

COMPARATIVE EVALUATION OF SHEAR BOND STRENGTH OF MICROFILLED AND NANOFILLED COMPOSITE RESIN CURED UNDER LIGHT EMITTING DIODE (LED): AN IN VITRO STUDY

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ABSTRACT

Aim and Objectives: The present study was aimed to evaluate and compare the shear bond strength of nanofilled and microfilled composites polymerized using LED curing light. **Materials and Method:** Forty non-carious, extracted human premolar teeth were obtained and divided into two groups according to the type of restorative composite used. Group 1 – (n=20) microfilled composite cured using LED light. Group 2– (n=20) nanofilled composite cured using LED light. Composite was bonded to the prepared tooth surface in the form of a cylinder. The shear bond test was performed using Universal Testing Machine (Instron, USA) at a cross head speed of 5 mm per minute. **Results:** The mean shear bond strength was 19.92MPa for group-1 and 21.07MPa for group-2. Two sample T test showed no significant difference ($P > .05$) between groups 1 and 2. **Conclusion:** Nanofilled and microfilled composites have adequate shear bond strength and hence, both materials can be used satisfactorily to restore dental defects.

KEYWORDS: Bond strength; dental composite; light cure; light emitting diode

INTRODUCTION

Restorative dentistry has evolved a long way from the age old amalgam restorations to the present day's state of the art materials like nanocomposites. Nevertheless, a perfect union

with the tooth structure without inherent flaws, the utmost prerequisite for an ideal restorative material, has still deceived the dental researchers.^[1] The mechanical properties of dental composites depend highly on the concentration and particle size of the filler.^[2] Since the introduction of very first dental resin composites, many significant efforts have been undertaken to improve their long term clinical performance. Microfilled composite appeared in markets during mid-1960s which contained particles that are smaller than 1 micron. One of the major breakthroughs to the dental composites in the last few years has been the nanotechnology. Nanocomposites contain particles that are in the range of about 0.1-100 nanometers by various physical or chemical methods.^[2] Due to the reduced dimension of the particles and a wide sized distribution an increased filler load can be achieved, consequently reducing the polymerization shrinkage.^[3] The greatest advantage of light-curing adhesive systems is that they provide the clinician with ample time for placement before using light to polymerize the adhesive. QTH units have several shortcomings like short life of halogen bulbs, filters degrade over the time which results in a reduction of curing effectiveness.^[4] In 1995, Mills *et al.*, proposed the use of light emitting diode (LED) curing unit to overcome shortcomings of halogen light curing light systems which require no filters to produce blue light and having longer lifespan.^[5] Hence, the present study was

Table 1: Comparison of Mean and Standard Deviation of both groups

	Group I	Group II
No. of Observations	20	20
Mean	19.92	21.07
Standard Deviation	5.17	6.79
Standard Error of Mean	1.2	1.5

undertaken to determine the shear bond strength of nanocomposite with that of microfilled composite restorative material to measure its usability as a universal restorative composite resin.

MATERIALS AND METHODS

Forty non-carious, extracted human premolars were obtained from the department of oral and maxillofacial surgery. All the teeth were gently cleaned to remove any debris, plaque or calculus and stored in distilled water until use. The root portion of the teeth were embedded in the self cure acrylic resin base with each tooth oriented so that its labial surface of the crown would be parallel to the chisel during debonding when testing for shear bond strength. Thereafter the outer enamel surface was ground flat with the help of diamond disc to obtain a flat dentinal surface. The 40 specimens obtained were randomly assigned into 2 groups containing 20 samples each. Group 1 – (n=20) restoring the defect with microfilled composite and curing using LED curing light. Group 2 – (n=20) restoring the defect with nanofilled composite and curing using LED curing light. The dentin surface of each specimen was etched with 37% Phosphoric acid (Scotch Bond™ etchant; 3M ESPE, Germany) for 15 seconds, washed and blotted dry. Two coats of bonding agent (Adper Single bond 2™, 3M ESPE, Germany) was applied over each of the specimens and light cured for 10 seconds. A Plastic ring was used to build the composite cylinders for the two restorative composites on the dentinal surface measuring 3 mm in diameter and 2 mm in depth. Each specimen was light cured for 40 seconds using LED light cure unit. The prepared specimens of the two groups were stored separately in distilled water for 24 hours at room temperature. The shear bond test was performed using a Universal Testing Machine (Instron, USA) at a cross head speed of 5 mm per minute in a compression mode using a blade parallel to the dentinal surfaces.

