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Comparison of Surface Roughness of Nanohybrid Composite Before and After Brushing with Tooth Whitening Dentifrice

Vignesh M[1]*, Dr. S. Subhash Sharma[2], Dr. Balaji Ganesh[3]

[1]*Undergraduate student, FINAL YR BDS Student, SAVEETHA DENTAL COLLEGE,
Email:vikimds2000@gmail.com, Phone no: +91-7339663812
[2]Assistant Professor, Department of Conservative dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai- 600077, Tamil Nadu, India
[3]Assistant Professor, Department of Periodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai- 600077, Tamil Nadu, India

***Corresponding Author:** Vignesh M
*Undergraduate student, FINAL YR BDS Student, SAVEETHA DENTAL COLLEGE, Email:vikimds2000@gmail.com, Phone no: +91-7339663812

Abstract

Aim: This study compared the surface roughness of nanohybrid composite before and after brushing with a tooth whitening toothpaste.
Background: A person's smile is a very important part of their face. It greatly affects how they feel about themselves and how they interact with others. Nowadays, people care a lot about how things look. This makes patients want more dental treatments. Composite resin restorations are a big part of daily dental work. Their use has grown because more patients want better-looking teeth. A rough surface on these direct composite resins can cause problems. It makes plaque stick more, leading to gum swelling (gingival inflammation), slight color changes on the surface, and new tooth decay (secondary caries). This study aims to compare surface roughness of nanohybrid composite before and after brushing with tooth whitening dentifrice.
Materials and Methods: Eight disc-shaped samples were made from each nanohybrid composite. The surface roughness of these discs was measured before brushing. A Stylus profilometer (Mitutoyo SJ 310) was used for this. It had a 2µm tip at a 60° angle. The device moved on the surface of the nanohybrid composite disc material to get the values. After brushing simulation, the samples were checked again for surface roughness using the Stylus profilometer.
Results: It was found that brushing did change the surface roughness. Te econom plus was less effective. This was because it had high surface roughness after the brushing test.
Conclusion: Brushing with a teeth whitening toothpaste increased the surface roughness of Nanohybrid Composite. Nanohybrid Composite samples had more surface roughness after the brushing test. So, it should not be used with tooth whitening toothpaste.

Keywords: Brushing simulation, Te econom plus, superficial discoloration, Nanohybrid Composite

INTRODUCTION:

Introduction

A smile is a very important part of a person's face. It greatly affects how someone interacts with others and how they feel about themselves [1]. Today, many patients want dental treatments because they care a lot about how things look. Composite resin restorations have become very popular. This is because more and more patients want their teeth to look better [2]. These materials are now common in daily dental work. They are widely used to fix both front and back teeth directly [3].

Tooth whitening toothpastes were made to help with how teeth look. They work by removing stains that come from food, drinks, and smoking. These toothpastes often have soft abrasive materials. Examples include hydrated silica or calcium carbonate. These help to polish the tooth enamel. Also, chemical agents like hydrogen peroxide or carbamide peroxide are often added. They make the whitening effect stronger by breaking down stains at a very small level. Some whitening toothpastes also include enzymes or activated charcoal. These make their stain removal abilities even better.

Brushing stimulators, both electric and mechanical, are designed to work with regular toothbrushes. They help improve how clean the mouth is. These devices massage the gums. They make blood flow better. They also help remove plaque from between teeth and along the gum lines, where germs often build up. They are especially helpful for people with braces or those who find it hard to brush well by hand. They make brushing more thorough and effective.

New esthetic restorative materials are always being developed. This has led to better composite resins with improved strength and looks [4]. The newest nanocomposites have very tiny particles, from 0.1 μm to 100 nm. They meet the beauty needs for front teeth because they look shinier and stay polished longer [5]. However, how long these materials last depends on how smooth their surface is. This smoothness relies on things like the type of organic material, the size of filler particles, their makeup, and how they are spread out. Also, being exposed to acidic things from food, drinks, and mouth rinses can affect how strong the surface of these fillings is [6].
A rough composite resin surface makes plaque stick more. This leads to gum swelling (gingival inflammation), slight color changes on the surface (superficial discoloration), and new tooth decay (secondary caries) [7]. Surface roughness also plays a very important role in how bacteria stick to the surface and form layers (biofilm). This can lead to cavities [9]. So, checking the surface roughness of composite fillings is key to knowing how well they will perform in the mouth. The main roughness measurements are Ra (average roughness), Rq, and Rz. These are usually measured using a stylus profilometer. Profilometers give a 2D view of surface roughness. But, a scanning electron microscope (SEM) is needed for a more detailed look at the surface shape [10].
Past studies have looked at how brushing affects different qualities of filling materials. These include how long color stays stable, how strong they stick, and how much leakage they have. However, limited research has looked at how tooth whitening toothpastes affect the surface roughness of **nanohybrid composite resins**.
The objective of this study is to compare the surface roughness of nanohybrid composite resins before and after brushing with a tooth whitening toothpaste. By checking changes in surface roughness, this research aims to give insights into what whitening toothpastes mean for dental filling materials in real use. Also, the study looks at how brushing stimulators help improve mouth hygiene. It considers their effect on gum health and their possible role in stopping gum diseases (periodontal diseases).

