Wear Resistance of Packable Resin Composites after Simulated Toothbrushing Test

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ABSTRACT

Purpose: The purpose of this study was to determine the wear resistance of five different packable composites versus two different composite controls using a laboratory toothbrushing simulation test.

Materials and Methods: Twelve samples measuring 5 mm in diameter and 3 mm thick were prepared from the following resin composites: Packable resin composites SureFil® (Dentsply Ind. Com. Ltda, Petrópolis, Rio de Janeiro, Brazil), Alert® (Jeneric Pentron Incorporated, Wallingford, CT, USA), Filtek P60™ (3M ESPE Dental Products, St. Paul, MN, USA), Prodigy Condensable® (sds Kerr, Orange CA, USA), Solitaire® (Heraeus Kulzer GmbH, Wehrheim, Germany), and control resin composites Z100 Restorative™ (3M ESPE) and Silux Plus™ (3M ESPE). Finishing and polishing were conducted with Sof-Lex™ disks (3M ESPE), and baseline weight (grams) and surface roughness (measured with Hommel Tester® T 1000, Hommelwerke, GmbH, Alte Tuttinger Strebe 20. D-7730 VS-Schwenningen, Germany) were recorded. Specimens were aged for 2 weeks until they reached a weight that remained constant for 5 consecutive days, and then were subjected to 100,000 cycles of brushing (representative of 4.2 yr) using a toothbrushing testing machine. Toothbrush heads with soft bristle tips (Colgate Classic™, Colgate-Palmolive Co., Osasco, São Paulo, Brazil) with dentifrice suspension (Colgate MFP™, Colgate-Palmolive Co.) in deionized water were used under a 200 g load. Changes in weight and surface roughness were determined after toothbrushing cycles.

Results: Significant differences of weight loss and surface roughness were found (paired t-test, $p < .05$). Weight loss percentage (mean [SD]) ranged from 0.38 to 1.69% (analysis of variance and Tukey's least significant difference, $p < .05$); the weight loss of the materials ranked from least to most as follows: SureFil (0.38 [0.56]), Alert (0.52 [0.18]), Z100 (1.16 [0.27]), Filtek P60 (1.31 [0.17]), Solitaire (1.51 [0.45]), Prodigy Condensable (1.55 [0.47]), and Silux Plus (1.69 [0.66]). Regarding surface roughness, Prodigy Condensable (0.19 [0.08]), Solitaire (0.28 [0.06]), and Z100 (0.30 [0.07]) became less rough after toothbrushing, whereas all the others were rendered rougher: Alert (0.49 [0.29]), Filtek P60 (0.28 [0.08]), Silux Plus (0.39 [0.09]), and SureFil (0.81 [0.32]).

Conclusion: SureFil and Alert were statistically more resistant to wear (less weight loss) than were the other materials. SureFil became significantly rougher than did all the others.

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CLINICAL SIGNIFICANCE

Overall, packable resin composites are unlikely to show superior wear resistance with regard to weight loss and surface roughness compared with current resin composites also indicated for posterior restorations.

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Dentistry has recently experienced technologic advances that have resulted in new products and formulations of previously available materials.[1–5] Drawbacks of amalgams, particularly the lack of esthetics, have largely contributed to the increased use of resin composites for posterior restorations.[6,7] Packable or "condensable" resin composites are a new category of esthetic material specifically formulated for use in posterior teeth.[2,7–10] They were developed to offer similar handling characteristics to amalgam as it was thought that their higher density might permit the material to be compacted into cavities.[7–10] Despite the fact that superior mechanical and handling properties have been expected, such advantages have not been properly confirmed.[2,3,6,7,9–12]

For years, wear has been a challenge in dentistry.[1,3,11,13–21] Jones and colleagues defined wear as a progressive loss of substance from the surface of a body as a result of mechanical action.[22] Depending on the degree of wear, a restoration can fail for one of two main reasons: submargination or changes in surface roughness.[20,23–25] Loss of material substance can result in a loss of anatomic form, and some authors consider component elution with its biologic implications a possibility.[26,27] Moreover, rough surfaces can predispose restorations to staining, plaque and food accumulation, and gingival irritation.[27–30]

For restorations in the posterior region, occlusal wear is a main concern; however, other types of wear are also involved.[15,31–33] Abrasion is a specific wear process characterized by a progressive material removal from the surface of a solid by the cutting action of an abrasive material.[22] This type of abrasion can result from different processes such as the sliding of a food bolus and toothbrushing. Besides its beneficial action, toothbrushing may cause some damage on the surface of restorative materials (such as rougher surfaces), which can result in a higher propensity for plaque accumulation and soft tissue irritation.[20,25,27–29,31,34–37]

The severity of this damage depends on either the resin composite or the dentifrice features and their interaction.[38–42] Resin composite characteristics such as particle size, shape, and composition; organic matrix constitution; and curing system are related to their performance.[31,36,43] On the other hand, dentifrices should have as low an abrasive quality as is possible, while retaining cleansing and debris-removal capabilities.[14,35,44] The amount of wear caused by toothbrushing depends mainly on toothbrushing habits, toothbrush quality, and the dentifrice used. Additionally, dentifrice abrasive, the load applied, slurry dilution, and temperature can influence the results of wear.[14,23,31,36,41,42,44] Thus, the standardization of laboratory tests is important.

