# Influence of mouth rinses on the surface hardness of bulk-fill resin composite

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## Abstract

**Introduction:** Consumption of certain Mouthrinses may affect the physical properties of the BulkFill composite.

**Aim:** The aim of this study was to investigate the effect of Six different Mouthrinses (i) Listerine (ii) Periogard (iii) Povicidal (iv) Hexidine (v) Hexidine EP (vi) Hiora, on surface microhardness bulk- fill sculptable composite resin (SoniFill).

**Materials and Methods:** Sixty specimens of a bulk-fill resin composite material taken in acrylic mold. Each specimen will be cured for 40 s from the top and another 40 s from the bottom using LED light cure unit at 1200 mW/cm2.

The baseline micro hardness values of the specimens will be recorded prior to immersion in the mouth rinses. Microhardness will be measured using Vicker's micro hardness tester. The specimens will then be immersed in 20ml of respective mouth rinses with both sides of specimen exposed and kept in an incubator at 37o C for 24h. Microhardness values will then be checked for each specimen using the same microhardness tester and same load and dwell time as previously mentioned above for pre-immersion test.

**Results:** According to the result of the present study, prior to immersion, Sonicfill resin composite showed no significant difference in mean hardness before immersion between groups 1(Listerine), 2(Periogard), 3(Provicidal), 4(Hexidine), 5(Hexidine Ep) and 6(Hiora). Therefore, the null hypothesis all the mouth rinses used in the study irrespective of the presence or absence of alcohol reduced the micro hardness of Bulkfilled resin composite.

**Conclusions:** All the Mouthrinses used in this study reduce the surface hardness in the materials tested.

**Keywords:** Hardness, Microscopy, Mouthrinses, Bilk-filled-resin Composite.

## Introduction

Resin-based composites have been successfully used in dentistry for many years and widely replaced amalgam as a posterior restorations.1 Dental composites are expected to have mechanical properties comparable to that of enamel and dentin and provide a long life of span of teeth. Many factors limit the performance of composites, especially depth of cure and degree of conversion (DC).

The major disadvantages resin based composite technologies is an insufficient depth of cure. Due to insufficient depth of cure, incremental placement technique, with a maximum 2 mm thickness, were used for composite restorations. Dental composite in an incremental placement technique, and light curing each increment individually is time consuming. Recently, a newclass of resin-based composite, the so called "bulk-fill" composites have been introduced into the dental market with the purpose of time and thus cost savings. The Main advantage of this new material is that it can be placed in a 4 mm thickness and that to be cured in one step.Mouth rinses are widely used to prevent and control caries and periodontal diseases, with some individuals using mouth rinses at a frequency of six times per day. Mouth rinses contain water, antimicrobial agents, salts, preservatives and in some cases alcohol. The variation in the concentration of these substances affects the pH of mouth rinses.

Therefore in the light of these observations, this study was choosen so as to evaluate the effect of different mouth rinses on surface microhardness and surface micromophology on bulk-fill sculpable composite resin material i.e SonicFill.

SonicFill is a material which transforms tedious, repetitive posterior restorations into easy and reliable SingleFill placement: filling cavities up to 5mm in depth in a single increment, with a single material – and no liner or capping layer.

## Materials and Methods

The Present study was carried out in the Department of Conservative Dentistry and Endodontics, Department of Biochemistry, Seema Dental College and Hospital, Rishikesh, Uttrakhand and Department of Materials Science and Metallurgy, Indian Institute of Technology, Varanasi, Uttar Pradesh with an aim to evaluate the effect of four different Mouthwashes on the surface hardness of bulk fill sculptable composite resin.

### Equipment's

1. Vicker's micro hardness tester (UHL VMHT Microhardness tester; Walter Uhl, technische Mikroskopie GmbH & Co. KG Loherstraße 7 35614Aßlar, Germany)
2. Digital pH meter (Servewell Instruments and Equipments Pvt. Ltd, Bangalore, India)
3. Incubator

### Source of Data

One bulk-fill resin composite and three alcohol-containing and alcohol-free mouth rinses will be used in this study.