MATERIALS AND METHODS

This study took place at Saveetha Dental College under Saveetha University, in Chennai, after IRB approval
Te Econom Plus is a commercially available nanohybrid composite restorative chosen for this study (Figs. 1). Eight disc-shaped samples were made from each Nanohybrid composite. The surface roughness of the prepared Nanohybrid composite discs was measured before brushing. This was done using a Stylus profilometer (Mitutoyo SJ 310). It had a 2μm tip at a 60° angle. The device was moved physically on the surface of the Nanohybrid composite disc material to get the values for surface roughness before brushing (Figure 2).After getting the surface roughness value before brushing, the GIC discs were kept in the brushing stimulator. A toothbrush simulator (ZM3.8 SD Mechatronik) was used for brushing. It had a minimum pressure of 3N, and a tooth whitening toothpaste was used. The surface roughness value after brushing was then measured using the stylus profilometer following the same steps. The surface roughness values before and after thermocycling of the Nanohybrid composite material were obtained and put into a table. The results were then analyzed using SPSS software version 26.0 and shown in graphs. Fig. 1 shows the 8 discs prepared from Te Econom plus Nanohybrid composite. Fig. 2 shows the Stylus profilometer - Mitutoyo SJ 310 used to get the surface roughness values.

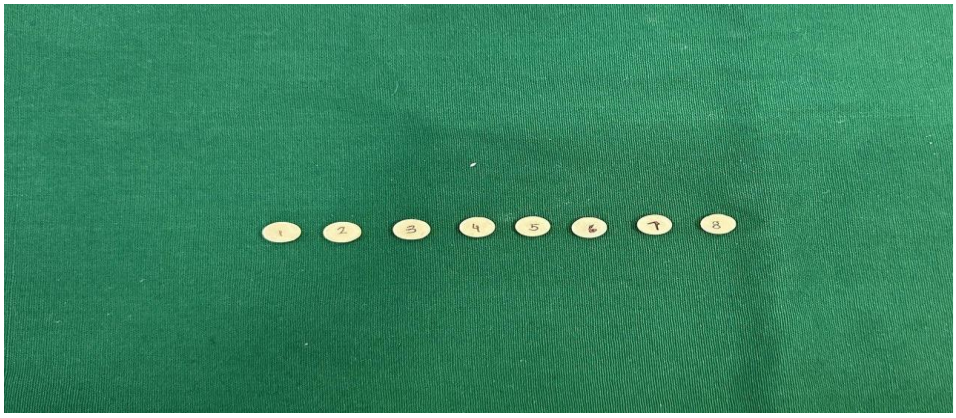

Fig 1: Represents the 8 samples prepared from nanohybrid composite(Te Econom plus)

Fig. 2. Stylus profilometer - Mitutoyo SJ 310 used to obtain the values of surface roughness

