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Original Article

Effect of Some Pediatric Drugs on Microhardness of Polychromatic And Monochromatic Nano-Composite Resin: IN-Vitro Study

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Abstract

Aim: This work seeks to determine how certain pediatric drugs affect the microhardness of two types of resin composite materials.

Subjects and methods: Specimens made of Filtek Z350 XT and Omnichroma dental composites were prepared. The specimens from both groups of the two composite resin materials were then randomly divided into four subgroups based on the liquid drug medium they were immersed in. The used drugs were (Antibiotic: Augmentin, Analgesic: Brufen, Antitussive and Expectorant: Oplex-N, Multivitamin: Sansovit plus). Through the use of a Vickers hardness scale, the impact of drugs on restorative materials was assessed.

Results: Filtek Z350 XT showed higher micro-hardness values. When comparing the changes (before vs. after) between the two materials for any medicine, no statistically significant differences were discovered. In Omnichroma, there were significant differences observed between drugs, Oplex-N caused the largest decrease while Sansovit plus had the least impact on micro-hardness. In Filtek Z350 XT there were no significant differences observed between drugs.

Conclusion: Filtek Z350 XT had better microhardness values compared to Omnichroma composite resin. The microhardness values of the composite resin are dependent on the patient's medication regimen and the composition of the material.

Keywords: Surface hardness , Medications, Omnichroma, Filtek Z350.

I. INTRODUCTION

A major worldwide health concern and ongoing burden are millions of carious untreated primary teeth. Different approaches, ranging from minimally invasive dentistry to restorative procedures, can be used to treat primary teeth that are carious. Maintaining the hard dental tissue and extending the dental restoration cycle are the goals of conservative caries treatment approaches, which also help the tooth stay in the oral cavity for a longer period. But in order to lessen the caries activity of the lesion, it is advised to restore carious lesions that present with cavitated surfaces that cannot be sufficiently cleansed or sealed **(Amend *et al.*, 2022)**.

Tooth type, age of the kid, cavity size, isolation technique, and experience of the ator are some of the variables that can ct how long dental restorations last. The l's age-related cooperation, the caries risk, the short lifespan of primary teeth due to iological exfoliation must all be considered while determining the course of treatment **(Chisini *et al.*, 2018).**

Beginning at the turn of the 20th century, numerous developments and enhancements in the caliber of various materials and procedures utilized in restorative dentistry were made. Dental restorative materials come in a variety of features depending on what their intended purpose is. The development has led to the discovery of new restorative materials, whose qualities and attributes have significantly improved **(Singh *et al.*, 2017)**.

A revolutionary substitute for traditional polymer composites has been made possible by the use of nanoscale fillers to enhance the mechanical and physical characteristics of polymers. In order to overcome some of the limits of polymers and hence expand their applications, fillers of various sizes are frequently utilized for reinforcing polymers. Through innovative combinations of nanoscale fillers and polymer materials, polymer nanocomposites with intriguing properties can be produced as a result of special opportunities provided by nanoscience and nanotechnology **(Young *et al.*, 2012).**

The launch of Omnichroma (Tokuyama Dental America) occurred in 2019. It was the first composite resin that could be applied to any patient and match any shade of the tooth. Because of a special feature of Omnichroma, clinicians don't have to worry about multiple shades . This is a quick and simple method that creates restorations with great esthetic and functional properties. Omnichroma's key features include superior polishability, great handling, and resistance to ambient light effects. It also has high wear and abrasion resistance **(Eliezer *et al*., 2020).**

By utilizing nanotechnology, mechanical properties can be controlled to create composites that resemble natural teeth. Furthermore, this method has simplified the process of creating nano-sized filler particles, which can be used in composite resins either alone or in the form of nanoclusters **(Ghods *et al.*, 2022).**

To enable a restoration to last longer, one of the most desired qualities of any restorative material is its resistance to pressure and chemical challenges found in the oral environment. Dental restorative materials are more vulnerable to erosive attacks that compromise their physiochemical properties due to the altered pH of the oral cavity caused by various food, beverage, and medicine intakes. Abrasion resistance and compressive strength are two crucial characteristics that are closely linked to the microhardness of resin composite surfaces; a decrease in this microhardness could be a sign of the materials' poor wear resistance **(Barve *et al.*, 2020).**

