

EFFECT OF DIFFERENT TYPES OF WATER ON CUSP DEFLECTION OF TEETH RESTORED WITH COMPOSITE

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ABSTRACT

Objective: It is in vitro study to evaluate the influence of various mouth washes on cusp deflection of premolar teeth restored with different types of composite.

Methods: A total of 45 human premolars were used in this study. The teeth were randomly divided into three equal groups according to the type of resin composite (Silorane, Bulk fill and Filtek™ Z250). Each group were immersed for three months in three different solutions (alcohol-containing mouth rinse, alcohol-free mouth rinse, and artificial Saliva). The cuspal deflection was measured after curing of the composite resin and after immersion in the solution using digital caliper.

Results: All the composite resin specimens show cusp deflection. The lowest value of cusp deflection was recorded for the Silorane specimen in comparison to other types of composites. The specimens who immersed in alcohol containing mouth wash recorded the highest values.

Conclusion: Alcohol-free mouth rinse may prefer to alcohol containing mouth rinse in patients with extensive restorations

INTRODUCTION

During the last decades. The development of resin composite materials for direct restorations with improved physical and mechanical acceptable surface smoothness. Leads to increase demand for esthetic dentistry [1] Polymerization shrinkage remains a concern and a major drawback for direct composite resins as it is accompanied by stress

buildup which can lead to adverse effects on the bonding to the tooth structure with subsequent marginal staining, microleakage, and recurrent caries^[2-4]. When the adhesive strength exceeds the contraction stress, the restoration maintains an internal tension that pulls the cavity walls together, reducing the intercusp distance (i.e. cuspal deflection).^[5] the use of an antiseptic agent such as a mouth rinse as an adjunct to tooth brushing with

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a dentifrice may be justified, especially in caries-active patients^[6,7]. If the composite resin restorative materials bathed in saliva the water absorption will occur. The factors which affect the amount of water absorption of the composite restoration materials are filler content, curing time, the resin content, distance from composite cured and the coupling agent^[8-10]. When the filler content of the composite is more the water absorption will be less^[8, 11]. The proper the bonding of the coupling agent the lesser the water absorption^[12,13]. For resin-based composite materials water absorption may induce weakening of the matrix followed by breakdown of resin filler interface. It is also expected the hygroscopic expansion of composite that result from absorption of water may be able to compensate for the effect of polymerization shrinkage and relieve stresses^[14].

The organic matrix of conventional resin composites is generally based on methacrylate chemistry, especially cross linking dimethacrylate. The solubility of dimethacrylate based resin composites in various solutions including water and mouth rinses has been widely studied^[15, 16-18].

AIM OF THE WORK

This in vitro study was conducted to determine the influence of various fluids on cusp deflection of three types of composite.

MATERIAL AND METHODS

Forty five (45) human premolars extracted for orthodontic reasons stored in normal saline were used. The selected teeth were placed 3 mm below the cemento-enamel junction in an acrylic mold with dimensions of 15mm internal diameter, 25mm external diameter, and 20 mm height. The teeth set in the acrylic mold were fixed with a vice and a large Mesiooccluso distal cavity (MOD) cavity was prepared. The mesio-distal proximal box was extended 0.5 mm bucco-lingually, and the width of the axial and gingival walls of the box was 1mm.

The width and depth of the pulpal wall of the MOD cavities was 2×3mm. The reference point for cavity depth was the central groove. The reference point for measuring the specimens before and after the procedure was two metal tips (cut from dental needle C-K Ject, Korea, Queens Singapore) for each specimen (0.5 × 4 mm) that was fixed (using Clearfill SE Bond) horizontally and perpendicular to the long axis of the specimen at the cusp tip of the tooth, one buccally and the other lingually. The end of this tip was located beyond the buccal and lingual tooth contour by 2 mm in order to be attached to the microscope probes during cusp deflection measurement.

