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Fracture Resistance of Laminate Veneers Made with Different Cutting and Preparation Techniques

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Abstract Introduction: The purpose of this study was to evaluate the fracture resistance of most used three preparation techniques applied laminate veneers made with three different restoration methods. Materials and Methods: 195 same sized maxillary central incisor teeth were grouped 10 different groups randomly. (testing groups n=20, control group n=15) Three different preparation techniques used for teeth preparation which were feather-edge, insical overlap and window. Laminate veneers were produced with three different methods that direct, indirect technique, and CAD/CAM milling. Control group was chosen from untreated teeth. Universal testing machine was used for fracture resistance test. Data were analyzed with two-ways ANOVA and Tukey LSD. Results: According to results, statistically differences were found between all groups.(p<0,05) Combination of insical overlap preparation and direct technique has higher fracture resistance values than other groups.(563,9 N). Conclusions: Preparation and restoration techniques are important for fracture resistance of laminate veneers.

Keywords: *CAD/CAM, laminate veneer, fracture resistance, resin composite, resin nano ceramics*

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1. Introduction

Personal appearance is getting more and more important in society as it is the aesthetic aspect that is primarily realized in people. A properly formed smile line and teeth that are aligned and contoured in accordance with this line are considered the most important factors that affect appearance. Orthodontic, periodontal and restorative operations are performed together or separately in patients, who make this request.

Treatments administered depend on the age of the patient, the relationship of the teeth to adjacent tissue and teeth, the skills of the dentist, socioeconomic status of the patient, cause of the aesthetic problem and the material to be used. Aesthetic restorative treatments are the most preferred methods.

Dr. Frank Faunce defined acrylic prefabricated laminate veneers in the 70's. In 1975, Rochette suggested using resin connected ceramics on anterior teeth. In 1983, Horn, in 1987 Hobo and Iwata attempted platinum folio and castable porcelain as a means to produce porcelain laminate veneers. As better adhesion was achieved with silane application, this was used more commonly and more materials are used for this application.

Laminate veneers are made using two techniques. Direct laminates are made by placing resin composite material on tooth in the clinic. Indirect laminate veneers are made by applying porcelain or resin composite on the models based on the patient and administered on the patient by using an adhesive agent. [1]

One of these two methods shall be chosen considering the severity of the dental problem, technical sensitivity and costs. In addition to these considerations, the restoration material to be used may be subject to change after it is determined if the existing aesthetics problem is limited to dentine or not.

Laminate veneers should be prepared with special cut drills and within the boundaries of the dentine. There are four different cutting techniques that can be used in this manner and be chosen in accordance with the event. These are:

- In-dentine window technique: This is a cutting technique applied by leaving 1 mm openings at all edges of the teeth and by remaining within the healthy dentine section. These are generally used in acrylic resin laminate veneers.
- Feather edge incisal cutting technique: This technique is applied with abrasion on the facial surface without shortening the cutting edge of the tooth. This is terminated at the incisal edge.
- 30 – 40 ° angled incisal bevel cutting technique: In addition to the abrasion on the facial surface, the incisal edge of the tooth is shortened by 1.5 mm and added to the preparation.
- Incisal overlap (cutting including the whole incisal edge, terminated at the palatine of the tooth) technique: The cutting edge of the tooth is

shortened by 2 mm and this cutting technique includes 1.5-2 mm of the palatine of the tooth. [2]

Direct composite veneers have several advantages such as protecting dental tissue, superior physical characteristics, acceptable edge compatibility and sufficient aesthetic characteristics. Also, when compared with porcelain restorations, resin composites are less risky in terms of catastrophic fractures and have a less abrasive effect. It costs less when compared to the indirect method. One of the most important characteristics of this method is that it is reversible. [1]

