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Article

Effect of the manual manipulation of composite resin with latex gloves.

Efecto de la manipulación manual de resina compuesta con guantes de látex.

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Abstract: Purpose: This *in vitro* study aimed to evaluate the influence of the manual manipulation of two composite resins: Filtek™ Z350XT (3M ESPE) and Herculite Précis® (Kerr), with latex gloves contaminated with powder, human saliva and alcohol, on the microhardness values. Material and Methods: Manual manipulation was evaluated using latex gloves with powder, latex gloves without powder, latex gloves without powder with saliva, latex gloves without powder with alcohol, and without hand manipulation or contaminants (control). Each resin was manually manipulated for 10 seconds and photoactivated for 20 seconds with a light intensity of 1000mW/cm^2 using a VALO –Ultradent LED light– cured unit, and then each sample was evaluated on the microhardness Vickers tester Leitz (Wetzlar). The collected data were analyzed using Kruskal –Wallis and Mann – Whitney post-test (p<0.05). Results. Microhardness values showed a significant difference between the evaluated and control groups, showing lower microhardness values in the group of latex glove with powder for Filtek™ Z350XT and the group of latex glove without powder with saliva for Herculite Précis®. Conclusion. The manual manipulation of composite resins decreases their surface microhardness.

Keywords: *Composite resins; physical contaminants; hardness tests; gloves surgical; saliva; control groups.*

Resumen: Propósito: Este estudio *in vitro* tuvo como objetivo evaluar la influencia de la manipulación manual de dos resinas compuestas: Filtek ™ Z350XT (3M ESPE) y Herculite Précis® (Kerr), con guantes de látex contaminados con polvo, saliva humana y alcohol, sobre los valores de microdureza. Material y Métodos: La manipulación manual se evaluó utilizando guantes de látex con polvo, guantes de látex sin polvo, guantes de látex sin polvo con saliva, guantes de látex sin polvo con alcohol, y sin manipulación manual o contaminantes (control). Cada resina fue manipulada manualmente durante 10 segundos y fotoactivada durante 20 segundos con una intensidad de luz de 1000mW/cm^2 usando una unidad de fotocuración LED VALO - Ultradent, y luego cada muestra fue evaluada en el tester de microdureza Vickers Leitz (Wetzlar). Los datos recopilados se analizaron utilizando Kruska – Wallis y post-test Mann– Whitney (p<0.05). Resultados: Se observó una diferencia significativa en los valores de microdureza entre los grupos evaluados y el grupo control, con valores más bajos de microdureza en el grupo de guantes de látex con polvo para Filtek™ Z350XT y el grupo de guantes de látex sin polvo con saliva para Herculite Précis®. Conclusión. La manipulación manual de resinas compuestas disminuye su microdureza superficial.

Palabras Clave: *Resinas compuestas; contaminantes físicos; pruebas de dureza; guantes quirúrgicos; saliva; grupos control.*

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INTRODUCTION.

A composite resin restoration is a sensitive technique[1] and its success can be affected by several factors. Contaminating agents such as saliva or blood are found in the oral cavity, while other materials powder from the gloves or local anesthetic could affect the composite polymerization. These products can be incorporated into the composite resin or bond system and affect their properties, contributing to the failure of the restorations in a short time.

Studies have been conducted on how these contaminants influence the resin bond adhesive systems,[2] by reducing the physical and mechanical properties of the adhesive interface, and affecting the restoration durability.[3]

However, the effect of contaminants on composite resin manipulation is still unclear, due to few published studies on the subject.[4,5] In addition, there are professionals that manipulate the composite resin with their fingers during the restorative procedure, making both the composite and the bonding system highly vulnerable to contamination.[6]

For that reason, the aim of this study was to evaluate the microhardness of the composite resin manually manipulated with latex gloves contaminated with saliva, alcohol and powder. The tested hypothesis was that the manipulation of the composite resin with contaminated latex gloves reduces microhardness values.

