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# Comparison of the Effects of Different Toothpastes on the Micro Hardness of A Nano Hybrid Composite Resin – An in-Vitro Study

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***Abstract:*** *The aim of this study is to compare the microhardness of a nanohybrid composite resin after brushing with different toothpastes. Rubber moulds were used to prepare 80 composite specimens of 3M ESPE Filtek Z350. The specimens were light cured for 60 seconds, polished and cleaned in distilled water. Specimens were randomly divided into 4 groups of 20 specimens each and subjected to tooth brushing for 2 minutes twice daily with a motorised toothbrush for 30 days. In control group no paste was used with the toothbrush. In other 3 groups, Colgate Total Advanced Whitening toothpaste, Dabur Herbal toothpaste, and Himalaya Complete Care toothpaste were used. Vicker's hardness test was performed for all the specimens. Data obtained in the study was subjected to statistical analysis using One-way Anova and Bonferroni test. There is a statistically significant difference in reduction of microhardness among all the groups compa Control > Himalaya > Dabur > Colgate. Bonferroni test showed that all the experimental groups showed significant reduction in micro hardness compared with the control group (P < 0.001 for all intergroup comparison) except group D (Himalaya). From the results it is evident that the effect of using the herbal toothpaste is almost similar to the effect of brushing on the composite surface without any toothpaste. While using non-herbal toothpaste a reduction in the microhardness was seen.*

***Keywords:*** *Microhardness, nano-hybrid composite, Vickers hardness test*

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## I. Introduction

Toothpastes contain abrasive particles such as natural calcium carbonate, silica micro granules, and small percentages of $H_2O_2$ and carbamide peroxide. Studies have shown that the movement of agents associated with tooth brushing can cause damage to the brushed substrate and are capable of altering the surface and properties of the restorative material. Microhardness is an important property of the restorative material that correlates with strength, proportionality limit, wear resistance, and hence, surface roughness and color stability. Some studies show that the use of toothpaste reduces the surface hardness of microhybrid composite resins. The aim of this study is to compare the microhardness of a nanohybrid composite resin after brushing with different toothpastes.

## II. Materials And Methods

To compare the effect of different toothpastes on microhardness of composite resin, a nano-hybrid composite (Filtek Z 350XT 3M ESPE) was chosen. The samples were divided based on the toothpaste that they were subjected to brushing. Among these groups, one group was kept as a control group in which samples were brushed without using toothpaste.

### 2.1 Classification of groups

Group A (control group) – samples were brushed without using any toothpaste
Group B – samples were brushed using Colgate Total Advanced Whitening toothpaste
Group C – samples were brushed using Dabur Herbal toothpaste
Group D – samples were brushed using Himalaya Complete care toothpaste.
Samples were brushed using a powered toothbrush (Colgate 360 sonic power battery-operated tooth brush). Composition of each toothpaste and their effects are given in the TABLE 1-3.

### 1.2 Making of specimens

**Figure 1**: rubber mould used to make specimens

Figure 2: composite being packed into the mould

Specimens were made from the composite using a rubber mould that is having a well diameter of 15mm and a depth of 2mm. The rubber mould was open on both sides. A glass plate was fixed on to a table and above that, the mould was placed (fig.1). Composite was packed into the mould using composite placement instrument (GDC) (fig.2). The mould was slightly over-filled with the composite. After placement of composite, mylar strip was placed over it. Another glass plate was placed over the mylar strip and it was pressed to get rid of the excess composite. Then the composite was light cured for 30 seconds on the operator facing side of the specimen. The other side of specimen was then cured for 30 seconds (fig.3). Curing of the specimens was done by using Monitex, Bluelex GT1200. After curing, the specimens were polished using medium, fine and superfine polishing discs in a sequential manner (Sof-lex, 3M ESPE). The polished specimens were cleaned in distilled water for 2 minutes to remove any surface contaminants. All discs were stored in 37°C distilled water for 24 hours.

