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Effect Of Different Curing Times Of Composite Resin And Glass Ionomer Liner Use On The Pulpal Temperature

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Abstract

Aim: The present study was performed to measure intrapulpal temperature when photoirradiation of composite resin and glass ionomer liner at different curing times.

Material and Methods: Thermocouple (TC) was placed in the intrapulpal space of an extracted human mandibular premolar which had a ClassV cavity preparation (1.5mm dentin thickness remaining on the buccal surface), and restored with composite resin" a bulk fill "and with LED unit " a high-intensity " at different photoirradiation times (10, 20. & 40sec). A temperature increase was obtained during photo-irradiation.

Result: The Rise in intrapulpal temperature was associated with an increase in photo-irradiation times and significant in each study groups ($p<0.05$)**.**

Conclusion: intrapulpal temperature increase was attributed to photo-irradiation's time of composite resin. However, temperature's increase during polymerization were below the critical value.

Key words: intrapulp temperature, photoirradiation's time, composite resin.

Introduction

Vitality of pulp tissue is influenced during restorative procedures. The photo-irradiation process of composite resin may cause a heat generation, which theoretically could damage the pulp tissues. Although, the sensitivity of the pulp tissue to thermal changes which can be tolerate by the pulp is still unknown, burn reactions at the pulp periphery due to injuries on the odontoblastic leading to degeneration, coagulation, expansion in the dentinal tubules, → and increased flow outward from tubules [1,2].

Intra-pulpal temperature raises during photo-irradiation process pointed to

the contributing factors such as the type of light, curing unit, density power, duration of exposure, the space between composite surface and the tip of light source, shade of composite, composite thickness and remaining of dentin [3,4]. The introduction of light emitting diode LED unit is predicted to result in less temperature and less pulp injury in deep cavity close to the pulp. [5] LED units do not require the presence of filters, and 93% of total output of energy is convert to heat. [6]

The glass ionomer (GI) liner is protecting the pulp tissue from restorative material and from the heat generated especially in deep cavity. [7] The purpose of GI cement liner is to decrease the pulpal temperature under the accepted 5.5°C following photo-irradiation of a composite restoration.

The purpose of this study was to measure the Ttemperature at the pulp space during different photo-irradiation times of composite by a LED unit with and without glass ionomer cement lining.

Material and Method

This study was approved by the scientific committee in the Department of Conservative Dentistry, College of Dentistry, University of Mosul, Mosul, Iraq. Thirty non-carious permanent mandibular premolars extracted for orthodontic. Teeth were received scaling and polishing to remove calculus and stain then stored at room temperature in distilled water. Before preparation, the thickness of dentin at the buccal aspect was measured by radiographs and a vernier ruler use which varied between "2.5 - 3mm". Standarized Cl.V cavities were prepared on buccal aspects one mm above the CEJ and axial depth of cavity (1- 1.25 mm) using high speed hand piece "turbine" with dental round bur and cooling water. The occlusal aspect was perforated at the top aspect of the pulp cavity also using high-speed hand piece (turbine) with dental round bur until reach the pulp cavity . The Digital Ki and BNT model (TC: ST-1, China) was inserted into the pulp camber through the occlusal aspect. Inside the pulp chamber the TC was fixed by red wax. The position of the TC was then determined by a radiograph (show in figure 1). [8,13] Prepared teeth were distributed into two groups randomly, (one group with GI liner and second group without GI liner). Each group was subdivided according to photo-irradiation time (second) into three subgroups (n=5).

First group: the composite" Cavex Quadrant Universal LC/ A2 universal hybrid composite enriched with sub-micron particles (Cavex Holland BV, Netherlands, Germany) was injected in the Class V cavity without acid etch and bond after GI liner place, cured with a high-intensity LED unit (woodpecker model: YZB155-2013, China), light tip was directly placed over a celluloid strip for different curing time (10sec, 20sec and 40sec) with intensity of 1600mW/cm$^{2.}$ temperature was measured during curing process using the digital TC inside pulp chamber.

Second group: The bulk fill composite without acid etch and bond was injected in the Class V cavity without GI liner place, cured with a high-intensity LED unit and light cure tip were directly placed over a celluloid strip for different curing time (10 sec, 20 sec and 40 sec.). Temperature was measured during curing process using the digital TC inside the pulp chamber. Temperature of the canal during the curing process of the composite restorative material was recorded. Temperature data were analyzed using methods of descriptive, Post Hoc Tests and one-way (ANOVA test) at level of significant set at 0.05.

Result

The mean of temperature for each sub-group are presented in Table 1.

Temperature change without GI liner and with GI liner were 3.02 ± 1.33∘C and 2.63 ± 1.06∘C, respectively, the greatest intrapulp temperature in the second group.

