The difference of bond strength between multi step and self adhesive resin cements in indirect composite restoration

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ABSTRACT

Resin based luting cement application generally requires pre treatment procedure such as, etching and adhesive application prior to cementation. This multi step application technique might compromise bonding alternative effectiveness and is time consuming. An alternative for multi step resin cement is the self adhesive resin cement that combines the use of etch, adhesive and cement in one single application. The objective of this study was to compare the bonding effectiveness of the multi step resin cement and the self adhesive resin cement using tensile bond strength method towards indirect composite block dentin surface. This study was a true experimental research conducted by in vitro method on 30 flat dentin surfaces created from extracted lower premolars samples. Samples were divided into two groups, each 15 samples for multi step and self adhesive resin cements. An indirect composite block (2x2x10 mm) was then cemented to each dentin surface using multi step resin cement (Rely X ARC, 3M ESPE) or self adhesive resin cement (Rely X Unicem, 3M ESPE) according to manufacture's instruction. Samples were storage for 24 hours in saline water and tensile bond strength of each samples were tested using the LRX Plus Lyod Instrument at 1 mm/minute speed. The result of the study concluded that the tensile bond strength of multi step resin cement towards indirect composite restoration and dentin surface was significantly higher than the self adhesive resin cement.

Key words: Multi step resin cement, self adhesive resin cement, tensile bond strength.

INTRODUCTION

Extensive damaged tooth which has lost its structure demands a dentist able to build a restoration that has good ability to function optimally and also possesses the esthetic nature which is accepted by patients.[1] Indirect restoration is one commonly chosen alternative.[2] Up to now, there have been varieties of indirect restoration, such as cast metal, porcelain, or even inlay and onlay made of composite.[3,4,5] Metal inlay is not really preferred due to its color, while porcelain inlay is brittle nature and might cause the opposite tooth to worn out.[6] Composite inlay has been regarded to possess more advantages compared to those materials mentioned.[7]

Indirect restoration retention is influenced by the preparation and cementation factors. Indirect composite restoration should be adhered to the tooth structure using resin cement in order to get an optimum restoration. Adherences or bonding capacity of luting cement towards restoration and tooth surface very important in the operative procedure, and becomes a significant factor which supports the clinical success of a restoration.[8] The indirect composite

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restoration's integrity is influenced by the physical and mechanical properties of the restoration and the luting cement used as well, but the most important thing is the bond effectiveness between the tooth and indirect restoration facilitated by luting cement.[7]

Resin cement has the ability to bond with tooth structure or restoration.[9,10] Up to now, there are varieties of resin cements which can be used for pin cementation of crown, fixed bridge protheses, veneer, pin, metal inlay or onlay, porcelain, and composite.[11-16] All kind of resin cement provided in the market nowadays work on the basis of etch-and-rinse or self-etch adhesive which are combined with low viscosity composite resin.[9,17] The multi step technique, might reduce the bonding effectiveness and is time consuming due to the longer working steps, which is regarded to be inefficient.[10]

The alternative of multi step resin cement is the self adhesive resin cement which is a combination of adhesive agent and cement in one step application. So that, a pretreatment to the tooth restoration is not necessary. A questioning matter's whether the bond strength between self adhesive resin cement could be as good as the multi step resin cement.

This research aimed to compare the tensile strength between multi step resin cement and self adhesive resin cement used for indirect composite restoration cementation.

MATERIALS AND METHODS

The research was conducted in a real experimental in vitro. Composite blades with 2x2x10 mm in size were made in an acrylic mold using Kenering technique. Polymerization using LED was performed on each 2 mm composite thickness, and then heated using an oven (Nabelterm) at a temperature of 140^0 for 10 minutes.[18]

Thirty extracted lower premolar were cleaned and soaked in 0.9% physiologic saline and then cut horizontally at the most convex area of the tooth. Dentin surface at the apical part was used as the dentin base which would be cemented using resin cement. Dentine slices were divided into two groups, each group comprised 15 teeth. The first group performed composite beams cementation using multi-step (RelyX ARC, 3M Espe) and the second group used self adhesive resin cement (relyX Unicem, 3M Espe) according to the manufacturer instructions of each type of resins.