## Preparation of Sample

One thirty two disk-shaped specimens were prepared for composite resins by packing the material into custom made cylindrical acrylic ring mold of 10 mm internal diameter and 5 mm height. The mould was placed on a glass slab covered with a dark opaque paper background and a polyester mylar strip. The mould was bulk filled with the composite resin sonic fill through the handpiece to excess. Another polyester mylar strip was placed on the top of the filled mould and a glass slab of 350 gms was weighed down onto the mould for 30 seconds. This aside ensuring the standardization of shape and size of each sample also resulted in equal dispersion of composite resin, removal of excess material, prevention of incorporation of air bubbles and to form a flat and smooth surface which did not require further grinding or polishing. The glass slab was then removed and the samples were light cured according to the manufacturer's directions with a polywave LED light-curing unit with an output of 1200 mW/cm2 operating on high mode. Light-curing was performed by positioning the light tip of the curing unit concentrically with the mold, maintaining a constant distance of 1 mm. The light intensity was monitored with a manual radiometer. While still in their molds, all the samples were stored in an incubator at 37°C in distilled water for 24 hours for Rehydration and Completion of Polymerization.

## The pH Measurements

Six Mouthwashes were used in this study: Listerine, Provicidal, Perioguard, Hexidine, Hexidine EP, Hiora. The pH of each mouthwashes was determined using a pH meter (HI 221; Hanna Insruments Inc., Woonsocket, RI, USA). Ten pH readings of mouthwashes were obtained in order to get a mean pH measurement for each mouthwashes.

## Immersion in Mouth Washes

After 24 hours of storage, each material was randomly divided into six subgroups of 22 samples each (n=22), according to the mouth washes used (Table 4). 22 samples from each of the six subgroups were subjected to surface microhardness test. All samples were stored in an incubator at and not immersed in any mouthwash..

1. In Group 1 The Samples were Immersed In Listerine.
2. In Group 2 The Samples were Immersed In Periogard.
3. In Group 3 The Samples were Immersed In Provicidal.
4. In Group 4 The Samples were Immersed In Hexidine.
5. In Group 5 The Samples were Immersed In Hexidine EP.
6. In Group 6 The Samples Were Immersed In Hiora.

## MicroHardness Testing

The Baseline Microhardness values of the specimens were be recorded prior to immersion in the mouth rinses.Microhardness was measured using Vicker's micro hardness tester(UHT VMHT Microhardness tester; Walter Uhl,technische Microskopie GmbH & Co.KG L oherstraBe 7 35614 Blar, Germany). A load of 50g was applied on the surface of the test specimens with a dwell time lof 30s.Three indentations were made on the top surface of each specimen.These indentations were equally placed over a circle and not closer than 1 mm to the adjacent ones or to the margin of the specimen. The average of the three readings were taken and microhardness value was calculated. The specimens were then immersed in 20 ml of respective mouth rinses and kept in an incubator at 370 c for 24h. Then specimens were removed from the mouth rinses, rinsed with deionized water, blotted dry using tissue paper, and subjected to post immersion surface microhardness testing. Microhardness value were checked for each specimen using the same microhardness tester and same load and dwell time as mentioned above for pre immersion test. The average of the three readings was taken and microhardness values were calculated (kg/mm2).



**Fig. 1: Cured SonicFill in Disc**



**Fig. 2: Measuring the indentation made on composite**

## Statistical analysis

1. Data obtained were statistically analysed with SPSS version 16.0 software for Windows (SPSS Inc.; Chicago, IL, USA).
2. Discriptive statistics of microhardness of bulk-fill composite resin material were analyzed and expressed in terms of mean and standard deviation.

