Effect of Contamination of Bulk-Fill Flowable Resin Composite with Different Contaminants during Packing on its Surface Microhardness and Compressive Strength: In Vitro study.

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Research Article

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Abstract

Background:

Proper isolation and restoration of class V subgingival cavities are technique sensitive, thus the resin composite restoration is liable to contamination. This in vitro study was conducted to evaluate the surface microhardness and compressive strength of bulk-fill flowable resin composite after being contaminated during its packing.

Materials and methods:

Resin composite discs were prepared using split mold. The contaminated specimens were allocated into four groups (n=20) according to the contaminant used: hemostatic agent (Group 1), alcohol (Group 2), artificial saliva (Group 3) and powdered gloves (Group 4). The non-contaminated specimens (n=20) were used as control group. The surface microhardness and compressive strength of each group were tested one-day post-photocuring (n=5) and one-month post-photocuring (n=5). Values were presented as mean, standard deviation (SD) values and confidence intervals.

Results:

At one-day and one-month post-photocuring, the highest surface microhardness mean values were recorded in control groups. The difference between all groups was statistically insignificant at one-day post-photocuring (p=0.299) and at one-month post-photocuring (p=0.880). The highest compressive strength mean values at one-day and one-month post-photocuring were recorded in control groups (110.42 MPa and 172.87 MPa respectively), followed by alcohol groups, then hemostatic agent groups, followed by artificial saliva with the least value recorded in powdered gloves groups (56.71 MPa and 49.5 MPa respectively).

Conclusions:

Contamination of bulk-fill flowable resin composite with hemostatic agent, alcohol, artificial saliva, or powdered gloves during its packing decreased its compressive strength at one-day and one-month post-photocuring; but did not affect its surface microhardness.

Clinical Relevance:

The findings confirmed that resin composite packing is a technique-sensitive procedure where any negligence contributing to resin composite contamination could lead to decrease of its mechanical properties.

1. Introduction

Assessing the mechanical properties of resin composite is essential to evaluate the ability of material to survive all challenges present in the oral environment. One of the most useful properties to assess is the surface microhardness because it is correlated with resistance to abrasion [1]. Additionally, the compressive properties of resin-based composites are of great importance as the stress due to mastication is mainly of compressive nature. When parafunctions are present, the compressive stresses are multiplied, leading to fracture of the tooth and restoration [2]. The laboratory testing of compressive strength observes the in vitro fractures that may occur clinically [3]. Flowable resin composite have been preferred by most dentists because of its lower viscosity and subsequent higher flow that allow easier filling the cavity, better adaptation to cavity walls and greater elasticity when compared with other available products [4, 5] Compared to traditional incremental filling techniques, cavities with a depth higher than 4 mm can be filled through the bulk-fill technique, thus reducing the chair time to fill a cavity [6]. Flowable resin composite has lower

modulus of elasticity, thus they are recommended to restore Class V lesions to absorb the mechanical forces during function [7].

Contamination of bulk-fill resin composite during packing could happen accidently when complete proper isolation is difficult to obtain, especially when used to restore class II or class V subgingival caries. Salivary contamination of the cavity can have adverse effects on the longevity of the restoration and may lead to microleakage, sensitivity, tooth discoloration and finally, loss of the restoration [8]. Many studies investigated the effect of contamination of enamel, dentin or adhesive joint with either gloves or saliva on the bond strength of resin composite to tooth structure [9]. Other studies evaluated the effect of contamination of the composite on the incremental layer bond strength during the incremental layering technique [10, 11, 12]. However, the current study focused on the contamination effect of resin composite during bulk-filling technique on its mechanical properties. As dentists may rub the hemostatic agent against the tissues before retraction cord application, contamination of the prepared cavity to be restored or the resin composite restoration itself could accidently happen. Many studies investigated the bond strength of enamel and dentin contaminated with hemostatic agent to resin composite [13, 14, 15]. However, no studies assessed the effect of contamination of resin composite restoration itself with hemostatic agent during its packing on its mechanical properties. Many clinicians manipulate the resin composite during its packing using either powdered gloves or using their fingers that might be contaminated with saliva or alcohol. Therefore, the aim of this in vitro study was to investigate the effects of contamination of bulk-fill flowable resin composite during packing with different contaminants (Hemostatic agent, artificial saliva, ethyl alcohol and powdered gloves) on its surface microhardness and compressive strength.

