Effect of Preheating on Surface Microhardness of Six Composite Resins *

Efecto del precalentamiento en la microdureza superficial de seis resinas compuestas

Efeito do pré-aquecimento na microdureza superficial de seis resinas compostas

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ABSTRACT

Background: Preheating resins has been shown to improve physical properties such as surface microhardness. Some low-cost composite resins have not been well studied and preheating could improve their properties. **Purpose:** To evaluate if preheating increases the surface microhardness of 6 composite resins and if the microhardness of the preheated low-cost ones equals that of the other resins **Method:** In this *in vitro* experimental investigation, 6 resins were used, EnaHri®UE2 and UD2 (Micerium, Genoa, Italy) as control, Z350® and Z250® (3M ESPE, Minnesota, United States) commonly used composites and LUNA® and ROK® (SDI, Victoria, Australia) as low-cost resins. Specimens without preheating (sp) and preheating at 39 °C (p) were created for each resin. Polymerization was performed according to manufacturers' instructions. Three measurements were made per sample using a microhardness tester applying a 300 g load for 10 seconds. **Results:** Resin-enamel microhardness: LUNA® sp 69.93 HV (95 %, CI 62.02-77.85), Z350® sp 89.9 HV (95 %, CI 80.56-99.23), LUNA®

p 70.05 HV (95 %, CI 62.97-77.12), Z350® p 87.47 HV (95 %, CI 78.71-96.23). Microhardness of resins-dentin: ROK® sp 85.16 HV (95 %, CI 69.91-100.4), Z250® sp 95.99 HV (95 %, CI 74.8-117.2), ROK® p 92.19 HV (95 %, CI 80.83-103.6), Z250® p 104.7 HV (95 %, CI 97.76-111.6). Preheating did not significantly increase microhardness except for control resins. ROK® sp is equivalent to Z250® sp (p = 0.2825). **Conclusion:** Preheating does not increase surface microhardness of the composite resins analyzed. The microhardness of ROK® sp resin is equivalent to Z350® sp.
Keywords: composite resin; dental materials; dentistry; hardness test; preheated resin; surface hardness; surface microhardness

RESUMEN

Antecedentes: Se ha comprobado que el precalentamiento de las resinas mejora propiedades físicas como la microdureza superficial. Algunas resinas compuestas de bajo costo no han sido muy estudiadas y el precalentamiento podría mejorar sus propiedades. **Objetivo:** Evaluar si el precalentamiento aumenta la microdureza superficial de 6 resinas compuestas y si la microdureza de las de bajo costo precalentadas iguala a las otras resinas **Método:** En esta investigación experimental *in vitro* se usaron 6 resinas, EnaHri UE2® y UD2® (Micerium, Génova, Italia) como control, Z350® y Z250® (3M ESPE, Minnesota, Estados Unidos) resinas de uso convencional y LUNA® y ROK® (SDI, Victoria, Australia) como resinas de bajo costo. Se realizaron especímenes sin precalentar (sp) y precalentados a 39 °C (p) para cada resina. Se polimerizaron según indicaciones de los fabricantes. Se realizaron 3 mediciones por muestra usando un microdurómetro aplicando 300 g de carga durante 10 segundos. **Resultados:** Microdureza de resinas-esmalte: LUNA® sp 69.93 HV (95 %, IC 62.02-77.85), Z350® sp 89.9 HV (95 %, IC 80.56-99.23), LUNA® p 70.05 HV (95 %, IC 62.97-77.12), Z350® p 87.47 HV (95 %, IC 78.71-96.23). Microdureza de resinas-dentina: ROK® sp 85.16 HV (95 %, IC 69.91-100.4), Z250® sp 95.99 HV (95 %, IC 74.8-117.2), ROK® p 92.19 HV (95 %, 80.83-103.6), Z250® p 104.7 HV (95 %, IC 97.76-111.6). El precalentamiento no aumentó significativamente la microdureza a excepción de las resinas control. ROK® sp fue equivalente a Z250® sp (p = 0.2825). **Conclusiones:** El precalentamiento no aumenta la microdureza superficial de las resinas compuestas analizadas. La microdureza de la resina ROK® sp es equivalente a la Z350® sp.
Palabras Clave: dureza superficial; materiales dentales; microdureza superficial; microdureza Vickers; odontología; prueba de dureza; resina compuesta; resina precalentada