3. The intra group comparisons were done using one-way Analysis of Variance (ANOVA) followed by Post-hoc bonferroni test.
4. The inter group comparisons between the MothWashes were done using Post-hoc bonferroni test.
5. p < 0.05 were considered significant.

## Results

**Table 1: Mean hardness before immersion**

|  | Hardness before immersion | | | |
|---|---|---|---|---|
|  | Mean | Std. Deviation | F-value | p-value |
| Group 1 | 59.84 | 0.83 | 1.377 | 0.101 |
| Group 2 | 59.27 | 0.40 |  |  |
| Group 3 | 59.95 | 0.64 |  |  |
| Group 4 | 59.53 | 0.45 |  |  |
| Group 5 | 59.52 | 0.47 |  |  |
| Group 6 | 59.51 | 0.44 |  |  |

**One-way ANOVA test # Non-significant difference**

The comparison of mean hardness before immersion was done between groups 1, 2, 3, 4, 5 and 6 using the **One-way ANOVA test**. There was no significant difference in mean hardness before immersion between groups 1, 2, 3, 4, 5 and 6.

**Table 2:**

|  |  | Hardness before immersion | |
|---|---|---|---|
|  |  | Mean Difference | p-value |
| Group 1 | Group 2 | 0.57 | 0.083 |
| Group 1 | Group 3 | -0.10 | 1.000 |
| Group 1 | Group 4 | 0.32 | 0.944 |
| Group 1 | Group 5 | 0.32 | 0.842 |
| Group 1 | Group 6 | 0.33 | 0.769 |
| Group 2 | Group 3 | -0.68 | 0.091 |
| Group 2 | Group 4 | -0.26 | 1.000 |
| Group 2 | Group 5 | -0.25 | 1.000 |
| Group 2 | Group 6 | -0.24 | 1.000 |
| Group 3 | Group 4 | 0.42 | 0.205 |
| Group 3 | Group 5 | 0.43 | 0.178 |
| Group 3 | Group 6 | 0.44 | 0.160 |
| Group 4 | Group 5 | 0.01 | 1.000 |
| Group 4 | Group 6 | 0.02 | 1.000 |
| Group 5 | Group 6 | 0.01 | 1.000 |

**Post-hoc bonferroni test # Non-significant difference**

The inter-group comparison of mean hardness before immersion was done using the **Post-hoc bonferroni test**. No significant difference was reported for the inter-group comparison of mean hardness before immersion between different groups.

**Table 3:**

|  | Hardness after immersion | | | |
|---|---|---|---|---|
|  | Mean | Std. Deviation | F-value | p-value |
| Group 1 | 50.53 | 2.27 | 281.638 | < 0.001* |
| Group 2 | 55.08 | 0.55 |  |  |
| Group 3 | 58.90 | 0.48 |  |  |
| Group 4 | 59.45 | 0.43 |  |  |
| Group 5 | 59.42 | 0.47 |  |  |
| Group 6 | 59.42 | 0.42 |  |  |

**One-way ANOVA test * Significant difference**

The comparison of mean hardness after immersion was done between groups 1, 2, 3, 4, 5 and 6 using the One-way ANOVA test. There was a significant difference in mean hardness after immersion between groups 1, 2, 3, 4, 5 and 6.

**Table 4: Hardness after immersion**

|  |  | Mean Difference | p-value |
|---|---|---|---|
| Group 1 | Group 2 | -4.55 | < 0.001* |
| Group 1 | Group 3 | -8.37 | < 0.001* |
| Group 1 | Group 4 | -8.92 | < 0.001* |
| Group 1 | Group 5 | -8.90 | < 0.001* |
| Group 1 | Group 6 | -8.90 | < 0.001* |
| Group 2 | Group 3 | -3.82 | < 0.001* |
| Group 2 | Group 4 | -4.38 | < 0.001* |
| Group 2 | Group 5 | -4.35 | < 0.001* |
| Group 2 | Group 6 | -4.35 | < 0.001* |
| Group 3 | Group 4 | -0.55 | 1.000 |
| Group 3 | Group 5 | -0.53 | 1.000 |
| Group 3 | Group 6 | -0.53 | 1.000 |
| Group 4 | Group 5 | 0.03 | 1.000 |
| Group 4 | Group 6 | 0.03 | 1.000 |
| Group 5 | Group 6 | 0.00 | 1.000 |

**Post-hoc bonferroni test  * Significant difference**

The inter-group comparison of mean hardness after immersion was done using the **Post-hoc bonferroni test**.