The aim of this study was to determine the weight loss and surface roughness of five packable composites, one microhybrid composite, and one microfilled resin composite when subjected to a laboratory toothbrushing test. The null hypothesis was that no differences in weight loss and surface roughness would be found among the materials.

MATERIALS AND METHODS

Five packable resin composites SureFil®, Alert®, Filtek P60™, Prodigy Condensable®, and Solitaire® were compared with Z100

Restorative™ microhybrid and Silux Plus™ microfilled resin composites. The brands, manufacturers, and respective compositions of the resins are listed in Table 1. Twelve samples of each material were obtained from a silicone mold with internal dimensions of 5 mm in diameter and 3 mm thick. After insertion of the material into the mold, the surface was covered with a polyester matrix strip (TDV Dental, Santa Catarina, Brazil) that was lightly pressed with a glass slab. Polymerization was carried out with a visible light-curing unit (3M Curing Light™ XL 1500, 3M Dental model 5518AA, 100 to 240 V, 50/60 Hz, London, ON, Canada, X 101856 series) for 60 seconds at 500 mW/cm^2 energy density, which was periodically monitored with a light meter (curing radiometer, model 100P/N-150503, Demetron Research Corp., Danbury, CT, USA). After one side was cured, the specimens were removed from the mold and the opposite side was irradiated in the same manner.

The samples were immediately polished with cooling water and Sof-Lex™ disks (3M ESPE), from the coarsest to the finest granulation disks, for 15 seconds each at low speed. Between each finishing step, the samples were cleaned in running water. Samples were finally cleaned ultrasonically (Tempo Ultrasonic Ind. Com. LTDA, Taboão da Serra, São Paulo, Brazil, model T-14, 90 W) in deionized water for 10 minutes to remove the polishing debris. They were then identified and aged in deionized water at 37°C. The samples were weighed every 24 hours during the 2-week aging time until they reached a constant weight on 5 consecutive days of measurement. The weight loss was assessed by an analytic balance (Sartorius® 2002, Sartorius-Werke A.G., Goettingten, Germany) with 0.0001 g accuracy.

A roughness tester (Hommel Tester® T 1000, Hommelwerke, GmbH, Alte Tuttinger Strebe 20. D-7730 VS-Schwenningen, Germany) was used to analyze the surface roughness (Ra values). Values were expressed in micrometers as a Ra value that is the average mean distance between the peaks and valleys of the surface profile. This device is accurate to 0.01 μm. A 5 μm radio diamond needle (Hommelwerke, T 1E, − 100 5 90° 1.6–30/1.95 0.75/0; Art Nr.: 224160 GmbH) was used to record surface roughness measurements with constant speed of 0.15 mm/s and a force of 0.8 mN. Surface roughness was determined five times in random directions, and the average of these readings was established as the baseline Ra value. Ra values were previously established at 0.01 to 0.8 μm. Readings were taken from a 1.5 mm length with a cutoff value set at 0.25 mm to maximize filtration of surface waviness.

Tests were conducted following International Standards Organization guidelines.[45] The abrasion test was performed with a mechanical toothbrushing machine equipped with six stainless steel holders in which an acrylic resin base was placed so that two samples could be positioned protruding 0.5 mm off the surface.[46] The brush heads were fixed to a special device that maintained their long axis parallel to the acrylic bases. Toothbrush heads with soft, nylon bristles (Colgate Classic™, Colgate-Palmolive Co., Osasco, São Paulo, Brazil), with 25 planar tufts and 60 bristles per tuft, were used under a 200 g load in a direction perpendicular to the sliding surface. In total, 100,000 strokes were performed at a frequency of approximately 374 strokes/min. Stroke length was determined as 38 mm. A slurry was prepared by mixing 2:1 ratio of deionized water and a Colgate MFP™ dentifrice (Colgate-Palmolive Co.) immediately before testing, resulting in a final pH of 8.6. This slurry was constantly stirred to avoid settling of the abrasives. The abrasion procedure was performed at a room temperature of 23 ± 1°C. Toothbrushes were replaced at every new cycle of 50,000 strokes. The two specimens in each holder had their positions exchanged after 50,000 strokes.

After the test, specimens were cleaned with running water followed by an ultrasonic bath for 10 minutes. The surface roughness and weight were determined again in the abraded specimens and

