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# EFFECT OF CURING LIGHT DISTANCE ON MICROLEAKAGE AND COMPRESSIVE STRENGTH OF PEDIATRIC COMPOSITE RESTORATIONS

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## ABSTRACT

**This study analyzed compressive strength and microleakage of Filtek p60 (3M ESPE) light cure composite cured from differing distances. Standardized class V cavities were prepared on 30 human extracted teeth and divided into 3 groups as 0mm, 3mm and 6mm depending on curing distance. Teeth were sectioned labio-lingually and examined under stereomicroscope for microleakage. Compressive strength was checked by using universal testing machine. Compressive strength was found to be decrease with increase in the distance of curing light . Microleakage was found to be increase with increase in curing distance. In pediatric practice decrease in compressive strength of composite resins due to longer curing light distance could be compensated by increasing the curing time.**

**KEYWORDS :** Curing Light Distances, Class V Cavity, Pellets, Microleakage, Compressive Strength, Posterior Composite

Light cured resin composites are finding wider usage in daily clinical practice because of their esthetic advantage, ease of usage, improved bonding to tooth structure, and enhanced mechanical properties. (Yoshikawa and Burrow et al ; 2001)

The introduction of the visible light system for the photo-activation of composite resins had its beginning in 1970 with the use of ultraviolet light. However, due to the adverse effects caused by this light system, it was substituted quickly by the halogen light system. (Galvao and Caldas et al ; 2013)

Irrespective of the type of curing light system, it is imperative that an adequate light with correct wavelength reaches all areas of a light activated restoration to ensure suitable polymerization and long-term clinical success which in turn are dependent on several variables such as material composition, exposure time, color, location of light source and quality of the light source. (Sobrinho and Lima et al ; 2000)

Compressive strength and Microleakage are the two key elements which determine the longevity and clinical success of any posterior composite restoration. In fact clinical microleakage has been cited as the most important reason for failure of composite restorations leading to post-operative sensitivity, marginal discoloration, secondary caries, or pulpal inflammation. (Sanchez and Farias et al ; 2013)

There is paucity of literature stating the exact effect of curing light distances on microleakage and compressive strength of posterior composite restorations in children because the child's behavior and head movement may significantly alter the ideal position of the curing tip. Therefore, this present study has been undertaken to check the influence of curing tip distance on compressive strength and microleakage of composite resins in pediatric dentistry.

## METHODOLOGY

The specimens were obtained from a stainless steel mold, with 6mm inner diameter and 4mm height. (Kumar and Gururaj et al ; 2012) This mold was covered with a Mylar matrix.

The resins were inserted into the mold, in a single increment, with slight excess and covered by another transparent matrix to the margins of the mold thus creating a flat surface on both specimen surfaces.

The specimens were light cured for 20 seconds with the following distances: 0mm (surface contact), 3mm and 6mm from composite surface,( Zhu and Platt ; 2009) using a quartz-tungsten-halogen light source with an irradiance of approximately 560mW/cm$^2$. The distance were standardized using plastic rings that acted as spacers with 3mm and 6mm heights respectively. Excess material was removed after irradiation.

The specimens were then stored dry at 37°C for 24 hours in the dark. The compressive strengths were measured using a universal testing machine with a load cell of 500 kgf and crosshead speed of 0.5mm/min.( Silva and Dias ; 2009) Data was tabulated and analyzed statistically using ANOVA and POST HOC Duncan's test.

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For microleakage analysis forty five sound human molars were carefully scaled of calculus, soft tissue, and other debris by using an ultrasonic scaler. The teeth were stored at room temperature in 0.1% thymol solution to avoid bacterial contamination. (Sanchez and Farias et al ; 2013)

Forty five class V cavities (3.0 mm mesial-distal, 2.0mm occlusal-gingival, and 1.8 mm deep) were made on the occlusal margin in enamel and the gingival margin in cementum (dentine). (Sanchez and Farias et al ; 2013) The preparations were made with diamond burs in high-speed hand piece cooled with an air-water spray. Prepared cavities were etched using 37% phosphoric acid for 15 sec and rinse dried.

The Adper Single Bond 2 (3M-ESPE, Saint Paul, USA) was used as adhesive system.

After bonding, the cavities were each filled with increments of the microfilled composite Filtek P 60 ( 3M ESPE) and light activated for 40 s with 560mW/$cm^2$ quartz-tungsten-halogen light source ( Confident, India). The teeth were stored at 37°C for 24h and the restoration surfaces were finished. (Sanchez and Farias et al ; 2013)

Teeth were subjected to thermal stresses for 500 cycles in separate distilled water baths at 5°C and 55°C, with dwell and transference times of 15 and 5s, respectively.

The entire tooth surface was sealed with two coats of commercial nail varnish, with a 1 mm wide border being left around the restoration margins. The teeth were immersed in 1% methylene blue for 24 h. After washing, the specimens were sectioned longitudinally through the center of the restoration, from the facial to lingual surface. Thus, two sections were obtained from each restoration. (Prabhakar and Sankriti et al ; 2011) Microleakage at the enamel and dentine margins was analyzed with stereomicroscope.

