ODOVTOS
International Journal of Dental Sciences
https://revistas.ucr.ac.cr/index.php/Odontos | ISSN: 2215-3411

BASIC RESEARCH

DOI: 10.15517/IJDS.2021.44391

Received:
23-VIII-2020

Accepted:
12-X-2020

Published Online:
28-X-2020

Effect of Surface Wetting Resin on the Color Stability and Microhardness of Esthetic Composites

Efecto de la resina humectante de superficies sobre la estabilidad del color y la microdureza de resinas compuestas estéticas

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ABSTRACT: Objective: The aim of this study was to evaluate and compare the effects of the superficial application of two different modeling resins on the surface microhardness and discoloration of composite resins. Material and Methods: The present study used two different composites and modeling resins. The composites were placed in plastic molds. Subsequently, the modeling resins were applied on the surface of the two composite groups. The microhardness and color pertaining to all the groups were evaluated. The current study used the One-Way ANOVA and Kruskal Wallis tests, in order to perform the statistical evaluation ($p<0.05$). Results: The present study compared the microhardness pertaining to the groups and the highest microhardness values were observed in the Estelite Asteria group (none), whereas the lowest values were observed in the GC Essentia group (Ultradent). Moreover, the current study evaluated the color stability and the greatest discoloration was observed in the control group of the GC Essentia group, whereas the least discoloration was observed in the Estelite Asteria group that included the samples prepared using Ultradent Wetting Resin. Conclusions: The results of the present study demonstrated that the use of modeling resins, which facilitate the placement of composite resins, reduced the microhardness and discoloration of composite resins. The aforementioned effect can be attributed to the variations in the structure of the filling. However, further studies are warranted to support and verify the results of the current study.

CANGUL S., ERPACAL B., ADIGUZEL O., UNAL M., GUNAY A., 2021: Effect of Surface Wetting Resin on the Color Stability and Microhardness of Esthetic Composites.-ODOVTOS-Int. J. Dental Sc., 23-2 (May-August): 82-89.

KEYWORDS: Composite wetting resin; Color stability; Microhardness; Composite resins.

RESUMEN: Objetivo: El objetivo del presente estudio fue evaluar y comparar los efectos de la aplicación superficial de dos resinas humectantes sobre la microdureza superficial y la decoloración de las resinas compuestas. Material y métodos: El presente estudio utilizó dos resinas humectantes y resinas de modelado diferentes. Las resinas compuestas se colocaron en moldes de plástico. Posteriormente, se aplicaron las resinas humectantes sobre la superficie de los dos grupos. Se evaluó la microdureza y el color de todos los grupos. El presente estudio utilizó las pruebas One-Way ANOVA y Kruskal Wallis, para realizar la evaluación estadística ($p<0.05$). Resultados: Los valores más altos de microdureza se observaron en el grupo Estelite Asteria, mientras que los menores valores se observaron en el grupo GC Essentia (Ultradent). La mayor decoloración se observó en el grupo control o el grupo GC Essentia, mientras que la menor decoloración se observó en el grupo Estelite Asteria con Ultradent Wetting Resin. Conclusiones: Los resultados del presente estudio demostraron que el uso de resinas humectantes, que facilitan la colocación de resinas compuestas, redujo la microdureza y decoloración de las resinas compuestas. El efecto mencionado anteriormente se puede atribuir a las variaciones en la estructura del relleno. Sin embargo, se necesitan más estudios para respaldar y verificar los resultados del presente estudio.

PALABRAS CLAVE: Resina humectante; Estabilidad de color; Microdureza; Resinas compuestas.

INTRODUCTION

Composite resins are frequently used for indirect restorations, on account of the good physical and mechanical properties as well as the esthetic properties (1). However, the need for adhesive systems and the application technique that warrants the placement of the material in layers renders the application procedures challenging. The layering technique of placement of composite resins has two objectives. First, the composite resins display clinically acceptable polymerization depths of up to 2mm in thickness (2). Second, in order to achieve perfect and esthetic results, a combination of composites in different color tones should be used (3). However, in view of the fact that composites comprise viscous monomers and the material adheres to the dental instruments, the placement and shaping of the restorative material during the layering procedure might be challenging (4). Recently, manufacturers have started using modeling resins, in order to facilitate the transport, adaptation, and shaping procedures pertaining to composites. Furthermore, practitioners coat the manual dental instruments with the aforementioned resins or dentin bonding agents, in order to facilitate the use of composites (5,6).