Considered to be one of the key elements influencing any restorative material's longevity is surface microhardness. As a result of the material's low surface hardness, the restoration will fail because it is more prone to scratches. Uneven surface structure can lead to material stains and discolorations, plaque deposition, and subsequent caries, all of which can worsen the restoration's quality. Moreover, the surfaces of dental restorations may become discolored or altered since the oral cavity is exposed to different solutions every day **(Roopa *et al.*, 2016; Valera *et al.*, 2022).**

Taking liquid medication on a regular basis may be the daily routine for kids with systemic disorders. To maintain or improve health, these drugs' active constituents are essential. But a few of its inert components endanger the tooth or the materials used for restorations. All these drugs have a low endogenous pH and a high titratable acidity, which can have negative effects on dental

restorations, erosion, and the hardness of the tooth surfaces **(Kathiria *et al.*, 2021).**

The purpose of this work is to evaluate how several pediatric drugs affect the microhardness of two different kinds of resin composite materials (Filtek Z350 XT and Omnichroma).

II. SUBJECTS AND METHODS

Study Design and Settings

This work was an in-vitro study, performed in the Pediatric Dentistry and Dental Public Health Department Faculty of Dentistry, Cairo University, Egypt. Micro hardness measurement was conducted by (Wilson hardness tester model TUKON 1102 Germany) at the Oral and Dental Research Institute lab, Cairo, Egypt. The Research Ethics Committees (REC) of the Faculty of Dentistry, Cairo University, Egypt approved the study protocol.

Sample Size calculation

According to the results of **(Valera et al., 2022),** the true mean difference was 1.51 when the responses within each subject group had a normal distribution with a standard deviation of 0.52 , the minimum calculated allowable sample size was 24. The power was set at 80% and a type I error probability of 0.05, and sample size was calculated using G* Power 3.1.9.7.

Sample Grouping

Twenty-four specimens were prepared using dental composites made of Nano-filled Filtek Z350 XT[1] (Filler type : zirconia and silica particles, Matrix type : Bis-GMA, UDMA,TEGDMA,PEGDMA and Bis-EMA monomers) and Supra nano-filled Omnichroma [2] (Filler type: zirconia and silica particles, Matrix type: UDMA and TEGDMA monomers). Twelve specimens were made from each composite material. Based on the drug liquid medium, the specimens from each group of the two distinct composite resin materials were divided randomly into four subgroups (n = 3). The drugs used were (Antibiotic: Augmentin, Analgesic: Brufen, Antitussive and Expectorant: Oplex-N, Multivitamin: Sansovit plus). Each sample was placed in a different, sealed container with a separate label.

Samples preparation

The specimens were formed in cylinder-shaped plastic molds placed on a glass slab with a celluloid strip, which were then coated with another celluloid strip and pressed by another glass slab above the mold to eliminate any gaps after being filled with the tested resin composite. The study included none of the discs that had any cavities or irregularities. Using a light-curing unit [3], every specimen had its top and bottom surfaces light-cured for 20 seconds on each side. Subsequently, the molds were dismantled and samples extracted from them. For a full day, samples were rehydrated and allowed to complete polymerization in distilled water at 37°C. Samples were taken at random from each material during the course of the seven-day test period, and they were submerged three times a day for two minutes at 37°C in each of the four drug liquids (10ml undiluted pediatric liquid). Every day, fresh solutions were added. Between immersion periods, the specimens were kept in artificial saliva **(Gupta *et al.*, 2018)**.

Microhardness Assessment

A computerized Vickers hardness tester was used to measure the surface microhardness[4]. Before immersion in pediatric drugs, the baseline readings were taken for all the specimens. Three consecutive readings were taken and their arithmetic mean was taken as a baseline. After completion of the immersion period (7 days), the average micro-hardness of three readings of each specimen was evaluated in a way similar to that done for baseline microhardness evaluation **(Barve *et al.*, 2020)**. In the Vickers test, the indenter is forced into the test specimen by

[1] 3M ESPE, St. Paul, Minnesota, USA.

[2] Tokuyama Dental Co., Tokyo, Japan.

[3] Guilin Woodpecker Medical Instrument Co., Ltd, China.

[4] Wilson hardness tester, model TUKON 1102, BUEHLER Company − Germany.

applying a smooth, impact-free 50g stress. For twenty seconds, the indenter is maintained in position. The formula for calculating Vickers hardness (HV) is HV = 1854.4L/d2, where L is the load in gf and d is the average diagonal in μm.