TABLE 1. MATERIALS UNDER INVESTIGATION.*

Product	Manufacturer and Location	Batch No.	Filler	Matrix	Percentage Filler	Filler Medium Size (μm)
Z100 Restorative™	3M ESPE Dental Products, St. Paul, MN, USA	8004	Zirconium, silica	BIS-GMA, TEGDMA	84.5% of weight, 71% of volume	0.6
Silux Plus™	3M ESPE	5702	Silica	BIS-GMA, TEGDMA	52% of weight, 40% of volume	0.04
Filtek P60™	3M ESPE	8100	Zirconium, silica	BIS-GMA, BIS-EMA, UDMA	83% of weight, 61.7% of volume	0.6
SureFil®	Dentsply Ind. Com. Ltda, Petrópolis, Rio de Janeiro, Brazil	980910	Fluoro-aluminate-boro silicate glass of bario	BIS-GMA, TEGDMA	84% of weight, 60% of volume	0.8
Solitaire®	Heraeus/Kulzer GmbH, Wehrheim, Germany	30	Fluoro-aluminate-boro-silicate glass of bario (26%), dioxide silica (30%), fluorosilicate aluminate glass (5%)	BIS-GMA, multifunctional acrylate monomers	65% of weight, 90% of volume	11 (mean)
Alert®	Jeneric Pentron Incorporated, Wallingford, CT, USA	N15AB	Barium-boro-silicate glass, silicon dioxide	BIS-GMA, PCDMA, dimethacrylate groups and glass fibers	84% of weight	0.7
Prodigy Condensable®	sds Kerr, Orange, CA, USA	905015	Barium-aluminum borosilicate, colloidal silica	BIS-GMA	80% of weight, 62% of volume	0.6

BIS-EMA = bisphenol A-polyethylene glycol diether dimethacrylate; BIS-GMA = bisphenol A- glycerolate dimethacrylate; PCDMA = polycarbonate dimethacrylate; TEGDMA = tetraethylene glycol dimethacrylate; UDMA = urethane dimethacrylate.
*All product information is supplied by the manufacturers.

recorded as described previously. Comparisons before and after the test of weight loss and surface roughness of each material were determined by paired t-tests ($p < .05$). Additionally, the results were expressed as a weight loss percentage and difference of surface roughness, which were then analyzed with one-way analysis of variance followed by Tukey's least significant difference (LSD) at

$\alpha = .05$. Correlation between weight loss and surface roughness was calculated ($p < .05$).

Scanning electron micrographs were taken of the surface of each resin composite before and after the abrasion procedure to illustrate possible events. Samples were mounted on metal stubs, sputter coated with gold, and examined under a scanning electron microscope (SEM) (JSM T220A, JEOL-USA, Inc., Peabody, MA, USA) at ×500.

TABLE 2. MEAN INITIAL WEIGHT, FINAL WEIGHT, AND PERCENTAGE WEIGHT LOSS AFTER SIMULATED TOOTHBRUSHING.

Material	Initial Weight (SD)*	Final Weight (SD)*	Percentage Loss (SD)†
SureFil‡	0.1282 (0.0058) A	0.1277 (0.0062) B	0.382 (0.562) a
Alert‡	0.1510 (0.0122) A	0.1502 (0.0122) B	0.519 (0.179) a
Z100‡	0.1251 (0.0044) A	0.1237 (0.0043) B	1.157 (0.267) ab
Filtek P60‡	0.1353 (0.0050) A	0.1335 (0.0050) B	1.313 (0.167) ab
Solitaire‡	0.1031 (0.0051) A	0.1015 (0.0053) B	1.506 (0.448) b
Prodigy Condensable‡	0.1299 (0.0050) A	0.1279 (0.0049) B	1.550 (0.471) b
Silux Plus‡	0.0912 (0.0034) A	0.0897 (0.0035) B	1.695 (0.662) b

*There is no difference between values within a line that are marked with the same uppercase letter (paired t-test, $p < .05$).
†There is no difference between values within a column that are marked with the same lowercase letter (Tukey's least significant difference, $p < .05$).
‡$n = 12$.

RESULTS

All materials presented a significant change in weight from before to after testing (paired t-test, $p < .05$) (Table 2). Regarding surface roughness, only Filtek P60, Silux Plus, and SureFil presented significant changes after toothbrushing test (paired t-test, $p < .05$) (Table 3).

The percentage of weight loss of each material as well as a statistical comparison among groups is shown in Table 2 (Tukey's LSD, $p < .05$). The materials presented average weight losses ranging from 0.38 to 1.69%. SureFil and Alert presented the lowest weight loss, followed by Z100 and Filtek P60. Solitaire, Prodigy Condensable, and Silux Plus presented higher weight losses compared with the other resin composites.

Surface roughness changes were variable (see Table 3). Generally, no differences were noted in the pattern of surfaces of the different resin composites after the finishing step with Sof-Lex disks. However, Alert, Filtek P60, Prodigy Condensable, Z100, and Silux Plus revealed grooves on the surface (Figures 1–7, images A). After the test, two distinct patterns were observed. Prodigy Condensable, Solitaire, and Z100 became smoother after testing, despite no significant statistical

TABLE 3. MEAN INITIAL ROUGHNESS, FINAL ROUGHNESS, AND DIFFERENCE IN ROUGHNESS AFTER SIMULATED TOOTHBRUSHING.

Material	Initial Roughness (SD)*	Final Roughness (SD)*	Difference in Roughness (SD)†
Prodigy Condensable‡	0.21 (0.06) A	0.19 (0.08) A	−0.01 (0.06) a
Solitaire‡	0.32 (0.10) A	0.28 (0.06) A	−0.05 (0.10) a
Filtek P60‡	0.19 (0.05) A	0.28 (0.08) B	−0.06 (0.14) a
Z100‡	0.37 (0.12) A	0.30 (0.07) A	0.07 (0.33) a
Silux Plus‡	0.23 (0.05) A	0.39 (0.09) B	0.10 (0.09) a
Alert‡	0.42 (0.15) A	0.49 (0.29) A	0.16 (0.12) a
SureFil‡	0.34 (0.11) A	0.81 (0.32) B	0.47 (0.34) b

*There is no difference between values within a line that are marked with the same uppercase letter (paired t-test, $p < .05$).
†There is no difference between values within a column that are marked with the same lowercase letter (Tukey's least significant difference, $p < .05$).
‡$n = 12$.

