

EFFECT OF PREHEATING ON MICROLEAKAGE AND MICROHARDNESS OF COMPOSITE RESIN (AN IN VITRO STUDY)

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ABSTRACT

INTRODUCTION: advancements in composite restorations have been suggested, including preheating of composite resins before photo polymerization by a heating device.

OBJECTIVE: The aim of the study was to investigate the effect of preheating before curing on microleakage and microhardness of composite resins.

MATERIALS AND METHODS: thirty extracted human molars were used for microleakage assessment. Sixty class V cavities were made in the buccal and lingual surfaces of teeth, and were randomly divided into three groups according to temperature of composite (Group I: 10 °C, Group II: 24°C, and Group III: 54-60°C). Each group is further divided into two subgroups according to the type of composite (nanohybrid composite (Grandio Voco Germany), and microhybrid composite (Z250 3M Espe), where subgroups (IA, IIC and IIIE received nanohybrid composite), and subgroups (IB, IID and IIIF received microhybrid composite). Microleakage was determined by dye penetration test with scoring criteria from (0-3).sixty composite discs were used in vickers microhardness test (VHN),with same experimental grouping as used in microleakage assessment. VHN was determined using calibrated Vickers indenter. Data were collected, tabulated and statistically analyzed by using ANOVA F-test and Chi-square test ($p < 0.05$).

RESULTS: concerning microleakage ; there was no significant difference between the groups. The cervical margins showed more microleakage than the occlusal margins. The least microleakage was obtained in subgroup IIIE with mean 0.5 ± 1.08 in 80% of specimens occlusally and, also IIIE showed the least microleakage in 50% of cases with mean 1 ± 1.25 cervically. Concerning top microhardness; subgroups IA obtained the highest mean top VHN 113.35 ± 10.1 followed by subgroup IIIE 108.43 ± 1.52 . While regarding bottom microhardness subgroup IIC obtained the highest mean bottom VHN 88.49 ± 1.29 , followed by subgroup IA with mean value 85.49 ± 9.69 .

CONCLUSION: it was concluded that preheating enhanced microhardness of composite resin materials, but have no effect on microleakage.

KEY WORDS: microleakage, preheating, Vickers microhardness, Calset, resin composite.

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INTRODUCTION

Composite based on BISGAMA was first introduced by Bowen in 1963, and since then, many trials have been introduced to improve their clinical performance. Despite improvements in resin composite materials, drawbacks still compromise the longevity of resin composite restoration. The most common drawbacks are shrinkage during polymerization, thermal expansion, marginal leakage and recurrent caries. Also A high viscosity and stickiness of the highly filled composite make insertion and adaptation of the material to the cavity preparation walls difficult (1-3).

Weak adhesion between dentin and restorative material causes marginal gap formation, which leads to microleakage. This is a phenomenon where oral microorganisms, fluids, and chemical substances diffuse through the interface between tooth structure and restorative material. Fluids progressing through the microleakage area through dentin into the pulp result in post operative sensitivity, recurrent caries, pulpal inflammation, and restoration failure (4,5).

Different techniques have been suggested to improve sealing; such as incremental layering technique to reduce C factor, soft start and pulse delay curing methods to modify

reaction rate and the use of flowable composite to allow better marginal adaptation (6). Flowable composites with their low filler content and more fluidity act as stress absorber as they are resilient, but the lower filler content of flowable composite materials results in greater

polymerization shrinkage which are expected to be greater than universal composite (7).

The hardness of composite resin materials is influenced by several factors, such as organic matrix composition, type of the filler particles and degree of conversion. There is a positive correlation demonstrated between increasing hardness and increasing degree of conversion. Hardness is defined as the resistance of a material to indentation or penetration. It has been used to predict the wear resistance of a material and its ability to abrade or be abraded by opposing tooth structures (8,9). The Vickers microhardness test (VHN) has been commonly used to evaluate the hardness of dental materials, as it is usually used for brittle materials and small film thickness materials. Hardness tests are the most frequently used method to evaluate the curing depth and the polymer cross-linking of dental composites (9-12).