Samples were embedded in the resin beams and the area of contact between resin cement with dentin at the size 1.5 x 1.5 mm with the specimen's length of 18.5 mm. The specimen then were soaked in 0.9% physiological saline for 24 hours, and the tensile strength measured using tensile strength testing machine (Lloyd Instruments LRX Plus) at speed up to 1 mm/minute until fractured. The data obtained during the fracture was recorded and was statistically tested by the student-t test method.

RESULTS

The average of cementation tensile strength using multi-step resin cement was 6.0797 MPa, while self-adhesive resin cement was 3.9806 MPa. These results were analyzed using the student-t test with 95% level of significance. It was obtained, that the t calculation (2.576) was greater than the t table (1.761). This meant that the test was significant. This showed that there was a real difference between the averages of tensile strength of indirect composite resin cementation

Table 1. Tensile strength result of multi step and self adhesive resin cements.

No Sample	Multi step resin cement (MPa)	Self adhesive resin cement (MPa)
1	4.341	2.713
2	6.189	4.069
3	4.441	2.609
4	3.917	7.006
5	2.674	2.911
6	5.375	3.954
7	4.881	3.480
8	6.539	4.186
9	4.423	3.615
10	12.715	3.051
11	5.397	2.933
12	6.043	4.495
13	5.077	4.079
14	12.951	7.514
15	6.224	3.902
Average	**6.0797**	**3.6149**

using multi-step resin cement which was greater than the average with self-adhesive resin cement on dentin surface.

To evaluate the difference of bond strength between the dentin surface, resin cement and indirect composite, the failure pattern of the tensile bond test result was checked using a microscope with 10 magnifications. The dentin surface was dipped into methylen blue solution in order to see the penetration into dentin. The classification of bond failure type used was in line with the classification used by Mak et al.[10] which is; Adhesive failure between the indirect composite surface and resin cement cohesive failure in resin cement; cohesive failure between adhesive material surface and cement; adhesive failure between dentin surface and resin cement.

From 15 samples in the multi-step resin cement group bond failure type 1 of 6 samples, type 3 of 6 samples and type 4 of 3 samples were obtained. In the group of self-adhesive resin cement, all samples indicated bond failure type 4. The assessment of bond failure type 1 could be seen from the layer of cement on the dentin surface that was not penetrated by methylen blue. The bond failure type 3 could be noted from the absence of cement layer on the dentin surface, but no penetration of methylen blue in the dentin, whereas type 4 shows the failure of dentin surface that was penetrated by methylen blue.

DISCUSSION

The International Standard (ISO/TS) 11405:2003 about "Dental materials-testing of adhesion to tooth structure" is an international standard on testing method of bond strength material in vitro.[19] Tensile bond strength test with small specimens was the testing method widely used for adhesion to dentin. Smaller specimen allowed a more equitable stress distribution on adhesive surface[8,13], and reduced the intra group bond strength variation might be tested; where failures would occur in the adhesive layer, not in the material to be tested.[20] Small specimen also minimized the possibility of internal defects which could cause crack propagation.[13,20]

In the multi-step resin cement group, etching application 35% phosphoric acid was conducted on the dentin surface that would eliminate the smear layer, open dentin tubule, causing demineralization on dentin and increase the permeability of dentin. To provide a good bond between the demineralized dentin surface and cement resin, adhesive material was applied (Single bond adhesive) which was a combination of primer and bonding agent in solution one bottle solution.

The application of adhesive material after the etching procedure would form a hybrid layer between resin cement and dentin tissue which was the key bond between resin and dental cements. Hybrid layer formation with the penetration of resin into the exposed collagen tissue after the use of conditioner on dentin was expected to create a strong bond between the dentin and resin[21] to form a mechanical bond between the resin adhesive and dentin.[22-23]

The adhesive property of self adhesive resin cement was due to the acid monomer which caused demineralization and infiltrated tooth structures, so that a micromechanical interlocking bond occurred. The second reaction was a chemical bond with the hydroxyapatite of the tooth structure.[17,24] Resin monomer (phosphoric acid methacrylate) could react with the cement filler material and tooth apatite formed calcium phosphate methacrylate causing a chemical bond with the tooth.[25-26]

