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Original Research

Comparative Evaluation of Effect of Two Different Bonding Systems on Shear Bond Strength of Composite and Compomer to Mineral Trioxide Aggregate: An *In Vitro* Study

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Abstract:

Background: To evaluate the shear bond strength of a hybrid resin composite and a compomer to mineral trioxide aggregate (MTA) using two different bonding systems (total-etch one bottle system and self-etch one step system) and to evaluate the type of bond failure in tested samples using scanning electron microscope.

Materials and Methods: A total of 120 customized rectangular self-cure acrylic blocks were prepared with a central hole measuring 4 mm in diameter and 2 mm in depth. The specimens were divided into four groups. In Group I, Z-250 was placed over MTA with a single bond (3M ESPE St. Paul, MN). In Group II, Z-250 placed over MTA with Easy One (3M ESPE AG D-82229 Seefeld). In Group III, Dyract (Dentsply DeTrey, Konstanz, Germany) was placed over MTA with a single bond. In Group IV, Dyract was placed over MTA with Easy One. The shear bond strength was measured on the universal testing machine (Star Testing Systems, India model no. STS 248) and the fractured surfaces were examined with scanning electron microscope (Coslab Laboratory Equipment, India).

Results: The results were statistically analyzed using descriptive statistics, one-way ANOVA, Scheffe multiple comparison test, and student's unpaired *t*-test. The results suggested that the total-etch one-bottle adhesive system provides a stronger bond to MTA for both the resin composite and the compomer.

Conclusion: On the basis of the results, it is advisable to use total-etch one bottle bonding system in a clinical situation requiring bonding to MTA.

Key Words: Compomer, composite resin, shear bond strength, mineral trioxide aggregate

Introduction

Conservation of the tooth structure and good esthetics have always been a long sought after goal in restorative dentistry. Earlier, exposed pulp was considered to be a doomed organ. With the major advances in vital pulp capping procedure, the emphasis shifted from the doomed organ concept to one of hope and recovery.[1] The use of mineral trioxide aggregate (MTA) in vital pulp therapy has gained popularity. It has been proposed as a potential material for furcation repair, internal resorption treatment, management of open apex, pulpotomy procedures, and capping of pulps with reversible pulpitis.[2-7] The success of pulp capping agents depends upon the restorative material that is used over it, which can provide a better coronal seal. Quality of coronal seal is dependent on choice of material for coronal restoration and also adhesion between coronal restoration and the tooth structure, hence, the material that would be placed over MTA as final restoration is an important matter. The aim of this study was to evaluate the bond strength of a resin composite (Z-250; 3M/ESPE, St. Paul, MN) and a polyacid modified composite resin or "compomer" (Dyract Dentsply DeTrey, Konstanz, Germany) when bonded to MTA (Dentsply, Tulsa Dental) with two different bonding systems (one bottle total-etch and one-step self-etch).

Materials and Methods

A total of 120 specimens of MTA (Dentsply, Tulsa Dental) were prepared by using rectangular acryl blocks. The blocks had central hole measuring 4 mm in diameter and 2 mm in depth. MTA was mixed according to the manufacturer's instructions. The prepared central holes were filled with MTA, and covered with a wet cotton pellet, and temporary filling material, Cavit (ESPE America, Inc., Norristown, PA). Then, the specimens were stored at 37°C with 100% humidity for 48 h to encourage setting. After the removal of the temporary material specimens were divided into four groups of 30 specimens.

Group I

The MTA surface was etched for 15 s with 37.5% phosphoric acid etching gel (Kerr, Karlsruhe, Germany), rinsed with water for 10 s, Single Bond (3M/ESPE) was then applied in two consecutive coats and light cured with light emitting diode light curing unit (Rotex, India) for 10 s. Resin composite (Z-250 3M ESPE. St. Paul MN) was applied into a cylindrical shaped plastic matrix (With an internal diameter of 2 mm and height of 2 mm) and then light cured with light-emitting diode light curing unit (Rotex, India) for 20 s.