Indirect composite laminate veneers are applied in the laboratory on the model prepared in accordance with the measurements taken after cavity preparation. They are polymerized in the furnaces in the laboratory, which use various polymerization techniques. There are secondary and high polymerization furnaces in form of pressure-heat-light and heat-light. In systems that provide high polymerization, light is used on the restoration placed inside the polymerization beads for 4-6 minutes and then heat is applied under 60 psi pressure at 130°C in water for 10-12 minutes. This type is the polymerized composite resin with composite homogenous micro and hybrid filling and is less porous and has better color stabilization compared to the polymerized nanofilled composite resin. Also, as this type reaches high polymerization values, shrinkage and amount of residual monomers are scarce. Laminate veneers prepared in the laboratory are fixated using dual-cure resin cement. [3]

As resin composites are fixed with adhesive, they are better at transmitting the stress imposed on the restoration compared to the ceramic types due to their low elasticity modules. Also marginal discoloration, secondary decays, postoperative complaints and microleaks causing pulpal problems have been reduced.

CAD/CAM stands for computer aided design/computer aided milling. Dr. Duret, Dr. Anderson and Dr. Mörmann have created dental CAD/CAM systems with the studies they have conducted. After these pioneer scientists, dental CAD/CAM systems have progressed rapidly and their scope of indications has grown.

Today, laminate veneer, inlay, onlay, bridgeworks, structures of partial denture, personal implants, implant supported dentures and crowns can be made. In this system, prefabricated blocks are used for drilling. These blocks may be manufactured for various indications with various content such as ceramics, metal alloys, zirconium oxide and resin.

The purpose of our study is to perform a comparative evaluation of the fracture resistance data of laminate veneers prepared using the most common cutting types and production techniques in literature and clinical practice.

In this study, our hypothesis is that different cutting techniques and different preparation methods can affect the fracture resistance of laminate veneers.

2. Materials and Methods

The effect of certain cutting techniques and various restoration materials used in laminate veneers on the fracture resistance was experimented in vitro. 195 same sized, freshly pulled out, maxillary central incisor teeth, without any decay, defect or cracking, with a crown length of 12 mm and mesiodistal width of 9 mm were used in this study. After the residues on the teeth were removed, the healthy ones without restoration were included in the control group. (n=15) 20 teeth were included in each group randomly. The Power analysis was performed using the universal software (SPSS 20.0, IBM, Chicago, USA) in order to determine if the amount of samples in the control group affect the statistical analysis.

60 of the samples prepared using the window type, feather and incisal overlap cutting techniques were restored using resin nano ceramic based blocks, 60 of the samples were restored using indirect composite resin and 60 were restored with nanohybrid composites. A braking resistance test was performed on the samples prepared, in accordance with the literature. Groups determined for fracture resistance test are provided in Table 1.

Table 1. Cutting techniques and production methods by group numbers

Group	Cutting Technique Used	Production Method Used
1		Indirect Technique
2	Feather Type - Terminated at Incisal	CAD/CAM System
3		Direct Method
4		Indirect Technique
5	Incisal Overlap	CAD/CAM System
6		Direct Method
7		Indirect Technique
8	In-dentine Window	CAD/CAM System
9		Direct Method
10	Not Processed	

2.1. Preparation of Samples

For standardization, a drilling set specific for laminate veneer preparation (Laminate Veneer Set, Axis, Kerr, Texas, USA) was used. Guiding grooves were created on the facial surfaces of teeth 0.3 mm wide at cervical 1/3, 0.5 mm wide at middle and incisal 1/3, using depth determination drills numbered M834-016 and M834-021 (Axis, Texas, USA). Diamond burr numbered H284K-016 (Axis, Texas, USA) was used on the preparation surface. The middle trio of the preparations was corrected using correction burr numbered SF134-014, and the cervical and incisal trios were corrected using correction burrs numbered SF132-008 and SF379-023 (Axis, Texas, USA).

Each group was cut differently. For in-dentine window preparation, 1 mm of the dentine was left at four edges of the tooth, without including the cutting edge. For feather preparation, cutting was terminated at incisal, without shortening the cutting edge. For incisal overlap preparation, the cutting edge was shortened for 2 mm and preparation was also applied at palatine. Samples of each group of the experiment were prepared concomitantly.