Recent literatures recommend that chair side warming of composite resins before photo polymerization. The increase in temperature of universal composite with high filler loading may enhance its flowability which can be advantageous in placement of composites, and better adaptation to the cavity, thus increase the durability of the restoration (13,14).

A device named Calset warmer (Calset™ AdDent, Inc. Danbury, CT USA) has been introduced to the market to preheat composite resin before placement in the cavity and it was claimed that preheating the composite resin may be recommended to enhance physical and mechanical properties (15-17).

Many questions still remain regarding the effect of preheating on the mechanical properties of resin based composite and if preheating improves them or not. Also if it could increase the flowability of material so enhance or prevent microleakage; therefore this study was made to investigate the effect of preheating on microleakage and microhardness of microhybrid and nanohybrid composite resins. The null hypothesis of the present study was that there is no difference in the microleakage and microhardness of preheated, refrigerated and room temperature composites.

MATERIALS AND METHODS

Microleakage assessment was made on thirty sound molars free of caries and restorations extracted due to periodontal causes. Molars were collected from the out-patient clinic of the Oral Surgery Department, Faculty of Dentistry Alexandria University. Teeth were cleaned and polished with pumice slurry and water using low speed handpiece then, rinsed thoroughly with tap water.

Sixty standard class V cavities were prepared on the buccal and lingual surfaces of thirty extracted human molars with total number of sixty cavities. Teeth were grouped into three groups according to temperature subjection of composites. Each group was divided into two subgroups (n=10) according to composite resin used. Buccal class V cavities were filled with nanohybrid composite (Grandio VOCO Germany), and lingual class V cavities were filled with microhybrid composite (Z250 3M ESPE).

Standardized class V cavity preparations were prepared on the buccal and lingual surfaces of molar teeth, to standardize cavity preparation of all teeth; a class V cavity was prepared in a tofflemire matrix band with dimensions (3mm mesiodistally x 2mm oclusocervically) then the band was adapted on all teeth during preparation using tofflemiere retainer, sixty cavities were made using carbid fissure bur (Komet H21314008 Lot 980042 Lemgo, Germany) on a high speed handpiece. Class V cavities were designed as followed (3mm mesiodistally x 2mm oclusocervically x 2mm (depth) pulpally). (18,19).

A standardized cavity depth of 2mm was achieved using half the length of the cutting tip of the carbid fissure bur, the occlusal margins of the cavities were in enamel, and the gingival margins located 1 mm above the cemento-enamel junction. The bur was changed every five cavities, the cavities dimensions were checked using graduated periodontal probe (15,20).

The cavities were grouped as followed: **Group I:** composite resins refrigerated to temperature 10°C. **Group II:** composite resins were stored at controlled room temperature at 24°C. **Group III:** composite resins were preheated to temperature 54°C - 60°C. Composite resins in the preheated group were placed in a heating unit (Calset™ AdDent, Inc. Danbury, CT USA). (Figure 1)

Groups I, II and, III were subdivided as followed:

Group I

Subgroup IA: nanohybrid composite specimen subjected to temperature 10°C.

Subgroup IB: microhybrid composite specimens subjected to temperature 10°C.

Group II

Subgroup IIC: nanohybrid composite specimens subjected to temperature 24°C.

Subgroup IID: microhybrid composite specimens subjected to temperature 24°C.

Group III

Subgroup III E: nanohybrid composite specimens subjected to temperature 54-60°C.

Subgroup III F: microhybrid composite specimens subjected to temperature 54°C-60°C.



Figure 1: Preheating of composite syringes in calset device at (54-60°C).

For all groups, cavities were etched, bonded and composite restorations were placed in the cavities and light cured using LED curing unit (P11060012A LED P5 Guilin, Guangxi, Medical instrument CO., China) with a light intensity of 1200 mW/cm², and with curing time of 40s according to the manufacturers. Composite restorations were finished and polished. Materials trade name, composition, instructions for use and manufacturer (Table 1).

Table 1: Materials used in the study.