2. Materials And Methods

2.1. Materials:

The materials used in this study are shown in [Table 1].

2.2. Methods

2.2.1. Specimen Grouping:

A total of 100 specimen of disc-shaped resin composite were prepared using Teflon split mold. The contaminated specimens were allocated into four groups (n = 20) according to the contaminant type used. The non-contaminated specimens (n = 20) were used as control group. Each group was further subdivided into two subgroups of ten specimens each to test the microhardness (n = 10) and the compressive strength (n = 10) at one-day post-photocuring (n = 5) and one-month post-photocuring (n = 5).

2.2.2. Specimen Preparation:

Control Group (Non-contaminated group): 20 specimens were prepared by injecting the bulk-fill flowable resin composite into the central hole of Teflon split mold (4 mm diameter X6 mm height) put on a clean dry glass slab followed by adequate packing.

The top surface of the resin composite was covered with a celluloid matrix strip (0.05 mm thick); the excess material was removed by pressing the glass slab against the strip [16]. Finally, the resin composite (of 6mm height) was photo-cured for 40 sec from the top surface using LED light-curing unit of 470 wavelength (Elipar S10, 3M, ESPE) with light intensity of 700 mW/cm^2. The curing protocol performed was standard irradiation at a continuous light-intensity for 40 sec, with the light curing tip positioned directly onto the celluloid strip at zero distance.

Group 1–4 (contaminated groups): 20 specimens of each group were prepared by injecting half the specimen height (3mm) in the lower half of the mold followed by adequate packing. The top surface of the lower half resin composite was contaminated with hemostatic agent (Group 1), alcohol (Group 2), artificial saliva (Group 3) and powdered gloves (Group 4). Groups 1–3; one drop of each contaminant agent was applied on the resin composite surface for 10 sec using a clean microbrush in a circular motion. Group 4; powdered gloves were cut into 20 pieces of 1 × 1 cm each [10]. Each piece was applied on the resin composite surface in a circular rubbing motion for 10 sec. Then, the upper half of resin composite (3mm) was injected in the mold. No light curing was performed between the 2 coats. The top of the resin composite was covered with a celluloid strip, and the excess material was removed by pressing the glass slab against the strip. Finally, the resin composite (of 6mm height) was photo-cured for 40 sec with the light tip positioned directly onto the celluloid strip at zero distance. After removing the specimens from the molds, their dimensions were confirmed using a digital caliper (Mitutoyo MTI Corporation, Tokyo, Japan). The samples were incubated at 37°C and 95% relative humidity for one day and 30 days.

2.2.3. Testing The Surface Microhardness:

The microhardness of each group was tested one-day post-photocuring (n = 5) and one-month post-photocuring (n = 5). The specimens were tested using Digital Display Vickers Microhardness Tester (Model HVS-50, Laizhou Huayin Testing Instrument Co., Ltd. China) with a Vickers diamond indenter and a 20X objective lens. A load of 100g was applied on the surface of each specimen for 20 sec. Three indentations were made on the surface of each specimen. The indentations were equally placed over a circle, not closer than 0.5 mm to the adjacent indentations. The diagonals length of the indentations was measured by built in scaled microscope and Vickers values were converted into microhardness values. Microhardness was calculated using the following equation: $HV = 1.854\ P/d^2$ where, HV is Vickers hardness in Kgf/mm^2, P is the load in Kgf and d is the length of the diagonals in mm.

2.2.4. Testing the Compressive Strength:

The compressive strength of each group was tested one-day post-photocuring (n = 5) and one-month post-photocuring (n = 5) using Bluehill® Lite, Instron Instruments. All samples were individually & vertically mounted on a computer-controlled materials testing machine (Model 3345; Instron Instruments Ltd., USA) with a loadcell of 5 kN and data were recorded using computer software (Bluehill Lite; Instron Instruments). Then the samples were statically loaded (in compression manner) using stainless-steel rod ended with flat plate (40mm x 60mm) attached to the upper movable compartment of the machine at a crosshead speed of 0.5 mm/min until failure. The maximum failure load was recorded in N and converted into MPa. The compressive strength was calculated from the recorded peak load divided by sample surface according to the following equation: Compressive strength (CS) = $4P/\pi d^2$, where P is the load (N) at the fracture point and d is the diameter (mm) of the cylindrical specimen.