34% phosphoric acid was applied on all groups that have undergone the cutting process (Scotchbond Universal Etchant, 3M ESPE, St. Paul, USA) and after 15 seconds, it was sprayed with water for 15 seconds, and dried by spraying air for 30 seconds. The materials used are provided in Table 2 in detail.

A fine layer of isolating material (Die Separator, Bisco, Schaumburg, USA) was used on the teeth that will be prepared using indirect composite resin in Group 1, 4 and 7 in order to prevent the composite from getting stuck and to create a cement space. After the lower composite layer (Tescera Body, Bisco, Schaumburg, USA) was placed using the composite layering technique, this piece was placed on a special device (Tescera ATL, Bisco, Schaumburg, USA) that provides polymerization with heat and light. First, it was placed in the beads in the light container and was exposed to a pressure and light cycle for 2 minutes. After this procedure, a grey microfilled composite (Tescera Incisal, Bisco, Schaumburg, USA) was used as the upper layer and the light cycle was repeated. Following the completion of the cycle, the light container was moved away from the device. After these processes, restoration was removed from the cavity and was put in the bin inside the heat container half filled with distilled water. An oxygen cleaning capsule was placed in the bin and the restoration was subjected to a pressure, light and heat cycle for 10-13 minutes.

Table 2. Name, content and manufacturers of the materials used

Name of Product	Composition	Manufacturer
Tescera Incisal	<40% Ethoxylated Bis-GMA <20% Triethylene glycol dimetacrylate <85% Glass Filler	Bisco Inc., Schaumburg, USA
Tescera Body	<15% Ethoxylated Bis-GMA <15% Urethane Dimethacrylate <80% Glass Filler <25% Amorphous Silica 60-80% Silanized Ceramics	Bisco Inc., Schaumburg, USA
Filtek Ultimate	1-10% Silanized Silica 1-10% Diurethane Dimethacrylate 1-10% Silanized Zircon 1-10% Bis-GMA <5% Triethylene glycol dimetacrylate	3M ESPE, St. Paul, USA
Lava Ultimate CAD/CAM Block	80% Resin Nano Ceramics	3M ESPE, St. Paul, USA
Scotchbond Universal	15-25% Bis-GMA 15-25% 2-Hydroxyethyl Methacrylate 5-15% Decamethylene Dimethacrylate 10-15% Water 10-15% Ethanol 5-15% Silanized Silica 1-5% Itaconic Acid Copolymer	3M ESPE, St. Paul, USA
Scotchbond Universal Etchant	35% Phosphoric acid	3M ESPE, St. Paul, USA
RelyX Ceramic Primer	70-80% Ethyl Alcohol 20-30% Water <2% Methacryloxypropyltrimethoxysilane	3M ESPE, St. Paul, USA
RelyX Arc	60-70% Silanized Ceramics 10-20% Triethylene glycol dimetacrylate 10-20% Bis-GMA 1-10% Silanized Silica	3M ESPE, St. Paul, USA

Teeth in groups 2, 5 and 8 were secured on an artificial maxilla. The purpose of this procedure was to obtain a more reliable image using the optic measurement cap of the CAD/CAM device. Appropriate restorations were selected on the models obtained with the computer system and the cement opening (300 µm) was set. Afterwards, resin nano ceramic block (Lava Ultimate, 3M ESPE, St. Paul, USA) was placed in the milling device (CEREC MC XL, Sirona Dental, New York, USA) and veneers were produced.

For groups 3, 6 and 9, acid was applied on teeth (Scotchbond Universal Etchant, 3M ESPE, St. Paul, USA) and a single stage all-in-one dental adhesive bonding agent (Scotchbond Universal, 3M ESPE, St. Paul, USA) was used. It was slightly dispensed with air for 15 seconds, in accordance with the instructions provided by the company. Polymerization was performed in plasma mode, with an LED device with a light density of 1800 mW/cm^2 and wavelength of 430-480 nm (Valo LED, Ultradent, South Jordan, USA) for 10 seconds. After acidification and bonding, nanohybrid resin composite (Filtek Ultimate, 3M ESPE, St. Paul, USA) with a layering technique. Veneers were completed after each layer was polymerized for 20 seconds in plasma mode using a LED device with a light density of 1800 mW/cm^2 and wavelength of 430-480 nm.