Material	Composition	Type	Manufacturer
Filtek Z250	Surface modified zirconia / silica / inorganic filler 81.8%by wt/BIS-GMA /UDMA /PEGDMA/TEGDMA	Microhybrid universal composite	3M, ESPE USA www.3m.com
Grandio	Glass ceramic fillers 87%bywt nanohybrid inorganic filler (65.6% by volume) in a methacrylate base substance (BIS-GMA, TEGDMA, HEDMA).	Nanohybrid composite	Voco, Germany www.voco.com
Scotch bond Universal Etchant	Phosphoric acid (35%), with a pH of approximately 0.1 colloidal silica thickener, color, water	Etching Gel	3M, ESPE USA www.3m.com
Single bond	Polyalkenoic acid, hydroxyethyl methacrylate, bisphenol A diglycidyl ether dimethacrylate, dimethacrylate copolymer, ethanol, water	Adhesive	3M, ESPE USA www.3m.com
Enhance	Polymerized Urethane Dimethacrylate Resin Aluminum Oxide Silicon Dioxide	Finishing and polishing system	Dentsply Germany www.dentsply.com

Teeth were stored in distilled water for 24 hours till thermocycling. All samples were thermocycled for 500 cycles between 5°C and 55°C with a dwell time of 1 minute to simulate changes in temperature in the oral cavity. Before immersion in dye for microleakage assessment by dye penetration test; the apices of the teeth were sealed with sticky wax and the whole surface was coated with a nail polish 1 mm away from the restoration margins in order to reduce other leakage elsewhere that could lead to false positive results. The teeth were immersed in split copper cylindrical molds to form acrylic blocks where teeth were embedded in to facilitate the handling of the specimens, where teeth emerged 2mm above the cemento-enamel junction. Then molars were immersed in 0.5% methylene blue solution for 24 hours at room temperature. The blocks were immersed upside down where the restorations were

immersed in dye to decrease leakage other than the tooth restoration interface.

To measure the extent of microleakage; teeth were sectioned longitudinally through the restorations in a bucco-lingual direction with a low speed diamond saw. (Isomet 4000 microsaw, Buehler, USA.) (15, 21).

The sectioned teeth were evaluated with a stereomicroscope (Olympus model no.SZ11. Japan) at (50x) magnification. The degree of microleakage determined through the extent of dye penetration and was scored according to scoring criteria (0 to 3) as followed 0= No dye penetration (no microleakage), 1 = Dye penetration involving the half or less of the occlusal/gingival wall, 2 = Dye penetration involving more than half of occlusal/gingival wall, 3 = Dye penetration involving the axial wall (15,20). (Figure 2)

Microhardness test was carried on sixty samples of composite resin discs of dimensions 6mm in diameter and 2mm in thickness.

The composite discs were prepared and grouped as followed: **Group I:** composite resins refrigerated to temperature 10°C. **Group II:** composite resins were stored at controlled room temperature at 24°C. **Group III:** composite resins were preheated to temperature 54°C - 60°C. Composite resins in the preheated group were placed in (Calset) unit.



Figure 2: Figure showing microleakage assessment using dye penetration test for Preheated (54-60°C) nanohybrid composite (score 0 occlusally ,3 cervically) and microhybrid composite (score 1 occlusally, score 3 cervically) placed in class V cavities under stereomicroscope of (50x) magnification .

Groups I, II and, III were subdivided (n =10) as followed:

Group I

Subgroup IA: nanohybrid composite specimen subjected to temperature 10°C.

Subgroup IB: microhybrid composite specimens subjected to temperature 10°C.

Group II

Subgroup IIC: nanohybrid composite specimens subjected to temperature 24°C.

Subgroup IID: microhybrid composite specimens subjected to temperature 24°C.

Group III

Subgroup III E: nanohybrid composite specimens subjected to temperature 54-60°C.

Subgroup III F: microhybrid composite specimens subjected to temperature 54°C-60°C.