2.2.5 Statistical Analysis:

Values were presented as mean, standard deviation (SD) values and confidence intervals. Data were explored for normality using Kolmogorov-Smirnov test of normality. The results of Kolmogorov-Smirnov test indicated that data were normally distributed (parametric data), therefore one-way analysis of variance (ANOVA) test, followed by Tukey's post hoc test was used for comparison between groups. Paired t test was used to compare values obtained at one day and one month within the same group. The significance level was set at $p \leq 0.05$. Statistical analysis was performed with SPSS 18.0 (Statistical Package for Scientific Studies, SPSS, Inc., Chicago, IL, USA) for Windows.

3. Results

3.1. Surface Microhardness Test Results:

3.1.a- Comparison between groups

At one-day post-photocuring, the highest surface microhardness mean value was recorded in control (non-contaminated) group (76.73 ± 4.06 Kgf/mm^2), followed by artificial saliva group (75 ± 2.09 Kgf/mm^2), powdered gloves group (74.58 ± 1.7 Kgf/mm^2), followed by hemostatic agent group (73.9 ± 2.16 Kgf/mm^2), with the least value recorded in alcohol group (72.23 ± 4.77 Kgf/mm^2). ANOVA test revealed that the difference between groups was not statistically significant (p = 0.299) [Table 2, Fig. 1]. At one-month post-photocuring, the highest mean value of surface microhardness was recorded in control group (76.1 ± 1.18 Kgf/mm^2), followed by alcohol group (75.81 ± 1.69 Kgf/mm^2), then artificial saliva group (75.78 ± 1.53 Kgf/mm^2), followed by powdered gloves group (75.44 ± 2.19 Kgf/mm^2), with the least value recorded in hemostatic agent group (74.92 ± 2.73 Kgf/mm^2). ANOVA test revealed that the difference between groups was not statistically significant (p = 0.880) [Table 2, Fig. 1].

3.1.b. Comparison within the same group (Effect of time)

Comparison within the same group revealed no significant difference between one-day and one-month post-photocuring within each group as the difference didn't reach the significance level in control group (p = 0.782), powdered gloves group (p = 0.608), alcohol group (p = 0.07), hemostatic agent group (p = 0.532) and artificial saliva group (p = 0.557) [Table 3].

3.2. Compressive Strength Results

3.2.a. Comparison between groups

At one-day post-photocuring, the highest compressive strength mean value was recorded in control group (110.42 ± 15.10), followed by alcohol group (104.22 ± 14.62), then hemostatic agent group (91.59 ± 26.09), followed by artificial saliva (72.45 ± 11.33) with the least value recorded in powdered gloves group (56.71 ± 16.66). ANOVA test revealed that the difference between groups was statistically significant (p = 0.000). Tukey's post hoc test revealed no significant difference between control and alcohol groups. Alcohol, hemostatic agent and artificial saliva groups were not significantly different. Moreover, powdered gloves group was not significantly different from artificial saliva group [Table 4, Fig. 2]. At one-month post-photocuring, the highest compressive strength mean value was recorded in control group (172.87 ± 31.92), followed by alcohol group (122.66 ± 27.7), then hemostatic agent group (94.55 ± 24.34), followed by artificial saliva group (77.71 ± 42.77) with the least value recorded in powdered gloves group (49.58 ± 31). ANOVA test revealed that the difference between groups was statistically significant (p = 0.000). Tukey's post hoc test revealed no significant difference between control and alcohol groups. Alcohol, hemostatic agent and artificial saliva groups were not significantly different. Moreover, hemostatic agent and powdered gloves groups were not significantly different from artificial saliva group [Table 4, Fig. 2].

3.2.b. Comparison within the same group (Effect of time)

In control group, a significantly higher mean value of compressive strength was recorded at one-month post-photocuring in comparison to one-day post-photocuring value (p = 0.029). In experimental groups, comparison within the same group revealed no significant difference between one-day and one-month post-photocuring within each group as the difference did not reach the significance level in powdered gloves group (p = 0.742), alcohol group (p = 0.215), hemostatic agent group (p = 0.852) and artificial saliva group (p = 0.820) [Table 5].

