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An evaluation of the effect of Alcohol and Non-Alcohol based mouth rinses on the microhardness of two esthetic restorative materials – An *in vitro* Study

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Abstract
Objectives: This present study was done to evaluate the effect of different mouthrinses on the microhardness of two esthetic materials.
Materials and Methods: Fifty specimens of each group i.e., **Group I** – nanofilled composite **Group II** – compomer were prepared to a size of 3 mm in diameter and 3mm in height. The prepared specimens were immersed in artificial saliva for 12 hrs followed by baseline microhardness testing. Each group was divided into five subgroups based on the mouth rinses used for immersion. **SubGroup I** - Alcohol + Fluoride Based **Sub Group II** - Alcohol + Non-fluoride Based **Sub Group III** - Alcohol Free + Fluoride Based **Sub Group IV** - Alcohol Free + Non- Fluoride **Sub Group V** - Artificial Saliva (Control) and were immersed for 12 hrs in respective test groups. The post-immersion microhardness testing was done using Vickers microhardness Tester.
Results: Statistical analysis was done using one-way ANOVA followed by Student ‘t’ test. Group I showed statistically significant difference when compared to Group II.
Conclusion: Nanofilled composites showed decrease in microhardness with alcohol based mouth rinses while compomers did not show any significant reduction in the microhardness with alcohol based mouth rinses.

Keywords: nanocomposite resins, compomer, mouthrinses, microhardness.

1. Introduction

Tooth-coloured restorative materials have been widely used to meet patients’ esthetic demands in dental practice. Composite resins, polyacid modified resin based composites (compomers) and resin modified glass ionomer cement are most commonly used esthetic restorative materials.

To be clinically successful, tooth coloured restorative materials are required to have long term durability [1] and a high degree of long term wear resistance in the oral cavity [2, 3]. However, the chemical environment has appreciably influenced the degradation of these materials in vivo [4, 5, 6]. Now-a-days, the use of mouth rinses for antimicrobial control & implant maintenance has increased [7]. However, frequent use of mouth rinses may have detrimental effects on oral tissues and on the restorations present in the oral cavity [8].

Currently a wide variety of mouth rinses are available with fluorides incorporated and many of them are not studied for their effect on esthetic restorative materials. The performance of biomaterials is most frequently evaluated using laboratory tests [9]. One such parameter is surface microhardness that evaluates material surface resistance to plastic deformation by penetration.

Hence the aim of the study is to evaluate the effect of different types of mouth rinses on the microhardness of commonly used aesthetic restorative materials.

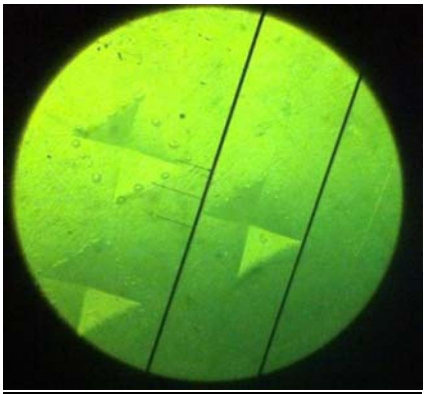
2. Materials and Method

Fifty cylindrical discs of each group i.e., **Group I:** Nano Filled Composite Restorative Material (Ivoclar Vivadent) **Group II:** Compomer (Dentsply Dyract XP) were fabricated using silicon Teflon mold (3mm in diameter and 3 mm in height). The mold was placed on a transparent matrix strip and glass slide. The different materials were mixed according to the manufacturers’ instruction and injected into the mold. The filled mold was covered with a

