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# SURFACE ROUGHNESS OF NANO-FILLED COMPOSITE BEFORE AND AFTER POLYMERIZATION AND STORAGE IN DIFFERENT SOLUTIONS

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**ABSTRACT**
**Aim:** This study aims to measure the flowable composite restorative of shade A3.5, "Dentsply Sirona-Spectra ST flow," for surface roughness both before and after polymerization and storage in various media.
**Materials and Methods:** Four discs of Dentsply Sirona-Spectra ST flow restorative composite in shade A3.5 have been prepared and cured under visible light. These discs are now immersed in a total of four different solutions for 7 days, and the pre- and post-immersion surface roughness is noted.

**Results:** From the current study, the mean values and the standard deviation of the mean (Ra) values of the surface roughness of the resin composite discs after 7 days resulted in almost a decrease in Ra in all groups except for group 4 (turmeric water), which increased the surface roughness after 7 days. Thus leading to the need for the replacement of the restoration.
**Conclusion:** Based on the values provided by the stylus profilometer, it shows that turmeric water caused the surface roughness to be extremely high, followed by orange juice. Milk and water made almost no difference. Despite having the best physical and chemical properties, the nanofilled resin composite's surface roughness appears to have an impact on how long the restoration would persist and also on the esthetic properties of the resin composite restoration.

**Keywords:** composite, resin, nonofilled, restorations, surface roughness

## INTRODUCTION:

Resin composite is a restorative material used to fill the gap created by the removal of decayed teeth or tooth loss that is primarily caused by dental caries. It can also be caused by erosion, fracture, etc. The aesthetic appearance and smoothness of the surface are the main objectives of the resin composite materials. This is why resin composite is preferred over conventional restorations, i.e. amalgam restorations. Both anterior and posterior teeth can be restored using resin composites. However, because of their aesthetic properties, they are most frequently utilized for the reconstruction and restoration of anterior teeth. It can also be used as a veneer material. (1) Resin composite restorations are also used for other non-restorative properties such as cementation for orthodontic brackets, Maryland bridges, ceramic crowns, inlays, onlays, laminates, repair of chipped porcelain restorations, and as pits and fissure sealants. They are also used to build cores. The typical composition of a resin composite is matrix (BisGMA, TEG DMA, and UDMA), fillers (silica), and coupling agents. Additionally, they contain color pigments, an opacifier, a UV absorber, and hydroquinone. The physical and mechanical properties, wear and tear resistance, and translucency are based on the type of matrix, fillers, and coupling agents that are used. The type of filler used reduces staining, softening, roughness, shrinkage during polymerization, etc. (1) The resin composite restorations are classified based on: 1. Depending on the type of polymerization method used (light-cured, UV-cured, visible-cured, dual-cured, self-cured, etc.), 2. Depending on the filler particle size, according to Phillips (conventional, small, microfilled, and hybrid), 3. According to Marzoak (first to sixth generations of composites), 4. Based on the composition of the matrix (TEGDMA, UDMA, Bis-EMA, Bis-GMA, etc.), 5. Depending on the radiopacity of the composite (whether radiopaque or not), 6. Depending on the mode of supply of the composite, 7. (type 1 macrofilled, type 2 microfilled, type 3 hybrid), 8. Depending on the viscosity of the composite (flowable, medium viscosity, packable), 9. Depending on which tooth surface the composite is used on (anterior and posterior composites), 10.

According to Bayne & Heyman (megafill, macrofill, microfill, midfill, minifill, nanofill),. (2) The conventional composite restoration (macrofilled) has some greater disadvantages when it comes to clinical considerations, such as difficulty in polishing, staining easily, and poor resistance to occlusal wear. The most important disadvantage of the conventional macro-filled composite was the increase in surface roughness, which led to staining. But the demand for flowable composites is increasing due to their aesthetic properties. It is preferred over amalgam due to the mercury toxicity caused by amalgam restorations. These flowable composites are used as fissure sealants, class 2 restorations in posterior teeth with limited access, and class 1 restorations in gingival regions. (3) The most common complications of resin composite restorations are fracture due to masticatory and occlusal forces, color changes, which is a major setback since the whole point of the restoration is to match the color of the tooth, and other complications like an increase in surface roughness, etc. The physical properties, like strength, color, and roughness, of the nano-filled resin composite vary depending on the oral environment. The durability of the resin composite used in dentistry is usually long-term and able to withstand the pH and adverse conditions of the oral cavity. But due to the acidic pH and constant exposure to drugs, beverages, alcohol, food, and brushing, prolonged exposure to such components can cause abrasion, attrition, and erosion on the resin composites, especially in acidic conditions. (4) As a result, the surface of the resin composite restorations becomes rougher. When the gingiva is subjected to the roughness of the restoration, it can cause irritation, redness, inflammation, and pain. This can lead to the replacement of the composite restoration (5).