MATERIALS AND METHODS.

The materials used in this study: Composite resin disks were made and divided into two groups according to the composite used: 1). Filtek™ Z350XT (3M ESPE), 2). Herculite Précis® (Kerr).

Each group was divided into 5 subgroups according to the contaminant presence or absence in the composite resin manipulation: a) Latex glove without powder and contaminated with saliva, b) latex glove without powder and contaminated with alcohol, c) latex glove with powder, d) latex glove alone, without powder or any contaminant, e) spatulas (no gloves were used). As such, 10 study groups, with a sample of 10 disks per group, were included. (Table 1)

Latex gloves contamination

a. With saliva: Unpowdered latex glove surface was coated with human saliva, collected from one healthy donor, and was left to dry at room temperature for two minutes.

b. With alcohol: Unpowdered latex glove surface was rubbed with 70% alcohol for 30 seconds and left to dry for the same time.

c. With powder: Powdered latex gloves were used, no extra powder was added.

Sample preparation

A metallic matrix was used to produce composite resin disks (8mm diameter and 2mm thick). From each composite syringe 1) Filtek™ Z350XT (3M ESPE), and 2) Herculite Précis® (Kerr), a composite resin increment was taken with a sterile spatula. Each increment was manually manipulated during 10 seconds, resulting in a composite resin sphere. This procedure was repeated in each study group, except for the groups that used a spatula, where the composite resin was extracted from their syringe and manipulated only with spatulas.

The metallic matrix was placed over a Mylar matrix band, which was placed on a 1cm thick glass plate with a black background. Then, a composite resin increment was placed on the metallic matrix; and on the top of the increment, another Mylar matrix band with another 1cm thick glass plate was placed onto it, in order to apply pressure and result in a uniform surface.

The glass plate was removed and the composite resin was light-cured according to the manufacturer's instructions - for 20 seconds, using a LED VALO – Ultradent light– cure unit (1000mW/cm^2). All the specimens were stored for 24hrs, in the dark at room temperature.

Microhardness test

After 24hrs, the samples were placed in a Leitz (Wetzlar) Germany microhardness machine. Three Vickers indentations were made on the surface, with a static load of 50g for 30 seconds.

Statistical analysis

Test data were analysed using the Shapiro Wilk test to check normal data distribution, and the Kruskal-Wallis test for multiple comparisons between means to determinate significant differences was used at the alpha level of $p<0.05$ for the analysis of results. To determine which mean values differed significantly, the Mann-Whitney post-test was used at 5% significance level.

RESULTS.

Results from Vickers microhardness test values (kgf/mm^2) of Filtek™ Z350XT (3M ESPE) and Herculite Précis® (Kerr) composites resins. (Table 2)

The Filtek™ Z350XT composite resin manipulated with spatulas group showed the highest microhardness values with a statistically significant difference compared to all the other groups (p<0.02). The powdered latex glove group showed the lowest values with statistically significant difference compared to the other groups (p<0.0001). In contrast, there were no significant differences between the groups of latex glove without powder, latex glove without powder with saliva, and latex glove without powder with alcohol.

Regarding the Herculite Précis®, there were no significant differences between the control group, the latex glove with powder and latex glove without powder with alcohol. There were significant difference between the latex glove without powder and latex glove without powder with saliva groups compared to the other groups, with the latter group showing the lowest microhardness value.

Table 1. Materials used in the present study.

Batch numbers	Manufacturer	Description and composition	Material
1005510306	Cranberry Multisafe Sdn, Malaysia.	Natural rubber latex + cornstarch	Cranberry® powdered latex glove
056308	Supermax Glove Manufacturing Sdn, Malaysia.	Natural rubber latex	Supermax® unpowdered latex glove
N753280	3M ESPE, St Paul, MN, USA.	Light activated, shade Enamel A2, nanohybrid restorative composite	Filtek™ Z350XT
6011242	Kerr, CA, USA	Light activated shade Enamel A2, nanohybrid restorative composite.	Herculite Précis®

Table 2. Mean and standard deviation of the Vickers microhardness (kgf/mm^2) of the composite resins Filtek™ Z350XT–3M ESPE and Herculite Précis®– Kerr, manipulated according to each study group.