After the completion of the restorations, silane (RelyX Ceramic Primer, 3M ESPE, St. Paul, USA) was applied on veneers in groups 2, 5 and 8. After the teeth prepared for all indirect veneers were etched with acid (Scotchbond Universal Etchant, 3M ESPE, St. Paul, USA) and a single stage all-in-one dental adhesive bonding agent (Scotchbond Universal, 3M ESPE, St. Paul, USA) was used. It was slightly dispensed with air for 15 seconds, in accordance with the instructions provided by the company. Polymerization was performed with a Valo LED device for 10 seconds in plasma mode. After these procedures, restorations were attached to the teeth with an adhesive resin cement developed for veneers (RelyX Arc, 3M ESPE, St. Paul, USA) and cementation was completed after polymerization for 40 seconds with a Valo LED device. After the cementing procedures are completed, aluminum oxide plated discs (OptiDisc Set, Kerr, Bioggio, Switzerland) were applied in all groups and rubber pieces (Identoflex Composite Polishing Set, Kerr, Bioggio, Switzerland) were used and the teeth in all experimental groups were subject to finishing and polishing procedures.

After the samples in the experimental and control groups were held in distilled water at 37°C for 24 hours, 1200 thermal cycles were applied consisting of maintaining the samples between temperatures of 5°C-55°C in each water tank for 20 seconds in the thermal cycler (Atatürk University Faculty of Dentistry Pedodontology Department, Erzurum, Turkey).

2.2. Fracture Resistance Test

After the thermal cycle procedure, teeth were held in distilled water at 37°C for 24 hours. Before the samples were embedded in acrylic, the nozzle part of 10 cc injectors (Maviset, İzmir, Turkey) were cut using a scalpel numbered 11. Injectors were secured with a 90° angle to the ground level. Autopolymerization repair acrylic (SC Soğuk Akrilik, Imicryl, Konya, Turkey) was placed in the gap formed and teeth were inserted in this gap with an angle of 135°. After acrylic is hardened, samples were held in distilled water at 37°C for 24 hours.

Mechanisms were installed in the universal test device (Instron 3350, Instron Industrial Products, Grove City, USA) and a 0.75 mm/min force was applied towards the incisal direction. Data obtained at first fracture were taken down in Newton units.

In experiments carried out with the feather cutting groups, 2 samples produced with the indirect technique and 1 sample produced using CAD/CAM system gave wrong results without providing any data.

Broken samples were examined at a zoom rate of 10x under a light microscope (SOIF Biocular Light Microscope, Shangai Optical Instruments, Shangai, China) and types of breaking were determined. The differences between the breakage test data of groups were analyzed with “Two-way ANOVA”, two item comparisons were performed with “TUKEY post-hoc” and a “Chi square analysis” was performed for the determination of the ratio between fracture severity. The confidence interval was set as 95%+ and a software (SPSS 20.0, IBM, Chicago, USA) was used for statistical analysis. Significant difference indicator, p was taken as >0.05.

3. Results

In this study, the fracture resistance of laminate veneers produced with different types of preparation and restored using different restoration techniques were analyzed. The maximum breaking resistance data, which explain the final fracture value, were noted in Newton (N) unit.

Highest fracture resistance values were obtained at Groups 1, 2 and 3, with feather type preparation; 326 N, 410.4 N and 510.37 N, respectively, at Groups 4, 5 and 6 with incisal overlap type preparation; 451 N, 513 N and 563.91 N, respectively and at Groups 7, 8 and 9, with feather type preparation; 322.5 N, 399 N and 456.3 N, respectively. In Group 10, which consists of unprocessed samples, which were only subject to aging, the highest value was measured as 530.82 N.

