RESEARCH ARTICLE
NON-BIO MEDICAL

Clinical observation of two different resin cements on lithium disilicate glass-ceramic veneer

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Abstract

Objective: To assess the bonding effect of two resin cement on lithium disilicate glass ceramic veneer.

Method: The study was conducted at the Medical School of Nanjing University, Nanjing Stomatological Hospital, China, in 2023, and comprised isolated teeth that were prepared at the occlusal surface of premolars using high-speed emery needle under running water, and then divided into groups A, B, C, D and E with the enamel area ratio being 0%, 25%, 50%, 75% and 100%, respectively. Each group was divided into subgroups 1 and 2. Groups A1, B1, C1, D1 and E1 were bonded by RelyX U200 bonding system, while groups A2, B2, C2, D2 and E2 were bonded using the Variolink Veneer bonding system. Followed by 24h of constant water bath, all the bonded specimens were placed in a universal dynamometer for shear strength test. The bond fracture interface was observed under stereopicroscope. Data was analysed using SPSS 22.

Results: Of the 100 specimens, 20(20%) were in each of the 5 groups. The shear strength of Variolink Veneer group on lithium disilicate glass ceramic veneer was higher relative to the RelyX U200 group ($p<0.05$). The shear strength between isolated teeth in group A1 and lithium disilicate glass ceramic veneer was the weakest, while the shear strength between isolated teeth in group E1 and lithium disilicate glass ceramic veneer was the strongest. With the increase of the enamel area ratio, the shear strength between isolated teeth and lithium disilicate glass ceramic veneer was enhanced ($p<0.05$). There were 21 failures; 9(43%) interface and 12(57%) mixed.

Conclusion: The bonding strength of Variolink Veneer was higher than RelyX U200.

Keywords: Disilicate glass ceramic veneer, Variolink Veneer, RelyX U200, Bonding strength.

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Introduction

In the modern age, people have higher and higher requirements for tooth defect repair, and the traditional functional repair has gradually developed to the current aesthetic repair category.[1] Compared to traditional metal or metal-baked porcelain prosthesis, all-porcelain prosthesis have better aesthetic performance, and also have good mechanical function and performance in terms of strength, hardness, corrosion resistance, and fatigue resistance, in addition to having excellent biocompatibility.[2]

Currently, the classification of ceramic materials is different according to standards, and there are many classification methods in line with composition, processing technology, crystal phase, and glass content.[3] In recent years, chairside repair computer-aided design/computer-aided manufacturing (CAD/CAM) technology based on digitally-aided design has become more and more important for the development of the repair system because of its advantages, such as precise control of the shape of the repair body, shortening of the duration of clinical operation and the number of visits, and often one-time completion of treatment.[4] Therefore, the machinable ceramic system dedicated to digital restoration has become the fastest growing oral ceramics, and is widely used in clinical practice.[5] Machinable ceramics are mainly divided into four categories: glass ceramics, alumina ceramics, zirconia ceramics, and resin-based composite ceramics.[6]

Lithium disilicate (Li2Si2O5) glass ceramics is a newly emerging ceramic material in the oral materials market in recent years that can effectively prevent crack propagation compared to traditional glass ceramics.[7] Because the refractive coefficient of Li2Si2O5 glass ceramics is close to the glass substrate, its aesthetic effect is also outstanding.[8]

There are many kinds of all-ceramic repair systems, and various brands of all-ceramic bonding systems are also emerging, mainly including 4 categories: resin cement, glass ion cement, resin reinforced glass ion cement, and phosphate cement. In terms of compressive bond strength and tensile bond strength (MPa), the performance of resin adhesives is far superior to the other three.[9]

The current study was planned to assess the bonding effect

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of two resin cement on Li2Si2O5 glass ceramic veneer.