Infiltration of resin on tooth structure was influenced by the concentration and viscosity of resin, molecular weight and size, and time of penetration. RelyX Unicem cement has more filler material (72 wt%) and high viscosity. Smear layer on dentin surface was a solid buffer so that the acid of resin cement were likely neutralized fast and reduced the etching ability of monomers in self-adhesive resin cement. Limited ability of self-adhesive resin cement to penetrate into the demineralized dentin causing a hybrid layer very thin or almost resulting very weak bond strength between resin cement and dentin.[13]

The same thing was expressed by Gerth et al.[15] which indicated that the interaction between the dentin surface and RelyX Unicem cement was very superficial. Although the initial pH of the cement was low, the demineralization effect was very poor and the resin tag was not formed.[15] This statement was supported by Wang et al.[27] stated that self-adhesive resin cement has a low pH, but

on the examination with the SEM the demineralized dentin was not apparent. This might be due to the relatively high material viscosity and the short interaction time with the dental tissue made low material penetration.

Another study by De Muck et al.[28] Rosentritt[29], Yang et al.[13] and Hikita et al.[24] also stated similar things. They studied the attachment between RelyX Unicem cement to dentin and declared the absence of a clear hybrid layer between resin and dentin. The absence of demineralized dentin and hybrid layer expressed by many other researchers previously might have been the reason of the weak bond between RelyX Unicem to dentin surfaces in this study.

From the analysis of bond failure type in the multi-step resin cement group, many bond failures occurred at the surface between resin cement with composite and between resin cement with adhesive material attached to the dentin surface. This was probably due to the new resin monomers could not diffuse into the matrix of indirect composite resin that had undergone perfect polymerization.[5] Silane materials contained in the composite had exhausted so that the bonding between the matrixes is not optimal.

On the other hand, the bond between resin cement to the etched dentin surface that had been applied with adhesive material before indirect composite cementation showed a fairly strong bond than the bond between the composite resin cement with composite. This showed the importance of a treatment such as silane application or sandblasting on the surface of the composite inlay before cementation. The treatment was expected to increase the bond between the resin cement and indirect composite.

Similar results were also presented by Mak et al.[10] which examined the bond failure between the RelyX ARC cement with composite inlay. From the results of the research conducted by Mak et al.[10] 72.4% failure occurred along the surface of resin cement with inlay composite resins and any bond failure between dentin with resin cement was not found. Analysis of bond failure between the composite inlay with multi-step resin cement production of other manufacture showed various failure between adhesive resin cement in inlays, resin cement with dentin and cohesive failure which could reach 73.9%.[10]

Different results were seen in the self-adhesive resin cement test group. In this group, bond failure occurred entirely on the surface between resin cement and dentin. The results of this study were similar to other studies.

Hikita et al.[24] tested the tensile strength of RelyX Unicem to dentin and enamel, then analyzed the type of bond failure occurred using stereomicroscope with 50 magnification. The results of this study showed that bond failure of RelyX Unicem cement in the enamel was 78.6%. It was an adhesive failure between the enamel surface and resin cement. Attachment to the dentin, was 100% adhesive failure between the dentin surface and resin cement.[24]

Adhesive failure in the bond between dentin and self-adhesive resin cement was also supported by several other studies.[10,18,24] This adhesive failure was probably caused by high concentration of hydrophilic monomer and the absence of separated application of hydrophobic resin which could act as a semi-permeable membrane after polimerization.[25] In addition, the limited number of hydrophobic monomers in the dentine surface after the application of self-etch adhesive material resulted in a decrease of mechanical strength which affected the bond strength.[30-32] Covering dentin surface with a hydrophobic adhesive layer before cementation could increase the bond strength with the dentine and reduce nano leakages in the hybrid layer.[24,30,33-34]

CONCLUSION

Based on the research result and the statistical analysis conducted, it can be concluded that the tensile strength between the indirect composite restoration cementation with multi-step resin cement is higher than the cementation with self-adhesive resin cement. In the clinical situation, indirect composite cementation in a cavity will increase the configuration factor. Which might affect the effectiveness of resin cement bond. Considering the effect of polymerization shrinkage toward the resin cement bond strength in an inlay cavity need a further study. The development of dental materials, especially cement luting material offered a better material has with a better bond to dentin and the easy application. Therefore, a fundamental understanding of bonding techniques

and accured processes dental tissue should really be understood, to support the clinical success.

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