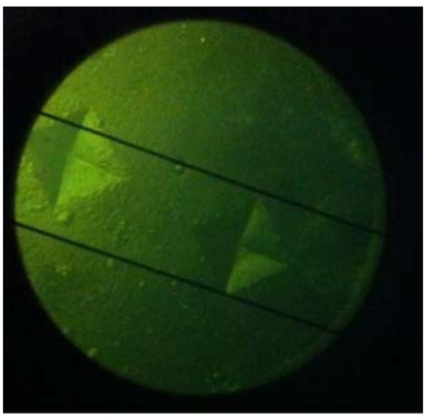
second transparent matrix and glass slide; light pressure was applied to expel excess material from the mold. Each specimen was polymerized through the top of the glass slide for 40 second with a dentsply light-curing unit. The set cylindrical cube was then separated from the mold; the bottom of the specimens was also polymerized for 40 seconds to ensure complete polymerization of the material. The excess material was removed with a scalpel blade, then the specimens were ground flat using 600- grit silicon carbide abrasive paper, and polished with 0.05 micrometer polishing compound and polishing cloth. All specimens then were immersed in 20 ml of artificial saliva for 12 hours. Base line microhardness recorded using Vickers Hardness Tester.
Each group is subdivided into 5 subgroups each containing ten specimens based on the different mouth rinses used for immersion. The pH of five commercial mouth Rinses was recorded using a digital pH meter.

Sub Group I: Alcohol + Fluoride Based Mouth Rinses (Colgate Plax)
Sub Group II: Alcohol + Non-Fluoride Based Mouth Rinses (Hexidine)
Sub Group III: Alcohol Free + Fluoride Based Mouth Rinses (Clohex Plus)
Sub Group IV: Alcohol Free + Non- Fluoride Based Mouth Rinses (Rexidin)
Sub Group V: Control **(**Artificial Saliva)

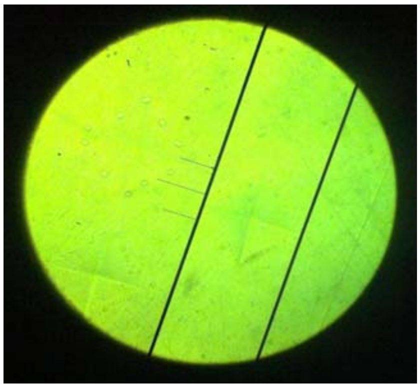
The specimens of Group I, Group II and Group III were immersed in 20 ml of the test mouth rinses and incubated for 24 hr. at 37 ^{0}C. The post immersion micro hardness values of the specimens were recorded using Vickers Hardness Tester (Matsuzawa-Seiki Co-Ltd., Tokyo Japan, Model No. MHT-1).



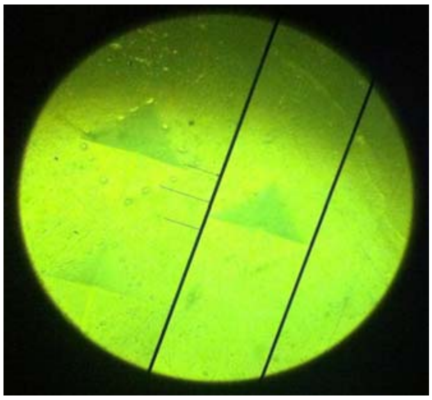
Sub Group I: Alcohol + Fluoride Based Mouth Rinses (Colgate Plax)



Sub Group II: Alcohol + Non-Fluoride Based Mouth Rinses (Hexidine)



Sub Group III: Alcohol Free + Fluoride Based Mouth Rinses (Clohex Plus)



Sub Group IV: Alcohol Free + Non- Fluoride Based Mouth Rinses (Rexidin)

3. Surface hardness measurement
Microhardness measurements of top surfaces of the specimens were determined by Vickers hardness testing machine. The Vickers surface microhardness test method consisted of indenting the test material with a diamond tip, in the form of a right pyramid with a square base and Vickers microhardness readings were undertaken using a load of 50 g for 20 seconds.
All hardness values were expressed in vickers hardness, where $1HV=1.854\ P/d^2$, with P being the indentation load and d the diagonal length.
As the Vickers microhardness tester was very sensitive to operational procedures, an average reading of three indentations were taken to avoid operator bias. **(Table-I)**
The tabulated observations were then statistically analyzed using Analysis of variance technique (One Way ANOVA) to evaluate the difference among five sub groups followed by Student's 't' test for inter group comparison with SPSS 17 software. A "p" value of <.05 was considered for statistical significance.

