental dokular

SHEAR BOND STRENGTH OF LAMINATE VENEER RESTORATIVE MATERIALS APPLIED ON DIFFERENT DENTAL TISSUES

ABSTRACT

Aim: This study aimed to investigate of shear bond strength of laminate veneer restorations required minimal preparation in different preparation depths and with different restorative materials.

Material-Method: 128 extracted maxillary central incisor teeth were randomly divided two main groups (Group E and ED) according to bonding surface [enamel (E) and enamel-dentine(ED)]. The main groups were performed surface treatments ; Control(C), 1.5 watt Er-YAG laser(L), Hydrofluoric acid (HF), Tribochemical coating (TC) (n=8). After surface conditioning, porcelain (VITA Porcelain) and composite (Herculite XRV Ultra) disc (5 mm diameter, 2mm height) samples cemented on teeth surface by light cure resin cement (Rely X TM Veneer). Shear bond strength test was performed in a universal test device at 1 mm/min after artificial aging. Failure mode was evaluated by stereomicroscopic examination.

Results: Group E-TC showed the highest bond strength value. Group ED-C and E-C were showed the lowest value when compared the others, and this difference was statistically significant between intragroups($p<0.05$). The different material's SBS value were statistically significant ($p<0.05$). Tribochemically coated composite samples were showed higher value than porcelain. This difference between material according to surface treatments was statistically significant ($p<0.05$). Adhesion failure mode was seen to be more common the others.

Conclusion: Depending on the properties of the dental tissues, it was seen that the SBS values of the materials were changed. Adhesion to enamel tissue was higher values and it was concluded that the bonding of the materials can be strengthened by surface conditioning.

Clinical Relevance: For the application of laminate veneer restorations, if possible, enamel tissue should be preserved, if the preparation required, sufficient enamel tissue should be left. For long term use and good bonding, tribochemical coating and alternative surface treatments can be recommended.

Keywords: laminate veneer restorations, feldsphatic porcelain, dental composite, shear bond strength, dental tissue

INTRODUCTION

Laminate veneer restoration (LVR) is preferred in aesthetic applications due to its natural-like appearance and it requires minimal tooth preparation. Mechanical behaviour, optic and aesthetic property are effective in the choosing of laminate veneer restoration material.

The clinical success of LVR is closely related to the material to be chosen and the method to be used. It is known that composite resins are not perennial and cause complications such as discoloration, low wear resistance, marginal fractures and decreased aesthetics in the long term (Peumans,1997). Composite resins, which have a limited usage area due to their low wear resistance and poor bonding to tooth surface, have a wide range of indications today in parallel with the developments in adhesive dentistry (Koray,2002). Although composite veneers are aesthetic, they can not provide enamel-like reflection and transparency when compared to dental ceramic. Low fusing dental porcelain materials, which have superior aesthetic properties, have made porcelain laminate veneers a preferred treatment in minimally invasive dentistry both due to the fact that laboratory procedure isn't required out of glazing and the advances in clinical techniques in adhesive technology(Shaini,1997) (Lin et al, 20l2)

(Li 2014). Silicate ceramics composed of quartz, feldspate and kaolin are heterogenous materials (Font, 2006).

The necessity of preparation on the surface of the tooth for LVR and the depth of the preparation are still controversial issue. Minimal preparation is recommended for LVR as it reduces the stress of porcelain (Öztürk,2013) (St Germain,2015). In clinical studies, failure was reported on the enamel surface, where no treatment was performed (Dumfhart,2000). (Calamia,2007) A minimum 0.5mm-0.7mm tooth preparation is required to ensure the durability of the restoration, to be able to mask discolorated areas or to be able to change the existing tooth color (Radz, 2011). However, with the advances in adhesive materials, non-prep restorations can be performed successfully for microdontics, diastema, abrasion and malposed teeth with a proper planning (Volkan,2016) .

The purpose of changing the surface conditions is to make the surface micro-mechanically suitable for adhesion. Acide etching, laser applications which are thought to be an alternative to acidification in recent years, and tribochemical coating which is based on the coating of porcelain surfaces with a thin and glassy silicate layer and which increases the strength of bonding with the formed silicate layer and resin are among the current surface conditioning processes (Üşümez,2003) .

