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EVALUATION OF BOND STRENGTH BETWEEN LITHIUM DISILICATE AND PREHEATED COMPOSITE

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ABSTRACT

Objective: investigation of the microshear bond strength between lithium disilicate with preheated viscous composite, flowable composite and resin cement by comparison of their microshear bond strength.

Material and method: forty-five samples were prepared and divided into three groups; preheated viscous composite, flowable composite and resin cement. Materials were injected into plastic transparent molds (2 mm height, 2 mm diameter) on the surface of lithium disilicate discs previously surface treated with ceramic etchant (hydrofluoric acid 4.5%) and ceramic primer (silane coupling agent). Microshear bond strength test was performed samples by universal testing machine.

Results: highest microshear bond strength was recorded for preheated viscous composite.

Conclusions: preheated viscous composite is an excellent material in cementation of lithium disilicate ceramic restorations.

KEYWORDS: Lithium disilicate; Preheated composite; microshear bond strength.

INTRODUCTION

Lithium disilicate has excellent esthetics, high translucency, biocompatibility, low plaque accumulation, wear resistance, color stability, durability and good mechanical properties [(1–3)]. Adhesive cementation of lithium disilicate increases its strength and fracture resistance and can be used with minimal preparations [(4)]. Routinely, lithium disilicate is cemented with resin cement but it is weak due to its low filler content [(5)]. The recent technique in cementing lithium disilicate restorations is using a preheated viscous composite as a cementing material [(6)]. viscous composite is an excellent restorative material due to its good wear resistance, excellent esthetics as well as its high filler content. Also, high filler content lessened the polymerization

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shrinkage and raised mechanical properties [7–10]. The drawback of using viscous composite as a cement is its high viscosity and low adaptation. Preheating of viscous composite decreases its viscosity and increases its adaptation and also decreases its film thickness [11,12]. Accordingly, preheating viscous composite makes it a good cementing material. The hypothesis of this research was that the microshear bond strength of the preheated viscous composite is similar to that of flowable composite and resin cement.

MATERIAL AND METHOD

Materials

Lithium disilicate CADCAM blocks (IPS e.max CAD HT, Ivoclar Vivadent, Schaan, Liechtenstein), viscous composite (Filtek Z350, 3M ESPE, Minnesota, USA), flowable composite resin (Filtek Z350 XT, 3M ESPE, Minnesota, USA), light cure resin cement (RelyX Veneer, 3M ESPE, Minnesota, USA), hydrofluoric acid 4.5% as (ceramic etchant) (IPS Ceramic Etching Gel, Ivoclar Vivadent, Schaan, Liechtenstein) and silane coupling agent (ceramic primer) (Monobond Plus, Ivoclar Vivadent, Schaan, Liechtenstein) were used in the current study.

Methods

Forty-five samples were prepared and divided into three groups (fifteen samples each); preheated viscous composite group, flowable composite group and resin cement group.

Sample preparation:

Lithium disilicate CADCAM blocks were cut into two mm thickness discs using a specific saw (isomet 1000, Buehler, Virginia, USA). Discs were divided in groups as mentioned above. Lithium disilicate samples underwent crystallization using a specific furnace (Programat CS/CS2, Ivoclar Vivadent, Schaan, Liechtenstein). Each lithium disilicate disc underwent surface treatment according to the manufacturer instructions. First, discs were etched with ceramic etchant gel (hydrofluoric acid) for 20 seconds and well rinsed with water spray and dried with oil free air till chalky white appearance appears. Then, ceramic primer (silane coupling agent) was applied to the etched ceramic surface for one minute and then dispersed with air (manufacturer's instructions).

Viscous Composite was heated using a composite heater (ENA Heat, Micerium S.P.A., Avegno (GE), Italy). Preheated viscous composite, flowable composite and resin cement were injected into transparent plastic molds (2 mm height, 2 mm diameter) on the previously treated lithium disilicate disc. Then, each sample was light cured using LED curing light (LED Elipar, 3M ESPE, Minnesota, USA).