Table 1: Vickers Microhardness values in Kg/mm^2 for the three esthetic restorative materials before and after immersion in the mouthrinses.

	Nano Composite		**Compomer**	
	BASE-LINE	**AFTER 12 HRS**	**BASE-LINE**	**AFTER 12 HRS**
SUBGROUP I	79.95	62.81	70.06	68.19
SUBGROUP II	77.84	60.26	71.90	69.01
SUBGROUP III	77.26	71.56	73.27	71.94
SUBGROUP IV	76.45	71.20	72.12	71.06
SUBGROUP V	79.57	78.94	73.43	73.10

4. Results

The mean and standard deviation were calculated for each group **(Table-II & Table-III)**. The results indicated that materials and mouthrinses are significant factors in changing the surface hardness.

Table 2: Mean, Standard Deviation and Test of Significance of Microhardness within Different Groups

Sub Group	Group	N	Mean	SD	t –value*	p-value*	Significance# groups at 5% level
I	I	10	71.38	1.76	13.241	<0.001 (Sig)	I≥II
	II	10	69.12	1.72	13.162		
II	I	10	69.05	1.72	13.092	<0.001 (Sig)	I≥II
	II	10	70.45	1.73	13.215		
III	I	10	74.41	1.82	15.301	<0.001 (Sig)	I>II
	II	10	72.60	1.80	15.216		
IV	I	10	73.82	1.80	15.216	<0.001 (Sig)	I>II
	II	10	71.59	1.76	15.973		
V	I	10	79.25	1.89	16.763	<0.001 (Sig)	I>II
	II	10	73.26	1.80	14.986		

Statistically significant level at P<0.05; S: significant; NS: Not significant.
***** One –way ANOVA was used to calculate the p-value
*Student's 't' test was used to calculate the t-value for inter group comparison

Table 3: Mean, Standard Deviation and Test of Significance of Microhardness within Different Sub Groups

Group	Sub Group	N	Mean	SD	p-value*	Significance# groups at 5% level
I	I	10	71.38	1.76	**<0.001 (Sig)**	V>III>IV>I>II
	II	10	69.05	1.72		
	III	10	74.41	1.82		
	IV	10	73.82	1.80		
	V	10	79.25	1.89		
II	I	10	69.12	1.72	**0.681 (NS)**	-
	II	10	70.45	1.73		
	III	10	72.60	1.80		
	IV	10	71.59	1.76		
	V	10	73.26	1.80		

Statistically significant level at P<0.05; S: significant; NS: Not significant.
***** One –way ANOVA was used to calculate the p-value

Group I showed maximum microhardness when compared to Group II before immersion in test mouth rinses. Group I showed statistically significant difference in microhardness before immersion in test mouth rinses and after immersion in test mouth rinses. Group II showed no effect in microhardness before immersion in test mouth rinses and after immersion in test mouth rinses. Intra group findings have shown that alcohol with no fluoride mouth rinse (Subgroup II) has affected the microhardness of the test materials maximum. Artificial saliva (control) has shown least effect on the microhardness of the test materials.

5. Discussion

In recent years, the popularity of tooth colored restorative materials has promoted a rapidly increasing use of resins to meet the cosmetic expectations of the patients. The longevity and durability of the esthetic restorative materials in the oral environment are important factors for the proper selection of the material.

The use of antimicrobial mouth rinses is an approach to limiting the accumulation of dental plaque, with a primary objective of controlling the development and progression of periodontal diseases and dental caries [10]. Mouth washes are frequently used, even without professional prescription. The formulation of these mouthwashes consists of water, anti microbial agents, salts and in some cases alcohol [11] and the different concentrations of these substances can affect the pH of mouthwashes [12, 13]. Alcohol in mouthrinses is used as solvent, taste enhancer and as an antiseptic agent [14]. Concern has been expressed regarding the use of alcohol containing mouthrinses as it may soften the tooth coloured restorative materials.