Group II

The MTA surface was dried for 10 s with chip syringe to ensure dry surface. Self-etch bonding agent (Easy One 3M ESPE AG D-82229 Seefeld) was applied and light cured with light emitting diode light curing unit (Rotex, India) for 10 s. Resin composite (Z-250 3M ESPE. St. Paul, MN) was applied into a cylindrical shaped plastic matrix (with an internal diameter of 2 mm and height of 2 mm) and then light cured with light-emitting diode light curing unit (Rotex, India) for 20 s.

Group III

The MTA surface was etched for 15 s with 37.5% phosphoric acid etching gel (Kerr, Karlsruhe, Germany). The MTA surface was rinsed with water for 10 s. Single Bond (3M ESPE St. Paul, MN) was then applied in two consecutive coats and light cured for 10 s. Compomer material (Dyract Dentsply Germany.) was applied into a cylindrical shaped plastic matrix (with an internal diameter of 2 mm and height of 2 mm) and then light cured with a light-emitting diode light-curing unit (Rotex, India) for 20 s.

Group IV

The MTA surface was dried for 10 s to ensure dry surface. Self-etch bonding agent (Easy One 3M ESPE AG D-82229 Seefeld) was applied, and light cured with light-emitting diode light-curing unit for 10 s. Compomer material (Dyract, Dentsply Germany.) was applied into a cylindrical shaped plastic matrix (with an internal diameter of 2 mm and height of 2 mm) and then light cured with light-emitting diode light curing unit (Rotex, India) for 20 s.

The polymerized specimens were stored in 100% relative humidity at 37°C for 24 h. For shear bond strength testing, the samples were sheared with a knife-edge blade on a universal testing machine (Star Testing Systems, India Model no. STS 248) at a cross-head speed of 1.0 mm/min. Shear bond strength in MPa was calculated from the peak load at failure divided by the specimen surface area (Figure 1). A scanning electron microscopic examination was done to determine the nature of failure at MTA and restorative materials (composite and compomer) interfaces (Figure 2). The obtained results were statistically analyzed. The statistical tests used for analysis of the result were descriptive statistics, one-way ANOVA, Scheffe multiple comparison tests, Student's unpaired test.

Results

The mean values and standard deviations of shear bond strengths are given in Table 1 and 2. When the adhesive systems were compared, Single Bond presented significantly higher bond strength values than Easy One in both Z250 and Dyract groups ($P < 0.05$). When comparing the restorative materials, the difference between Single Bond applied with Dyract (19.11MPa) was not statistically significant ($P > 0.05$) from Single Bond applied with Z250 (18.26 MPa). A scanning electron microscopic examination showed adhesive fracture pattern in all samples.

Discussion

A clinical trial is the most valid way to evaluate the quality and efficacy of adhesion of materials.[8] The most common method to evaluate adhesive properties of restorative materials is a bond strength assessment.[9,10] Etching of MTA causes selective loss of matrix from around the crystalline structures with minimal loss of cement which results in a "honeycomb" etched pattern and exposure of crystalline structures that could provide a satisfactory surface for bonding of resin materials.[11] Hence, the shear bond strength test has been used in this study to evaluate the adhesive properties of MTA to composite and compomer restorative materials. The bond strength between two materials is of importance for the quality of the fillings. It has been estimated that bond

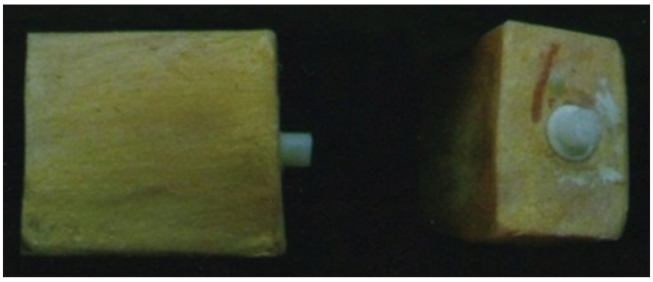

Figure 1: Composite and compomer cylinders (2 mm in diameter and 2 mm in height) Bonded to mineral trioxide aggregate.