**Table 5: Change in Hardness**

|          | Mean | Std. Deviation | F-value | p-value |
|----------|------|----------------|---------|---------|
| Group 1  | 9.32 | 2.20           | 323.739 | < 0.001* |
| Group 2  | 4.19 | 0.77           |         |         |
| Group 3  | 1.05 | 0.42           |         |         |
| Group 4  | 0.08 | 0.02           |         |         |
| Group 5  | 0.10 | 0.06           |         |         |
| Group 6  | 0.09 | 0.07           |         |         |

**One-way ANOVA test    * Significant difference**

The comparison of mean change in hardness from before to after immersion was done between groups 1, 2, 3, 4, 5 and 6 using the One-way ANOVA test. There was a significant difference in mean change in hardness from before to after immersion between groups 1, 2, 3, 4, 5 and 6.

**Table 6:**

|         |         | Change in Hardness | |
|---------|---------|-----------------|---------|
|         |         | **Mean Difference** | **p-value** |
| Group 1 | Group 2 | 5.12  | < 0.001* |
| Group 1 | Group 3 | 8.27  | < 0.001* |
| Group 1 | Group 4 | 9.24  | < 0.001* |
| Group 1 | Group 5 | 9.22  | < 0.001* |
| Group 1 | Group 6 | 9.23  | < 0.001* |
| Group 2 | Group 3 | 3.14  | < 0.001* |
| Group 2 | Group 4 | 4.12  | < 0.001* |
| Group 2 | Group 5 | 4.10  | < 0.001* |
| Group 2 | Group 6 | 4.11  | < 0.001* |
| Group 3 | Group 4 | 0.97  | 0.017* |
| Group 3 | Group 5 | 0.96  | 0.020* |
| Group 3 | Group 6 | 0.96  | 0.019* |
| Group 4 | Group 5 | -0.02 | 1.000  |
| Group 4 | Group 6 | -0.01 | 1.000  |
| Group 5 | Group 6 | 0.01  | 1.000  |

Post-hoc bonferroni test * Significant difference

The inter-group comparison of mean change in hardness from before to after immersion was done using the Post-hoc bonferroni test. The mean change in hardness from before to after immersion was significantly more among group 1 in comparison to group 2 which was significantly more than group 3 which was significantly more than groups 4, 5 and 6.

## Discussion

The resin composite tested in this study were Sonicfill. This is a Bulk-Fill sculptable resin composites. Unlike low-viscosity bulk-fill composites, which must be covered by a 2-mm occlusal capping layer using another methacrylate-based hybrid composite suitable for posterior teeth, with this bulk-fill material completely restoration of the whole cavity with one material is possible.

According to the manufacturer's data, SonicFill is a sonic-activated, single-step bulk fill product that does not require a liner or final capping layer. Through exceptional engineering, it delivers the most important benefits of both flowable and sculptable bulk fill composites.1

The Sonicfill system is a unique material, it contain of a hand piece and a new composite unidose tips for composite material. This system utilizes the patented sonic-activation technology. The KaVo handpiece, delivers sonic energy at varying intensities, handpiece is adjusted on the shank from low to high (1 to 5) to control rate of composite extrusion. A Unidose tipsfor composite is manufactured by Kerr Corporation (USA) is screwed directly on the handpiece. Unidose tips has smaller diameter of 1.5 mm for accessing deep cavities, compared to the conventional larger 2.5 mm preloaded tips.