Materials and Methods

The study was conducted at the Medical School of Nanjing University, Nanjing Stomatological Hospital, China, in 2023, and comprised first premolars without caries that were removed and the soft tissue was disinfected with 75% ethanol and stored in normal saline at 4°C for use within 3 months. This study was approved by the Ethics Committee of the Medical School of Nanjing University, Nanjing Stomatological Hospital. Other than silicon carbide sandpaper 120 mesh, 400 mesh, 800 mesh, 1000 mesh and 1500 mesh, the study used RelyX U200 (Minnesota Mining and Manufacturing, Saint Paul, Minnesota, United States), Variolink Veneer (Ivoclar Vivadent, Liechtenstein, Switzerland), Li2Si2O5 glass ceramics IPS e.max CAD (Ivoclar Vivadent, Liechtenstein, Switzerland), self-coagulating dental powder and monomer (Shanghai New Century Dental Materials Co., Ltd., Shanghai, China), LED light curing lamp (Elipar™ DeepCure, 3M, USA), high-speed turbine Airhank (Dongguan, Guangdong, China), electronic vernier caliper Shahe (Wenzhou, Zhejiang, China), and universal material tester T-61010K (Bisco Company, USA).

The isolated teeth were prepared at the occlusal surface of premolars using high-speed emery needle under running water. The occlusal surface after grinding was horizontal plane perpendicular to the tooth axis. A hollow cylindrical silicone rubber embedding mould with an inner diameter of 15mm and a height of 20mm was made, and the dental self-curing resin material was filled with a small amount and several times. The spare root of the isolated tooth was embedded in the dental self-coagulation plastic. While keeping the long axis of the tooth body perpendicular to the embedding interface, the self-coagulation resin embedding position was located 3mm below the enamel cementum boundary of the isolated tooth. After the coagulated resin was fully hardened, it was removed and each surface of the embedded plastic was polished with a model sander to make it smooth without edges and corners (Figure 1). Under the condition of water cooling, the test surface of all specimens was polished step by step in the same direction with water sandpaper of 120 mesh, 400 mesh, 800 mesh, 1000 mesh and 1500 mesh. A stereopicroscope was used to observe the adhesive surface, and a double-sided tape with a 3mm circular hole with an internal diameter was affixed to the tooth surface to limit the adhesive area (Figure 2). The enamel area ratio was determined by a microscope.

Li2Si2O5 glass ceramic cylindrical specimens with diameter of 4mm and height of 3mm were prepared. The bonding surface was treated with hydrofluoric acid etching and salinisation.

Figure-1: Self-setting resin after embedding.

Figure-2: A double-sided tape with a 3mm circular hole with an internal diameter was affixed to the tooth surface to limit the adhesive area.

The teeth were divided into groups A, B, C, D and E with the enamel area ratio being 0%, 25%, 50%, 75%, 100%, respectively. Each group was divided into subgroups 1 and 2 using RelyX U200 and Variolink Veneer resin cement bonding, respectively.

Groups A1, B1, C1, D1 and E1 were bonded by RelyX U200 bonding system, while groups A2, B2, C2, D2 and E2 were bonded using the Variolink Veneer bonding system. All were bonded according to the manufacturers' instructions. All specimens were pressurised with 200g weights, and the excess resin cement was removed and cured. The prepared specimens were stored in distilled water at room temperature for 24h, waiting for shear force test by universal material testing machine.

The universal material testing machine was used to test the shear strength of each group of bonding specimens. During testing, the adhesive specimen was fixed in the fixture of the universal testing machine. The direction of the loading head was consistent with the bonding surface.

The speed of the loading head was set at 1.0mm/min until the adhesive surface of the bonding specimen was broken. The shear force value (N) when the adhesive surface was broken was recorded on the display screen. The shear strength of each specimen was calculated using the formula:[10] shear strength (MPa)=maximum load shear force (N) / adhesive area (mm^2).

The damaged section of the specimen was observed under stereomicroscope, and the adhesive failure types were classified and statistically analysed. There were three types of bonding failure: interface failure meaning fracture occurred between dentin and composite resin, including cohesive failure of adhesives; cohesive failure in which fracture occurred in dentin or composite resin, respectively; and mixed failure in which both interface failure and cohesive failure occurred.