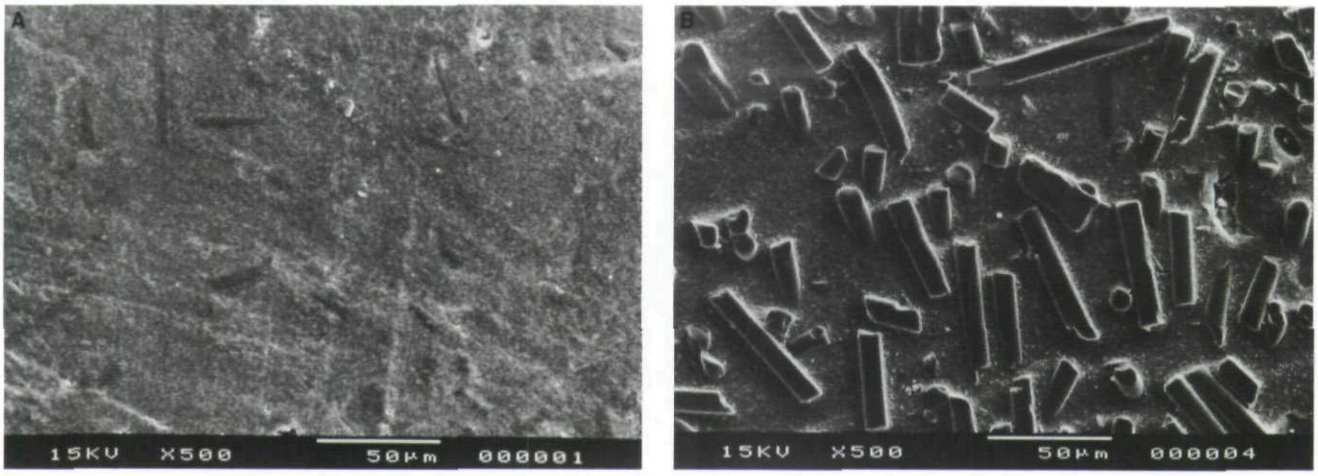

Figure 1. Alert composite. A, *Surface pattern finished with Sof-Lex disks prior to the toothbrushing test (surface roughness [Ra] = 0.42 μm);* B, *surface pattern after the toothbrushing test (Ra = 0.49 μm) (×500 original magnification; bar denotes 50 μm).*

differences being detected. Alert, Filtek P60, Silux Plus, and SureFil presented a rougher surface compared with baseline; however, Alert was not significantly different after the toothbrushing simulation. The increased surface roughness presented by SureFil was significantly higher than that of the other materials (Tukey's LSD, $p < .05$). No correlation was detected between weight loss and surface roughness. Pearson correlation was calculated with $R = -0.184$ ($p = .094$).

SEM observations revealed altered surfaces for all the resin composites after the toothbrushing simulation (see Figures 1–7). Before testing, smooth surfaces were observed and scratches were occasionally present owing to the finishing procedures. After toothbrushing, surface texture suffered distinct alterations that varied according to each material. Filler particle exposure, loss of filler particles, organic matrix