The Sonicfill composite is a combination of flowable and universal composites both. This incorporates a highly-filled resin with special modifiers that react to sonic energy. As sonic energy is applied to the hand piece with five different levels of flowability, the modifier causes the viscosity to drop (up to 87%), increasing the flowability of the composite. In Sonicfill material when sonic energy is stopped, the composite returns to a more viscous, non-slumping state which is best for for carving and contouring. SonicFill is a light-cured, hybrid composite for direct restorations in posterior teeth, and may also be used for Class V restorations, extended fissure sealing in molars and premolars and for reconstructive build-up.Sonicfill is available in four universal shades A1, A2, A3 and B1.4

Sonicfill bulk-fill can be applied in "bulk" increments of up to 5 mm without any adverse effect on the material's polymerization behavior or mechanical properties. It can be cured with conventional LED curing lights with a light intensity $\geq$ 500 mWcm2 in 20 seconds and using a light source such as Bluephase G2 light cure unit (Ivoclar Vivadent Schaan, Liechtenstein) with a light intensity $\geq$ 1000 mWcm2 in just 10 seconds.

Mouth rinses are widely used to prevent and control caries and periodontal diseases, with some individuals using mouth rinses at a frequency of six times per day. Mouth rinses contain water, antimicrobial agents, salts, preservatives and in some cases alcohol. The variation in the

concentration of these substances affects the pH of mouth rinses.

Mouth rinses contain alcohol which may soften the resin composite restorative materials. Low pH increases sorption, solubility and surface degradation of resin composites. The type of restorative material also influences the degradation of restorative materials.

The use of BulkFill resin composites has become popular in recent years because of their esthetics and good mechanical properties. Hence the aim of the study was to comparatively evaluate the effect of six commercial mouth rinses on the micro hardness of a bilkfill resin composite.[7]

In this study, mainly specimens were selected to record baseline micro hardness values prior to immersion in the mouth rinses. Microhardness was measured using Vicker's micro hardness tester. A load of 50g was applied on the surface of the test specimens with a dwell time of 30s. Three indentations were made on top surfaces of each specimen. All these indentations were equally placed over a circle and were not closer than 1 mm to the adjacent ones or to the margin of the specimens placed. The average of the three readings were taken and microhardness values were calculated. The specimens were immersed in 20ml of respective mouth rinses with both sides of specimen exposed and kept in an incubator at 37o C for 24h. Then specimens were removed from the mouth rinses, rinsed with distilled water, blotted dry using tissue paper, and subjected to post-immersion surface microhardness testing. Microhardness values was checked for each specimen using the same microhardness tester and same load and dwell time as previously mentioned above for pre-immersion test.

According to the result of the present study, prior to immersion, Sonicfill resin composite showed no significant difference in mean hardness before immersion between groups 1(Listerine), 2(Periogard), 3(Provicidal) 4(Hexidine), 5(Hexidine Ep) and 6(Hiora).

The inter-group comparison of mean hardness before immersion was done, no significant difference was reported for the inter-group comparison of mean hardness before immersion between different groups.(Table 4)

Post immersion, samples in all the subgroups showed reduction in microhardness with Sonicfill resin composite. With respect to mouthwashes, Sonicfill immersed in Listerine and Periogard showed significant difference in microharness with other mouthwashes (Table 5-6), Listerine, Periogard and Provicidal are alcohol-based mouth rinses. Hexidine,Hexidine Ep,Hiora are alcohol-free mouth rinses. (Table 7-8)

Therefore, the null hypothesis all the mouth rinses used in the study irrespective of the presence or absence of alcohol reduced the micro hardness of Bulk filled resin composite.