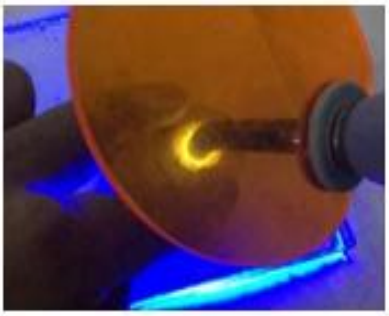

**Figure 3:** curing of specimen

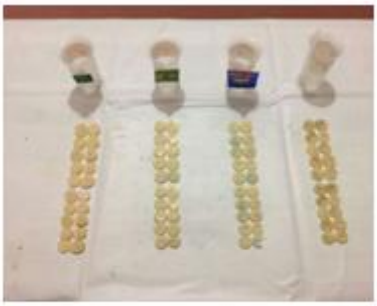

**Figure 4:** samples divided into 4 groups

**Figure 5:** hardness testing machine, Matsuzawa, Japan

2.3 Brushing of specimens

After making a total of 80 specimens, they were divided into 4 groups of 20 specimens in each group (fig.4). The first group, i.e. group A was control group in which the specimens were brushed without adding any toothpaste. The next group, group B was brushed with Colgate total Advanced whitening toothpaste. Specimens in group C were brushed with Dabur Herbal toothpaste. Specimens in group D were brushed using Himalaya complete care toothpaste. Specimens were brushed using a powered toothbrush (Colgate 360 sonic power battery-operated tooth brush). Each time toothbrush head was loaded with tooth paste of 0.25 mg weight and travelled horizontally for 2 minutes. The tooth paste slurry was prepared by mixing one of the dentifrices with water at a ratio of 1:3 by weight. Two erosive/abrasive cycles were carried out per day. While brushing, the specimens were placed in the mould and the mould was fixed on the table so that the specimens were stable during the abrasive cycle.

After the specimens were brushed, they were subjected to Vicker's hardness test in the production lab of Department of Mechanical Engineering, National Institute of Technology, Calicut. The Vicker's hardness test was done using Vicker's hardness testing machine (Matsuzawa, model VMT-X7, Japan) (fig:5). The test was done under room temperature using a test force of 10 N for a dwell time of 15 seconds. For the calculation of Vickers microhardness (VHN), the lengths of the two diagonals of each indentation were measured and VHN was calculated using the following formula: $VHN = 1.854F/d^2$ (where F is the load applied in Newtons and d is the mean length of the two diagonals of each indentation).

**Table 1:** Components Of Colgate Advanced Whitening Toothpaste

| **Ingredient** | **Effects** |
|---|---|
| Silica | Used as abrasive to remove plaque |
| Glycerine | sweetening and preserving agent |
| Sorbitol | A liquid that keeps toothpaste from drying out |
| Sodium lauryl sulphate | a foaming agent and detergent |
| Sodium saccharin | artificial sweetener |
| PVM/MA( poly vinyl methyl ether/maleic acid)copolymer | binding agent |
| Carrageenan Gum | thickening and stabilizing agent |
| Propylene glycol | act as a humectants |
| Triclosan | antimicrobial agent, to fight against gingivitis |
| Sodium fluoride | anti caries agent |
| Titanium dioxide | It gives white color to the toothpaste. |
| Mica | Used for its sparkle. It is also used as a mild abrasive |
| Sodium carboxymethyl cellulose | thickener |
| FD & C blue no.1 | FDA approved synthetic dye produced from petroleum. |

**Table 2**: Components Of Dabur Herbal Toothpaste

| **Ingredient** | **Effects** |
|---|---|
| Babool extract | Forms a protective layer over the gingiva. It has also got antibacterial effect. |
| Calcium carbonate | mild abrasive |
| Xanthan gum | used as a stabilizer and thickener. |
| Sorbitol | A liquid that keeps toothpaste from drying out. |
| Glycerine | sweetening and preserving agent |
| Silica | Used as abrasive to remove plaque |
| Sodium lauryl sulphate | a foaming agent and detergent |
| Lodhra (from bark of symplocos racemosa) | analgesic as well as anti-inflammatory. |
| Jamun (from bark of Eugenia jambolana) | it strengthens gum and teeth. |
| Sodium benzoate | used as preservative. |
| Formaldehyde | it is used as a disinfectant |
| .FD&C yellow#5, FD&C blue#1 | FDA approved synthetic dye produced from petroleum. |

**Table 3:** Components Of Himalaya Complete Care Toothpaste

| **Ingredient** | **Effects** |
|---|---|
| Sorbitol | Humectants |
| Hydrated silica | used as abrasive |
| Glycerine | sweetening and preserving agent |
| Silica | Used as abrasive to remove plaque |
| Sodium lauryl sulphate | a foaming agent and detergent |
| Xanthan gum | it is used as a viscosity agent. |
| Titanium dioxide | coloring agent |
| Sodium saccharin | artificial sweetener |
| Sodium benzoate | used as preservative |
| Punica Granatum (pomegranate) pericarp extract | astringent, antibacterial and antioxidant |
| Potassium sorbate | preservative |
| Calcium fluoride | anticariogenic |
| Zanthoxylum alatum fruit extract | anti-inflammatory and anti-oxidant effect |

| | |
|---|---|
| Acacia Arabica stem bark extract | anti-gingivitis [2] |
| Terminalia chebula fruit extract | anti-bacterial effect[3] |
| Terminalia Bellerica fruit extract | astringent [3] |
| Emblica officinalis fruit extract | astringent effect |
| Embelia ribes fruit extract | antioxidant, anti-inflammatory and analgesic properties[4] |
| Azadirachta indica bark extract | antibacterial effect. [5] |
| Thymol | antimicrobial effect |
| Citric acid | used as preservative. [6] |