**METHODS**:

Twenty disc-shaped material specimens (6 mm in diameter and 3 mm in thickness) were created using a metal mold (ring) with the proper dimensions. The mold was set on a glass plate, and the material was forced into it from the top. The composite material was directly injected into the ring above the glass plate using a syringe. Using plastic instruments, the resin composite material is pressed. Next, the top surface of the materials is pressed with a mylar matrix cellulose strip, which is then placed on the ring. The composites are then cured with a light curing unit. The "Woodpecker LED D Curing Light Unit" is the light cure device in use here. Each material (Dentsply Sirona-Spectra ST flow restorative composite in shade A3.5) was exposed to light for 40 seconds at a distance of 2 mm from the material surface using the light-curing unit's tip, in accordance with the manufacturer's instructions. After the metal blocks were taken out, the specimens were cured for an additional 20 seconds to ensure adequate curing. The specimen surfaces were polished in the following stage using Shofu Super Snap Mini Kit discs (5 for each group of solution) of the Dentsply Sirona-Spectra ST flow restorative composite (6mm x 3mm) in shade A3.5, which had been polished and prepared using the Shofu composite polishing kit. Then the discs are immersed in 4 different solutions, namely: 1. water (50 ml), 2. milk (50 ml), 3. orange juice (50 ml), and 4. turmeric water (50 ml), for 7 days. Each specimen has been immersed in the solution for 5 minutes in the morning and 5 minutes in the evening for 7 days. After immersion in the solution, the specimens are returned to the test tube filled with distilled water and kept at room temperature. The pre-immersion surface roughness values (Ra1, Rq1, and Rz1) have been noted on day 1. The post-immersion values are noted on day 7. The values are checked using a Stylus Profilomoter (Mitutoyo). The mean values and results are provided via SPSS software. (4)

**RESULTS**:

The above results are obtained from SPSS software using the values that are found using the stylus profilometer for the specimens before and after being submerged in the given solutions.

**FIGURE 1:**

| SURFACE ROUGHNESS | | |
|---|---|---|
| **GROUPS** | **Mean** | **Std. Deviation** |
| **Water** | **.2016** | **.05257** |
| **Milk** | **.4420** | **.11129** |
| **Orange Juice** | **.7214** | **.05593** |
| **Turmeric Water** | **1.5608** | **.02702** |
| **Total** | **.7315** | **.53006** |

Figure 1 shows the standard deviation and mean values (Ra). The average value (Ra) of group no. 4, i.e., Turmeric water has significantly increased in the 7-day time period. However, there was no significant rise in the other groups, which included orange juice, milk, and distilled water.

**FIGURE 2:**

| **Dependent Variable: SURFACE ROUGHNESS** | | | | | | |
|---|---|---|---|---|---|---|
| **Tukey HSD** | | | | | | |
| **(I) GROUPS** | **(J) GROUPS** | **Mean Difference (I-J)** | **Std. Error** | **Sig.** | **95% Confidence Interval** | |
| | | | | | **Lower Bound** | **Upper Bound** |
| **Water** | **Milk** | **-.24040*** | **.04360** | **.000** | **-.3651** | **-.1157** |
| | **Orange Juice** | **-.51980*** | **.04360** | **.000** | **-.6445** | **-.3951** |
| | **Turmeric Water** | **-1.35920*** | **.04360** | **.000** | **-1.4839** | **-1.2345** |
| **Milk** | **Water** | **.24040*** | **.04360** | **.000** | **.1157** | **.3651** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Orange Juice** | **-.27940*** | **.04360** | **.000** | **-.4041** | **-.1547** |
| | **Turmeric Water** | **-1.11880*** | **.04360** | **.000** | **-1.2435** | **-.9941** |
| **Orange Juice** | **Water** | **.51980*** | **.04360** | **.000** | **.3951** | **.6445** |
| | **Milk** | **.27940*** | **.04360** | **.000** | **.1547** | **.4041** |
| | **Turmeric Water** | **-.83940*** | **.04360** | **.000** | **-.9641** | **-.7147** |
| **Turmeric Water** | **Water** | **1.35920*** | **.04360** | **.000** | **1.2345** | **1.4839** |
| | **Milk** | **1.11880*** | **.04360** | **.000** | **.9941** | **1.2435** |
| | **Orange Juice** | **.83940*** | **.04360** | **.000** | **.7147** | **.9641** |

*** The mean difference is significant at 0.05 level.**

Fig. 2 exhibits the mean difference (the difference of surface roughness values on the first day and the 7th day after immersion in distilled water).

