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An evaluation of the effects of different finishing / polishing techniques on smoothness of composites

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Abstract

Rough, poorly polished resin – based composite surfaces contribute to staining, plaque accumulation, gingival irritation and recurrent caries. Proper finishing and polishing enhance both the esthetics and longevity of restored tooth. To evaluate the effect of different finishing / polishing techniques on the surface roughness of minifilled hybrid Filtek Z250 and very fine particles hybrid Latitude composite resins. Two types of composite resin were used, Filtek Z250 and Latitude. 32- disc shaped specimens for each type of composite were made (with diameter of 10 mm and 2mm thick) and total is 64 –specimens. All the specimens were cured under Mylar – matrix strip and divided into four groups: control had no surface treatment, finished with fine and extra fine diamond burs, finished with 12 – fluted and 30 – fluted carbide finishing burs, treated with diamond burs plus coarse, medium, fine and extra fine Sof – lex discs. Surface roughness of the specimens was evaluated using profilometer, and the data were analyzed by 2 – way ANOVA test and LSD test. There was statistically significant difference in the average surface roughness values among Mylar – strip, diamond bur, carbide bur, diamond bur plus Sof – Lex discs. For both materials, there was no significant difference between them. Surface roughness of composite resin is directly influenced by finishing / polishing technique used. For both types of composite resin tested in this study, there was no significant difference between them. The Mylar strip provided a smoother surface than the other groups. It was followed by diamond bur plus Sof – Lex disc, carbide bur and, the diamond bur produced the highest surface roughness values.

Key words: surface roughness, finishing, polishing.

Introduction

Over the years, several changes have been made in the fabrication of dental resin composites to obtain better color stability over time, greater wear resistance, and clinically acceptable surface smoothness of restorations. [1] The esthetic appearance and lack of mercury are characteristics that have made composites a desirable and popular restorative material among clinicians and there are many kinds of composite materials, that vary by the filler type and content which affects their handling characteristics and physical properties. [2] Surface qualities are important to the longevity of a tooth-colored restoration in the oral cavity since surface roughness of resin composites affects plaque accumulation, abrasively and wear kinetics, as well as tactile perception. [3] The aesthetic appearance of tooth-

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colored restorations is of great interest to both the dentist and patient. [4] since restorations that are smooth, uniform, and highly polished are more esthetic and can be more easily maintained than restorations with rougher surface. The result is longer lasting restorations and satisfied patients. [2]

Proper finishing of restorations is desirable not only for esthetic considerations but also for oral health. The primary goal of finishing is to obtain a restoration which has good contour, occlusion, healthy embrasure forms and a smooth surface, [5] and the resin composite restorations should be smooth to reduce plaque retention to minimize possible gingival irritation, surface staining and patient discomfort [6]. Finishing and polishing of composite resin restorations are essential steps in restorative dentistry. The esthetics and life span of tooth-colored restorative materials are dependent on the quality of the surface finish. [7]

Finishing refers to the gross contouring or reduction of the restoration to obtain the desired anatomy[7] while polishing refers to the reduction of the roughness and scratches created by the finishing instruments, [2,7] and various finishing and polishing techniques have been examined with different types of composite resin in an attempt to produce a smooth surface. [8] A wide variety of finishing and polishing devices have been investigated, including coated abrasives such as diamond burs and aluminum oxide or silicon carbide finishing discs. Bonded abrasives, i.e., rubber or silicone compounds, and several polishing pastes containing fine-particle-size abrasives have also been recommended for polishing of composite resins. [7, 9] Discs are nondestructive, but their effect on anatomically contoured occlusal surfaces is limited because they cannot access the narrow fissures on the surface for geometric reasons.[10] Proper finishing and polishing are important steps that enhance both esthetics and longevity of both restored teeth. Restoration finish, surface roughness and surface integrity as well as the physicochemical properties of the material itself, can influence plaque retention, periodontal disease, recurrent decay and staining of the resin composite. [8] The purpose of this study was to evaluate the surface roughness values of minifilled hybrid Filtek Z250 and very fine particles hybrid Latitude with the use of different finishing / polishing techniques.