RESULTS

Results derived from present study are tabulated in Table 1. The mean shear bond strength was 19.92MPa for group 1 and 21.07 MPa for group 2. Two sample ‘T’ test was performed to study the difference between means of shear bond strength of two groups. The test results showed statistically no significant difference between mean of Group I and mean of Group II [Estimate for difference: -1.15, 95% CI for difference: (-5.03, 2.73), T-Value = -0.60, p Value = 0.551, DF = 35].

DISCUSSION

Dentin bond strength is influenced by many factors such as tooth conditioning, adhesive system used, and the mode of cure. The shear bond strength test is a simple method used for the laboratory evaluation of adhesive systems. Other bond strength tests including tensile and fracture toughness tests have also been suggested. In order to predict the performance of adhesive systems bonding tests are necessary and useful. These test results may correlate with clinical conditions, but clinical success cannot be obtained by relying on in-vitro investigations alone.^[6] Mills *et al.*, in 1995 proposed solid-state light emitting diode technology for the polymerization of light activated dental materials. This type of curing light was developed specially to overcome the shortcomings of halogen VLC units. Instead of hot filaments used in halogen bulbs, light emitting diode uses junctions of doped semiconductors to generate light. Thus heat production is less and they have a lifetime of over 10,000 hrs and undergo little degradation of output over this time.^[5] Shear stress is considered to be more representative of clinical situation. Bond strength is the force per unit area that is required to break a bonded assembly with failure occurring in or near the adhesive / adherend interface. The bonding mechanism is based on the combined effect of hybridization and the formation of resin tags.^[7] Most studies conducted for bond strength were done on the tooth surfaces made flat with sand

paper. Clinically dentin is prepared with dental burs rather than sand papers, since there is only a small difference in magnitude of the bond strength that validates the use of sand papers relatively to dental burs.^[8] Today, fifth generation adhesives are promising an equal adhesive performance with less time consuming application protocols. These so called one component dentin adhesive systems combine the chemical properties of primer and bonding resin within one bottle. Although the effectiveness of multistep dentin adhesive system has been good, the easy handling properties of self priming resins have made them very popular with dental practitioners.^[9] The variation of shear bond strength values between different composites used in this study may not be attributed to the ability of the bonding agents used, but the difference in mechanical properties of the composite may in part contribute to these variations. "Single Bond", a fifth generation adhesive, was used having both primer and adhesive in one bottle. The same bonding agent was used for all the groups according to manufacturer's instructions. The main reason to use an adhesive was to combat the penetration of composite into the etched dentin surface to provide a better bond to tooth structure. Single Bond adhesive was found to provide up to 97% retention rate.^[10] Many factors affect the development of contraction stresses in the dental composite. These can be separated into material formulation factors (filler content, monomer chemistry and structure, filler/matrix interaction, additive, etc). Ferracane *et al.*, demonstrated that the contraction stress was reduced when thicker adhesive layers were placed under the composite. The magnitude of the contraction stress is directly related to the filler concentration. The relationship is likely the result of the correlation between filler content and elastic modulus.^[11,12] Monomer formulation may also significantly affect contraction stress. This has been demonstrated by the use of oxirane (epoxy) that can yield significantly lower stress.^[13] It has also been hypothesized that contraction stress could be partially relieved by introducing nanofiller silica particles that were not surface treated or treated with silane coupling agent, thereby minimizing the interaction between the filler surface and the forming polymer.^[14] For the above mentioned possibilities, it can be assumed that

nanocomposite showed some better performance (higher bond strength) than the other composites, as it contains Bis-EMA and nanofiller (5-75 nm). The results which show that microfilled composite resin have less shear bond strength than nanofilled, the reason may be that microfilled have a lesser filler loading and they are not silane treated. The results of the study conducted by YoncaKorkmaz, Nuray Attar found that the shear bond strength of nanofill and microhybrid composite cured with LED were not significantly different.^[6] This is similar to the results of our study. Hence, nanofilled and microfilled composites have adequate bond strength to be used satisfactorily.

CONCLUSION

To conclude all the composite resins and curing lights used in this study can be used for restorative purpose with good bonding characteristics. Also, combining the observations of an in vitro study with that of an in-vivo, one could affirm the extent of the changes that could affect the clinical integrity of material in oral environment. So, the true test of effectiveness of nanocomposites must come from clinical outcomes and further studies are needed to confirm these findings.

CONFLICT OF INTEREST & SOURCE OF FUNDING

The author declares that there is no source of funding and there is no conflict of interest among all authors.

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