Results

From the analyzed results, the Ra, Rq, and Rz values for Te Econom Plus (Nanohybrid composite) were obtained for before and after brushing (Table 1). From the raw data, it can be concluded that the composite had less surface roughness before brushing and higher surface roughness after brushing. A paired student t-test was done for Te Econom Plus values for both before and after brushing using SPSS statistics version 26.0. The paired student t-test showed that the Ra values before and after brushing for the Te Econom Plus samples had a significance of 0.01 (>0.05). Thus, the difference was statistically insignificant (Table 1). In Rz measurements, only the five highest peaks and the five deepest valleys are averaged. This means extremes have a much bigger impact on the final rating. Surface roughness increased after the brushing simulation. The smoothness of the nanohybrid composite's surface fully depends on what it is made of. This study looked at how brushing simulation affected the surface roughness of nanohybrid composite. There were no statistically significant differences for any material tested. Profilometric measurements and scanning electron microscopic (SEM) evaluation showed that most of the material's surface roughness significantly increased. However, after polishing the materials, the roughness values decreased. Fig 3 shows a bar graph comparing pre-op and post-op values using specific parameters like Ra, Rq, Rz.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Ra_postop - Ra_preop	1.14350	.91857	.32476	.37556	1.91144	3.521	7	.010
Pair 2	Rq_postop - Rq_preop	1.68363	1.36414	.48230	.54317	2.82408	3.491	7	.010
Pair 3	Rz_postop - Rz_preop	8.40862	6.51644	2.30391	2.96074	13.85651	3.650	7	.008

Table 1:. This table represents the Ra, Rq and Rz value of Pre and Post surface roughness of Nanohybrid composite

From figure 1
Ra (Pair 1: Ra_postop - Ra_preop)

- The mean difference is 1.14350 with a standard deviation of 0.91857 and a standard error mean of 0.32476.
- The 95% confidence interval for the mean difference ranges from 0.37556 to 1.91144.
- The t-value is 3.521 with 7 degrees of freedom (df).
- The p-value (Sig. 2-tailed) is 0.010, indicating a statistically significant increase in Ra postoperatively.

Rq (Pair 2: Rq_postop - Rq_preop)

- The mean difference is 1.68363, with a standard deviation of 1.36414 and a standard error mean of 0.48230.
- The 95% confidence interval ranges from 0.54317 to 2.82408.
- The t-value is 3.491, with 7 degrees of freedom (df).
- The p-value (Sig. 2-tailed) is 0.010, confirming a significant increase in Rq postoperatively.

Rz (Pair 3: Rz_postop - Rz_preop)

- The mean difference is 8.40862, with a standard deviation of 6.51644 and a standard error mean of 2.30391.
- The 95% confidence interval ranges from 2.96074 to 13.85651.
- The t-value is 3.650, with 7 degrees of freedom (df).
- The p-value (Sig. 2-tailed) is 0.008, confirming a statistically significant increase in Rz postoperatively.

The results show a significant increase in surface roughness for Ra, Rq, and Rz after the brushing. The p-values for all three parameters are below 0.05. This suggests that the changes in roughness measurements are statistically significant. The roughness values after brushing were higher than before brushing. This indicates that brushing, or the intervention applied, had a measurable impact on the surface texture.

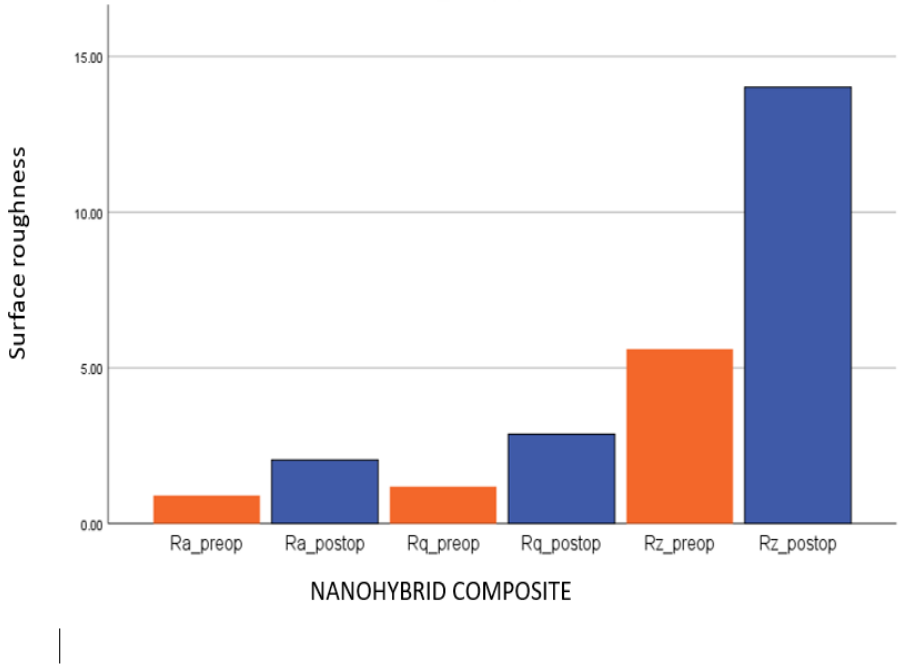

Fig 3: Bar graph depicts the association between surface roughness of Te Econom plus before and after subjecting it to brushing. The X axis represents the Te Econom plus sample and the Y axis represents the mean value of surface roughness prior and after brushing. Blue denotes Ra,Rq,Rz post op, Orange denotes Ra,Rq,Rz preop. Surface roughness was increased after brushing simulation

