Effect of five commercial mouth rinses on the microhardness of a nanofilled resin composite restorative material: An in vitro study

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Abstract

Aim and Objectives: This in vitro study was designed to comparatively evaluate the effect of five commercial mouth rinses on the microhardness of a nanofilled resin based restorative material. Materials and Methods: Fifty specimens of resin composite material (Filtek Z350XT, 3MESPE, St Paul, MN USA) were prepared and immersed in artificial saliva for 24 h. The base line micro hardness of specimens was recorded using Vicker's micro hardness tester (MMT - X7 Matsuzawa, Japan). The specimens were randomly distributed into five groups, each containing 10 specimens (n=10) as follows - Group I Listerine (alcohol based), Group II Periogard (alcohol based), Group III Colgate plax (alcohol based), Group IV C-prev (alcohol free), Group V Hiora(alcohol free). The specimens were immersed in 20 ml of mouth rinses and incubated for 24 h at 37°C. The post immersion micro hardness values of the specimens were recorded and the data was tabulated for statistical analysis. Kruskal-Wallis test was used for inter group comparison followed by pair wise comparison of groups using Mann Whitney U test. The level of significance was set at P<0.05. Results: Significant reduction in the mean VHN (Vicker's micro hardness number) was observed in all the groups after exposure to the tested mouth rinses (P<0.01) and the reduction in mean VHN values were as follows: Group I 12.09, Group II 3.42, Group III 1.51, Group IV 1.03, Group V 0.57. Inter group comparison showed statistically significant reduction in micro hardness in Groups I and II compared to all other groups with P<0.001. There was no significant difference between Groups III, IV and V. Conclusion: All the mouth rinses showed a reduction in the microhardness of nanofilled resin composite material with listerine (Group I) containing maximum amount of alcohol, showing highest reduction in micro hardness value.

Materials and Methods

The details of the commercial mouth rinses and the tested resin composite are shown in [Table 1] and [Table 2]. Specimen preparation

Fifty specimens of nanofilled resin based composite material with 3 mm in diameter and 3 mm in height were prepared using a plastic mold which was custom modified to get the desired size. The mold was placed on a glass slide(Microglass industries,pahari DhiraJ,Delhi) and filled with resin composite to a slight excess using composite filling instrument (GDC Marketing co, Hoshiarpur, India) covered with a clear matrix strip (Samit products, Jandewalan, New Delhi) and another glass slide was placed on top and gently pressed for 30 s to extrude excess material to obtain a smooth surface. Each specimen was cured for 40 s from the top and another 40 s from the bottom using LED light cure unit (Blue phase C8, Ivoclar Vivadent, Aetria) at 800 mW/cm² . The specimens thus prepared were kept in artificial saliva for 24 h to simulate the oral environment.

pH Evaluation

The pH of five commercial mouth rinses was recorded using a digital pH meter (servewell instruments and equipments Pvt Ltd, Bangalore). The values are entered in [Table 1].
Micro hardness testing

The specimens were randomly divided into five groups of 10 specimens each (n=10) as follows: Group I Listerine (alcohol based), Group II Periogard (alcohol based), Group III Colgate plax (alcohol based), Group IV C-Prev (alcohol free, fluoride containing), Group V Hiora (alcohol free, herbal). The baseline micro hardness values of the specimens were recorded using Vicker's micro hardness tester (MMT - X7 Matsuzawa, Japan) with a load of 200 g and a dwell time of 15 s.

The specimens were then immersed in 20 ml of respective mouth rinses and kept in an incubator at 37°C for 24 h. The specimens were then checked for post immersion micro hardness using the same micro hardness tester previously mentioned for baseline values. The data was tabulated and subjected to statistical analysis.

Statistical tests

The intra group (pre and post immersion values) comparison of the mean value of micro hardness of the specimens was done using Wilcoxon signed rank test. For inter group comparison Kruskal-Wallis test followed by Mann-Whitney U test was used with SPSS version 16 (SPSS Inc.,Chicago) and micro soft excel version 7 (Micro soft corporation NY, USA). The level of significance was set at P=0.05.

Results

Significant reduction in the micro hardness was observed in all the groups after immersion in the mouth rinses compared to baseline values with P<0.01.

Kruskal-Wallis test showed a statistically significant difference in micro hardness between the five groups of mouth rinses with P< 0.05. Further analysis was done applying Mann-Whitney U test for pair wise comparison.

Group I (Listerine) and Group II (Periogard) showed significant reduction in the micro hardness compared to Group III (Colgate plax), IV(C-Prev) and V(Hiora) with P>0.001, whereas there was no statistically significant difference between Groups III and IV (P=0.8), Groups III and V (P=0.48) and Groups IV and V (P=0.19) as shown in [Table 3].

Discussion

The present in vitro study was designed to comparatively evaluate the effect of mouth rinses on the micro hardness of a nanofilled resin composite Filtek Z350 XT. Listerine, Periogard and Colgate Plax are alcohol-based mouth rinses. C-Prev and Hiora are alcohol-free mouth rinses. The study design is an "active arm controlled trial" which does not require a parallel placebo arm. Hence there is no control group included in the study.

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. [16] Hardness may be defined as the resistance of a material to indentation or penetration. [17] Strength, proportional limit and ductility are related to hardness. Hardness has also been used to predict the wear resistance of a material and its ability to abrade or be abraded by opposing dental structures and materials. [18] So a 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 micro hardness of the tested nanofilled resin composite material compared to base line values. This may be because of the acidic pH of the mouth rinses which would have caused acid erosion of the resin composite by acid etching and leaching the principle matrix forming cations. This is in accordance with the observations by Dieb et al in 2007 [7] who reported that mouth rinses with low pH are detrimental to the hardness of resin composites. Basically the low pH of mouth rinses may have acted in the polymeric matrix of the nanofilled resin composite used in the study, through catalysis of ester groups from dimethacrylate monomers present in the composition (Bis GMA, Bis EMA, UDMA and TEG DMA). [19] The hydrolysis of these ester groups may have formed alcohol and carboxylic acid molecules that may have accelerated the degradation of the resin composite. [20]

Inter group comparison showed Listerine (Gr. I) and Periogard (Gr. II), containing alcohol 21.6% w/v and 11.6 % w/v respectively, resulting in statistically more reduction in the micro hardness compared to Grs. III, IV and V. Colgate plax (Gr. III) although contains alcohol (7.2% v/v) did not show statistically significant difference compared to C-Prev (Gr. IV) and Hiora (Gr. V) which are alcohol free. This may be because of the lower percentage of alcohol in Colgate plax. This observation is in accordance with the observations by Penugonda et al[4] who reported that the higher percentage of alcohol in the mouth rinses causes more reduction in the hardness of restorative materials.

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 [21] and irreversible leaching of the components. [22] 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 -

Greater surface area to volume ratio derived from the non agglomerated 20 nm silica filler.Poor impregnation of 5 to 20 nm sized primary particles by the polymeric matrix.

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 in reducing the micro hardness of the resin composite tested. Though Hiora has low pH than Periogard, it shows less reduction in micro hardness than Periogard, maybe because it has no alcohol in it.

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

Conclusions

Within the limitations of the experimental design and the test parameter, it can be concluded that -

Listerine mouth rinse containing highest amount of alcohol showed maximum reduction in micro hardness of nanofilled resin composite Filtek Z350 XT. All the mouth rinses used in the study irrespective of the presence or absence of alcohol reduced the micro hardness of nanofilled resin composite.

References

4. Hiora has low pH than Periogard, it shows less reduction in micro hardness than Periogard, maybe because it has no alcohol in it.