The analyses performed at a confidence interval of 95% with “Two-way ANOVA”, and significant differences were observed at the content of restorative materials used in groups, preparation types and laminate veneer production techniques used (p<0,05). (Table 3)

Table 3. Variance analysis for the maximum fracture resistance values of various restoration techniques and cutting types

Variation Source	Square Totals	Degree of Freedom	Square Average Values	F	p
Restoration Technique	237781,806	2	118890,903	50,964	.000
Cutting Type	352995,052	2	176497,526	75,658	.000
Technique * Cutting Type	19934,656	4	4983,664	2,136	.078
Error	422242,271	181	2332,830		
General	28123169,463	191			

The broken samples were analyzed under light microscope and defined as adhesive, cohesive or mixed in accordance with the type of breaking. Based on the chi square analysis, adhesive fractures were observed in groups, to which the indirect technique was applied, at an approximate rate of 76%, cohesive fractures were observed in groups, to which the direct technique was applied, at an approximate rate of 57% and adhesive fractures were observed in groups, to which CAD/CAM system was applied, at an approximate rate of 63% Also, when the types of breaking are compared in accordance with their cutting techniques, in groups where feather type cutting technique was used, adhesive fractures were observed at around approximately 40%, in groups where incisal overlap type cutting technique was used, adhesive fractures were observed at around approximately 42% and in groups where window type cutting technique was used, adhesive fractures were observed at around approximately 57%. Mixed breaking was not observed in groups, where window type cutting technique was used.

4. Discussion

The results obtained with this study, where the cutting techniques and veneer production methods used for the restoration of teeth, shows that the cutting and production techniques used for the preparation of laminate veneers affect the fracture resistance at this type of restorations.

One of the techniques used on the anterior teeth, which are discolored, broken or has hyperplasic regions is layering. [4] In this techniques, several layers of composite resin (dentine, body) is applied at various thicknesses and restoration is completed by applying a dentine composite resin. Thus, an aesthetic restoration with characteristics similar to the dentine tissue is obtained. [5] With this method, which aims to benefit from the characteristics of composite resins to the maximum extent, the skills and experience level of the dentist has high importance. As there were disadvantages with this technique such as the success of the restoration work performed with this technique being dependent on the dexterity of the dentist, the color stability being obtained in the long run and being dependent on the diet of the patient and the physical, mechanical and optical characteristics of the composite resin material having a significant effect on the life cycle of the restoration, composite resin laminate veneers were created.[6]

In dentistry, laminate veneers can be produced using special polymerization furnaces with indirect composite resins, computer supported milling systems with ceramic or composite resin blocks, in laboratory environment with porcelains and inside the patient's mouth with special composite resins manufactured for this aesthetic region. Although long term clinical observations support the view that for laminate veneers, the best results are obtained with porcelain laminate veneers, these are used less commonly as resin composites are being improved and ceramics with composite content are obtained. Moreover, Robbins [7] has also stated in his study that the length of treatment is a disadvantage.

Fracture resistance test is one of the stress tests recommended by ISO. It is recommended as a simple, precise and reliable method. [8] Spheres, bars or bar shaped fracture tips may be used for fracture resistance tests. [9] Also, Hara et al. have obtained 91% adhesive breaking with tests at 0.75 mm/min. In our study, we have used a sphere tip with a diameter of 1 mm and the tests were performed using the application rate of 0.75 mm/min, in accordance with the studies in the literature. [9] In a study conducted by Lin et al. [10], it was proven that the fracture tip being applied from the edge with an angle of 135°, recreates the force laminate veneers are subjected to in the mouth.