RESUMO

Antecedentes: Resinas de pré-aquecimento demonstraram melhorar as propriedades físicas, como a microdureza superficial. Algumas resinas compostas de baixo custo não foram bem estudadas e o pré-aquecimento pode melhorar suas propriedades. ***Objetivo:*** Avaliar se o pré-aquecimento aumenta a microdureza superficial de 6 resinas compostas e se a microdureza das resinas pré-aquecidas de baixo custo é igual à das demais resinas. ***Métodos:*** Nesta investigação experimental *in vitro*, foram utilizadas 6 resinas, EnaHri UE2® e UD2® (Micerium, Gênova, Itália) como controle, Z350® e Z250® (3M ESPE, Minnesota, Estados Unidos) convencionalmente usaram resinas e LUNA® e ROK® (SDI, Victoria, Austrália) como resinas de baixo custo. Amostras sem pré-aquecimento (sp) e pré-aquecimento a 39 °C (p) foram feitas para cada resina. Foi polimerizado de acordo com as instruções dos fabricantes. Três medições foram feitas por amostra usando um testador de microdureza aplicando uma carga de 300 g por 10 segundos. ***Resultados:*** Microdureza resina-esmalte: LUNA® sp 69,93 HV (95 %, IC 62,02-77,85), Z350® sp 89,9 HV (95 %, IC 80,56-99,23), LUNA® p 70,05 HV (95 %, IC 62,97-77,12), Z350® p 87,47 HV (95 %, IC 78,71-96,23). Microdureza das resinas-dentina: ROK® sp 85,16 HV (95 %, IC 69,91-100,4), Z250® sp 95,99 HV (95 %, IC 74,8-117,2), ROK® p 92,19 HV (95 %, IC 80,83-103,6), Z250® p 104,7 HV (95 %, IC 97,76-111,6). O pré-aquecimento não aumentou significativamente a microdureza, exceto para resinas controle. ROK® sp é equivalente a Z250® sp (p = 0,2825). ***Conclusão:*** O pré-aquecimento não aumenta a microdureza superficial das resinas compostas analisadas. A microdureza da resina ROK® sp é equivalente a Z350® sp.
Palavras-chave: dureza superficial; materiais dentários; microdureza superficial; microdureza Vickers; odontologia; resina composta; resina pré-aquecida; teste de dureza.

INTRODUCTION

The use of amalgam is still common to treat dental tissue that was lost as a result of dental caries, violence, and accidents. When performing surgical treatments for many years, amalgam was the material of choice for posterior teeth. Due to its unique composition, amalgam is easy to handle, shows adequate mechanical behavior, and has low cost and long life (1,2). However, Amalgam is being banned worldwide

due to contamination associated with mercury. In Colombia will start restricting the use of amalgam in 2023 because of the Minamata treaty (3) that seeks to solve the problem of using this pollutant.

Composite resins have evolved over the years to improve both their aesthetic and functional properties. Some low-cost and easily accessible composite resins in Colombia have deficiencies in terms of their clinical performance: low wear resistance, incomplete polymerization, delamination, and/or material fracture (4). Those complications compromise the integrity of a restoration and the longevity of a treatment. Still, these materials should become the imminent replacement for amalgam as a direct restoration.

Fracture is the most common complication among the main causes of failure of resin restorations, followed by secondary caries and marginal maladjustment (5). This type of complications is caused not only by the patient's habits, but also by the superficial microhardness and resistance of dental materials to masticatory forces. For this reason, surface microhardness is one of the most important properties to evaluate in materials exposed to changes in temperature, humidity, and different types of chewing force.

Surface hardness and microhardness are defined as the resistance of a material to being penetrated and is evaluated from notch depth measurements made by a specific indenter under a static load (6). Vickers hardness (VH) is the most commonly used test for polymeric materials and uses a square-based pyramidal-shaped indenter with an angle of 136° between its surfaces (7,8). HV measures the diagonals produced by the indenter after removing the load.