Bond strength evaluation:

Microshear bond strength test was performed for each sample. Each disc with its own attached microcylinder was installed into a specifically designed centralized hole with a sample holder which was tightened horizontally with screws to the lower fixed compartment of a universal testing machine (Model 3345; Instron Industrial Products, Norwood, MA, USA) has a loadcell of 5000 N. Data was recorded using computer software (Instron® Bluehill Lite Software Instron Industrial Products, Norwood, MA, USA). A loop prepared from an orthodontic wire (0.14 mm diameter) was wrapped around the bonded microcylinder assembly as close as possible to the base of the microcylinder and aligned with the loading axis of the upper movable compartment of the universal testing machine. A shearing load with tensile mode of force was applied via universal testing machine at a crosshead speed of 0.5 mm/min. The load required to debonding was recorded in Newton. The load at failure was divided by the bonding area to express the bond strength in MPa:

$$\tau = P/ \pi r^2$$

where, τ = microshear bond strength (in MPa), P = load at failure (in N), π =3.14 and r = radius of microcylinder (in mm).

Statistical analysis

Data analysis was performed in several steps. Initially, descriptive statistics for each group results. Two-way ANOVA followed by pair-wise Tukey's post-hoc tests were performed to detect significant effect of variables. One-way ANOVA and student t-test was done between groups and subgroups. Sample size (n=15) was large enough to detect large effect sizes for main effects and pair-wise comparisons, with the satisfactory level of power set at 80% and a 95% confidence level. Statistical analysis was performed using GraphPad InStat statistics software for Windows (GraphPad Software Inc., California, USA). P values ≤0.05 are statistically significant in all tests.

RESULTS

It was found that the highest microshear bond strength was recorded for preheated viscous composite group and the lowest microshear bond strength was recorded with both flowable composite and resin cement group (table 1).

TABLE (1): Comparison of microshear bond strength test results (Mean±SD) as function of material groups.

Variables		Microshear bond strength
Material group	Composite group	$26.187^{A}\pm8.13$
	Resin cement group	$19.651^{B}\pm5.91$
	Flowable group	$21.209^{B}\pm4.11$
Statistics	P value	0.0177*

Different superscript capital letter in the same column indicating statistically significant difference ($p < 0.05$). *; significant ($p < 0.05$) ns; non-significant ($p>0.05$).

DISCUSSION

Preheating of viscous composite is a new technique used to improve its properties (13–16). Composite heating to 60 °C is found to increase the monomer conversion degree (16), as the molecular mobility is enhanced and collision frequency of reactive groups is increased (13–16). Composites with high degree of conversion are found to be better cross linked and to have higher mechanical properties (17). Accordingly, the free volume within the polymer network, solvent uptake and material degradation in the oral environment is reduced (18). viscous composite has higher filler content than flowable composite that makes it better in mechanical properties, wear resistance, higher hardness and lesser in polymerization shrinkage (7–10). In addition, viscous composite contains high molecular weight monomers that increases the conversion degree and decrease polymerization shrinkage (19,20). It is found that mechanical properties of 60 °C preheated viscous composites are considerably better after curing (21). viscous composite in room temperature is viscous and has low ability to flow and adapt but its viscosity decreases and its ability to flow and adapt increases with increasing temperature. Preheating of viscous composite also proved to decrease the film thickness and increase the marginal adaptation (11,12). The viscosity change degree is attributed to many factors such as fillers' content, shape and resin composition (7,10). Shade of resin cement affect the color stability of ceramic restorations so, diversity of shades of viscous composite is very helpful to the clinicians in cementing the esthetic restorations (22). Current research was to compare the microshear bond strength between lithium disilicate with preheated viscous composite, flowable composite and resin cement to evaluate the reliability of using preheated viscous composite in cementing lithium disilicate ceramic restorations. Lithium disilicate ceramic is usually cemented by resin cements despite its low mechanical properties although its low filler content increases the chance of cohesive failure and debonding of restorations [5]. Before thermocycling, the preheated viscous composite showed highest microshear bond strength that goes well with Tomaselli et al. [23] who found that the preheated viscous composites is a good alternative to cement ceramic veneers like flowable composites. Goulart et al. [6] who found that preheating of viscous composite for cementing purposes didn't improve microshear bond strength, although it could be used to decrease material viscosity and increase restoration setting.

CONCLUSION

The preheated viscous composite is a reliable substitute of flowable composite and resin cement in cementation of lithium disilicate ceramic restorations.

