Research Article

An In Vitro Comparative Evaluation of Shear Bond Strength of Nanocomposite with Microhybrid Composite

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ABSTRACT

Introduction: Majority of composites previously available were of universal hybrid or microhybrid resin containing glass filler particles around or less than 1 µm and colloidal silica. Polymerisation shrinkage of composites leading to inadequate marginal seal at tooth-restoration interface have been one major disadvantage of its applicability. Recently introduced nanofilled resin composites contain filler particle size of 0.1-100 nm consequently reducing polymerisation shrinkage. Measurement of shear bond strength of composite-tooth interface is one of the factors to determine adhesion between dental hard tissue and the composite.

Objective: The objective of this study was to investigate the difference in shear bond strength of nanocomposites and microhybrid composites.

Materials and Method: An in vitro comparative evaluation of shear bond strength of nanocomposites with a microhybrid composite was conducted. The buccal surfaces of the 20 teeth were acid etched and rinsed with water and air-dried. Posts were prepared of the restorative materials (Z100 and Filtek Supreme Z350) on smoothened buccal surface of the respective groups consisting of 10 teeth measuring 3 mm diameter and 2 mm depth using plastic templates. The samples were tested in the Instron Universal Tesing Machine. **Result:** The mean value of the shear bond strength of both the materials were found to be similar (15.67 MPa) and there was no statistical difference between the two groups.

Conclusion: The shear bond strength using a single bonding agent,were same in both the materials which did not show disparity in the adhesive capacity in the two groups.

Keywords: Microhybrid composite; nanocomposites; shear bond strength.

INTRODUCTION

A plethora of composite materials are now available in the market with improvised properties and its clinical success claimed to be due to nanoparticles used in the materials. The majority of resin composites previously available in the market were universal hybrid or microhybrid resin composites containing a heterogeneous aggregate of glass filler particles around or less than 1µm and colloidal silica.

Nanofilled resin composites recently introduced containfiller particle size of 0.1 to 100 nanometres, and due to the reduced dimension of the particles and to a wide size distribution,an increased filler load has consequently reduced polymerisation shrinkage and increased mechanical properties which are equivalent or even higher than universal composites.[1] The dental nanocomposite system studies showed high translucency, high polish and polish retention similar to those of microfills while maintaining physical properties and

wear resistance equivalent to those of several hybrid composites.[2]

The polymerisation shrinkage of resin composite represents a problem in operative dentistry because it may lead to gap formation between the composite resin restoration and the cavity walls.[3] The inadequate hermetic marginal seal between the tooth restoration interface by volumetric shrinkage of composite resin may also lead to decrease in the bond strength between the material and the tooth.[4,5] Adhesion of composite to the dental tissue is considered to be the most important factor for improving the bond between the restoration and the tooth.[4,5] Thus to produce and maintain a leak proof restoration, strong, and durable bonds between the resin composite and tooth structures must be established.[3] One of the basic factors to determine adhesion between dental hard tissue and the composite is measuring the shear bond strength of the material-tooth interface.[4,5]

The purpose of this study was to investigate the difference in shear bond strength of nanocomposites and microhybrid composites.

MATERIALS AND METHOD

The sample consisted of 20 premolar teeth extracted for orthodontic purpose. The buccal surfaces were smoothened and cleaned with pumice and rubber cup. The teeth were divided into 2 groups of 10 teeth in each:Group I = Microhybrid Composites(Z100); Group II = Nanocomposites (Z350).

The buccal surfaces of the teeth were acid etched with 37% phosphoric acid, rinsed thoroughly and air-dried. Posts were prepared by placing the restorative materials (Z100 and Z350) on smoothened tooth surface of the respective groups by using cylindrical plastic templates measuring 3 mm diameter and 2 mm depth prepared from straw pipes. The materials (Z100 and Z350) were placed in the mould using a cement carrier and condensed using the ball burnisher. The excess material was removed from around the template and the restorations were polymerised for 40 seconds as per the manufacturer's instructions using a light cure unit (Smartline Dentsply, India). The plastic templates used were cut away using a scalpel to expose the posts and the posts were finished using the composite finishing kit and were polished with Enhance Kit. All the samples were stored in distilled water for 24 hours prior to testing of shear bond strength.

The mounted samples were subjected to "shear bond strength test" by usingInstron Universal Testing Machine, Model 4206 with a crosshead speed of 1mm/min, a chisel-shaped shearing blade attached to the crosshead was aligned parallel with the flat dentin surface of the bonded specimen and the edge was positioned immediately adjacent to the composite restoration on the buccal surface. The force at which the posts dislodged from the dentin surface of each group was recorded in kilograms (Kgs) and the shear bond strengths were calculated inMegapascals (MPa) from the cross-sectional area and tabulated.

Formula for Calculation of Shear Bond Strength:

$$\text{Shear Bond Strength} = \frac{\text{Kg X } 9.8(N)}{\text{Cross sectional area}}$$

Where, Cross sectional area = $p\ d^2 / 4$; d = internal diameter of the plastic mold.

