Original article

Effect of Resin Cement Type and Micro-Shear Technique on Bond Strength to Hybrid Ceramic Material

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ABSTRACT

Background and aim*. Bond strength is highly influenced by micro shear testing procedures and the types of resin cement used, however information on these factors is not clear. This study was aimed to evaluate the influence of the micro shear technique (Starch-based templates and Taygon tubes) and the type of resin cement (Adhesive and self-adhesive) on bond strength to Vita Enamic.* ***Methods.*** *An Isomet saw was used to cut an 8-slice block of Vita Enamic. According to the type of resin cement used to attach the ceramic specimens (n=4), the specimens were split into two groups: Group 1 (Adhesive resin cement), and Group 2. (Self-adhesive resin cement). Later, each group was split into two subgroups based on the method used to produce the specimens (n=2): subgroup A (Starch-based template approach), and subgroup B. (Tygon tube technique). Each slice of the Vita enamic had five micro cylinders of either type of resin cement glued to it. Utilizing a universal testing machine, micro-shear bond strength (SBS) was measured (Intsron 3345, BOSTON, USA). A two-way ANOVA test was used to tabulate and statistically evaluate the data.* ***Results****: There were no discernible differences between the adhesive and self-adhesive resin cement. However, when compared to the Tygon tube technique, the starch-based template technique produced statistically significantly higher SBS values.* ***Conclusion****. The micro shear bonding test findings from the starch-based template technique were more accurate.*

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INTRODUCTION

All-ceramic materials are employed frequently as a result of a revolution in dental ceramics that focused on optical characteristics, composition, and indications [1]. Dental ceramics can be categorized based on their microstructure, which helps with comprehension of the material's structure and chemical composition [2]. Ceramics' clinical behavior is influenced by both its composition and processing methods; as a result, classifying ceramics according to these factors makes it easier to choose the best material for each clinical circumstance. Dental ceramics can be divided into three main groups, including porcelain, which is mostly made of a glass phase, glass, which contains a lot of reinforced crystals, and poly-crystalline, which is primarily made of crystals.

Various restorative materials are currently used with CAD/CAM systems. Glass ceramics are often preferred especially in anterior restorations due to their high aesthetic properties [3-6]. The mechanical properties of glass ceramics can be improved by various methods [7-9]. Alternative Materials with the exact ceramic properties are also improved.

Nano ceramics and hybrid ceramics have been developed to combine the favorable properties of ceramics and composites. Hybrid ceramics (polymer-infiltrated glass-ceramics) Materials consisting of two infiltrated phases are stronger than single-phase materials [10-12]. Based on this idea, hybrid ceramics were developed. Hybrid ceramics consist of a combination of inorganic and organic components. The inorganic and organic structures consisted of ceramics and polymers, respectively. In VITA ENAMIC, the dominant ceramic network structure and the reinforcing polymer network structure completely merge with each other. The main advantage of these two ceramic-polymer networks is that the new composition combines the advantages of ceramic and composite materials into one excellent product. Material science tests show that VITA ENAMIC not only offers enormous strength but also exceptional flexibility, even with integrated anti-cracking protection. This new material offers significantly less fragility than pure dental ceramics and better wear than conventional composite materials. Vita Enamic is placed in the hybrid ceramic group and the flexure strength of the material, modulus of elasticity, and rigidity (hardness) are 150-160 MPa, 30 GPa, and 2.5 GPa, respectively [13]. Vita Enamic has a modulus of elasticity of 30 GPa and the material has the same elastic properties as teeth.9,40. The hardness values of the hybrid ceramic were lower than those of the silica-based ceramic, so the hybrid. Ceramics wear less than traditional ceramics. In addition, due to the low hardness of hybrid ceramics, more material is lost during wear than in traditional ceramics [14-16]. Vita Enamic allows the production of inlay, onlay, laminate veneer, crowns, and anterior-posterior restorations.