One of the most important factors in the clinical success of LVR is its strong bonding with the tooth. Resin cements have become the first choice in the cementation of veneers in general as they provide sufficient aesthetics for the cementation of all ceramic restorations, low resolution in the oral environment, high bonding strength to the tooth structures, superior mechanical properties and support for restoration (Magalheaes,2013).

Artificial aging process is a suitable method to evaluate the physical, chemical and optical properties of non-metallic materials such as resin cement and composite (Heydecke ,2001) (Aguilar, 2012) (Rattacaso,2011).

The purpose of our study is to measure the bonding of the restoration materials, which are roughened with different surface methods at different preparation depths, with the tooth after aging. Our first null hypothesis is that the variability of the preparation materials does not affect the bonding adversely. Our second null hypothesis is that different surface conditioning processes do not change the bonding.

2. MATERIAL – METHOD

Preparation of Experimental Study

Ethics committee approval was received from Sivas Cumhuriyet University Clinical Research Ethics Committee. In the study, a total of 128 non-carious human maxillary incisors which were decided to be extracted within the last 6 months due to periodontal or orthodontic reasons. Coronal pulps was removed by cutting the roots of the teeth, which were kept at room temperature and in 0.01% thymol solution, and the labial surfaces of the teeth was embedded in autopolymerizing acrylic blocks (Major Repair; Major Prodotti Dentari SPA, Moncalieri, Italy) in parallel with the blocks. Teeth surfaces was grinding and polishing (Minitech 233 Polishing Machine, Presi, Budapest, Hungary) to have a smooth surface under water cooling respectively with 240-, 400-, 600-, 800-, 1000-grit silicon carbide sandpapers (Würth Industry Products, Istanbul, Turkey). After standardized tooth surfaces was obtained, surface preparation was performed in the teeth that were cleaned and made sure that there were no addition on it.

Preparation of Tooth

The teeth were randomly divided into two main groups (Group E and ED). Group E was performed no preparation but only grinding with coarse diamond bur. For the preparation of the teeth prepared in enamel-dentin complex (Group ED), enamel preparations was controlled preparations by grinding with 100-, 400-, and 600 - grit silicon carbide abrazive papers (Leco1 VP 100, Leco Instrumente GmbH, Germany) until the dentin tissue was exposed in cervical third. Thus, the adhesion area was provided to contain half enamel and half dentin tissue. The cervical finishing line was positioned approximately 1 mm above the enamel-cement border. All the procedures were performed only by one examiner.

Preparation of Porcelain and Composite Samples

A1 colour feldspathic porcelain (VITA Porcelain, VITA Zahnfabrik, D-79704 Bad Sackingen, Germany) samples were placed in stainless steel molds and roasted in accordance with the manufacturer's instructions. A1 colour composite disc samples were polymerized by layering technique by placing them in stainless steel molds. Porcelain and composite samples were prepared disc shape (5 mm in diameter , 2 mm in height). Before the cementation, all disc samples were washed with distilled water and air-dried. All of the discs were then ground with silicon carbide abrasive paper of grits 400, 600, and 1200 (Leco1 VP 100, Leco Instrumente GmbH, Germany). The information of materials used in the study is presented in *Table 1*.

Surface Treatment – Adhesive Cementation

Each main group was divided into 4 subgroups and experimental groups were performed according to the surface treatment to be applied (n = 8). All teeth were cleaned, rinsed and dried with pumice slurry before roughening with 37% orthophosphoric acid. Surface conditioning processes of porcelain and composite samples to be cemented on the tooth surfaces were performed. The subgroups were performed according to their surface treatments: C, group without any surface treatment, L: the group applied under water cooling with Er-YAG laser (Smarty A-10 Deka-Laser, Florance, Italy; 20 seconds, 1.5 watts, 1 mm distance); HF: the group applied with hydrofluoric acid (9% Porcelain Etch, Ultradent® Products Inc, South Jordan, UT, USA) for 4 minutes for surface conditioning; TC: chairside silica coating with 30 µm SiO_2 particles (CoJet Sand, 3M ESPE, Seefeld, Germany; 25 seconds, 2.5 bar, 15-mm distance). Before silanization, the surfaces of LV samples were checked using ultraviolet light to see possible fractures. Porcelain and composite discs, which were made ready for cementation by silaning, were placed on the tooth surface with finger pressure in accordance with the manufacturer's instructions, and irradiated with UV light device at 1100 mW /cm^2 power for 30 seconds from each surface.

