SURFACE WEAR AND ROUGHNESS OF COMPOSITE RESINS

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ABSTRACT

This study was designed to assess the wear resistance and compare it to the surface roughness of two composite resins. Twenty specimens were prepared, being 10 of each material. Finishing was standardized for all specimens. Gold diamond burs #2135F (KG Sorensen) were employed to remove the gross excess and to shape the specimen. Removal of small excess was performed with silver diamond burs #2135FF (KG Sorensen). The burs were employed at low-speed with oscillating movements for 15 seconds for each instrument under thorough irrigation. After hydration, the specimens were weighed in a four-digit Sartorius digital scale, and the values on grams were recorded in a table containing the mean of three weighings for determination of the initial mass (IM) of the materials investigated. The surface texture of the composite specimens was evaluated by a model Surtronic 3+ portable roughness meter. After completion of the brushing process, the specimens were weighed on the same scale, the mean of three weightings in grams *was recorded as the final mass (FM), and roughness was remeasured. The difference between FM and IM represented the loss of mass. Both composite resins displayed different outcomes as to the wear induced by brushing and the surface roughness. These resins were introduced in the market with specific indications, being the Z250 for anterior teeth, on which esthetics is the most important aspect, whereas the P60 is indicated for posterior teeth, for which resistance is a major requirement.*

KEY WORDS: Composite resin; wear; surface roughness

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INTRODUCTION

In the late 80s professionals preferred an only composite resin to be used in anterior and posterior restorations. Most demanded properties were wear resistance and cosmetic quality.

The ideal would be for resins to wear evenly, but this is a product with a phase of very hard inorganic particles and another phase with resin substance, so the abrasion follows a non uniform pattern of wearing (NAGEM FILHO, 2000). For this reason, new materials are being produced specifically for anterior teeth and for posterior teeth. Presently, resins are made especially for posterior restorations, in which the objective is resistance to wearing, or for anterior restorations and the components are modified accordingly (BUSATO et al., 1996).

Although familiar, the term "wear" is difficult to define. It occurs when pastes with hard particles are scrubbed on the surface of the resin, promoting the wear. In a simulated scrubbring wearing is the result of the friction in the resin surface with the dental past and the dental brush. This provokes abrasion in the matrix and removal of particles resulting in gaps that, due to their roughens, leads to the adhesion of food particles or bacterian plaque. In the upper teeth, as there are no masticatory forces or food friction resins in action they are prone to a greater abrasion wear. In the three samples wear, as the name reveals, there is need for three elements to achieve this mechanism. There are two surfaces, teeth and brush and a paste in between. The erosive wear seeks the last resistant areas, therefore, the target is the matrix only. In opposition, the two proof tests wearing occur in both matrix and particles. Although laboratorial results are divergents, it is not known if this is true in terms of longevity of restoration. More studies are needed to determine the effects of brushing in composite resins with different molecular

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weight (mass). More than that, findings in surface roughness must be evaluated in what regards its influence in the texture and in the final polishing.

MATERIALS AND METHODS

For this study two BISGMA/BISEMA based photopolimerizable hybrid composite resins were selected. Characteristics of the resins as informed by manufactures can be seen in FIGURE 1.

Resins	Manufacturer	Matrix	Load	% in weigth
Z250	3M	BISGMA/BISEMA	Zirconium/Silic (Synthetized)	78
P60	3M	BISGMA/BISEMA	Zirconium/Silic (Synthetized)	84

FIGURE 1 – Characteristics of the composite resins.

The scrubbing and roughness determination of samples was done by the same person in order to avoid variability.