The restorative dental modeling insertion technique (RDMIT), which is recommended for esthetic restorations, has attracted increasing interest from dental practitioners. In RDMIT, low-viscosity, resin-based solutions are used to facilitate the easier manipulation of composite resins, especially in large restorations that require a combination of composite components. Consequently, low-viscosity modeling resins have been developed. Increasing concerns regarding the effects of RDMIT on the mechanical and physical properties of composite restorations have resulted in research involving the attempts to evaluate the materials and restorations pertaining to RDMIT.

Modeling resins can be directly applied between the layers using a brush or can be used as a lubricant on manual instruments. In both the aforementioned techniques, the ease of instrumentation during the placement of esthetic restorations is superior, compared to the traditional restorative techniques. Moreover, any pores or gaps on the surface of the composite placed by means of the layering technique can be easily resolved. Hence, the modeling resin facilitates the reduction of defects in the body of the restoration and aids in improving the mechanical properties and color stability (6,7).

Previous literature has reported that the use of hydrophobic resins as the modeling liquid for composite resins has been observed to be more suitable (7). In addition, the fact that adhesive resins that are used as the modeling liquid comprise hydrophilic monomers and the negative effect of solvents on the color stability of the composite has resulted in the search for a new, alternative method (8). Previous studies have supported the use of solvent-free adhesives containing higher proportions of hydrophilic resin, which can be selected as the modeling liquid (9).

The effect of wetting resins on the physical and mechanical properties of composites is not fully known. Clinical success requires acceptable surface smoothness, color stability, and microhardness levels pertaining to the dental composite materials. It can also be defined by means of the difference in the chemical components, such as the color stability, polymeric structures, and photo-initiator systems pertaining to the composite resins (5).

The aim of this study was to evaluate the effects of using modeling resins on the surface microhardness and discoloration pertaining to different composites.

MATERIAL AND METHOD

The current study used two different composites (Estelite Asteria A2, Tokuyama, Japan; Essentia LE, GC, Belgium) and two different modeling resins (Modeling Liquid, GC, Belgium, Composite Wetting Resin, Ultradent Products, USA). Plastic molds, 5 mm in diameter and 2 mm in thickness, were used to obtain the composite discs.

Modeling resin was used during the placement of the composite in the samples pertaining to the Groups 1a, 1b, 2a, and 2b. Prior to the procedure of polymerization, the modeling resins were applied on the surface of the composite and the surface was smoothened. Both sides of the samples were covered with glass to obtain a uniform surface. Subsequently, the samples were polymerized using an LED light source (Guilin Woodpecker, China, 1100 mW/cm^2) under pressure. The samples in the control groups, namely, 1c and 2c, were prepared by placing the composite in plastic molds without the use of modeling resins. The polymerization of the control groups was concurrent with the technique used in the other groups. All the samples underwent finishing and polishing procedures using Sof-lex (3M ESPE, St. Paul, MN, USA) polishing discs. Subsequently, all the samples were placed in distilled water at room temperature for 24 hours.

In order to evaluate the surface microhardness and color stability, the present study formed six groups with ten composite samples in each group; a control group that involved the placement of composites without the application of modeling resin, a group that involved the application of Modeling Liquid, and a group that involved the application of Composite Wetting Resin (Table 1).

Table 1. The sample groups.

	Composite resin		Modeling resin
Group 1 (n=30)	GC Essentia	Group 1a (n=10)	GC Modeling Liquid
		Group 1b (n=10)	Ultradent Composite Wetting Resin
		Group 1c (n=10)	None
Group 2 (n=30)	Estelite Asteria	Group 2a (n=10)	GC Modeling Liquid
		Group 2b (n=10)	Ultradent Composite Wetting Resin
		Group 2c (n=10)	None

The current study used a digital test device (Shimadzu HMV-M3, Kyoto, Japan) to evaluate the microhardness pertaining to all the groups. The Vickers tip of the device was applied to each composite sample with a load of 100 g for 15 seconds. Measurements were obtained from five distinct points on the upper and lower surfaces of the samples. Subsequently, the mean Vickers microhardness value was calculated.