Data was analysed using SPSS 22. Normality test and homogeneity test of variance were conducted for each group of data. If the data presented normal distribution and the variance was homogeneous, the experimental parameter values of each group were presented as mean±standard deviation, and the overall differences in the mean of each group were compared by two-factor analysis of variance (ANOVA), and the test level was 0.05 on both sides.

Results

Of the 100 specimens, 20(20%) were in each of the 5 groups. The shear strength of Variolink Veneer group on IPS e.max CAD was higher (p<0.05 (Figure 3).

The shear strength between isolated teeth in group A1 and IPS e.max CAD was the weakest, while the shear strength between isolated teeth in group E1 and IPS e.max CAD was the strongest (Figure 4). With the increase of the enamel area ratio, the shear strength between isolated teeth and IPS e.max CAD was enhanced (p<0.05).

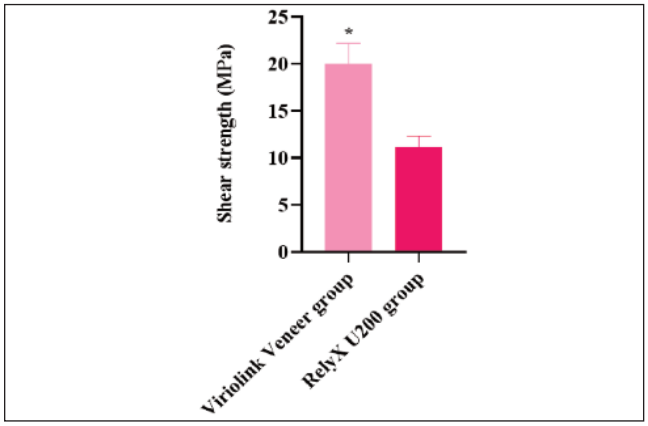

Figure-3: Shear strength of different resin cement on lithium disilicate glass ceramic veneer. **p<0.05.*

Table: The fracture interface and porcelain block bounded by different resin cement.

Groups	Cohesive failure	Interface failure	Mixed failure
Variolink Veneer group	0	2	9
RelyX U200 group	0	7	3

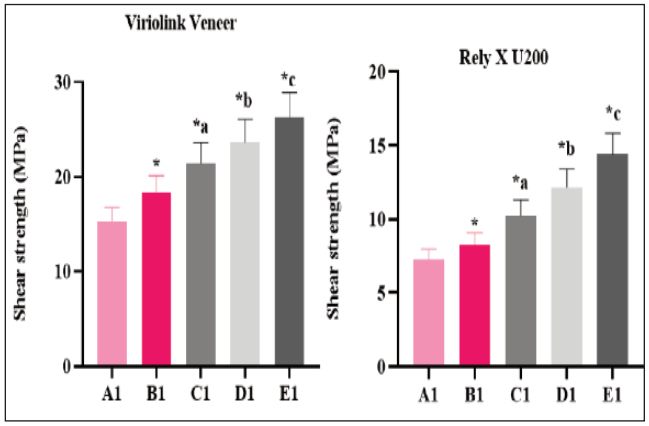

Figure-4: Shear strength between different extracted teeth and lithium disilicate glass ceramic veneer. **p<0.05 compared to A1, ap<0.05 compared to B1, bP<0.05 compared to C1, cP<0.05 compared to D1.*

There was a lot of interface failure in RelyX U200 group, while Variolink Veneer was mostly mixed failure (Table).