Thermal Cycles and Shear Bond Strength Test

Thermal cycles were applied to the samples whose cementation was completed. 5000 thermal cycles at 5±2°C and 55±2°C were applied to all samples. Samples with artificial aging were embedded in acrylic blocks and SBS test was performed on a universal test device (Lloyd Instruments, Fareham, UK) at a head speed of 1 mm/min.

Failure Mode Analysis

After the SBS test, all samples were evaluated with stereomicroscope (ZEISS, Axioscope 2 MAT, Oberkochen, Germany). The modes of fracture failure were listed in Table 3.

(i) Adhesive failure; on the bonding surface between the material and the tooth

(ii) Mixed failure (partial failure between tooth surface and material and/or resin cement combined with partial cohesive failure (less then %40 in the bonding area) in tooth structure and resin cement

(iii) Cohesive failure in tooth structure and resin cement

Statistical Analysis

Shear bond strength was dependent variable of the study. Adhesion surface (Enamel, Enamel-Dentine) and surface conditions (Control, Er-YAG Laser, Hydrofloric acide, Tribochemical Coating) were independent variables. The data was analysed using SPSS 22.0 (SPSS 22.0, SPSS Inc., Chicago, USA) program. Kruskall Wallis and Mann Whitney U statistic tests were performed to state if there were statistically significant differences between all groups. The statistical differences are adopted significant when p value is <0.05. Chi-square test was applied to test failure mode types.

RESULT

The normality test was performed and the bonding values distribution was found to be normal. Average SBS values and standard deviations are shown in Table 2. When the SBS values were compared according to the data obtained from the study by applying the Kruskall Wallis test, the difference between Group E and Group ED was found statistically significant in terms of surface treatments ($p < 0.05$). The highest SBS values were obtained on Group E tooth surfaces. When the surface treatments applied on Group E tooth surfaces were evaluated, the highest bond strength was obtained in the tribochemical coating group (5.54 ± 3.43). When groups were compared among themselves, there is no statistically significant difference between Group E-C, Group E-L and Group E-HF ($p > 0.05$). Statistical significance is only seen between Group ED-C and Group E-TC ($p < 0.05$). While the highest SBS value was obtained in TC applied group in both groups, the lowest shear bonding value was obtained in the control group in which no treatment was performed in both groups (*Table 2*).

Among the groups, the highest SBS value was obtained in the tooth group that was applied tribochemical coating and treated at the level of enamel. The lowest SBS value was obtained in the enamel and enamel-dentin group without surface conditioning. It was obtained that surface conditioning processes increase bonding in each group. However, this difference wasn't found to be statistically significant ($p > 0.05$). In our study where two different restorative materials were used, it was observed that the composite material better bonding to the tooth surface than porcelain (*Table 3*). The best bonding for both materials was obtained in samples conditioned by TC, and the difference was found to be statistically significant when surface treatments are compared between each other ($p < 0.001$).

When the distribution of the failure modes was evaluated, the most common failure type was adhesive rupture observed between the adhesion surface and the resin cement (*Table 4*). While the most common type of failure in porcelain samples was adhesive failure (89.1%), mixed (4.1%) and cohesive (6.8%) ruptures were to be less. Similarly, adhesive failure was 82.8%, mixed failure was 9.3%, and cohesive failure was 7.8% in composite samples.