In dentistry, surface hardness and microhardness are measures of a restoration's ability to wear or be worn by opposing structures, which relate to the mechanical resistance and rigidity of dental materials (9). Consequently, the factors that affect the hardness and superficial microhardness of a restoration can improve material longevity by avoiding complications such as fracture (10). A method to improve this property is preheating of the composite resins before polymerization. Resin preheating is a thermal process described in the literature since the 1980s with self-curing resins (11), though it has become more widely accepted in the last decade because it increases fluidity, reduces viscosity, improves adaptation, and increases surface hardness and resistance to compressive forces (12). When preheated, the molecular mobility of resins increases, which improves the distribution of filler molecules and facilitates polymerization. As a consequence, it prevents the material from breaking, showing mismatches, losing polish, changing color, or dislodging from restored teeth (13,14). On the other hand, preheating the resin compounds increases the depth of cure and the hardness of the compounds (15) . The effect of preheating on the superficial and deep microhardness of composite resins has shown a significant increase when compared to non-preheated resins (16).

The most used temperatures described in the literature to preheat resins are 54 °C and 60 °C. However, when removing the material from the heater, the temperature drops by 50 % after two minutes (17,18). Using these temperatures generates a higher viscosity and a difficult handling of the resins to be used as direct restorative materials. Temperatures above 50 °C allow the use of preheated resins as luting material. These temperatures have shown, during *in vivo* placement of the composite that the preheated resin increases the temperature from 6 °C to 8 °C with respect to room temperature, that is, it does not reach critical levels and does not affect the dentin (19). The greatest cause of intrapulpar temperature increase is attributed to curing lamps rather than preheated resin (18). It has been verified that multiple preheating exposures to a temperature not higher than 59 °C do not affect the resin that remains in the container (20).

Preheating the resin to 39 °C allows it to be manipulated and it is the temperature indicated and described by the commercial house Micerium® as the working temperature to conduct direct restorations. The research question proposed in this study is, what is the effect of preheating on the surface hardness of conventional low-cost resins (ROK® and LUNA®) and resins highly used (Z350® and Z250®) when compared with each other and with the resin indicated to preheat (EnaHri®)? The purpose of this study was to determine if preheating composite resins at 39 °C increases the surface

microhardness of low-cost resins. The end goal was to determine if preheating improves mechanical characteristics of lower-cost resins, when matching them to those more frequently used, so that more people can access treatment without complications such as premature wear and fracture. Findings will serve to find out if composite resins are the material that should replace dental amalgam.

MATERIALS AND METHODS

An *in vitro* experimental study was carried out using 6 types of composite resins (table 1): two resins considered of low cost and easy to access by Colombian dentists (LUNA® and ROK®--SDI, Victoria, Australia); two resins used on a daily basis by Colombian dentists (Filtek Z350® and Filtek Z250 XT®--3M ESPE, Minnesota, United States), and a control group consisting of two resins (EnaHri®--Micerium, Genoa, Italy), UE2 ® (enamel) and UD2 ® (dentin), as they are indicated for use with and without preheating. Color equivalent to A2 was selected for all resins.

TABLE 1
Composite Resins Used in the Study*

Composite Resins	Manufacturer	Particle Size	Indications for Use
EnaHri UE2 ® (21)	Micerium	Microparticles	Anterior and posterior sector. Enamel
EnaHri UD2 ® (21)	Micerium	Microparticles	Anterior and posterior sector. Dentine
LUNA ® (22)	SDI	Micro and nanoparticles	Anterior and posterior sector
ROK ® (23)	SDI	Hybrid, micro and macroparticles	Posterior sector
Filtek™ Z250 XT (24)	3M ESPE	Microparticles	Anterior and posterior sector
Filtek™ Z350 (25)	3M ESPE	Micro and nanoparticles	Anterior and posterior sector

* The scale on which the filler particles are found and the indications for use according to the manufacturer are described.
Source: the authors.

A silicone matrix of 5 mm in diameter by 2 mm in height was made (figure 1) following the ISO 4049 standard (26). Ten specimens of each resin were assigned into 2 groups: 5 specimens preheating the resin at 39 °C (p) and 5 specimens without preheating (sp), at room temperature of 25 ± 1 °C. The samples were coded with letters and numbers.

Obtaining Specimens Without Preheating

The matrix was placed on a Mylar® strip, using a glass tile as a base, to obtain a flat surface. The resin was packed into the matrix, filling it with a single increment of resin. A strip of Mylar® was placed on the surface of the matrix with resin and light pressure was exerted with a glass tile to leave the surfaces flat, parallel and homogeneous, avoiding the formation of bubbles. The tile was removed and light-cured on the Mylar® strip for 20 seconds at a distance of 1 mm, according to the manufacturers' recommendations, using a Bluephase® light-curing lamp (Ivoclar Vivadent S: 050043, Schaan, Liechtenstein) with an intensity of 800 mW/cm2 and a wavelength range between 430-490 nm. This polymerization process was conducted on both bases of the resin cylinder (9).