The present study obtained the measurements of the color pertaining to all the samples using the Vita Easy Shade Advance 4.0 device (VITA Zahnfabrik, Bad Säckingen Germany). Measurements were obtained using a white background under the D65 standard lighting conditions. The device was calibrated before each measurement. Measurements were repeated three times in each sample and the mean CIE L * a * b * values were recorded. Then samples were left in coffee (Nescafe Gold) for 1 week. The samples taken from coffee were brushed with toothbrush and toothpaste and the coffee sediments on the composite surfaces were cleaned. Subsequently, the second color measurement was taken and the delta E values were calculated. The following formula was used for the calculation of delta E (Judd and Wyszecki, 1975; International Commission on Illumination, 1986):

$$\Delta E^* = [(L1^* - L0^*)2 + (a1^* - a0^*)2 + (b1^* - b0^*)2]\ ½$$

The CIE L * a * b * values pertaining to the samples after being left in the beverage are represented by the L1, a1, and b1 values, respectively. The CIE L * a * b * values measured during the initial stage are represented by the L0, a0, and b0 values, respectively.

The current study used the one-way ANOVA, post-hoc Tukey, Kruskal Wallis, and Mann Whitney U tests for the statistical evaluation of the groups ($p<0.05$).

RESULTS

The present study performed a comparison of the groups with regard to the microhardness and observed that the highest microhardness values (51,94) were displayed by the Estelite Asteria composite group, followed by the GC Essentia group (35,87). Both the aforementioned groups were prepared without the application of the modeling resin. The lowest microhardness values were observed in the GC Essentia composite group prepared using the GC Modeling Liquid (22,09), followed by the GC Essentia group prepared through the application of the Ultradent Composite Wetting Resin (26,28). The present study observed that the use of modeling resins reduced the microhardness of composites.

The statistical median values of the groups, according to the Kruskal Wallis and Mann Whitney U tests, are shown in Table 2 and Figure 1.

Table 2. The statistical median values of the microhardness of the groups.

Groups	Median ΔE Ig R	Kruskal Wallis	Mann Whitney U p
1a	22,09±19,63		1a-2c (P=0.000)
2a	28,20±16,39		2a-2c (P=0.000)
1b	26,28±4,23		1b-2b (P=0.016) 1b-1c (P=0.001) 1b-2c (P=0.000)
		0.000	
2b	32,83±8,20		2b-2c (P=0.000)
1c	35,87±7,80		1c-2c (P=0.000)
2c	51,94±7,85		2c-1a (P=0.000) 2c-2a (P=0.000) 2c-1b (P=0.000) 2c-2b (P=0.000) 2c-1c (P=0.000)

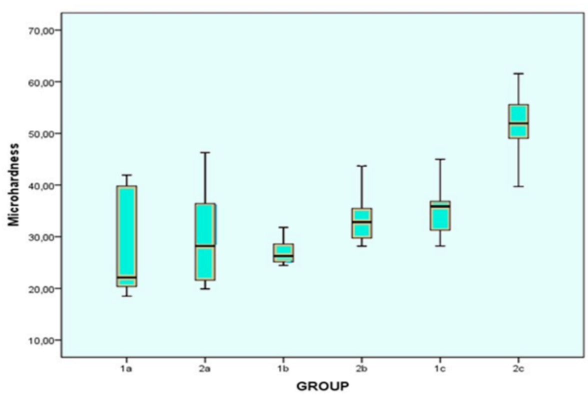

Figure 1. Graphic representation of the statistical median values of microhardness of the groups.

Regarding the evaluation of the color measurements after the samples were left in coffee for a week, the greatest discoloration was observed in the GC Essentia composite resin in the control group and the least discoloration was observed in the Estelite Asteria samples prepared using Ultradent Composite Wetting Resin. Regardless of the type of modeling resin applied, the discoloration pertaining to the GC Essentia composite groups were observed to be greater, compared to the Estelite Asteria resin groups. Furthermore, the current study compared the modeling resins in the same composite and observed that the GC Modeling Liquid displayed more discoloration, compared to the Ultradent Composite Wetting Resin (Table 3, Figure 2). The present study observed that the application of modeling resins reduced the discoloration of composites.

The statistical mean values of the groups, according to the one-way ANOVA and post-hoc Tukey tests, are shown in Table 3 and Figure 2.

Table 3. The mean values pertaining to the discoloration of the samples left in coffee for one week.