GROUPS	COMPOSITE RESIN	
	Filtek™ Z350XT 3M ESPE	Herculite Precis® Kerr
Spatulas (Control)	60.733 (3.413)^{Aa}	38.263 (2.548)^{Ba}
Latex gloves with powder	38.3 (3.108)^{Ab}	37.733 (8.521)^{Aa}
Latex glove without powder	57.066 (3.795)^{Ac}	33.133 (3.857)^{Bb}
Latex glove without powder with alcohol	55.333 (3.67)^{Ac}	37.666 (6.093)^{Ba}
Latex glove without powder with saliva	57.133 (4.15)^{Ac}	32.133 (2.542)^{Bc}

Different superscript lower case letters indicate significant differences between study groups, and different superscript capital letters indicate significant differences between composite resins (p<0.05).

DISCUSSION.

The aim of this study was to evaluate the microhardness value of composite resins manipulated with contaminated latex gloves, and to compare the microhardness of both composite resins studied in the different contaminated groups.

When spatulas are used the Filtek™ Z350XT composite resin presents the higher microhardness value compared with all the other the samples manipulated with gloves. This suggests that manual manipulation of composite resin is a procedure that should be avoided, being worst with powdered latex gloves.

This result partially agrees with Martins *et al.*,[4] who found that the flexural strength of composite resins manipulated with powdered and unpowdered latex gloves was reduced by the presence of powder; and with Heck in 2006, who attributes this effect to an alteration in the composite resin composition due to

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the incorporation of external products.[7]

The latex used in gloves manufacturing may have a direct influence on the composite physical properties. It is known that sulfides released from latex gloves inhibit the polymerization of the silicone in impression materials based on polyvinyl siloxanes, when it reacts with chloroplatinic acid from silicones.[8] Extrapolating this concept to the manipulation of composite resin with latex gloves, it could be that sulfides from latex may chemically react with any composite resin compound or any photoinitiator, when they are in direct contact. In this regard, Kimoto *et al.,*[9] stated that there is a transference of sulfide residual elements and sulfide chloride compounds from the latex glove other materials, like vinyl gloves or retraction cord, after a short contact time (5 seconds) between both kind of gloves. More studies are needed to determinate whether there is any chemical reaction between latex gloves sulfides and composite resin.

Furthermore, some latex gloves have powder inside to facilitate hands insertion. Besides there are "unpowdered" latex gloves, like in this study, which have powder, but a smaller amount.

Our findings could be the result of the physical barrier action of powder particles deposited on the composite resins during their manipulation, knowing that these particles have an average size of 2.5-10μm,[10] while Filtek™ Z350XT has cluster particles of 4-11nm and 20nm,[11] and Herculite Précis® presents particles 50nm and 0.4μm in size.[12] A powder particle bigger than the composite filling particles could interfere in the composite curing process and microhardness value or, on the other hand, the powder particle could leave an empty area on the composite resin surface, likewise affecting the microhardness.

Regarding the Herculite Précis® composite resin, no significant difference was found between the control group, the powdered latex group and the unpowdered latex gloves with alcohol group. In this composite group, the powder is not apparently an agent that affects the composite resin microhardness, unlike for Filtek™ Z350XT. This result is similar to results found by Martins *et al.,*[4] who state that manipulation with gloves with or without powder does not have significant difference in tensile bond strength. Despite this being a different methodology to assess microhardness, the study provides an idea of what could occur with the material.