After the initial polymerization with light-curing lamp, the specimens were placed in a Binder® incubator (BD 53, 02-30792 Tuttlingen, Germany) for 24 hours, at a temperature of 37 °C, to finish the curing process of polymerization (9). After incubation, the surfaces were polished and finished with

polishing discs (Praxis-TDV), going through the 4 sizes: coarse, medium, fine, and extra-fine grains. During this process, the measurements of each sample were rectified, checking if the surface presented irregularities or bubbles with a stereomicroscope (MOD stemi 305, 178762 New York, United States). Samples with irregularities on the surface, fissures, and bubbles were excluded and performed again, working only with samples that presented the appropriate measurements with smooth surfaces and parallel cylinder bases (figures 1A, 1B).

Obtaining Prewarmed Specimens

To control the temperature, the silicone matrix was placed on a glass tile on a specialized Magnetic Stirrer® (SH-2) laboratory heating plate, maintaining a temperature of 37 °C to simulate body temperature. The tile temperature was kept constant and was verified with a thermocouple connected to a digital multimeter (UT33C+, Guangdong, China) throughout the process (figure 1C).

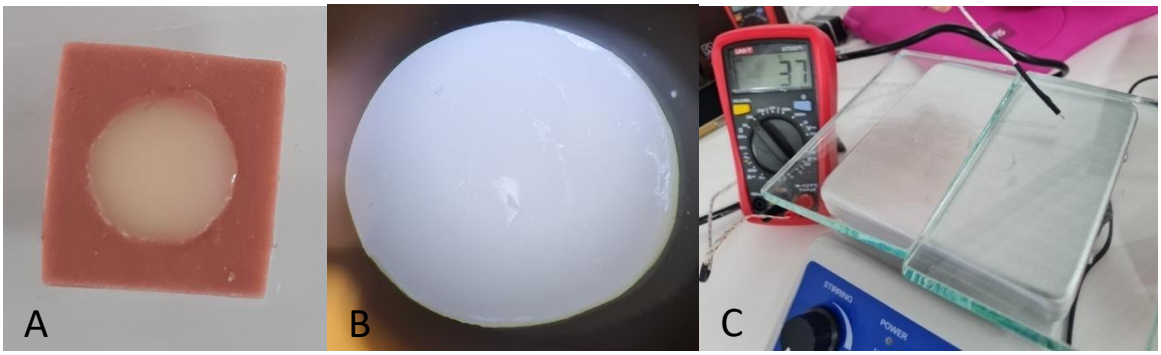

FIGURE 1

A. Silicone matrix of 2 mm in diameter and 5 mm in height for the creation of the specimens. B. Sample observed under a microscope with irregularity on the surface, not suitable for the microhardness test. C. Glass tiles on a heating plate with constant temperature at 37 °C

Source: the authors

An ENA HEAT drum (Micerium®) was used at a temperature of 39 °C to preheat the resins, temperature that was constantly checked with a thermocouple connected to a digital multimeter (UT33C+, Guangdong, China). The matrix was placed on a Mylar® strip on the surface of the glass tile at 37 °C. The process of packing the resin inside the matrix began, taking enough material to make a single increase of the material with an FP3 spatula. The temperature of the resin was measured when it was incorporated into the matrix before being polymerized. A strip of Mylar® was placed on top of the matrix and controlled pressure was exerted with another tile at 37 °C in order to give the desired thickness generated by the matrix. Both surfaces of the cylinder were cured with the Bluephase light, as described in the specimens without preheating. Before starting the packing process in the die, the temperature of the preheating drum, the syringe with the resin, and the FP3 spatula were verified. The polymerization was completed in an incubator for 24 hours at 37 °C. The same polishing protocol was conducted with the specimens without preheating, verifying the measurements and surfaces of each of the resin cylinders.