Composite discs were prepared using split Teflon molds with dimensions 6mm in diameter and 2mm in depth. The resin composite was packed in the split Teflon mold using Teflon coated plastic filling instrument. A polyester strip was

placed over the material and a glass slab was placed over the mold to obtain a flat surface. The glass slab was then removed and the light cure was placed directly onto the polyester strip touching it for 40 seconds curing.

The composite discs were stored in dry opaque box for 24 hours. Then the VHN analysis was performed by means of microhardness tester using a 100 gm load with a dwell time of 15 seconds. The specimens were tested on both top and bottom surfaces. For each side, three points were taken on both top and bottom of the composite resin specimens and the three indentations made by the square based diamond indenter of angle 136, the mean value was calculated for each top and bottom of each specimen and VHN was calculated by the following equation:

$$\text{VHN: } \text{HV} = 1.854 \text{ P/d}^2$$

Where, HV was Vickers hardness in Kgf/mm², P was the load applied in Kgf and d was the length of the diagonals in mm and 1.854 was a constant number.

To analyze the effect of temperature on resin composite microleakage and microhardness statistical tests were performed. Statistical analyses of the data were achieved, where Data were fed to the computer using IBM SPSS software package version 20.0., Qualitative data (microleakage assessment) were described using number and percent. Comparisons among different groups regarding categorical variables were tested using Chi-square test.

The distributions of quantitative variables (microhardness assessment) were tested for normality using Shapiro-Wilk test and D'Agostino test. The data were normally distributed, ANOVA test used. One way analysis of variance (ANOVA) was performed for comparison among more than two groups.

Quantitative data were described using mean and standard deviation for normally distributed data. Comparison among more than two populations were analyzed by F-test (ANOVA) and Post Hoc test (Scheffe). Correlations between two quantitative variables were assessed using Pearson coefficient.

Significance test results were quoted as two-tailed probabilities. Significance of the obtained results was judged at the 5% level.

RESULTS

The microleakage scores at the occlusal and cervical margins at the tooth and restoration interface revealed the following:

At 50X magnification, none of the materials used at the three different temperatures completely prevent microleakage. The restoration and tooth interface for all subgroups exhibited varying amount of microleakage along the entire interface of the restoration. The cervical margins mostly showed more microleakage than the occlusal margins. Table (2), Figure (3).

As for the occlusal margins; no significant difference was found between any of the three groups. The least microleakage was obtained in subgroup III E (preheated Grandio Voco) with mean 0.5 ± 1.08 in 80% of specimens showed score 0, 10% showed score 2 and 10% showed score 3 on the other hand the highest microleakage was found in subgroup IID (room temperature Z250) in 50% of specimens showed score 3, 20% score 2, 20% score 0 and 10% score 1 with mean 2 ± 1.25 .

Regarding the cervical margins; there was no significant difference between the three groups. The dye penetration

scores from (0-3) at the cervical margins where subgroups IIC (room temperature Grandio Voco) and IIIE (preheated Grandio Voco) showed the least microleakage in 50% of cases with mean 1 ± 1.25 while the highest microleakage was found in subgroup IB(refrigerated Z250) in 50% of cases with mean 1.9 ± 1.2 .

Intergroup comparison between microleakage scoring criteria at the occlusal and cervical margins in the six subgroups of the study in the three different temperatures revealed no significant difference between the three temperatures applied on both types of resin composite restorative materials at the occlusal and the cervical levels.

Concerning top microhardness, results revealed that group I (refrigerated temperature) obtained the highest mean top VHN where mean values of subgroups IA and IB were 113.35 ± 10.1 and 106.15 ± 5.24 respectively. This was followed by group III (preheated temperature) with mean values of subgroups IIIE and IIIF were 108.43 ± 1.52 and 99.57 ± 4.32 respectively. The lowest mean top VHN was recorded in group II (room temperature) where mean values of subgroup IIC and IID were 90.77 ± 1.37 and 85.61 ± 1.76 respectively.

Anova F-test 44.548 proved significant ($p=0.0001$) in the top VHN among the three groups. Post Hoc test (Scheffe) for pair wise comparison between subgroups showed that group III had significantly higher mean top VHN than group II. Also significant difference between group I and group III was found. Table (3), Figure (4).