**FIGURE 3:**

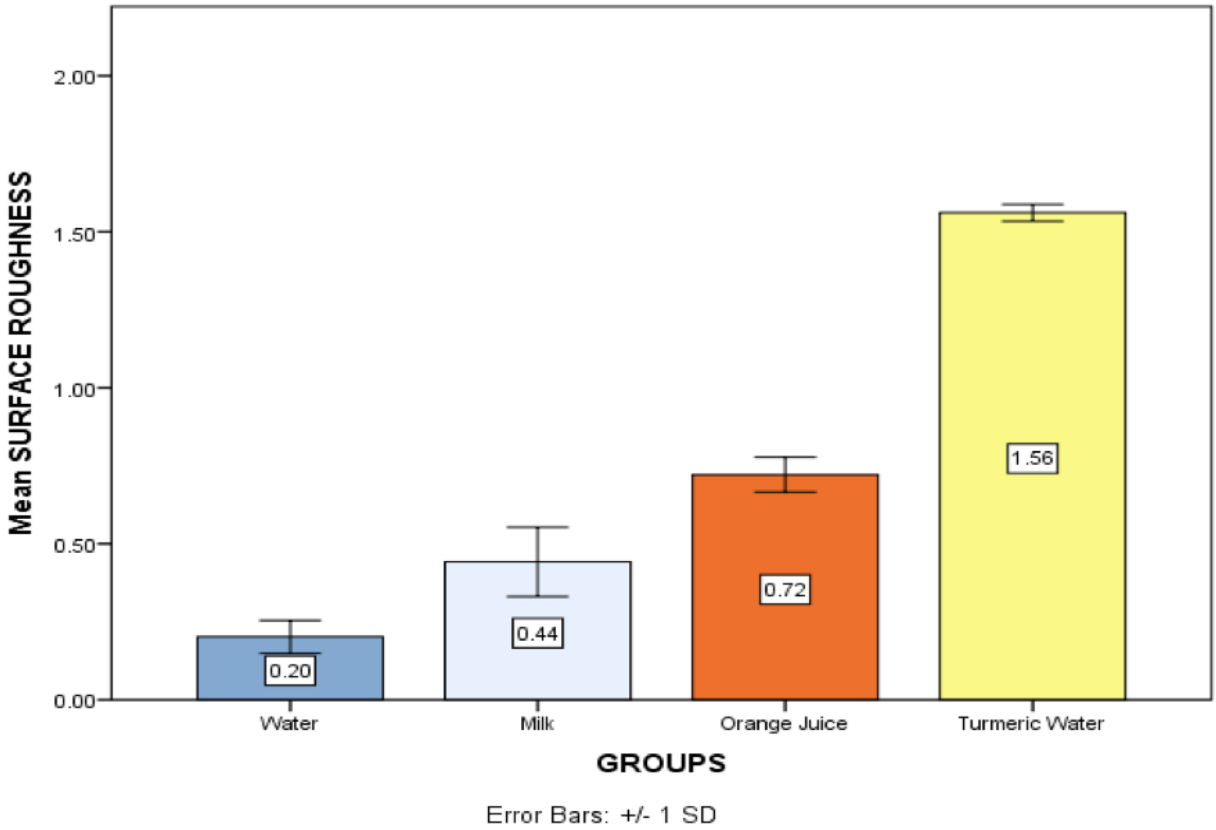


Fig. 3 exhibits the mean increase or decrease in the surface roughness of composite restorations in different solutions.

The above results are obtained from SPSS software using the values that are found using the stylus profilometer for the specimens before and after being submerged in the given solutions. SPSS (Statistical Package for the Social Sciences) is a software package used for the analysis of statistical data. Being one of the easiest statistical tools to analyze data and manage data, it comprises bivariate statistics, cross-tabulation and frequencies. It offers reliable and fast answers. It's dynamic and has useful tables and graphs. Used for both quantitative and qualitative data. The chances of errors are few. From the above interpreted value, it is evident that there is a significant difference between before and after immersion in different solutions (mean difference = 0.05).