Microhardness Tests

Vickers microhardness (HV) tests were conducted with the equipment of the Pontificia Universidad Javeriana's School of Engineering (digital display microhardness tester model HVS 1000A) with a load

of 300 gF for 10 seconds. Considering the specifications in ISO 6507-1 and ASTM E384-22, the samples were randomly selected and 3 indentations per sample were made (figure 2). The data from the measurements of the diagonals of each indentation were analyzed. The 3 measurements obtained for each sample were averaged. The GraphPad Prism program was used to perform the univariate and bivariate descriptive statistical analysis. Significant differences lower than 0.05 were accepted.

FIGURE 2
Image of the indented surface where the diagonals generated by the pyramidal tip of the microdurometer can be observed
Source: the authors

RESULTS

The findings of the tests conducted in the microdurometer are shown in table 2. HV averages of all the composite resins without being preheated from lower to higher resistance to penetration (UE2®, UD2®, LUNA®, ROK®, Z350®, and Z250®) were considered, as well as the HV averages of the preheated composite resins from lowest to highest microhardness (UD2, LUNA®, UE2®, Z350®, ROK®, and Z250®). Among all preheated and non-preheated resins, Z250® showed the highest surface microhardness. In all preheated resins, an increase in HV was observed with the exception of Z350® that, on the contrary, showed a decrease in HV values. However, the latter decrease was not statistically significant ($p < 0.05$). There was a decrease in the standard deviation of the preheated LUNA®, ROK®, Z250® UE2®, and UD2® resins when compared to values without preheating.

The resins with a lower surface hardness were those from Micerium®. The 2 resins were the only ones with a statistically significant increase when preheated (UE2 ® (sp-p) $p = 0.0110$, and UD2 ® (sp-p) $p = 0.0325$).

TABLE 2
Results of the surface microhardness testing HV of the 6 resins *

Composite resin	Maximum measure (HV)	Minimum measure (HV)	Mean (HV)	Standard deviation	IC less than 95 %	IC greater than 95 %	p value
ROK® sp	97.3	70.53	85.16	12.28	69.91	100.4	0.3341
ROK® p	106.4	82.13	92.19	9.15	80.83	103.6	
LUNA® sp	76.2	59.42	69.93	6.372	62.02	77.85	0.9771
LUNA® p	77.17	61.57	70.05	5.696	62.97	77.12	
Z250® sp	110.1	66.37	95.99	17.06	74.8	117.2	0.3108
Z250® p	114.2	99.73	104.7	5.569	97.76	111.6	
Z35® sp	98.13	81.42	89.9	7.516	80.56	99.23	0.6124
Z350® p	96.3	76.57	87.47	7.054	78.71	96.23	
UE2®sp	67.6	39.73	55.17	11.27	41.17	69.16	0.011
UE2® p	75.08	68.08	72.21	2.688	68.87	75.55	
UD2 ®sp	63.93	46.77	58.92	6.939	50.3	67.54	0.0325
UD2® p	75	63.83	68.69	4.842	62.68	74.71	

* p = preheated specimens; sp = non-preheated specimens.
Source: the authors

We compared the HV of resins from two groups based on their dentin or enamel indication in the posterior or anterior sector. Resins without preheating that can be used as dentin had the following HV behavior: ROK® sp HV was equal to Z250® sp ($p = 0.2825$); ROK® sp and Z250® sp were greater than UD2®sp ($p = 0.0020$ and $p = 0.0032$, respectively). These same preheated resins showed that ROK® p HV was less than Z250® p ($p = 0.0314$). ROK® p and Z250® p HV were greater than UD2® p ($p < 0.000$ and $p = 0.0010$, respectively). It is worth noting that ROK® p HV did not outperform Z250® sp ($p = 0.6760$) (figure 3).

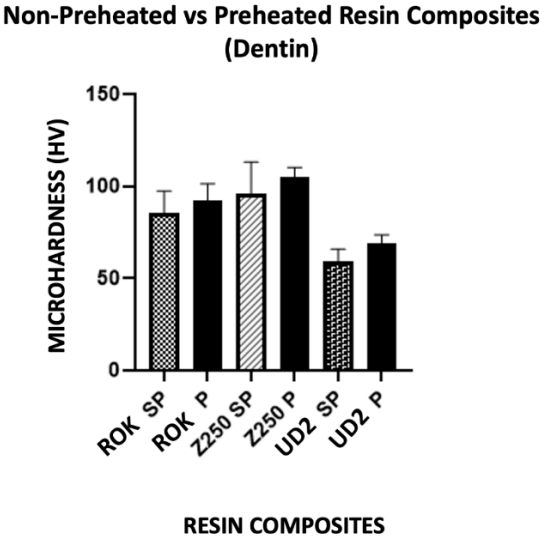

FIGURE 3
Vickers Microhardness (HV) of the Resins Used as Dentin With or Without Preheating
Source: the authors