DISCUSSION

In limitation the study, the first null hypothesis expressed the hypothesis that material diversity in the bonding of the tooth surface will not adversely affect the bonding was rejected. As a result of the data, the bonding of the restorative material with composite material was better than the feldspathic ceramic material. The second null hypothesis, which suggested that surface treatments will not affect the bonding positively, was also been rejected. In the samples with surface roughening, more shear bond strength (SBS) values were obtained for both materials (composite and porcelain).

Ceramic fractures and marginal defects were shown among the most common failures of porcelain material in clinical trials (Beier,2012) (Gürel, 2012) (Layton, 2012). Despite the aesthetic superiority, wear resistance and superiority in colour changes of the porcelain material, it was brought the use of different materials to agenda in aesthetic applications due to the fact that it requires more tooth cutting in coloured tooth tissue, adhesion problem and a long chair-time in repair operations (Okamura,2004) (Aykent,2005) (Stappert,2005) (Zorba, 2008). Altenatively LVR were increased the popularity of composite restorations in recent years due to its low cost, short application time and less preparation compared to porcelain (Özdemir,2009) (Korkut,2018). In their 8-year randomized clinical follow-up study, Gresnigt et al. emphasized that porcelain ceramic veneers performed significantly better clinical performance than composite materials (Gresnigt,2019). Ceramic LVR has advantages such as requiring less amount of preparation compared to traditional crown-bridge applications, their high color stability, their resistance to wear compared to composites, their strong bonding to enamel when they are roughened with acid, their resistance to tensile force and shear strength when adhered, providing excellent aesthetics, resistance to liquid absorption, and short preparation times (Peumans,2000). After the thermal cycles application (5000 cycles), which corresponds to a 6-month aging period, SBS values of composite restorations after artificial aging were observed to be higher in the study. This difference makes us think that it may be because the method of the study was different (in vivo and in vitro) and the mechanical and physical properties of reinforced glass ceramics, which are frequently used in clinical applications, were different from conventional low fusing porcelains.

One of the most controversial issues about laminate veneers is whether or not to make preparations, and if so, how much should be done in which zone. Today, it is recommended to make preparation with a minimally invasive approach in order to prevent overcontour, to provide a smooth outlet profile, to cover the colored tooth surface, to increase mechanical resistance, and to provide adhesion (Walls,2002) (Gürel,2004) (Kılıçarslan,2006). Ceramic veneer preparations are often limited to enamel to achieve a durable bonding interface and longer clinical durability. The complex tubular structure of the dentine has a higher elasticity coefficient than ceramic, which causes the risk of dental restoration to break. For this reason, strict attention was paid to stay at the enamel level in the current study. Ala Alavi et al. were examined the bonding of the ceramic material on the prepared and non-prepared anterior teeth in their study and were obtained the highest shear bond stregth value on the non-prepared tooth surface (Alavi ,2017). Similar results were obtained in present study and the highest shear bond strength value was measured on the surface of the enamel tissue.

Thanks to the developing adhesive technologies, it has become possible to make aesthetic porcelain laminate veneers not only having high mechanical properties but also protecting the tooth structure more (Pini,2012). Adhesive is required for compensating stress caused by polymerization shrinkage of composite resin, which should be at least 17-20 MPa to dentine shear bonding and 20 MPa to enamel tissue (Pekkan,2009). However, dual-cure resin cements have shown a bond strength value below 10 MPa in a study by Kameyama et al (Kameyama,2015). The data obtained in the study was below this value and not within the clinically acceptable limits. Due to the fact that the material prepared depending on the properties of the dual cure resin cement was prepared thicker, it shows parallelism with the studies conducted. Thickness of material is an important parameter in the use of cementation because of light transmittance. In a study using new generation self-adhesive resins, Abo Hamar et al. were evaluated the bonding to enamel and dentin tissue and were obtained the lowest shear bonding value in dentin tissue in the samples they applied with artificial aging (Abo-

Hamar,2005). The presence of enamel tissue was influence the connection positively. Similar to the data obtained in the mentioned study, SBS values were obtained lower in the samples in which dentin tissue was exposed as a result of present study.