4. Discussion

The current in vitro study was conducted to assess the microhardness and compressive strength of bulk-fill flowable nano-hybrid resin composite contaminated during packing with hemostatic agent, alcohol, artificial saliva and powdered gloves. One hundred disc-shaped resin composite specimens were prepared using split mold. The contamination of resin

composite was performed after packing the first increment (3 mm). After packing the second increment (3mm), the resin composite specimens were photocured for 40 sec. The contaminated specimens were allocated into four groups (n = 20) according to the contaminant used either hemostatic agent (Group 1), alcohol (Group 2), artificial saliva (Group 3) and powdered gloves (Group 4). The specimens of control group (n = 20) were not contaminated during packing. Each group (n = 20) was assessed to test the microhardness (n = 10) and the compressive strength (n = 10). The microhardness and compressive strength were tested one-day post-photocuring (n = 5) and one-month post-photocuring (n = 5).

Bulk filling of cavity would be advantageous if compared with incremental layering of resin composite in reducing treatment time for cavity restoration, polymerization stress, contraction stress and improving esthetic quality [17]. Flowable composite can be used as a stress-breaker intermediate layer between restoration and substrate to relieve the stress associated with polymerization shrinkage [18]. Our study used bulk-fill flowable resin composite as it become common to be used by the clinicians especially in class II subgingival caries, root caries, deep cavities. These areas are difficult to be properly isolated and are accidentally liable to contamination. The mechanical properties of resin composites are significantly influenced by the filler particle shape, size range, and volume content [19]. The introduction of nanometer sized particles is thought to offer superior esthetics and polishability in addition to excellent wear resistance and strength [19]. Nanohybrid resin composites include a mixture of nanosized and conventional filler particles [19].

The current study used artificial saliva among the used contaminants; because salivary contamination to resin composite during packing is common in some clinics where rubber dam is not used; or when leakage occurs due to improper use of rubber dam. The study also used alcohol among contaminants because many dentists may digitally manipulate the resin composite with their fingers that could be contaminated with alcohol. Aluminium chloride ($AlCl_3$) is one of the hemostatic agents used at a concentration between 0–25% to promote hemostasis before placement of a restoration by protein precipitation and constriction of blood vessels.[20] Aluminium chloride (25%) was used in the current study because of its minimum tissue irritation, ease of use and effective results [20]. Many clinicians manipulate the resin composite material during packing with gloves containing powder, causing its contamination. Therefore, powdered gloves were used in this study as contaminant during packing resin composite.

Microhardness is one of the most useful properties to assess because it is closely correlated with resistance to abrasion when used for restoration in load bearing areas [1]. Compressive strength is a vital test for the selection of core material since most of the masticatory forces are of compressive nature [16].

It was observed that the tested contaminants did not affect the resin composite surface microhardness at one-day and one-month post-photocuring. However, the compressive strength of resin composite was significantly decreased after being contaminated with the tested contaminants at one-day and one-month post-photocuring. This might be due to the application of the contaminants between the two increments, not on the surface of the specimen. Vickers hardness test could only assess the surface microhardness of resin composite specimen [21]. Moreover, Celluloid strip and glass slab were used in specimen preparation, so oxygen inhibited layer was not formed on the resin composite specimen surface [21]. Absence of oxygen inhibited layer on the specimen surface might be the cause of proper resin polymerization with subsequent increased surface microhardness.

Our results were inconsistent with Widiandini *et al.* who demonstrated that the salivary contamination did not affect the compressive strength of nanohybrid composite [2]. This inconsistence of results could be due to the application of the contaminant in that study onto the surface of the specimen, while the contaminants in the current study were applied in-between increments. However, Cobanoglu *et al.* stated that when saliva encounters the dentin surface, a saliva layer is deposited on dentin surface; water is evaporated and leaves a glycoprotein layer [23]. Likewise, Shimazu *et al.* found that the bond strength among composite resin layers is reduced when it is contaminated with saliva [24]. Similarly, significant

decrease of the compressive strength of resin composite contaminated with artificial saliva could be due to presence of organic adherent layer and other elements of saliva in between increments interfering with proper polymerization.

