



Original Research Article

Effect of mouthwashes on sorption and solubility of three different esthetic restorative materials – An in vitro study

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ABSTRACT

Aims: To evaluate the sorption and solubility of three restorative materials in three different mouthwashes.**Methods and Material:** A total of 45 samples of restorative materials were made in a stainless steel mould of 15+0.1 mm diameter and 2mm thickness as per ISO guidelines and three groups (n=15); Group I: Type IX Glass ionomer cement (GIC), Group II: Cention N and Group III: composite, were assigned. After measuring weight of the samples before immersion (m₁) using digital analytical scale, 5 specimens from each group were immersed in the mouthwashes and grouped as Subgroup 1: Listerine, Subgroup 2: Plax, Subgroup 3: Periogard for seven days. Then the weight after immersion (m₂) and the weight after final drying (m₃) were determined using the same digital analytical scale and values were estimated using the Oysaed and Ruyter formula.

Statistical analysis used: The data were statistically analyzed using two way ANOVA followed by Tukey's post hoc test.

Results: The three mouthwashes had effect on sorption and solubility of tested materials. Type IX GIC showed maximum sorption and solubility when compared to Cention N and composite. Among mouthwashes, listerine showed significantly higher values when compared to Periogard and Plax.**Conclusions:** Mouth washes having alcohol content with low pH may increase the sorption and solubility of all the tested materials. Also the type and mean particle size of filler, the coupling agents, and the solvent in which they are immersed affect these two properties.© 2020 Published by Innovative Publication. This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by/4.0/>)

1. Introduction

Advances in the field of esthetic restorative materials which requires very conservative tooth preparation are in a rapid pace. Moreover clinical and laboratory researches concerning them play an important role because of the patients' preferences for these materials.^{1,2}

Composites are superior in their aesthetic quality and adhesion capability to tooth substrates. The improved mechanical properties of composite forced the clinicians to choose it as a better option for both anterior and posterior restorations.³ Highly viscous GIC (Fuji IX), is widely used in Atraumatic Restorative Technique (ART).^{4,5} In this, the powder is modified by replacing calcium with strontium

ions which improves its hardness and wear resistance.^{1,6} Cention is an "alkasite" restorative material, like compomer or ormocer and is considered to be a subgroup of the composite. It contains special patented filler (Isofiller) which functions as a shrinkage stress reliever.⁷

Two important phenomena that can affect the durability of restorations are water sorption and solubility. Water sorption can increase the volume of the material and thereby can act as a plasticizer resulting in the deterioration of the matrix structure.⁸ Solubility is defined as the extent to which a material dissolves in a solvent within a given temperature.⁹

Nowadays mouthwashes are widely used even without a dental prescription. According to a study by Moran JM et al, frequency of using mouthwashes was up to six times per day.¹⁰ Water, antimicrobial agents, salts, preservatives, and

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alcohol are the different constituents of mouthrinses.¹¹ It was reported that ethanol in mouthwashes might speed up the degradation of resin based constituents.¹²

Periogard mouthwash contains chlorhexidine, which is a bisbiguanide antiseptic having four chlorophenyl rings and two biguanide groups bonded by a hexamethylene bridge.¹³ Listerine mouthwash is an essential oil type, which contains thymol, eucalyptol and menthol in an alcohol solvent.^{10,14} Plax mouthwash has Cetyl pyridinium chloride, which is a quaternary ammonium compound.¹¹

Always there is a concern about effects of mouthwashes on the properties of composite resins like discoloration, staining, and translucency. But only few researchers assessed the influence of mouthwashes on the mechanical and chemical properties of the composites,¹⁵ Moreover there is no study till date on comparing the effects of different mouthwashes on Cention N, composite and Type IX GIC. In the light of this, present study was conducted.

2. Materials and Methods

Restorative materials and solutions used in this study are Cention N (Ivoclar vivadent), Type IX GIC (GC Corporation Tokyo, Japan), Filtek™ Z350 XT (3M ESPE), Listerine, Alcohol based (Johnson and Johnson Healthcare Products), PerioGard with alcohol (Colgate Palmolive Ind.com.Ltda), Colgate Plax, Alcohol free, fluoride containing, (Colgate Palmolive Ind.com.Ltda,)

Preparation of Specimens

For each material, 15 disc-shaped specimens were prepared using a stainless steel mould of 15±0.1 mm diameter and 2mm thickness. Products were handled according to the manufacturer's instructions.

The mould was lubricated with petroleum jelly to facilitate removal of the materials after setting. After proper cleaning and polishing of specimens, they were first stored in a desiccator at 37°C with silica gel for 24 hours (hrs). Later they were transferred to a desiccator at 23°C for 1 hrs. They were weighed to an accuracy of 0.1mg in a digital analytic balance and the same process was repeated till a mass of loss not more than 0.1mg in any 24 hrs period is achieved. This is the sample weight before immersion (M_1).

