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Water Sorption Property of Two Different Commercially Available Composite Restorative Material- An In Vitro Study

1Padmalochini S, 2Vaishnavi K, 3S. Jayalakshmi, 4Dr. Balaji Ganesh. S

1Undergraduate student, Saveetha Dental College and Hospital., Saveetha Institute of Medical & Technical Sciences (SIMATS), Saveetha University , Chennai -77, Tamil Nadu, India.

2Tutor, White lab - Materials Research Centre, Saveetha Dental College and Hospital., Saveetha Institute of Medical & Technical Sciences (SIMATS), Saveetha University , Chennai -77, Tamil Nadu, India.

3Chief Scientist, White lab - Materials Research centre, Saveetha Dental College and hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai -77, Tamil Nadu, India.

4Senior lecturer., White lab - Materials Research Centre, Saveetha Dental College and Hospital, Saveetha Institute of Medical & Technical Sciences (SIMATS), Saveetha University, Chennai -77. Tamil Nadu. India.

CORRESPONDING AUTHOR

Padmalochini S, Saveetha Dental College and Hospital., Saveetha Institute of Medical & Technical Sciences (SIMATS), Saveetha University , Chennai -77, Tamil Nadu, India.

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KEYWORDS

Water sorption, composite, thermocycling, polymerisation shrinkage, micro leakage.

ABSTRACT:

Introduction: Water absorption is defined as the quantity of water absorbed through the surface of the material. Polymerisation reaction is defined as the process of conversion of all the monomer molecules to polymer chains. Since the composite material is in the oral environment it undergoes a sequence of physical conversions during polymerisation which results in the water absorption.

Aim: The aim of the study is evaluation of the water sorption property of the two different commercially available composite resin restorative materials.

Materials and methods: Two different composites were selected for the study and were grouped. Group A includes the Tetric n Ceram bulk fill and Group B includes the te Econom Plus. The specimen was subjected to thermocycling in a chewing simulator of thousand cycles. After thermocycling the specimen was weighed again to check the water sorption property of the composite materials used.

Results: While analysing the water sorption property and comparing with different materials it was found that Group A (Tetric N ceram bulk fill) composite has comparatively higher water sorption property than the Group B (Te Econom Plus) composite. The statistical analysis of the data was found to be insignificant ($P \leq 0.05$).

Conclusion:

Tetric n ceram bulk fill material resulted in increased water sorption with less solubility in comparison to Te econom plus. Moreover, no statistical difference was encountered after thermocycling between the bulk fill composite material and conventional composite with regards to the water sorption property and solubility.

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1.Introduction:

Dental composites are dental cements made up of resins. In 1956, Dr. R. L. Bowen was the first person to develop a polymer based on dimethacrylate. Resins came up as a restorative material because they were insoluble, insensitive to dehydration and easy to manipulate. The resin is composed of Bis- GMA, TEGMA, UDMA, HDDMA and the silica as a filler material. Dimethylglyoxime is added to achieve the flowability. Composites have lesser longevity compared to amalgam restoration. But the appearance of composite resin is far superior than the amalgam restoration [1]. Resin filler material is composed of glass materials and ceramic particles. Glass filler material contains silica, silica dioxide, lithium and aluminium glass and borosilicate glass material. Ceramic filler material contains Zirconia and silica or Zirconium oxide particles. The fillers available are macro filler, micro filler, hybrid filler, nano filler and bulk filler [2].

Composites are extensively used in core buildups, as sealants and as a preventive resin restoration materials, esthetic enhancer materials, cements, veneering metal crowns- bridges, temporary restorative materials, periodontal splinting, for non carious lesions, for enamel hypoplasia conditions, for composite inlays, for repairing old composite restorations and indicated in patients who are allergic to metal restoration like amalgam. The advantages of the composite restoration includes, it is more esthetic because it appears more like a tooth, conservation, it is less complex, used almost universally, for strengthening, has high corrosion resistance, no health compliance and it is cheap to porcelain. The disadvantages of the composite resin includes, Polymerization shrinkage encountered, it is technique sensitive procedure, it has increased coefficient of thermal expansion, more time consuming procedure, high occlusal wear rate, decreased elasticity modulus, it lack anticariogenic property and results in staining [3]. The recent advancements in composites include flowable composite which is introduced to improve the handling characteristics of existing composites, packable composites, antibacterial composites, nanocomposites, ormocers- organically modified ceramics, compomer, Giomers- Hybrid of GIC and composite, ceromers- ceramic optimized resins [4].