RESULT

The shear bond strength values were recorded using the Instron Universal testing Machine in 20 premolar teeth extracted for orthodontic purposes and divided into two groups:Group 1- microhybrid composite and Group 2- nanocomposite.The experiment was commenced by increasing the load of the Instron machine in increments and continuing the loading until breakage. The breaking load obtained were noted in Kgs and tabulated in MPa. The mean and standard deviations were calculated and the two groups, Group 1- Microhybrid Composite (Z100) and Group 2- Nanocomposite (Z350), were compared by using standard statistically analysis i.e. Student's unpaired t-test. Table1and Table2 show the shear bond strength values obtained for microhybridcomposite and nanocomposite respectively to dentin for all the samples. These observations were subjected to statistical analysis using the Student's unpaired t-test. The mean of the shear bond strength of both the microhybrid composite (Group 1) and nanocomposite (Group 2) were similar (mean value of 15.67 MPa) and there was no statistical difference between the groups (Table 3). It can be stated that both the composite types had similar shear bond strength (Figure 1).

DISCUSSION

The polymerisation shrinkage of resin composite

represents a problem in operative dentistry because it may lead to gap formation between the composite resin restoration and the cavity walls. Such gaps may compromise the restoration. Thus to bridge the gap a leak proof restoration, strong and durable bonds, be established between the composite and the tooth structure.[6] A durable bond depends on the chemical composition of the adhesive agent and the surfaces that are connected.[6]

Table 1: Shear bond strength of microhybrid composites to dentin for various samples (Group1).

Specimen No.	Shearing Load (Kg)	Shear Bond Strength (Mpa)
1	13	18.04
2	9	12.49
3	8	11.1
4	9	12.49
5	7	9.71
6	20	27.7
7	11	15.26
8	10	13.88
9	14	19.43
10	12	16.65

Table 2: Shear bond strength of nanocomposites to dentin for various samples (Group 2).

Specimen No.	Shearing Load (Kg)	Shear Bond Strength (Mpa)
1	8	11.1
2	20	27.7
3	8.5	11.79
4	9.5	13.18
5	15	20.82
6	7	9.71
7	7	9.71
8	8	11.1
9	18	24.98
10	12	16.65

Table 3: Shear bond strength of the two materials to dentin.

Group	N	Mean	Standard Deviation	t
1	10	15.6750	5.22216	.00000
2	10	15.6750	6.60763	p= 1 ns

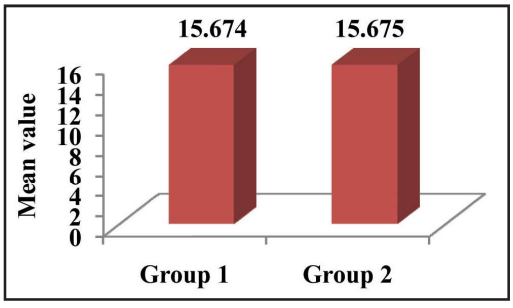

Figure 1: Comparison of mean shear bond strength.

Figure 2: Samples for shear bond test.

Figure 3: Testing the samples for shear bond strength.

Dentin however is less favourable substrate than enamel for bonding.[3] Attaining a bond to dentine is more complex because dentine is a vital tissue with a high water or organic content.The earlier dentin adhesives had low bond strengths and performed rather poorly in clinical studies. Improvised dentin adhesives have shown better results in various clinical studies with reliable adhesion and consistent predictability.[3,8]

The shear bond strength measurement is the considered to be reliable in obtaining a realistic and comprehensive picture about the strength of the bond between composite material and the enamel and dentin and is performed under in-vitro conditions.[5]

From their study, Richard Price et al found that the shear bond strengths of the 5 mm specimens were significantly lower than those of the 2 mm specimens so it was suggested that clinicians should not try to bond 5 mm increments of composite to dentin the shear bond strengths of the 5 mm specimens were significantly lower than those of the 2 mm specimens.[9] An increment of 2mm of composite was therefore used in the present study.

In the present study, Adper Single Bond (3M), a total-etch adhesive containing the moisture-tolerant Vitrebond copolymer in a water/ethanol solvent, provided by the manufacturer was used because it has been stated that incompatible adhesive system, can compromise the bonding between the restorative material and the tooth.[3,5] Vera et al[5] found in their study that using strictly compatible adhesive systems and following the instruction for use as recommended, significantly improves the strength of the bond between dental tissues and composite material.

This study, showed the shear bond strength of nanocomposite in a range between 9.71 to 24.98 MPa,while that of microhybrid composite ranged between 9.71 to 27.7 MPa (Table 1, 2). However, the mean value of both the materials bonded using the same adhesive system was 15.67 MPa each (Table 3, Figure 1). There was no difference seen in the mean between the two materials. The mean value obtained for Z100 in the present study coincided with the findings of Schneider et al[10] but was in contrast to that of Leirskar et al.[3] The mean value of nanocomposite was almost similar to one obtained by Korkmaz et al[11] (15.99 MPa) where nanocomposites like in the present study were bonded using Adper Prompt and cured using the Elipar Light Curing Unit based on LED system.

CONCLUSION

In the present study the shear bond strength using a single bonding agent, were same in both the materials which did not show disparity in the adhesive capacity in the two groups.

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