Marginal microleakage was scored as follows-

- 0: absence of penetration of tracer agent through the enamel or dentine margin;
- 1: penetration to one-third of the cavity;
- 2: penetration to two-thirds of the cavity; and
- 3: penetration to more than two-thirds and in the axial wall of the cavity. (Prabhakar and Sankriti et al ; 2011)

All of the procedures were performed by a single calibrated examiner.

Kruskal Wallis ANOVA was used to compare the microleakage scores.

## RESULTS

### Microleakage Analysis

A. Mean score of dye penetration analysis for

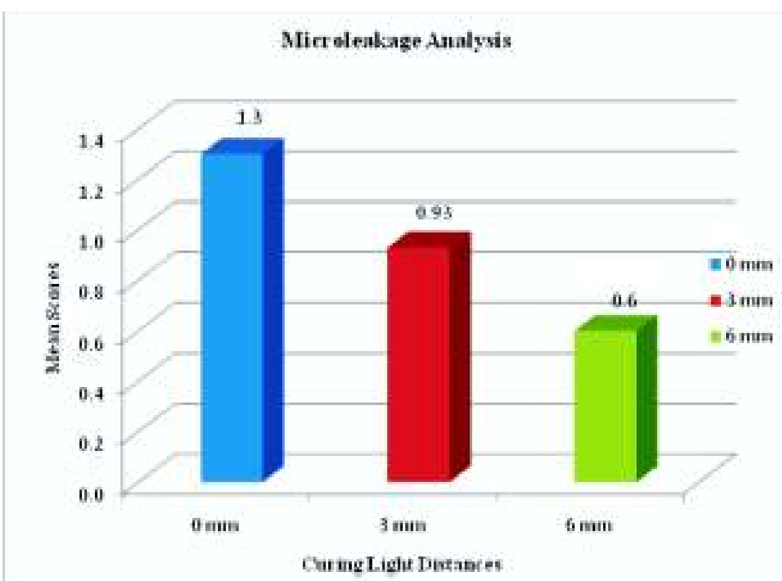


**Figure 1**

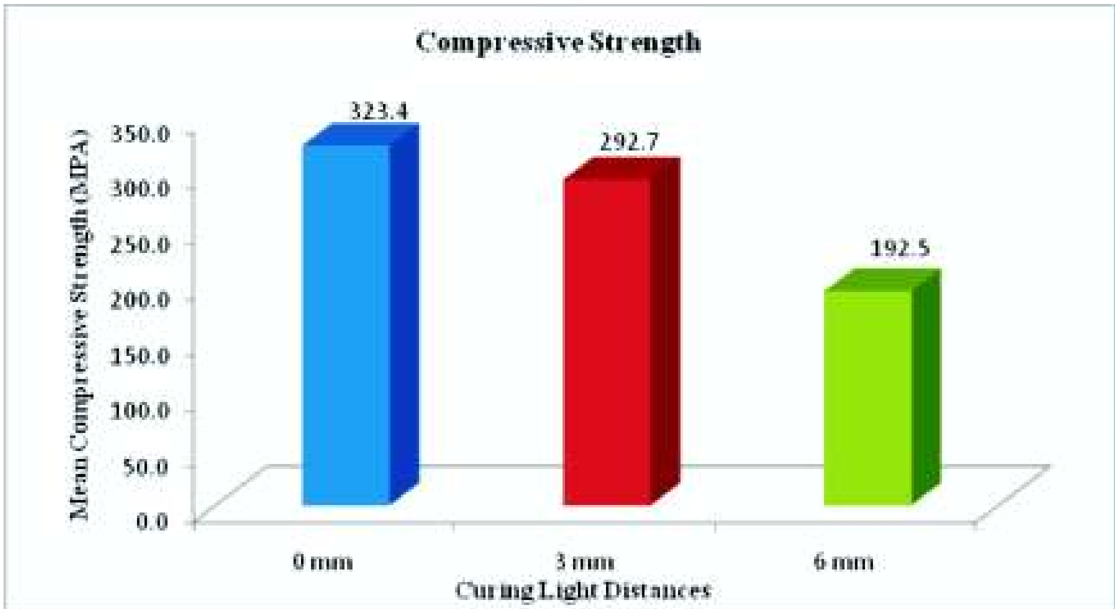


**Figure 2**

microleakage showed decreasing level of microleakage as distance increased.(Figure 1)

B. Statistical Analysis

Kruskal-Wallis ANOVA was done to analyze distribution of data, which showed P value of 0.04 which is statistically significant. (Table 1)

C. Group wise comparisons of mean scores was done using MANN-WHITNEY TEST which showed significant difference at distances of 0-6mm. However difference at 0-3mm &3-6mm was shown to be statically not significant.(Table 2)

**Compressive Strength Analysis**

A. Compressive strength analysis showed decrease in compressive strength with decrease in curing light distances. (Figure 2)

B. Statistical analysis

One way ANOVA showed highly significant result for mean compressive strength. (Table 3)

C. Group wise comparisons was done by using POST HOC TUKEY'S TEST which showed results as highly significant outcomes at distance of 0-6mm