The US Food and Drug Administration (FDA) defined ethanol as a liquid that simulates fatty foods and alcoholic beverages. In several studies, ethanol led to degradation or “softening” of composites and reduction of its microhardness [25]. It was previously revealed that ethanol has a more aggressive potential and causes higher water sorption and solubility than water or artificial saliva [26]. Ethanol contamination was found in a previous study to inhibit the resin composite polymerization causing significant decrease of surface microhardness. However, the resin composite surface microhardness was only affected which can be removed by routine polishing resulting in hardness that was similar to the uncontaminated resin composite [27]. The conflict of results between previous studies and our current study could be due to the use of nanohybrid resin composite with high mechanical properties. Nanofillers can accomplish more close contact with the matrix resin than microfillers, therefore nanofilled composites can achieve high hardness as well as good polishability [16, 19].

It was previously postulated that manual manipulation of resin composite with powdered latex gloves should be avoided [28]. Martins *et al*. found that the flexural strength of resin composite manipulated with powdered gloves was reduced [11]. It was previously revealed that sulfides released from latex gloves inhibited the polymerization of the silicone in impression materials based on polyvinyl siloxanes, when it reacts with chloroplatinic acid from silicones [28]. The results of the current study confirmed previous studies. Our findings could be the result of the physical barrier action of powder particles deposited on the resin composite interfering with complete polymerization and subsequently affecting the mechanical properties namely the compressive strength of resin composite.

It was previously demonstrated that the acidic pH of Al Cl_3 used as hemostatic agent resulted in smear layer removal, and dentin etching effects [13, 14]. Similarly, the chloride ions could penetrate the uncured resin matrix or in-between the fillers and might slightly etch the resin matrix or the fillers reducing the compressive strength of the resin composite specimen.

At one-month post-photocuring, the control group recorded a significantly higher compressive strength mean value when compared to one-day post-photocuring value. Our findings confirmed the results of Gornig et al. [29]. However, the contaminated groups showed no significant difference between compressive strength mean value at one-day and one-month post-photocuring. The stability of compressive strength of contaminated resin composite at one-month post-photocuring indicates the negative effect of hemostatic agent, alcohol, artificial saliva and powdered gloves on the compressive strength.

Conclusion

Contamination of bulk-fill flowable nanohybrid resin composite during packing with either hemostatic agent, alcohol, artificial saliva, or powdered gloves decreased the compressive strength at one-day and one-month post-photocuring. Whereas contamination of resin composite did not significantly affect its surface microhardness.

Declarations

Future Scope:

Further studies are recommended to evaluate the effect of contamination of bulk-fill resin composite on its color stability, physical and mechanical properties.

Competing Interests:

The author declares that he has no competing interests.

Funding:

No funding was obtained for this study.

Ethical Approval: Not applicable.

No biological materials from human or animal subjects were used in this in vitro study.

Informed Consent: Not applicable.

Availability of data and materials:

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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Tables

Table (1): Materials used in the study.

	Manufacturer	Composition
Bulk-fill Flowable resin composite	Nexcomp Flow, Meta Biomed, Korea.	Nanohybrid flowable composite 40 nanosized filler: Barium Aluminum borosilicate, Bis-GMA, UDMA, Bis-EMA, TMPTMA.(75 weight % , 37 volume %)
Hemostatic agent	Hemo Stop solution, JK Dental Vision Company, Egypt.	25% Aluminium Chloride solution
Artificial saliva		Prepared by mixing of 0.4 g sodium chloride (NaCl), 1.21 g potassium chloride (KCl), 0.78 g sodium dihydrogen dehydrate ($NaH_2PO_4.2H_2O$), 0.005 g hydrated sodium sulfide ($Na_2S.9H_2O$), and 1 g urea $CO(NH_2)_2$ in 1000 ml deionized water. The pH of this mixture was modified with 10N sodium hydroxide until it reached 6.7 on a pH meter.[15]
Alcohol	Safwa Company, Egypt	70% Ethyl alcohol
Powdered gloves	SRI Trang Argo-Industry Public Company.,LTD, Thailand.	Powdered Latex examination gloves.