While concerning bottom microhardness results revealed that group II (room temperature) obtained the highest mean bottom VHN value in subgroup IIC 88.49 ± 1.29 . This was followed by subgroup IA (refrigerated temperature), subgroup IIIE (preheated temperature) with mean values were 85.49 ± 9.69 and 81.11 ± 1.59 respectively. The lowest mean bottom VHN was recorded in subgroup IID (room temperature) where mean value was 57.75 ± 3.61 .

Table 2: Comparison between microleakage scoring criteria at the occlusal and the cervical margins of the six subgroups at the three different temperatures.

Score	Group												
	Group I grandio voco 10°		Group II grandio voco 24°		Group III grandio voco 54-60°		Group IV Z250 3M 10°		Group V Z250 3M 24°		Group VI Z250 3M 54-60°		
	Occl.	Cerv.	Occl.	Cerv.	Occl.	Cerv.	Occl.	Cerv.	Occl.	Cerv.	Occl.	Cerv.	
0	No.	2	5	4	2	8	4	3	1	5	2	5	2
	%	20.0	50.0%	40.0	20.0%	80.0	40.0%	30.0	10.0%	50.0	20.0%	50.0	20.0%
1	No.	6	2	0	1	0	2	3	4	2	2	2	4
	%	60.0	20.0%	.0	10.0%	.0	20.0%	30.0	40.0%	20.0	20.0%	20.0	40.0%
2	No.	1	2	4	2	1	1	1	0	1	2	1	1
	%	10.0	20.0%	40.0	20.0%	10.0	10.0%	10.0	.0%	10.0	20.0%	10.0	10.0%
3	No.	1	1	2	5	1	3	3	5	2	4	2	3
	%	10.0	10.0%	20.0	50.0%	10.0	30.0%	30.0	50.0%	20.0	40.0%	20.0	30.0%
Range	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3	0-3
Mean	1.1	0.9	1.4	2	0.5	1.3	1.4	1.9	1	1.8	1	1.5	
S.D.	0.875	1.1	1.26	1.25	1.08	1.34	1.26	1.2	1.25	1.23	1.25	1.18	
X ²	3.62		3.58		4.33		2.64		2.29		2.15		
p	0.305		0.30		0.227		0.450		0.515		0.541		

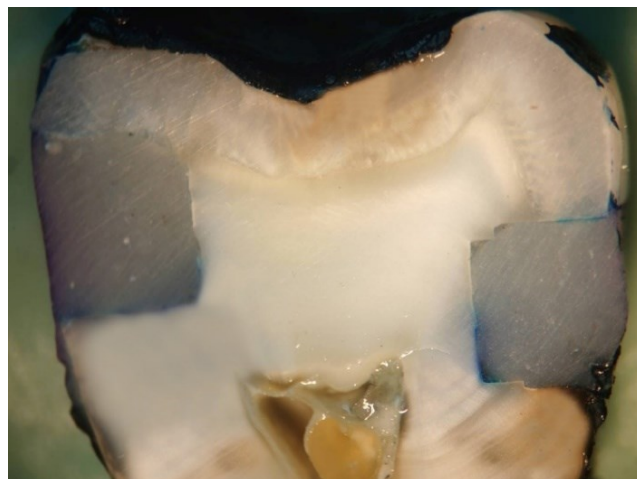


Figure 3: Comparing between microleakage scoring criteria at the occlusal and cervical margins in the six subgroups of the study at the three different temperatures at the restoration tooth interface.

ANOVA F-test 64.575 proved significant ($p=0.0001$) in the bottom VHN among the three groups. Post Hoc test (Scheffe) for pair wise comparison between subgroups showed significant relation between subgroups except for subgroups IIIE and IIIF there was no significant difference in-between (there was no significant difference between the two types of composite resin materials in the preheated temperature.). Also there was no significant difference between subgroup IA and subgroup IIC in bottom VHN (there is no significant difference between nanohybrid composites at room temperature and at refrigerated temperature). For microhybrid composite resins; subgroup III F (preheated microhybrid composite) showed the highest bottom VHN.