**Table 2 : Group wise comparisons**

| Groupwise comparisons of Mean scores for microleakage | |
|---|---|
| Groups compared | P value |
| 0 mm - 3 mm | 0.20 , ns |
| 3 mm - 6 mm | 0.23, ns |
| 0 mm -6 mm | 0.014 *, S |

Mann-Whitney test

* P < 0.05, S

** P < 0.001, HS

**Table 1 : Statistical Analysis**

| **Microleakage** | | | | | | |
|---|---|---|---|---|---|---|
| **Groups** | **No.of samples** | **Microleakage Scores** | | | | **Mean Score ± SD** |
| | | **0** | **1** | **2** | **3** | |
| | | **n (%)** | **n (%)** | **n (%)** | **n (%)** | |
| **0 mm** | 30 | 7 (23.3) | 15 (50) | - | 8(26.7) | 1.30± 1.12 |
| **3 mm** | 30 | 10 (33.3) | 17 (53) | - | 4 (13) | 0.93± 0.94 |
| **6 mm** | 30 | 13 (43.3) | 16 (53.3) | 1(3.3) | - | 0.60 ± 0.56 |

K-W ANOVA, H = 6.08, P =0.04, S

**Table 3**

| Groups | Compressive strength (Mpa) | | |
|---|---|---|---|
| | Mean±Sd | Min | Max |
| **0 mm** | 323.4 ± 54.9 | 238.3 | 434.6 |
| **3 mm** | 292.7± 81.1 | 196.3 | 424.7 |
| **6 mm** | 192.5± 55.3 | 148.2 | 296.2 |

One Way ANOVA, F = 18.70, P < 0.001, HS

**Table 4**

| Group wise comparisons for compressive strength | | |
|---|---|---|
| Group compared | Mean Diff. | P value |
| **0 mm - 3 mm** | 30.7 | 0.41, ns |
| **0 mm - 6 mm** | 130.9 | 0.00 ** |
| **3 mm - 6 mm** | 100.2 | 0.00 ** |

Post-hoc Tukey's test
** P < 0.001, HS

and 3-6mm but statistically non-significant difference difference at 0-3mm. (Table 4)

## DISCUSSION

Light cured composite restorations have almost replaced traditional amalgam as the material of choice in contemporary pediatric restorative dentistry. (Soncini and Maserejian et al ; 2007) However the ideal position of the curing tip may not always be possible to achieve in children due to the challenges posed by their behaviour, constant tongue movement etc. There is paucity of literature addressing the exact effect of such positional deviations on the ultimate clinical outcome of the rendered restoration in terms of microleakage and compressive strength. Therefore, the present study was undertaken to check the influence of curing tip distance on the compressive strength and microleakage of composite resins used in pediatric dentistry.

Statistically significant difference was noted between the curing light distance and compressive strength of composite at distances of 0mm-6mm and 3mm-6mm.(T-4) This is in agreement with the work of Pires et al (Pires and Cvitko et al ; 1993) and Correr-Sobrinho et al, (Correr and Lima et al ; 2000) who showed a decrease in microhardness values with an increase in distance from the curing tip to the resin composite. It is also in accordance with Rode et al who showed that microhardness values were influenced by curing light distances of 6mm and 9mm and degree of conversion of composite decreased at distances of 6mm and 9mm. ( Rode and Kawano et al ; 2007) Although some studies found no correlation between hardness and the degree of conversion, Ferracaneproved that this correlation does exist. (Ferracane ; 1985) Similarly, a positive correlation between hardness and compressive strength has been established by Sheng et al. (Sheng et al ; 2009)

Thus the results of the present study as well as several others cited above suggest that compressive strength of composite resin is definitely affected by the curing tip distance. Based on the observed outcome we could infer that the use of higher irradiance but a shorter irradiation time be recommended to achieve satisfactory depth of cure and to improve the mechanical properties.

On the microleakage front, the present study revealed a trend of reduced dye penetration at the groups irradiated at 6mm when compared to groups irradiated at 0mm.(Figure 1)At irradiated surface, this can be explained by the reduced degree of conversion observed for the 6mm groups. A lower degree of conversion is expected to be accompanied by reduced volumetric shrinkage,which in turn, has been related to reduced polymerization stress. Since a positive relationship has already been established between microleakage and stress, it is possible that the reduced conversion led to reduced microleakage. Another hypothesis that could help to explain the reduced microleakage with 6mm groups is that the reduction in irradiance achieved at this level may have slowed the reaction rate, providing extended opportunity for chain rearrangement, there by relaxing some of the stresses developed within the bonded interface. There is evidence to prove that the use of higher initial irradiance leads to greater polymerization stress.( Froes and Pfeifer et al ; 2009)

## CONCLUSION

It can be concluded that curing light should be at an optimum distance of 3mm so that physical properties do not get compromised yet the incidence of microleakage is kept as minimal as practically possible.

Further in vivo studies are recommended to evaluate the influence of curing tip distances on compressive strength and microleakage in accordance with the outcomes of this in vitro trial.

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