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Research Report

The surface roughness difference between microhybrid and polycrystalline composites after polishing

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ABSTRACT

Background*: One of the success criteria for a composite resin restorative material is the surface roughness that can be achieved through polishing. Considering that there are so many types of composite resin materials on the market, including polycrystalline composites, information on this type of composite's surface roughness is needed.* ***Purpose****: The aim of this laboratory experiment was to compare the surface roughness difference between microhybrid and polycrystalline composite after polishing.* ***Methods:*** *In order to obtain this, a laboratory experiment was done. Four groups of composites were produced, the first two groups consist of microhybrid composite and the second two groups consist of polycrystalline composite. Two groups with the same material were treated with two different treatments as follows: the first group was not finished (the surface is under celluloid matrix), the second group was finished and polished. After these treatments, each sample's surface was measured using surface roughness measuring instrument and then the* ***Results:*** *were analyzed statistically using independent t-test ($\alpha = 0.05$).* ***Conclusion:*** *The result showed that after polishing, the surface roughness of polycrystalline composite is lower than that of microhybrid composite.*

Key words*: surface roughness, microhybrid composite, polycrystalline composite*

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INTRODUCTION

In the mastication system, teeth have a major function. Today, beside this function, patients tend to correlate teeth with esthetics on how to make their teeth look better.[1,2] In conservative dentistry, this is surely connected with the right choice of supporting dental instruments and materials. Considering this, currently there are many esthetic-based dental instruments and materials developed in the market.[3,4] In relation with esthetics, to get a natural dental restoration, a restorative material should bear a surface roughness and gloss equal to natural enamel.[5]

Based on clinical observations, composite-resin restorations usually change in color and prone to secondary caries. These are caused by massive plaque and food pigments deposition caused by rough restoration surfaces as a result from incomplete finishing and polishing.[6] According to previous studies against microhybrid composite-resins, finishing and polishing with various instruments and methods have not satisfactorily provided an acceptable natural smooth surface.[7] This makes the availability of better composite-resin types and polishing instruments in high demand.[5–8]

Composite resins are considered as one of highly acceptable esthetic materials because of their wide varieties of natural shade selection.[9] The most widely used composite resin is the microhybrid type because of its wide range of applications, but this type of composite-resin has softer matrix with irregular filler shape and size, resulting a higher inter-filler space, therefore finishing and polishing would abrade the softer matrix and leave the un-abraded harder filler, hence resulting a rough surfaced restoration. A new composite resin type that has been introduced lately is the polycrystalline composite-resin, containing phenolic-epoxyne (PEX) liquid crystal matrix and glass-ceram silica fillers.

This polycrystalline composite resin was introduced to have better physical properties compared to regular composites and the use is clinically multi purpose.[10] This composite resin contains nano-sized particles and has tight filler-matrix structure in nano-cluster, resulting in high consistency and density, therefore finishing and polishing might not leave filler un-abraded and resulting a smooth surface, since finishing and polishing is an integral part that must be done in making such restorations. Polycrystalline composite resin is a new product in the market and there are limited experiments and references regarding this type of composite resin, therefore more information about this composite resin is needed.

Considering that there are so many types of composite resins available in the market, dentists as clinicians need information to choose the right materials which have better properties, and applicable in their daily practice. According this background, information about the surface roughness between microhybrid and polycrystalline composite resin after polishing is needed. The purpose of this article is to know the surface roughness difference between microhybrid and polycrystalline composite resins after polishing.

MATERIALS AND METHODS

Materials used in this experiment were Esthet-X (Dentsply, USA), Diamond Lite (DRM Research Laboratories Inc., USA), Sharpcut fine finishing diamond bur No.503 EF (Dentsply, USA), Astropol (Ivoclar-Vivadent, Liechtenstein), cotton pellet, distilled aqua, glue, and marker (Bic, France). Whereas the instruments used in this experiment were curing light QHL 75 (Dentsply, USA), E type low speed contra angle (NSK Nakanishi Inc., Japan), micromotor (NSK Nakanishi Inc., Japan), dental unit (Belmont, Japan), Pana Air high speed contra angle (NSK Nakanishi Inc., Japan), jar and tweezers (Kohler, Germany), scale and timer (Tanita, Japan), celluloid matrix (Svenska Dentorama, Sweden), glass slab and acrylic mould (3M, USA), plastic filling instrument (Dentsply, USA), and surface roughness measuring instrument (Hahn&Kolb TESA, Germany).

The samples prepared for this experiment were disc-shaped composite resins in 8 mm diameter and 3 mm thickness.[11] In order to produce the composite resin samples according to the certain criteria, 8 mm diameter holes were made in a 3 mm thick acrylic sheet. This acrylic sheet was then used as mould. Composite resins were screwed out from the syringe packaging to make 28 composite resin samples. Fourteen samples were prepared for microhybrid (M) group and fourteen others were prepared for polycrystalline (P) group. These composite resins were applied to the mould using plastic filling instrument. After the mould has been filled thoroughly with composite resins, the upper part of the mould were covered with celluloid matrix and glass slab and then weighted with 1 kilograms of weigh for 60 seconds. The remaining excess of composite resins was cleaned. These composite resin samples were then cured with curing light for 20 seconds as directed by the manufacturer. After curing, these composite resin samples were taken out from the mould.