Table (2): Descriptive statistics and comparison of surface microhardness (HV) between groups at one-day and at one-month post-photocuring (ANOVA test).

Microhardness		Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max	F	P
					Lower Bound	Upper Bound				
One-Day Post-Photocuring	Control	76.73	4.06	1.82	71.69	81.78	73.04	83.60	1.314	.299 ns
	Powdered gloves	74.58	1.70	.76	72.47	76.69	72.74	77.29		
	Alcohol	72.23	4.77	2.13	66.31	78.15	66.53	77.10		
	Hemostatic agent	73.90	2.16	.97	71.22	76.58	71.10	76.63		
	Artificial saliva	75.00	2.09	.94	72.40	77.60	72.92	77.26		
One-Month Post-photocuring	Control	76.16	1.18	.53	74.69	77.62	74.30	77.40	.292	.880 ns
	Powdered gloves	75.44	2.19	.98	72.73	78.15	72.82	78.87		
	Alcohol	75.81	1.69	.76	73.71	77.91	73.93	78.20		
	Hemostatic agent	74.92	2.73	1.22	71.53	78.30	71.79	78.43		
	Artificial saliva	75.78	1.53	.68	73.88	77.67	74.03	77.46		

Significance level $p \leq 0.05$, ns=non-significant.

Table (3): Comparison of microhardness (HV) within the same group at one-day and at 1-month post-photocuring (paired t test test).

Groups	Time	mean	Sd	Paired Differences					t	P
				Mean	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference			
							Lower	Upper		
Control	**1 D**	76.73	4.06	.58	4.35	1.95	-4.83	5.98	.296	.782 ns
	1M	76.16	1.18							
Powdered gloves	**1 D**	74.58	1.70	-.86	3.48	1.56	-5.19	3.46	-.555	.608 ns
	1M	75.44	2.19							
Alcohol	**1 D**	72.23	4.77	-3.59	3.27	1.46	-7.65	.48	-2.449	.070 ns
	1M	75.81	1.69							
Hemostatic agent	**1 D**	73.90	2.16	-1.02	3.33	1.49	-5.16	3.12	-.683	.532 ns
	1M	74.92	2.73							
Artificial saliva	**1 D**	75.00	2.09	-.78	2.73	1.22	-4.16	2.60	-.640	.557 ns
	1M	75.78	1.53							

Significance level $p \leq 0.05$, ns=non-significant. 1 D = one-day post-photocuring, 1 M = one-month post-photocuring.

Table (4): Descriptive statistics and comparison of compressive strength (MPa) between groups at one-day and at one-month post-photocuring (ANOVA test).

Compressive strength		Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean		Min	Max	F	P
					Lower Bound	Upper Bound				
One-Day Post-photocuring	Control	110.42[a]	15.10	6.75	91.68	129.17	94.54	126.83	8.163	.000*
	Powdered gloves	56.71[c]	16.66	7.45	36.02	77.39	31.27	74.14		
	Alcohol	104.22 [a,b]	14.62	6.54	86.07	122.37	84.11	122.53		
	Hemostatic agent	91.59[b]	26.09	11.67	59.20	123.98	65.76	130.02		
	Artificial saliva	72.45 [b,c]	11.33	5.07	58.39	86.52	59.34	84.71		
One-Month Post-photocuring	Control	172.87[a]	31.92	14.27	133.24	212.50	133.60	214.57	10.679	.000*
	Powdered gloves	49.58[c]	31.00	13.86	11.09	88.07	.00	80.57		
	Alcohol	122.66 [a,b]	27.70	12.39	88.26	157.06	89.01	156.37		
	Hemostatic agent	94.55 [b,c]	24.34	10.88	64.34	124.77	69.35	131.05		
	Artificial saliva	77.71 [b,c]	42.77	19.13	24.60	130.82	7.26	121.58		

Significance level $p \leq 0.05$, * significant

Table (5) Comparison of compressive strength (MPa) within the same group at one-day and at one-month post-photocuring (paired t test test).