Groups	Mean ΔE (SD)	ANOVA P	Post-hoc Tukey P
1a	4,98±1,51		1a-2b (P=0.016)
2a	2,87±1,44		NS
1b	4,41±1,72	0.000	NS
2b	2,21±1,82		2b-1a(P=0.016), 2b-1c (P=0.012)
1c	5,06±2,09		1c-2b (P=0.012)
2c	3,57±2,23		NS

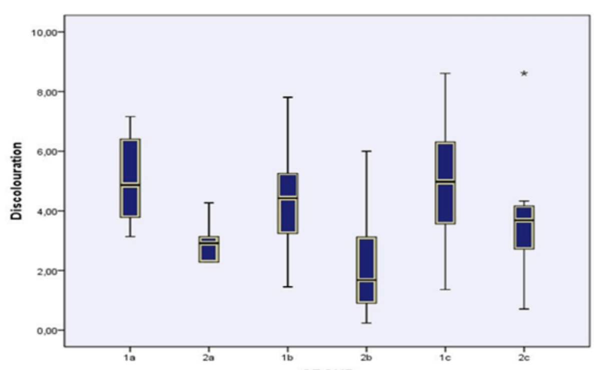

Figure 2. Graphic representation of the mean discoloration values of the groups.

DISCUSSION

Clinicians use various instruments and modeling resins during the placement of composite resins, on account of the fact that the viscosity of different composite resins differ. The use of modeling resin facilitates the placement of composite resin restorations, adaptation to the tooth is made easier, and it allows the modeling of the composite resin (1). Tuncer *et al*. (5) reported that the use of these liquids in composite restorations applied with modeling resins had a partially negative effect on properties such as the color, smoothness, and microhardness. The current study evaluated the microhardness and discoloration in composite restorations prepared using modeling resin and the control groups (without modeling resins).

Hardness, which is accepted as a significant parameter pertaining to the evaluation of the amount of deformation of a material, is associated with the degree of transformation under different conditions of polymerization (10,11). Properties such as the type of composite resin, the filling type, size, and the composition affect the microhardness values. A previous study showed that the microhardness values pertaining to the composites with a high filler content were higher, compared to the other composites (5). Yeh *et al*. (12) reported that the microhardness of the Grandio composite resin, which comprises a greater amount of filler, was higher, compared to the other resins. This was attributed to the greater quantity of non-polymerized particles in these composite resins. The monomer structure and the degree of polymerization in particular have a significant effect on the microhardness.

Monomers that do not participate in the reaction after polymerization have a direct negative effect on the microhardness (13). Lombardini *et al*. (14) studied the microhardness of different composite resins and concluded that the microhardness varied in accordance with the size and density of the filler particles. Concurrently, the current study observed that the various components in modeling resins had a negative effect on the microhardness and the microhardness values were higher in the groups that were prepared without the application of liquids (Estelite Asteria composite).

The color pigments in food contents stain the surface of the composite restoration and penetrate the material, which results in discoloration (15,16). Discoloration of restorations constitutes a major problem, owing to the increased esthetic demands of the patients. The concept of color is important in providing esthetics in dental restorations. Color discoloration, which is one of the reasons for renewing composite restorations, is one of the most important disadvantages. The discoloration in composite resins varies, depending on several factors, such as the size of filler particles, the depth of polymerization, and coloring agents (17). In addition to the components of the material, other factors that affect the discoloration of composite resins include finishing and polishing procedures, diet, and oral hygiene (18).

Ertaş *et al*. (19) studied the discoloration of composite resins and reported that the microhybrid composites displayed a greater change in color, compared to the nanohybrid composites. Bagheri *et al*. (20) reported that lesser discoloration was observed in the resins containing UDMA, compared to the resins containing TEGDMA. The increased discoloration was attributed to the separation of inorganic fillers from the resin matrix, which creates a gap on the surface and the associated roughness (21).

Sedrez-Porto *et al*. (22) investigated the effects of modeling resins on the discoloration of composites and reported that the modeling resins positively affected the color change. The aforementioned observation was attributed to the capacity of modeling resins to form chains between the fixed molecules and the monomeric units of resin composites. Consequently, the discoloring agents were prevented from penetrating the inner surfaces. Similarly, Araujo *et al*. (9) evaluated the effect of modeling resins on the color change and opacity of composites and concluded that the modeling resin did not affect the color. In the current study, the use of modeling resin was observed to have a positive effect on the color change.

CONCLUSION

In conclusion, the results of the present study demonstrated that the use of modeling resins facilitate the placement of composite resins and reduce the microhardness and discoloration. The aforementioned effect can be attributed to the difference in the filler structure. Nevertheless, further studies are required to verify the observations presented in the current study.

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