On the other hand, the similarity between the results of the control group and two of the contaminant groups could be due to another factor, manipulation itself. Composite resin is vacuum packed and theoretically can be used without any risk of air bubbles. However, it is possible that even the use of spatulas could produce air bubbles or porosities, which are related to the insertion technique and viscosity,[1] and viscosity is clinically increased in Herculite Précis® composite.

Our results show that contamination of powdered latex gloves with alcohol does not affect the microhardness values, and this could be due to the compound's volatility. In addition, there are studies that evaluate the use of alcohol as a disinfectant of gloves with powder and saliva[2,4] and suggest the utility of cleaning contaminated gloves and avoid possible adverse effects.

Contamination with saliva could affect mechanical properties, reducing the microhardness values, similar to results found by Eiriksson *et al.,*[2] where bond strength was decreased by the presence of saliva caught between composite resin layers. Saliva is mainly composed of water (94%) with 0.6% solids. These solids are macromolecules like proteins, glycoproteins, amylase, particles of calcium, sodium, chloride, urea, amino acids, fatty acids, and glucose.

Cobanoglu *et al.,*[13] stated that when saliva comes in contact with the dentin surface, a saliva layer is deposited on the surface; water is evaporated and leaves a glycoprotein layer. Likewise, Eiriksson *et al.,*[2] found that the bond strength among composite resin layers is reduced when it is contaminated with saliva and porosities are produced on the surface.

Heck[7] identified foreign elements in contaminated normal composite resin, which included magnesium, nickel, calcium, chlorine and potassium, which are present in saliva and other materials. Based on that, it is possible that the glycoprotein layer and other elements would become stuck on the resin, blocking a correct polymerization and interfering in the microhardness measurement. Heck[7] also stated that any contaminant, without surface treatment or silane like bonding agent, may reduce the resin microhardness as it would not be properly incorporated into the organic matrix.

Comparing the saliva and powder effect on composite resins, according to Martins *et al.*,[4] the presence of saliva on gloves, may counter the negative effect produced by powder. Saliva proteins present between increments would not be as detrimental as the presence of powder. This agrees with our results for Filtek™ Z350XT composite, since the layer of saliva in gloves acts like a barrier avoiding the powder from coating the composite.

Both composites in this study have differences regarding their composition that could be related to the differences found in the microhardness values. Filtek™ Z350XT is a nanofilling composite resin with 78.5/63.3 (wt%/vol%) and with 4-11nm and 20nm particles,[11] while Herculite Précis® is a nanohybrid composite with 78% filling and 50nm and 0.4µm particles.[12]

The difference in the particle size would be in favor of nanometrics ones, considering their smaller size and combination with nanoclusters (for example, Filtek™ Z350XT) that would reduce the interstitial space into the filling particles, and help increase the filling, protect the resin matrix from abrasion, and result in lower curing shrinkage and better mechanical properties.[14]

Besides particle size, there are also differences in the kind of particle used in both composites. In Filtek™ Z350XT, the filling particles are based on silica and zirconium,[12] while in Herculite Précis® they are based on silica and barium glass.[11] This could also influence the microhardness values we found in this study, as zirconium based particles of Filtek™ Z350XT would be more resistant than the barium glass based particles of Herculite Précis®.

The literature reports Vickers microhardness values for Filtek™ Z350XT of 8415 and for Herculite Précis® values of 40.89,16 which are similar to our results. The difference of microhardness values of both composites could be due to the presence of pre-polymerized particles in the composition of Herculite Précis®, different to Filtek™ Z350XT.[12,17] These pre-polymerized particles are added to unpolymerized material, producing a difficult uniform curing process,[18] and polymer chains being separated by a molecule without a primary chemical bonding.[19]

Within the limits of an in vitro study, we conclude that the composite resin microhardness is negatively affected when it is manually manipulated with contaminated gloves. Filtek™ Z350XT composite is affected when it is manipulated with latex gloves contaminated with powder, while Herculite Précis® composite is affected when it is manipulated with latex gloves without powder with saliva.

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