The present *in vitro* study was designed to comparatively evaluate the effect of mouth rinses on the microhardness of nanofilled composite resins and compomer.

One of the most important physical properties of restorative filling material is surface hardness, which correlates well to compressive strength and abrasion resistance of the material. Hardness is defined as the resistance of a material to indentation or penetration.

Hardness is considered as the test parameter as it is an important property for the restorative materials to have long-term durability in the oral cavity [15]. So decrease in the hardness of a material may result in premature failure of a restoration requiring its replacement.

In the present study, all the mouth rinses irrespective of the presence or absence of alcohol resulted in significant reduction in the microhardness of the tested materials compared to baseline values. This may be because of the acidic pH of the mouth rinses which would have caused acid erosion of the restorative materials [16].

Intra group comparison showed that alcohol with no fluoride based mouth wash subgroup showed statistically more reduction in the microhardness when compared to other subgroups [17].

Since nanotechnology was introduced to dentistry, nanocomposites with filler sizes ranging from 0.01 to 0.04 mm have been developed [18]. Wear resistance of nano composites has been shown to be comparable or superior to that of microfill and microhybrid composite resins [19].

Group I (Nano composite restorative materials) showed relatively less microhardness when compared to Group II (compomers) when stored in alcohol with fluoride and alcohol with no fluoride mouth rinses, this is because of the softening effect of alcohol in the mouth rinses on the resin composite [20, 21]. This may be due to susceptibility of bisGMA based polymers present in them and irreversible leaching of the components [22]. According to some studies, alcohol acts as plasticizes of the polymeric matrix, making the material more ductile.

In addition, ethanol can reduce bonding between resin matrix and inorganic fillers which might decrease erosion resistance and cause staining of resin matrix [23]. Studies have shown that composite soaked in mouth rinses containing alcohol significantly reduced hardness of composites than the ones soaked in non alcoholic mouth rinses [20].

The only Group that did not show a significant softening effect from mouth rinse immersion was Group II (Compomer). The compomer used in this study is UDMA based material. Studies stated that the resin material using UDMA show more stability than other resins because of their lower viscosity and water sorption properties [21].

There is no statistically significant difference on the microhardness of the test materials with or without Fluoride. The physiologic solution used in this study was prepared with inorganic ion concentrations similar to saliva [24]. The microhardness in artificial saliva was high in all the groups. The test specimens were placed in 20 ml of each of test rinses for 12 hours to simulate a one-year regimen of rinsing for 2 minutes per day. The immersion technique that was selected (continuous for 12 hours) represents an extreme test condition.

The effect of mouth rinses on structure and consequently hardness of the restorative materials may be originated from the materials themselves and from some other deleterious components in the mouth rinse. Significant interaction was found between mouth rinses and material. The results of this study indicated that there is decrease in surface hardness with a consequent increase in surface disintegration.

Vickers hardness tester was developed in 1924 by Smith and Sandland. The Vickers hardnes is the quotient obtained by dividing the KgF load by the square mm area of indentation. When the mean diagonal of the indentation has been determined the Vickers hardness may be calculated from the formula $HV=1.854\ F/d^2$.Vickers test is easier to use than other hardness tests since the required calculations are independent of the size of the indenter, and the indenter can be used for all materials irrespective of hardness.

6. Conclusion

The effect of mouth rinses on the microhardness was material dependent. This may be attributed to the differences in chemical composition and filler type of each material.

Group II did not show any significant reduction in microhardness with alcohol based mouth rinses. Group I showed statistically significant decrease in microhardness with alcohol based mouth rinses. There was no reduction in the microhardness in artificial saliva subgroup which acts as a control.

However, the results of this *in vitro* study may not be directly related to the clinical situation where saliva may dilute or buffer the mouth rinses. Hence further in vivo studies are recommended to substantiate the results of this present study.

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