Statistical analysis

The statistical analysis was conducted using SPSS 16 ® (Statistical Package for Scientific Studies), Windows Excel, and Graph Pad Prism. The Shapiro-Wilk and Kolmogorov-Smirnov tests were used to explore the provided data for normality, and the results indicated that the data came from a normal distribution. As a result, Tukey's Post Hoc test was used for multiple comparisons after the One Way ANOVA test was used to compare various medications. comparing the intervention and control groups using an independent t-test. A significant threshold of $p \leq 0.05$ was established.

III. RESULTS

1. Comparison between intervention and control groups:

Table (1) compares the micro-hardness between Omnichroma and Filtek Z350 XT groups for different drugs. Filtek Z350 XT consistently showed higher micro-hardness values compared to Omnichroma. For each drug, no statistically significant differences were seen in the alterations (before vs. after) between the two materials ($p > 0.05$).

Table (1): Comparison between Omnichroma and Filtek Z350 XT regarding micro-hardness before, after, and the difference between them regarding all drugs.

Vickers		Omnichroma		Filtek Z350 XT		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		P value
		Mean	Standard Deviation	Mean	Standard Deviation			Lower	Upper	
Augmentin	Before	36.83	.97	62.25	4.35	-25.42	2.23	-30.87	-19.97	0.0001*
	After	33.38	1.63	56.76	1.68	-23.38	1.17	-26.25	-20.52	0.000*
	diff	-3.46	1.44	-5.49	3.37	2.04	1.83	-2.45	6.53	0.31
Brufen	Before	34.75	2.22	57.06	2.99	-22.31	1.86	-26.86	-17.75	0.0001*
	After	31.68	1.64	56.17	3.86	-24.49	2.10	-29.62	-19.37	0.0001*
	diff	-3.08	.59	-.89	2.51	-2.19	1.29	-5.34	0.97	0.14
Sansovit plus	Before	38.12	3.44	59.16	2.36	-21.04	2.08	-26.13	-15.94	0.0001*
	After	37.28	2.31	56.63	2.77	-19.36	1.80	-23.77	-14.94	0.0001*
	diff	-.85	1.40	-2.53	4.07	1.68	2.15	-3.59	6.95	0.47
Oplex-N	Before	37.38	.96	59.83	4.30	-22.46	2.20	-27.85	-17.06	0.0001*
	After	33.54	.34	56.33	3.41	-22.80	1.71	-26.99	-18.60	0.0001*
	diff	-3.84	.86	-3.50	5.14	-0.34	2.61	-6.72	6.04	0.90

*Significant difference as P<0.05.

2. Comparison between drugs:

Table (2) contrasts the impact of several medications on the microhardness of the two dental materials: In Omnichroma group: Significant differences were observed between drugs, Oplex-N caused the largest decrease in micro-hardness significantly different from Sansovit plus which had the least impact on micro-hardness. In Filtek Z350 XT: No significant differences were detected between drugs.

Table (2): Comparison between different drugs regarding their effect on micro-hardness.

	Augmentin		**Brufen**		**Sansovit plus**		**Oplex-N**		
Microhardness changes	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	**P value**
Omnichroma	-3.45 **ab**	1.44	-3.08 **ab**	0.59	-0.85 **b**	1.40	-3.84 **a**	0.86	0.01*
Filtek Z350 XT	-5.49 **a**	3.37	-0.89 **a**	2.51	-2.53 **a**	4.07	-3.50 **a**	5.14	0.43

*Significant difference as P<00.05.
Means with dissimilar superscript letters were significantly different a P<0.05.
Means with the similar superscript letters were not significantly different a P>0.05.

IV. DISCUSSION

Durability is a key factor in evaluating the long-term effectiveness of aesthetic dental restorations. The resistance of dental composite restorations to degradation stemming from exposure to food particles, plaque acids, and enzymes that may soften the composite material is a major factor in their lifetime. The aim of this investigation was assessing the impact of regularly used medications on the surface microhardness of two different kinds of composite resins, one of them was polychromatic and the other was monochromatic **(Barve et al., 2020).**

According to **(Safy and Aboalazm, 2021),** a microhardness test with Vickers's microhardness testing machine was utilized in the study to examine the clinical performance of composite restorative materials as it is easy to apply and offer consistent data. Many factors influence surface hardness, such as filler content, distribution, level, surface procedures (silanization) applied to the filler, filler matrix interaction, and organic matrix structure. Better-polymerized surfaces resist abrasion and erosion because they have harder surface characteristics **(Han et al., 2008; Hamouda, 2011).**