**DISCUSSION:**

Composite resin is now the preferred material of choice for anterior tooth restorations, thanks to the increased demand for aesthetic restorations and the evolution of nano-filled composite resin materials. The restoration's longevity is nevertheless limited by surface roughness, even with improvements made to its chemical and physical properties. (6) The use of composite restoration has increased due to its improved aesthetic properties and durability and patient demand for the same. The surface roughness of resin composite materials was impacted by time and exposure to various solutions in the oral cavity. The type of solution and the amount of acidity in it determine how different solutions affect the resin composites' surface roughness characteristics. Hence, the composite restorative material should match well with the initial surface properties and preserve the esthetic property over

time in the restored tooth (7). The process of finishing and polishing the composite restoration is an important part of enhancing the aesthetics and longevity of the restored teeth. (8) Inappropriate and subpar polishing methods cause a rough surface restoration, which in turn causes surface discoloration, plaque buildup, gingival irritation, and recurrent caries. (9) The physical characteristics of the composite restorations, such as volume, hardness, number of fuller particles, and resin matrix organization, are correlated with the polishing quality of their surfaces. (10)

Hicham Nuaimi et al. conducted a study based on the effect of coffee on the surface roughness of two nano-hybrid composites with novel monomers and methacrylate. This study lends credence to the theory that coffee affects methacrylate resin more so than the use of novel monomers. The study selected coffee because it has been used daily as a socially aggressive beverage. The results after 90 days show a non-significant increase in surface roughness (Ra) values in resin-based composites (7) . For refreshing properties, commercial orange juices include carbonic, phosphoric, and citric acids. These drinks have a lower pH (around 2.6) and cause erosion, attrition of the tooth surface, etc., thus leading to an increase in surface roughness. (11) (12)

According to one of the current studies, red wine and Coca-Cola had a negative impact on the composite's surface roughness, which in turn reportedly shortened the composite’s lifespan. Certain foods, liquids, and acidic beverages have been linked to changes in resin composite surface roughness. The amount and distribution of fillers have an impact on how quickly resin materials deteriorate on the surface. Consequently, a rise in surface roughness may result from the loss of inorganic filler particles, the polymer matrix, and the degradation of the resin-filler interface. (13) (14) (15) Under in vitro conditions, two types of hybrid composites—one based on methacrylate and the other on silorane—were immersed in various commercially available lemon juices (Nimbooz), Coca-Cola, and alcohol. The basis of this study is the surface micromorphology that influences surface roughness and color stability. (15) (16) The results of this investigation showed that, compared to the silorane-based microhybrid composite resin, the methacrylate-based nanohybrid composite's surface roughness was more susceptible to alcoholic and non-alcoholic solutions. (17) According to a previous study, Coca-Cola's surface roughness changes more than whisky's does (18).

A prior investigation revealed that the composition and filler distribution, resin monomer, and coupling agents all have an impact on the surface roughness of composite resin materials. These elements have an impact on the composite resin's stiffness, compressive strength, surface roughness, color stability, and depth of polymerization. (19) Additionally, it was found that increased filler content in a composite can reduce water absorption, which in turn results in fewer variations in surface roughness (20). The study's surface roughness mean values indicated either no decrease or a slight one in the surface roughness in the water and milk solutions, which has minimal impact on the durability of the resin composite restoration. But the surface roughness drastically increased in the 4th solution, i.e.,. turmeric water, followed by the 3rd solution, i.e.,. orange juice. The turmeric water increased the surface roughness and also stained the restoration deeply. This leads to the need for the replacement of the existing restoration. (21) (22) (23) The surface roughness of resin composite restoration should be maintained to avoid irritation. When the surface roughness is increased, it may lead to the recurrence of caries (recurrent caries), cause the retention of food debris leading to the formation of plaque, and extensively cause inflammation and pain in the gingival and periodontal regions (24) (25). Also, if the surface roughness is increased, the scattering of light is increased, which in turn compromises the aesthetic property of the particular composite restoration. (26) The oral cavity's pH, physicochemical

characteristics, acidity, and mineral content all affect the increase in surface roughness. It is also altered by the physical and chemical properties of the resin composite material. The surface roughness is also altered by the type of food, if the food is too hot or cold, etc. (27) Both the color and surface roughness can be altered by prolonged exposure to beverages, alcohol, mouthwash, etc. (28) The physical characteristics of the resin composite in this study are therefore similar to those in earlier ones, particularly with regard to surface roughness.

**CONCLUSION:**

Due to the limitations of this current in vitro study, it can be concluded that the selected group of solutions affected the surface roughness of the "Dentsply Sirona-Spectra ST flow" flowable composite restorative in shade A3.5. The increased surface roughness depends on the increasing timing, type of solution, pH of the solution, composition of the solution, types of filler used in the composite, and polymerization methods. The time period being 7 days, the surface roughness values are noted on days 1 and 7. Based on the values provided by the stylus profilometer, it shows that turmeric water affected the surface roughness extremely strongly, followed by orange juice. Milk and water made almost no difference. Despite having the best physical and chemical properties, the nanofilled resin composite's surface roughness appears to have an impact on how long the restoration would persist and also on the aesthetic property of the resin composite restoration. A further elaborated study with a large number of specimens and a longer duration can be conducted for more accurate and variable results.

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