6 main designs were proposed by McLaughlin [11] for the cutting techniques that may be used for veneer restorations. Incisal overlap, feather edge, bevel and in-dentine window type cuttings were the ones that were used most commonly. Incisal overlap cutting technique is recommended by many scientists, which include a section of the palatinal edge, which is aesthetically satisfactory as it provides better imitation of teeth and increases the resistance of the incisal edge to occlusal forces. [12] Highton et al. have proven that, incisal overlap preparation decreases the stress concentration in laminate veneers by dispensing the occlusal force to a wider area in a study, where two dimensional photo elastic stress analysis was performed. [13] Berksun et al. [14] have stated that stress is most commonly observed at bevel type cuts and in window preparations, where the whole restoration is inside dentine, window preparation was the most resistant cutting technique in terms of axial stresses. Meijering et al. [15] have shown that the preparation type of the incisal edge is not related to the success of restoration, in a clinical study conducted for a term of 2.5 years. Troedson et al. [16] have reported that the direction of the chewing force on teeth is more significant for the success of restoration than the type of preparation. In light of all these data, feather edge, incisal overlap and in-dentine window preparation types were used.

With the increased use of computer supported systems and inclusion of software in our daily lives, computer supported systems have also started being used in dentistry. CAD/CAM systems have enabled many restorative applications to be performed more rapidly, without the need of a laboratory. Although CAD/CAM systems are equipped with a system that allows applications directly on the patient (CEREC system, Sirona Dental, New York, USA), the number of resin containing blocks are extremely low. [17] Today, these are Vita Zahnfabrk, Bad Säckingen, Germany), Lava Ultimate CAD/CAM (3M ESPE, St. Paul, USA) and Cerasmart (GC America Inc., Illinois, USA) blocks. Lava Ultimate blocks have 80% nanoceramic filling in UDMA resin and thus they have an elastic structure compared to the porcelain containing materials. [17] In this study, it was shown that fracturability is similar to direct composite resin veneers, considering the amount of cracks and plastic deformations.

The success of the restoration depends on a strong and durable adhesion between the enamel and dentine, and restorative material and resin cement. The main purpose of using adhesive bonding cements was to reinforce the weakened dental structure and support the enamel and dentine tissue underneath. We mainly used dual cure adhesive cement hardened with light, developed for anterior region laminate veneers. Mahmood et al. [18] have reported that a proper cement material would absorb the stress caused by the force of chewing and be effective in preventing fractures and adhesive type breaking. Our study has revealed that adhesive breaking was observed in cemented restorations more commonly and cohesive and mixed breaking is more common in direct restorations.

In direct composite applications, high value results were obtained at crown fractures and cervical region fractures, in line with previous studies. [19] Also, Hagge and Lindemuth [20], have reported that adhesive fractures are observed at lower values and cohesive fractures are observed at higher values. In our study, fractures in highly resistant direct composite resin restorations were cohesive and on the exterior hard dental tissue and fractures in indirect composite resin restorations, which are less resistant to fractures, breaking is often adhesive and at the connection between the cement and teeth or restoration and cement. When the fracture types in CAD/CAM systems are analyzed, adhesive fractures are more common, though a significant difference was not observed.

Turkaslan et al. [21] have proven that fracture resistance can reach 552-790 N, in a study concerning the fracture resistance of laminate veneers prepared using different restoration techniques and materials. Hagberg [22] states that the physiologic biting forces in adults are between 108 and 230 N. This is why the maximum force level, where the main fracture occurs is important. In our study, these values were determined to be between 253 N and 563 N, considering all groups. Although techniques used in our groups may be superior to each other, as the data obtained in all types were higher than the biting force of an adult, they are proven to be suitable for clinical practice.

Meijering et al. [15] have defended that the minimal the invasiveness of the preparation, the higher the resistance of the tooth will be. Calamia [23] has reported that window type preparations are more resistant to fractures than the ones terminated at the incisal edge, however, in clinical practice, the fracture incidence of incisal overlap cuts were lower. De Andrade et al. [24] have proven that when feather type cutting is compared to incisal overlap cuts, incisal overlap cuts are 3 times more resistant to the axial forces than feather type cuts. Highton et al.have explained this difference with the observation that the forces at the incisal edge being dispensed better at overlap cuts. [13] Pascotto and Benetti [25] have stated that veneers made using feather type preparations would not break after 3 years and suggested using feather type preparations as it was difficult to completely mask the enamel restoration connection at the incisal edge of the in-dentine preparation. In a study concerning the photo elasticity of porcelain laminate veneers, Highton et al. have reported that laminate veneers produced using the incisal overlap cutting technique dispense force more effectively and have higher fracture resistance when compared to natural teeth. [13] In light of the findings of our study, we are also able to say that incisal overlap preparation increases resistance to fractures in laminate veneers.