One-way ANOVA of the temperature within the different curing time were significantly different between groups (first group and second group). presented in table 2

Comparisons of different curing time at each group, the result shows significant differences in temperature ($p>0.05$) as presented in (Table 3).

Figure 2 shows real temperature measurements (from 1.4600 to 3.0267) at the end of the curing procedure without GI liner while Figure 3 shows real temperature measurements (from 1.4600 to 2.6333) at the end of curing procedure with GI liner.

Discussion

The research hypothesis was accepted not in the manner expected. There was not significant difference in temperature value when photoirradiation of composite restorative without GI liner developed higher temperatures than intrapulpal temperature with GI liner, overall. However, these differences were very minor, as in table 1 and table 2.

Class V cavities in the present study allowed heat transfer by the surrounding enamel and dentin instead of disk-shaped specimens used in previous studies. A TC placed at the contact with the surrounding dentin in the pulp chamber close to the cavity floor. Temperature measured in this in vitro setup relates to the temperature to which the pulpal tissue would be exposed during photoirradiation of composite restorative material. The recorded pulp temperature may have been higher if the TC had been closer to the ceiling. The same might also be true if the TC had been placed in the pulp horn closest to the cavity [9,10]. *In vitro* studies using extracted teeth will not give the same results to be found *in vivo*, where there are differences in blood movement through the pulp with heat distribution. In other words, when any heat external stimuli fluid movement from-to the pulp, will increase in an attempt to reduce of pulpal temperature. Thus, the actual *in vivo* pulp regulatory system has shown to be more effective in dissipating [11,12]. In this study, temperature was not from the curing times only, but also from the heat generated resulted by the composite itself during polymerization, a GI liner use with the curing times allows for a better comparison of intrapulpal temperature changes.

In both groups there was significant difference in the temperature rise during the curing of composite immediately after the curing procedure find pulp temperatures were lower which can be attributed to the thermal insulation offered by the material itself. There was significant temperature rise in first groups which could be attributed to the small standard deviation in temperature that can be seen in the present study. This was most likely due to the thermal insulating effect of GI liner that agreed with Millen C. et.al, finding[13] (figure 3).

Zach and Cohen (1965), found increase in intrapulpal temperature more than 5.5°C lead to irreversible pulpitis turn to necrotic [14]. In my study, in all groups the temperature increases were less than 5.5°C to protect of the pulp vitality from thermal damage must be GI liner use for distributed of heat in the area and curing time of composite according to manufacturer's recommend a curing time 20 second for the high powered LED light.

The temperature rise which ccme with light curing of composite material was caused by both the heat generation from composite during photopolymerisation and heat from light source. In addition, different factors, such as curing time, the amount of remaining dentin thickness, the position of light curing units, the space between curing units and material surface, and the light intensity of the light curing units. All these can affect the temperature during the photopolymerisation [15,16,17]. The curing time of the composite resin arise as an important factor for the intrapulpal temperature during polymerization. Present study, applied three different curing times (10,20.40sec.).

The highest temperature increase was observed in second group this rise of temperature is probably related to the GI liner absent (Table 1 and figure 2) and the rise of temperature in first and second groups prepared with the three curing times were compared (Table3).

There is a possible risk of pulp damage induced by heat generation during photoinatiated of composite resin. However, the blood circulation in the pulp chamber and the fluid motion in the dentinal tubules may play role in reducing the temperature rise induced by the composite resin polymerization. The surrounding periodontal tissue can also promote heat distribution which result in reduction of the intrapulpal temperature rise [18,19].

Conclusions

The rise of intrapulpal temperature was attributed to photo irradiation's time of composite resin and temperature's increase during polymerization. However, this rise in temperature was below the critical value. The use of GI liner under composite restorations does reduce the rise of the intrapulpal temperature, type of restorative materials, duration of curing time and remaining dentine affect the pulpal temperature. The clinician therefore, should take these factors into consideration to prevent thermal pulp damage.

Conflicts of Interest: The authors declare no conflicts of interest.

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Table 1: mean and stander deviation

		N	Mean	Std. Deviation
Temp without GI liner	10	5	1.4600	.31305
	20	5	3.1000	.34641
	40	5	4.5200	.40866
	Total	15	3.0267	1.33602
Temp with GI liner	10	5	1.4600	.18166
	20	5	2.5200	.35637
	40	5	3.9200	.13038
	Total	15	2.6333	1.06682

Table 2 one- way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Temperature without GI liner	Between Groups	23.449	2	11.725	91.361	.000
	Within Groups	1.540	12	.128		
	Total	24.989	14			
Temperature with GI liner	Between Groups	15.225	2	7.613	129.028	.000
	Within Groups	.708	12	.059		
	Total	15.933	14			

Table 3 Multiple Comparisons of curing times(Post Hoc Test)

Dependent Variable	(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.
Temperature without GI liner	10	20	1.64000-*	.22657	.000
		40	3.06000-*	.22657	.000
	20	10	1.64000*	.22657	.000
		40	1.42000-*	.22657	.000
	40	10	3.06000*	.22657	.000
		20	1.42000*	.22657	.000
Temperature with GI liner	10	20	1.06000-*	.15362	.000
		40	2.46000-*	.15362	.000
	20	10	1.06000*	.15362	.000
		40	1.40000*	.15362	.000
	40	10	2.46000*	.15362	.000
		20	1.40000*	.15362	.000

* The mean difference is significant at the 0.05 level.