The teeth were randomly divided into three main groups (15 each), according to type of composite used. The first main group was restored with a hydrophobic resin composite (Silorane), the second main group was restored with hydrophilic one (Bulk fill) and the third main group was restored with (Filtek™ Z250). The restoration of composite followed the manufactures' instruction. Cuspal deflections were measured using a digital micrometer at 5 minutes after completing the restoration. A Standardized LED light curing unit (Kerr - Demi -LED Light-Curing System, CA, USA) was used for polymerization of all composites (20 seconds for irradiation was used throughout the study. Each main group divided into three groups (n=5) according to the type of treatment solution: distilled water, alcohol-containing and alcohol free-containing. Each group was stored three months. Cuspal deflections were measured at the end of the storage period the measurements were made by the same operator. Cuspal deflection measurements were calculated in Microns by subtracting the second readings from the initial ones.

The results were statistically analyzed using ANOVA followed by Student-Newman-Keuls post hoc tests ($p = 0.05$).

TABLE (1) Materials used in the study.

Tetric EvoCeram Bulk Fill Light cured methacrylate-based bulk-fill composite resin	Monomer matrix of dimethacrylates - Fillers (Bariumglass-ytterbium trifluoride-mixed oxide prepolymer)	S09720	Ivoclar Vivadent, USA
Filtek™ Z250 universal restorative composite	Microhybrid	N833614	3M/ESPE, St. Paul, MN, USA
Filtek Silorane (posterior restorative)	Silorane (3,4-epoxycyclohexylethylcyclopolymethylsiloxane, bis-3,4-epoxycyclohexylethyl-phenylmethylsilane) Fillers: Quarz (silane layer) radiopaque yttrium fluoride Filler loading 76% (wt %)	N236344	3M/ESPE, St. Paul, MN, USA
Scotchbond etchant	35% phosphoric acid gel	N274688	
Adper Single Bond Plus	Two step etch-and-rinse adhesive system	N446453	
Oral-B, Pro-Expert mouth rinse (alcohol-free mouth rinse)	Aqua, Glycerin, polysorbate 20, Aroma, methylparaben, cetylpyridinium chloride, sodium fluoride, sodium saccharin, sodium benzoate, propylparaben, CI 42051, and CI 47005	99602155	Procter & Gamble MN GmbH, Straße e 1, 64521 Gross Gerau, Germany
Oral-B, Advantage mouth rinse (alcohol-containing mouth rinse)	Aqua, glycerin, alcohol, aroma, methylparaben, poloxamer 407, cetylpyridinium chloride, sodium fluoride, sodium saccharin, Propylparaben, CI 42051, and CI 47005	95587215	Procter & Gamble UK, Weybrige, KT13 0XP
Artificial saliva	NaCl (400mg/L), KCL (400mg/L), CaCl ₂ •2H ₂ O (795mg/L), NaH ₂ PO ₄ •H ₂ O (690mg/L) KSCN (300mg/L), Na ₂ S•9H ₂ O (5mg/L), and urea (1000mg/L)		

RESULTS

TABLE (2) Showing the means (SEs) of cuspal deflections of tested groups in microns. Of various composite resin under various mouth washes

Composite resin	Saliva	Alcohol-free containing mouth rinse	Alcohol-containing mouth rinse
Silorane	6	6.5	7.5
Bulk fill	8	9	10
Filtek™	10.5	11	11.5

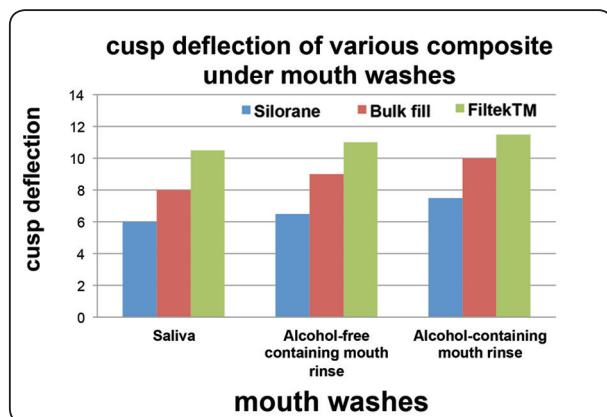


Fig. (1) Bar chart showing the means (SEs) of cuspal deflections of tested groups in microns of various composite resins under various mouth washes

All the composite resin specimens show cusp deflection. The Silorane specimen recorded the lowest value while the highest values were recorded for the filtek Z250 specimens. The alcohol-containing mouth wash specimen recorded the highest value while the lowest values were recorded for saliva followed by the alcohol free- containing mouth wash. There is no significant difference between the bulk file specimens and the Silorane specimen while there were there is significant difference between the Silorane specimen and the filtek Z250 specimens.