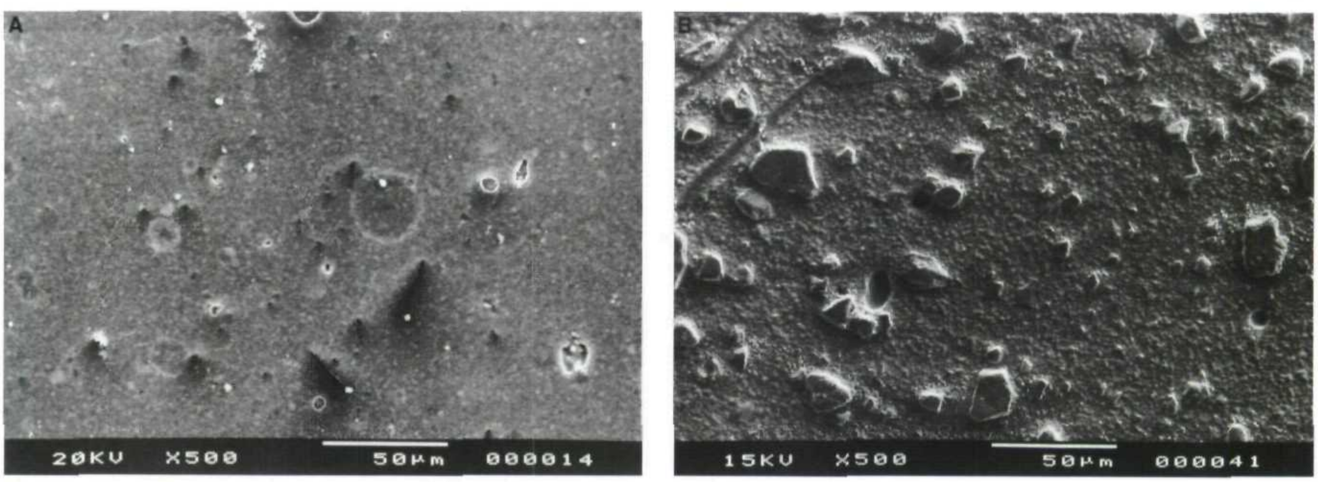

Figure 2. SureFil composite. A, *Surface pattern finished with Sof-Lex disks prior to the toothbrushing test (surface roughness [Ra] = 0.34 μm);* B, *surface pattern after the toothbrushing test (Ra = 0.81 μm) (×500 original magnification; bar denotes 50 μm).*

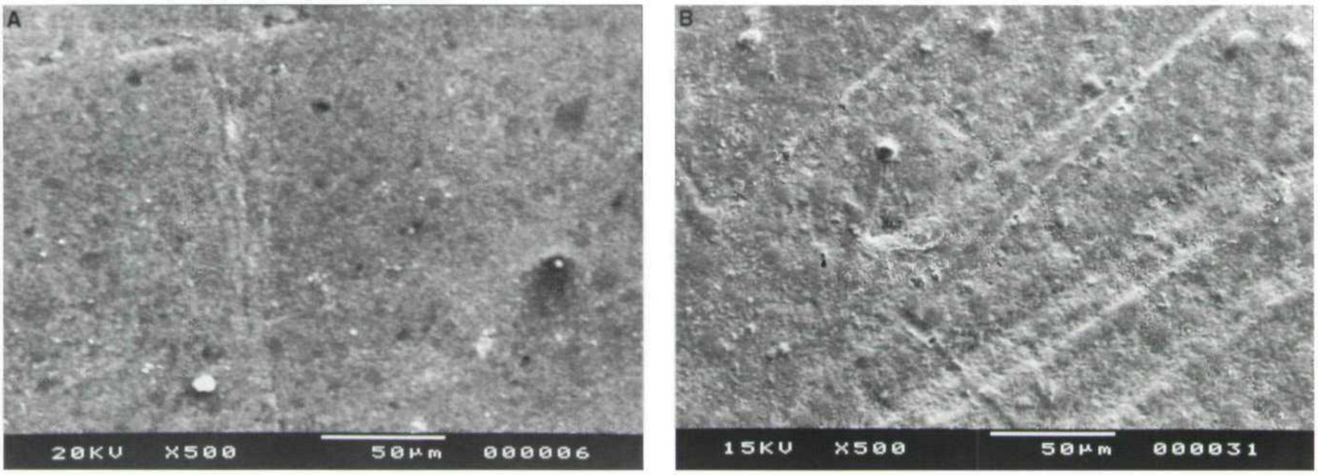

Figure 3. Solitaire composite. A, *Surface pattern finished with Sof-Lex disks prior to the toothbrushing test (surface roughness [Ra] = 0.32 µm);* B, *surface pattern after the toothbrushing test (Ra = 0.28 µm) (×500 original magnification; bar denotes 50 µm).*

wear, and a combination of these events were detected.

DISCUSSION

Even though a laboratory study is not able to reproduce all the conditions of the oral environment, it is still relevant for prediction of clinical performance. Laboratory studies demand less time and cost to be conducted than do clinical studies. Different methods have been employed to evaluate quantitative and qualitative abrasion resistance of dental composites, such as weight loss,[23,33,47] profilometric tracings,[17,18,36] surface roughness,[17,23,40] and photomicrographs.[23,46,47] Simulated toothbrushing has been used to mimic a frequent oral abrasion to evaluate the resistance of different materials.[20,21,25,31,32,36,48] The results make possible the comparison and ranking of materials submitted to various standardized conditions in an attempt to reproduce a common oral hygiene procedure, which is highlighted in preventive dentistry.

