Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Effect of Preheating on Surface Roughness and Microhardness of a Nanohybrid Composite Resin - An *In Vitro* Study

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Abstract

Introduction: The success of dental composites in restorative dentistry stems from their good aesthetic properties and adequate durability. The clinical performance of composite resins is directly related to the degree of monomer conversion after photo polymerization. Placing composites at an elevated temperature reduce their viscosity and increase the efficiency of polymerization. Heating the composite prior to placement in the cavity increases monomer conversion rate and therefore the duration of the irradiation period may be reduced.

Purpose of Study: Evaluate and compare effect of pre-heating on surface roughness and microhardness of nanohybrid composite resin subjected to two different temperatures and two different durations using light emitting diode curing unit (LED LCU).

Methods: Nanohybrid composite resin was tested at two temperatures (37°C and 55°C) and pre-heating of composite was done using incubator at two durations (10 and 20 minutes) respectively. Samples were injected into cylindrical Teflon molds and the top surface of the specimens were polymerized using LED LCU for 40 s. After preservation for 24 h, specimens checked for surface roughness and Vickers hardness measurements. Statistical analysis were performed using one-way analysis of variance and Tukey *post hoc* test at a level of significance of $P < 0.05$ for both surface roughness and microhardness.

Results: Pre-heating of composite affect on microhardness and did not influence on surface roughness.

Conclusion: Pre-heating of resin composite increases microhardness and no significant effect on roughness.

Key words: Pre-heating, Nanohybrid composite, LED light curing unit

INTRODUCTION

The success of dental composites in restorative dentistry stems from their good esthetic properties and adequate durability. The clinical performance of composite resins is directly related to the degree of monomer conversion after photopolymerization.[1]

Access this article online

IJSS
www.ijss-sn.com

Month of Submission : 12-2018
Month of Peer Review : 01-2019
Month of Acceptance : 01-2019
Month of Publishing : 02-2019

Blue light-emitted diode-based light curing units (LCUs) have a narrow spectral range with a peak around 470 nm which coincides with the optimum absorption wavelength for CQ activation. It has also been found that blue light-emitting diode (LED) source produced a degree of monomer conversion that was significantly higher than that obtained with halogen source, even though all the sources were adjusted to produce the same irradiance (100 mW/cm^2).[2]

Nanohybrid resin composites are claimed to have the positive characteristics of macrofilled and microfilled resin composites, they are widely used as universal resin composites in both anterior and posterior

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teeth.[3] Placing composites at an elevated temperature reduce their viscosity and increase the efficiency of polymerization. Heating the composite before placement in the cavity increases monomer conversion rate, and therefore, the duration of the irradiation period may be reduced.[1]

Current one-step systems appear to be as effective as multistep systems for polishing dental composites. With the ultimate goal of achieving a smooth surface of the composite restoration in fewer steps, the one-step polishing systems are appealing to the clinician.[4]

Hence, the purpose of the present study was conducted to evaluate and compare the effect of preheating on surface roughness and microhardness of a nanohybrid composite resin - an *in vitro* study.

MATERIALS AND METHODS

The composite resin used in this study was nanohybrid Herculite Precis (Kerr). The preheating of composite was done in a utilizing incubator (M KWO OPTIK) at 37°C and 55°C to 10 and 20 min durations, respectively. A total of 60 specimens were fabricated and divided into two groups as Group A and Group B.

- Group A: The specimens in this group were divided into two subgroups A1 and A2.
  - Subgroup A1:15 specimens were preheated at 37°C for 10 min.
  - Subgroup A2: 15 specimens were preheated at 37°C for 20 min.
- Group B: The specimens in this group were divided into two subgroups B1 and B2.
  - Subgroup B1: 15 specimens were preheated at 55°C for 10 min.
  - Subgroup B2: 15 specimens were preheated at 55°C for 20 min.

Placement of Composite Resin and Curing

A glass slide was placed at the bottom of mold with Mylar strip covering it and preheated composite of individual subgroups was immediately injected into the mold. A second Mylar strip was placed on top of the mold with coverslip covering it. All the specimens were cured according to manufacturer's instructions using LED curing unit (Bluephase N LED, Ivoclar Vivadent) for 40 s each and embedded in acrylic resin.

The specimens of composite resin were preserved for 24 h in dark and polished using polishing discs followed by aluminum oxide impregnated polymer points (enhance finishing system, Dentsply). The surface roughness was checked using surface roughness tester (Mitutoyo, Japan model SJ 210).

After the specimens had been checked for surface roughness, they were subjected to Vickers hardness measurements (Reichert Austria Make, Sr No. 363798).