## III. Results

In this study we tried to find microhardness values of a nano-hybrid composite resin after being subjected to toothbrushing using three different toothpastes for a time period of 30 days. The specimens were divided into 4 groups. The mean microhardness value of each group was taken (TABLE 4). Data were analyzed by one way ANOVA and Bonferroni test. One-way ANOVA test (TABLE 5) showed statistically significant difference in reduction of microhardness among the groups ($P < 0.001$). Inter-group comparison done by Bonferroni test (TABLE 6) shows that all the experimental groups showed significant reduction in micro hardness compared with the control group except Group D in which there was no significant reduction in microhardness when compared with the control group. Maximum reduction in microhardness was found in group B in which Colgate was used. Group C (Dabur) showed more reduction in microhardness than group D (Himalaya).

**Table 4:** Mean Microhardness Value Of Each Group And Their Standard Deviation

| Group | N | Mean | SD |
|---|---|---|---|
| Control | 20 | 61.3310 | 1.02114 |
| Colgate | 20 | 57.1575 | 0.82737 |
| Dabur | 20 | 58.4740 | 0.64667 |
| Himalaya | 20 | 60.6775 | 0 .70459 |

**Table 5:** Anova Test Results

| | df | F | Sig. |
|---|---|---|---|
| Between groups | 3 | 113.521 | .000 |
| Within groups | 76 | | |

**Table 6:** Bon Ferroni Test Result

| (I) group | (J) group | Sig. |
|---|---|---|
| Control | Colgate | .000 |
| | Dabur | .000 |
| | Himalaya | .078 |
| Colgate | Control | .000 |
| | Dabur | .000 |
| | Himalaya | .000 |
| Dabur | Control | .000 |
| | Colgate | .000 |
| | Himalaya | .000 |
| Himalaya | Control | .078 |
| | Colgate | .000 |
| | Dabur | .000 |

## IV. Discussion

A person's physical appearance and emotional state can be strongly affected by their smile and the colour of their teeth.[1,7] The concept of aesthetic dentistry has got a wide attention and in this scenario, factors affecting the properties of aesthetic restorative materials are studied with much importance. Changes in tooth colour can affect both teeth and aesthetic restorations. [8-11] Degradation of the composite resins in the oral environment can result from chemical or abrasive action. Microhardness is one of the important properties of the restorative materials which correlates with strength, proportional limit and wear resistance[12]. In our study, we have tried to compare the effect of different toothpastes on the microhardness of a nanohybrid composite. We have selected one non-herbal and two herbal toothpastes for brushing the composite specimens made from the nano-hybrid composite resin, Filtek Z350, 3M ESPE.

Hardness of the toothbrush is known to produce alteration in surface hardness of the resin composite on which it is used[13]. Considering this, a soft toothbrush was used in this study. A single operator performed the polishing procedures to minimize variation.

In a study by ***Nainan et al*** in 2014, they compared the microhardness of a nanohybrid composite, Tetric N Ceram, Ivoclar Vivadent, Asia, after brushing with three different whitening toothpastes. From their study they have found a significant reduction in the microhardness among all those samples brushed with those

toothpastes when compared with the control group. When they did an inter-group comparison they have found that maximum reduction in microhardness was seen in the group that used non-herbal toothpaste, which was colgate total advanced whitening when compared with groups brushed with herbal toothpastes. This study co-relates with our study in the sense that, in our study also, non-herbal toothpaste was found to reduce microhardness more when compared with the herbal toothpastes.

**Roopa et al** conducted a study in 2016, to evaluate the effect of whitening dentifrices on microhardness, color stability and surface roughness of restorative materials. They subjected a microhybrid composite resin, Fulfill extra, to brushing using 2 different toothpastes for 2 weeks and 4 weeks. The microhardness values they got were in the range of **30.55** to **31.56**.

**René García-Contreras et al** in 2015, have tested the microhardness of the nano-hybrid composite; Filtek Z350 and from this test they have found the Vicker's Hardness Number of the nano-hybrid composite Filtek Z350 (3M ESPE) to be **71.96** with a standard deviation of **6.44** [18]. In our study, we have calculated the Vicker's Hardness Number of the same nano-hybrid composite Filtek Z350 after subjecting it for toothbrushing with 3 different kinds of toothpastes and the values were near to the result obtained in this study.

