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ORIGINAL ARTICLE

The effect of wrapping of light-cure tips on the cure of composite resin

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ABSTRACT

Aim: Dental curing lights are vulnerable to contamination during routine intra-oral use. The purpose of this study was to evaluate the effect of wrapping light-cure tips on the hardness of cured composite resin. **Settings and Design:** Two types of barriers were used, which are the commercially available cellophane wraps and the disposable light-cure sleeves. A new light-cure unit used with a standard light-cure tip fixed at distance of 0.5 mm from the specimens. **Materials and Methods:** Sixty molds of 8 mm diameter and 2 mm depth filled with same type and shade of composite resin; 20 specimens cured without wrapping the tips, and 20 used for each wrapping method with new barrier was placed for each. The light-cure intensity and the Knoop hardness value were recorded. **Statistical Analysis:** Kruskal-Wallis test was used to analyze the statistical differences between the groups. Pearson's correlation analysis was used to determine the correlation between light intensity and Knoop hardness values. **Results:** The results of this study showed that there were significant differences in the light intensity among the groups. However, there were no significant differences in the Knoop hardness values among the 3 groups. The cellophane-wrapped around the light-cure tips is appeared to cause the least reduction of hardness from the non-wrapped tip. **Conclusions:** The effect of the barriers on the hardness of composite resin was small and probably clinically insignificant. The light intensity output was above the acceptable curing levels using any of the two barriers. The use of non-opaque barriers with the light-cure tips is recommended to prevent cross contamination.

Key words
Composite, hardness, infection control, light-cure, wrapping

INTRODUCTION

Visible-light-activated dental resin composites have been widely used as esthetic restorative materials for anterior and posterior teeth.[1] Both the physical and the biological properties of the resin are affected by the degree of polymerization.[2]

The minimum light intensity required to cure 1.5-2.0 mm depth of composite is between 280-300 mW/cm^2.[3] The intensity of emission is reduced by debris adherent to the light guide tip, repeated sterilization of the light guide, and damaged or chipped light guides.[4]

Dental offices must maintain a high level of infection control to protect patients and personnel, yet the light guides used when curing resins are often in direct contact with oral tissue.[5,6] A variety of infection control methods has been used to prevent cross-contamination including surface disinfection,[7,8] autoclavable tips,[9,10] pre-sterilized single-use disposable tips,[11,12] and covering or wrapping the light-cure tip with a non-opaque impermeable barrier.[13,14]

Wiping with a disinfectant solution is quick and convenient, but some studies have shown that glutaraldehyde-based solutions may reduce light transmission through a light guide or damage the fibers in the light guide.[15] Autoclaving may significantly reduce the ability of the guide to transmit light from the light-cure unit to the tooth.[9,16]

A pre-sterilized, single-use, plastic light-curing tips are available to be used. The main disadvantage noted was the glare generated by light escaping through the sidewalls of the light guide, which pose a potential risk to the eyes of the operator and assistant.[12]

Use of disposable translucent barriers such as plastic

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wrap, light tip sleeves, and finger cots may be a cost-effective alternative to avoid contamination of the light guide. They also eliminate the risk of damaging the guide during autoclaving or chemical disinfection.[6,13]

The placement of a disposable barrier has an additional advantage over other methods of cross-infection control in that it prevents the adherence of composite to the light-guide tip, which has been found to cause a significant decrease in the depth of polymerization.[13]

The purpose of this study was to evaluate the effect of wrapping light-cure tips on the curing light intensity and the hardness of cured composite resin.

MATERIALS AND METHODS

Two types of non-opaque impermeable barriers are used to wrap light-cure tips, which are the general-purpose cellophane wrap and the commercially available disposable light-cure sleeve (Pinnacle Cure Sleeve, Kerr, Orange, California, USA).

Each type of barrier was randomly selected and subsequently placed over the tip of a new light-cure unit with an 11-mm standard light-cure tip (Elipar S10, 3M ESPE, St. Paul, Minnesota, USA) fixed at distance of 0.5 mm from the composite resin (Herculite XRV, shade A3; Kerr, Orange, California, USA).

The same shade was used throughout, as variation in shade has been shown to have a marked influence on the depth of cure of the composite.