The most important factor for a successful restoration is an effective and strong bonding between the material and the dental tissue. Many processes can be applied to the tooth surface or restoration to increase the bonding. It was stated using of HF acide (eg, etching of porcelain surface or intraoral repair of fractured porcelain restoration) is safe for dental applications in %4 to %10 concentrations (Alex,2008). Etching with low concentration hydrofluoric acid (%9) was found to be a process that increases the bonding in this study. However, there are implications in the literature that HF acid does not increase bonding (Ali ,2019). Our findings contradicting the conclusion that HF acid does not increase the bonding in materials that do not contain glassy material is not surprising due to the composition of the materials we use. Ali et al. stated that the application of acid etching to zirconia material is not an effective method to increase bonding, but thermal aging process weakens bonding (Ali,2019). The reason for the difference of these findings can be shown as contents of the restoration materials being not the same. In literature, HF acide etching is more effective method than laser application on bonding of hybride and glassy CAD/CAM blocks (Hou,2018). Researchers was stated that Er,Cr:YSGG laser (2 W) resulted in the creation of shear bond strength like with acid-etching mechanism, although laser application with the lower power (1 W) created a significantly less amount of bond strength compared to the application of acid. For this reason laser irriadiation was applied on samples at 1,5 W in the study (Üşümez,2002). Although it is a more effective method, the etching time with HF acide is so long and it takes more time than laser application (Poosti,2012). The data we obtained from the study shows that surface conditioning processes positively affect bonding. SBS value in the control group is at the lowest for both materials (composite and porcelain). However, in Er-YAG laser, hydrofluoric acid and silica coating groups, bonding was obtained at higher values. With the tribochemical coating that strengthens the bonding by providing chemical bonding in the material containing silica, the highest findings were obtained, similar to the literature. In 2013, Özcan et al was stated that coating on titanium surface increases the bond strength of materials containing silica (Özcan,2013). Although the materials were different, similarly, coated restorative samples were showed the highest values in the current study.

The long-term success of the restoration depends on the hybrid layer between tooth and resin remaining intact. Well-made clinical studies are the most reliable criteria for the evaluation of adhesive systems. However, since clinical studies are time consuming, in vitro studies are required to evaluate rapid changes in adhesive technologies. Thermal cycle (TC) is an aging process that gives more information about the behavior of dental materials in the oral environment. In present study, 5000 TC have been performed, corresponding to a 6-month period, to mimic the oral environment. It was reported that TC treatment is a significant decrease effect on SBS value between materials (Kong,2016). However, this study does not give information about how thermal cycle affects the connection between materials.

There are in vivo and in vitro studies available for researchers to evaluate the performance of materials (Lee,2007). However, in vivo studies are the ultimate method in which the clinical performance of the materials can be assessed, and it may present several difficulties to the researcher in the correct detection of failure. The current study was planned on the bond strength of dental material in vitro with the SBS test, which is an easier method for preparing fragile materials and performing the experimental procedure and obtained as numerical data. However, there is a need for literature data that can help clinicians for the debonding problem and for the rebonding stage.

Defining the adhesion zone is vital for the classification of the status of the failure. For this purpose, analysis with microscopic imaging can provide more reliable and complementary information. In our study, it has been observed that the types of fracture in the samples with low bond strength were mostly adhesive ruptures. It was also seen that there is a very large amount of adhesive failure in the samples that ruptured before the breaking test was applied. The failure type was reported to be adhesive at lower bond strength values. The same researcher suggested that when adhesion is provided with improved methods at the adhesive interface, the bond strength value can exceed the cohesive strength values of the resin cement (de Barros,2006) (CN, 2006). When failure types on the rupture surfaces are evaluated, adhesive failure between the tooth surface and cement is mostly seen in the control groups, whereas the cohesive failure is mostly seen in the laser groups.