Materials and Methods

In this study, two light polymerized composite resins (shade A2) with different sized filler content were use and are listed in table (1). Finishing and polishing systems used in this study were listed in table (2). Thirty two disc – shaped specimens were prepared for each composite resin material with dimensions of (10 X 2mm) for a total of sixty four specimens, using polytetrafluoroethylene mold. The restoration materials were placed in the mold and covered with a Mylar – strip and then compressed with a glass slide using hand pressure to extrude excess material. The samples were then light polymerized according to the manufacturer's instructions using Astralis – 3 (Ivocclar Vivadent, Schaan, Liechtenstien) curing light with an output intensity of 600 mW/cm^2. The polymerized specimens were removed from the mold and stored in distilled water at 37C° for 24 hours. Diamond and carbide burs were applied using light pressure in a single direction. After application on five surfaces, a new bur was used. The aluminum oxide discs were discarded

after each use. The specimens were grouped as followed:

Group (1): samples were left undisturbed after the removal of the Mylar – matrix strip (control).

Group (2): Fine and super fine diamond burs sequentially applied for 20 seconds each, using water – cooled high speed hand piece, moved on single direction on the entire specimen surface.

Group (3): samples were finished with 12 – fluted and 30 – fluted carbide finishing burs applied in the same way as described for group (2).

Group (4): Diamond burs applied as described for technique (2), plus coarse, medium, fine and extra fine Sof – lex aluminum oxide discs, applied for 20 seconds each, using a low speed hand piece with circular movements and without water cooling.

The average surface roughness (Ra μm) was measured on each specimen by means of a surface profilomater (Talysurf Plus, Tailor-Hobson, Leicester, UK). Three measurements in different directions were recorded for every specimen from of each group, and the mean Ra value was determined for each specimen. The data were analyzed using 2 – way ANOVA test followed by LSD test.

Results

The results of 2 – way ANOVA used to test the surface roughness of the composite resin showed that the type of composite resin was not significant ($P > 0.05$) , while the finishing / polishing techniques used and the interaction with composite resin were statistically significant ($P < 0.01$) as shown in table (3). The mean Ra values, SDs (Standard of Deviation) and differences within groups of composite resin according to the types of finishing / polishing techniques are listed in table (4).

Discussion

Surface finishing is a critical step in achieving an esthetically acceptable restoration, and different materials and instruments may be used.[11]Finishing refers to gross contouring or reducing of the restoration to obtain the desired anatomy, while polishing reduces the roughness and scratches created by finishing instruments. Rough, poorly polished surfaces contribute to staining, plaque accumulation, gingival irritation and recurrent caries.[12]The effectiveness of finishing and polishing procedures on contemporary tooth–colored restorative surfaces is an important consideration in the restorative process.[13]The results of the present study showed that Mylar strip produced the smoothest surface and this agree with Özgũnaltay et al.[13],Üçtasli et al.[14], Yzici et al.[15] since Özgũnaltay et al.[13] stated that although the Mylar strip is a versatile instrument, it does not meet all the criteria with respect to contour and form. Üçtasli et al. [14] found that, after placing of the composite restorations, removal of excess material or re – contouring of the restoration is often necessary. Furthermore, the Mylar exposed surface is a resin rich surface layer that is easily abraded in the oral environment. If it's not polished, rough, inorganic filler material will be exposed.

In this study, the use of diamond bur alone in group (2) yielded a remarkable increase in the surface roughness of the two composite resins evaluated into which the Ra values obtained with diamond bur were significantly greater than those obtained with group (3) and group (4). This is in agreement with Ferracane et al. [16] who reported that finishing

using diamond burs tended to leave a more irregular surface when compared with finishing using carbide bur and agrees with Jung [17] and Barbosa et al. [9] who suggested that finishing diamonds were best suited for gross removal and contouring because of their high cutting efficiency of composite surface, while carbide finishing burs would be best suited for smoothing and finishing as a result of their low cutting efficiency.