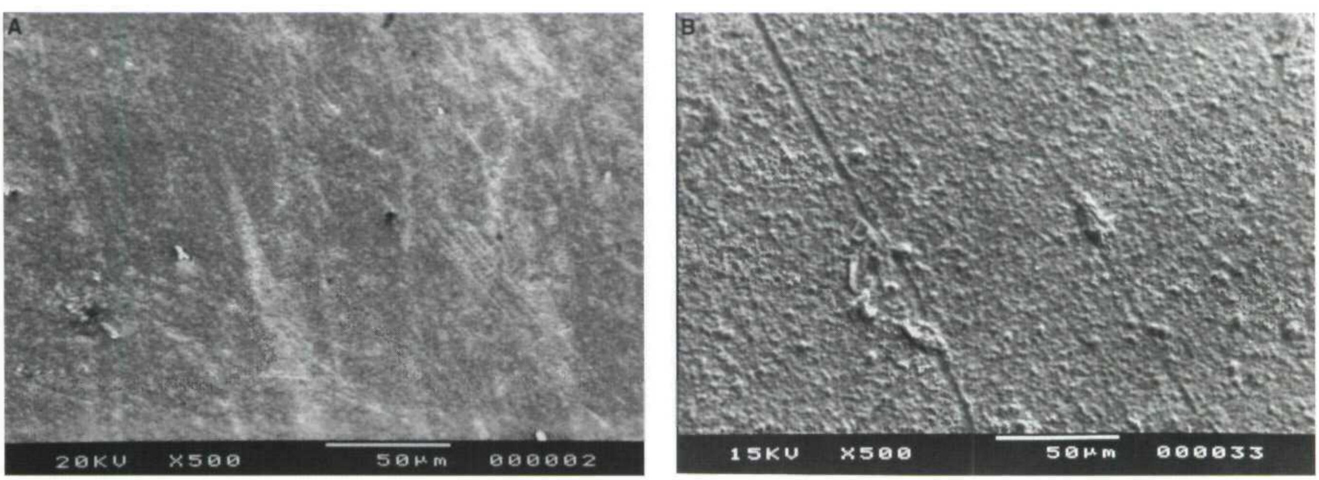

Figure 4. Filtek P60 composite. A, *Surface pattern finished with Sof-Lex disks prior to the toothbrushing test (surface roughness [Ra] = 0.19 µm);* B, *surface pattern after the toothbrushing test (Ra = 0.28 µm) (×500 original magnification; bar denotes 50 µm).*

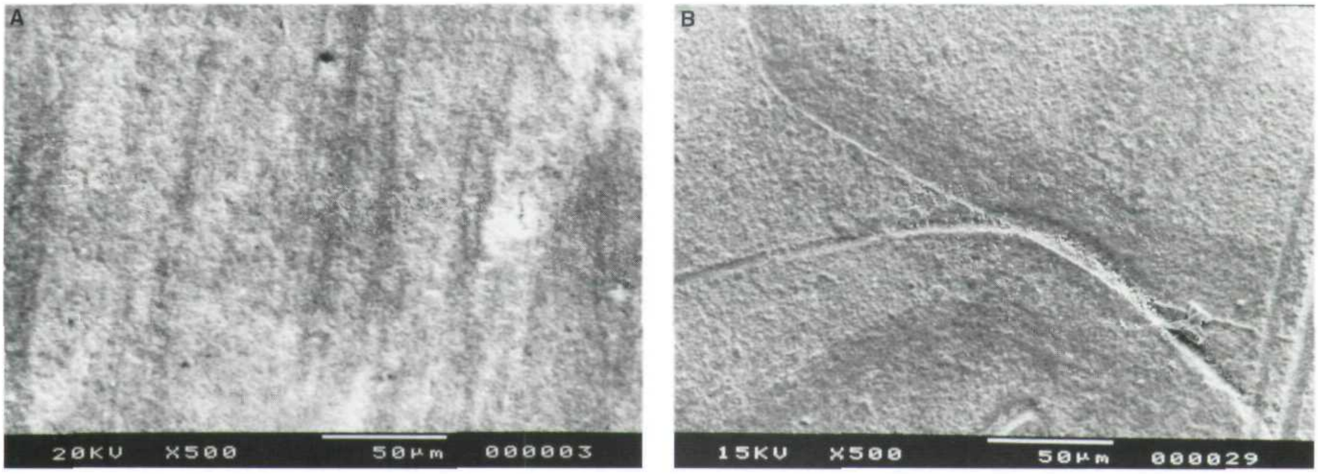

Figure 5. Prodigy Condensable composite. A, *Surface pattern finished with Sof-Lex disks prior to the toothbrushing test (surface roughness [Ra] = 0.21 µm);* B, *surface pattern after the toothbrushing test (Ra = 0.19 µm) (×500 original magnification; bar denotes 50 µm).*

Thus, toothbrushing wear resistance is a relevant aspect related to the durability of restorations.

In the present study, each resin composite presented a distinct performance, which suggests that results were dependent upon each formulation. Weight loss percentage ranged from 0.38 to 1.69 after simulated toothbrushing. Previous studies under similar conditions also demonstrated a similar rate of weight loss. Rios and colleagues evaluated toothbrushing abrasive resistance of some fissure sealants and observed that Vitremer™ (3M ESPE) and Ketac-Molar™ (3M ESPE) presented 1.26 and 1.52% of weight loss, respectively.[21] In our study SureFil, Alert, Z100, and Filtek P60 showed higher abrasion resistance (as measured by weight loss percentage) compared with the other resin composites. These brands contain a higher filler percentage than do Solitaire, Prodigy Condensable, and