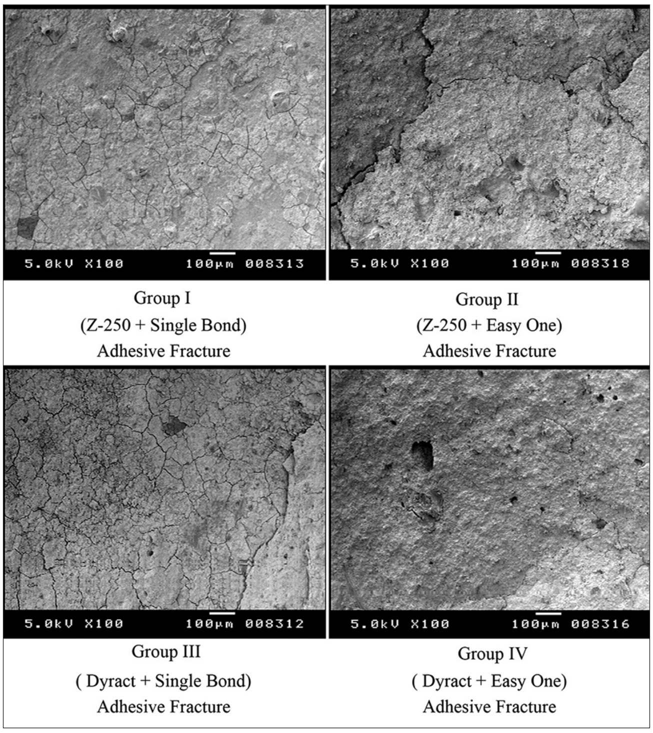

Figure 2: Fracture analysis by SEM

Table 1: Mean shear bond strength values (in MPa).		
***n*=30**	**Single bond**	**Easy one**
Z-250	18.26±3.98	14.69±4.18
Dyract	19.11±2.93	13.68±2.93

Table 2: Descriptive statistics.

Groups	*N*	Mean	SD	SE	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
Group I	30	18.26	3.98	0.72	16.77	19.74	11.31	24.50
Group II	30	14.69	4.18	0.76	13.13	16.25	5.36	22.40
Group III	30	19.11	2.93	0.53	18.01	20.20	11.32	25.30
Group IV	30	13.68	2.93	0.53	12.58	14.77	10.34	18.70

SD: Standard deviation, SE: Standard error

strengths of 17-20 MPa may be required to resist contraction forces sufficiently to produce gap-free restoration margins.[12,13] In the present study, the total-etch one-bottle bonding system (Single bond) showed significantly ($P < 0.05$) higher bond strengths in both composite and compomer materials compared with the one-step self-etch bonding system (Easy One) when bonded to MTA.[14-16] The reasons for the low bond strength of self-etching primers might be, (1) the combination of acidic hydrophilic and hydrophobic monomers into a single step may compromise polymerization of the adhesive, (2) the inherent low strength of the adhesive polymer, (3) the lower degree of polymerization of the resin monomer because of a major solvent/oxygen inhibition effect during light activation of these materials. (4) The incompatibility between the adhesive and the restorative material.[9] Self etch was applied in single coat which could also be the reason for low bond strength, as quality of adhesive layer, is responsible for bonding performance, which can be improved with application of multiple coats of adhesive.[13] The present results have shown that the bond strength to MTA is not affected by the choice of restorative material (composite, compomer) instead it depends on the choice of bonding agents to be used.

Conclusion

With the limitations of this *in vitro* study the following conclusions are drawn:

1. The shear bond strength of the single bond is significantly higher compared to that of Easy One with both composite and compomer when bonded to MTA.
2. It is advisable to use total-etch one bottle system in a clinical situation requiring bonding to MTA.

Further studies are required to evaluate the efficiency of various self-etch and total-etch bonding agents in combination with different restorative materials in different testing conditions.

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