Discussion

Porcelain veneer is a commonly used method to repair dental defects in clinical practice, which is suitable for aesthetic repair of front teeth such as enamel dysplasia, tetracycline teeth, fluorosis teeth, malformation teeth, excessive dental space, adjacent caries and incisal end defects.[11] Clinically, commonly used porcelain finishing materials include light garnet reinforced feldspar porcelain, light garnet reinforced cast porcelain and Li2Si2O5 reinforced cast porcelain.[12] IPS e.max CAD reinforced glass ceramics used in this study is a representative Li2Si2O5 reinforced cast porcelain material. Hydrofluoric (HF) and silane coupling agents are generally used to treat the bonding surface of the veneer before bonding. HF reacts with the glass ceramics to form hexafluorosilicate ion (SiF6), and micro-pores are formed on the ceramic surface after removal.[13] The increase of the bonding area is beneficial to the entry of the binder into the formation of micromechanical retention, and then the silane coupling agent is used for surface treatment.[14] After hydrolysis of the silane coupling agent, one end of the molecule is combined with the –oxhydryl (Oh) on the surface of the glass ceramic to form -silicone (Si-O)- bond, and the other end of the organic functional group is polymerised with the resin to enhance the chemical combination of the resin binder with the glass ceramic.[15]

RelyX U200 self-adhesive resin cement is simple to operate without acid etching of the tooth surface, and isobutylene

phosphate monomer is added to the composition. When it is just in contact with the moisture of the tooth body, its lower pH demineralises the tooth surface, and the resin watergate penetrates into the demineralised tooth body to produce micromechanical retention. As the phosphate group reacts with the alkaline packing in RelyX U200, the pH rapidly rises to neutral, and the water generated by the neutralisation reaction makes the resin watergate cement obtain hydrophilicity, increasing the wetting of dentin, which improves edge adaptability and moisture tolerance with teeth. In the following reaction, water is very important for RelyX U200, which can not only hydrolysis and release hydrogen ions to demineralise the tooth surface, but also to neutralise the reaction between functional monomers of phosphoric acid and basic groups.[16-18] This property enables RelyX U200 to change intelligently between hydrophilic and hydrophobic, thus ensuring high bonding strength and long-term stability.[19] The isobutene phosphate monomer of RelyX U200 can also form chemical bonding with calcium ions of hydroxyapatite components of tooth enamel and dentin.[20] The micromechanical mosaics formed by resin infiltration into demineralised teeth and the chemical bonding between isobutene phosphate monomer and calcium ions are the main retaining force of self-bonding resin cement RelyX U200.[21]

Variolink Veneer is an "easy clean-up" micro-filled resin cementation system with a unique "value" shade system. It uses pure light curing resin binder, and there is no colour change after bonding. There are up to 7 colours, one of which is a high transparent colour, and, after bonding, the excess binder is easier to remove using submicron filler. It has better refractive index of light, small wear, high polishability, and high bond strength.[22,23]

The results showed that the bonding strength of self-adhesive resin cement RelyX U200 was lower than that of Variolink Veneer for bonding IPS e.max CAD, which was similar to a previous report.[24] It may because RelyX U200 is viscous and has poor fluidity, which impedes the wetting and penetration of the dental body and prosthesis. Although the initial pH value of the self-adhesive resin cement is low, the adhesion to the enamel is superficial, mainly micromechanical retention, and there is no obvious resin process and mixed layer for the adhesion to the dentin.[25] Besides, the current study found that, with the increase of the ratio, the shear strength between isolated teeth and IPS e.max CAD was enhanced. It may be because self-etching mode could not dissolve denatured dentine collagen fibres, which was not conducive to the penetration of adhesives.

In addition, it could be seen from the interface type of bonding cross-section that there was a lot of interface damage at the bonding fracture interface between RelyX U200 and dentin and enamel, and the rest were mostly mixed damage. The interface failure was mostly the bonding interface failure between dentine and resin cement, which indicated that the bonding strength of resin cement and Variolink Veneer porcelain block was high, while the bonding strength of RelyX U200 was weak.

However, the main limitation of our study was that the sample size was not calculated. This could influence the generalisability and power of the study.

Conclusion

The bonding strength of Variolink Veneer was higher than RelyX U200. Variolink Veneer is recommended for use when bonding IPS e.max CAD.

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Conflict of Interest: None.

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