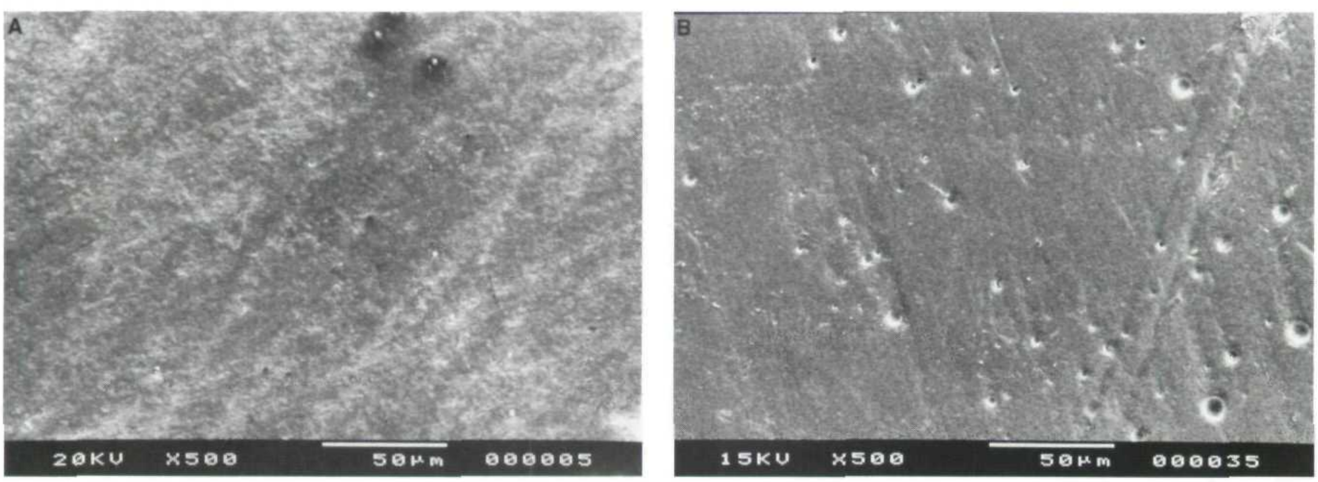

Figure 6. Z100 composite. A, *Surface pattern finished with Sof-Lex disks prior to the toothbrushing test (surface roughness [Ra] = 0.366 µm);* B, *surface pattern after the toothbrushing test (Ra = 0.30 µm) (×500 original magnification; bar denotes 50 µm).*

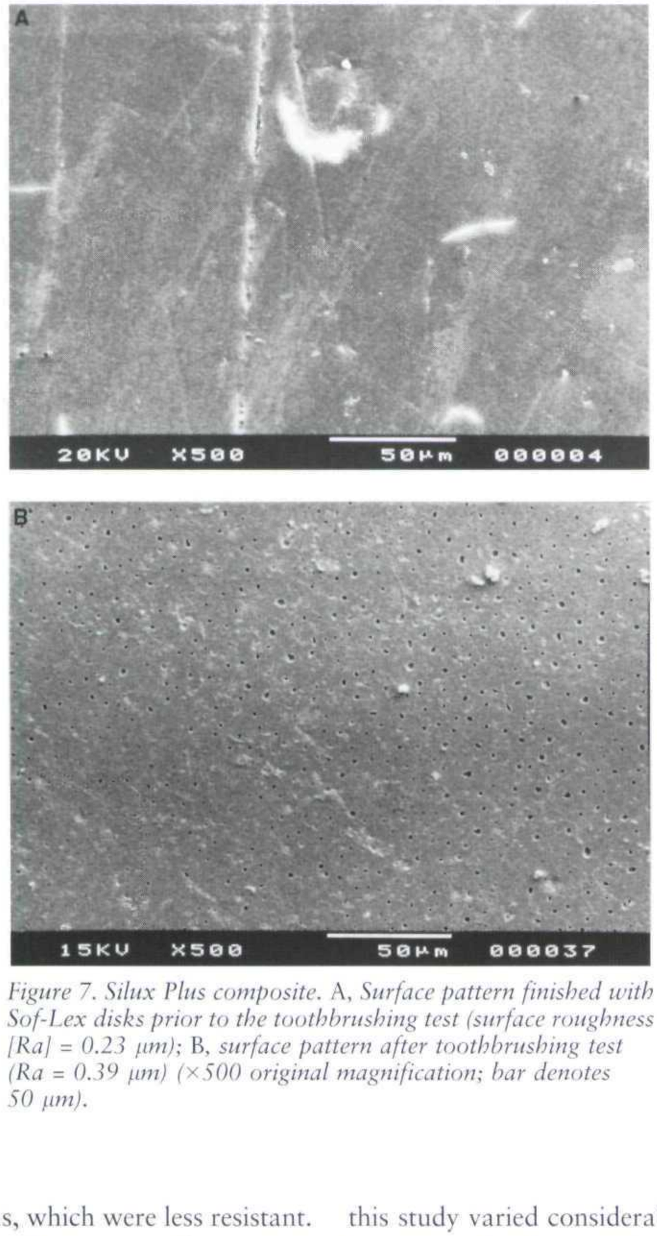

Figure 7. Silux Plus composite. A, *Surface pattern finished with Sof-Lex disks prior to the toothbrushing test (surface roughness [Ra] = 0.23 µm);* B, *surface pattern after toothbrushing test (Ra = 0.39 µm) (×500 original magnification; bar denotes 50 µm).*

Silux Plus, which were less resistant. A higher filler content offers protection for the organic matrix, reducing the wear process.[38]

