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ORIGINAL RESEARCH

Effect of Dental Prophylaxis Techniques on the Surface Roughness of Resin Composites

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ABSTRACT

Aim: The aim of this study is to evaluate the effect of dental prophylaxis techniques on surface roughness of composite resins.

Materials and methods: A total of 36 nanohybrid resin composite test specimens were fabricated and divided into three groups (n = 12). They were kept in distilled water at 37°C for 24 hours and submitted to the finishing and polishing technique. For the prophylactic techniques, in group G1, a mixture of pumice stone and distilled water was used with the aid of a rubber cup; in group G2, Herjos-F prophy paste was used with a rubber cup; and in group G3, a bicarbonate jet spray was used. Afterward, all the samples were repolished using the Soflex pop-on disks. A roughness meter was used to measure surface roughness at three points in time: Before the prophylactic techniques (1st evaluation), afterward (2nd evaluation), and following repeat polishing (3rd evaluation).

Results: It was found that roughness values changed significantly between the 1st and 2nd evaluations ($p < 0.05$) and between the 2nd and 3rd evaluations ($p < 0.05$), showing that the change in roughness depended on the type of prophylactic treatment. Roughness was significantly higher after the bicarbonate jet ($p < 0.05$).

Conclusion: Prophylaxis using the sodium bicarbonate jet significantly altered the roughness of nanoparticle-reinforced resin.

Clinical significance: Dental prophylaxis is the most common practice employed to remove bacterial plaque and other coatings. However, one side effect of the cleaning may be a rougher surface subject to degradation and staining. The correct use of prophylactic devices and avoiding prolonged use on resin restorations reduce surface roughness.

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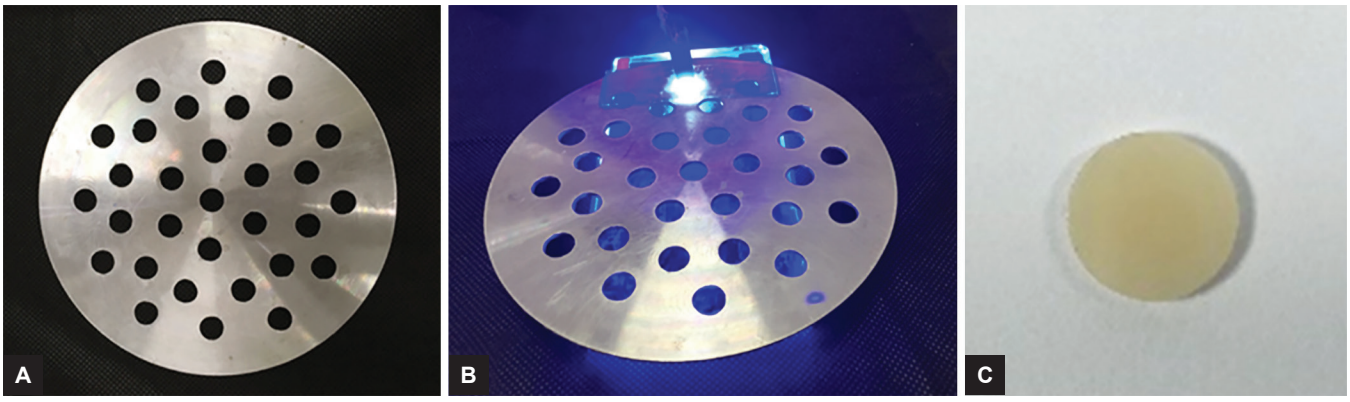
INTRODUCTION

In the recent decades, restorative dentistry has made significant advances in the evolution of materials and techniques for restoring shape and function to the dental structure, as well as offering the patient an opportunity to have a more harmonious smile.[1] One of the materials that has seen great progress is resin composites; these are used in both the anterior and posterior teeth and possess good, mechanical, biological, and physical properties, as well as providing excellent esthetics.[2]

The particle size is hugely important for surface hardness and smoothness; the smoother the surface of resin composite restorations is, the lower is the biofilm adhesion. Better optical and esthetic properties will also be obtained.[3] Within the evolution of resin composites, at the present time, nanoparticle-reinforced resins are the most noteworthy. These are composed of inorganic substances of nanometric scale and are thus, are very strong and have excellent optical properties.[4]

The success and longevity of resin composite restorations are a function of the material selected, the professional's technical skills, and the patient, who must take responsibility for his/her own oral hygiene, eating habits, and preventive measures, as carious lesions have been one of the causes of replacement of direct resin composites.[5,6]