CONCLUSION

Within the limitations of our current study, it may be recommended to stay in the enamel tissue as much as possible in the construction of laminate veneer restorations and if some preparation is required, some enamel tissue should be preserved. According to data of the current in-vitro study, etching the enamel tissue and exposing the dentin tissue have weakened the bonding. It can be concluded that surface conditioning processes can be performed for increasing the bonding of feldspathic ceramics and composite materials. It has been observed that one of the most effective methods among the existing systems is the tribochemical coating that can be easily applied in a chair-side way. Our data show that composite material can be an alternative to porcelain. However, clinical and in-vivo studies are needed as a result of long-term clinical use.

REFERENCES

Abo-Hamar Sahar E et al. "Bond strength of a new universal self-adhesive resin luting cement to dentin and enamel." Clinical oral investigations 9.3 (2005): 161-167.

Alavi Ali Asghar, Zeinab Behroozi, and Farid Nik Eghbal. "The shear bond strength of porcelain laminate to prepared and unprepared anterior teeth." Journal of Dentistry 18.1 (2017): 50

Alex Gary. "CE 1-Preparing Porcelain Surfaces for Optimal Bonding." Compendium 29.6 (2008): 324.

Ali Shams Waaz Amgad, and Shereen Kotb Salem. "Effect of Aging on The Shear Bond Strength of Zirconia Ceramic With Different Surface Treatments". Egyptian Dental Journal 65.1-January (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics) (2019): 453-461.

Aykent Filiz, et al. "Effect of provisional restorations on the final bond strengths of porcelain laminate veneers." Journal of oral rehabilitation 32.1 (2005): 46-50.

Beier Ulrike Stephanie, et al. "Clinical performance of porcelain laminate veneers for up to 20 years." International Journal of Prosthodontics 25.1 (2012).

Calamia John R and Christine S. Calamia. "Porcelain laminate veneers: reasons for 25 years of success." Dental clinics of north America 51.2 (2007): 399-417.

de Barros Pereira, Carolina Nemesio. "Influência do padrão de evaporação do silano sobre a resistência de união entre uma cerâmica à base de dissilicato de lítio e um cimento resinoso quimicamente ativado: avaliação in vitro através de um ensaio mecânico de microtração." (2006).

Dumfahrt Herbert. "Porcelain laminate veneers. A retrospective evaluation after 1 to 10 years of service: Part I--Clinical procedure." International Journal of Prosthodontics 12.6 (1999).

Font Antonio Fons, et al. "Choice of ceramic for use in treatments with porcelain laminate veneers." Med Oral Patol Oral Cir Bucal 11.3 (2006): 297-302.

Gresnigt MMM, et al. "Randomized clinical trial on indirect resin composite and ceramic laminate veneers: up to 10-year findings." Journal of dentistry 86 (2019): 102-109.

Gürel Galip. The science and art of porcelain laminate veneers. London: Quintessence,, 2003.

Gürel Galip, et al. "Clinical performance of porcelain laminate veneers: outcomes of the aesthetic pre-evaluative temporary (APT) technique." International Journal of Periodontics & Restorative Dentistry 32.6 (2012).

Heydecke Guido, Feimin Zhang, and Michael E Razzoog. "In vitro color stability of double-layer veneers after accelerated aging." The Journal of prosthetic dentistry 85.6 (2001): 551-557.

Hou Yepo, et al. "Shear Bond Strength of Different CAD/CAM Ceramics: Acid vs Er: YAG Laser Etching." Photomedicine and laser surgery 36.11 (2018): 614-620.

Kameyama Atsushi, et al. "Luting of CAD/CAM ceramic inlays: Direct composite versus dual-cure luting cement." Bio-medical materials and engineering 25.3 (2015): 279-288.

Kılıçarslan MA, Eskitaşçıoğlu G, Zaimoğlu A, Karaağaç E. Evaluation of different laminate veneer crowns under functional forces by finite element stress analysis method. Ankara Univercity Dental Journal (2006): 33: 23-31

Kong Yuan-Yuan, et al. "Influence of thermocycling on shear bond strength of glass ionomer cement to Er: YAG laser-prepared enamel." Lasers in surgery and medicine 48.10 (2016): 978-984.

Koray F. and Yücel T. Restorative materials and clinical applications: The use of the composite in the anterior region teeth, Journal of the Turkish Dental Association (2002): 71:16-23.