Before finishing and polishing procedure, seven composite resin samples of each group were taken and called M_0 for samples with microhybrid composites and P_0 for samples with polycrystalline composites. On the remaining seven composite resin samples of each group according to the grouping, initial finishing were done using fine finishing diamond bur with 30.000 rpm speed, 50 grams of pressure (these actions were performed under the help of a digital scale), and simultaneous one-direction movements for 10 seconds (5 movements). After that, polishing were done using Astropol each with 10,000 rpm speed, 50 grams of pressure (these actions were also performed under the help of a digital scale), and simultaneous one-direction movements for 60 seconds (30 movements).

These treated groups (finished and polished) were taken and called M_1 for samples with microhybrid composites and P_1 for samples with polycrystalline composites. Each composite resin sample were coded according to grouping and were immersed in a jar containing distilled aqua and stored in an incubator at 37° C temperature. Twenty-four hours afterwards these samples were measured using surface roughness measuring instrument. The surface roughness of each sample's flat surface was measured using surface roughness measuring instrument with 100 times magnification and 2 mm range.

RESULT

Based on the result of 28 samples using surface roughness measuring instrument, several series of data were recorded and tested for the normality using one-sample Kolmogorov-Smirnov test. Further statistical analysis was performed using independent t-test with 95% level of accuracy between sample groups. The independent t-test results between sample groups could be seen on table 1.

Table 1. Statistical analysis result of the surface roughness between microhybrid and polycrystalline before initial finishing and after polishing

Sample Group	Mean ± Standard Deviation	Significance
M_0	0,6571 ± 0,0976	p = 0,789 (> 0,05)
P_0	0,6429 ± 0,0976	Not Significant
M_1	0,9286 ± 0,0951	p = 0,007 (< 0,05)
P_1	0,7857 ± 0,0690	Significant
M_0	0,6571 ± 0,0976	p = 0,000 (< 0,05)
M_1	0,9286 ± 0,0951	Significant
P_0	0,6429 ± 0,0976	p = 0,008 (< 0,05)
P_1	0,7857 ± 0,0690	Significant

According to table 1, independent t-test between M_0 and P_0 groups show no significant difference ($p > 0.05$). Independent t-test between M_1 and P_1, M_0 and M_1, P_0 and P_1 groups showed significant differences ($p < 0.05$).

DISCUSSION

Based on the result on this experiment involving microhybrid and polycrystalline composite resin samples, it was known that the surface roughness between microhybrid and polycrystalline before initial finishing has no significant difference in surface roughness, this indicate that both microhybrid and polycrystalline has equal surface roughness. This could happen since the surface of both microhybrid and polycrystalline composite resins follow the smoothness of celluloid matrix which was originally smooth. This condition appeared on the smooth-glossy surface of each corresponding samples, this was supported by the mean measurement result which was the lowest among all other groups. This phenomenon was following the basic nature of composite resins.

There was significant difference on the sample groups between the surfaces of microhybrid and polycrystalline composite resins after polishing. The greater mean on the surface roughness of microhybrid composite resin showed that after polishing, microhybrid composite resins has rougher surfaces, and otherwise, the polycrystalline composite resins has smoother surfaces. The rough surface of microhybrid composite were caused by prominent composite resin filler particles which was hard and could not be abraded by abrasive particles of the finishing instrument during polishing procedure.[6] The smoother polycrystalline composite resin surface was caused by the smoother composite resin filler particles, regular shaped and high density filler particle composition. The abraded matrix surface during polishing procedure was equal to the abraded filler particles, therefore producing a lower surface roughness.[10]

The experiment on sample groups between microhybrid and polycrystalline composite resin's surfaces before initial finishing and after polishing were significant, with average mean surface roughness higher than before initial finishing (surface under the celluloid matrix) means that the surface roughness under the celluloid matrix was the smoothest surface compared to all other groups. This phenomenon revealed that polishing modifies the surface of composite resins.[12] The modification was resulted from the abrasion of matrix and filler particles sequentially by coarser to smoother abrasive particles of the polishing instrument.[13] Furthermore, this was happened because the smoother matrix would be abraded first and afterwards smoother the surface achieved by the previous polishing instrument, repeatedly until the last step of polishing by the smoothest abrasive particles of the polishing instrument producing the lowest surface roughness.

Polishing caused the surface of composite resins both microhybrid and polycrystalline coarser if compared to the surface under celluloid matrix surface. However polishing is always an important step in making any restorations because the end result would still smoother if compared to without polishing at all after initial finishing, in consideration that initial finishing is needed to take away excess or residue of composite resins and to form the appropriate dental anatomy during the restoration-making procedure. Therefore finishing and polishing are clinically integral steps, thus must be carried out one after another in making every composite resin restoration.

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