Twenty samples were made being 10 with each material. The specimens were made in Teflon matrix in sphere shape. The matrix was isolated with a thin layer of Cel-lac (SSWhite) and the resin was inserted through the matrix hole that was laying against a glass plaque (SWARTZ et al., 1983) with a Centrix-DFL (MONDELLI et al., 2003) syringe by the incremental technique in two layers. The initial polymerization system lasted 20 seconds for the first increment using a Demetron Optilux 401 (Research Corporation-Danbury-USA) photopolymerizer equipment with a 1.2 cm diameter active point and 580mW/cm^2 potency as measured with a Dmetron 100 radiometer. The second or last resin layer was slightly pressed against by cover glass slide aiming to uniform the surface, and than it was polymerized for 20 seconds. After that the glass was removed and again the light was applied for 40 seconds. Albers (1966) and Onose et al. (1985) referred that the period of 60 seconds is better since it increases the uniformity of the grade of resin conversion. A greater time of polymerization does not affect the resin properties, and does not improve it either. The proof bodies were removed out of the matrix and macroscopically examined with a 4x magnifying glass for observe possible internal bubbles or irreparable flaws. The proof bodies were stored 24h immersed in a recipient with distilled water at 37ºC. The finishing was standardized to all proof bodies. Golden fine KGSorebse nº 2135F diamond burs were used to remove gross excess and to make the contour of the proof bodies (JUNG, 1997). Later, to remove the rest extra-fine KGSorensen nº 2135FF silver burs were used. They were used in low rotation for 15 seconds with oscilating movements for each instrument under abundant water flow. Pratten and Jonhson (1988) showed that the finishing with diamond points in low rotation produced smoother surfaces than with carbide drills or Arkansas stone.

For the sequence of surface polishing flexible discs with alluminium oxide Solf-lex (3M) in decreasing range of abrasivity were employed. They were applied with light pressure in circular movements under intermitent water flow (NAGEM FILHO, 2003).

Finishing and polishing were done and the specimens kept imerse in distilled water in an oven at 37ºC±2 for six days for complete hydration and linear expansion (OLIVA; LOWE, 1986).

After hydration specimens were weighed in a four-digit Sartorius digital scale and values (in g) were recorded in a form with the means obtained in three weighings, which determined the initial mass (Mi) of both examined materials.

Surface roughness measurement

The texture of the surface of the proof bodies of the composite resin were assessed with a portable surface roughness measurement equipment (Surtronic 3+) with digital electronic reading in the metric system, with precision of 0.01 Bm and reading precision of 2%

The maximum gliding of the pointer is 25.4mm automatically adjusted to the selectd cut-off. This term is used to define each section of the profile given by the division of the length of evaluation (Ln) of the sample, whereby the calculation of the parameters are made to identify irregularities of the surface.

The bodies of proof, after storage, were dried under a light air jet and measured with the roughness measuremente equipment using a total length (Ln) of 4 mm and a cut-off of 0.8mm to filter the surface ondulations.

To describe the texture of the samples surface it was selected the “Ra” parameter, which is a universally accepted roughness measure and the most used one. “Ra” is the arithmetic mean of the values for all absolute distance of the roughness profile of the central line in the length measurement.

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The mean for three measurements, which gives the initial roughness (R1), and the standard deviation for each sample was recorded in a specific form for the three examined materials.

For the wearing test of the three bodies a specially designed device was used named "simulated brushing machine" (GARCIA, 2001; MONDELLI et al., 2003).

The movement of the crankshaft sets the arms in motion with the active part of the brush in a unique direction and in two courses, forward and backward.

To record the number of movements there is a counter fixed in the base of the machine, which was activated by a rod connected to the brush support. The brushing speed was 347 cycles per minute totaling 100.000 cycles according to ISO # 14569. The total time was 4h and 35 minutes of mechanical activity (DOMENE, 1998). To each brush it was attached a weigh of 200 g (VIEIRA, 1960).

The soft brush (Colgate) was changed at every 20.000 cycles and the slurry solution was constantly replaced in a proportion of 1:2. The tooth paste (Colgate) was diluted: 50 g in 100 ml of distilled water (ANTONIAZZI, 2001).

After brushing the proof corps were removed from the metallic matrix and immediately rinsed held by a clinical forceps to achieve complete removal of the tooth paste and then inserted in a T 14 (Ultrasonic Cia Ltda, Taboão da Serra) ultra sonic vibration equipment for 10 minutes for removal of residues.

The final mass was determined after brushing and cleaning of the proof corps stored again in saline for six days in an oven at 37ºC±2, for complete hydration and weighed in previous mentioned scale for three times and the mean values in gramas were recorded as final mass (Mf) in a specific form.