Composites generally have some physical properties which includes biocompatibility, strength, wear resistance, polymerization shrinkage, Thermal conductivity, water sorption and Radiopacity [5]. In the current study the water sorption property of two different composites materials were explored. Water absorption is defined as the quantity of water absorbed through the surface of the material. Polymerization reaction is defined as the process of conversion of all the monomer molecules to polymer chains. Since the composite material is in the oral environment it undergoes a sequence of physical conversions during polymerisation which results in the water absorption causing two opposing phenomena: 1. Due to the water diffusion, it releases the leftover reactionless monomers and ions from the matrix of resin, which results in the loss of weight ending in solubility. 2. Hygroscopic expansion is seen due to absorption of water which will compensate for the polymerization shrinkage effect and helps in relieving stresses and there will be marginal gaps reduction to a certain amount [7]. Water sorption sorption usually affects the composite material by the reduction in their mechanical properties and wear resistance. The polymer matrix adsorbs the water and later affects the filler matrix resulting in debonding and hydrolytic dependent degradation of the filler materials. But, the water sorption property of the composite resin is completely a diffusion- controlled procedure, therefore water reuptake usually occurs largely in the matrix of the resin [8]. Our team has extensive knowledge and research experience that has translated into high quality publications[9–18].

The aim of the present study is to do evaluation on the water sorption property of different commercially available composite materials.

2. Materials and methods:

2.1 Preparation of the specimen : Two conventional composite were studied in this investigation; Group A includes Tetric n Ceram bulk fill and Group B includes the te Econom Plus. Eight specimens in the shape of disc (diameter- 10mm, thickness- 2mm) were prepared using stainless steel mold at room temperature.The composite material was placed in the mold using a plastic instrument and it was covered by a microscopic slide and pressed gently. Now the material was polymerised using a light curing unit. Light activation was done for 45 seconds based on manufacturers instructions, and the

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sample was removed from the mold, excess cement from the edges were carefully removed by using a surgical blade and all the samples were polished using a composite polishing kit.

2.2 Weight Analysis: All the samples were weighed electronically using a digital weighing scale() and the pre weight was recorded.

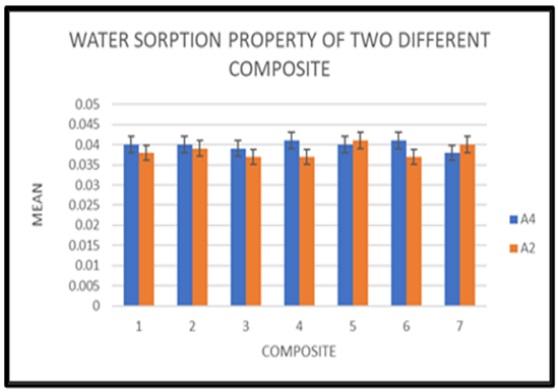
2.3 Thermocycling: Samples were subjected to thermocycling with distilled water in a chewing simulator (SD MECHATRONIK CHEWING SIMULATOR CS - 4.4) for thousand cycles between 5-55 degree Celsius with a 30 seconds for dwell time and 10 seconds of transfer time. After thermocycling the specimens were weighed again to check the water sorption property of the composite materials used.

(a) (b)

Figure 1: Representative images of sample preparations of (a) Group A (Tetric N ceram bulk fill) and (b) Group B (Te Econom plus)

3.Results:

The mean water sorption property of the two different composites is shown in Graph 1 and the results of the statistical analysis is given in Table 1. Results have shown that effects of thermocycling on water sorption was material dependent. While analysing the water sorption property and comparing with different materials it was found that Group A (Tetric N ceram bulk fill) composite has comparatively higher water sorption property than the Group B (Te Econom Plus) composite. Therefore the data has no statistical significance ($P \leq 0.05$).