Table 3: Comparison between the six subgroups regarding Mean top and bottom VHN at the three different temperatures.

Mean VHN	Group I grandio voco 10°C	Group II grandio voco 24°C	Group III grandio voco 54-60°C	Group IV Z250 3M 10°C	Group V Z250 3M 24°C	Group VI Z250 3M 54-60°C
Top						
Min.	103	88.9	105	93	82.5	93.2
Max.	129	93.3	110.3	110.3	88.2	106.7
Mean	113.35	90.77	108.43	106.15	85.61	99.57
S.D.	10.1	1.37	1.52	5.24	1.76	4.32
ANOVA	44.548					
P	.0001*					
P1		0.001*	0.035*	0.003*	0.0001*	0.001*
P2			0.001*	0.0001*	0.027*	0.0001*
P3				0.321	0.001*	0.001*
P4					0.001*	0.006*
P5						0.0001*
Bottom						
Min.	74.7	86.5	78.5	65.6	53.7	77.03
Max.	101.2	90.9	83.5	73.6	64	80.1
Mean	85.49	88.49	81.11	70.42	57.75	78.97
S.D.	9.69	1.29	1.59	2.57	3.61	1.02
ANOVA	64.575					
P	.0001*					
P6		0.137	0.032*	0.0001*	0.001*	0.002*
P7			0.021*	0.001*	0.001*	0.001*
P8				0.001*	0.0001*	0.288
P9					0.0001*	0.0001*
P10						0.0001*

P1 comparison between group 1 and other groups.
 P2 comparison between group 2 and other groups.
 P3 comparison between group 3 and other groups.
 P4 comparison between group 4 and other groups.
 P5 comparison between group 5 and group 6.
 P6 comparison between group 1 and other groups.
 P7 comparison between group 2 and other groups.
 P8 comparison between group 3 and other groups.
 P9 comparison between group 4 and other groups.
 P10 comparison between group 5 and group 6.



Figure 4: Figure showing mean top and bottom VHN of the six subgroups.

DISCUSSION

Over the past years; the use of esthetic materials for restoration of posterior teeth had been developing. However; significant problems still hinder their use in large stress bearing areas. Efforts have been made to improve the clinical performance such as Preheating resin composite. It was claimed to allow handling characteristics similar to those of flowable composite (22-24).

Concerns related to the ability of microhybrid universal composite and nanohybrid composite resins to adequately adapt to internal areas of the cavity walls and the cavosurface margins have been raised. The high viscosity of these materials could increase the possibility of internal voids. To offset these problems; some attempts have been suggested including the use of preheated resin composite. Although the effect varies according to the brand of material studies revealed greater flow of the preheated resin composite. In addition, composites cured at elevated temperatures have increased the rate of cure and a higher degree of conversion. This could result in improved mechanical properties. Whether preheating could improve the mechanical and physical properties or not of microhybrid universal composites Z250 3MEspe and nanohybrid composite resins Grandio Voco; it is a question needed to be verified (25-27).

The high viscosity of heavily filled materials, as packable composites and microhybrid composites, may create a difficulty in producing a good marginal adaptation which may lead to void formation especially at the critical gingival margin (26). Therefore, microhybrid composite was selected for this study as it was suggested that preheating increased its flow properties, and hence improved its handling characteristics as reported by knight et al (28), in 2006.

In this study, Resin composite was preheated for the time recommended by the manufacturer. As well as it was maintained in the device for 1-2 minutes in order to achieve the maximum preset temperature as Daronch et al (30) in 2006 suggested. Resin composite used in the study was in the form of syringes. To provide the higher maintained temperature, therefore the heating unit was very close to the specimen prepared for hardness testing or for the cavity restored to allow quick application and to allow minimum amount of heat to be dissipated during manipulation. This comes in agreement with Daronch et al (30) in 2006 as many authors advised the clinician to work with the composite quickly in order to ensure the least temperature drop

possible and achieve the best clinical performance. Several pilot studies were done to fix the time of resin composite application to be as quickly as possible (8-10 seconds). A previous in vitro study had showed that when a composite compule was preheated, the actual pre-delivery composite temperature was less than the selected temperature stated on the heating device. Also, during the placement of preheated composite, the composite temperature dropped rapidly upon syringe removal from the heating unit until its placement on the prepared tooth (28).