Groups	Time	mean	Sd	Paired Differences					t	P
				Mean	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference			
							Lower	Upper		
Control	1 D	110.42	15.10	-62.44	41.95	18.76	-114.53	-10.36	-3.328	.029*
	1M	172.87	31.92							
Powdered gloves	1 D	56.71	16.66	7.13	45.26	20.24	-49.07	63.33	.352	.742 ns
	1M	49.58	31.00							
Alcohol	1 D	104.22	14.62	-18.44	28.02	12.53	-53.22	16.35	-1.471	.215 ns
	1M	122.66	27.70							
Hemostatic agent	1 D	91.59	26.09	-2.96	33.25	14.87	-44.25	38.32	-.199	.852 ns
	1M	94.55	24.34							
Artificial saliva	1 D	72.45	11.33	-5.26	48.33	21.62	-65.27	54.76	-.243	.820 ns
	1M	77.71	42.77							

Significance level p≤0.05, * significant, ns=non-significant. 1D = one-day post-photocuring, 1M =one-month post-photocuring.

Tukey's post hoc test: Within the same comparison (observation time), means sharing the same superscript letter are not significantly different.

Figures

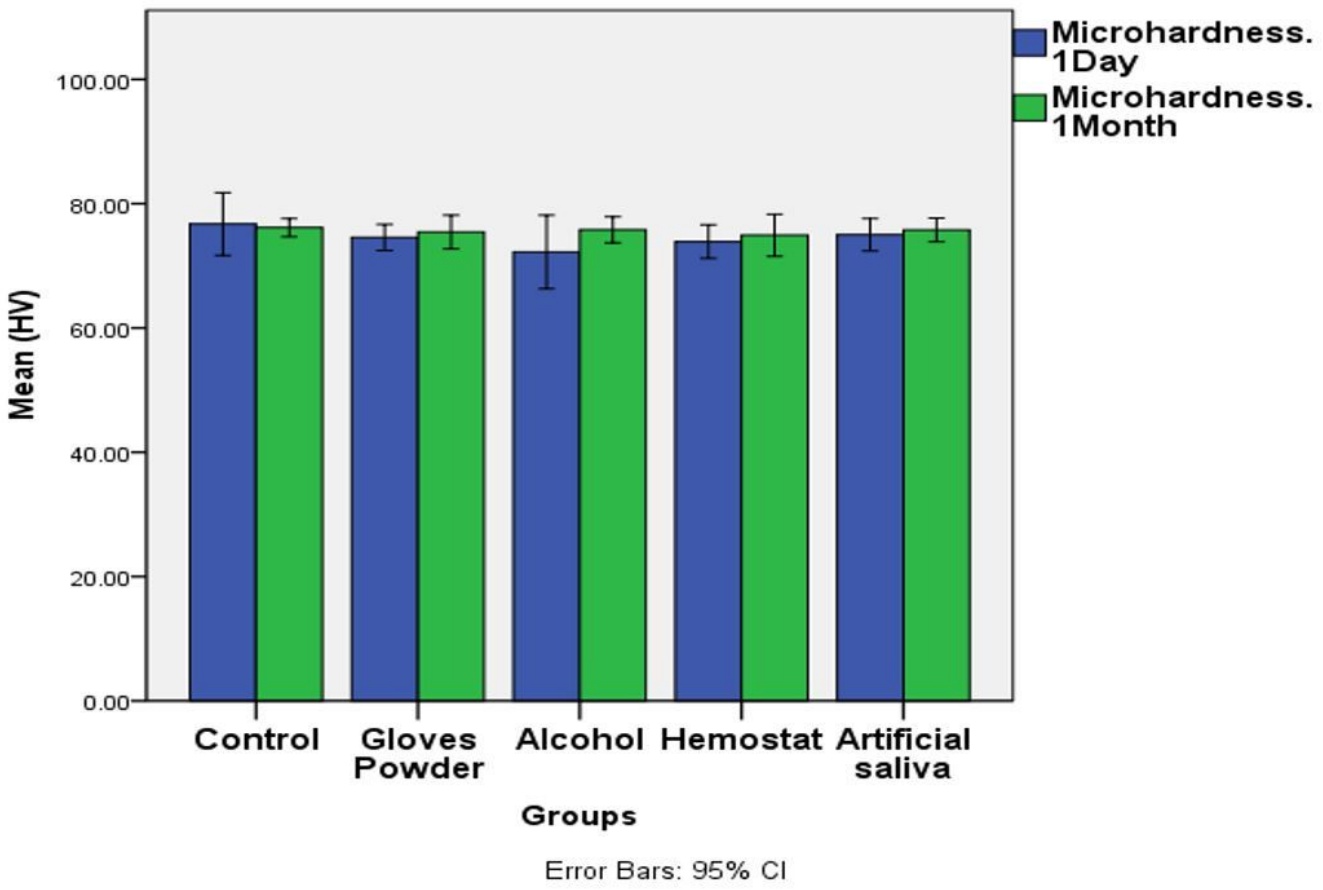

Figure 1

Bart chart illustrating mean value of microhardness (HV) in different groups at one-day and one-month post-photocuring

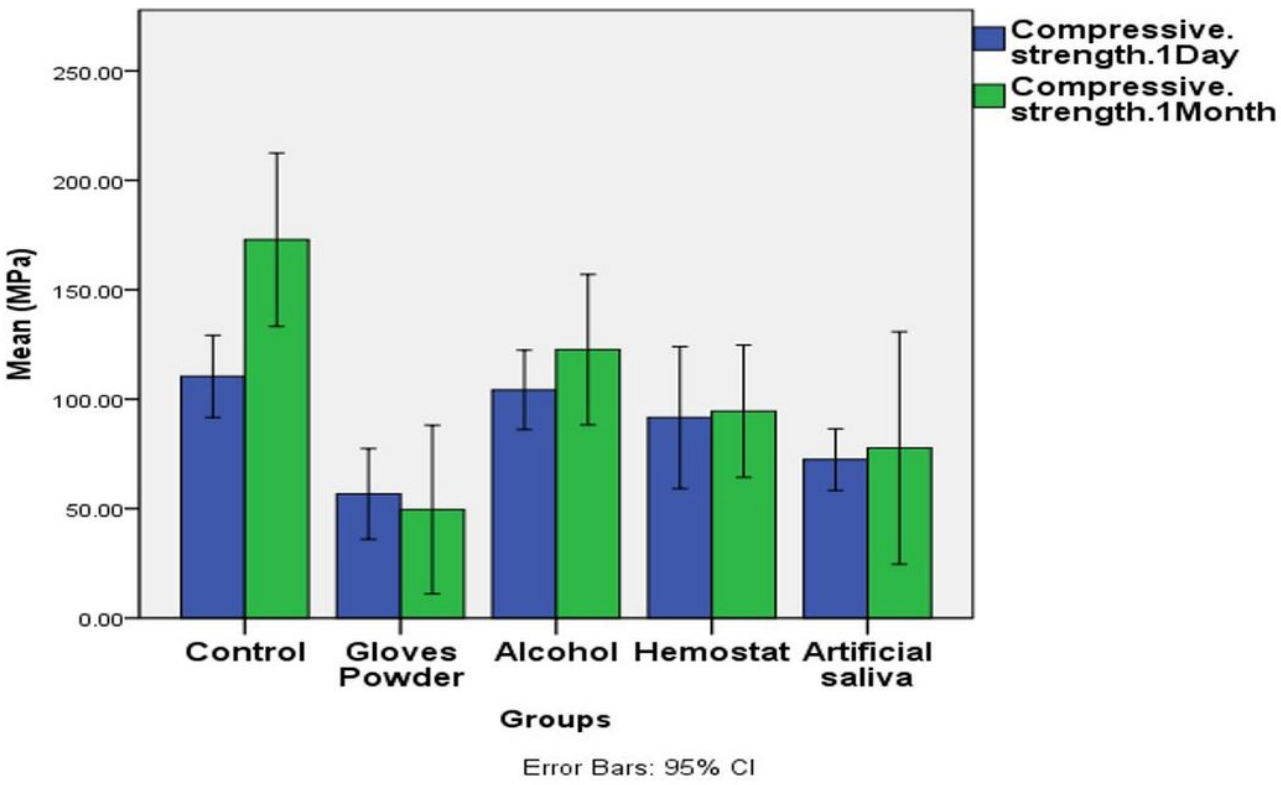

Figure 2

Bar chart illustrating mean value of compressive strength (MPa) in different groups at one-day and one-month post-photocuring