As the specimens were not exposed to any mechanical forces so the changes observed in surface microhardness would be attributed to the chemical reaction between the mouthwashes and materials and to the difference in composition of the two materials. Acidic pH of the mouth rinses would have caused acid erosion of the resin by acid etching and the principle matrix leaching forming cations. This is in accordance with the observations by Dieb et al in 2007 who reported that mouth rinses with low pH are detrimental to the hardness of resin composites.[8] Basically the low pH of mouth rinses may have acted in the polymeric matrix of the Bulkfilled resin composite used in the study, through catalysis of ester groups from dimethacrylate monomers present in the composition.[3]

Listerine(Gr I),containing thymol – 0.06% w/v, Eucalyptol-0.09% w/v, Menthol- 0.04%w/v, Ethanol-21.6%v/v and Periogard (Gr II)(alcohol and chlorhexidine containing) 4.54 Chlorhexidine gluconate- 0.12% w/v, Ethyl alcohol-11.6% v/v alcohol 21.6% w/v and 11.6 % w/v respectively, resulting in statistically more reduction in the micro hardness compared to Grs. III, (Provicidal) IV(Hexidine),V(Hexidine Ep)and VI(Hiora). Povicidal (Alcohol based-0.2% iodine,citric acid, disodium phosphate, nonoxynol-9, sodium hydroxide, water)did not show statistically significant difference compared to Hexidine (Gr IV), Hexidine ep(Gr V) and Hiora (Gr. VI) which are alcohol free. This may be because of the lower percentage of alcohol in Provicidal.

The softening effect of alcohol in the mouth rinses on the resin composite may be due to susceptibility of Bis GMA and UDMA based polymers present in them and irreversible leaching of the components. This effect may be more pronounced in nanofilled resin composites according to the observation by Karabela et al[23] and Almeida GS et al[5] who showed higher sorption rate for nanofilled resin composites in ethanol/water than in water or saliva. The reasons for this may be –
1. Greater surface area to volume ratio derived from the Non Agglomerated 20 nm silica filler.
2. Poor Impregnation of 5 to 20 nm sized primary particles by the polymeric matrix.

Alcohol content and low pH mainly effect on the micro hardness of resin composite. However pH and alcohol content not depend on each other.

## Conclusion

Mouth rinses are widely used to prevent and control caries and periodontal diseases, with some individuals using mouth rinses at a frequency of six times per day. Mouth rinses contain water, antimicrobial agents, salts, preservatives and in some cases alcohol. The variation in the concentration of these substances affects the pH of mouth rinses.

Mouth rinse use for daily oral hygiene is a feasible treatment option for the remineralization of dental tissues and/or biofilm control, depending on the patient's risk of developing caries or periodontal disease. Routine usage of such moth rinses could affect the characteristics of some restorative materials. Some mouth rinses with high ethanol contents may soften the resinous components of restorative materials, affecting the materials microhardness and therefore their longevity.

Within the Limitation and On the basis of the results of this study, it can be concluded that:

All the Mouthrinses used in this study reduce the surface hardness in the materials tested.

Listerine (Gr I) and Periogard (Gr II) respectively, resulting in statistically more reduction in the micro hardness compared to Grs. III, IV, V and VI. Povicidal (Alcohol based-0.2% iodine, citric acid, disodium phosphate, nonoxynol-9, sodium hydroxide, water) did not show statistically significant difference compared to Hexidine (Gr IV), Hexidine ep(Gr V) and Hiora (Gr. VI) which are alcohol free. This may be because of the lower percentage of alcohol in Provicidal.

As observed in the study, alcohol content and low pH can have an effect on the micro hardness, but these two factors may not be interdependent on each other for microhardness reduction of the resin composite tested. Periogard has more pH than Hiora, it shows less reduction in micro hardness than Periogard, may be because it has no alcohol in it.

Hence the long-term, use of mouth rinses like Listerine and Periogard which contain higher alcohol content (21.6% w/v and 11.6% w/v respectively) and low pH may be detrimental to the Bulkfilled filled resin composite used in the present study.

**Conflict of Interest:** None.

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