Discussion

Syncope is the most common emergency seen in dental offices. It makes up 50% to 60% of all emergencies. While it mostly happens in adults, it can happen in a children's dental office too. This is because adults always come with child dental patients. Syncope happens from a "fight or flight" response. It also happens when a patient does not move their muscles. This leads to a brief loss of consciousness. It is most common in young adults, from 16 to 35 years. It is seen more in men than women. This might be because men feel pressure to handle stress without showing fear. Children rarely faint because they openly show their fears. They react emotionally and physically when stressed.

If a child patient or an adult over 40 years faints without clear reasons, they should see a doctor. Vasovagal syncope (VVS), called a common faint, is a neurally mediated syndrome. It causes low blood pressure (hypotension) and a slow heart rate (bradycardia). This is due to the brain not getting enough blood (cerebral hypoperfusion), usually more than a 20% drop. Early signs, called presyncope, include a pale face, sweating, nausea, and feeling warm. This often happens

when a patient sits upright for a long time. It also happens when patients are stressed, in pain, or in medical places. Vasovagal syncope can happen at any age.

Factors that can cause syncope are divided into two main groups: psychogenic factors and non-psychogenic factors. Psychogenic factors include fright, anxiety (from thinking about discomfort or the fee), and stress. Getting unwelcome news, perhaps about treatment or its cost, can also cause it. Sudden and unexpected pain, like from an injection or during treatment, is another factor. Seeing blood, on gauze or dental instruments, can also cause fainting. For example, a parent with a history of bad dental experiences, accompanying their child for an emergency tooth removal, who is informed of the treatment fee and stands observing the extracted tooth in blood-soaked gauze from the treatment room doorway, is very likely to faint. Non-psychogenic factors include sitting upright for too long, especially during an injection, or not moving while standing. This causes blood to collect in the arms and legs, reducing blood flow to the brain. Hunger from dieting or missed meals leads to less sugar for the brain. Exhaustion, poor physical condition, and hot, humid environments are also non-psychogenic factors.

The way syncope starts in the body involves a series of steps. Stress causes more catecholamines, like epinephrine and norepinephrine, to be released into the blood. These prepare the body for more muscle activity, a "fight or flight" response. These catecholamines cause less blood resistance in the body's outer parts. More blood flows to the muscles in the arms and legs. If muscles move, the blood returns to the heart. If muscles do not move, like when sitting still, more blood collects in the arms and legs. Less blood returns to the heart. This leads to less blood circulating, a drop in blood pressure, and less blood flow to the brain, resulting in syncope. If the body cannot quickly make up for this decreased blood, it leads to reflex bradycardia (slow heart rate), decreased cardiac output (less blood pumped by heart), lower blood pressure, cerebral ischemia (not enough blood to brain), and sometimes convulsions.

Signs and symptoms of syncope are in early and late stages. In the early stage, the patient feels warm. They look pale with an ashen-gray skin tone. They sweat a lot. They report "feeling bad" or "feeling faint" and feel nauseous. Their blood pressure may be slightly lower, and heart rate might be fast (tachycardia). In the late stage, the patient shows pupillary dilation, yawning, fast, deep breathing (hyperpnea), cold hands and feet (cold extremities), low blood pressure (hypotension), slow heart rate (bradycardia), visual problems, dizziness, and then loss of consciousness.

The first step in managing syncope is prevention. This is done by taking a full medical and dental history to find any factors that cause syncope. These include a past history of fainting, fear of dental treatment from bad experiences, or low blood sugar (hypoglycemia). Anxious patients should eat a light meal before treatment. This helps keep blood sugar stable during stressful treatment. Patients should be treated lying flat (supine position) or partly sitting up (semi-supine position, 30-45 degrees), especially during injections. Anxiety-reducing methods like premedication and nitrous oxide anxiolysis can also be considered.