The above Graph 1 depicts the water sorption property of two different composites. The X axis represents the Te econom plus and tetric N ceram bulk fill composite and the Y axis represents the mean water sorption values of two different composites

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Table 1: Independent sample t test of two different composites.

GROUPS	MEAN	STANDARD DEVIATION	SIGNIFICANCE
TETRIC N CERAM BULK FILL	0.039	0.0009	0.16
TE ECONOM PLUS	0.038	0.0016	0.16

4.Discussion:

Water sorption is absorption of the water from any surface. Similarly, composites also absorb water and that is why it is considered to have good water sorption properties. But it has many disadvantages as it affects the other properties also. Water causes embrittlement of the material as detected from the flexural properties. It affects the dimensional stability and bonding strength with the tooth structure. As a sequence it causes polymerization shrinkage which leads to flexion and crack formation of the natural tooth [19] [20] [21].

Thermocycling refers to stimulation of the thermal stress to which the restorative materials and the teeth would be exposed by consuming drink and food for a short span of time. Thermocycling is done for creating the thermal strains at the interface of the bonding of the composite material by the temperature difference which dissolutes the bond between the matrix of the resin and filler material. Thermocycling is performed in vitro to check for the physical and mechanical properties of all the available dental materials [22] [23].

In the present study it was found that Group A (Tetric N ceram bulk fill) composite has comparatively higher water sorption property than the Group B (Te Econom Plus) composite. Waleed et al in their study evaluated water sorption properties of five different composites materials. They have concluded that the water sorption of the materials increased steadily. They have also reported that the composite material with the highest filler quantity will have the low water sorption capacity after a duration of 8 months of storage of the water [19]. Similarly, Yap et al in their study evaluated the cycles of temperature differences on water sorption and solubility of the composite resin and concluded that thermocycling effects on water sorption was dependent on the material used and the composite materials used in their study did not have any thermocycling effect on the property of solubility [24]. (Reddy et al, 2006). Ghavami et al in their study wanted to do an evaluation to check the effect of thermocycling and mechanical properties of a microhybrid dental composites. From the results of their study they concluded that after thermocycling the microhybrid resin composite exhibited reduction in the surface microhardness and flexural strength and increment in the degree of conversion [25].

Although in the present study Group A composite has comparatively higher water sorption property than the Group B composite, the statistical analysis of the data was found to be insignificant. Swastika et al did evaluation to check the effect of thermocycling changes on the stability of the color of the aesthetic restorative resin. So they performed a two way Anova test for the statistical analysis and the study was found to be significant and among the resin materials used Cention N exhibited increased color stability [26]. Efeito et al in their study checked for any relation between the thermocycling effect on micro leakage of resin composite restorations. It was concluded that the study was found to be insignificant, so it was concluded that if there is an increase in cycles of difference in temperature there will not be any micro leakage. [27]. Based on the results of the current study, the bulk-fill resin composites could be an alternative treatment protocol for treating anterior and posterior teeth. However, clinical trials of increased time duration are suggested. Bulk fill composite material can be a good treatment option for esthetically compromised patients.

5. Conclusion:

Tetric n ceram bulk fill material resulted in increased water sorption with less solubility in comparison to Te econom plus. Moreover, no statistical difference was encountered after thermocycling between the bulk fill composite material and conventional composite with regards to the water sorption property and solubility.

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8. CONFLICT OF INTEREST

The author declares that there was no conflict of interest in the present study.

9. AUTHORS CONTRIBUTION:

Padmalochini S: Literature search, data collection, analysis, manuscript drafting.

Vaishnavi K: Data verification, manuscript drafting.

S Jayalakshmi: Data verification, manuscript drafting.

Balaji Ganesh S: Data verification, manuscript drafting.

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