In this study, considering the indirect composite resin laminate veneer production technique, there is no significant statistical difference between feather type cuts and window type cuts and the highest fracture resistance data was observed with incisal overlap cuts. In groups, where direct composite resin laminate veneer production technique is used, the order of fracture resistance from the highest to the lowest is; incisal overlap cuts, in-dentine windows and feather edges. In veneers produced using computer supported nano ceramic blocks, the highest values were obtained with incisal overlap cuts. In light of these data, we can state that incisal overlap cuts, which are claimed to distribute the stress most efficiently, have proven their success in all three groups. [19,25]

Incisal overlap cut direct composite resin laminate veneer technique, which has provided the highest fracture resistance values, transmitted the force to hard dental tissue and the fractures were mainly observed at the cervical region of the teeth; at the crown and root. Restorations produced using the CAD/CAM system, with the same cutting technique, have similar fracture resistance, however, they have proven to protect the hard dental tissue and were broken adhesively. Thus, the force absorbing effect of cement material is also proven in this study.

In light of all these data, it can be stated that when incisal overlap type cuts are applied, all Tescera ATL, direct and CAD/CAM systems provide acceptable fracture resistance values. However, in order to reach a final conclusion, this study should be supported with in vivo studies.

5. Conclusion

1. A significant statistical difference was observed in groups prepared using different preparation and production techniques. ($p<0.05$) The highest value in all groups was 563.9 N, at the incisal overlap cut direct composite resin laminate veneer group. The lowest value observed was 253 N, at the feather type cut indirect composite resin laminate veneer group.
2. The average value of all groups is higher than the anterior biting force. (108-230 N) Thus, with this study, it is proven that all of the groups used in the study can be used at the anterior region on the condition that the patients are selected properly and the techniques are used for the right indications.
3. Groups prepared using the incisal overlap cutting method have the highest resistance to fractures as they dispense the forces on the teeth most efficiently on hard tissues.
4. In groups where feather preparations are used, there is no significant statistical difference between CAD/CAM and direct composite resin techniques and in order to prevent the fractures at the hard dental tissue, CAD/CAM restorations may be preferred.
5. In groups, where in-dentine preparations are used, the results were not aesthetically satisfactory and in this study, these preparations have proven to be the weakest group in terms of fracture resistance.
6. The type of fracture observed in direct composite resin laminate veneers is cohesive and fractures are observed at high values. In cemented (indirect composite resin and CAD/CAM drilling) groups, adhesive cement acts as a force absorbing buffer and prevents cohesive fractures on hard dental tissues. However, these may facilitate adhesive type fractures at lower values.

References

[1] Nakamura T, Imanishi A, Kashima H, Ohyama T, Ishigaki S. Stress analysis of metal-free polymer crowns using the three-dimensional finite element method. Int J Prosthodont 2001;14:401-405.

[2] Crispin BJ. Indirect composite restorations: alternative or replacement for ceramic? Compendium of continuing education in dentistry 2002;23:611-614, 616, 618 passim; quiz 624.

[3] Soares CJ, Santana FR, Fonseca RB, Martins LR, Neto FH. In vitro analysis of the radiodensity of indirect composites and ceramic inlay systems and its influence on the detection of cement overhangs. Clin Oral Investig 2007;11:331-336.

[4] Jackson RD, Morgan M. The new posterior resins and a simplified placement technique. Journal of the American Dental Association 2000;131:375-383.

[5] Samet N, Kwon KR, Good P, Weber HP. Voids and interlayer gaps in Class 1 posterior composite restorations: a comparison between a microlayer and a 2-layer technique. Quintessence international 2006;37:803-809.