Korkut Bora. "Smile makeover with direct composite veneers: A two-year follow-up report." Journal of dental research, dental clinics, dental prospects 12.2 (2018): 146.

Layton Danielle M and Terry R. Walton. "The up to 21-year clinical outcome and survival of feldspathic porcelain veneers: accounting for clustering." International Journal of Prosthodontics 25.6 (2012).

Lee Jason Jonghyuk, et al. "Using extracted teeth for research: the effect of storage medium and sterilization on dentin bond strengths." The Journal of the American Dental Association 138.12 (2007): 1599-1603.

Li Raymond Wai Kim, Tak Wah Chow, and Jukka Pekka Matinlinna. "Ceramic dental biomaterials and CAD/CAM technology: state of the art." Journal of prosthodontic research 58.4 (2014): 208-216.

Lin Tai-Min, et al. "Fracture resistance and marginal discrepancy of porcelain laminate veneers influenced by preparation design and restorative material in vitro." Journal of dentistry 40.3 (2012): 202-209.

Magalhães Ana Paula Rodrigues de, et al. "Influence of the resin cements color on the shade of porcelain venners after acelerated artificial aging." (2013).

Okamura Mitsunobu, et al. "Application of Alumina Coping to Porcelain Laminate Veneered Crown." Dental materials journal 23.2 (2004): 180-183.

Özcan Mutlu, Gurel Pekkan, and Ashkan Khan. "Does rinsing following particle deposition methods have a negative effect on adhesion to titanium." J Adhes Dent 15 (2013): 307-310.

Özdemir Eylem, Süleyman Agüloğlu, and Yalçın Değer. " Aesthetic rehabilitation of three patients with enamel defects in their anterior teeth by using composite and porcelain laminate veneers (case report)" Journal of Gazi University Faculty of Dentistry 26.3 (2009): 171-176.

Öztürk Elif, et al. "Shear bond strength of porcelain laminate veneers to enamel, dentine and enamel–dentine complex bonded with different adhesive luting systems." Journal of dentistry 41.2 (2013): 97-105.

Pekkan Gurel, and Canan Hekimoglu. "Evaluation of shear and tensile bond strength between dentin and ceramics using dual-polymerizing resin cements." The Journal of prosthetic dentistry 102.4 (2009): 242-252.

Peumans Marleen, et al. "The 5-year clinical performance of direct composite additions to correct tooth form and position." Clinical oral investigations 1.1 (1997): 12-18.

Peumans Michael, et al. "Porcelain veneers: a review of the literature." Journal of dentistry 28.3 (2000): 163-177.

Pini Núbia Pavesi, et al. "Advances in dental veneers: materials, applications, and techniques." Clinical, Cosmetic and Investigational Dentistry 4 (2012): 9.

Poosti Maryam, et al. "Porcelain conditioning with Nd: YAG and Er: YAG laser for bracket bonding in orthodontics." Lasers in medical science 27.2 (2012): 321-324.

Radz Gary M. "Minimum thickness anterior porcelain restorations." Dental Clinics of North America 55.2 (2011): 353-370.

Rattacaso Raphael Mendes Bezerra, et al. "Bleaching agent action on color stability, surface roughness and microhardness of composites submitted to accelerated artificial aging." European journal of dentistry 5.02 (2011): 143-149.

Shaini FJ, ACC Shortall and PM Marquis. "Clinical performance of porcelain laminate veneers. A retrospective evaluation over a period of 6.5 years." Journal of oral rehabilitation 24.8 (1997): 553-559.

Stappert Christian FJ, et al. "Longevity and failure load of ceramic veneers with different preparation designs after exposure to masticatory simulation." The Journal of prosthetic dentistry 94.2 (2005): 132-139.

St Germain Jr HA and TH St Germain. "Shear bond strength of porcelain veneers rebonded to enamel." Operative dentistry 40.3 (2015): E112-E121.

Ural Çağrı et al. "The effect of laser treatment on bonding between zirconia ceramic surface and resin cement." Acta Odontologica Scandinavica 68.6 (2010): 354-359.

