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Research Article

Comparing the Bonding of a Resin Luting Agent to Different All Ceramic Systems with Different Surface Treatments

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Abstract

Aim of the Study: The aim of this study was to assess the efficacy of Panavia luting agent bonding with three all ceramic systems (CEREC, VITA VM7 and E-max) treated with three surface treatments (alumina abrasion, hydrofluoric acid and combination of the two methods).

Materials and Methods: Ninety mandibular teeth were used. They were divided into three groups regarding the method of treatment (alumina abrasion, hydrofluoric acid and combination of the two methods). The groups were then further subdivided into: ceramic system subgroups (CEREC, E- max and VITA VM7).Compressive load was applied on the cementation interface and shear bond was assessed. Statistical analysis was done using two ways analysis of variance (ANOVA) and Tukey's Post-hoc test.

Results: The highest shear bond strength was recorded with cementing of CEREC ceramic system with the Panavia cement after hydrofluoric acid surface treatment(10.9 Mpa) while the least was recorded with cementing the VM7 after alumina abrasion (4.9 Mpa).

Conclusion: The type of surface treatment applied to the different ceramic systems and showed the highest bond strength with Panavia cementation was the hydrofluoric acid etching.

Keywords: *Panavia Cement; Resin; Alumina Abrasion*

Introduction

Nowadays, the main goal in dentistry is to have the maximum esthetic results with the most conservative restorations. So indirect ceramics are the choice [1]. Due to tremendous increase in esthetic demands, there is also great increase in advanced ceramic technologies demand [2]. The cad/cam systems are now used commonly for simple and complex prosthetic designs as well [3,4]. From the most successfully used type of ceramics are the emerging pressable ceramics, with high marginal quality and excellent esthetics [5]. Advanced

ceramics techniques have emerged lately, but still the conventional layering is used [6]. Of course it is important to have a restoration with optimal longevity. And one of the main goals to have a properly retentive prosthesis is to have proper micromechanical interlocking between the cement and the ceramic fitting surface. So, having active ceramic surface is extremely beneficial for this purpose [7]. There are many methods of surface treatments suggested and under investigations recently to have better roughening of the ceramic surface. From these methods: acid etching, silane coupling and alumina particle blasting [8]. The acid etching is known to increase the surface area of the fitting surface because of the production of micro porosities or irregularities in the surface. So now the adhesive or bonding agent will penetrate more and spread to form the needed micro retentive features [7]. It was found also that alumina air blasting produce also the same features with a variety of techniques [9]. Also it was reported that the silane coupling agent played a great role in connecting the ceramic surface with the resin penetrating into the rough surface with subsequent increase in bond strength [10]. All the previously mentioned methods can be used each with his own or combining more than one method to have better bonding. Good bonding with the indirect prosthesis not only enhances the retention but also, enhances the marginal adaptation with its resultant prime important feature which is prevention of marginal leakage and marginal discoloration. After bonding, the structure with its different components (tooth-resin-ceramic complex) will act as one unit resulting in more facture resistance. The aim of this study was to evaluate the bond strength of three ceramic systems after three surface treatments using the panavia cement.

Material and Method

Sixty three extracted mandibular posterior teeth were used. The inclusion criteria were: Teeth free from caries, restorations and developmental defects. The exclusion criteria were: Teeth with carious lesions, restorations or developmental defects. Proper calculus removal was done to the teeth and then they were stored in normal saline. Teeth were embedded in resin blocks. Occlusal third was grind under copious coolant in each tooth leaving flat dentin surface ready for bonding and cementing agent application. Teeth were divided into three groups according to the method of surface treatment; each group with twenty one teeth. The first group was subjected to alumina abrasion, the second was subjected to acid etching and the third were subjected to both types of surface treatments, each group was subdivided into three subgroups of seven teeth each according to the type of ceramic system. (first subgroup CEREC ceramic, the second with E-Max while the third with VM7). Discs were prepared with the same number of teeth using the tested ceramics with 6 mm diameters and 2 mm height. List of materials in table 1.

No.	Material	Specification	Manufacturing
1	Cerec blocks	Cad Cam Cerec system	Sirona. Germany
2	Vita VM7	Vitadurvest powder	Vita-zahnfabric. Germany
3	E-Max press	IPS E-Max ingots	Ivoclar Vivadent. Schaan, Liechtenstein
4	Ultradent porcelain etch	Hydrofluoric acid	Ultradent Products
5	Ultradent silane	Silane coupling agent	Ultradent Products
6	Panavia dental cement	Chemically cured adhesive resin cement	J.MORITA USA inc.