In the present study, microleakage was investigated by the dye penetration test that permit seeing the extent of leakage occurred between the tooth restoration interface. Failure of the restoration to achieve an adequate seal may contribute to marginal staining, adverse pulpal response, post operative sensitivity and recurrent caries. In the present study the samples were subjected to thermocycling in order to simulate the intraoral environment; all the test specimens were thermocycled for 500 cycles between temperature of 5°C and 55°C with a dwell time of 1 minute in the thermocycling machine. The teeth were sectioned longitudinally through the center of the restoration; therefore, the microleakage scores could be evaluated as two dimensional. In the current study that method was preferred because it was easier and cheaper than other techniques (31, 32).

During the procedures of this study, the flowable behavior of preheated resin composite increased slightly at 37°C and markedly at 54-60°C ; it was in agreement with Knight et al (28), in 2006, who found that the photo activated composites flowed better when the temperature was elevated higher than the oral temperature. Freedman (33) in 2003 also stated that the viscoelastic materials as composites exhibit decreased viscosity when the temperature was increased, and that affected the rheological properties of the material and that was occurred in the study.

In the present study it was observed that Least microleakage scoring was obtained in preheated nanohybrid composites (Grandio Voco) followed by preheated microhybrid (Z250 3M) and similarly the control group of microhybrid composites specimens that stored in room temperature, but overall groups there was no significant difference between the six subgroups and that indicate that the temperature change does not prevent microleakage but it may affect the extent of microleakage through the tooth restoration interface.

Although preheating could decrease the viscosity of the hybrid composites and may enhance composite adaptation to the internal walls but with no significant difference between the microleakage scores of preheated, room temperature and refrigerated hybrid composite in the study. This could be attributed to the possibility of thermal contraction that would have occurred when composite was cured immediately or delayed at high temperature; higher temperatures could cause the material to try to return more rapidly to a previous shape, and this what assumed to be occurred in this study due to the viscoelastic behavior in the composite, which caused it to pull away from the walls of the tooth preparation. Two basic types of viscoelastic deformation come into play when placing resin composites viscous deformation and retarded elastic deformation. Viscous deformation is responsible for the majority of the forming of the composite. Retarded elastic deformation occurs at the same time as viscous deformation, and it is also present during shaping of the composite; however, this

retarded elastic deformation is temporary and the composite slowly tries to return to a previous shape. In a sense, it has a "memory." The retarded elastic deformation is not instantaneous; instead, it occurs slowly, depending on a number of factors, including temperature. Higher temperatures could cause the material to try to return more rapidly to a previous shape, this was demonstrated in the study made by Wagner et al (21) who related that delayed curing increased microleakage.

Also it was noticed that microleakage is more cervical than occlusal and this could be indicated that better sealed interfaces are formed at the occlusal margins than at the cervical margins. And that could be explained due to that the greater amount of enamel at the occlusal margins allows for better sealing and reduce microleakage. Finally, the rheological properties of the restoration could affect the ease of placing the composite between the occlusal and cervical margins; similar agreements were also found with Arslan et al (15), Wagner et al (21), Lohbauer et al (34) and Karaarslan et al (35).

For two types of composites used in the present study; mean top VHN increased with preheating. Bottom VHN of the microhybrid composite samples were the highest after preheating. These findings were in accordance with previous studies done by Fróes-Salgado et al (16), Daronch et al (29) and Tatbirojn et al (36).

Preheating significantly increased the top and bottom VHN of Z250, The greater increase in microhardness achieved at the top surface of samples relative to the bottom surface can be explained by the attenuation of light (because of reflection, absorption and dispersion phenomena) as it travels through the composite. In the current study, microhardness at the top and bottom surfaces was measured at 2 mm depth, the suggested increment thickness for composite placement. At a depth of 2 mm, the attenuation of light may reduce irradiance to approximately 75% of that reaching the top surface. It has been attributed that, on average, resin composites can achieve 50% to 70% conversion of monomers at room temperature (8, 9, 11).