If a patient faints, specific steps are needed. First, stop treatment. Assess consciousness by checking response to touch or sound. Activate the office emergency system; call for help, bring oxygen and the emergency drug kit. Position the patient lying flat with feet slightly raised. Check breathing and airway, adjusting head and jaw if needed. Monitor pulse and blood pressure. Provide care by giving aromatic ammonia ampoules. Crush it under the patient's nose. The fumes stimulate movement, helping blood return to the heart and brain. Watch for early symptoms like sweating, dizziness, paleness. Advise physical actions like leg crossing and arm tension. If syncope happens, place the patient lying flat with raised legs or on their side, and give oxygen at 15 l/min. An oxygen cylinder and masks or Ambu bags should be in every dental office. Training courses are advised to improve diagnosis and treatment skills. Taking a detailed medical history, noting past fainting, is necessary. Dentists should understand the patient’s past experiences and fears and build trust.

For Post-Syncopal management, if recovery is under 15 minutes, postpone further dental treatment. If recovery takes longer than 15 minutes, contact EMS. Continue care until emergency providers arrive. Then, find the cause of the syncope, like anxiety, seeing blood, unexpected pain, or low blood sugar.

In a study by Roulet, almost all pastes made the surfaces of dental fillings rougher. Only a few pastes made tooth enamel smoother [11]. Catrise also looked at how mouthwashes affected the surface roughness of composite resin. They found that mouthwashes had an effect, but it was not very big over a short time [12]. Surface roughness can also be affected by how the filling is finished and polished. Studies show that using a matrix with an abrasive strip can create a composite surface that has more polymer and is less stable. This might affect how long the filling lasts.

A study by Rajasri Pradeep and others showed that mouthwashes and brushing simulation significantly changed the surface roughness of bulk-filled composite resin [1]. In another study by Prateeksha.R and team, adding very small particles like strontium and magnesium greatly improved how well dental composite resins kept their color. This could make fillings last longer and make patients happier [2]. T. Keerthana and others showed that toothpastes with fluoride protect teeth, but those with more abrasives might cause more wear on the surface. This could increase the risk of enamel erosion and plaque sticking [3]. A study by Sneha Kannan.S and others showed that brushing simulation with fluoridated and herbal toothpaste did not greatly affect the important surface roughness of soft-tissue liners [4].

Bulaha and others did a study with 100 samples, divided into EF and ZI categories. The samples were brushed virtually with water and Colgate. Surface roughness (Ra) was measured before and after brushing. The results showed important changes in the average roughness values [14]. This study also found that Super-snap abrasive discs made surfaces

smoother than Astropol and Astrobrush silicone polishers for composite and ormocer-based restorative materials. However, these findings mostly applied to flat surfaces that were easy to reach.

According to this present study, the nanohybrid composite used was Te Econom Plus. The results showed that brushing greatly affected its surface roughness. Te Econom Plus became rougher after brushing. This means Te Econom Plus may not be good to use with tooth whitening toothpastes. The abrasive parts in these toothpastes can make the surface get worse. More surface roughness can lead to problems in the mouth. These include more plaque collecting, more staining, and the filling not lasting as long.

Several studies have looked at how different finishing and polishing methods affect composite surface roughness. They also looked at the effect of brushing and mouthwashes. Roulet and Catrise highlighted the role of pastes and mouthwashes. Bulaha and others analyzed brushing effects with specific abrasive agents. Our study supports these findings. It shows that brushing greatly increases surface roughness in nanohybrid composites. Unlike earlier studies that checked many types of filling materials, our research focused only on Te Econom Plus. This gave a more specific look at this particular nanohybrid composite.

This study had some limits. The sample size was quite small. This might affect how much the results can apply to everyone. Also, only one brand of nanohybrid composite (Te Econom Plus) was checked. Including more brands of nanohybrid composite would have given a better comparison of materials available in the market. Also, this study only measured surface roughness. Other factors like strength (diametral tensile strength and flexural strength) would have given a more complete idea of how long the composite lasts.

Future studies should include more patients and more brands of nanohybrid composite. They should also look at other physical and strength properties. This will make the findings more reliable. Also, how brushing affects surfaces over a long time, especially with different toothpastes, should be studied. This will give a clearer understanding of how surface properties change over time.

Conclusion

Brushing simulation with a teeth whitening toothpaste increased the surface roughness of Nanohybrid Composite. Nanohybrid Composite samples had more surface roughness after brushing simulation. Therefore, it should not be used with tooth whitening toothpaste.

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