For a composite finishing system to be effective, the abrasive particles must be relatively harder than the filler material, other wise, the polishing agent will only remove the soft resin matrix and leave the filler particles protruding from the surface. [7, 8] In this study, composite resin specimens finished by diamond burs and then polished with aluminum oxide discs had the lowest Ra values in comparison with specimens finished with carbide or diamond burs. This finding agrees with Özgũrnaltay et al. [13] who evaluated various finishing / polishing procedures on the surface roughness of tooth – colored restoratives and found that the use of carbide or diamond finishing burs followed by aluminum oxide discs provided the smoothest surface for all materials tested. This result also agrees with Jung et al. [18] who evaluated four finishing and polishing systems on the surface roughness of three packable and one hybrid resin composite and found that, Sof – Lex discs caused a significant reduction in roughness. Such result could be explained that, the aluminum oxide discs overcame the surface roughness created by finishing diamond burs.[15] Such result agrees with Özgũrnaltay et al. [13] who stated that the discs having the ability to remove the surface scratches created by carbide or finishing burs and agree with Barbosa et al. [9] who stated that the aluminum oxide discs having their own malleability that promotes a homogenous abrasion of the filler and the resin matrix.

For both types of composites tested in this study, there was no significant difference when comparing between their groups. This could be explained by their filler particle size. For Filtek Z250, the average filler particle is 0.6μm, while for latitude composite, the average filler particle size is 0.7 μm and this agrees with Nagem – Filho et al. [10] who stated that different compositions of the particles and matrix of composite resins are not important in determining surface roughness after use of diamond bur, probably due to the rough surface they produce. The result of the present study also agrees with Da Costa et al.[1] who evaluated surface finish of minifilled, nanofilled, and microfilled composites polished with six polishing systems. They found that the surface roughness for the microfilled composite was not significantly different from that of the nanofilled and minifilled composite. As a conclusion, surface roughness of composite resin is directly influenced by finishing / polishing technique used. For both types of composite resin tested in this study, there was no significant difference in surface roughness values. The Mylar matrix strip provided a smoother surface than diamond bur plus Sof – Lex aluminum oxide disc. The diamond bur plus Sof – Lex aluminum oxide disc produced smoother surface than carbide bur. Furthermore, the diamond bur produced the highest surface roughness values.

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Table (1) Composition of composite resin used in this study

Composite resin	Filler	Filler loading by volume	Filler loading by weight	Average filler particle size	Batch No.	Company
Filtek Z 250	Zirconia/ Silica	60%	82%	0.06µm	6020 A2	3MESPE Dental Products, USA
Latitude	Ba-Al-Fluorosilicate glass	60%	80%	0.07µm	X28258	AB Ardent, Arlandastad, Sweden

Table (2) Finishing and polishing systems used in this study

Material	Batch No.	Manufacture
Carbide finishing bur 12 – fluted	D18150976	BeaversDental, Morrisburg,Ontario, Canada
Carbide finishing bur 30 – fluted	A18150998	BeaversDental, Morrisburg,Ontario, Canada
Fine diamond bur	8324985	Diatech Dental, Heerbrugg, Switzerland
extra fine diamond bur	8324989	Diatech Dental, Heerbrugg, Switzerland
Sof – Lex finishing and polishing discs (super fine, fine, medium, coarse)	1980	3MESPE Dental Products, USA

Table (3) Two – way ANOVA test

Source of variance	Sum of square	df	Mean square	F	P-value
Composite resin	0.035113	1	0.105586	3.287944	0.325
Finishing/ polishing technique	0.605738	3	0.201913	18.90714	0.01
Composite resin X Finishing / polishing technique	0.184826	3	0.025579	9.276628	0.01
Error	0.032038	5	0.010679		
Total	0.857715	12			

$P < 0.01$ (Highly significance)
$P > 0.05$ (Non significance)

Mean and SD Ra values and differences within groups

Composite resin	Group (1)	Group (2)	Group (3)	Group (4)
Filtek Z250	0.37 ± (0.04)	0.96 ±(0.06)	0.79 ± (0.04)	0.53 ± (0.05)
Latitude	0.40 ± (0.08)	1.30 ± (0.10)	0.82 ± (0.05)	0.66 ± (0.05)

Connecting bar indicating non significant difference (P-value > 0.05)