RESULTS

The mean and standard deviation among the groups were calculated by ANOVA (One Way Analysis of Variance) and multiple comparisons among the groups were carried out by using Post Hoc Tukey's t-test. The *p*-value was taken as significant when less than 0.05.The data was analysed using Statistical package for Social Sciences (SPSS) version 17.

Analysis of Surface Roughness

The results indicated that there was statistically insignificant difference between the groups for surface roughness ($P > 0.05$) [Table 1].

Analysis of Surface Microhardness

The results indicated that there was statistically significant difference between the groups for surface microhardness ($P < 0.05$) [Table 2].

Table 1: *Post hoc* tests (surface roughness)

(I) Groups	(J) Groups	Mean difference (I-J)	*P* value
A1	A2	0.0090667	0.998
	B1	−0.0101333	0.998
	B2	0.1274667	0.113
A2	A1	−0.0090667	0.998
	B1	−0.0192000	0.986
	B2	0.1184000	0.158
B1	A1	0.0101333	0.998
	A2	0.0192000	0.986
	B2	0.1376000	0.076
B2	A1	−0.1274667	0.113
	A2	−0.1184000	0.158
	B1	−0.1376000	0.076

Table 2: *Post hoc* tests (surface microhardness)

(I) Groups	(J) Groups	Mean difference (I-J)	*P* value
A1	A2	−6.4853333*	0.008
	B1	−7.6353333*	0.001
	B2	−24.7440000*	0.000
A2	A1	6.4853333*	0.008
	B1	−1.1500000	0.933
	B2	−18.2586667*	0.000
B1	A1	7.6353333*	0.001
	A2	1.1500000	0.933
	B2	−17.1086667*	0.000
B2	A1	24.7440000*	0.000
	A2	18.2586667*	0.000
	B1	17.1086667*	0.000

DISCUSSION

The clinical use of resin composite has expanded considerably over the past few years due to increased esthetic demands by patients, new development in formulation, and simplification in bonding procedures.[5] Studies have revealed that preheating of composite resin increases monomer conversion and reduces the duration of light exposure. The increase in the degree of polymerization of the composites may lead to better internal adaptation to cavity walls, improved mechanical properties, and increased wear resistance.[1]

The material used in this study was nanohybrid composite (Herculite précis, Kerr company) which contains prepolymerized filler, silica nanofiller (20–50 nm), and submicron hybrid filler (0.4 μ).[6]

The use of LED to polymerize resin composites was proposed by Mill's, in 1995.[7] The spectral output of blue LEDs falls conveniently within the absorption spectrum of the camphorquinone photoinitiator (400–500 nm), and so no filters are required when LED LCUs are used. LED units generate minimal heat and so do not require cooling fans which have associated noise and power consumption.[8]

The results of the present study revealed that there was no significant effect of preheating of composites on their surface roughness.

The results indicated that there was a statistically significant increase in microhardness as the temperature of composite increased from 37°C to 55°C with the increase in the duration of preheating of the composites from 10 to 20 min.

Repeated preheating procedure did not negatively influence the mechanical properties of the resin composites. Further studies might be needed to assess the clinical relevance of the other variables connected to the repeated preheating and cooling cycles.[9]

A concern regarding preheating is the impact of this elevated temperature on the pulp tissue. According to Maeda *et al*., the intraoral physiologic temperature range in humans is from 34.2°C to 36.6°C. Other studies reported critical temperature limit for pulpal fibroblast to be 41.5°C. According to Trujillo *et al*.,[10] the pulp vitality may potentially be compromised by temperature rises of greater than about 5°C from the baseline level of approximately 32–34°C.[11]

Limitations of the present study were that there was decrease in temperature of the composites during their removal from incubator to Teflon mold stimulating clinical situation. The results of this *in vitro* study correlate to clinical situations where there are accessible and relatively flat surfaces. Future laboratory studies should be conducted to establish efficiency of one-step polishing systems on concave and convex surfaces.

CONCLUSION

A resin composite restoration can be imperceptible to the naked eyes when its surface closely resembles the surrounding enamel surface. Thus, polished restoration should demonstrate an enamel-like surface texture and gloss. Finishing and polishing procedures can be completed using single instrument, and it appears to be effective as multistep polishing systems for polishing dental composites.

There was no significant difference between the groups for surface roughness. There was significant difference between the groups for microhardness.

Preheating resin composite increases the monomer conversion rate and increases the depth of cure and microhardness of tested composite. However, further studies with larger sample size, involving various restorative materials, need to be undertaken to assess the result of preheating for optimum clinical advantage.

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How to cite this article: Wetam RB, Kamat SB, Hugar SI, Nanjannawar GS, Patil PD. Effect of Preheating on Surface Roughness and Microhardness of a Nanohybrid Composite Resin-an *in Vitro* Study. Int J Sci Stud 2019;6(11):66-69.

Source of Support: Nil, **Conflict of Interest:** None declared.