Üşümez Serdar, Metin Orhan, and Aslıhan Üşümez. "Laser etching of enamel for direct bonding with an Er, Cr: YSGG hydrokinetic laser system." American Journal of Orthodontics and Dentofacial Orthopedics 122.6 (2002): 649-656.

Üşümez Aslihan and Filiz Aykent. "Bond strengths of porcelain laminate veneers to tooth surfaces prepared with acid and Er, Cr: YSGG laser etching." The Journal of prosthetic dentistry 90.1 (2003): 24-30.

Volkan TURP, et al. "SINGLE NO-PREP PORCELAIN LAMINATE VENEER RESTORATIONS; 2 CASE REPORTS." Aydın Dental Journal 2.3 (2016): 29-34.

Wall, AWG, JG Steele and RW Wassell. "Crowns and other extra-coronal restorations: porcelain laminate veneers." British dental journal 193.2 (2002): 73-82.

Zorba YO and E Ercan. "Direkt uygulanan kompozit laminate veneerlerin klinik değerlendirilmeleri: iki olgu sunumu." SÜ Diş Hek Fak Derg 17.2 (2008): 130-5.

Materials	Manufacturer	Composition
Prime-Dent	Prime Dental Manufacturing,ABD	Ortophosphoric acid
Feldspathic Porcelain	VITA Porcelain—VITA Zahnfabrik, D-79704 Bad Sackingen, Germany	Alumina, leusite, silicon dioxide
Herculite XRV Ultra	Kerr, USA	Ethoxylated Bisphenol A-dimethacrylate 3-Methacryloxypropyltrimethoxysilane 2,2-ethylenedioxydiethyl dimethacrylate BIS-GMA
Porcelain Etch Silane	ULTRADENT, USA	9% Buffered Hydrofloric Acid
Rely X TM Veneer	3M ESPE Seefeld Germany	Bis-GMA, TEGDMA, Ziconia/silica and fumed silica, Pigments, Photoinitiator

Table 1 : Materials used in the study.

Groups	n	Surface Treatment	Mean MPa (SD)	p
Group E	16	Control (C)	2.88(1.92)	0,0001*
	16	Er-YAG Lazer(L)	3.05(1.00)	
	16	Hydrofloric Acide (HF)	4.99(4.08)	
	16	Tribochemical Coating(TC)	5.54(3.43)	
Group ED	16	Control (C)	1.76(0.90)	0,193
	16	Er-YAG Lazer(L)	2.74(1.07)	
	16	Hydrofloric Acide (HF)	3.45(2.21)	
	16	Tribochemical Coating(TC)	5.25(2.86)	

Table 2. SBS values of materials according to surface treatments

	n	Control	Er-YAG Laser Etching	Hydrofloric Acide Etching	Tribochemical Coating	p
Porcelain	16	1.11 (0.42)	2.34 (0,56)	2.05 (0.81)	7.00 (2.07)	0.001*
Composite	16	3.53 (1.36)	3.45 (1.11)	2.28(1.02)	8.19 (2.01)	0.001*

Table 3. Shear bond strength values according to restorative materials.

Groups	Adhesive		Mixed		Cohesive	
	Porcelain	*Composite*	*Porcelain*	*Composite*	*Porcelain*	*Composite*
Group ED-C	6 75%	5 62.5%	1 12.5%	2 25%	1 12.5%	1 %12.5
Group ED-L	8 100%	7 87.5%	0	1 12.5%	0	0
Group ED-HF	7 87.5%	7 87.5%	1 12.5%	1 12.5%	0	0
Group ED-TC	7 87.5%	8 100%	0	0	1 12.5%	0
Group E-C	8 100%	6 75%	0	0	0	2 25%
Group E-L	7 87.5%	6 75%	1 12.5%	1 12.5%	0	1 12.5%
Group E-HF	6 75%	7 87.5%	0	1 12.5%	2 25%	0
Group E-TC	8 100%	7 87.5%	0	0	0	1 12.5%

Table 4. Failure modes of the groups.