Figure 1 light curing of composite resin and place of thermocouple

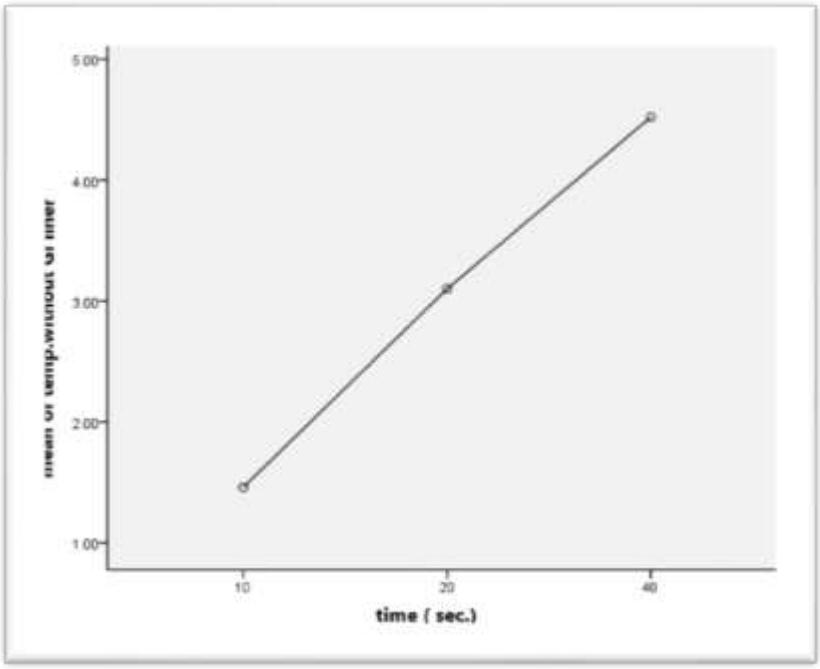

Figure 2 mean of temperatures without GI liner

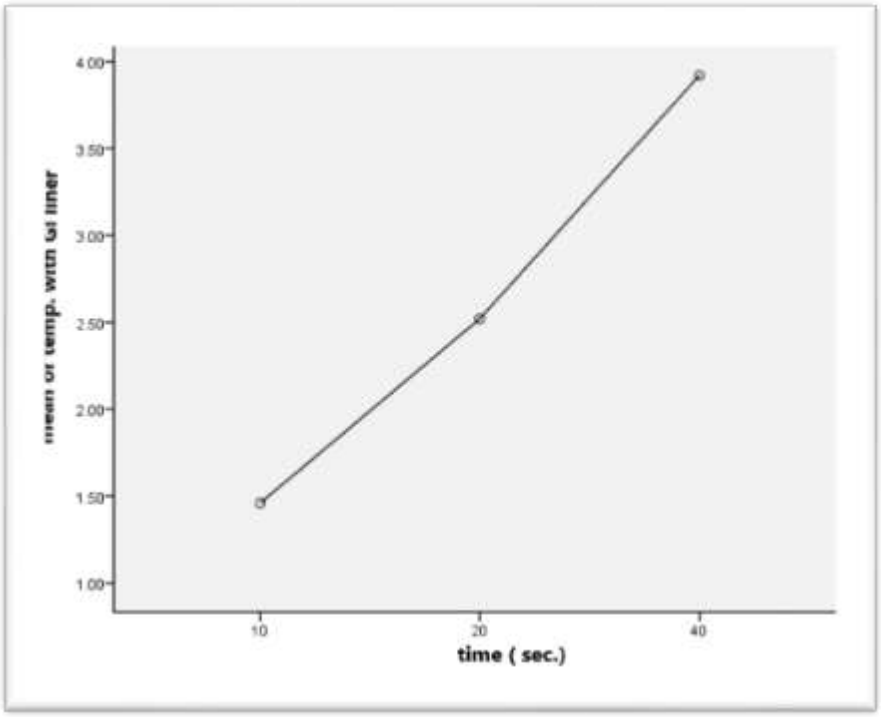

Figure 3 mean of temperature with GI liner