Regarding enamel resins, LUNA® sp HV was lower than Z350® sp (p = 0.0019), but higher than UE2® sp (p = 0.0342). LUNA® p HV was lower than Z350® p (p = 0.0026), equal to UE2® p (p = 0.4649). LUNA® p HV is less than Z250® p (p = 0.0015) (figure 4).

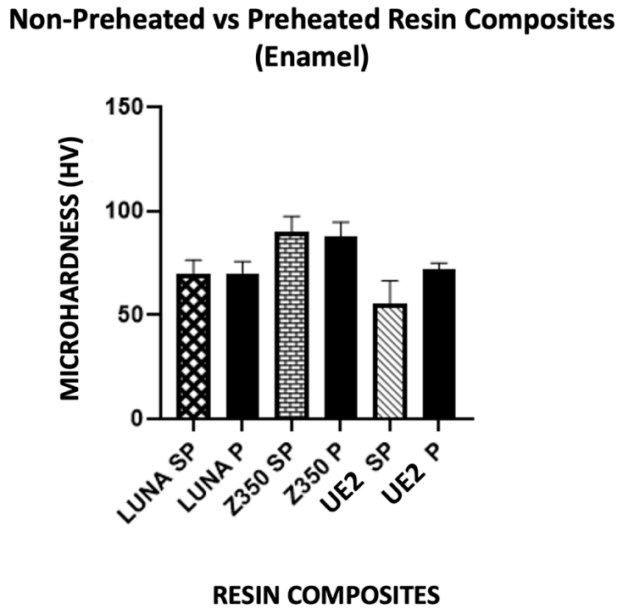

FIGURE 4
Vickers Microhardness (HV) of the Resins Used as Enamel With or Without Preheating
Source: the authors

Among the low-cost resins used in this study, the non-preheated and preheated ROK® resin had significantly higher HV than LUNA® (p = 0.0393 and p = 0.0018, respectively). The Z250® was significantly harder than the Z350® (p = 0.0027).

DISCUSSION

In this experimental study, we determined that, when preheating resins at 39 °C, there was a change in the viscosity of the materials, which allows for better handling. Moreover, when removing resins from the preheated syringe to be packed into the matrix, there is an average temperature decrease of 5 + 1 °C of the preheated resin. This allows for greater safety when working with the resin since an increase in intrapulpar temperature will not be generated in the case of vital teeth. The increase in temperature on the pulp tissue, as described in the literature, is more likely with the use of an inappropriate light-curing lamp, rather than with preheating the resin to this temperature (27).

In this study, preheating to 39 °C, indicated for handling the resin and use as a direct filling, did not generate significant increases in the HV of LUNA®, ROK®, Z350®, and Z250 resins but did significantly increase the surface microhardness of ENAHRI® (figure 3). This can be attributed to its chemical composition in which the presence of 1,4 butanediol dimethacrylate (BDDMA) stands out. BDDMA is a molecule that provides polymers with characteristics such as greater chemical resistance, heat resistance, abrasion resistance, and water resistance (28). At a temperature of 39 °C, preheating generated a decrease in the standard deviation value of all samples with the exception of Z350® (table 2). This indicates that the preheating of the resins can have an impact on the molecular organization,

favoring a more constant behavior before penetration forces, which improves the capacity of resistance to indentation. This may be due to a greater molecular movement that allows a better formation of polymer chains and a greater crosslinking, which directly optimizes the mechanical properties of the material (29-31).