Table 1: *Materials used in the study.*

Preparation of samples

Cerec blocks were milled. The E-max samples were done by pressing the ceramic ingots after wax pattern construction and investing. For the VM7, the samples were done using special split metallic disc former providing 6 × 2 mold space; the porcelain is mixed and applied to the mold then fired. The thickness of the sample is verified by digital caliper.

Cementation

Samples were randomly divided. One group was with surface treatment 9% hydrofluoric acid for 4 minutes. The second group was surface treated with aluminum oxide 50 microns particles abrasion with 200 KPa pressure for 15 seconds. The third group was surface treated with alumina abrasion then followed by acid etching with the same procedures as the previous groups. Then rinsing of samples with water for ten seconds. Application of silane coupling agent then air spray for ten seconds. Prepared teeth surfaces were treated with 35% phosphoric acid for 15 seconds, washed with water for ten seconds, dried with dry sponge to prevent desiccation of dentin. After salinization of the ceramic discs, they are cemented to the teeth surfaces using Panavia resin cement. A weight of 4 Kg was put on the samples to have uniform thickness of the cement. The excess cement was removed using a probe. Then bond strength was measured.

Bond strength measurement

Circular interface shear test was done to evaluate the bond strength. All samples were mounted on a testing machine (model LRX-Plus; Lloyd instruments Ltd., Fareham, UK) with load cell 5 KN, then data were recorded using software (Nexygen- MT; Lloyd instruments). Shear bond strength was evaluated by compressive mode of force applied at ceramic tooth interface using a mono-bevelled chisel shaped metallic rod attached to the upper movable compartment of the testing machine travelling at cross-head speed of 0.5 mm/minute.

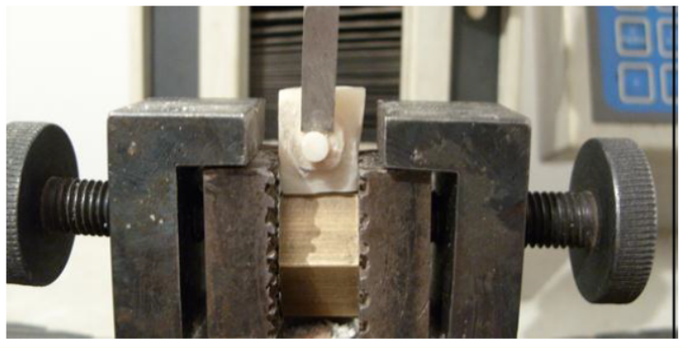

Figure 1: *Samples secured to the universal testing machine.*

Statistical analysis

The collected data were analyzed using two-way analysis of variance (ANOVA). Tukey's post-hoc analysis was used to compare between the means when ANOVA test is significant. For all groups the significance level was set at $P \leq 0.05$. Statistical analysis was done with SPSS 20.0 for windows.

Results

Results for mean shear bond strength measures and standard deviations of studied groups are listed in table 2. The highest mean shear bond strength measurement was found for Cerec group treated by acid etching (10.98 Mpa), while the least bond strength was found for VM7 group after treatment with alumina abrasion only (4.93 Mpa). For the studied materials, two -way ANOVA showed insignificant difference between the material groups $P > 0.05$.

Ceramic	Surface treatment	Mean	Standard deviation
Cerec	Alumina abrasion	6.97	1.20
	Acid etching	10.98	1.52
	Alumina abrasion +acid etching	8.32	1.77
e-max	Alumina abrasion	5.66	1.05
	Acid etching	8.96	0.79
	Alumina abrasion +acid etching	9.12	1.28
VM7	Alumina abrasion	4.93	0.81
	Acid etching	7.64	0.75
	Alumina abrasion +acid etching	6.94	0.57

Table 2: *Descriptive statistics for shear bond strength values.*

Regarding surface treatments subgroups, two-away ANOVA showed significant difference between surface treatments ($P < 0.001$). Post hoc Tukey test revealed a significant difference between subgroups treated with alumina abrasion and subgroups treated with acid etching ($P < 0.001$), also subgroups treated with alumina abrasion in addition to acid etching ($P < 0.05$), but there was no statistical significant difference between subgroups treated with hydrofluoric acid and subgroups treated with alumina abrasion in addition to acid etching ($P > 0.05$). Away from the tested materials, surfaces treated with acid etching revealed the highest mean shear bond strength measurements with the Cerec and VM7 groups while the highest measurement with e-max was after alumina abrasion in addition to acid etching. The surface treatment with alumina abrasion only revealed the least measurements. Two-way ANOVA showed a significant effect of the interaction between the materials and different surface treatments on the mean shear bond strength measurements ($P < 0.05$).