While choosing the composite specimen for our study, we have considered certain aspects. A study conducted by ***Oliveira et al*** [14] in 2012 evaluated the impact of the size and distribution of inorganic particles on the surface roughness and wear of composites after simulated tooth brushing *in vitro*, finding better results in the nanoparticle group (Filtek™ Z350). The organic matrix of nanoparticle composites comprises urethane dimethacrylate (UDMA), Bisphenol A-Glycidyl Methacrylate (Bis-GMA), and bisphenol A-methacrylate (Bis-EMA) [13]. According to Barszczewska-Rybarek[15] UDMA is less viscous and more flexible than Bis-GMA and has a greater amount of crosslinking and hardness. On the other hand, the Bis-GMA molecule is more rigid, with a small amount of double crosslinks and tends to be less stiff and has a higher water sorption[16,17]. Bis-EMA is a Bis-GMA analog molecule that allows more double coupling conversion while transforming the polymer into a more flexible and less rigid structure[18]. These above-mentioned aspects were taken into consideration when choosing the restorative material to be employed in the present study.

In our study we tested the microhardness of samples by calculating the Vicker's hardness number. The reason for choosing Vicker's hardness number over Knoop hardness number is that, Vickers hardness test is less sensitive to surface defects and textures (surface conditions) and more sensitive to measurement errors when equal loads are applied due to its shorter diagonals[19].

Another important aspect is the correlation between the use of dentifrices and the type of brush used by the patient. Thus, dentifrices with extremely high Relative Dentin Abrasivity values (i.e., more abrasive) should be used in combination with soft bristles [20]. The electric toothbrush used in our study had soft bristles and worked with oscillating and rotating movements (20,000 strokes per min). A toothbrush with extra-soft bristles eventually boosts a dentifrice's abrasive action and shortens the toothbrush life. A study by ***Toshimitsu et al*** in 2012 indicated that soft toothbrushes cause more abrasion as they retain more toothpaste in their fine bristles[20].

Previous studies have shown that dentifrices, which have neutral or acidic pH, produced more abrasion than those with a basic pH. In our study, Himalaya complete care contains citric acid, which is added in the toothpaste as a preservative[6], whereas Colgate total advanced whitening toothpaste is free of acids. However, in this study, Colgate Total Advanced whitening toothpaste with a basic pH of 9.68 [21] showed more abrasive properties (alteration in microhardness of composite) than Himalaya complete care toothpaste with acidic pH. Therefore, it can be suggested that the abrasive properties of non-herbal whitening toothpastes can cause more alteration in the microhardness of the substrate to which it is exposed rather than the acidic content of the herbal toothpaste. The presence of abrasives in the composition of toothpastes is responsible for brushing-related abrasion.[22] Hydrated silica is formed by mineral compounds with different physico‑chemical properties and is considered a good cleaning agent with high abrasive capacity; it is compatible with most fluorinated compounds. Moreover, this component has a thickening and stabilizing function in dentifrices[23]. However, titanium dioxide, which is also added to toothpaste as a coloring agent, is able to temporarily modify the enamel shade by its impregnation onto surface irregularities of the tissue. Therefore, the user of these products is led to believe that teeth are whiter; however, both the tooth and the restorative material surfaces have increased their roughness, becoming prone to future staining[24]

## V. Limitations Of The Study

A toothbrush simulator machine would have been a better option in delivering standardized strokes with uniform pressure. In this study, only microhardness of the composite resin was evaluated. It would have been better if other mechanical properties such as surface roughness, color stability were also studied. Abrasion of composite specimen after toothbrushing also could have been measured. In this study, the microhardness value for the sample without brushing was not evaluated, if so, it would have given an idea about the effect of toothbrush on the specimen as well. The results obtained and the conclusions drawn are based on in-vitro

studies, correlation to clinical practice requires further in vivo research to evaluate long term effects of tooth paste on aesthetic restorative materials with larger sample size.

## VI. Conclusion

In our study we have compared the effect of toothpastes of three different types on the microhardness of a nano hybrid composite resin. From the results it is evident that the effect of using the herbal toothpaste is almost similar to the effect of brushing on the composite surface without any toothpaste. While using non-herbal toothpaste a reduction in the microhardness was seen. Thus, these results make us to be cautious before prescribing whitening dentifrices. The number of restorative material should be considered before prescribing. Also dentifrices are used daily and these novel preparations claiming whiteness of the teeth attract the people, resulting in its widespread use. The deleterious effects this can have on the aesthetic restorations also need to be accounted for. Instead of relying blindly on over-the-counter products, patients need to opt for professional tooth whitening under the guidance of a dental professional, where the parameters can be controlled. For this, patient needs to be well educated.

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