Although there are descriptions of significant changes in surface microhardness in the literature when resins are preheated (28,30), such changes are reported at temperatures close to 60 °C. At these temperatures, the resins completely change their viscosity, which makes them difficult to manipulate in the process of shaping and contouring direct fillings. Viscosity is a property of matter that describes the resistance of a fluid to gradual deformation. In this case, the resins are polymeric macromolecules whose characteristics are both fluid and solid, and do not present a defined crystalline or amorphous structure (32,33). For this reason, the viscosity at temperatures greater than 54 °C is similar to the preparation of phosphate for cementing in which filaments or threads are formed. Therefore, at these temperatures, the resins are indicated as cementing agents and not as direct sealing materials. Although in this study there were not statistically significant changes in the low-cost composite resins, we observed in all the composite resins that preheating changed the viscosity of the material, increasing its fluidity. This can provide a better adaptation to the walls that are part of the cavities, reducing microleakage and increasing the durability of restorations (30,34,35).

Considering the information provided by each maker, that is, 3M ESPE, SDI, and Micerium, analysis based on the composition and fillers of each resin can be performed to identify the differences in HV (figure 3). The Z250® resin presented the highest HV values. Z250® resin is a micro hybrid resin with a particle size of 0.01 to 3.5 µm with an average of 0.6 µm. The load of inorganic filler material is 60 % by volume, mostly composed of zirconium/silica (24). This resin is considered a universal resin that works for both the anterior and posterior sectors. In this study, Z250® was taken as indicated for use in the posterior sector and was compared with ROK® (posterior sector resin) and EnaHri UD2® (universal dentin resin). ROK® has a filler material load of 67.7 % by volume with a high percentage of glass (23). When comparing ROK® to Z250® without preheating, although ROK® has a higher filler percentage by volume, the filler type makes this resin less hard and possibly the higher glass filler type is responsible for the lower HV values for ROK®. EnaHri UD2® presents 63 % filler by volume, composed mainly of zirconium nano oxides and silicon dioxide with an average particle size of 0.04 µm (21). This means that UD2® has the lowest HV value due to its high filler content with smaller particle size when compared to Z250® and ROK®.

LUNA®, on the other hand, is nanohybrid. This means that it features nanometer and micrometer filler particles between 40 nm and 1.5 µm, with the majority being nanometers. Fillers make up 58 % of the volume. Its filler is not mostly larger particles, which affects the microhardness of the material but allows obtaining a better surface finish (22). In this study, LUNA® was used as a more esthetic material for the anterior sector and compared to Z350® (enamel) and EnaHri UE2® (figure 4). Z350® has a 20 nm nanosilica filler and agglomerates of 5-20 nm zirconium/silica particles that form a nanocluster. The particle size of the aggregate oscillates between 0.6 and 1.4 µm and its filler load is 63.3 % by volume (21). The particle size of these two resins is similar, but the filler charge per volume is much higher in Z350®, which may be a significant factor in the higher HV strength of Z350®. EnaHri UE2® is made up by zirconium nano oxides (12 % by weight) and glass filler (silicon dioxide) to increase the refractive index (68 % by weight) with particles of 0.04 µm in average. This makes UE2® highly aesthetic due to its high filler content with small particles that provide translucency. The filler load by volume is 63 % with an average filler particle of 4.3 µm (21). Although HV values without preheating are lower for UE2®, a significant increase is observed when preheating, exceeding those values of LUNA®. The zirconia/silica nanoclusters and high content of filler particles of Z350® and UE2® improve the

resistance to indentation, which increase the translucency in UE2®, have a negative effect in terms of surface microhardness.

When comparing the resins as enamel or as dentin in the study, higher HV values were observed in dentins than in enamels. This may be due to the composition of these materials in which the particle size and filler content is higher in dentin than in enamel. The larger the particle size and filler content, the higher the surface microhardness (36). The filling finished with these resins with a high content of fillers and larger particles is deficient in terms of polishing and shine, thus they are not indicated for use in highly aesthetic sectors (37).

CONCLUSIONS

Preheating to 39 °C did not increase the superficial microhardness of low-cost and commercial resins, neither enamel nor dentin, but it does increase in Micerium® resins that were used as a control group.

Preheating to 39 °C seems to have an impact on the molecular organization of the specimens, favoring a more constant behavior in commercial resins.

Microhardness of ROK® (low cost) resin is equivalent to Z350® without preheating. In the other side, microhardness of preheated LUNA® (low cost) resin was different from Z350® without preheating.

RECOMMENDATIONS

It is recommended to conduct more studies with temperatures other than 39 °C in a range that allows obtaining an adequate viscosity for the handling of resins. This will make it possible to determine if temperatures other than 39 °C generate changes in the superficial microhardness of composite resins for direct fillings.

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