Using digital caliper, the diameter of each sample was measured at two points perpendicular to one another and the average diameter was estimated. Then the thickness of each specimen was measured at the center in four equally spaced points and average thickness was estimated. Using the formula, $V = \pi \times r^2 \times h$, where r is the radius (average diameter/2) and h is the average thickness, volume was calculated.

Five samples of each material were immersed in 10ml of three mouthwashes at 37°C for seven days. After seven days, they were removed and washed. The adherent water was removed with a tissue paper. The samples were kept at 37°C for 15 seconds and weighed (M_2). Then the specimens

were reconditioned to constant weight in the desiccator using the earlier cycle. The sample weight after immersion (M_2) and desiccation (M_3) were noted. The solvent uptake and solubility were estimated in $\mu\text{g}/\text{mm}^3$ using the Oysaed and Ruyter formula as follows:

$$\text{Sorption} = (M_2 - M_3) \div V$$

$$\text{Solubility} = (M_1 - M_3) \div V$$

Where, M_1 = Sample weight before immersion

M_2 = Sample weight after immersion and

M_3 = Sample weight after immersion and desiccation.

2.1. Statistical Analysis

SPSS version 21.0 (Amonk, IBM corp., NY) was used for analysing the data statistically. Analysis was done using two way ANOVA and Tukeys post hoc test. P values less than 0.05 were considered statistically significant.

3. Results

Sorption and solubility mean values are given in figure 1 and 2 as graphical representations. ANOVA showed significant difference in sorption and solubility values. Post hoc test was used to compare groups and subgroups. Values of Post hoc test are given in Table 1 and 2 respectively. Sorption is within the permitted values of ISO standard but solubility showed significantly higher values more than permitted limit.

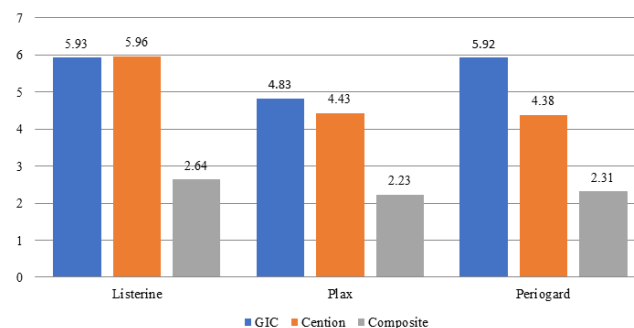


Fig. 1: Mean values of sorption of restorative materials in different mouthwashes

4. Discussion

The resistance against degradation of restorations plays an important role in their clinical longevity.¹⁶ Thus increase in the knowledge about sorption and solubility properties should have a critical role in predicting the success of restorations. According to ISO 4049 (2009) standardisation, restorative materials should have water sorption lower than $40\mu\text{g}/\text{mm}^3$ and solubility lower than $7.5\mu\text{g}/\text{mm}^3$ for 7 days of storage period.¹⁷

Nanofilled composite and Glass-ionomer cements are used in dentistry in a wide manner nowadays.^{1,2} Cention N

Table 1: Comparison of sorption of restorative materials in mouthwashes using Tukeys Post Hoc Test

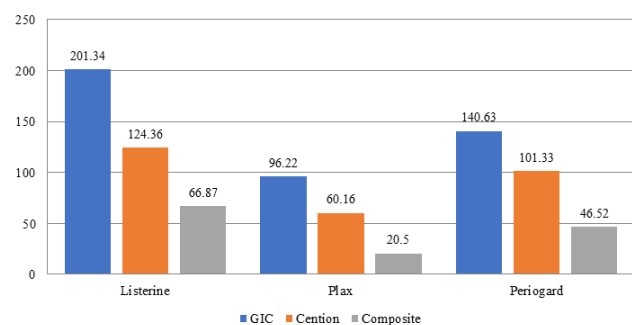
Dependent Variable Sorption	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Listerine	GIC	cention	-.03400	.51479	.998	-1.4074	1.3394
	GIC	composite	3.29400*	.51479	.000*	1.9206	4.6674
	Cention	composite	3.32800*	.51479	.000*	1.9546	4.7014
plax-	GIC	cention	.40200	.29540	.391	-.3861	1.1901
	GIC	composite	2.60000*	.29540	.000*	1.8119	3.3881
	Cention	composite	2.19800*	.29540	.000*	1.4099	2.9861
Periogard	GIC	cention	1.54000	.59353	.057	-.0435	3.1235
	GIC	composite	3.61000*	.59353	.000*	2.0265	5.1935
	Cention	composite	2.07000*	.59353	.012*	.4865	3.6535

*. The mean difference is significant at the 0.05 level.

Table 2: Comparison of solubility of restorative materials in mouthwashes using Tukeys Post Hoc Test

Dependent Variable Solubility	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Listerine	GIC	cention	76.98000*	2.11881	.000*	71.3273	82.6327
	GIC	composite	134.46800*	2.11881	.000*	128.8153	140.1207
	Cention	composite	57.48800*	2.11881	.000*	51.8353	63.1407
Plax	GIC	cention	36.05200*	2.81537	.000*	28.5410	43.5630
	GIC	composite	75.72000*	2.81537	.000*	68.2090	83.2310
	Cention	composite	39.66800*	2.81537	.000*	32.1570	47.1790
Periogard	GIC	cention	39.29600*	6.36009	.000*	22.3281	56.2639
	GIC	composite	94.10600*	6.36009	.000*	77.1381	111.0739
	Cention	composite	54.81000*	6.36009	.000*	37.8421	71.7779

*. The mean difference is significant at the 0.05 level.