Despite minimal weight loss, resultant surface roughness did occur, which is the major problem that presented.[23] Wear patterns and surface microstructure of the different resin composites included in this study varied considerably. Various studies have evaluated material surfaces by SEM after a wear process.[33,47] O'Brien and Yee observed five principal wear standards of composite restorations: fracture, loss of particles of filler, wear of the resin matrix, failure of the matrix through cracking, and exposure of air bubbles.[33] These events were noticed in the present study (see Figures 1–7, images B). SEM illustrations were important to determine the wear patterns of the investigated resin composites. Prodigy Condensable, Solitaire, and Z100 became smoother, whereas the others became rougher. This result could be explained by a possible polishing action of dentifrice, depending on the interaction between the surface and the abrasive particles, as described by Grabenstetter and colleagues.[34]

Microscopic observations of Alert revealed particle sizes larger than the 0.7 µm announced by its manufacturer (see Figure 1B). Filler content became exposed as regular fibers. SureFil also presented a larger size of particles than indicated by its manufacturer (see Figure 2B). In this case, irregular particles were observed clearly. After the toothbrushing test, some lacunae caused by filler disruption were present. In general, the higher resistance registered by these two packable composites may be due to a high content of filler that offers protection for the organic matrix.[38]

Solitaire surface changes consisted of partial-cutting particle as previously described by O'Brien and Yee[33] and organic matrix wear (see Figure 3B). This combination of events could contribute to the greater weight loss. Both Filtek P60 (see Figure 4B) and Prodigy Condensable (see Figure 5B) fillers were about 0.6 µm in diameter. They were characterized by projecting discrete particles with a homogeneous distribution. Jorgensen reported that when the distance between neighbor filler particles is around 0.1 μm, it protects against matrix wear.[38] One might speculate that it contributes to a better resistance. Despite a similar wear performance, however, Prodigy Condensable became smoother, probably because of its filler composition and form differences. Z100 demonstrated a satisfactory performance, presenting some particle exposure as well as matrix wear occurrence after toothbrushing test (see Figure 6B). Some small lacunae were present because of filler dislodgment. Although Filtek P60 and Z100 are from the same manufacturer, their performances were different, perhaps because of particle filler design. The latter composite presents with more irregular particles, whereas Filtek P60 presents with spherical particles.

Silux Plus is a microfilled composite with 0.04 μm particles (see Figure 7B). In this composite, filler particle disruption was obvious, resulting in many lacunae on the surface. The loss of particles contributed to a higher weight loss and a rougher surface after toothbrushing, which is in accordance with the findings of Ehrnford.[24]

One suggestion for improving the wear resistance of composites is to increase the abrasive resistance of the resin matrix, rather than increasing in the hardness of the filler particles.[42,49] These differences can be observed among the materials tested in this study. Most of the conventional resin composites are composed of dimethacrylate. Its high viscosity requires diluents such as tetraethylene glycol dimethacrylate. Urethane dimethacrylate corresponds to another alternative organic matrix composition and it is often present in current compositions. Different formulations are tried by manufacturers in an attempt to overcome the shortcomings; however, further investigations need to be performed to evaluate whether these changes promote superior mechanical properties.

According to the results of this study, clinicians should be aware of the correct indications for packable resin composites. Despite the manufacturers' promises, these resin composites require more definitive studies to determine their strengths and weaknesses. They seem to be advantageous more for their improved handling characteristics than for other reasons.[1] Previous studies have also demonstrated a performance similar to that of hybrid resins.[1,10] Amalgam performance in wear situations is still superior compared with that of resin composites restorations.[4,19]

In this study the method applied allowed for a ranking of the materials according to their resistance to abrasion under laboratory-specific conditions. Our study seems unique in this manner since there is no other investigation in the current literature that endeavors to compare the wear resistance of packable resin composites in response to toothbrushing.

Even though differences were detected comparing pre- and post-testing values and SEM observations, it is unknown whether these differences predict a poor clinical significance. An association with other properties has to be considered to determine the best composite for posterior restorations.[42,48–50] Previous clinical trials have presented different responses from packable composites,[51–54] focusing on the need for more detailed information regarding all their properties before their routine use.

CONCLUSIONS

This study rejected the null hypothesis. On the basis of the results obtained, it can be concluded that all tested resin composites lost weight. It was also observed that surface texture after toothbrushing presented two distinct results: Prodigy Condensable, Solitaire, and Z100 achieved smoother surfaces, whereas SureFil, Alert, Filtek P60, and Silux Plus became rougher. Finally, we conclude that no superiority of the packable composites should be expected.

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COMMENTARY

WEAR RESISTANCE OF PACKABLE RESIN COMPOSITES AFTER SIMULATED TOOTHBRUSHING TEST

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This study evaluated the effect of toothbrushing on material loss and surface roughness of five packable composites (Filtek P60, SureFil, Solitaire, Alert, Prodigy Condensable), one microhybrid composite (Z100), and one microfilled composite (Silux Plus). This was an interesting study because dental researchers and clinicians tend to concentrate on occlusal wear, forgetting that toothbrushing may contribute to overall material loss, rendering the surface rougher and more plaque retentive. The investigators fabricated composite disks in a mold, immediately polished them with the Sof-Lex disk system, and then stored them for 2 weeks to allow water absorption to occur. Once the weight of the specimens had stabilized, the specimens were weighed and surface roughness was assessed. They were then subjected to 100,000 strokes with a soft, nylon-bristled toothbrush at a constant load while immersed in a slurry of water and dentifrice. Subsequently, the specimens were reassessed for weight and surface roughness.

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