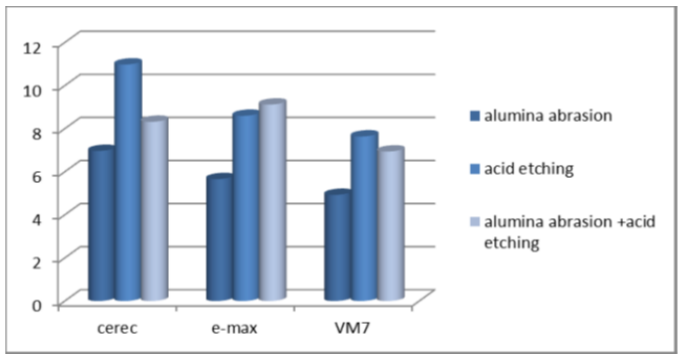

Figure 2: *The effect of different surface treatments on the shear bond strength of the studied ceramic to tooth structure.*

Discussion

Esthetic prosthetic materials are now of prime importance. The CAD/CAM techniques are increasingly developing and spreading but still it has the problem of high cost. But it is the best choice when we are talking about saving time and easier overall procedure [11]. Pressable ceramics have been used widely for prostheses till three units' bridges [12]. Silane had been a great aid to increase the bonding between resin cements and ceramics. When it is applied to treated ceramic surface it enables a chemical covalent and hydrogen bond between resins and silica based ceramics and is considered a main factor in proper bonding between them. They are bifunctional molecules bonding silicone dioxide with OH groups of the ceramic surface. Their functional groups degrades and copolymerize with the organic content of the resin [13]. Bonding of ceramics is dependent on Chemico-mechanical bonding mechanism between them and resin cements [12]. Different researches have studied and stated that there is good bond strength between ceramics and resin cements after surface treatment with acid etching by hydrofluoric acid [12,14,15]. All these agreed with our research. They clarified these results by the fact that the residual glass had been attacked by the hydrofluoric acid and what is left is rod shaped crystals at the surface which increased eventually the micromechanical interlocking. Matinlinna and Vallittu [14] in 2007 explained this result to the preferential dissolving of the glassy matrix of the ceramic with subsequent micromechanical retentive surface texture with the formation of hydroxyl groups on the surface as well. Zaghloul., *et al.* [15] in 2014 used atomic force microscopy to study the surface of ceramics after treatment with hydrofluoric acid. A very special surface texture found that increased the bond strength.

Alumina abrasion showed the least shear bond strength measures. This was in contrary to Erdemir., *et al.* [16] research in 2014 that supported that alumina abrasion produce good bond strength. This disagreement was explained by the fact that this study was for repairing ceramic using flowable composite not like this research where the study was on cementing the ceramic with tooth structure. The

cause of this low bond strength mainly is attributed to the high hardness of the ceramic and the difficulty in affecting its surface using the alumina abrasion. With smoother surface that that etched with the acid. Despite the fact that hydrofluoric acid is efficient in roughening the surface, its dangerous handling should be thought about with great caution as being an important point either in the clinic or in the lab. When we talk about the ceramic system, the Cerec blocks gave the best bonding strength measures. This was not in coincidence with the results of the research by Öztürk., *et al.* [17] in 2007 that stated that there is no difference between the Cerec and pressable ceramic. This difference in results may be explained as they performed the research on mesio-occlusal cavities while our research was done on flat dentin surfaces. The bonded surface geometry may efficiently affect the bond strength.

A combination of airborne particle abrasion (50 µm aluminum oxide), HF acid etching and application of a silane coupling agent is recommended by some researchers [18] and that was explaining the increased bond strength of this technique with the pressable ceramic.

Conclusions

Hydrofluoric acid etching for ceramic materials resulted in high bond strength. The shear bond strength of ceramics with cementation with panavia resin cement depends mostly on the surface treatment of the ceramic surface.

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