**Fig. 2:** Mean values of solubility of restorative materials in different mouthwashes

is considered to be a good replacement for amalgam as an esthetic posterior bulk fill material.⁷

In vitro studies made it clear about the subsurface and surface disintegration of composites while immersing in alcohol.¹⁸ At the same time, in vivo studies found that mouth rinses with and without alcohol had same effect in plaque control and reducing gingivitis.¹³ Thus this study aimed to find out the effect of three different mouthwashes like periogard, listerine and colgate plax on Nanofilled Composite, Type IX GIC and Cention N irrespective of the

presence of alcohol.

Variations in values from previous studies might be due to differences in the composition of the mouth washes and restorative materials used.¹⁵

In the present study, tested materials showed maximum sorption and solubility in listerine. This could be due to low pH (4.2) and 30% alcohol content when compared to other two mouthwashes. It may have caused wear of the filler surfaces and finally resulted in debonding.^{10,14}

Sorption is a diffusion-mediated process which occurs in the organic resin matrixes.¹⁴ Increased pressure due to change in dimensions by sorption property can constrain the material within the cavity.¹⁹ Resin matrix with hydrophilic HEMA and UDMA showed higher sorption values. Khokhar et al. observed that the UDMA had higher sorption when compared to Bis-GMA because of its urethane groups, which can be correlated with the current study result, that Cention N showed higher values when compared to Composite.²⁰

Mohsen and Craig opined that the true sorption values should be more than the reported ones usually since the gain in weight of the samples denotes the water gain, but in fact it is the difference between the weight gain and the release of low molecular weight components.^{21,22}

The solubility of restorations may cause surface deformation as well as marginal discrepancies.¹⁰ The effects of chemistry of the oral environment and curing units will be different relying on the type of the material being tested. One more factor that cause variation from previous studies might be due to differences in specimen size, since difference in size will affect time taken for solvent to completely infiltrate within the resin matrix.⁹

In composite, alcohol can cause swelling of the resin matrix and thereby release more unreacted monomers and oligomers.¹⁰ In Filtek Z 350, major amount of TEGDMA is replaced by UDMA and BisGMA. This replacement and copolymerization with BisGMA may create more flexible resins having lower water sorption and higher solubility values. TEGDMA can produce the most dense polymer network. But at the same time, it can absorb more water because of its heterogeneous property which creates microporosity and there by release the least amount of unreacted monomer. This might be the reason for lower values of Composite.

Two other possibilities are there to explain sorption of the nanofilled composite. First may be the higher surface area - volume ratio produced from the non-agglomerated silica filler of 20 nm size, which caused more solvent to get accumulated at the filler- resin interfaces where greater amount of silane and the hydrophilic groups available for higher rate of hydrogen bonding. Second, the liquid accumulated at the filler- matrix interzone might diffuse into the aggregates through path already produced by poor impregnation of 5-20 nm-sized primary particles.¹⁵

Type IX GIC showed highest sorption and solubility values when compared with other restorative materials. The continuous transferring of the samples to and from the weighing machine during the study was believed to cause minute wear on the surface, this might be the reason for variation in values from earlier studies.¹⁰

Sorption as well as solubility can result in hydrolytic degradation of GIC, which in turn affect the mechanical properties of the restorative materials.²³ One specific feature of GIC is its water uptake and loss. Ionic interaction is the main bonding mechanism of HVGIC between material constituents and hydroxyapatite of the tooth, which can be hampered by water loss.²⁴ Thus surface protector medium like petroleum jelly are required. Fluoride releasing property of GIC, which promotes the remineralization, is likely to be related to solubility. Thus, further studies should be required to rule out the effect of solubility on this property of GIC.⁹

Improper mixing of the material may cause air voids which in turn result in increased exposure to the solvent and may cause inhibitions zones of unpolymerized materials. This might be the another reason for higher values than expected one.⁹

As per Catani-Lorente et al.²⁵ since clinical scenario is quite different from in vitro conditions, dental practitioners

may need to be cautious about the manipulation and application of these restorative materials.

5. Conclusion

Based on the findings and the results, the following conclusions can be drawn:

Use of alcohol-containing mouth washes having low pH may increase the sorption and solubility of the restorative materials. Thus it is quite reasonable to use alcohol-free mouthwashes especially in patients with extensive restorations even the three mouthwashes used in the current study had effect on sorption and solubility of tested materials irrespective of alcohol content. This might be due to the composition of matrix, nature of filler particles, their hydrophilicity, efficiency of polymerization etc. Thus continuous improvement in the materials' properties should be required.

6. Source of Funding

None.

7. Conflict of Interest

None.

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