The use of adhesives that can create an impermeable seal between the restoration and the tooth is crucial for the long-term clinical survival of various indirect restorations. Therefore, the cementation process has a significant impact on the clinical effectiveness of indirect restorations [17]. In essence, fluid composite resins with low viscosity are what resin cement is. Its components are a monomeric system of bisphenol-A glycidyl methacrylate (Bis-Gma) or urethane dimethacrylate (UEDMA), with inorganic load particles (such as aluminum, lithium, and glass, silica, or colloidal silica) added. Additionally, it contains colloidal silica and ceramic particles, which are frequently seen in microparticulate resins. It could also consist of ethylene glycol dimethacrylate, a monomer of low-viscosity triethylene glycol dimethacrylate (TEGDMA) (EGDMA). Additionally, an adhesive monomer, such as 4-methacryloxyethyl trimellitic anhydride (4-META), hydroxyethyl methacrylate, or an organophosphate, often 10-methacriloiloxidecamethylene, may be used to create the resin matrix (MDP) [17-18].

Resin cement can be categorized based on activation processes or adhesion mechanisms. Different activation techniques should be used depending on the type of ceramic that is being used, for instance, chemical activation techniques must be chosen for restorations that have ceramic infrastructures like zirconia because of its opacity, which interferes with light transmission and prevents resin cement from activating. Dual-cured resin cement, which permits proper activation and polymerization even in regions where access to the light will be challenging, is gradually replacing chemically cured resin cement due to the complexity of employing them in terms of work scheduling and polymerization [19-21].

Resin cement is divided into three types based on the mechanism of adhesion: total-conditioning cement, self-conditioning cement, and self-adhesive cement. Total conditioning cement relies on a distinct process of acid conditioning of the tooth's adhesive surface, followed by the application of adhesive and cement. This method offers excellent bonding but takes more time to complete. It can be dual-cured or light activated. When used with a self-conditioning primer, self-conditioning cement provides adherent surface conditioning without requiring a separate step, and its bonding strength is comparable to that of total conditioning cement. When applied directly to the tooth surface, self-adhesive resin cement typically does not require the use of acid conditioning or adhesives [22].

Self-adhesive cement is regarded as hybrid material that combines the qualities of dental cement, self-etching adhesives, and composite restoratives. As effective and long-lasting chemical bonding to tooth structure requires a polyacid matrix structure, whether based on a preformed polyalkenoate or one that is created in situ during a curing process involving acidic monomers, the incorporation of acid-functionalized methacrylate or related monomers is a crucial part of self-adhesive resin cement. The primary functions of the acid monomers are to bond to and demineralize the tooth surface spontaneously. The contemporary self-adhesive resin cement is a two-part product that can be delivered by an auto-mixed dispenser, hand mixing, or capsule trituration [23].

This study was designed to assess the micro shear bond strength of the adhesive and self-adhesive resin cement to Vita enamic hybrid ceramic due to the introduction of new CAD/CAM Vita enamic materials and the availability of various types of resin cement [24,25].

METHODS

Using an Isomet saw, a block of Vita Enamic was divided into 8 slices, each measuring 12 mm by 14 mm by 2 mm. Slices were then polished using SiC paper to 600 grit. After that, each slice was placed inside an acrylic block for simpler handling and fixing during testing. According to the type of resin cement used to attach the ceramic specimens (n=4), the specimens were divided into two groups: Group 1 (Adhesive resin cement), and Group 2. (Self-adhesive resin cement). Later, each group was divided into two subgroups based on the method used to produce the specimens (n=2): Subgroup A (Starch-based template approach), and Subgroup B. (Tygon tube technique). The specimens were then ultrasonically cleaned for 30 seconds in distilled water after being abraded for 10 seconds with 50 m Al_2O_3 and silanated. Each slice of the Vita enamic substrate had five micro cylinders of either type of resin cement glued to it using one of the following techniques:

- *Starch-based template*

The Vita enamic specimens' surfaces were modified to fit a template made of plastic with a starch base. Five apertures with a 1 mm diameter and 1 mm depth were present on each template, serving as molds for the resin cement. The mold was then filled with any kind of resin cement, which was then photopolymerized for 20 seconds. After that, all substrates were placed in distilled water for 24 hours to dissolve the template and reveal the tiny resin cement cylinders.