Figs 1A to C: (A and B) Metal mold using to fabricate specimens; and (C) resin compost specimen

A great many factors can have an influence on the roughness of resin composites, including size and volume of inorganic matter and size and hardness of the abrasives used in the finishing and polishing techniques. Similarly, the techniques of dental prophylaxis followed by polishing can affect their roughness[7] and leave a rougher surface, i.e., subject to degradation and staining.[8] The correct use of prophylaxis devices reduces surface roughness in resin composite restorations.[9]

Pastes of pumice stone and water combined with the rubber cup, prophylaxis pastes, and bicarbonate jet sprays are used to remove dental biofilm and extrinsic stains. These systems are effective in terms of cleaning ability,[10] but may affect the surface roughness of the resin composites. Given the above, it is necessary to investigate if the different techniques and materials employed for dental prophylaxis on nanoparticle-reinforced resin composite restorations significantly alter the roughness and if repeat polishing is capable of restoring surface smoothness.

MATERIALS AND METHODS

The sampling calculation was performed with $\alpha = 5\%$ and a test power of 80% (Biostat 5.0, version 2007), resulting in the recommendation to use 36 test specimens.

Preparation of the Test Specimens

The test specimens were fabricated in the shape of disks 10 mm in diameter and 2 mm thick, using a perforated metal mold (Fig. 1A).

The mold was filled with Opallis nanoparticle-reinforced resin composite (FGM, Joinville, Santa Catarina, Brazil), color A2 for enamel, which was pressed using a polyester matrix strip (TDV, Pomerode, Santa Catarina, Brazil), with the assistance of a microscope slide (Labor Import, Osasco, São Paulo, Brazil), producing a smooth resin surface.

The resin was inserted in incremental fashion using a purpose-designed spatula (Prisma, São Paulo, Brazil) and then photopolymerized for 40 seconds per increment (following manufacturer's instructions) using the photopolymerizer Optilight Plus light-emitting diode light-curing unit (Gnatus, Ribeirão Preto, São Paulo, Brazil) with light intensity measured using a 600 mW/cm^2 Optilight LD radiometer (Gnatus Brasil, Joinville, Santa Catarina, Brazil; Figs 1B and C).

After fabrication, the test specimens were placed at random into plastic containers for examination along with distilled water and stored in a bacteriological incubator for 24 hours at 37 ± 1°C.

Finishing/Polishing and Dental Prophylaxis Techniques

The test specimens were divided at random into three experimental groups, to be submitted to different dental prophylaxis techniques, as shown in Table 1.

All the test specimens were submitted to the finishing and polishing technique (Soflex pop-on abrasive disks–3M, São Paulo, Brazil) for an initial analysis of roughness (Fig. 2A). Three readings were taken for each specimen. During the finishing/polishing procedure, medium- and fine-grit abrasive disks were used with movement in one direction only, and under controlled pressure for 40 seconds, by a single operator (Fig. 2B). The disk change was standardized once for every four resin test specimens.

After the finishing and polishing procedures, an evaluation of roughness was performed (1st reading) using a roughness meter (SJ-210, São Paulo, Brazil). For each specimen, a total of three readings were taken, using

Table 1: Distribution of groups according to polishing treatment order

Groups	*n*	*1st stage*	*2nd stage*	*3rd stage*
I	12	Soflex fin/pol	Prophylaxis—pumice stone	Soflex fin/pol
II	12	Soflex fin/pol	Prophylaxis—prophylaxis paste	Soflex fin/pol
III	12	Soflex fin/pol	Prophylaxis—bicarbonate jet	Soflex fin/pol

Figs 2A and B: (A) Finish and polish the specimens; and (B) evaluation of roughness using a roughness meter

the average of the values obtained. Subsequently, for each group, different prophylaxis protocols were carried out as follows:

- *Group I*: Prophylaxis with the aid of a low rpm micromotor (Kavo, Joinville, Brazil), rubber cup (Viking, Curitiba, Brazil), and a mixture of pumice stone (SS White, 3M, Rio de Janeiro, Brazil) and distilled water. The mixture proportion was 60 gm of pumice stone to 50 mL distilled water, for 10 seconds without interruption.
- *Group II*: Prophylaxis using Herjos-F prophylaxis paste (Vigodent, Rio de Janeiro, Brazil), for 10 seconds without interruption.
- *Group III*: Prophylaxis through the application of a sodium bicarbonate jet spray (Profi II – Dabi Atlante, Ribeirão Preto, Brazil). The tip of the jet was set at an approximate distance of 5 mm, as per manufacturer's recommendations, and at an angle of 90°, carried out for 10 seconds without interruption.