In the existing work, there were significant alterations in microhardness among Omnichroma and Filtek Z350 XT for all drugs, both before and after treatment. Filtek Z350 XT consistently had higher microhardness values. This coincides with the results obtained by **(Da Silva et al., 2016; Chen et al., 2019; and Bahbishi et al., 2020)** who

demonstrated that Filtek Z350 was higher in microhardness values in comparison to other composite resins**.** The mechanical properties of resins can be influenced by their shape and filler components. Nanoparticles of both zirconia and silica are included in the composite resin Z350 XT. Like a single filler, these particles aggregate into nanoclusters. Additionally, because the terminal OH-groups, which are prone to absorption and solubility, have been removed, the organic matrix Bis-EMA monomer, which has a high molecular weight, has an increased resistance to degradation. In addition, compared to TEGDMA and UDMA, Bis-GMA monomer forms the most rigid network with a moderate rate of water absorption.

In the present study, there was an overall decrease in microhardness in both types of composite after immersion in pediatric drugs. On the other hand, , there were no statistically significant variations discovered in the changes between the two different materials for any drug. This is confirmed by the results reported by **(Tanthanuch et al., 2014; Hamadamin and Saeed, 2021; Vejendla et al., 2023),** who looked into the possibility that immersion in various beverages and energy drinks may cause nanocomposite materials' surface micro-hardness to decrease. It was clarified that the components and acids in these solutions negatively impact the hardness of resin-based restorative materials and tooth surfaces.

Furthermore, **(Barve et al., 2020)** provided an explanation for the decline in microhardness by pointing out that there are two primary mechanisms for polymer degradation: passive hydrolysis and active enzymatic activities. The most significant mechanism is the passive hydrolysis of polymers. The hydrolytic breakdown of the nanocomposite and subsequent decrease in surface hardness upon immersion in different solutions may be attributed to increased water absorption by the nanocomposite. This was consistent with research by **(Almeida et al., 2010)**, which found that nano-filled composites had significantly higher absorption values than hybrid materials. They explained this by stating that the nano-filled composites contained nanoclusters.

In this investigation, significant differences were found between the medications in Omnichroma composite resin. Sansovit plus had the least impact on micro-hardness, whereas Oplex-N caused the largest decrease. Conversely, no statistically significant variations were noted among the medications in the Filtek Z350 composite group. This means that the effect of each drug on the restorative material depends on its components, acidity, PH, and duration of use which influence the substance's erosive potential. This is consistent with another study by **(Gurdogan Guler et al., 2021)** that discovered specific pediatric multivitamin syrups to be significantly responsible for a decrease in the microhardness of dental restorative materials.

Furthermore, a different study that supports these findings was published by **(Valera et al., 2022)**. The investigation came to the conclusion that a variety of pediatric medications, including bronchodilators, anxiolytics, multivitamins, and antiepileptics, lower the microhardness of various restorative dental materials. The findings of this investigation showed that the presence of acid, the medication's PH, its adhesion to tooth enamel, its buffering ability, its mineral content, and the patient's salivary flow rate can all contribute to the decrease in surface hardness when restorations come into contact with medications. Additionally, these findings support those concluded by **(Dhawan et al., 2017; Zhao et al., 2017),** according to whom liquid absorption reduces the material's surface hardness and degrades its surface regardless of the kind of medication utilized.

VI. LIMITATIONS:

Although artificial saliva was used to simulate oral conditions, factors such as drug composition , structural characteristics, irregular drug intake and variations in each

patient's salivary and fluid content may all affect the physical properties of dental restorative materials. So, the limitation of this in vitro study is that it did not mimic the real oral environment.

VII. CONCLUSION:

Filtek Z350 XT has better microhardness values compared to Omnichroma composite resin. Surface microhardness of composite resin is affected by the composition of the material and the type of drugs given to the patient. The selection of appropriate restorative materials is essential, as they must possess inherent characteristics such as high microhardness values.

Conflict of Interest:

No conflict of interest.

Funding:

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Ethics:

This study protocol was approved by the ethical committee of the faculty of dentistry-Cairo university on: 27/9/2022, approval number16-9-22.

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