- *Tygon tube technique*

Five resin micro-cylinders will be given to each Vita Enamic plate. Tygon tube micro-cylinders with dimensions of 1 mm in height and diameter were placed over the surface of the bar and filled with resin cement to form resin micro-cylinders with the same measurements. With the help of the included auto-mixing tip with an intra-radicular tip, resin cement was injected into the tygon tube micro-cylinder lumen. The resin cement was then light-cured for 20 seconds after being filled into the Tygon tube micro-cylinder. Tygon tube micro-cylinders were removed after resin cement light curing, and in order to avoid putting the resin-micro cylinders under shear stress, Tygon micro-cylinders were sectioned vertically using blade No. Utilizing a universal testing machine, micro-shear bond strength (SBS) was measured (Intsron 3345, BOSTON, USA). A wire with a 0.2 mm diameter was secured to the upper jig of the universal testing machine and attached to the resin-micro cylinder. Acrylic blocks were installed in the lower jig of the machine. A crosshead speed of 1 mm/min was used for the micro-shear test up until failure. SBS was determined in MPa by multiplying the load (Newton) by the corresponding surface area (mm2).

Data collection procedure

Multivariate analysis of variance was used to gather, tabulate, and analyze the data using SPSS software.

RESULTS

Table 1 shows the comparison of average bond strength. The columns show comparison according to the composite type (adhesive vs self-adhesive). The rows show comparisons according to cement technique. No significant differences were found between the adhesive and the self-adhesive resin cements. However, using the starch based template technique showed statistically significant higher µSBS values when compared to the tygon tube technique. No significant interactions were found between the cement type and the bonding technique. Although the mean of the adhesive resin cement was higher than the self-adhesive, this difference was not statistically significant.

Table 1. Illustrating the µSBS in MPa for all subgroups

Cement Technique	Adhesive	Self- Adhesive
Starch based template	32.4(4.9)^{a}	30.8(4.7)^{a}
Tygon tube	25.2(3.1)^{b}	23.5(3.1)$_{b}$

Letters (a and b) are statisticallysignificant (p≤0.05)

DISCUSSION

Utilizing composite resin cement to bond ceramics to tooth structure increases the restoration's and the tooth's fracture resistance and reduces micro leakage, which could make the difference between the restorative procedure's success and failure. The bond strength of these two interfaces should be improved when bonding an indirect restoration to tooth structure since there are two different interfaces to take into account: the restoration/cement interface and the tooth/cement interface [25]. One of the recently released materials for CAD/CAM blocks on the market is Vitra enamic. One of the first materials created employing a network structure that combines the best of what ceramic and composite materials have to offer. The most accurate and dependable approach to assessing the bond strength without including any additional variables is the micro shear bond strength test. The ability to connect multiple micro-cylinders to a single substrate without running the risk of interface errors or faults also makes testing more affordable. Additionally, this test permits a higher percentage of adhesive failure as opposed to cohesive failure when compared to the macro shear test [26].

Thus, testing of the new materials' micro shear bond strength to the widely used resin cement was done. When self-adhesive or adhesive resin cement was used to bond to Vita Enamic, the study's findings revealed no differences in the micro shear bond strength. This agreed with Souza and others [27]. Who, when contrasting self-adhesive to adhesive resin cement, came to the same conclusion that there was no change in the binding strength at the adhesive/ceramic interface. This is also consistent with the instructions provided by the manufacturers of both types of cement, which state that both must have the same ceramic surfaces treated before bonding; the only distinction is how the surface treatment is applied to the tooth structure, which increases the risk of damage to the tooth/ceramic interface.

When comparing the bonding methods, the starch-based method outperformed the Tygon tube method in terms of binding strength values. This might be because the higher results were obtained utilizing a starch-based approach, which reduced stress that developed during tube removal. This decrease is mostly because of the starch's chemical inertness and water solubility, which allowed them to hydrate and loosen on their own without the stress of cutting and removing the mold material as in the tygon tube procedure [28].

CONCLUSION

The type of resin cement (self-adhesive or adhesive resin cement) does not have a significant effect on bonding to vita enamic hybrid ceramic. Moreover, the starch-based plate's protocol offers a more reliable protocol for testing micro shear than tygon tubes protocol

Disclaimer

The article has not been previously presented or published and is not part of a thesis project.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

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