The difference between final and initial mass shows a panoramic view of the amount of wearing produced by brushing in a period of 100.000 cycles. The means for the three measurements of final roughness (r2) were evaluated after the wearing produced by the simulated brushing and the result reflects the aspect of the situation of the texture of the details left by the surface wearing of each sample was recorded as roughness profile.

RESULTS

Data on FIGURE 2 are the results of the difference obtained with the values before the samples were submitted to the brushing test and in a state of full soaking minus the final values for the measures after the period of brushing. Before brushing the resins show a texture representative of the surface after the finishing and polishing and after the brushing period the surface is again assessed with the roughness evaluation equipment.

Resin	Mass (g) diference – mean M_1-M_2)	Initial roughness	Final roughness
Z250	0.00541 A ± 0.001157	0.390 B ± 0.10	2.083 C ± 0.18
P60	0.00419 D ± 0.000347	0.490 B ± 0.09	2.103 C ± 0.11

* Capital letter in front of each number means the variation of the wearing or roughness. When letters are the same it means that the values have no statistical significance.

FIGURE 2 – Mean of the mass difference, surface roughness and respective standard deviation.

The results for the initial and final roughness evaluation (FIGURE 2) were submitted to a two criteria variation analysis revealing a significant effect of the material wearing procedure and surface roughness. The significant integration found indicates that the materials, despite bearing the same constitution, have no uniform behavior to the wearing procedures by brushing.

The statistical results aiming to evaluate the weight loss due to mass removal from the resin surface during brushing revealed that there are differences as the composite resins vary.

DISCUSSION

Attempting to minimize the resin wearing, industries have increased the load concentration, reducing the viscosity, which allows greater incorporation of particles. Thus, in the end of the 80s resins were indicated for anterior and posterior teeth. Later, it was observed that the Z100 could be a better resin if it were better specified. Therefore, Z250 was devisedfor anterior teeth and the P60 for posterior teeth. Both resins have similar constitution both for the matrix and the inorganic particles. However, the percentages are different: 84% for the P60 and 78% for the Z250.

Both composite resins, when submitted to wearing, undergo loss of weight. However, this characteristic is dependent on many extrinsic and intrinsic factors; the greater the weight over the brush, the greater the pressure on the proof bodies and the greater

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the wearing in the resin surface is. In the present study, as recommended by Vieira (1960) it was used a 200g weight, which lead to a pressure of circa 20 Mpa.

Being both resins of the same kind, wearing is the intrinsic factor that is influenced by the amount, in percentage, of the load incorporated to the resin mass. As there are two particles, synsthetized zirconium and colloidal silica, forming a sole monomodal system, the P60, with greater load, has less cementing mass and the resin is more resistant to brushing. However, if the silanization in the perimeter of the hybrid particle zirconium/ SiO_2 is flawed the adhesion of this particle by the adhesion agent to the matrix makes the binding more fragile and during brushing the particle miss the stability by wearing of its bases, it is removed and the resin looses weight. The texture in this place is jeopardized by the onset of a crater that allows for greater roughness of the surface. Thus, during brushing particles are removed by the physical force of the brushing movements. Besides reduction in weight, the surface shows greater roughness and a greater tendency for bacterian plaque adhesion. The greater the amount of resin matrix, the softer the wearing, removing more uniform layers resulting in a more uniform surface (MONDELLI et al., 2003). For this reason the P60 underwent less wearing in relation to the Z250 due to a greater load. However, as far as texture, the P60 showed a rougher surface due to the fact that eveness of a resin depends on the amount of resin contained in the mass.

CONCLUSION

The Z250 resins for anterior teeth, which demand greater cosmetic performance, showed greater wearing and the P60, used in posterior restoration in which the resistance in the main requisite, showed less shining.

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DILÁSCIO, Mauro Lúcio Cardoso; PRADO, Marco Aurélio Rodrigues do; D'AZEVEDO, Maria Teresa Fortes Soares. Surface wear and roughness of composite resins. *Salusvita*, Bauru, v. 24, n. 2, p. 285-292, 2005.