REFERENCES

1. Tysowsky G. The science behind lithium disilicate: Today's surprisingly versatile, esthetic & durable metal-free alternative. Oral Health. 2009;99(3):93.
2. Ariaans K, Heussen N, Schiffer H, Wienert A, Plümäkers B, Rink L, et al. Use of molecular indicators of inflammation to assess the biocompatibility of all-ceramic restorations. J Clin Periodontol. 2016;43(2):173–9.
3. Kwon SJ, Lawson NC, McLaren EE, Nejat AH, Burgess JO. Comparison of the mechanical properties of translucent zirconia and lithium disilicate. J Prosthet Dent. 2018;120(1):132–7.
4. Chen JH, Matsumura H, Atsuta M. Effect of different etching periods on the bond strength of a composite resin to a machinable porcelain. J Dent. 1998;26(1):53–8.
5. Scherer MM, Prochnow C, Venturini AB, Pereira GKR, de Lima Burgo TA, Rippe MP, et al. Fatigue failure load of an adhesively-cemented lithium disilicate glass-ceramic: Conventional ceramic etching vs etch & prime one-step primer. Dent Mater. 2018;34(8):1134–43.
6. Goulart M, Borges Veleda B, Damin D, Bovi Ambrosano GM, Coelho de Souza FH, Erhardt MCG. Preheated composite resin used as a luting agent for indirect restorations: effects on bond strength and resin-dentin interfaces. Int J Esthet Dent. 2018;13(1):86–97.
7. Roeters JJM, Shortall ACC, Opdam NJM. Can a single composite resin serve all purposes? Br Dent J. 2005;199(2):73–9.
8. Elkaffas AA, Eltoukhy RI, Elnegoly SA, Mahmoud SH. The effect of preheating resin composites on surface hardness: a systematic review and meta-analysis. Restor Dent Endod. 2019;44(4):1–13.
9. Acquaviva PA, Cerutti F, Adami G, Gagliani M, Ferrari M, Gherlone E, et al. Degree of conversion of three composite materials employed in the adhesive cementation of indirect restorations: A micro-Raman analysis. J Dent. 2009;37(8):610–5.
10. García AH, Lozano MAM, Vila JC, Escribano AB, Galve PF. Composite resins. A review of the materials and clinical indications. Med Oral Patol Oral Cir Bucal. 2006;11(2):E215-220.
11. Fróes-Salgado NR, Silva LM, Kawano Y, Francci C, Reis A, Loguercio AD. Composite pre-heating: Effects on marginal adaptation, degree of conversion and mechanical properties. Dent Mater. 2010;26(9):908–14.
12. Blalock JS, Holmes RG, Rueggeberg FA. Effect of temperature on unpolymerized composite resin film thickness. J Prosthet Dent. 2006;96(6):424–32.
13. Lovell LG, Lu H, Elliott JE, Stansbury JW, Bowman CN. The effect of cure rate on the mechanical properties of dental resins. Dent Mater. 2001;17(6):504–11.
14. Lovelh LG, Newman SM, Bowman CN. The effects of light intensity, temperature, and comonomer composition on the polymerization behavior of dimethacrylate dental resins. J Dent Res. 1999;78(8):1469–76.
15. Daronch M, Rueggeberg FA, De Goes MF, Giudici R. Polymerization kinetics of pre-heated composite. J Dent Res. 2006;85(1):38–43.
16. Daronch M, Rueggeberg FA, De Goes MF. Monomer conversion of pre-heated composite. J Dent Res. 2005;84(7):663–7.
17. Asmussen E, Peutzfeld A. Influence of pulse-delay curing on softening of polymer structures. J Dent Res. 2001;80(6):1570–3.
18. Ferracane JL. Hygroscopic and hydrolytic effects in dental polymer networks. Dent Mater. 2006;22(3):211–22.
19. Elshazly TM, Bourauel C, Sherief DI, El-Korashy DI.

Evaluation of Two Resin Composites Having Different Matrix Compositions. Dent J. 2020;8(3):76.

20. Elshazly TM, Bourauel C, Aboushelib MN, Sherief DI, El-Korashy DI. The polymerization efficiency of a bulk-fill composite based on matrix-modification technology. Restor Dent Endod. 2020;45(3).

21. BAUSCH JR de, Delange C, Davidson CL. The influence of temperature on some physical properties of dental composites. J Oral Rehabil. 1981;8(4):309–17.

22. Hoorizad M, Valizadeh S, Heshmat H, Tabatabaei SF, Shakeri T. Influence of resin cement on color stability of ceramic veneers: in vitro study. Biomater Investig Dent. 2021;8(1):11–7.

23. Tomaselli L de O, de Oliveira DCRS, Favarão J, da Silva AF, Pires-De-Souza F de CP, Geraldeli S, et al. Influence of pre-heating regular resin composites and flowable composites on luting ceramic veneers with different thicknesses. Braz Dent J. 2019;30(5):459–66.