At the end, the test specimens were washed in water for 10 seconds using a triple syringe, and then dried with the aid of jets of air for 5 seconds and evaluated for surface roughness, following the same procedure used in the 1st reading (2nd reading). Subsequently, all the test specimens underwent the same finishing and polishing sequences to carry out an evaluation of surface roughness (3rd reading).

Statistical Analysis

The following hypotheses were tested: (1) Whether the average roughness values changed significantly within the groups, between the 1st and the 2nd evaluations, and between the 2nd and 3rd evaluations, (2) whether there was a significant difference in the average roughness values between the groups before and after prophylaxis and after polishing.

To answer the first hypothesis, repeated measures analysis of variance (ANOVA) was employed, while the second was answered by employing, for each reading period, the one-way ANOVA test, supplemented by the *post hoc* Tukey test. The level of significance adopted was 5%. The statistical program used was Statistical Package for the Social Sciences version 23.0 (IBM, Armonk, New York, USA).

RESULTS

The mean and standard deviation values for roughness, after the three roughness readings, are in Table 2.

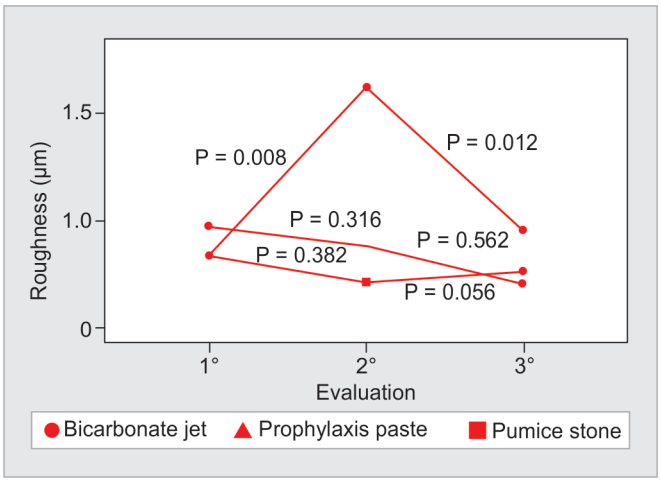
The repeated measures ANOVA showed that there was a significant change in roughness in the group, which used the bicarbonate jet spray, between the 1st and 2nd readings ($p = 0.008$), and between the 2nd and 3rd readings ($p = 0.012$). There was no difference between readings within the other groups ($p > 0.05$; Graph 1).

The one-way ANOVA, used for each reading period, enabled us to ascertain that there was no significant difference between the groups after the initial treatment ($p = 0.720$) and the final treatment with Soflex ($p = 0.531$); however, in the analysis of the 2nd reading, it was found that the roughness was different between groups ($p = 0.004$). The use of the bicarbonate jet spray afforded a significantly higher roughness value than the treatments with prophylaxis paste ($p = 0.005$) and sodium

Table 2: Mean roughness values (standard deviation) in μm, after the different prophylactic treatments

Groups	*1st Reading (Post-Soflex)*	*2nd Reading (Prophylactic treatment)*	*3rd Reading (Post-Soflex)*
		Pumice stone paste	
I	0.974 (0.446)	0.883 (0.324)[a]	0.706 (0.403)
		Prophylaxis paste	
II	0.830 (0.559)	0.711 (0.262)[a]	0.765 (0.486)
		Bicarbonate jet	
III	0.839 (0.432)	1.61 (1.045)[b]	0.951 (0.713)

Different letters superscript: Statistically significant difference, $p < 0.05$ (ANOVA, Tukey test)



Graph 1: Mean roughness values (µm) after different types of surface treatments and the comparisons between readings within the groups with the respective values ($p < 0.05$, statistically significant difference)

bicarbonate ($p = 0.025$); however, there was no significant difference between the prophylaxis paste and the sodium bicarbonate ($p = 0.796$; Table 2).