[6] Sturdevant CM, Barton RE, Sockwell CL, Strickland WD. The Art and science of operative dentistry. St. Louis: C.V. Mosby, 1985.

[7] Robbins JW. Color characterization of porcelain veneers. Quintessence international 1991;22:853-856.

[8] Zeng K, Oden A, Rowcliffe D. Flexure tests on dental ceramics. The International journal of prosthodontics 1996;9:434-439.

[9] Plengsombut K, Brewer JD, Monaco EA, Jr., Davis EL. Effect of two connector designs on the fracture resistance of all-ceramic core materials for fixed dental prostheses. The Journal of prosthetic dentistry 2009;101:166-173.

[10] Lin TM, Liu PR, Ramp LC, Essig ME, Givan DA, Pan YH. Fracture resistance and marginal discrepancy of porcelain laminate veneers influenced by preparation design and restorative material in vitro. J Dent 2012;40:202-209.

[11] McLaughlin G, Morrison JE. Porcelain fused to tooth--the state of the art. Restorative dentistry 1988;4:90-94.

[12] Seymour KG, Samarawickrama DYD, Zou L. Tooth preparation for porcelain veneers--which technique do I use? British Dental Journal 2002;192:1p.

[13] Shetty A, Kaiwar A, Shubhashini N, Ashwini P, Naveen D, Adarsha M, et al. Survival rates of porcelain laminate restoration based on different incisal preparation designs: An analysis. Journal of conservative dentistry : JCD 2011;14:10-15.

[14] Berksun S, Kedici PS, Saglam S. Repair of fractured porcelain restorations with composite bonded porcelain laminate contours. The Journal of prosthetic dentistry 1993;69:457-458.

[15] Meijering AC, Creugers NH, Roeters FJ, Mulder J. Survival of three types of veneer restorations in a clinical trial: a 2.5-year interim evaluation. J Dent 1998;26:563-568.

[16] Troedson M, Derand T. Effect of margin design, cement polymerization, and angle of loading on stress in porcelain veneers. The Journal of prosthetic dentistry 1999;82:518-524.

[17] Luhrs AK, Pongprueksa P, De Munck J, Geurtsen W, Van Meerbeek B. Curing mode affects bond strength of adhesively luted composite CAD/CAM restorations to dentin. Dent Mater 2014;30:281-291.

[18] Mahmood DJ, Linderoth EH, Vult Von Steyern P. The influence of support properties and complexity on fracture strength and fracture mode of all-ceramic fixed dental prostheses. Acta Odontol Scand 2011;69:229-237.

[19] Castelnuovo J, Tjan AH, Phillips K, Nicholls JI, Kois JC. Fracture load and mode of failure of ceramic veneers with different preparations. J Prosthet Dent 2000;83:171-180.

[20] Hagge MS, Lindemuth JS. Shear bond strength of an autopolymerizing core buildup composite bonded to dentin with 9 dentin adhesive systems. J Prosthet Dent 2001;86:620-623.

[21] Turkaslan S, Tezvergil-Mutluay A, Bagis B, Shinya A, Vallittu PK, Lassila LV. Effect of intermediate fiber layer on the fracture load and failure mode of maxillary incisors restored with laminate veneers. Dent Mater J 2008;27:61-68.

[22] Hagberg C. Assessment of bite force: a review. Journal of craniomandibular disorders : facial & oral pain 1987;1:162-169.

[23] Calamia JR. Materials and technique for etched porcelain facial veneers. The Alpha omegan 1988;81:48-51.

[24] De Andrade OS, Hirata R, Celestrino M, Seto M, Siqueira S, Jr., Nahas R. Ultimate ceramic veneer: a laboratory-guided preparation technique for minimally invasive laminate veneers. J Calif Dent Assoc 2012;40:489-494.

[25] Pascotto RC, Benetti AR. The clinical microscope and direct composite veneer. Oper Dent 2010;35:246-249.