DISCUSSION

Dental composites constitute an important group of materials in modern restorative dentistry [19]. However, polymerization shrinkage and shrinkage-related stress are two major drawbacks of resin composites that still need to be addressed. Resin composite materials come into extensive contact with food components, oral fluids, and drinks in the oral environment [20]. Water diffused into the resin matrix may contribute to the relaxation of polymerization shrinkage stress to some extent [21] the expanding the polymer matrix followed by increasing the bulk volume of the resin composite will reduce marginal gaps, which generated by polymerization shrinkage, this action occurs by water sorption [22].

The polymerization shrinkage of the composite resins in all tested groups resulted in an inward deflection of the cusps, in agreement with other studies. [23-26]

The methacrylate group recorded the highest value this may be due to the solubility of resin composites which is related to the dissolution and leaching of various components, particularly unreacted monomers [27]. The organic matrix of conventional resin composites is generally based on methacrylate chemistry, especially cross-linking methacrylate, as in FZ250. The density of the links in methacrylate-based resin composites may vary as a result of the polymerization of free radicals, causing spatial heterogeneity that may facilitate the entrapment of residual monomers in microgels, from where they may be easily leached [28]. While the solubility of the silorane was lower than FZ250 This finding is consistent with a previous study showing silorane-based resin composites to be more hydrophobic than methacrylate-based resin composites [29,30].

The low-shrinkage silorane-based composite resin (Filtek LS) showed the lowest significant cuspal deflection. This may be attributed to the cationic ring opening polymerization reaction of Filtek LS which results in a lower polymerization contraction, During the ring opening step in the polymerization of silorane based composite, when the acidic cations attack the oxirane rings, the cleavage and opening of these rings gain space and counteract the loss of volume occurring when the covalent bonds are formed. [31,32] These findings may also be attributed to that siloranes have slow polymerization rate allowing time for the material to flow and for stress relaxation, resulting in a lower final degree of cuspal strain. [33] the photoactivated cationic polymerization process of silorane resins is relatively insensitive to oxygen. Not only does this reduce polymerization shrinkage, it also increases the degree of conversion [34, 35, 36].

Bulk-fill nonflowable composite, showed the least polymerization shrinkage stress. Several factors might have affected the results. First, this material contained a shrinkage stress reliever, which is a special filler functionalized with silane.^[37] The manufacturer stated that the shrinkage stress reliever features a lower modulus of elasticity so that it acts like a microscopic spring, attenuating the forces generated during shrinkage.^[33] Second, the material included prepolymerized fillers. Resin composites typically show a relatively low elastic modulus with the use of prepolymerized filler particles.^[38] The mouth rinse containing alcohol recorded high result than the alcohol-free mouth rinse due to Ethanol, which is found in many mouth rinses, may accelerate the hydrolytic degradation of resin-based materials^[39]. The mouth rinse containing alcohol produced the subsurface and surface degradation of resin composites by storing them in ethanol.^[40] These findings suggest that it may be preferable for patients with extensive restorations to avoid the use of mouth rinse containing alcohol as part of their daily oral hygiene routine so as to prevent the need for recurrent restorative treatment.

CONCLUSION

Within the limitations of this in vitro study, the following

Conclusions can be drawn:

- (1) The solubility of FS was lower than that of FZ250 in all the solutions tested;
- (2) Solubility of both of the restorative materials tested was lower in alcohol-free mouth rinse than in alcohol mouth rinse containing;
- (3) Alcohol-free mouth rinse may prefer to alcohol containing mouth rinse in patients with extensive restorations

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