DISCUSSION

Some of the most important characteristics in restorations in anterior teeth relate to surface roughness. A new type of photoactivated composite resin, known as nanohybrid resin, was recently introduced to the dental marketplace. Its characteristics give the material properties that surpass those of hybrid composites, namely, better polishing, ease of handling, and the ability to preserve the anatomical structure for long periods of time.[4] Therefore, as a way to keep abreast of the evolution of composite resins, the present study used, for its methodology, a nanohybrid composite resin (Opallis-FGM).[6]

The studies have shown that the percentage of bacterial plaque retained on restored surfaces is higher than on tooth surfaces, and that this deposition provokes the onset of periodontal disease. The finishing and polishing procedures reduce the surface roughness of restoration materials, thereby guaranteeing the oral health of patients and the longevity of the restorative treatment.[7]

In the literature, no standard finishing and polishing technique has been established. In fact, there are many such techniques, with different recommendations for instruments and materials to attain this objective.[11] Polishing affords greater tolerance of the periodontal tissue to the restorations,[12] and according to Chung,[13] these procedures produce reduced roughness, ranging from 26 to 74%. In the present study, Soflex pop-on abrasive disks were used (3M, São Paulo, Brazil) to perform the finishing and polishing techniques, in view of the fact that these mechanisms have demonstrated excellent results in the performance of finishing and polishing with resin composite restorations.[5]

No significant difference was found between the groups that initially underwent finishing and polishing with the Soflex disk when compared with the groups that were repolished after applying the prophylactic methods (Table 2). In this regard, the results obtained by Yap et al,[14] in their evaluation of the surface roughness of resin composites subjected to finishing and polishing systems, showed that the Soflex abrasive disks promoted greater surface smoothness, corroborating the studies conducted by Da Costa et al[12] and Ergücü and Türkün,[15] where the average polishing with Soflex abrasive disks was higher (0.470 µm) than with the enhanced abrasive rubber cups (1.180 µm).

As far as the techniques of dental prophylaxis are concerned, the present work found that the use of the bicarbonate jet produced a significantly higher average roughness than the treatments that used prophylaxis paste or pumice stone paste. This finding agrees to the study by Alawjali and Lui[2] in which an analysis was carried out for the surface roughness of microhybrid resin composites after the application of the sodium bicarbonate jet spray, demonstrating that all resin composites exhibited a considerable increase in surface roughness over the initial values. The study conducted by Lu et al,[16] however, showed contradictory results, finding greater roughness with the prophylactic treatment carried out with pumice stone instead of the bicarbonate jet.

According to Jost-Brinkmann,[17] variances may be found in the distance from the tip of the jet or in angularity, depending on the region to be worked, which may interfere with the effectiveness of the outcome. In the literature, we found large variations in both angularity and distance and in Scotti et al,[18] e.g., an inclination of just 30°.

In terms of the distance from the tip of the bicarbonate jet to the resin surface, differences were found ranging from 3 to 10 mm. The manufacturer recommends a distance of 5 mm and an angle of between 45° and 90°. These differences in distance and angularity may in some way influence the results of alteration in the roughness of resin composites. Therefore, within the criteria and in accordance with that which the majority of authors advocate, the present study established a distance of 5 mm and an angle of 90° for all the studied samples.

In the present study, the prophylaxis technique that uses the bicarbonate jet afforded a significant increase in surface roughness, thereby demonstrating the need to carry out a repolishing of resin composite restorations. The prophylaxis techniques used were bicarbonate jet and

rubber cup with pumice stone paste. Surface roughness was evaluated before and after the prophylaxis techniques. The results showed an increase in average surface roughness of the resins after the two prophylaxis techniques. After repolishing, the groups exhibited a decrease in surface roughness, for both of the resins under analysis.

Roeder and Powers[9] remind us of the correct use of the devices for prophylaxis, avoiding protracted use on restorations and regions of dentin and cement. To reduce surface roughness and marginal seepage, the repolishing of restorations is advocated after prophylaxis as well as the use of surface sealants.

Thus, surface roughness caused by the absence of repolishing after dental prophylaxis could give rise to a buildup of plaque, gum irritation, susceptibility to pigmentation,[17] increase in the rates of wear and tear, recurrent caries, and impairment of the brightness of the restoration, resulting in a reduced longevity.[11]

Based on the results of this study, it is recommended that, after prophylaxis using bicarbonate jets, pumice stone paste, or prophylaxis paste, resin composite restorations should be subjected to a fresh polishing to restore surface smoothness. Further studies are required using other types of resin, finishing and polishing methods, and prophylaxis techniques.

CONCLUSION

Based on the methodology employed and noting the results obtained, it may be concluded that:

- Dental prophylaxis techniques do have an influence on the surface roughness of resin composites;
- The bicarbonate jet produces an increase in surface roughness; and
- The repolishing of resin composites significantly reduces alteration in surface roughness.

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