Studies have reported that, the hardness values at the bottom surface should be between 80 and 90% of the hardness at the top surfaces in order to indicate a proper polymerization. In the current study, the exposure duration recommended by the manufacturer resulted in bottom-to-top-surface microhardness ratios about 70% for the tested resins (31-33). In this study microhardness of composite resin was found to be significantly affected by change in temperature where the preheated composite resin specimens were significantly higher than room temperature specimens in top Vickers microhardness measurements. And this comes in agreement with the findings of Cohen et al (37), who reported the need for exposing the specimens from a 5- to 20-fold longer time than that indicated by the manufacturer to achieve 70%- 80% bottom-surface hardness with respect to the top. Osternack et al (12) also suggested using a longer curing time in order to increase the energy density at the bottom of the layer and increased the degree of conversion.

Previous studies shown that, temperature had a significant effect on final conversion values of dental resin composites (9, 17). Preheating microhybrid composites to 54-60°C produces higher conversion rate. Such high reaction rate may result in elevated stress formation and accelerate development of the vitrification point causing

damage to the integrity of the resin/tooth interfacial bond (30). However, increased conversion of preheated composite resulted in enhanced restoration properties such as microhardness as was suggested by Torres et al (10). On the contrary, Didron et al (38) demonstrated that the preheating composite resins have no significant effect on microhardness.

In the studies demonstrated by Dranoch et al (17,30); preheating composite before curing enhanced conversion rate without hastening the time at which maximum cure rate occurs at the top and at 2mm depth this enhancement is probably attained by increased molecular mobility resulting from temperature increase and thus; the postponement of diffusion, controlled propagation and reaction diffusion controlled termination and autodeceleration, thereby allowing the system to reach higher limiting conversions before verification. As a result a higher cross linked polymer network or oligomeric network formed therefore improved mechanical and physical properties may be anticipated from composites when they were preheated to temperatures above that of the room temperature.

Thus result of the current study ; may be due to the fact that elevated temperature of composite increase the mobility of the free radical and so enhance additional polymerization, autoacceleration, autodeceleration and final conversion reaction continue then crosslinking, mobility are reduced. The system becomes more viscous until the reaction stops due to polymer vitrification. Onset of vitrification occurs as diffusion reaction became very slow due to formation of the polymeric network. Thus a slowdown in the polymerization processes take place determining the final degree of conversion; therefore less unreacted residual monomer remains free so better mechanical properties. These come in agreement with Daronch et al (17), Osternack et al (12), Jin and Kim (39). But was disagreement with Didron et al (38) and Torres et al (10) stating that the preheating composite resins have no significant effect on microhardness, who demonstrated the strong influence of composite temperature on polymerization contraction behavior of dental resin composites. Didron et al (38) pointed out that Preheating composites to higher temperature significantly increased the rate of polymerization and polymerization contraction stress. The increased stress at elevated temperature seems to be a consequence of the system thermal contraction rather than an increase in materials' conversion, since the composites' mechanical properties were not significantly improved at elevated temperatures (13, 30).

Therefore it was concluded that Increased temperature enhances both radical and monomer mobility, resulting in higher overall conversion and accelerate diffusion reaction rate; thus better physical and mechanical properties.

CONCLUSIONS

Under the conditions of this in vitro study; it was concluded that the preheating to 54°C-60°C did not affect the microleakage of the tested composite resins. It was noticed that it affected on the marginal adaptation of the composite resin materials to the cavity walls.

It lowered the viscosity of the resin composite materials where it eases its introduction to the cavity by increasing its flowability.

Preheating and precooling could affect the hardness of the resin composite materials but it mainly depends on type of composite resins used, the amount, depth of cure and the type of light curing unit used. So this will need further

investigations. Also Further investigations required on preheating and its effect on pulp vitality and intrapulpal pressure.

CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

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