Sixty molds of 8 mm diameter and 2 mm depth filled with same type and shade of composite resin; 20 specimens cured without barrier protection on the tips as the control group and 20 specimens for each wrapping method. Each composite specimen received 30 seconds of light activation. The measurements of the specimens were checked to an accuracy of ±0.1 mm using a digital Vernier.

The method of curing of composite resin specimens is illustrated in Figure 1.

The general-purpose cellophane wrap was well-fitted on the light-cure tip as shown in Figure 2, which prevents contamination of surfaces underneath the barrier.

The disposable barrier was placed over the light-cure tip at the start of the curing cycle. After each specimen was cured, the barrier was checked for any damage by visual inspection for any holes, rips, or tears. New barriers were placed in the light-cure tip with the curing of each specimen.

With the selected barrier still on the tip, the light cure unit was switched on for 10 seconds prior to taking the output reading. Light cure tip is then placed over the radiometer sensor (Cure Rite, Caulk/Dentsply, Milford, Delaware, USA), which display the highest output.

The Knoop hardness value for each cured specimen was recorded at 3 different points within the central part of the back side of the specimen using the digital microhardness tester.

Data processing and analyzes were carried out using SPSS (Version 12) to analyze the results.

RESULTS

The mean values for the light intensity records are illustrated in Figure 3. The mean values for the control, cellophane-wrap, and cure sleeve groups were 569.43 mW/cm^2, 535.4 mW/cm^2, and 497.16 mW/cm^2, respectively.

The Kruskal-Wallis test was used to analyze the statistical differences between the groups. A K-W value of 47.31, P<0.0001 was determined. Therefore, there was a significant difference in the light intensity output among the groups.

The mean values for the hardness obtained by the Knoop Hardness test as mentioned in Figure 4 showed that

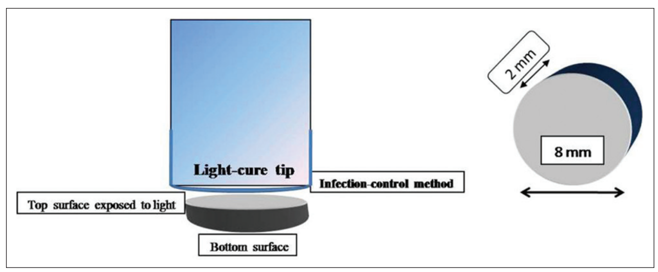

Figure 1: Diagram illustrating the method of curing composite resin specimens

Figure 2: The use of cellophane-wrap around the light-cure tip

specimens cured with the light tips that was not covered by a barrier were the hardest followed by the those cured with the light tips covered by general-purpose cellophane wraps and covering the light tips with disposable cure sleeves produced specimens with the lowest hardness values.

The Kruskal-Wallis test was used, and the K-W value was 5.956, P=0.051. Therefore, there was no significant statistical difference in the Knoop Hardness values among the 3 groups (P>0.05).

Analysis of variance (ANOVA) and Fisher's protected least significant difference (PLSD) test for multiple comparisons were used to determine if there were significant differences in the Knoop Hardness values between the control and the 2 disposable barriers as shown in Table 1. Results showed that there was no significant difference between the control and the cellophane-wrapped group. This statistical test showed that the use of cure sleeve reduce the knoop hardness significantly in relation to the control group.

Pearson's correlation analysis was used to determine the correlation between light intensity and Knoop hardness values. No significant differences were found as shown in Table 2.

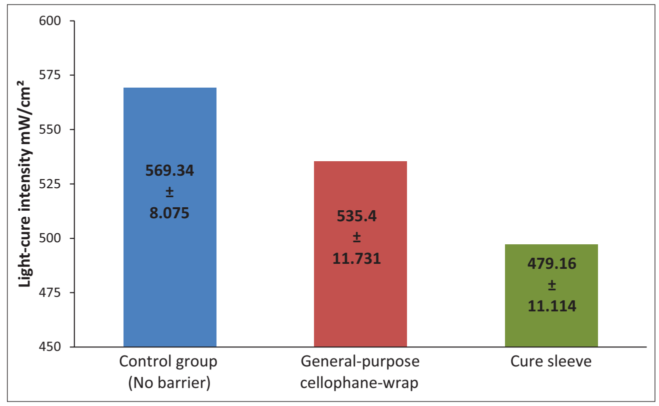

Figure 3: Bar chart shows light intensity output for the 3 groups in mW/cm²

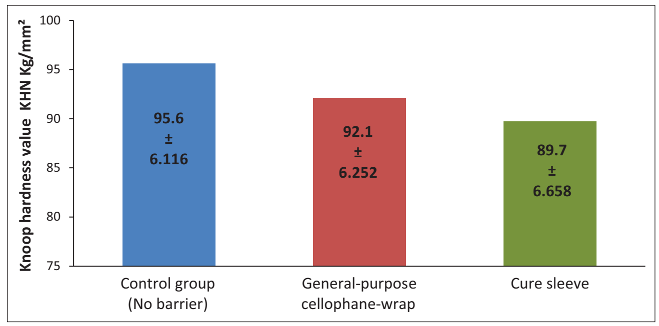

Figure 4: Bar chart shows Knoop Hardness values (KHN) for the 3 groups in Kg/mm²

Table 1: Mean difference in Knoop Hardness values for the 2 barriers, relative to control

Comparison	Mean difference in Knoop Hardness values (Kg/mm[2])	Fisher's F-test value	*P* value
Control v. Cellophane wrap	3.45	3.1168	0.085524 NS
Control v. Cure sleeve	5.9	8.5557	0.005781 S

Table 2: The relationship between light intensity and Knoop Hardness values for the three groups

Group	r value	*P* value
Control group	0.6581	0.3419 NS
Cellophane-wrap	0.2670	0.7330 NS
Cure sleeve	0.6930	0.3069 NS
Overall	0.4996	0.5004 NS

DISCUSSION

It is important that light tips used for curing resin composites in the mouth be sterile. At the same time, it is important to ensure an adequate curing of the resin composite.

The determination of hardness of the specimens was done on the side farthest from the light-cure tip. This was done because any diminishing light intensity would adversely affect the cure and hardness of the composite resin, because this area was the farthest from the light source.[13]

The current study showed no significant differences among the 3 groups in the Knoop Hardness value.

Microhardness testing has been used in many studies, because surface hardness has been shown to be an indicator of degree of polymerization and, therefore, the efficiency of the light source.[17,18]

The measuring of Knoop Hardness values as a method of assessing clinical performance was used by Chong *et al.*, who found no statistically significant difference between the Knoop hardness values in the presence of steri-shield, finger cot, plastic glove, or cellophane wrap.

Furthermore, there was no significant association between light inte nsity values and Knoop hardness values obtained either when comparing the different disposable barriers or versus the no-barrier control.

Direct comparison between the control and barriers methods showed statistically significant difference with the cure sleeve group. The reduction in hardness value, although statistically significant, was small and not likely to be clinically significant.

The results of other studies into barrier methods of infection control on light output would suggest that while disposable barriers reduce the intensity of light, they do not have a clinically important effect on depth of cure.[13,14,19,20]

Cellophane wrapped around the light guide has been reported to cause the least reduction in Knoop Hardness value of the cured composite. These findings came in agreement with previous studies comparing this method of infection-control with other disposable barriers.[13,20]

In the current study, cure sleeves, which are designed specifically for use with light-cure units, produced the lowest hardness values. They are thicker and more robust than the cellophane wraps and are slightly more opaque. This may reflect differences in adaptation of the barrier to the tip, or perhaps variation in the thickness or optical properties of the barrier.[19]

Statistically significant differences occurred in the light intensity among the 3 groups. However, all recorded values remained above the required threshold as the researches stated that any light intensity above 300 mW/cm^2 is considered adequate for curing composite resin.[3,13]

Variations in the thickness and the relative opacity of the material were considered to account for the reduction in light output readings.[13]

The distance from the tip of the light guide to the resin has a much greater effect on power density than these disposable barriers. In this study, the light-cure tip was brought to 0.5 mm from the composite resin, distance and access of the light tip to the resin restoration *in vivo* should be also considered in the clinical situation.

CONCLUSIONS

The following conclusions can be drawn under the experimental conditions of this study:

1. Disposable barriers are recommended for use with light-cure tips to prevent cross-contamination
2. Wrapping the light-cure tip with general-purpose cellophane has no effect on the hardness of the cured composite resin. While the effect of the use Cure Sleeve barrier on the Knoop Hardness value was small and not likely to be clinically significant
3. Light intensity output was above the acceptable curing levels regardless of the infection control barrier methods used
4. No correlation was found between the Knoop hardness and light intensity for any of the wrapping methods used.

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